Signs of Harappan Culture:
Contextual Narratives of Excavated Artefacts

विद्या वाचस्पति की

उपाधि की अपेक्षाओं की आंशिक पूर्ति में प्रस्तुत शोध प्रबंध

A thesis submitted in partial fulfillment of the requirements of the degree of Doctor of Philosophy

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Dedication

To my dad...

To his passion for data, maps, and systems...

I wish he were on my side while I complete this journey.

To my grandparents...

To their exuberant identities...

I miss their pat on my back today.

Declaration

I declare that this written submission represents my ideas in my own words and where others' ideas have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.



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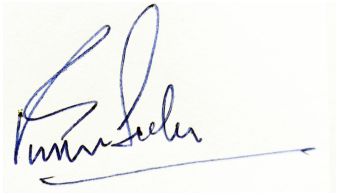
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Certificate

Certified that the work incorporated in the thesis entitled “Signs of Harappan Culture: Contextual Narratives of Excavated Artefacts”, Submitted by Pallavee Gokhale was carried out by the candidate, under my supervision. The work presented here or any part of it has not been included in any other thesis submitted previously for the award of any degree or diploma from any other University or institution.



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As I write this, I feel lucky to be supported, mentored, and loved by so many!

Abstract

Harappan culture, also known as Indus Valley Civilization, is an archaeologically significant episode. The period from 2600 BCE to 1900 BCE is identified as the 'Mature' phase[1] or 'Integration' era.[2] Peculiar signs on the artefacts of this cultural phase, such as seals, sealings, and tablets, are assumed to bear the 'script' of the then existing language(s). The assumption of such a 'script' has been used to designate this period as 'proto-history'.[3] The 'script' is composed of a debatable number of signs, and has been given primacy over other attributes of the artefacts. The historiographic study of this scholarship reveals biases because of the prevalent socio-political conditions and archaeological theories over the past century. This bias has resulted in a linguistic hegemony in the archaeological discourse.[4] This existing scholarship has rendered a 'framework of hypotheses' which includes urbanisation, seal-sealing relationships, migrations, contained sign-lists, and 'script' decipherment possibilities. These issues are therefore privileged and assumed to be decisive in understanding the archaeological record. The consequence is a latency in the typological studies of these artefacts; which could instead be the basis for a material interpretation epistemology.

This research examines the form and material diversity of approximately five thousand of these artefacts (seals, sealings, and tablets), and the signs on them are treated merely as one of their many attributes. Their posited character as a script of a contemporary language has been kept at the background. The primary aim is to understand how multitude of properties of these artefacts can be documented, analysed, and in-

1. Gregory L. Possehl, "A short history of archaeological discovery at Harappa," in *Harappa Excavations 1986–1990: A Multi-Disciplinary Approach to Third Millennium Urbanism*, ed. R. H. Meadow, Monographs in World Archaeology 3 (Prehistory Press, 1996), 5–11.

2. Jonathan Mark Kenoyer, "Origin and Development of the Indus Script: Insights from Harappa and other sites," in *Studies on the Indus Script: Proceedings of the International Conference on the Indus Script. National Fund for Mohenjo-daro, Culture, Tourism, and Antiquities Department, Government of Sindh, Pakistan, Karachi*, ed. K. Lashari (2020), 217–236.

3. Gregory L. Possehl, "Revolution in the urban revolution: The emergence of Indus urbanization," *Annual Review of Anthropology* 19, no. 1 (1990): 261–282.

4. Pallavee Gokhale, "Linguistic Hegemony and Latent Typology: The Case of Harappan Script Scholarship," *South Asian Studies* 38, no. 2 (2022): 161–182, https://doi.org/10.1080/02666030.2022.2111092.

terpreted given their diverse archaeological contexts. It is critical to see if the signs and non-sign properties demonstrate any discernible relationship with each other in the multi-dimensional space of attributes. Data science techniques are used for this multi-attribute analyses part. For the investigation of the archaeological contexts, GIS is used. The 'now inaccessible' already excavated layers of the DK-G(S) mound at Mohenjo-daro are digitally reconstructed along with the artefact find-spots. Thus, the virtual geospatial context of the artefacts, along with their inherent attributes, can be analysed to understand the 'place' of these artefacts in Harappan life. Finally, this research situates new observations within the above mentioned 'framework of hypotheses'. It examines whether the framework can accommodate new observations or if there is any possibility of other nuanced interpretations.

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Abbreviations

Acronyms

- ACG - Analytical Carving Group - Defined by Adam Green as part of his doctoral work
- ASI - Archaeological Survey of India
- BCE - Before Common Era
- CISI - Corpus of Indus Seals and Inscriptions
- DK(C) - Excavated locality in Mohenjo-daro named after K. N. Dikshit
- DKGS - Southern part of DK(G) mound at Mohenjo-daro. Mound was named after it's first excavator Rao Bahadur K. N. Dikshit
- EBUDS - Extended Basic Unique Data Set - Modified version on M77 created by TIFR team
- FSW - Collective work of Steve Farmer, Richard Sproat and Michael Witzel - explained in the thesis
- GIS - Geographic Information System
- HARP - Harappa Archaeological Research Project - https://www.harappa.com/content/harp
- HRP - Used in some cases as a abbreviation for Harappa
- ICIT - Interactive Corpus of Indus Texts - Initially developed by Bryan Wells based on his doctoral work, later improved and continuously maintained by Andreas Fuls
- m - Metre
- M77/ IM77 - Iravatham Mahadevan's original concordance of Harappan signs and sign sequences from 1977
- MHA - Marked Harappan Artefact(s) - A collective term coined for the artefacts in the present dataset. It is explained in the thesis. It is used both as singular and plural with the context.

- MJD - Used in some cases as a abbreviation for Mohenjo-daro
- ML/ DS - Machine Learning/ Data Science - used alternatively
- mm - Mili-metre
- MSL - Mean Sea Level
- nonMHA - non Marked Harappan Artefacts - Artefacts other than MHA
- OTH - Used in some cases as a abbreviation for sites besides Mohenjo-daro and Harappa
- ROC-AUC - Area under the ROC Curve (ROC - Receiver Operator Characteristic) - a measure of performance of a statistical model
- SD - Excavated locality in Mohenjo-daro named after A. D. Siddiqui
- SEM - Scanning Electron Microscope
- TIFR - Tata Institute of Fundamental Research - Collective term used for scholars from this institute and their co-authors from other institutes or organisations
- USSR - United States of Soviet Russia

Terminologies

- Allograph - Alternative forms of a letter or sign of an alphabet
- Aryan Invasion Theory - Terms used based on the studies by Banerjee and Thapar, cited in the main text.
- ASIS - Term coined for sign sequence documentation - As seen or As it is present on the original artefact.
- Boss - Term used by Wells and some other scholars for knob of the seals
- Chanu-daro - Same as Chanujo-daro
- Chi-square - A statistical test used to identify relationship between qualitative attributes

- Confusion matrix - Table that defines performance of classification algorithm. It generally has actual and expected reading as rows and columns
- Dataiku - Software application used for data analysis and visualisation
- Datum point - A point serving as a reference for the survey measurement of horizontal and vertical dimensions
- Diagonal-heavy matrix - Higher quantities for cells on the diagonal of the matrix - Generally used in the context of confusion matrix.
- Findsite - Location from where the artefact was found during excavation or exploration, generally referring to a site or broad area of find
- Findspot - Location from where the artefact was found during excavation or exploration. In DKGS context, the term is used at a more micro or local scale.
- Hatched-Neck, Hatched-Face, Collar - Decorations generally observed on unicorn motifs - Terms borrowed from Rissman's' study
- ICIT - Term used with reference to ICIT database - Used for sign sequence documentation in the context of the present day practice - Sign sequences on seals documented as they would have appeared in impressions and for all other artefacts, document as they appear on the original artefact.
- Impression - Marks created in a soft material due to pressing a hard surface. Used in the context of seals being used for creating the impressions. When these impressions on loose pieces of clay, these are called as sealings in most of the literature. Impression can also be made on a ceramic pot before it is baked.
- Inscribed artefacts - Artefacts bearing peculiar signs which are assumed to be a script of a language
- Law of Large Numbers - A law in probability theory - If same experiment is performed multiple number of times, the average of the results should be close to the expected value. Thus more the number of trials, closer the average result to the expected value.

- left-facing/ right-facing/ non-left-facing - Direction in which the animal motifs on MHA is facing. non-left-facing means all motifs except for left-facing - for example, animal head turned in opposite direction than the body or multiple heads in multiple directions or multiple animals in multiple directions, etc.
- Map_block-house_room - Findspot location of artefacts in DKGS case study. Map indicates a cultural period identified by Mackay and vaguely relates to the depth of the artefact; Block is a neighbourhood identified by Mackay - generally separated from nearing blocks by thicker wall and/or streets
- Metadata - Data about data
- Misc - One of the subtypes - a collection of statistically smaller number of multiple kinds of artefacts
- Monier Williams' dictionary - Sanskrit-English dictionary first published by Monier Williams in 1851
- Multi-sided/ Single-sided - MHA with signs on multiple sides or single side
- N-gram/ NG - Sequence of n words - https://web.stanford.edu/ jurafsky/slp3/3.pdf. It can also be a sequence of phonemes or syllables. Based on earlier work (n-gram paper by TIFR) I use the terms such as N-gram pair for bigram (2 item sequence) and N-gram triplet for trigram (3 item sequence).
- non-left-facing - Direction in which the animal motif in facing present on MHA - This term is collectively used for right-facing or for those with head turned backwards or for multi-headed animals with heads facing different directions etc.
- Object/ Artefact - Used intermittently indicating MHA; Also for loose or mobile objects including artefacts, ecofacts, skeletal remains etc. from archaeological context unless specified.
- Occam's razor - A Philosophical principle
- PEAKIT - Name of 3D data creation technology used by Konasukawa in his work
- Post-processual - Archaeological theory

- Pot - Subtype describing presence on signs on ceramic pots, dishes or any other kind of use wares - irrespective of the technique of sign production
- Processual - Archaeological theory
- Record - Mostly in chapter 4 and 5, wherever it has been used to describe MHA dataset, a record means a side of an artefact. Thus two-sided seal will have two records. Thus it is different than the actual count of artefacts in the dataset. Both have been described in the thesis.
- REV - Term coined for sign sequence documentation - Reverse sequence of what is present on the original artefact (All existing studies document the sign-sequences of seal in this manner)
- Script - Used for signs or sign sequences while referring to work or analysis of previous scholars (Mahadevan has referred to this as text in his literature.)
- Seal - Subtype describing presence on signs created using intaglio carving technique - Corresponds to existing use in the literature
- Sealing - Presence on signs on clay pieces - Corresponds to existing use in the literature
- Sign sequence - Multiple signs appearing on objects mentioned above. These are often identified as texts or inscriptions.
- Sign(s) and Sign-list - Symbols and (their collection) which have been identified as script - on Harappan artefacts popularly known as seals, sealings and tablets - Explained in the thesis.
- Signed/non-signed - MHA with presence or absence of signs
- Single Story - Concept narrated by Chimamanda Ngozi Adichie - https://youtu.be/D9Ihs241zeg
- Subtype - Term coined for 'Substitute Types' defined in the present study - Explained in the thesis
- tab - Common term used for tabB, tabC and tabI
- tabB - Moulded tablets where signs are produced in bas-relief technique

- tabC - Copper tablets
- tabI - Tablets where signs are produced by incisions
- tag - Subtype describing presence on signs on clay pieces besides ceramics or pots but different than moulded tablets - generally overlaps with sealings
- Terracotta - Collective term used to indicate artefacts manufactured from clay or ceramic. Different scholars have used different terminologies so using a single term here to accommodate those.
- Type-I error - Error caused due to detection of false-positive - Rejection of a null hypothesis that is actually true in the population
- u - Subtype where no specific type is defined
- Unicorn - A most common motif found on Harappan intaglio carved artefacts. It has been popularly termed as unicorn due to single horn seen in the motif. It has also been identified as single horned bull or animal of some bos variety by other scholars - Explained in the thesis.
- Unsigned - MHA with absence of signs

Chapter 1

Introduction

1.1 Background

Archaeological studies are initiated and are driven by tangible data and its quality. This data ranges from the past climate and geological records to charred grains and seeds retrieved from a potsherd. The materiality of this data is at the core of archaeological research. Analysis and interpretation of this data assists in understanding different aspects of past events. Collective study of many such datasets and events leads to an overarching knowledge about the societies in the past, their cultural systems, the environment, and their interrelations.

Harappan civilization, also known as Indus Valley Civilization, occupies an important place in the South Asian archaeological discourse. Guha gives a detailed account of various terms which are alternatively used for this material culture.[1] There are archaeological, historical, theoretical, nationalistic, and linguistic rationales which explain the use of different terms associated with the geography of the region. Indus civilisation (confined to present-day Indus river in Pakistan), Indus Valley civilisation (Indus and its larger basin area across the India-Pakistan border), Saraswati civilisation (Areas of present-day partially dry and supposedly lost Vedic river Saraswati - probably the Ghaggar-Hakra course), and Sindhu-Saraswati civilisation (combined area of Indus and Ghaggar-Hakra river basins) are the most widely used terminologies. I acknowledge the expanse of the shared material culture across the South Asian region by these terms. I choose to call this as the 'Harappan Culture' for following reasons. This deliberate choice adheres to the academic practice which identifies a culture by its first type site. It also brings parity in terminology when compared to contemporary chalcolithic or other cultures.[2] From an archaeological lens, 'culture' refers to 'tangible shared materi-

1. Sudeshna Guha, "Negotiating evidence: history, archaeology and the Indus civilisation," *Modern Asian Studies* 39, no. 2 (2005): 399–426.

2. Jonathan Mark Kenoyer, "Cultures and societies of the Indus tradition," *Historical Roots in the Making of 'the Aryan*, 2006, 21–49.

ality', both urban and rural, and not always to its wider possible intangible connotations in the social studies. Also, understanding of this 'sharedness' across the space does not resolve the contemporaneity problem of cultural phases at different sites. The term 'culture' is preferred over 'civilisation' because the term 'civilisation' indicates a definitive progressive or directional flow of society towards structured urbanisation. These are more abstract and intangible concepts. Their characteristics, pace, and contemporary perceptions could vary in different material cultures. Moreover, the user persona of the artefacts of the present study is still inconclusive.[3]

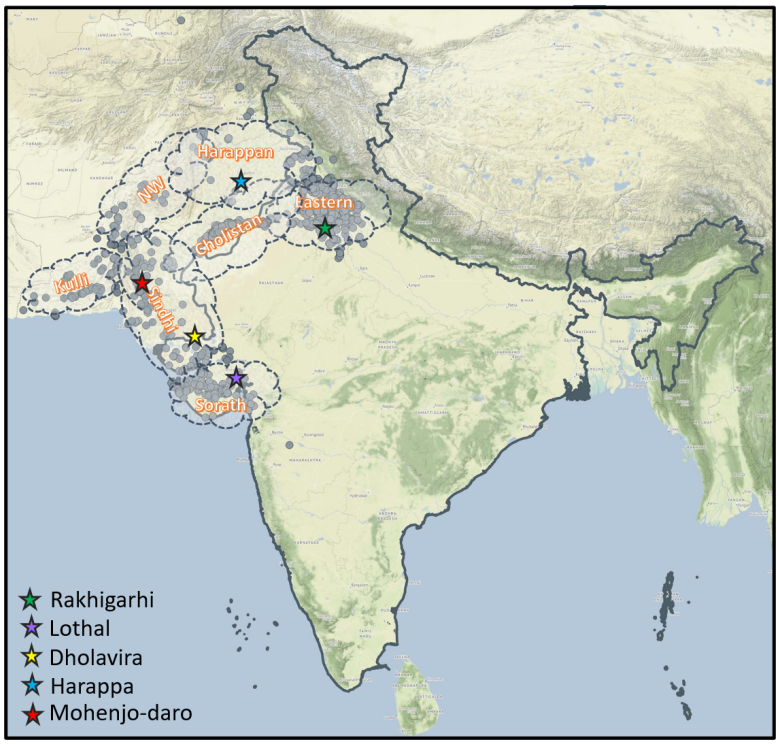


Figure 1.1: Distribution of Harappan culture sites and the cultural domains

Figure 1.1 Shows an overall expanse of the Harappan culture with respect to India and five major sites. The vast area can be seen divided in geographic zones which depict material cultural domains.[4] Sorath, though being contemporaneous to the classical Harappan culture has been identified as a distinct rural material culture that reflects

3. There is no objection to the evolved state of the society; civilisation is a specific phenomenon whereas culture can be a broader term encompassing the civilisation.

4. Modified after Gregory L. Possehl, *Indus Age: The Writing System*, vol. 3, Indus age (University of Pennsylvania Press, 1996)

regional aspects.[5]

During the middle of the third millennium BCE, this culture flourished in South Asia. Historical excavations in the early twentieth century at Mohenjo-daro and Harappa interpreted the stratigraphy based on the then current understanding of the cultural evolution, local events such as floods, and the borrowed concepts about civilisations from the west and central Asia. However, Mackay's[6] method to identify stratigraphy was criticised in the later interim reports.[7] He had not considered the undulation of the mounds and probably assumed uniform evolution of the culture from the earliest to latest periods. Table 1.1 shows how Mackay has interpreted the stratigraphy at Mohenjo-daro' DK-G(S) mound (hereafter DKGS) in order to translate it into cultural periods.[8] DKGS is Southern part of DK-G mound at Mohenjo-daro. This mound was named after it's first excavator Rao Bahadur K. N. Dikshit.

Based on numerous excavations during the last century and comparative analysis of materials across the sites, this culture is now roughly subdivided into three periods, namely the Early: 3200-2600 BCE, the Mature: 2600-2000 BCE, and the Late or post-urban: 2000-1200 BCE.[9] Based on the stratigraphy and material changes, there are various phases within these broad periods. The recent studies establish that this civilisation did not flourish in isolation and was very much in contact with the surrounding regions. Also, the contemporary regional material cultures contributed to the diversity seen across Harappan culture sites.[10] This phenomenon resists the idea of uniformity and demands the periodisation scheme to account for that. This has resulted in newer terminologies viz. Regionalisation era: 5500-2600 BCE, Integration era: 2600-1900 BCE,

5. Recent work at the site of Jaidak by Ajitprasad showcases the subtle differences that distinguish this material from the classical Harappan. P. Ajithprasad, "Jaidak (Pithad): a Sorath Harappan site in Jamnagar District, Gujarat and its architectural features," ed. Toshiki Osada and Akinori Endo Useugi, *Linguistics, Archaeology and the Human Past*, Occasional Paper 4, 2008, 83–99; Gregory L. Possehl, "The transformation of the Indus civilization," *Journal of World Prehistory* 11, no. 4 (1997): 425–472

6. Ernest J. Mackay, *Further Excavations in Mohenjo-daro*, vol. I (Manager of Publications, 1938).

7. Michael Jansen, "Water Supply and Sewage Disposal at Mohenjo-Daro," *World Archaeology* 21, no. 2 (1989): 177–192.

8. Mackay, *Further Excavations in Mohenjo-daro*, I:xiv–xv.

9. Possehl, *Indus Age: The Writing System*, 9.

10. Kenoyer, "Cultures and societies of the Indus tradition."

Strata/ period	Depth
Late Ia	0.86 ft. above to 3.2 ft. below datum level
Late Ib	Door-sills and pavements average 5 ft. below datum
Late II	average 7 ft. below datum
Great Flood	
Late III	average 9·9 ft. below datum
Uppermost stratum of the Intermediate Period	
ntermediate I	average 13 ft. below datum
Intermediate II	average 15.9 ft. below datum
Flood	
Intermediate III	average 20.4 ft. below datum
Last phase of the Early Period	
Early I	average 24 ft. below datum
Early II	Not known
Early III	Not known

Table 1.1: Cultural periods and stratigraphy of DKGS mound at Mohenjo-daro - as described by Mackay

and Localisation era 1900-1300 BCE. This is based on Shaffer's definition of cultural traditions, subdivided into eras and phases. It can be seen summarised and extensively used by Kenoyer[11] and also discussed by Manuel demonstrating the possible shortcomings.[12] The expanse of this culture is seen based on identification of regional variants, such as Sorath Harappan in Gujarat.[13] Recent radiocarbon studies on palaeobotanical remains at the site of 4MSR-Binjor, located in dry bed of palaeo-Ghaggar-Hakra channel in western Rajasthan, India, indicate early phase around 2880-2700 BCE, transitional phase 2620-2490 BCE, mature phase around 2340-2210 BCE, and cessation of occupa-

11. Jonathan Mark Kenoyer, "The Indus valley tradition of Pakistan and western India," *Journal of World Prehistory* 5, no. 4 (1991): 331–385.

12. Mark James Manuel, "Chronology and Culture-History in the Indus Valley," ed. P. Gunawardhan, G. Adikari, and R. A. E. Coningham, 2010, 145–152.

13. Possehl, "The transformation of the Indus civilization," 450.

tion around 1950-1690 BCE.[14] Table 1.2 shows the cultural periods or phases defined by Possehl.[15] Extended version of his chronology,[16] Kenoyer's revision based on his excavations at Harappa,[17] and its application to inscribed artefacts can be seen in the respective studies.[18]

Cultural period	**Absolute date**
Kili Ghul Mohammad	ca. 7000 - 5000 BCE
Burj Basket-marked	ca. 5000 - 4300 BCE
Togau	ca. 4300 - 3800 BCE
Kechi Beg/Hakra Wares	ca. 3800 - 3200 BCE
Early Harappan	ca. 3200 - 2600 BCE
Early/ Mature Harappan transition	ca. 2600 - 2500 BCE
Mature Harappan	ca. 2500 - 1900 BCE
Post-urban	ca 1900 - 1400 BCE

Table 1.2: Harappan culture's tentative broad chronology - as defined by Possehl

1.1.1 MHA - Marked Harappan Artefacts

The characteristic artefacts of Harappan culture are known as 'seals' and 'sealings'. These are at the centre of a significant portion of archaeological discourse in the Harappan archaeology. Majority of this scholarship revolves around three postulates: (i) The signs or sign sequences which appear on these objects indicate linguistic components and are part of a script, (ii) The 'seals' ought to be used as amulets[19] or as objects of

14. Shalini Sharma et al., "Dating adoption and intensification of food-crops: insights from 4MSR (Binjor), an Indus (Harappan) site in northwestern India," *Radiocarbon* 62, no. 5 (2020): 1356.

15. Possehl, "The transformation of the Indus civilization," 49.

16. Possehl, *Indus Age: The Writing System*, 9.

17. Kenoyer, "Origin and Development of the Indus Script: Insights from Harappa and other sites," 219.

18. Kenoyer, 221–223.

19. Mackay, *Further Excavations in Mohenjo-daro*, I:325.

economic activities like trade,[20] and (iii) The primary use of all seals is for creating the impressions which form 'sealings'.[21]

The decipherment of these signs has occupied majority of the discourse related to these artefacts. Important decipherment studies are reviewed in detail in chapter 2. The causes and consequences of this biased scholarship are also discussed. It must be noted that despite several sign encoding exercises and decipherment efforts over more than a century, there is no successful or consensual decipherment. However, due to this linguistic hegemony in academic scholarship, the materially diverse artefacts have been reduced to merely a sign-bearer role.[22] The consequence is latency in typological understanding of these artefacts.[23] Despite the identification of types such as seals, sealings, and tablets, the affordances and life-cycle of these artefacts are yet to be fully realised. No concurrence has been achieved in the definitions of these artefacts beyond a broad categorisation. In his detailed review of the Harappan script scholarship, Possehl acknowledges this hurdle and opts for the similar broad categorisation with subcategories.[24] It is observed that in the decipherment studies, the diverse artefact forms, content other than the signs, the vast geographical expanse, varied archaeological contexts within sites, and the cultural phases have not been acknowledged as contributing

20. Asko Parpola, "The Indus script: A challenging puzzle," *World Archaeology* 17, no. 3 (1986): 410; Jonathan Mark Kenoyer, "Indus seals: An overview of iconography and style," *Ancient Sindh Annual Reseach Journal* 9, no. 1 (2006): 14; Gregg M. Jamison, "Understanding Indus Seal-Carving Traditions: A Stylistic and Metric Approach," in *Seals and Sealing in the Ancient World: Case Studies from the Near East, Egypt, the Aegean, and South Asia*, ed. Marta Ameri et al. (Cambridge University Press, 2018), 168, https://doi.org/10.1017/9781108160186.013

21. Iravatham Mahadevan, *The Indus script: texts, concordance, and tables*, Memoirs of The Archaeological Survey of India 77 (Archaeological Survey of India, 1977), 7; Dennys Frenez and Marizio Tosi, "Lothal Sealings: Records from an Indus Civilization town at the eastern end of the maritime trade networks across the Arabian Sea," in *Studi in Onore di Enrica Fiandra. Contributi di archeologia egea e vicinorientale, Naples*, ed. M. Perna (2005), 87–211

22. Gokhale, "Linguistic Hegemony and Latent Typology: The Case of Harappan Script Scholarship," 14.

23. Gokhale, 19.

24. Possehl, *Indus Age: The Writing System*, 22–23.

factors.[25] The variety of these objects can be seen in the figure 1.2.[26] The entire artefact evidence with the sign sequence corpora has been treated like a single notional super-class of 'inscribed artefacts' in a monolithic container of space and time. With a presumed ascribed value of a script, the scholars use this corpora for sign frequency analysis in order to extract linguistic structures.



Figure 1.2: Variety of artefacts included in broad definition of MHA

This quasi super-class of 'seals', referred to as 'pseudo-seals' by Possehl,[27] has been simultaneously unique and ubiquitous to the Harappan culture. Discovery of these objects at sites within the Indian subcontinent have persuasively linked those to this material culture. When these artefacts are found in sites which are already identified with other known civilisations or cultures, it is interpreted as material evidence of communication with Harappans, highly likely via trade.[28] This explains the publication of multi-

25. The second chapter on literature review provides details regarding this overarching observation.

26. Common terminologies which have been used to identify these artefacts are: square steatite unicorn seal, rectangular or plano-convex seal with only signs, square steatite seal with different animal motifs, multi-sided seal, Bas-relief tablets in different shapes, multi-sided bas-relief tablets, incised tablets of different material, multi-sided incised tablets, copper tablets with only signs, multi-sided copper tablets, seal impressions on clay tags, seal impressions on ceramic, incisions on ceramics, copper implements with signs, seals with geometric motifs and no signs, undefined artefacts

27. Possehl, *Indus Age: The Writing System*, 23.

28. Steffen Terp Laursen, "The westward transmission of Indus Valley sealing technology: Origin and

volume project of 'Corpus of Indus Seals and Inscriptions', (CISI).[29] Here is a brief information about of all the five volumes:

- Joshi and Parpola, *Corpus of Indus seals and inscriptions - Collections in India*, vol. 1 - Published in 1987
- Shah and Parpola, *Corpus of Indus seals and inscriptions - Collections in Pakistan*, vol. 2 - Published in 1991
- Parpola, Pande, and Koskikallio, *Corpus of Indus Seals and Inscriptions - New material, untraced objects, and collections outside India and Pakistan, Part 1: Mohenjo-daro and Harappa*, vol. 3.1 - Published in 2010
- Parpola, Pande, and Koskikallio, *Corpus of Indus Seals and Inscriptions - New Material, Untraced Objects, and Collections Outside India and Pakistan. Part 2: ShahriSokhta; Mundigak; Mehrgarh, Nausharo, Sibri, Daudadamb; Chanhudaro; Ahar, Balathal, Gilund; Kalibangan; Rojdi*, vol. 3.2 - Published in 2019
- Parpola and Koskikallio, *Corpus of Indus Seals and Inscriptions - Indo-Iranian Borberlands*, vol. 3.3 - Published in 2022

These volumes contain corpus of these artefacts from more than 60 sites under a single title. The editors do establish or incorporate various categories and typologies of these objects; some are defined by themselves and some are used from existing publications. However, the overarching argument of the compilation is clearly articulated in the preface of the very first volume: "The purpose of the Corpus is to provide a basic tool for the research of the little understood script, language and religion of the Indus Civilization and for the study of the administrative organization and external cultural contacts of the Harappans."[30]

This is a teleological explanation for the existence of these artefacts where those are presumed to be the touchstones of script, language, and religion.

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development of the 'Gulf Type'seal and other administrative technologies in Early Dilmun, c. 2100–2000 BC," *Arabian Archaeology and Epigraphy* 21, no. 2 (2010): 96–134.

29. Currently 5 volumes are published. Fourth (Vol. 3.2) and fifth (Vol. 3.3) volumes were published in 2019 and 2022 respectively during the present doctoral work.

30. Joshi and Parpola, *Corpus of Indus seals and inscriptions - Collections in India*, 1:V.

Aligned to this primary hypothesis, other proposals about the role of these artefacts include:[31] (i) in administrative control systems,[32] (ii) as socio-economic identities,[33] (iii) as amulets,[34] (iv) as trade and accounting devices,[35] (v) in economic transactions,[36] or (vi) in religious practices.[37]

As mentioned earlier, the signs are believed to be the script of the then current language. Although the majority of the scholarly work is aimed at decipherment of these sign sequences, the unsigned objects are a part of the dataset in the CISI volumes.[38] These artefacts are devoid of signs but display similar iconographic motifs or possess geometric designs such as *swastikas* or concentric circles. The authors mention that they have tried to keep the "typological classification as simple and unambiguous"[39] as possible, but some issues persist. For example, they are forced to group some objects together as 'tablets'.[40] 'Typology' in this case is a result of overall appearance and not necessarily the purpose in the contemporary culture. It is thus evident that defining a dataset and justifying its scope is a critical task. Even after more than a century of research into these objects, the tentative nomenclature which was assigned by the early

31. The references cited here are only representative. The second chapter provides an in-depth review of multiple studies.

32. Frenez and Tosi, "Lothal Sealings: Records from an Indus Civilization town at the eastern end of the maritime trade networks across the Arabian Sea."

33. Dennys Frenez, "Private person or public persona? Use and significance of standard Indus seals as markers of formal socio-economic identities," in *Walking with the Unicorn: Social Organization and Material Culture in Ancient South Asia (Jonathan Mark Kenoyer Felicitation Volume)*, ed. Dennys Frenez et al. (2018), 166–193.

34. Mackay, *Further Excavations in Mohenjo-daro*, vol. I.

35. Kenoyer, "Origin and Development of the Indus Script: Insights from Harappa and other sites."

36. Rajesh P. N. Rao, "The Indus Script and Economics. A Role for Indus Seals and Tablets in Rationing and Administration of Labor," in *Walking with the Unicorn: Social Organization and Material Culture in Ancient South Asia (Jonathan Mark Kenoyer Felicitation Volume)*, ed. Dennys Frenez et al. (2018), 518–525.

37. Asko Parpola, "The Harappan unicorn in Eurasian and South Asian perspectives," ed. Toshiki Osada and Hitoshi Endo, *Linguistics, Archaeology and the Human Past*, Occasional Paper 12, 2011, 125–188.

38. This is the case even if the CISI title suggests 'Inscriptions'

39. Joshi and Parpola, *Corpus of Indus seals and inscriptions - Collections in India*, 1:XXVII.

40. Joshi and Parpola, 1:XXIX.

scholars still persists. It appears that for the lack of refinement in typology, the terms such as 'Seals and sealings' continue to be used. However, it has created a preconception for the interpretation. In fact, this has contributed to the critical hypotheses formation about (i) the direction of reading the script, and (ii) the usage of seals for creation of sealings. Though Possehl cautioned about possible different use of these objects than their Mesopotamian counterparts,[41] the wider academic scholarship, including the authors of CISI volumes, have presumed 'inscribed steatite stamp seals' as means to create the impressions (sealings). All the academic publications thus print the seal and its impression where impression is presumed to be the object of consumption. Meadow and Kenoyer[42] bring this up and question this practice of publishing. They argue that such normative academic exercise creates a subtext for interpretation. Therefore, I choose not to use these meaning-loaded terms as a generic terminology.

For the present study, which is concerned with the context of these heterogeneous objects, a new term needs to be coined. It must be generic to encapsulate the variety of techniques[43] and forms,[44] but also needs to be specific to capture the intangible characteristic of Harappan culture. It must be noted that throughout the existing scholarship, the term 'inscribed' has been used irrespective of the technique of sign production but for the presence of the signs.[45]

At an artefact level, the distinct combinations of form, material, technique, signs, and icons have created diverse affordances of these objects.[46] Figure 1.3 depicts a typical

41. Possehl, *Indus Age: The Writing System*, 26.

42. Richard H. Meadow and Jonathan Mark Kenoyer, "The 'tiny steatite seals' (incised steatite tablets) of Harappa: Some observations on their context and dating," *South Asian Archaeology 1997* 1 (2000): 221–340.

43. A recent study by Kenoyer is about analysis of painted Harappan signs Jonathan Mark Kenoyer, "Painted Indus Script on Ceramics and Steatite:: New Insights on Indus Script Calligraphy and Function," *Ancient Pakistan* 32 (2021): 1–15

44. Examples such as inscribed (or intaglio), incised, moulded, stamp impressed, with or without signs, with or without iconography, having different materials, in varied sizes, from different contexts, and other miscellaneous objects with Harappan signs.

45. Possehl, *Indus Age: The Writing System*, 23.

46. Varied terms are used to identify different components of these objects. I initially narrowed down on 'Inscribed or Intaglio' objects but then it left out the sealings, moulded tablets, and incised artefacts out. Also, 'inscribed' points to the 'script' and thus to that of a linguistic connotation. During a discus-

square steatite seals and its components.

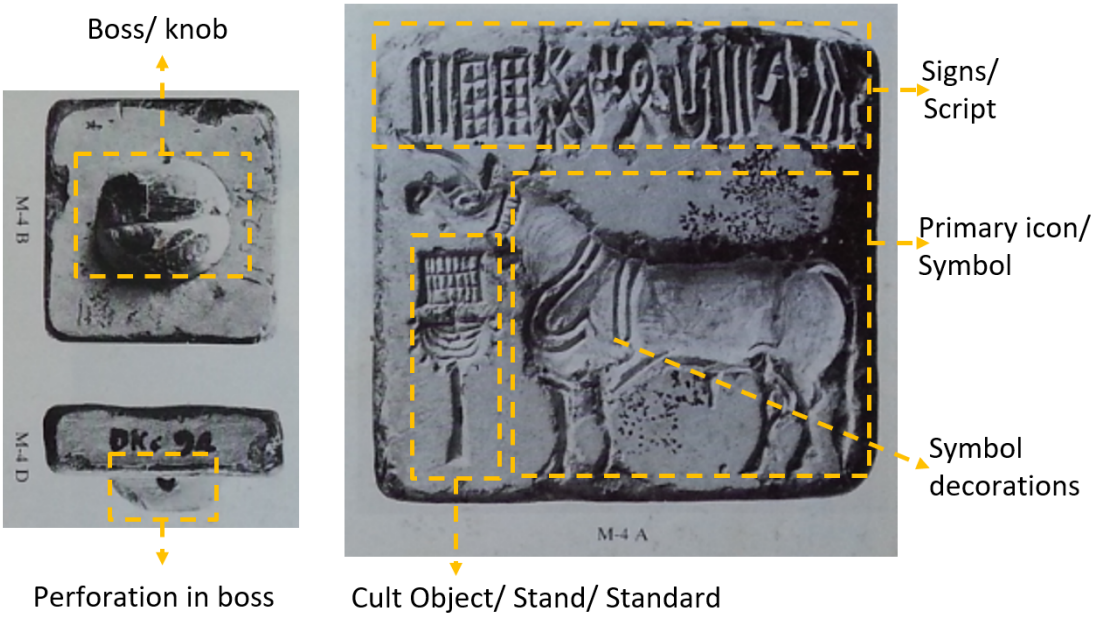


Figure 1.3: General terms for the parts of a square steatite seals

Thus, to overcome the engendered meanings which are attached due to the persistent use of specific terminology, accommodate the diversity which is otherwise evident, and to uniquely identify the artefacts with the culture of a particular space and time, I coin a relatively value-neutral term 'Marked Harappan Artefact(s)', MHA. For the inscriptions, I choose the terms 'sign(s)', 'sign sequence', and 'sign-list' to eliminate the presumption of a 'script' of written language.[47] Finally, one can only have etic approach in these studies. We can interpret the material only as 'constructs', which we impose, based on our present-day world-view. However, stringent constructs may lead to interpretative bounds and may challenge the meaning making process.

sion with a linguist friend, we stumbled upon a definition of a 'script'. Script may also mean logical or patterned arrangement of symbols not necessarily leading to vocal sound or linguistic components e.g. computer program or alphanumeric IDs such as vehicle number plates in India. However, script, in archaeological discourse generally entails a representation of language.; J. Mark Joshua, "Script - World History Encyclopedia," 2023, accessed January 12, 2023, https://www.worldhistory.org/script/

47. Note: Though the section highlights problems in existing jargon, I will continue to refer to some of the existing terms in specific sections. This is because the existing studies need to be understood in their own contexts. In addition to it, different analyses in the present work have been carried out on subsets of MHA and they refer to the previous research. The data preparation i.e. chapter 4 describes how the existing terminology has been adopted for the present work.

1.2 Unfolding the MHA scholarship

The archaeological research of the Harappan culture has occupied a centre stage in the South Asian archaeology due to its expanse in time and space, rich material variety, and long-distance contacts. The progression of MHA, from an 'accidental find' to the 'hallmark of a civilisation', is a reflection of the development of Indian archaeology itself.

Critical analysis of many pieces of work reveal different phases of research. Chronologically, these phases can be roughly identified with the political shifts such as colonial era, post-independence time-frame, and the recent period since around the last decades of the 20th century.[48] It is important to note that archaeology as a discipline has evolved very recently. The formal theories have been developed only within the latter half of twentieth century. The paradigmatic shifts and complementary approaches can be seen as one moves from antiquarianism, processual, behavioural, and post-processual archaeology, to the recent discussions of symmetrical archaeology. It would be rather surprising if one does not see manifestation of these evolving theories into Indian archaeology, especially the studies of Harappan culture and MHA. I thus observe the changes in the epistemic frameworks. These changes respond to the combined influence of multiple parallel developments in the socio-political atmosphere, archaeological theory, and technological innovations. From Thomas Kuhn's philosophical point of view, knowledge is historically conditioned; in this case the conditioning is multidimensional. This section elaborates upon the framework for situating the present research. The patterns of MHA scholarship and its transitions can be summarised in figure 1.4.[49]

In the formative years of Indian archaeology, it was a product of the British quest of 'discovering the orient'. It was a colonial project rather than locals exploring their own past. The initial years of research spanned the Cunningham era in the second half of the nineteenth century and early excavations till the time of independence. This period depicts some peculiar tropes of colonialism. Cunningham's remarks from 1870s, roughly 50 years prior to the first official announcement of Harappan civilisation in 1924, highlight the contemporary western notions about Indian subcontinent, its society, and its

48. Gokhale, "Linguistic Hegemony and Latent Typology: The Case of Harappan Script Scholarship."

49. Gokhale, 1.

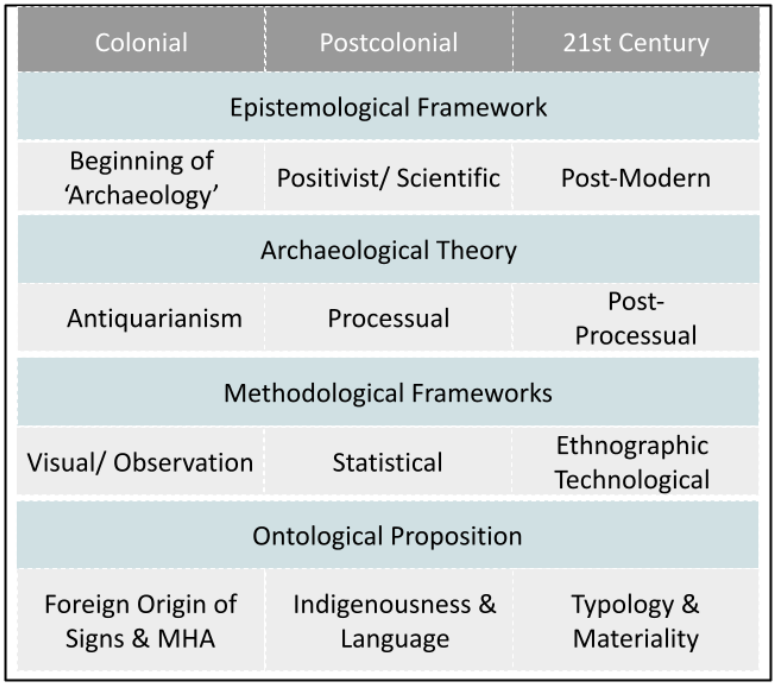


Figure 1.4: Overview of MHA Historiography

past: "... above the bull there is an inscription in six characters, which are quite unknown to me. They are certainly not Indian letters; and as the bull which accompanies them is without hump, I conclude that the seal is foreign to India."[50]

The most direct assumption was that these and other objects implied the 'history' of the same period. Lahiri states that Spooner related the unicorn seen on the seals to the earliest reference in classical literature called Indica by Ctesias; he mentioned it as wild ass with single horn as Indian peculiarity.[51] The same viewpoint is visible in the excavation reports. Mackay theorised the subdivision of rooms in the lower levels at Mohenjo-daro by correlating it to the long tradition where the bride went to the groom's house after marriage. He used this logic to justify the creation of private spaces under the same roof.[52] Despite total lack of knowledge about the Harappan polity, ruling class or ideology, acknowledgement of the human figurine as 'priest-king' and the promotion of the horned anthropomorphic motif as 'proto-shiva' are the traits of the similar mindset.

50. Alexander Cunningham, *Archaeological Survey, Report 1872-1873*, vol. V (The Superintendent of Government Printing, ASI, 1875), 108.

51. Nayanjot Lahiri, *Finding Forgotten Cities: how the Indus civilization was discovered* (Orient Blackswan, 2006), 290.

52. Mackay, *Further Excavations in Mohenjo-daro*, I:42.

Typical characteristics of this phase are: (i) collection and analysis of objects by disregarding the context, (ii) attestation of foreign origin of MHA and signs without prerequisite analysis, and (iii) linking archaeological finds to known cultural traditions. Thus, in the formative periods of Indian archaeology, a combined influence of British ideas of the Indian subcontinent's past and that of the prevalent antiquarian phase is seen. Irrespective of the gap in time and the lack of evidence for continuity, the material was naively assumed to corroborate the historical texts and the then living traditions. The cultural interpretations which emerged, had a mix of European notions of civilisation, textual and historical traditions within the Indian subcontinent, and a foreign outlook towards the past of the land. Archaeological perspective of 'analysis of the material in the absence of textual evidence' was yet to evolve.

The post-independence period created distress for the archaeological fraternity, especially for the Indian side of the partition. The hallmark sites such as Mohenjo-daro, Harappa, and Cholistan region had landed in Pakistan. Other contemporary chalcolithic cultures and early historical material cultures such as NBPW (Northern Black Polished Ware), or PGW (Painted Gray Ware) were yet to create their place and significance in the Indian archaeology. Therefore, to establish and legitimise the 'antiquity' of the region on this side of the border, the study of Harappan culture gained prime importance. The search for sites within these new borders became a high priority project for Archaeological Survey of India (ASI).[53]

This socio-political shift in the Indian subcontinent overlapped with the emerging phase of processual archaeology. There was an urge to imbibe the 'scientific' approach in all academic faculties because of its ability to produce reliable and verifiable knowledge.[54] Systematic data collection, empirical observations, precise measurements, quantitative analysis of data, and methodological ability 'to predict' were the key components of this epistemology. In addition to this, the processual theory proposed the notions of general laws of past life-ways. It conceptually helped imagine a unified identity of India in the past by focusing on the overall uniformity of Harappan culture.

53. Ashish Avikunthak, *Bureaucratic archaeology: state, science and past in postcolonial India*, vol. 17 (Cambridge University Press, 2022), 16–17.

54. Katragadda Paddayya, ed., "Role of Formation Processes in Indian Archaeology," in *Formation Processes and Indian Archaeology* (2007), 23–35.

The Harappan script studies immensely benefited from these changing paradigms. As revealed by the history of European state formation processes during eighteenth to twentieth century, the most significant identity of the nation was language.[55] The contemporary bronze age cultures of Harappan culture had their own languages and produced their own writing systems. Their writing systems had evolved in response to the needs of various functions. The secondary and tertiary occupations such as trade, account keeping, administration, royal proclamation, or even religious activities had evolved due to surplus agriculture production. However, these also helped those civilisations to transform from primary agriculture-based subsistence to urban life. Existence of language and ability to transform vocal sounds into readable signs played a crucial role in all these tasks; it thus became a fundamental characteristic of a civilisation and urbanity. It showcased a developed state of the society. This concept added a layer to the Indian subcontinent's remote past where Harappan material provided the uniform backdrop. As the archaeology fraternity theorised aspects of cultural material, they also internalised this positivist prejudice. This idea nurtured and legitimised the linguistic hegemony of MHA[56] and our conceptualisation of 'civilisation' in Harappan culture. Due to the etic perspective mentioned earlier, the script on MHA was assumed to depict the written form of a supposedly extinct uniform language. Subbarao's conceptualisation of domains of regional variation,[57] possibilities of contact with contemporary chalcolithic cultures, investigations into non-Harappan geographies, and the prospects of multilingual region in the past were obscured by a drive to 'read and deduce homogeneous identity' of the past. Thus, MHA were and are being seen as the manifestation of the linguistic past, as people's ability to 'write the spoken word', and as the urban character of the material culture.

Hodder, the proponent of post-processual thought, reacted to the processual framework of general laws for human behaviour and emphasised on 'context' for every aspect of archaeological study.[58] This framework was also a reflection of postmodern

55. Benedict Anderson, *Imagined communities: Reflections on the origin and spread of nationalism* (Verso books, 2006).

56. Gokhale, "Linguistic Hegemony and Latent Typology: The Case of Harappan Script Scholarship."

57. Bendapudi Subbarao, *The personality of India: pre and proto-historic foundation of India and Pakistan*, 3 (Faculty of Arts, Maharaja Sayajirao University of Baroda, 1958).

58. Ian Hodder, "Postprocessual archaeology," in *Advances in archaeological method and theory*, ed.

thought adapted in archaeology. Its major objections to processual theory were: (i) de-signification of human agency in the creation of material culture, (ii) rejection of the subjectivity in the academician's view about the material, (iii) context becoming irrelevant in the effort of generalisation, and (iv) belief in the material as a static and accurate record of the past. The postmodern framework provided a foundation to reject the notion of order, to deny a single objective truth, and a scope for the existence of an alternate narrative. In an introduction to the edited volume of essays, Meskell and Preucel discuss the development of postmodern response for archaeology based on Giddens' theory. They argue that "... material culture is not simply reflective of social practice but, rather, constitutive of it."[59] Thus the past needs to be constructed. As seen above, processual archaeology was a modern scientific era enterprise which advocated logical positivism based on empirical data. The basic idea of eliminating the subjectivity with the help of scientific methods was rational and appreciated on the backdrop of antiquarianism. However, the aim for objectivity undermined the 'human thought processes in and about the past'. From post-processual point of view, human behaviour is influenced by known and unknown conditions, and it constitutes more than causal relations such as intentions, narratives, and understanding.

The critique of postmodern theory is generally about its inability to create a single reliable account, apathy to produce 'coherent knowledge', and an apparent loss of distinction between high and low or right and wrong. Hodder mentions, "..reading of an event is never finished.. Continuously open for interpretations."[60] As the reader and her context is always unique in space and time, it then eliminates the chance to reject any narratives. Subsequently, in case of formation of MHA scholarship over the century, any interpretation is also a product of time. However, the essays in the edited collection about archaeological typology[61] emphasise that even the routine scientific methods of quantification, measurements, and definitions of variables possess inescapable subjec-

Schiffer M. B., vol. 8 (Elsevier, 1985), 1–26.

59. Lynn Meskell and Robert W. Preucel, *Companion to social archaeology*, ed. Lynn Meskell and Robert W. Preucel (Blackwell Oxford, 2007), 7.

60. Ian Hodder, *The meanings of things: material culture and symbolic expression* (Routledge, 2013), 70.

61. Robert Whallon and James A. Brown, eds., *Essays on Archaeological Typology* (Center for American Archaeology Press, 1982).

tivity. The authors argue that even processualism cannot shed away the subjectivity and it thus transcends into all stages of documentation, analysis, observation, and interpretation.

Having said that, the strength of post-processual theory lies in the fact that, while denying the order and a single confirmatory story, it allows multiple realities to exist. Those are grounded in the contexts of both the entity under study and the reader. There is neither a claim to single reality nor the insistence on falsifiability. While discussing the importance of subjectivity, feminist archaeologist Joan Gero argues:

> (in archaeology) Most often, the confusion, uncertainty and ambiguity are left out of our conclusions, overlooked, ignored, forgotten or erased. .... I will urge that we resist imposing meanings on our subjects: modern, disciplinary, uniform and universalist, and move instead towards honoring (instead of erasing) the evidence that will not yield to closure. Toward these ends, I begin by examining how the status quo rule-bound archaeological practice eradicates ambiguity in favor of a construction of certitude...[62]

Thus, uncertainty and ambiguity is introduced in archaeological scholarship at every step; from the site formation process itself up to our knowledge creation process. From a post-processual point of view, acknowledgment of these uncertainties and ambiguities translates into acceptance of the multiplicity of these contexts and denial of a single universal truth.

While emphasising the need of postmodern thought in archaeology, McGlade and Leeuw note:

> It seems to us that a more pluralistic approach is called for, one which recognizes process and event as complementary aspects of human history and tries to steer a course between the oversimplification which is inherent in so-called 'laws of human behaviour' and the limitations of extreme contextualism. In effect an attempt at understanding the past which accepts its own inherent limitations ...[63]

62. Joan M. Gero, "Honoring ambiguity/problematizing certitude," *Journal of archaeological method and theory* 14, no. 3 (2007): 312–313.

63. James McGlade and Sander E. Van der Leeuw, *Time, process and structured transformation in archaeology* (Routledge, 2013), 2.

As a consequence of these discussions and the acceptance to post-modern theory as an epistemological framework, two core philosophical principles needs to be recalled:[64]

- 'No body of knowledge should contain logically contradictory combinations of propositions'. This means that there can be complementary narratives but if those are contrasting or contradictory, those cannot help form a coherent body of knowledge.
- 'Once a set of axioms is accepted, its logical consequences also need to be accepted.' Thus the interpretation of certain analysis brings along its effects; those inevitably impact and contribute to the furtherance of knowledge.

Final chapter in this thesis explicates the applicability of these principles to the present study of MHA.

1.2.1 Locating the potential

Against this background, initial or even peripheral inquiries into the contextual characteristics of these artefacts suggest a mixture of different artefact 'types', though the definition of 'type' is still in rumination. Context, in this case, is inclusive of the material dimensions, along with the archaeological context of the findspot or findsite of the artefact. Primary observations into the shape, size, and form of MHA indicate 'discontinuities'[65] and hence high probability of distinct consumption practices of these artefacts. These are potential manifestations of different social or cultural systems with a diverse range of functions. This then reduces the possibility to qualify them as a single artefact category. As a result, there exists a heterogeneous set of objects with unknown boundaries and vague definitions.

To search possible multiple narratives of MHA, multiple contexts need to be identified. Once identified, those need to be built and organised in analysable forms. A postmodern outlook towards previous research can assist to explicate those as alternate narratives which result from their different vantage points e.g. decipherment study,

64. Notes from Classes of Dr K.P Mohanan - Introduction to Research 001, Sept-Nov 2019

65. Robert Whallon, "Variables and dimensions: The critical step in quantitative typology," in *Essays on Archaeological Typology*, ed. Robert Whallon and James A. Brown (Center for American Archaeology Press, 1982), 128.

stylistic analysis, statistician's viewpoint, and site-specific study. To address the lacunae in the post-processual framework, it is critical to see whether any of these studies can be triangulated to interpret MHA. DS (Data Science) and Geographical Information Systems (GIS) provide tools and techniques which help handle this problem.

It must be noted that besides the material evidence, there is no literary or textual insight into the social or cultural systems of the Harappan civilisation. Except for the conjectural mapping of Meluhha to 'Mleccha',[66] a cylindrical seal with a reference to 'translator of the Meluhhan language',[67] and Ghaggar-Hakra channel being speculated as dry riverbed of river 'Saraswati',[68] the entire understanding about this prehistoric period of Indian subcontinent is at the mercy of interpretation of available archaeological evidence including MHA. These are believed to be the most powerful artefacts of Harappan culture. However, the sources of power is yet to be discerned. Is it (i) the context from which these artefacts are recovered, (ii) the material and form which are unique and attractive even today, (iii) rarity, (iv) our lack of understanding about their contemporary value, (v) our interpretative frameworks (influenced by presentist views) which rank the objects, or a combination of all these?[69] To summarise, preliminary observations about MHA show that the scholarship is influenced by some perceived value about attributes, ideas, and material. It is critical that assumptions are not simplified while craving for unambiguous results. Gero notes that beyond the physical data...

> ... the ambiguity we confront can also have other sources such as the limitations of our own conceptual realms: asking the wrong questions, or asking questions at the wrong scale, either because we can simply not understand what we are seeing, or because we cannot recognize important implications

66. Madhukar Keshav Dhavalikar, *Cultural Imperialism: Indus Civilization in Western India* (South Asia Books, 1995); Romila Thapar, "A Possible Identification of Meluhha, Dilmun and Makan*," *Journal of the Economic and Social History of the Orient* 18, no. 1 (1975): 1–42

67. "CDLI seals 014339 (physical) (P525331) - Cuneiform Digital Library Initiative," 2021, accessed December 10, 2022, https://cdli.mpiwg-berlin.mpg.de/artifacts/525331; Gregory L. Possehl, "Shu-ilishu's cylinder seal," *Expedition* 48, no. 1 (2006): 42–43

68. Dhavalikar, *Cultural Imperialism: Indus Civilization in Western India*; Nitesh Khonde et al., "Tracing the Vedic Saraswati River in the Great Rann of Kachchh," *Scientific reports* 7, no. 1 (2017): 5476

69. Gokhale, "Linguistic Hegemony and Latent Typology: The Case of Harappan Script Scholarship," 19.

> of what we are looking at, perhaps because the data are incomplete but also perhaps because they are linked or relevant to conditions or instances that are unfamiliar to us or fall outside our logical systems.[70]

It's not just lack of material remains which hinders our studies, but also our inability to perceive and translate past systems from the constructs to concepts. If different narratives are created, those can be accepted or rejected based on "reliable criteria for approaching archaeological record at elementary level"?[71] Material remains help build constructs. However, extrapolating those to concepts, which are appropriate for the specific past is a crucial step. Coningham has summarised this idea as:

> In order to fully understand the social and economic organization of the Indus Civilization, archaeologists will need to accept and understand the distortion of the archaeological record generated by preconceived notions of past societies, which are in turn influenced by archaeologists' own social and political backgrounds.[72]

Published academic writing about Harappan seals is a large body of Indian and South Asian archaeological scholarship. A glimpse of 'Bibliography on Indus Script' on the official website of National Fund for Mohenjo-daro[73] gives a partial idea about it.[74] The list runs into more than thousand items with the latest publication only from 2010. Possehl, the academic authority on Harappan civilisation, dedicated an entire volume to the Harappan writing system in his multi-volume work titled 'Indus Age'. While being compendious about the topic, he described "thirty five research efforts in this writing

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70. Gero, "Honoring ambiguity/problematizing certitude," 318.

71. Katragadda Paddayya, *The New Archaeology and Aftermath: a view from outside the Anglo-American world* (Ravish Publishers, 1990), 53.

72. Robin Coningham and Mark Manuel, "Priest-kings or puritans? Childe and willing subordination in the Indus," *European Journal of Archaeology* 12, nos. 1-3 (2009): 15.

73. National Fund for Mohenjodaro, "Bibliography on Indus Script," 2015-2020, accessed February 16, 2020, http://mohenjodaroonline.net/index.php/indus-script/bibliography-on-indus-script.

74. Original site is not functional any more. The archived pages can be accessed at https://web.archive.org/web/20211206031037/http://mohenjodaroonline.net:80/index.php/indus-script/bibliography-on-indus-script

system."[75] When compared to material oriented studies, historiography is seen to be dominated by these decipherment studies.[76]

In this thesis, when I analyse MHA as archaeological objects, I treat signs as one of their attributes. The primary aim is to understand how different inherent and contextual attributes of MHA help interpret them in multiple contexts. Also, it is critical to see if the signs and non-signs attributes demonstrate any discernible relationship with each other. To reconstruct a virtual archaeological context, a GIS case study for DKGS mound at Mohenjo-daro is proposed. The context was permanently lost during excavation so now it is physically inaccessible.

As I situate MHA scholarship in the entangled theoretical framework described in earlier sections, it emerges as a classic case of tussle between the quantitative and interpretative methods or processual and post-processual theories. When these approaches are mapped to the topics of research, Possehl concurs that "An evaluation of the research on the Indus writing system is probably more a part of the domain of historical linguistics than that of archaeology."[77] Chapter 2 explains this proposition about patterns in methods, theories, and topics and the following chapter 3 elucidates the need of new problem definition and main objectives of this thesis. Chapter 4 details out the data preparation process. Chapters 5, 6, and 7 discuss the contextual analysis, insights from advanced data science techniques, and the geospatial analysis of DKGS mound at Mohenjo-daro respectively. The final chapter offers material-centric and context driven interpretation of MHA based on the work presented in these chapters.

1.3 Note

In the recent past, scholars from mathematical and statistical faculties have taken deep interest to decode the Harappan script. Though this has brought new ideas and techniques, their quantitative outlook, disconnect from the material centric approach, and their negotiation between material evidence, text, archaeological theories, and evolving interpretations has created disregard for the archaeological inputs. This thesis demon-

75. Possehl, *Indus Age: The Writing System*, 76.

76. He also mentions being aware of 60 serious claims of decipherment and Mahadevan knowing over 100. See p. 22 for more information.

77. Possehl, *Indus Age: The Writing System*, 19.

strates that these hypotheses do not succeed in building the academic credence.

In their contributions to Harappan script research, the TIFR team[78] has proposed the hypothesis that sign sequences observed on West Asian sites were probably being used for different content with different sets of grammars.[79] It must be noted that this was first put forth by Hunter in 1932,[80] upheld by Parpola,[81] recognised by Possehl,[82] and again studied by Laursen[83] where he identified those as 'Gulf type'. For an 'archaeological' study, these studies needed to be triangulated for their contribution or contradiction to this specific interpretation. Besides this lack of cross referencing, they also do not comment on the form or material differences of Gulf or West Asian type seals discovered in the Harappan sites of Mohenjo-daro, Chanhu-daro, and Lothal.

In a two-lecture course organised by Instucen Trust in January 2021,[84] the instructor - a former scientist from TIFR and a co-author in one of the above mentioned publications - argued that Harappan city growth was limited by technology. However, while explaining the trade network, he gave credit to advanced technology and communication networks. In this course, terms such as seal, grammar, script, and miniatures were consistently used. The use of such specific terms impact the audience's understanding, and thus establish a kind of a priori about MHA. In absence of clarity about (i) whether signs

78. A group of scholars at Tata Institute of Fundamental Research, TIFR and co-authors from other institutions have produced a number of research articles about Harappan script. These make use of advanced statistical techniques including machine learning (ML). All those can be read at the mentioned site: "List of papers and abstracts published till December 2011," 2016, accessed March 13, 2023, https://www.tifr.res.in/~archaeo/papers/Papers.html

79. Rajesh P. N. Rao et al., "A Markov model of the Indus script," *Proceedings of the National Academy of Sciences* 106, no. 33 (2009): 13685–13690; Nisha Yadav, "Sensitivity of Indus script to site and type of object," *Scripta* 5 (2013): 67–103

80. C. Subramanian, "The Contribution Of Indus Text Corpora / Concordances To The Textual And Contextual Analysis Of The Indus Script: A Comparative Study" (PhD diss., University of Madras, 2015), 39, https://shodhganga.inflibnet.ac.in/handle/10603/276228.

81. Asko Parpola, *Deciphering the Indus script* (Cambridge University Press, 1994), 133.

82. Possehl, *Indus Age: The Writing System*, 166.

83. Laursen, "The westward transmission of Indus Valley sealing technology: Origin and development of the 'Gulf Type'seal and other administrative technologies in Early Dilmun, c. 2100–2000 BC."

84. Mayank N. Vahia and Instucen Trust, "Harappan Script – India Study Center," 2021, accessed March 5, 2021, https://instucen.org/courses/harappan-script/.

represent a syllable or a word or something else, (ii) whether artefacts should be called as seal and why, and (iii) why should some objects be identified as miniatures when there is no bigger object which it represents, such jargon invites ontological debate. Even the terms such as 'grammar' and 'script' are used for the lack of a better ones. Grammar[85] essentially means rules for arrangement of words. In that case, each Harappan sign need to be given a status of the word or semantically complete component.

Based on their earlier publications,[86] in the most popular recent techno-scientific talk about these signs,[87] the authors claim to be able to 'Write' despite their inability to 'Read' the Harappan script. Their prediction logic has unified the signs across space, time, and type, which is unwarranted. There is no collective archaeological, typological, cultural, linguistic, or textual corroborative evidence to support this unification.[88] Possehl has already argued that this stagnancy in the writing system is "... almost certainly due to the lack of control over the chronology and developmental stratigraphy of Mature Harappan. It makes little sense to suppose that such a system was invented and used throughout the entire Harappan region without any modification."[89]

85. Cambridge Dictionary, "GRAMMAR | English meaning - Cambridge Dictionary," 2023, accessed July 1, 2022, https://dictionary.cambridge.org/dictionary/english/grammar.

86. Rao et al., "A Markov model of the Indus script"; Nisha Yadav et al., "Statistical analysis of the Indus script using n-grams," *PLoS One* 5, no. 3 (2010)

87. Rajesh P. N. Rao, "A Rosetta Stone for a lost language," 2011, https://www.ted.com/talks/rajesh_rao_computing_a_rosetta_stone_for_the_indus_script?language=en#t-901214.

88. This talk and the related paper are reviewed in detail in the next chapter.

89. Possehl, *Indus Age: The Writing System*, 57.

Chapter 2

Literature Review

The previous chapter provided an overview of Harappan culture for situating the MHA scholarship. It demonstrated how mixed environments have shaped the historiography of MHA. This scholarship has its roots in the antiquarian and 'Indological' era of British and European archaeology in the Indian subcontinent. It began as a colonial project when the discipline of archaeology itself was being conceived by the academicians.

The aim of this chapter is to paint an overarching picture of the current state of research on MHA. It includes examples which have helped create multi-faceted understanding of these artefacts and the culture they represent. It highlights the fact that sign encoding, which forms the basis of all decipherment studies, is an intellectual product with layers of abstraction. It presents an analysis of the lack of consensus in the decipherment studies. Later it demonstrates significance of archaeological context to extract the meaning of MHA. Some studies have been referred multiple times in different sections or even chapters. The idea is not to be superfluous but to correlate the arguments in different contexts. Numerous concepts such as mono-lingual society, purpose of writing, choice of a language for writing, literacy, people's ability to read and write, and the evolution of this 'script' appear to be both causal and consequential in these studies. This chapter also discusses these aspects. The literature can be broadly categorized into encoding or decipherment research (ED studies), and material or typological research, with little overlap between the two. Chapter 3 describes this lack of overlap itself as a space for problematisation. The topics covered in the present chapter are as follows:

- Sign encoding as a constraint
- Dravidian trope and other linguistic arguments
- Statistical studies
- Critique and defence
- Causes and consequences of linguistic hypothesis
- Material studies

- Contemporary material cultures
- Contextual studies

It is critical to note that the proportion of scholarship produced about the decipherment and linguistic analysis is too large compared to the studies on materiality of the artefacts. This review inevitably reflects this imbalance. Though the Dravidian argument is far more popular and many scholars have proposed it, there are irreconcilable differences. Their methodological lacunae, non-falsifiability, and comparison to non-Dravidian studies requires detailed illustration. Their disconnect from material-centric approach, causes and consequences of linguistic hypothesis, contact between Harappan and other contemporary cultures is not anecdotal but rather historiographical. As described in the next chapter, their debate questions if the material is being given justice that it deserves or the proto-history (?) is already trying to overpower the mute material evidence.

2.1 Sign encoding as a constraint

Encoding essentially means identifying the unique signs and then converting those into a system of codes, often numeric ones. Iravatham Mahadevan (hereafter Mahadevan) notes that the concept of 'normalised signary' was first introduced by A. H. Dani - "... comparing variant signs and arriving at normal form on the basis of the most frequent type."[1] From a linguistic analysis point of view, decipherment requires sign frequency analysis of sign sequences encoded in a particular system. It may further help extract the linguistic structures (if any) concealed in those sequences. The sign sequence would then be identified as a 'script'. The sign encoding thus forms a basic foundation for the decipherment.[2] The signs on MHA are believed to form a standard corpora. The documentation of these individual signs began in 1920s and 1930s. Repeating patterns of some sign sequences, repetitions of some individual signs, variation in standard forms, and resemblance of artefacts with those from other contemporary cultures have fostered the hypothesis of existence of a fixed sign-list. However, there is no consensus about

1. Mahadevan, *The Indus script: texts, concordance, and tables*, 15.

2. Possehl, *Indus Age: The Writing System*, 53.

the exact number of Harappan signs. The distinction between a specific sign and its possible allograph is unresolved. The disagreement lies in the encoding mechanisms of the signs as described below. Table 2.1 lists the significant encodings of Harappan signs. It is complied using multiple sources described in this chapter. Though the number of encoded signs ranges from 20[3] to 695[4] (now increased to 716),[5] these are not necessarily proportional to the increasing number of artefacts in a chronological order. Perhaps, after the major excavations which happened during the first half of the twentieth century, artefacts with completely new signs or icons are relatively less.

Here is a representative example that describes the process and its lacunae. In the identification of unique signs and their variants, Mahadevan has conflated many sign variants (allographs) into a single signs; as per his own data, 179 signs have variants adding up to 641 forms. In the same section he mentions the criteria adopted: "... variant signs look similar, have the same positional and functional characteristics and the variations are either too gradual or too numerous to denote meaningful differentiation."[6] He has given examples such as mirroring of the signs, change in orientation, bracketed signs, closely spaced strokes, and compounded signs. However, despite these clarifications, the number of variants is relatively high. Some of his assumptions regarding rhomboid and oval form (s267, s284) may not be easily accepted because these shapes have been documented separately for some other signs. When checked on artefacts and in ICIT, there is a significant difference in the graphic and also a notable number of artefacts with those variations. Sheer number of variants for sign s342 showcase the possibility of different signs being merged into a single code. The significant reasons for the emergence of sign variations which have been noted by him are "... different 'hands' of the scribes, material used, the mode of writing, regional variations or evolution in course of time."[7] Interestingly, many of the non-linguistic studies described later, use these reasons to identify differences and similarities in MHA: different 'hands' of

3. S. R. Rao, "Indus Script and Language," *Annals of the Bhandarkar Oriental Research Institute* 61, nos. 1/4 (1980): 157–188.

4. Bryan K. Wells, *Epigraphic Approaches to Indus writing* (Oxbow Books, 2011).

5. Andreas Fuls, "Ancient Writing and Modern Technologies – Structural Analysis of Indus Inscriptions.," 2020, https://youtu.be/MeQpiXF_8Yc.

6. Mahadevan, *The Indus script: texts, concordance, and tables*, 15.

7. Mahadevan, 15.

Scholar	Year	Available corpus	Total signs
Langdon	1931	750 obj - MJD, HRP	288
Hunter	1932-34	750	149/ 234
Meriggi	1934	~750	270
Dani	1963		537
Finnish Team	1973	2942 (Paris Concordance)	396
Soviet Team	1976	~2942	350
Mahadevan (IM77)	1977	2906 obj - Major, Minor, WA; Excluded - uninscribed / broken (549)	417
Finnish Team	1979	3237 Added - uninscribed (146), broken (103), new (46)	394
Finnish Team	1980	3265 New (28)	395
Finnish Team	1982	3265	396
S R Rao	1982	~3265	62»20
Fairservis	1992	Unknown but mentions that ~4000 are known (p. 5)	419 (200 basic graphemes)
Wells (ICIT)	2015	4794 (from 3903 objects)	694

Table 2.1: Scholars of Harappan signs and their sign inventories

the scribes,[8] material used,[9] regional variations[10] or evolution in course of time.[11]

8. Gregg M. Jamison, "The organization of Indus unicorn seal production: A diachronic comparative study of style, skill, and sociopolitical organization" (PhD diss., University of Wisconsin–Madison, 2017); Adam S. Green, "Stamp Seals in the Political Economy of South Asia's Earliest Cities" (PhD diss., New York University, 2015)

9. Randall W. Law, "Regional interaction in the prehistoric Indus Valley: initial results of rock and mineral sourcing studies at Harappa," *South Asian Archaeology* 2001 (2005): 179–190.

10. Ayumu Konasukawa, "Diversity of Harappan civilization: a case study of the Ghaggar basin with special reference to seals" (PhD diss., Department of AIHC, Archaeology, Deccan College Post Graduate, and Research Institute, 2014).

11. Paul C. Rissman, "The organization of seal production in the Harappan Civilization," *Old Problems and New Perspectives in the Archaeology of South Asia*, 1989, 159–170; Ayumu Konasukawa, "Indus Scripts Incised on the Seals Discovered from the Initial Phase of Harappan Period," 2020, https://youtu

Since encoding is a prerequisite for decipherment studies, it is prudent to look at selected efforts and situate those in the larger MHA scholarship. Over the years, different encoding systems have employed varied methodologies. In early years, it used similarities in graphic details of signs, and compared those with objects or other scripts. It has later shifted to statistical analysis of sign frequencies, sign positions within sequences, and identification of basic and compound signs. The process is a combination of heuristic and systematic methods. In all these cases, the efforts are directed towards identification of linguistic components such as prefixes, suffixes, case markers, verbs, roots, and nouns from the signs, and then 'reading' those in a particular language.

In the 1930s, Marshall was in charge of the excavation at Mohenjo-daro and indirectly got involved in the decipherment study. He can be assumed to be one of the early proponent of the Dravidian link.[12] His assumption was based on the then established theories about Aryan movement in the subcontinent.[13] According to him, Harappans, who belonged to a pre-Aryan culture, could not have Sanskrit or Vedic Sanskrit as their native language.[14] Hence he suggested that it had to be one or more from the earlier Dravidian languages. Hunter, just in the preceding year had proposed it to be a specific Dravidian variant, an ancestral Brahui.[15] Marshall had used presence of Brahui, a Dravidian isolate in north India, and agglutinative nature of Dravidian languages as supporting arguments for his Dravidian hypothesis.

Possehl has carried out one of the acclaimed academic reviews of the decipherment studies published till 1996.[16] Based on his work, a brief summary of various claims to

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12. John Marshall, ed., *Mohenjo-daro and the Indus Civilization: Being an Official Account of Archaeological Excavations at Mohenjodaro Carried out by the Government of India between the Years 1922 and 1927*, vol. 1 (Arthur Probsthain, 1931), 42.

13. There are several debates if 'Aryan' nomenclature should be used for characterising their ethnicity or language or culture or time-specific movement of people or a combination of these or not to use it at all. In the present work, it is referring to the meanings(s) intended by the cited scholarship.

14. Marshall, *Mohenjo-daro and the Indus Civilization: Being an Official Account of Archaeological Excavations at Mohenjodaro Carried out by the Government of India between the Years 1922 and 1927*, 1:42.

15. Possehl, *Indus Age: The Writing System*, 84.

16. Possehl.

different languages or content is created as follows:

- Sumerian or cuneiform script (Gadd and Smith - 1930)
- Sumerian language (Waddel - 1925, Fabri - 1937, Kinnier Wilson - 1974 (numerals), Michiner - 1975)
- Brahmi script (Langdon - 1925, Pran Nath - 1931, Kak - 1987, Priyanka and Manatunga - 1988)
- Proto Elamite, Hittite, Egyptian, Chinese (Barton - 1926-27)
- Dravidian (Hunter - 1929 (ancestral Brahui), Father Heras - 1953, Soviet team - 1965-68, Finnish team - 1969-70, Mahadevan - 1970-81, Fairservis - 1992 (chiefdom/clan names)),
- Egyptian hieroglyph logic (Petrie - 1932, Meriggi - 1934)
- Estruscan script (Piccoli - 1933)
- Study on Harappan numerals (Ross - 1938)
- Hittite (Hrozny - 1939)
- Shaiva Tantrism (Swami Sankaranand - 1943, Barua - 1946)
- Personal names/commemoratives as content (Chakravarti - 1975 (Pali names))
- Shamanism with picture story (Newburry - 1980)
- Poetic meter which relates to Vedic verse (Gupta - 1981, Punekar - 1984)
- Proto-Sanskrit (MVNK Rao - 1982)
- Semitic script (SR Rao - 1982)
- Sindhi script (Jetley - 1985)
- Miniature tablets as receipts or counting devices (Shendge - 1985)
- Numismatics (Kalyanraman - 1989).

Note - Besides this list, multiple researchers in 1930s related the signs to Easter Island signs of lost Rongorongo language without any explanations for the tangible links. They were heavily criticised.[17] Father Heras's work in 1950s demonstrated serious issues in interlinking the concepts of race, language, and culture.[18] Presumptions about a particular race (Dravidian) which settled in a particular geography (Mohenjo-daro/Sindh), spoke a particular language (Dravidian), and shared a same culture (Harappan) could not be substantiated with tangible evidence or logical reasoning. Fairservis provided a detailed discussion on the possibility of languages based on McAlpin's and others' work from 1970-80s. He advocated for proto-/Elamo Dravidian language family.[19]

To summarise, with fluid sign-lists and multiple meanings being assigned to the same sign, there is no recourse to cross-verification. Throughout the review of these sign encoding studies, it is observed that the scholars have preconceived notions about the language, content of the signs, and associated known/deciphered script. For example, the Soviet team argues for the presence of semi-variables, classes of signs, and blocks of signs.[20] They reject different possibilities as follows: (i) Sumerian, Hittite, and Elamite are discarded based on different linguistic characteristics such as position of determiner and post-positions, (ii) Indo-European affinity is rejected based on the absence of prefixes in the Harappan script, and (iii) Munda language does not qualify due to the absence of prefixes, infixes and agglutination in the script. As per their analysis, Dravidian language conforms to the Harappan script's linguistic structure i.e. the sign sequence composition. Thus, it became the most plausible option to read the Harappan signs. The next section elaborates on the solidification of this Dravidian postulate.

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17. Possehl, *Indus Age: The Writing System*, 90–100.

18. Possehl, 111.

19. Walter A. Fairservis, *The Harappan civilization and its writing: a model for the decipherment of the Indus script* (Brill, 1992), 14–24.

20. Yu V. Knorozov, "The Characteristics of the Language of the Proto-Indian Inscriptions," in *The Soviet Decipherment of the Indus Valley Script: Translation and Critique*, ed. Arlene R. Zide and Kamil V. Zvelebil (Mouton, 1976), 57–58.

2.2 The Dravidian trope

During the colonial period, preconceived notions of Aryan people moving into Indian subcontinent and its possible repercussions created basis for the initial decipherment efforts. As the movement of the Aryans (and the Indo-Aryan languages) has been hypothesised as an event after the decline of Harappan culture,[21] it has been considered as a tangible evidence for reading these signs in Dravidian language.[22] To evaluate these linguistic associations or to correlate the signs of MHA to any particular language are not the objectives of the present study. However, it is prudent to understand 'why' and 'how' the research community persists in their arguments about the sign and language relationship. This will provide an epistemological insight into the decipherment studies. This section reviews the most notable claims of Dravidian hypothesis.

2.2.1 Soviet and Finnish work

During the initial phase of work by the Soviet teams around 1965-68, they were the first to employ computer techniques to encode, sequence, and search for patterns in the signs. Critical steps for decipherment can be seen in this work.[23] They divided the signs in different classes from a linguistic point of view[24] and identified sign segments.[25] However, Zide and Zvelebil have raised serious questions about the assumptions regarding the distinction between the system of script and the system of language. Though they object to various methodologies employed by Soviet authors, they accept the "Dravidian affinity

21. Asko Parpola et al., *Decipherment of the Proto-Dravidian inscriptions of the Indus civilization: a 1st announcement*, vol. 1 (The Scandinavian Institution of Asian Studies, 1969), 4–5.

22. Iravatham Mahadevan, "Dravidian parallels in proto-Indian script," *Journal of Tamil Studies (Reprint)* 2, no. 1 (1970): 82–85.

23. Translation and critique of the Soviet work has been made available by Zide and Zvelebil in 1976. The edited volume combines both the translation and the critique of original Soviet studies.

24. A. M. Kondratov, "The Positional-Statistical Analysis of the Proto-Indian Texts," in *The Soviet Decipherment of the Indus Valley Script: Translation and Critique*, ed. Arlene R. Zide and Kamil V. Zvelebil (Mouton, 1976), 41.

25. Kondratov, 46.

of the Proto-Indian language" as "attractive and quite plausible hypothesis."[26]

In parallel to the Soviet work, the Finnish team headed by Asko Parpola also published serious decipherment claims. Their observations, published in three special publications in 1969-70, reached similar conclusions as that of their Soviet counterparts. The main points of agreement about the typology of the language and the typological characteristics of the script are (i) suffixation used instead of prefixation or infixation, (ii) modifiers precede the modified element, (iii) stable word order, and (iv) nouns before other nouns as modifiers.[27] As pointed out by Zide and Zvelebil in their preface, for implementing the decipherment, both the teams have basic assumption of the monolingual culture with limited extent and content.[28]

The Finnish team, in their first set of announcements, maps the signs to Dravidian sounds, then forms the words, creates meanings, and thus maps the script to the Dravidian language(s). Their flow of work is described in the first report.[29] To begin with, they recognise the object depicted by the sign. They then identify the meaning to be expressed and finally find the homophones. Presence of repeating and independently existing sign sequences have been inferred as individual words. This leads to a sequences of words and the existence of grammar rules to decode the logic of the sequences. For the content of the signs, the authors compare typical common steatite seals to the Sumerian seals. In the Sumerian context, these were mainly amulets. The Finnish authors do give a list of different types of objects on which these signs are found but they do not incorporate them in the decipherment or the meaning making exercise. They state that "... the language of the inscriptions has turned out to be Dravidian."[30] They use Dravidian Etymological Dictionary, also known as DED edited by Burrow and Emeneau, to identify the words, to recognise the sign as an object in Dravidian, and to interpret the meaning

26. Arlene R. Zide and Kamil V. Zvelebil, eds., *The Soviet Decipherment of the Indus Valley Script: Translation and Critique* (Mouton, 1976), 138.

27. Parpola et al., *Decipherment of the Proto-Dravidian inscriptions of the Indus civilization: a 1st announcement*, vol. 1.

28. Zide and Zvelebil, *The Soviet Decipherment of the Indus Valley Script: Translation and Critique*, 5.

29. Parpola et al., *Decipherment of the Proto-Dravidian inscriptions of the Indus civilization: a 1st announcement*, 1:10.

30. Parpola et al., 1:15.

that is to be conveyed.

In the same context, they quote M. B. Emeneau and argue that their logic has been upheld by eminent authorities. The endnote number 41 which refers to Emeneau's quote reads: "A Dravidian language may have been spoken by the people of the prehistoric Indus valley culture but this is no more than a guess."[31] Interestingly, Possehl notes that Emeneau called these three publications as "... speculative and arbitrary", and questioned their inferences related to the logo-syllabic nature of script, rebus principles for reading, and Dravidian as a supposed language.[32]

The Finnish team's hypothesis to prefer Dravidian over Mundas is justified by (i) comparatively higher and original culture of Dravidians in historical times, and (ii) presence of Brahui, a Dravidian outlier language in Baluchistan.[33] The Finnish authors insist that due to the links with Sumer, there exists a probability of loan Sumerian words but they completely deny the possibility of Indo-Aryan loan words.[34] The Soviet team on the other hand provided an explanation where the suffixation as a typological characteristic of the Harappan script, excludes Munda, Indo-Aryan, and Hittite languages.[35]

Though the Soviet team was aggressive to pursue the computational methodology, and Finnish team was successful in reaching the masses, both fail to substantiate Dravidian as 'the only possible argument'. Possehl has done a detailed review of the original works as well as the critique.[36] He shows that though the Soviet team began with a scientific and objective approach, they could not make their way in semantics of the signs. Thus their work resulted into speculative and unverifiable claims. For the Finnish team, critiques point out several borrowings. They 'assumed' the language to be Dravidian, unlike Soviets who 'derived' it to be so. To establish a contemporary cultural meaning for a sign irrespective of its archaeological context, and then to identify a word or homonym in Dravidian vocabulary are the most controversial aspects in both the stud-

31. Parpola et al., *Decipherment of the Proto-Dravidian inscriptions of the Indus civilization: a 1st announcement*, 1:56.

32. Possehl, *Indus Age: The Writing System*, 127.

33. Parpola et al., *Decipherment of the Proto-Dravidian inscriptions of the Indus civilization: a 1st announcement*, 1:6.

34. Parpola et al., 1:15.

35. Possehl, *Indus Age: The Writing System*, 66.

36. Possehl, 115–128.

ies. As discussed above, this precise feature has been critiqued by Emeneau, and by Zide and Zvelebil in the Finnish and the Soviet works respectively.

2.2.2 Asko Parpola

Asko Parpola, who led the Finnish team, is considered as an authority in the Indus script discourse. For more than three decades following the announcements by the Finnish team, Parpola continued to work on the problem to refine their solution. The culmination of his scholarly work was published in 1994.

In the preface itself he accepts the Finnish team's initial reports as premature and in need of lot of revision. With quote from Chadwick, He insists that in the decipherment effort, to theorise that only the proposed meaning is correct, is of utmost importance.[37] As he describes the pre-Vedic cultural and religious landscape of the Indian subcontinent, he proposes that there was an earlier wave of Indo-European speakers before the *Rigvedic* Aryans. They called themselves as *Dasas*. He notes that such reconstruction then provides a "... good reason to expect the names of Harappan deities to be mentioned on Indus inscriptions. Personal names, both in the ancient Near East and in historical India, often contain gods' names as their building blocks ... ."[38] This presumption is based on the comparison with contents of near eastern archaeological material. He has an interesting observation about the description of ancient ruins described in Vedic texts which supposedly date from 1200 to 500 BCE. The texts such as *Taittariya Brahmana*, *Rigved Samhita*, *Taittariya* and *Katha Samhita*, *Jaiminiya Brahamana*, and *Latyayana Shrautasutra* describe scattered abandoned habitations of foreign people, find places of potsherds, and abandoned settlements along the banks of rivers Indus, Saraswati, and Drushadvati.[39] Based on the religious backdrop used for interpretation, Parpola undoubtedly identifies the Great Bath of Mohenjo-daro to have a religious significance.[40] With respect to writing and its purpose, Parpola observes contemporary usage such as to record the time, debt, or commodities. He notes that inventions represent response to particular needs. As he describes process of the Sumerian or cuneiform script decipher-

37. Parpola, *Deciphering the Indus script*, xv.

38. Parpola, 4.

39. Parpola, 5.

40. Parpola, 6.

ment, he describes concepts of polyphony and polysemy. Rebus technique, which is considered as a crucial step in phonetic action of Sumerian, has been heavily borrowed by Parpola for his own work on Harappan script.[41]

Parpola proposes a final and revised sign-list which consists of 386 (+12?) signs.[42] He elaborates on his encoding criteria as follows. The signs are considered variants of a single sign if (i) reasonably similar signs with intermediate form variants exist, (ii) signs appear in identical contexts, and (iii) ligatures behave the same way as the original sign. He concludes that the script is logo-syllabic.[43] While he describes the process to identify the internal evidence for structure of language or languages from type of script, he has already submitted to the notion that signs encode the phonetic values. He dives into morphological classification of languages such as isolating, agglutinating, or inflecting, and in basic functional components such as subject, verb, or object. Based on a long and detailed historical linguistic analysis, he concludes that early form of Dravidian is the most probable candidate to be the language of Harappans.[44] In this process, he has essentially assumed that they were encoding the same content in the signs which they were speaking. Could this be the 'only possible argument' even if the spoken language is identified correctly? In the hindsight, is this probable candidate language same across the vast region over multiple centuries?

What appears missing in Parpola's work is that he completely overlooks the signs of contemporary cultures for comparing the meanings. He has used those to understand the structure of the script but not to correlate the meanings or sounds.[45] He has already dismissed this approach as a "mistaken method"[46] since different script will highly likely render different language than the one being searched for. He dedicates a roughly twenty page chapter in establishing 'why' and 'how' the fish sign is to be interpreted as (i) an object in the sky i.e. depiction of star, astral divinities, (ii) an emblem of Proto-Shiva, Enki, Varuna, Kama, (iii) Fish offerings, (iv) Number + Fish as depiction Ursa Major or

41. Parpola, *Deciphering the Indus script*, 33.

42. Parpola, 79.

43. Parpola, 85.

44. Parpola, 174–175.

45. Parpola, 58.

46. Parpola, "The Indus script: A challenging puzzle," 407.

brightly shining star, and (v) Fish ligatures with diacritic signs as symbol for Mercury and Saturn.[47] He has heavily borrowed from mythology, religious texts, astrology, and astronomy for extracting and extrapolating the meanings of the signs.

For the artefact terminology part, he establishes his usage of word "seal (inscription)" as "... impressions made with the respective seal stamp unless otherwise specified".[48] In majority of the other studies related to MHA, original object is referred to as 'seal' and its impression as 'impression', 'sealing', or 'tag'. Parpola's practice to refer to seal for the supposed intended use is ontologically problematic. Also, it is non-archaeological at the data documentation level. Such terms possess specific meanings in different cultural contexts. However, he borrows those at a conceptual level and employs an inappropriate construct. In addition to this, it is observed that excavation reports as well as CISI volumes have standardised the practice of printing the impressions because "... that represent the text as it was intended to be read."[49] Meadow and Kenoyer have warned about possible bias being introduced due to this practice.[50] They strongly object to the publication of impressions of the engraved objects, which was probably copied from the practice of publishing the impressions of cylindrical seals. For an academic pursuit, this is a presumptuous act. It essentially forces the researcher to believe of the impression as 'the actual artefact' or 'intended final product' instead of the original artefact. The duo also question the strongest pillar of the language hypothesis, the direction of writing. The review of studies dealing with production process, material, carving technique, involved artisans, and their possible level of literacy does not permit the authors to logically conclude the direction of writing.[51]

As Parpola describes steps to understand the nature of the Harappan script, he argues that it is " .... almost fully standardized", except for a few variations in miniature tablets.[52] These tablets are considered as the earliest text but are preceded by square

47. Parpola, *Deciphering the Indus script*, 179–197.

48. Parpola, 64.

49. Parpola, 64.

50. Meadow and Kenoyer, "The 'tiny steatite seals' (incised steatite tablets) of Harappa: Some observations on their context and dating," 18–19.

51. Meadow and Kenoyer, 18–19.

52. Parpola, *Deciphering the Indus script*, 54.

stamp seals at Harappa. Parpola categorically distinguishes between 'internal' or linguistic (sign related) attributes and 'external' (archaeological or artefact's contextual) evidence.[53] He opts to deal with internal evidence on priority. He argues that identical inscriptions do not add to the linguistic information and the reason for duplication is not linguistic but cultural.[54] The form, material, and iconography attributes are considered 'external' by him and hence excluded in the analysis of the signs. This essentially means that within his decipherment scope, he assumes that sign usages and their meanings are unaffected by their 'external' or 'cultural' context. It thus leads to the dismissal of the polyvalence possibilities in this script which may arise due to these contextual attributes.

Interestingly, a recent short article highlights Parpola's curiosity to understand the possible correlation of the signs with iconographic motifs on the copper tablets from Mohenjo-daro.[55] This is one of his rare studies which involves non-linguistic approach towards the signs. However, in search of linguistic meanings for the Harappan signs, his later publications move back into the linguistic, mythology, religion, and cultural tradition space. Despite not having any validation, he continues to search these meanings by using available Dravidian etymology, for example fish sign, crab sign, fig tree motif,[56] crocodile,[57] wild ass,[58] and unicorn.[59]

Iravatham Mahadevan (here onwards Mahadevan) had reviewed Parpola's work in

53. Parpola, *Deciphering the Indus script*, 64.

54. This is also argued by scholars who use M77 database or its modified versions. It is described in the later sections in the chapter.

55. Asko Parpola, "Copper tablets from Mohenjo-daro and the study of the Indus script," in *Intercultural relations between South and Southwest Asia: Studies in commemoration of ECL During Caspers (1934-1996)*, ed. E. Olijdam and R. H. Spoor, BAR International Series 1826 (Archaeopress, 2008), 132–139.

56. Asko Parpola, "'Hind Leg'+'Fish': Towards Further Understanding of the Indus Script," *Scripta* 1 (2009): 37–76.

57. Asko Parpola, "Crocodile in the Indus Civilization and later South Asian tradition," ed. Toshiki Osada and Hitoshi Endo, *Linguistics, Archaeology and the Human Past*, Occasional Paper 12, 2011, 1–57.

58. Asko Parpola and Juha Janhunen, "On the Asiatic wild asses and their vernacular names," ed. Toshiki Osada and Hitoshi Endo, *Linguistics, Archaeology and the Human Past*, Occasional Paper 12, 2011, 59–124.

59. Parpola, "The Harappan unicorn in Eurasian and South Asian perspectives."

1995 and referred to it as an 'Encyclopedia'.[60] While he appreciates the swathe and detailing of the work, he objects to Parpola's heavy reliance on mythology and related interpretations. He closes the four page review with the following comment: "The near-total absence of matters relating to the mundane, everyday concerns of the Harappans, and of the minimal linguistic features expected even in short texts is perhaps the strongest argument against accepting Parpola's model of decipherment in its present form."[61]

2.2.3 Iravatam Mahadevan

Around the same time as Parpola, Mahadevan himself had embarked on the journey of the decipherment. Though he published a detailed concordance and sign encoding in 1977, now popularly known as M77,[62] he had already published a paper in 1970, titled 'Dravidian parallels in Proto-Indian script'.[63] Mahadevan's work can be found in a collection of papers hosted by Roja Muthiah Research Library in Chennai.[64]

As part of his concordance, he created a sign-list and defined line of text as a unit for analysis. He identified the frequent sign groups across 3573 lines.[65] The artefact typology was mostly been borrowed from the excavation reports without much deliberation into their definitions. For iconography, hundred different types were identified and encoded along with the text number. This was published very close to the Soviet and Finnish announcements, where both had concurred with Dravidian as a possible

60. Iravatham Mahadevan, "An encyclopedia of the Indus script," *Historical Studies* XIX, no. 6 (1995): 9–12.

61. Mahadevan, 12.

62. Mahadevan, *The Indus script: texts, concordance, and tables*.

63. Mahadevan, "Dravidian parallels in proto-Indian script."

64. "Papers on the Indus Script by Dr. Iravatham Mahadevan," 2022, accessed January 24, 2022, https : / / rmrl . in / research - papers - on - the - indus - script - by - dr - iravatham - mahadevan/; Original site is not functional any more. The archived pages can be accessed at https://web.archive.org/web/20220208003634/https://rmrl.in/research-papers-on-the-indus-script-by-dr-iravatham-mahadevan/. Around September 2021, on the lines of Bryan Wells' ICIT database, RMRL has published a web application to access Mahadevan's database. It can be accessed at https://indusscript.in/.

65. Mahadevan, *The Indus script: texts, concordance, and tables*, 9.

language to read the Harappan script. Though Mahadevan acknowledges the use of their statistical data in addition to his original work, he claims to have used different methodologies which involved parallelism. His main assumptions to consider Dravidian as a possible language are archaeological data, its historical continuity, and Dravidian substratum in Vedic Sanskrit as seen through historical linguistics.[66] Though Possehl appreciates his openness to new ideas, 'working hypothesis' approach, and his stand on Dravidian only as a probability i.e. 'tentative conclusions', he also points out that parallelism brings weakness in the methodology.[67] Eventually one finds solidification and confirmation of the Dravidian argument only, and extrapolation of the sign meanings on the basis of use of homonyms and rebus techniques. It thus takes parallelism to its extreme. In the following years, Mahadevan's probabilities are seen strengthened without any significant archaeological or linguistic discoveries or methodological breakthroughs.

A glimpse of this journey can be captured here. In the 1989 publication,[68] Mahadevan provides a basic idea about the writing systems, their components, and evolution. After describing the material remains for Harappan script, he lists the followings as well established facts - (i) direction of writing from right to left with exceptional cases of left to right and boustrophedon modes (substantiated by observing 'direction markers'), (ii) structure of script as logo-syllabic, (iii) identification of words and phrases by comparing sign blocks, and (iv) identification of introductory phrase, substantive, case suffix, main phrase attributes, and nominal suffix.[69] Direction of writing, which has been a major supporting evidence for the language argument, was established based on what Mahadevan calls as internal evidence.[70] He mentions that there are three sets of 'direction markers', viz. the orientation of asymmetric signs, the terminal signs/sign groups which occur with greater frequency at the left or right end positions, and sequence of the

66. Mahadevan, "Dravidian parallels in proto-Indian script."

67. Possehl, *Indus Age: The Writing System*, 130.

68. Iravatham Mahadevan, "What Do We Know about the Indus Script? Neti, neti (not this, not that)'," *Journal of the Institute of Asian Studies* 7, no. 1 (1989): 1–38.

69. Mahadevan, 6–16.

70. Subramanian, "The Contribution Of Indus Text Corpora / Concordances To The Textual And Contextual Analysis Of The Indus Script: A Comparative Study," 102; Possehl, *Indus Age: The Writing System*, 62

more frequently occurring group of signs. It is important to note here that the carving and the reading directions need not be identical.[71]

Besides sign encoding, a brief note about Mahadevan's coding for iconography is important. Though he calls these as field symbol codes, he has created 99 of these. In most of the cases, those are actual description of the iconographic motifs. For example, 07 is 'Elephant, sometimes with trough in the front' and 08 is 'Horned elephant'.[72] From data analysis point of view, different codes need to identify exclusive properties and thus create a point of separation. Here, the commonality of the motif i.e. elephant, and differentiation i.e. trough or horn are masked by the single coding scheme.

Beyond the initial theories of preference of Harappan script for suffixes, speculation of introductory symbol as place name, and direction of writing from right to left, Mahadevan advances to interpret sign meanings (without the use of rebus technique) by their graphical similarities to Egyptian and Sumerian signs, and then to identify Dravidian terms which match that meaning. Agriculture surplus being the foundation of urban life, he develops a probability of "... Harappan seals and sealings would contain information on agricultural production and distribution."[73] He also proposes to have identified the sign sequence for the Dravidian deity named *Muruku* - .[74] It is important to note that with a different logic, Parpola has also identified a sign for interpreting *Muruku* -  .[75] Mahadevan later goes on to interpret the jar sign as *Agastya* based on legends in Vedic texts.[76] While working on one of the most discussed fish signs, he objects Father Heras' and Finnish team's extended conjecture to interpret fish sign as the names of the

71. Meadow and Kenoyer, "The 'tiny steatite seals' (incised steatite tablets) of Harappa: Some observations on their context and dating," 18.

72. Mahadevan, *The Indus script: texts, concordance, and tables*, 793.

73. Iravatham Mahadevan, "Agricultural terms in the Indus Script," *Journal of Tamil Studies* 70, no. 1 (2006): 1.

74. Iravatham Mahadevan, "A Note On The Muruku Sign Of The Indus Script," *International Journal of Dravidian Linguistics* XXXV, no. 2 (2006): 177. The signs are from ICIT sign-list which are closest to Mahadevan's sign-list and are only used for representation of the signs from Mahadevan's article.

75. Parpola, *Deciphering the Indus script*, 230; The sign used here is from ICIT sign-list which is closest to Parpola's encoded sign and is only used for representation of the sign from Parpola's text.

76. Iravatham Mahadevan, "Meluhha and Agastya: Alpha and Omega of the Indus Script," *Journal of Tamil Studies*, no. 76 (2009): 91–110.

constellations. He rejects Fairservis' interpretation for the same sign as knot or twist in a loom. He proposes gendered reading of the fish sign with arrow and jar signs for feminine and masculine meanings respectively, and four stroke sign as a combination for plural.[77] Based on Kosambi's work, many other parallels from other cultures, and the supposed ritualistic purpose of the 'Great Bath', he reads the fish sign and its variants as water nymphs.[78] The modified fish signs are read as Goddesses of dawn and night or nymphs. Later the femininity assigned to arrow sign is transformed into *Shakti* or Mother Goddess.[79] In his 2014 article, titled 'Dravidian Proof of the Indus Script via the Rig Veda: A Case Study', he establishes a comparison between an identified Harappan phrase, old Tamil and Indo-Aryan i.e. *Rigvedic* interpretation.[80] A sample of his work can be seen in figure 2.1.

In 2015, during a convocation address delivered at the Dravidian University, Kuppam,[81] Mahadevan does not claim full decipherment but mentions:

> ... I sincerely believe that I have discovered important clues for interpreting many of the frequent Indus signs and sequences proving conclusively the Dravidian character of the language and the survival of the Indus elements in the twin streams of later Dravidian and Indo-Aryan traditions.[82]

Just as a representative example from the same transcript, figure 2.2 shows how some signs have been identified as place signs. Mahadevan correlates the sign graphics with some archaeological remains such as roads and streets in cardinal directions or areas with fortifications. He expects Harappans to consciously reflect their ideas of urban life in the inscriptions of the period. It is important to note that elements such cardinality, fortification, lower or middle towns, or palace are our constructs with perceived values

77. Iravatham Mahadevan, *The Indus Fish Swam in the Great Bath :A New Solution to an Old Riddle*, Bulletin of the Indus Research Centre 2 (Indus Research Centre, Roja Muthiah Research Library, 2011), 11.

78. Mahadevan, 32.

79. Mahadevan, 52.

80. Iravatham Mahadevan, *Dravidian proof of the Indus script via the Rig Veda: a case study*, Bulletin of the Indus Research Centre 4 (Indus Research Centre, Roja Muthiah Research Library, 2014).

81. Iravatham Mahadevan, *Interpreting the Indus Script: The Dravidian Solution*, 2015.

82. Mahadevan, 3.

Grid of correspondences between Indus Phrase ABCD, Old Tamil and Indo-Aryan *(RV)*
Result Nos. within brackets; p: para; f: fig.

Signs	A: (back of the) WOLF		B: HOOK		C: CROSSROADS		D: JAR
Parallels	1	2	1	2	1	2	
Indus	(1) ***mār-*** barter.	braided & knotted hair. Pictorial motif. p 1.1 (i), f.4	(2) ***koḷ-*** receive.	(3) ***ceṭ-*** lightning, thunderbolt.	(4) ***pāṭ-*** street, settlement.	(5) ***vāḻ-*** residence, prosperity.	*-(a)ṉṟ-* masc. sg. suffix. p.1.4, f.7
Indus Phrase: barter-receiver prosperous/resident of the city-he (p. 1.5).							
Old Tamil	(6) ***māṟa-***	***kuṭumi.*** p.2.1 (ii) (a) ***caṭaiy-aṉ*** late. <Skt. ***jaṭā.*** p.1.2 (ii) (b)		(7) ***ceḻi-a*** ***ceṇṭu*** hook-like weapon. p.2.2 (ii), f. 8	(8) ***pāṇṭi-*** also from: Sign E: CITY. p.2.3 (ii)	(9) ***vaḻuti***	*-aṉ.* p.2.5
Name, titles and insignia of the **Pāṇṭiya** Dynasty (p.2.5).							

Signs	A: (back of the) WOLF		B: HOOK		C: CROSSROADS		D: JAR
Parallels	1	2	1	2	1	2	
Indo-Aryan (*RV*)	(15) ***ajāśva*** one whose horses are goats < Dr. ***maṟi*** goat, sheep. (16) ***agōhya*** one from whom nothing is concealed < Dr. ***māṟṟu*** hide, conceal.	***kapardin*** he of braided and knotted hair < Dr. ***kuṭumi.*** p. 3.8, f. 4	(13) ***āghṛṇi*** the glowing one < Dr. ***koḷḷi*** firebrand.	(14) ***aṣṭrā/ārā*** goad/awl < Dr. ***ceṭ-*** hook, goad.	(10) ***pathaspati*** Lord of the path < Dr. ***pāṭ-*** street. (12) ***karambhād*** eater of gruel < Dr. ***ampal-*** gruel, assembly (fm. Sign F: ASSEMBLY). ***vidatha*** assembly, ***vidathya*** member of the assembly.	(11) ***Pūṣan*** prosper-er < Dr. ***vāḻ-*** prosper.	
Name, traits and characteristics of **Pūṣan** *(RV)* (p. 3.10).							

Figure 2.1: Mahadevan's Harappan phrase comparison to old Tamil and Indo-Aryan (RV)

and meanings. Extrapolating those to a society that lived at least 4500 years ago and expecting the same to be reflected in MHA is unwarranted.

Indus Sign	Pictorial identification	Phonetic value in Dravidian	Old Tamil parallels
	city	*pāḻ(-i)*	*pāḻi* 'town, city'. cf. *pāḻi* (Ka.) 'row, line, order'; *pāṇṭi* 'a Tamil dynasty'
	palace (fort, court)	*aka-(tt-i)* *cūḻ(-i)*	*akattiyaṉ* 'eponymous ancestor of the Tamils' (i) *cōḻa, cōḻiya* 'a Tamil dynasty' (ii) *cūḻ* 'counsel' (iii) *uḷi, uḷai* 'precincts of the palace' (iv) *uḷaiyar* 'counsellors' (v) *ūḻiyar* 'temple/palace servants'
	assembly (place at four-road junction)	*ampal(a)*	*ampalam* 'assembly, court, temple'
	exclusive quarters	*kēr(-i)*	(i) *cēra, cēral* 'a Tamil dynasty' (ii) *cēri* 'exclusive habitation of Brahmans (inscr.) (or) excluded habitation of depressed classes
	ordinary quarters	*pāṭ(-i)*	(i) *pāṭi* 'hamlet' (ii) *pāṇṭi* 'a Tamil dynasty'

Place signs in the Indus Script and their evolution in Old Tamil polity

Figure 2.2: Mahadevan's identification of place sign and comparison to old Tamil

2.2.4 Walter Fairservis

Fairservis objects to the use of computers for standardisation of signs and identification of sign variants. To rely on statistical or quantitative data is termed as "... western scientific syndrome... "[83] by him and he categorically states its invalidity to cultural complexes. Surprisingly, his objection to standardisation is limited to the creation of signary only. He approves the use of a single nomenclature of 'Seal Tablets' for all the MHA objects irrespective of the form variations. Though he extensively draws on the theories put forth by the Soviet scholars, the Finnish team, and Mahadevan, he comes up with his own interpretation of the signs. He agrees with the Dravidian hypothesis. However, his logic to identify a word (lexeme) for the sign is more vague since he tries to keep the possibilities open for all the possible languages in the Dravidian family. For

83. Fairservis, *The Harappan civilization and its writing: a model for the decipherment of the Indus script*, 7.

example, he lists words for 'bow' in 18 languages of Dravidian family.[84] He provides translations of the selected texts and vocabulary. For example, for the fish sign, he identifies the graphic as a 'twist', Dravidian equivalent as 'pir', and interprets the meaning based on Dravidian Etymological Dictionary as 'great man/lord/chief'.[85] Having said that, the conclusion section from his work is archaeology driven. He has tried to match the material evidence to his interpretations of the texts. For example -

- "... Harappan civilisation was a hegemony of chiefdoms..... their responsibilities included heading the bureaucracy.... Storage and redistributive systems sustained by the bureaucracy were the economic heart of the system... "[86]
- "A particular group within this bureaucracy was known as kavadi(y)an.... prestigious post... honorific qualities... kavadi(y)ans are listed in the Harappan texts found in Mesopotamia."[87]
- "Costume was scanty. .... women wore elaborate headdresses of cloth or basketry... Wrap-around and off shoulder cotton robes... Some topless female figures have been found."[88]

2.3 Other linguistic arguments

Parallel to the dominant Dravidian argument, scholars have also explored other possibilities listed in the beginning of this chapter. Some of the critical ones are discussed in this section.

S R Rao, defined the signs as composite structures of various basic elements.[89] He encoded 62 signs for the mature Harappan phase and 20 signs for the late phase. Based on the theory that Semitic people had borrowed the late Harappan script, he assigned Semitic phonetic values to Indus signs. As per his analysis, with those phonetic values,

84. Fairservis, *The Harappan civilization and its writing: a model for the decipherment of the Indus script*, 20.

85. Fairservis, 185.

86. Fairservis, 133.

87. Fairservis, 134–135.

88. Fairservis, 135.

89. S. R. Rao, "Indus Script and Language."

it turned out to be an old Indo-Aryan language. It contained 24 sounds, 40 basic signs, and it resembled *Rigveda*. He deduced that the content of the scripts was mostly names or titles of the rulers and the purpose was to seal trade items or documents. He relied on Monier-Williams' dictionary to extract the Indo-Aryan terms and to read the signs.

To theorise the evolution of script from mature period to later period by tracing the changes in script such as from logographic-syllabic (more pictorial) to syllabic-alphabetic script (more linear) is a rare example in ED studies.[90] Konasukawa has recently proposed a similar hypothesis about chronological change in the script.[91] Except for these two, majority of the arguments from other scholars are about the standardisation of the signs across time and space.

Mahadevan has objected to S. R. Rao for his interpretation of signs and also for subjectivity introduced in the identification of basic and compound signs.[92] Interestingly, TIFR team has carried out similar exercise on M77. They describe how basic and composite signs can be categorised based on the use of modifiers.[93] They have performed this classification based on the sign design whereas S. R. Rao had done it based on the signs' Indo-Aryan phonetic value derived by him. Their design based separation may seem more robust than the phonetic one. This is because unlike some similarity of signs with known objects or scripts, there is no external clue to assign any phonetic value to the signs. Having said that, in the total absence of chronological control over the data, their argument about the static writing system for 700 years across more than one million square kilometres is speculative and unwarranted.[94]

Besides his own contributions, Mahadevan has critically reviewed five decipherment studies based on Sanskrit, Tamil, and numerical system.[95] He points out several

90. S. R. Rao, "Indus Script and Language," 172.

91. Konasukawa, "Indus Scripts Incised on the Seals Discovered from the Initial Phase of Harappan Period."

92. Iravatham Mahadevan, "S R Rao's Decipherment of the the Indus script," *The Indian Historical Review (Reprint)* VIII, nos. 1-2 (1982): 58–73.

93. Nisha Yadav and Mayank N. Vahia, "Indus script: A study of its sign design," *SCRIPTA: International Journal of Writing Systems* 3 (2011): 133–172.

94. Yadav and Vahia, 37.

95. Iravatham Mahadevan, "Aryan or dravidian or neither? a study of recent attempts to decipher the indus script (1995-2000)," *Electronic Journal of Vedic Studies* 8, no. 1 (2002): 1–19.

methodological issues in all the studies and non-verifiability as a common factor in all. For Mishra's work from 1996-98, despite his claim to Vedic interpretation, Mahadevan agrees with the basic language structure. However, he seems to be offended due to Mishra's remarks such as "..(using)... DED to read the Indus texts is abortive" and "... the Tamil merchants should never have found a place in (the Indus) inscriptions of ethical and philosophical nature".[96] Jha and Rajaram's publication in 2000, which became a major topic of debate, is also reviewed by Mahadevan. Their extrapolation of the perceived meanings to those of Vedic concepts does not follow any guideline to read the signs. Their convenient artistic reconstruction of a broken seal with a horse iconography turned into a huge debate in the academia. Mahadevan refutes these claims since they can not be tested for direction, word segmentation, and frequency-distribution analysis. In another study, Gurumurthy links Indus signs to Tamil. It is based on linking the Harappan signs to iron age pottery graffiti from Tamil Nadu. Those graffiti marks are linked with Brahmi and have Tamil phonetic values assigned to those. Mahadevan argues that this does not follow any archaeological evidence for continuity of material over the particular geographical expanse. In concluding remarks, Mahadevan provides a list of three tests viz. direction, word segmentation, and frequency distribution. According to him, those should be satisfied by any decipherment claim but there is a chance of false positives.[97]

Besides the Dravidian linguistic argument and its critique, other widely discussed proposal is that of Harappan culture being the Indo-European/ Indo-Aryan culture.[98] Talageri illustrates various historical references from second century BCE from West Asia, draws upon studies in historical linguistics, and also produces detail analysis of Vedic texts and *Puranas* of Indian subcontinent. He denies the Aryan invasion theory in totality. As mentioned in the previous section, movement of people identified as Aryans, has been a major building block in the Dravidian proposition to read the signs on MHA. Talageri's rejection leads him to denote this culture as Indo-European. He proposes the identity of the occupants based on the references in *Puaranas*, "... probably a mixture

96. Mahadevan, "Aryan or dravidian or neither? a study of recent attempts to decipher the indus script (1995-2000)," 6.

97. Mahadevan, 26–27.

98. Shrikant G. Talageri, *Aryan invasion theory and Indian nationalism* (Voice of India, 1993).

of *Purus* and *Anus* with perhaps also an element of *Yadus*".[99] He does not move forward to read the signs on MHA in any of the Proto-Indo-European or Indo-Iranian languages. However, his theory and arguments, which reject the Dravidian speaking population of Harappan culture, question the basis for Proto-Dravidian or Davidian reading of the signs on MHA. In his recent book, Talageri has responded to Tony Joseph's study on the formation of present day Indian population.[100] Though this debate is beyond the scope of present thesis, it raises several points regarding the theories of migration such as Aryans and their association with Harappan culture, movement of people and languages, and interpretation of the data from the genetic studies. In the midst of these debates, Witzel's work from early years of twenty-first century must be looked into. Based on linguistic analysis, he demonstrates that Rigveda has a presence of several loan words from central Asia. He notes that these represent several "... intrusions by Indo-Iranian speakers into the world of the great Mesopotamian, Bactro-Margiana and Indus civilisations as well as their individual, local acculturation."[101] Witzel and Talgeri have also landed in a debate where Witzel has documented several methodological lacunae in Talageri's book on historical analysis of *Rigveda*.[102]

In yet another acclaimed work, Shendge hypothesised about the language of Harappans by relating Rigvedic and Harappan material with Mesopotamia.[103] In a short article, she has proposed Akkadian or its descendent as a probable contender. However, there aren't many supporters to take this proposition forward. In her recent book, she has analysed changing sign distributions and has discussed possibilities of change in

99. Talageri, *Aryan invasion theory and Indian nationalism*, 403.

100. Shrikant G. Talageri, *Genetics and the Aryan Debate:" Early Indians", Tony Joseph's Latest Assault* (Voice of India, 2019); Tony Joseph, *Early Indians: the story of our ancestors and where we came from* (Juggernaut, 2018)

101. Michael Witzel, "Central Asian roots and acculturation in South Asia: linguistic and archaeological evidence from Western Central Asia, the Hindukush and northwestern South Asia for early Indo-Aryan language and religion," in *Indus Civilization: Text and Context*, ed. Toshiki Osada (Manohar, 2006), 87.

102. Michael Witzel, "WESTWARD HO! The Incredible Wanderlust of the Ṛgvedic Tribes, Exposed by S. Talageri," *Electronic Journal of Vedic Studies* 7, no. 2 (2001): 1–29.

103. Malati J. Shendge, "The Language of the Harappans: An unconsidered possibility," *Annals of the Bhandarkar Oriental Research Institute* 75, nos. 1/4 (1994): 143–170.

the usage and also across the sites of Mohenjo-daro and Harappan.[104] She has proposed steps to decode the logographic Harappan signs and to extract the meanings which they probably convey.[105] Irrespective of the language and only based on graphic similarity, the author has listed possible meanings for approximately 480 signs. For graphic similarities with natural objects such as varieties of shell, species of *bos* family, or fish varieties, she has provided the scientific names of species which highlight the morphological differences -

- - Labeo rohita - Rohu
- - Wallago attu - Catfish
- - Four
- - Great, Big

As these signs are combined into sequences, a meaningful phrase is built which describes lists, transactions of items, or materials. For example -

- - four large rohu[106]
- - horse receive[d][107]
- - guard (of) furrowed fields 2 [?][108]

With this logic, the Dholavira signboard has been interpreted as “Metal hammer, metal knife, metal stone (i.e. slag) smelt(ing) metal bull.” - first known board of a proto-historic metal manufactory.[109] The signs are -  .
Author has corroborated this with the evidence of metallurgical work and comparatively

104. Malati J. Shendge, *Unsealing the Indus Script. Anatomy of its Decipherment* (Atlantic Publishers, 2010).

105. Shendge, 214–218.

106. Shendge, 248.

107. Shendge, 253.

108. Shendge, 272.

109. Shendge, 307.

higher amount of copper objects than the ceramics.[110] Her arguments about possible use of artefacts is discussed in later sections.

Bonta brings an the interpretative approach for 'patterned inscriptions' through his research.[111] Wells has also used similar concept in his work.[112] Bonta attempts to group functionally homologous signs based on graphology, adjacency, and contrastive distribution.[113] The contrastive case is interesting where he groups the signs which rarely co-occur but occur in very similar 'environments'. Here, the intended meaning of environment is 'context'. However, as the paper proceeds, it is clear that it is only limited to the context of the signs within the sign sequence and not with the archaeological context of the artefact. Further, he uses a concept of markedness which is a characteristic of linguistic studies. This logic is based on phonology, sounds, and meanings. Less markedness results from less internal complexity. Bonta extends it to signs, and markedness of the signs is defined as a function of sign complexity and frequency: less marked the sign then high frequency of occurrence. Less complex and more frequent signs are considered as less marked compared to others in same functional class. He then describes compound forming strategies. The logic of markedness is interesting but how it implies and translates for signary is a critical aspect of the study. For each sign identified as a basic sign, he has studied the attributes such as position, duplication, occurrence with stroke numeral, frequent pairing, and sign compounds. He gives an example of the Jar sign which can be identified as an equivalent of 'be', a copular verb; and the modification with strokes as various noun formations. There are many common findings with those of Yadav and Vahia where the signs are classified based on their design elements.[114] Bonta's work probably creates a supporting argument based on linguistic concept of markedness. His approach is to move forward from individual signs which he identifies as less marked and then to derive the associated clusters. He concludes - basic fish sign as functional class, "... must therefore denote some semantic or mor-

110. Shendge, *Unsealing the Indus Script. Anatomy of its Decipherment*, 308.

111. Steven Bonta, "The Indus Valley script: a new interpretation" (Pennsylvania State University, Altoona, 2010), https://www.academia.edu/8691385/The_Indus_Valley_Script_A_New_Interpretation.

112. Wells, *Epigraphic Approaches to Indus writing*, 96.

113. Bonta, "The Indus Valley script: a new interpretation," 14.

114. Yadav and Vahia, "Indus script: A study of its sign design."

phosyntactic common feature."[115] He discards the probabilities of this sign as indicating calendrics, numerals, or street addresses, and he speculates metrological interpretation for the sign. He then enters the concepts of traded goods, commodities, and wealth. Without any direct or indirect evidence, he has related the seven fish signs with seven powers of two i.e. numbers 1 to 64, which is an abstract mathematical concept. As he relates the meaning of the sign to weights, and describes it as "Besides the number-like distributional behavior of the fish signs... ",[116] he refers to *ma-na* as a contemporary unit of weight used in many areas. Though the frequency of sign groups is observed across artefacts, the variety in material properties actually question the possibility of single objectification of these. Bonta's efforts to identify patterned inscriptions seems to have formed a basis for recent work by Mukhopadhyay, reviewed in the following section.[117]

Finally, a study by LeBlanc for his post-graduate dissertation suggests to look for Mesopotamian and Egyptian commercial spheres for possible correlations to writing systems.[118] It is based on a wide overview of material contacts across the Indian ocean and contemporary yet comparatively well documented history of that regions. He proposes that Elamite stamp seals could have inspired the tradition of Indus seals, just like they did for Egyptian and Near Eastern cultures.

2.3.1 ICIT database

Bryan Wells took up scholarly work on the Indus signs as part of his Masters thesis at the University of Calgary in 1998.[119] He later carried out doctoral research and is credited to

115. Bonta, "The Indus Valley script: a new interpretation," 55.

116. Bonta, 58.

117. Bahata Ansumali Mukhopadhyay, "Interrogating Indus inscriptions to unravel their mechanisms of meaning conveyance," *Palgrave Communications* 5, no. 1 (2019): 1–37, https://doi.org/https://doi.org/10.1057/s41599-019-0274-1.

118. Paul D. LeBlanc, "Indus Epigraphic Perspectives: Exploring Past Decipherment Attempts & Possible New Approaches" (Department of Classics and Religious Studies, Faculty of Arts, University of Ottawa (Canada), 2013), 107, https://ruor.uottawa.ca/bitstream/10393/26166/1/Leblanc_Paul_2013_thesis.pdf.

119. Bryan K. Wells, *An introduction to Indus writing* (University of Calgary, 1998).

have created an online database of the inscribed objects from the Harappan sites.[120] His later publication provides an insight into his approaches to understand and analyse the Harappan script.[121] Since he did not agree with the sign-lists which were available for analysis, he created his own encoding system and identified 700+ unique signs (709 as of January 2023). Compared to Mahadevan, Parpola, and Hunter's lists, Wells has separated out many signs from their variants as unique on the basis of contextual properties. These properties are: (i) appearances on different artefact types, (ii) locations, and (iii) positional frequencies of similar looking signs. This initial step in his work is critical since total number of signs is often used as a indicator to identify the nature of the script - for example alphabetic, syllabic, or logo-graphic. The contextual as well as temporal distribution of signs has been taken into consideration while encoding the signs. He describes the process of analysis[122] and the mechanisms to construct a sign.[123] Based on positional analysis, he has provided justification for keeping separate signs and for not collapsing those into fewer ones. A comparative example can be seen in figure 2.3 for Mahadevan's sign number 15, Parpola's sign number 4, and Wells' signs 153, 155, 156, 158.[124] He has built on S. R. Rao's concept of basic and compound signs but has also based his work on the analysis of potter's marks.

Wells' methodology is granular and tightly bound in the archaeological material. His tentative typology scheme and classification of iconographic features adheres to the material differences. He is also cognizant of the limitations of the dataset. The online version, i.e. ICIT database provides cross-referencing of the signs with those of Parpola and Mahadevan. For the artefacts, it has links to the identifiers from CISI volumes and excavation reports. ICIT, being a relational database system, it stores the information both at the artefact level and the sign level. This is a significant improvement over previous corpora. As per his observations, ignorance to typology, site, and period of artefacts has contributed to the stagnancy in the decipherment space. He has con-

120. Bryan K. Wells and Andreas Fuls, "Online Indus Writing Database," 2010-2023, accessed May 16, 2023, http://www.indus.epigraphica.de/.

121. Wells, *Epigraphic Approaches to Indus writing*.

122. Wells, 49.

123. Wells, 57.

124. Wells, 55.

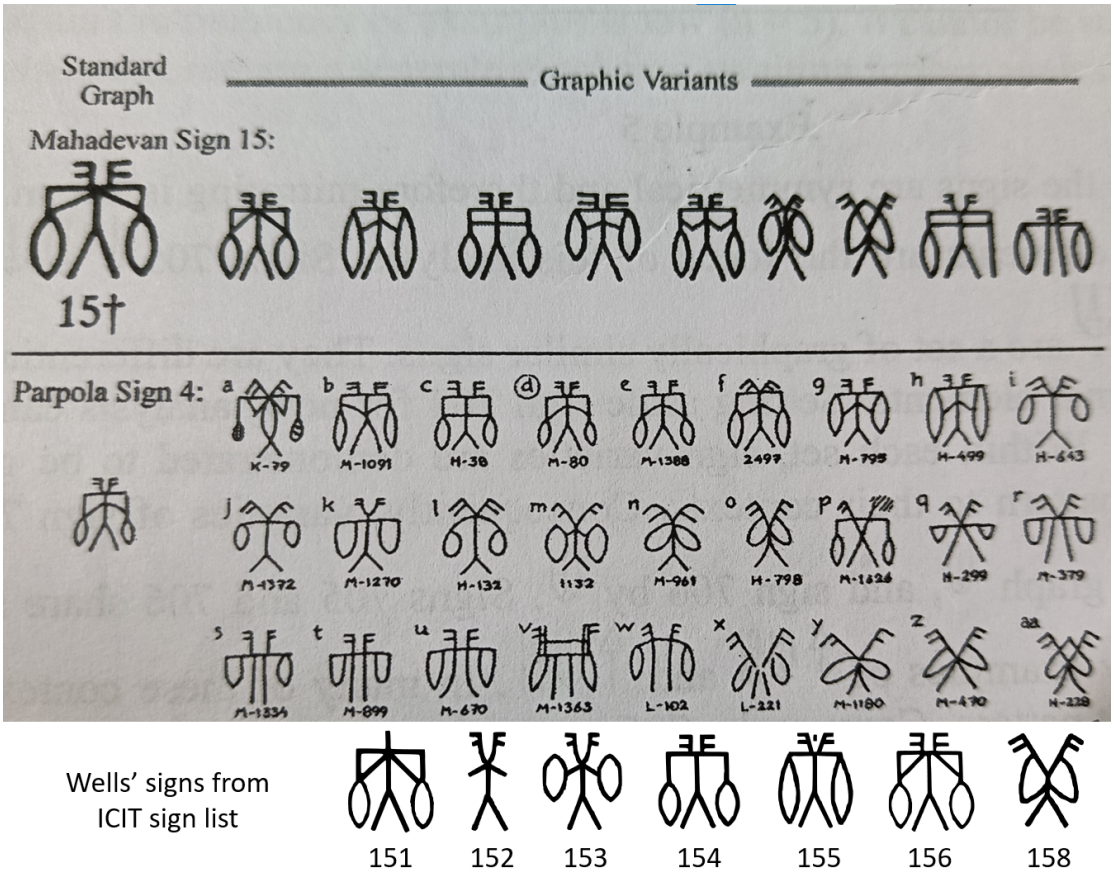


Figure 2.3: Sample of signs and variants by Mahadevan, Parpola, and Wells

ducted a detail review and analysis of potter marks in comparison with those from the contemporary cultures. He identifies at least 23 signs in Harappan script shared with Baluchistan's potters' marks, where this tradition forms a pre-cursor to the signs at least by few centuries.[125] About sealings, the probable use for wider circulation provides a clue about their location. In his analysis of the signs, some of his methods overlap with previous scholars such as sign frequencies, sign positions, identifying terminal markers, and text lengths. However, he also brings out new functional aspects of signs like enclosures, possible numeral signs, and most importantly association of these signs with the underlying artefacts.

He emphasises the fact that there is no reasoning behind assignment of the phonetic values to the signs or the use of rebus like techniques.[126] Having said that, and following his own path to acknowledge the archaeological context of the artefacts to

125. Wells, *Epigraphic Approaches to Indus writing*, 43.

126. Wells, 79.

better understand the Harappan signs, he is open to ideas of signs encoding phonetic values and having a syntax for a particular language. Like his other colleagues of the decipherment discourse, Wells tries to maps the signs to linguistic components such as root, derivational argument, morphological argument, cases, verbs, noun and adjective sequences, suffix, prefix, and infix. His short historical linguistic analysis, mostly based on Witzel's, McAlpin's, and Anderson's works tentatively concludes that verb and noun formation of Proto-/para-Munda is more closer to Harappan signs than that of Proto-Dravidian.[127]

Wells has dedicated a separate chapter for possible numeral signs. Though they look obvious for counting or measuring, Wells has categorically highlighted possible existence of polyvalence.[128] He has iterated this for non-numeric signs too. Though he rejects the possibility of accountancy, he finds the pattern similar to economy related texts of other scripts. Despite his proposal of possible linguistic affinity with Proto-/para-Munda against the Dravidian trend, he compares the numeric systems with Linear B and Proto-Sumerian. In his yet unpublished work, new observations are made regarding standardised weights of Harappan culture and their possible correlation with a set of signs.[129]

After his retirement, Dr Wells transferred the ownership and copyright of this online database to Dr Andreas Fuls, faculty at TU Berlin. Since then the database has been continuously updated with new artefacts, their attributes including the metadata, and also new signs as and when those are discovered on the artefacts. On the introduction page, the broad changes can be seen listed for each version of the database.[130]

Besides maintaining and updating the database, Fuls has performed a positional analysis of similar looking signs in ICIT sign-list and has revealed that their usage patterns and positional frequency can be far different. These may act as a complementary attribute to graphic similarity.[131] He proposes that the position of the signs within the sign

127. Wells, *Epigraphic Approaches to Indus writing*, 140–144.

128. Wells, 116.

129. Bryan K. Wells, "Epigraphic Evidence for the Indus Economy" (2015).

130. Wells and Fuls, "Online Indus Writing Database."

131. Andreas Fuls, "Positional Analysis of Indus Signs," *Voprosi Epigrafika* Launch VII, Part 1 (2013): 253–275.

sequence are important because it may contribute to the intended meaning. These positional frequencies and identifiable differences in the shapes cannot simply be accounted for styles or scribe's skill. Hence, to merge them into a single sign due to some graphic similarity may not be appropriate. These usage patterns can also be seen impacted by the broad grouping such as seals, bas-relief tablets, and copper tablets. This is an important contribution for the sign encoding exercise. This underlines the fact that sign encoding itself is an abstraction, and artefact forms can impact the observed patterns and sequences. It is evident that as variants of single sign are identified as different signs, the number of signs would increase and might introduce some redundancy. However, reduced number of signs can permanently mask the different signs with a single representative graphic and hence can conflate the information embedded in the variants.[132] An immediate result of the extended sign encoding is seen in frequency analysis of mirror signs, described in the next chapter. In June 2023, Dr Fuls has published the entire database in the form of a book title 'A Catalog of Indus Signs'.[133]

2.3.2 Note

Throughout the decipherment studies a persistent search for morphology and syntax is observed. Morphology is seen through the changes to sign forms and their use as indicators of the inflections to the assumed basic sign. Syntax is seen in analysis of sign positions, pairing, and frequencies. Both these properties have been essentially and predominantly borrowed from linguistics. This, if not otherwise, is more of a teleological approach, but most putative till date. The roots can be traced in the first chapter where the combined effects of (i) the need for nation's identity creation, (ii) European influence, (iii) quantitative analysis as a processual theme, and (iv) presentist notions about writing as a sign of advanced stage of society in the past were discussed. Though scholars like Bonta mention the variety of forms observed amongst the inscribed objects, they do not necessarily argue that these call for different interpretations of presumably similar content in terms of signs. Rather, Bonta questions:

> ... we find much the same sort of patterned inscriptional material on all of

132. Mahadevan, *The Indus script: texts, concordance, and tables*, 785–792; Parpola, *Deciphering the Indus script*, 70–78

133. Andreas Fuls, *A Catalog of Indus Signs*, vol. 4, Mathematica Epigraphica (Independent, 2023).

> these media ..... why the same, or similar, information that appears on seals also appears, and often very repetitively, on other completely different types of objects, whose every appearance suggests that they did have some kind of commercial or monetary purpose.[134]

On the contrary, sensitivity study on signs by Yadav mentions "While there is a common thread of rules and grammatical structures that are fairly well obeyed in the Indus writing, the present study suggests that writing on different types of objects and at different sites do have individualistic clues to their content."[135] Despite the use of limited dataset of M77 and vaguely defined typology, these observations demand critical analysis against Bonta's remarks.

After Possehl's profound review of the status of Indus writing in 1996 and Mahadevan's review of non-Dravidian decipherments in 2002, it is important to observe that the research into sign encodings of Hunter, Mahadevan, Parpola, and Wells, itself has qualified for a doctoral research.[136] While concluding the comparative analysis and evaluating the contributions made by these scholars and their corpora, Subramanian observes that contextual analysis of Indus texts is mostly unexplored and probably has potential to improve our understanding of these artefacts. Also, the prevalent thought to link Dravidian language to these signs is a result of the work of the first three of these scholars.[137] He also observes that Koskenniemi, Parpola, and Mahadevan have borrowed the typology from the excavation report. When he compares the artefact typology codes for all four, it is observed that Parpola's codes are finer than M77.[138] However, neither of them have necessarily arrived at it, nor do they question the adequacy of it for its persistent use in their ongoing research in decipherment. It is important to note that all typology codes have created a separate category for copper tablets. From typological scheme point of view, this is inconsistent because other objects are not always categorised primarily based on material (e.g faience, ivory, bone), nor are the copper

134. Bonta, "The Indus Valley script: a new interpretation," 122.

135. Yadav, "Sensitivity of Indus script to site and type of object," 99.

136. Subramanian, "The Contribution Of Indus Text Corpora / Concordances To The Textual And Contextual Analysis Of The Indus Script: A Comparative Study."

137. Subramanian, 231–232.

138. Subramanian, 134.

objects subdivided based on the form (like tablets and implements).

2.4 Statistical studies

Against the background of existence of the Soviet and Finnish sign-lists and sign sequence concordances, only M77 is seen subjected to rigorous statistical analysis by multiple scholars besides Mahadevan himself. The main objective of these analyses has been to understand the sign distribution and patterns of repetitions. Majority of that work comes from a group of scientists from TIFR. In 1980s, the TIFR had assisted Mahadevan to create a refined version of his concordance with the aid of computers.[139] In a short span of time since 2008, the team from TIFR, along with collaborators from other institutions have published multiple papers based on Mahadevan's sign-list and text concordance.[140] However, it is worth mentioning that despite more than 30 years after the birth of the concordance, and the new data being made available through the excavations, all these research papers continue to use the dataset as it was, without any significant additions or modification. They have accepted the sign-list, sign sequences, typology, and other attributes as is from M77. Neither do they provide justification about why the dataset continues to be optimum nor do they question the definitions in the dataset. All of these use 417 signs, 3573 lines of text, and 2906 artefacts grouped in seven buckets of sites and eight groups of artefact types.

The scholars have used this data for various studies such as sign segmentation, to associate the patterns to linguistic components, sign extraction by image processing, and iconographic analysis to a small extent. These studies exclusively work on the signs for understanding their associations with each other and extract syntactical or morphological structures. While the results of these studies are acknowledged and could be used as inputs for further archaeological research, some key points about sign encoding must be iterated as preconditions or constraints: (i) the signs themselves are result of a process of abstraction, (ii) lack of consensus in identification of unique signs and encoding them have resulted into multiple sign-lists as seen in the earlier sections, (iii) thus any statistical analysis performed on any sign-list is as good as the given list, and (iv) the data is

139. Iravatham Mahadevan, "A Computer Study of lhe Indus Script," *Current Science* 55, no. 2 (1986): 77–79.

140. "List of papers and abstracts published till December 2011."

highly biased toward two sites and hence not necessarily a representative sample.

In an interesting study by TIFR scientist,[141] where basic archaeological context of site and type is taken into consideration, a methodological contrast is encountered. Their conclusion section notes, "... the type of object, the length of the written texts and the usage of signs are a complex set of parameters that are sensitive to the sites from which the writing is discovered."[142] Further, the author mentions, "Any model of interpretation of the Indus script must therefore include site of occurrence and type of object as potential sources of fluctuations".[143] On the contrary, with the archaeological material, archaeologists begin the study by acknowledgement of the separation in material at all possible levels. This is because the default understanding is that the archaeological record is a distorted or transformed reflection of the past and is highly contextual. They then analyse the data to see if any trends or patterns can be discerned. Those can later be interpreted with respect to their contexts. The record is thus not treated as a random, uniform, or homogeneous sample. This basic tenet of archaeology is seen eluded in studies like the one mentioned above. The study demonstrates a reverse methodology employed by statisticians than that of archaeologists. They assume similarity and standardisation of these signs. Then based on the analysis of types and sites, they conclude that these are important factors and signs could be associated with those. Thus what would have been 'the preliminary material observation in an archaeological study' has turned out to be 'the inference of a statistical study'. In a hindsight, in their 2011 paper, the authors had concluded uniformity and robustness of signs over space and time (mentioned earlier in this chapter).[144]

Some of the recent studies have applied ML techniques on this dataset. In a 2017 study, the scholars created random clusters of texts.[145] To understand what these clusters mean is a difficult task. Besides two sites and two types, the remaining matrix

141. Yadav, "Sensitivity of Indus script to site and type of object."

142. Yadav, 97.

143. Yadav, 98.

144. Yadav and Vahia, "Indus script: A study of its sign design," 37.

145. Nisha Yadav, Ambuja Salgaonkar, and Mayank N. Vahia, "Clustering Indus Texts using K-means," *International Journal of Computer Applications* 162, no. 1 (2017): 16–21.

rarely demonstrates a comparable variation.[146] Experiments like K-means clustering which assume data as a random statistical sample, groups the texts which are similar to each other based on sign structures (without assumptions about the content). Almost all groups show affinity to Mohenjo-daro and Harappa, and seals and sealings; it is a known bias in the dataset. Though the clusters have affinity to signs and sign groups, the lack of specific affinity to sites and types does not help interpret them. Possibility of such cluster formation of texts is inline with the earlier work by Yadav.[147] There, the concept of segmentation of texts in pairs, triplets, and in groups of four signs is to propose that longer sequences can be formed by combination of such predefined segments.[148] The example from this study can be seen in figure 2.4.

Object No.	Segments of Text						
1232:	P148	P86					
	 342 48	 99 267					
	1279	4441					
4254:	P53	T148	P116	PM9	389		
	 14 2	 211 89 336	 342 341	 59 171	 389		
	2371		1226				
2537:	P41	PM14	67	PM9	389	344	PB1
	 342 149	 130 51	 67	 59 171	 389	 344	 123293
	8001						
2461:	T94	326	87	P131	178		
	 245 245 25	 326	 87	 15 389	 178		
	1437			2682			

Figure 2.4: Text segmentation example - by Yadav et al.

This is similar to Wells' exercise of structural analysis which leads to the concept of patterned texts.[149] However, he has proposed a significant improvement by incorpora-

146. Yadav, Salgaonkar, and Vahia, "Clustering Indus Texts using K-means," 19–20.

147. Nisha Yadav et al., "Segmentation of Indus Texts," *International journal of Dravidian linguistics* 37 (2008): 53–72.

148. Yadav et al., 71.

149. Wells, *Epigraphic Approaches to Indus writing*, 92–105.

tion of two major sites and artefact typology to interpret the occurrences of combinations of these patterns. The unsupervised K-means clustering work discussed above may become more meaningful with similar approach. This may create an interpretative power within the dataset. Figure 2.5 shows an example by Wells where longer sequences can be seen split in different combinations in different artefacts.[150]

	VII	VI	V	IV	III	II	I
M – 0371 Seal R	s617 s142 s384 s032	s154 s806 s467					
H – 158 Seal R		s158 s806 s472	s001 s740 s405 s590				
H – 008 Seal S		s354	s001 s740 s405 s590	s033 s706			s002 s690 s921
M – 0868 Seal S				s520 s033 s705	s231 s220		s002 s817
M – 0386 Seal R	s405 s004	s001 s137					
M – 0380 Seal R		s137 s003	s001 s740 s920 s322				
M – 0394 Seal R			s740 s752	s001 s033 s706			
H – 386 Seal S		s527 s555	s740 s055		s240 s415 s798		s060 s201
M – 0365 Seal R		s527 s550		s033 s705	s233 s415		s060 s550
M – 0631 Seal S				s520 s033 s706	s240 s220 s032	s368 s263	
M – 1052 Seal R			s679 s740		s220 s032 s806	s001 s595 s575	s001 s095
Seals with single segments	s617 s142 M – 0382 Seal R	s154 s806 s468 H – 152 Seal R	s740 s176 M0301 Seal S	s520 s033 s705 M – 0122 Seal S	s220 s017 H – 009 Seal S	s595 s575 s704 s140 M – 0074 Seal S	s002 s817 K – 027 Seal S
	s390 s003 M – 0179 Seal S	s527 s550 DK12783 Seal S					

Figure 2.5: Text segmentation and pattern analysis - by Wells

A network analysis study by Sinha et al.[151] is in close agreement with TIFR team's

150. Wells, *Epigraphic Approaches to Indus writing*, 95.

151. Sitabhra Sinha et al., "Network analysis reveals structure indicative of syntax in the corpus of undeciphered Indus civilization inscriptions," in *Proceedings of the 2009 Workshop on Graph-based Methods for Natural Language Processing, ACL-IJCNLP* (2009), 5–13.

results.[152] Authors corroborate the existence of certain combinations of signs as far more frequent than just by chance. To complement this work, a statistical analysis to compare the beginning and end signs' frequencies across multiple scripts has been carried out by Ashraf and Sinha.[153] As per their study, the probability distribution of signs on either ends is distinct across 24 scripts, including ICIT. This difference is a universal feature across the analysed scripts and is proposed as an indicator for the direction of writing since it "... is one of the basic pre-requisites for interpreting any linguistic sequence."[154]

Other examples of ML experiment fall in the image analysis space of both the artefacts and the signs. In their yet unpublished work, Palaniappan and Adhikari have carried out Deep Learning (DL) experiments on the images of Indus script. They try to extract the 'string of graphemes' by using M77 as a labelled data for training.[155] This is an optical character recognition (OCR) mechanism for automated extraction of signs from the images of seals or sealings. The accuracy achieved for jar sign is encouraging. The authors argue that the major obstacle in epigraphic studies is generally a standardized corpus of the inscriptions and it can now be tackled. Here too, though the present paper is just a prototype to identify the jar sign, the signary of M77 is provided as a labelled dataset for learning. Since the signs have to be assigned to one of the 417 signs of the labelled dataset, when they proceed for other signs, the algorithm may assign the rhomboid and oval to a single sign as mentioned above.[156]

Daggumati and Revesz employ convolutional neural networks (CNN) in image analysis to identify most similar signs from the Phoenician alphabet letters and Brahmi symbols to those of Harappan signs.[157] For the comparison, they have identified most common signs from ICIT. Their approach is interesting, and it might be worth experiment-

152. Nisha Yadav et al., "A statistical approach for pattern search in Indus writing," *International Journal of Dravidian Linguistics* 37, no. 1 (2008): 39–52; Yadav et al., "Segmentation of Indus Texts"

153. Md Izhar Ashraf and Sitabhra Sinha, "The "handedness" of language: Directional symmetry breaking of sign usage in words," *Plos one* 13, no. 1 (2018): e0190735.

154. Ashraf and Sinha, 8.

155. Satish Palaniappan and Ronojoy Adhikari, "Deep learning the Indus script" (2017).

156. Palaniappan and Adhikari, 7.

157. Shruti Daggumati and Peter Z. Revesz, "Data mining ancient script image data using convolutional neural networks," in *Proceedings of the 22nd International Database Engineering & Applications Symposium* (2018), 267–272.

ing with contemporary script systems to Harappan. Though the results shows higher matching strength of Phoenician over Brahmi, the quantitative difference is too small, i.e. 0.6546 vs. 0.6490. Also, the previous sections discussed the phonetic assignment experiments and issues there in. Thus, to conclude that Phoenician phonetic values are a better choice over Brahmi for mapping those to Harppan signs, needs more corroborative evidence.

The most recent publication by Mukhopadhyay employs M77, here identified as IDF-80 - the 'Input Data File', after some enhancements done in 1980.[158] The paper claims that seals, sealings, and tablets are the 'formalised data carriers' and the sign sequences employ "...both linguistic and non-linguistic (document-specific) syntaxes to convey their meanings."[159] The contextualisation in this work is with the present day 'formalised data carriers' such as stamps, coins, and government seals. The priori for this comparison is based on the scholarship which establishes the purpose of these objects as that for commercial and administrative activities. The text segmentation is achieved by identification of signs which show semantic completeness such as single occurrence, which have primary/sequential positions (phrase finals), numerical signs, metrological signs, and more such criteria. The author argues "...categorizing several Indus logograms into nine functional classes, it explores the way each sign-class has played unique functional roles for conveying complete messages through the brief inscriptions."[160] Example of functional classes are as follows: (i) phrase finals are identified based on their occurrence in the initial positions, (ii) metrological signs are based on perceived meaning related to quantification, and (iii) connective-morphemes are based on linguistic theory which joins two semantically complete sign sequences. The paper concludes that Indus signs should not be treated "... as phonograms in order to spell out words. Moreover, since the inscribed objects are identified as formalized data-carriers, in which linguistic and document-specific syntaxes can play equally important roles, a researcher would not have to explain each syntactic feature from a linguistic and gram-

158. Mukhopadhyay, "Interrogating Indus inscriptions to unravel their mechanisms of meaning conveyance."

159. Mukhopadhyay, 2.

160. Mukhopadhyay, 1.

matical aspect."[161] Mukhopadhyay has not explicitly given the total number of DILs (distinct inscription-lines) and number of artefacts she has worked on. Author mentions that "Excluding the 89 DILs which contain only single signs, and 323 DILs whose terminal signs are irretrievably lost, 1998 DILs of IDF-80 remain."[162] It thus appears that 2906 inscribed objects[163] and 2410 original total number of DILs existed in IDF-80. M77 had 3573 lines of text so dataset in this study is reduced to a great extent.[164]

This work is an improvement in approach over earlier mentions of clustering, segmentation, pattern search, and similar statistical analyses. The segmented components are glossed by the type of the segment i.e. functional class and then the texts are grouped which follow the same glossing patterns of the functional classes. This approach also follows an earlier effort from 1988, again performed on M77 only.[165] The probable sign sequence segments identified in that work demonstrate concurrence with Mukhopadhyay's works.

Though the author does not refute or question any claims by earlier scholars, she does not explain how her identification of partial non-linguistic nature i.e. presence of a document specific set of signs (groups named PF1 and PF2), fits into the Markov model theory,[166] conditional entropy logic,[167] or the N-gram analysis,.[168] Also the study does not comment on earlier interpretation of the same dataset such as Dravidian reading of these signs[169] or proposed affinity to old Tamil.[170] Since all these analyses have been performed on the same sign-list and sign sequences it is rational to expect a comment

161. Mukhopadhyay, "Interrogating Indus inscriptions to unravel their mechanisms of meaning conveyance," 35.

162. Mukhopadhyay, 8.

163. Mukhopadhyay, 6.

164. Mahadevan, *The Indus script: texts, concordance, and tables*, 9.

165. Gift Siromoney and Abdul Huq, "Segmentation of Indus texts: a dynamic programming approach," *Computers and the Humanities* 22, no. 1 (1988): 11–21.

166. Rao et al., "A Markov model of the Indus script."

167. Rajesh P. N. Rao et al., "Entropic evidence for linguistic structure in the Indus script," *Science* 324, no. 5931 (2009): 1165–1165.

168. Yadav et al., "Statistical analysis of the Indus script using n-grams."

169. Mahadevan, *Dravidian proof of the Indus script via the Rig Veda: a case study*.

170. Rao et al., "Entropic evidence for linguistic structure in the Indus script."

where a contrastive conclusion is drawn. On the other hand, none of the scholars from TIFR group have objected or raised concerns with the partial non-linguistic argument. Though the author has considered a variety of object forms, her interpretation is generic across the types and does not account for the deviation across space and time.

As the author proposes logo-graphic nature of these signs, she has not explained how the limited sign-list of 417 used in Mahadevan's corpus is comparable to established logo-graphic scripts like Chinese which has thousands of signs for it to be 'logo-graphic'.[171] It must be noted that Mahadevan himself opined differently in identification these signs as logo-syllabic writing[172] or ideo-graphic[173] or logo-graphic.[174]

Finally, the comparison with modern examples demonstrates a non-archaeological approach and many assumptions imposed on the possible use of 4500 year old artefacts. Example of seals found on objects like canisters to make stoneware bangles, those on huge jars, signs on ceramics and even the clay lumps with multiple overlapping impressions have not been considered or discussed at all.

The discussion till now illustrates how the argument about signs as 'a representation of the vocal sounds' and 'depicting a script for a language' has progressed and solidified over time. Following observations emerge from this review.

- Parpola, Soviet scholars, Mahadevan, and Fairservis propose Dravidian meanings of words for interpreting the signs but they do not concur with each other.
- Though S. R. Rao proposes the evolution of the script, relation with Semitic alphabets, and thus proposes Indo-Aryan phonic values, he is heavily criticised for the structural analysis of the signs.

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171. Iravatham Mahadevan, *Claims of decipherment of the Indus Script: Some objective methods to test their validity*, 1985; Mahadevan, "What Do We Know about the Indus Script? Neti, neti (not this, not that)""

172. Iravatham Mahadevan, "Towards a Grammar of the Indus Texts:'Intelligible to the Eye, if Not to the Ears'," *Tamil Civilization: Quarterly Research Journal of the Tamil University* 4, nos. 3-4 (1986): 15–30; Mahadevan, *Claims of decipherment of the Indus Script: Some objective methods to test their validity*

173. Mahadevan, "Agricultural terms in the Indus Script"; Mahadevan, *Dravidian proof of the Indus script via the Rig Veda: a case study*

174. Mahadevan, *The Indus Fish Swam in the Great Bath :A New Solution to an Old Riddle*.

- Wells has refuted all possibilities except for Proto/para-Munda and an unknown language.
- Persistent use of M77 by the scholars continues to extend the language argument based on the sign analysis.
- Mukhopadhyay's latest paper demonstrates that entirely opposite interpretations (non-linguistic nature of the texts) are possible on the same dataset when different techniques are employed - " ... positional preferences, co-occurrence-preferences and co-occurrence restriction patterns."[175]

However, some fundamental questions which still remain to be asked and answered are: (i) whether relevant data exists to answer the language question? (ii) whether the assumptions of monolingual nature across space, time, and type are plausible? (iii) is there a need to redefine the problems which are more archaeological than statistical and re-shape the dataset to seek answers for those?

2.5 Critique and defence

It is now evident that MHA scholarship is not only about the archaeological material but about a crucial intangible characteristic of the society viz. language. This almost confirmed linguistic hypothesis was attacked in 2004 by a team that consisted of a neurologist who specialised in systems biology and simulation, a computational linguist, and a Sanskrit scholar with expertise in Indology and Indian mythology (hereafter referred as FSW for the contributing authors Steve Farmer, Richard Sproat, and Michael Witzel respectively). Their paper titled 'The Collapse of the Indus-Script Thesis: The Myth of a Literate Harappan Civilisation',[176] its critiques from academia, and FSW's response to the critique[177] has created one of its kind academic debate. Their main ar-

175. Mukhopadhyay, "Interrogating Indus inscriptions to unravel their mechanisms of meaning conveyance," 2.

176. Steve Farmer, Richard Sproat, and Michael Witzel, "The collapse of the Indus-script thesis: The myth of a literate Harappan civilization," *Electronic journal of Vedic studies* 11, no. 2 (2004): 19–57.

177. Papers published by FSW team can be seen at Steve Farmer, "Papers and Lectures Online - Steve Farmer, Ph.D.," 2009-2023, accessed August 13, 2021, http://www.safarmer.com/

gument is against the ED studies which have been discussed in this chapter till now. This section elaborates the debate.

Prior to FSW's claim, there is no strong voice that rejected the language hypothesis. In his initial academic work on the Harappan civilisation, Fairservis did look at the artefacts as a material evidence. He mentions "Seal writing is not necessarily writing derived from the oral language. It has its own meanings and in effect need not have verb, adjective, or adverb."[178] However, his total acceptance of the Dravidian argument and publication of his own interpretation in 1992 demonstrates his submission to the language hypothesis. FSW, in the beginning of their argument point this out. Also, Fairservis' submission was not a result of new archaeological finds, but due to the great influence of the simultaneous announcements of Soviet and Finnish teams around 1970, which almost confirmed the script as a language. FSW's main points can be summarised as follows -

- Statistical regularities can be found even in non-linguistic symbol systems.
- Other contemporary scripts seem to omit phonetic, grammatical, semantic data, and use the signs in polyvalent ways. Thus identification of a language just from the positional data is not possible.
- Same sign has been read in multiple ways by the proponents of the Dravidian roots.
- This has triggered the claims for Indo-Aryan/Vedic Sanskrit interpretations of the signs.
- Both the claims are efforts to extend the history of the subcontinent by correlation of the archaeological material with Vedic texts or old Tamil traditions.
- Brevity of the inscriptions show that these cannot contain linguistic content.
- 'Lost-manuscript thesis' has no supporting evidence such as writing material or scribes.[179]

178. Walter A. Fairservis, *The roots of ancient India* (Macmillan, 1971), 282.

179. Farmer, Sproat, and Witzel, "The collapse of the Indus-script thesis: The myth of a literate Harappan civilization," 24.

- 'The combination of high general sign frequencies and low repetition rates in single inscriptions is inconsistent with what we expect from fully enabled scripts.'[180]

They conclude that the signs depict religious or political symbols. They deny the possibility of the verbal sounds which compose the language. To demonstrate objectivity, logic, and science, they end the thirty page long paper with a note on falsifiability. They state that their theory would be proven incorrect with at least one of the following archaeological discoveries - (i) remnant of or a full long text, (ii) sign duplication with required frequency, (iii) bilingual texts with previously deciphered script, (iv) creation of generic set of rules for reading, and (v) lexical list.

Their conclusions against the linguistic argument are determinative rather than probabilistic or incremental. As they claim the non-linguistic nature of signs, they also delve into causal questions such as why the Harappans never adopted writing; they further extend it into "... non-linguistic symbols enhanced social cohesion among their multilinguistic populations (after Boone and Mignolo)", and "Writing was not a necessity of ancient urban civilizations... ."[181] FSW argue that the non-linguistic nature of the signs or the non-literate status of the Indus society, essentially elevates the significance of the script. They propose multi-vocality of Indus signs. As per their interpretation, the sign usage is for agricultural magic and rituals, and not for accounting or trade; gendered depiction or holy trees imply communal indoctrination.[182]

Though there was a huge backlash from archaeologists, linguists, Indologists, and Sanskrit/Dravidian scholars, Richard Meadow showcases an archaeological mindset. He had provided a lot of published and unpublished data to the trio for their research. His emotional disconnect from the data and ethical tie with the field makes him believe that new models will always help to do 'science'.[183]

After a gap of three years, Massimo Vidale responded to FSW's article in a long ar-

180. Farmer, Sproat, and Witzel, "The collapse of the Indus-script thesis: The myth of a literate Harappan civilization," 31.

181. Farmer, Sproat, and Witzel, 47.

182. Steve Farmer, *Mythological functions of Indus inscriptions - Sixth Harvard Indology Roundtable*, 2004, http://www.safarmer.com/indus/Harvard2004.pdf.

183. A. Lawler, "Archaeology. The Indus script–write or wrong?," *Science (New York)* 306, no. 5704 (2004): 20–26.

ticulated paper.[184] He sensed an offensive tone in FSW's paper. He provided a detailed response from an archaeological point of view. He demonstrates that in their effort to unleash the "... truth behind the dark curtains of a dangerous scientific myth",[185] FSW land with "... wild speculation presented as serious scientific evidence."[186] Vidale's major concerns with their approach are their serious lack of archaeological factuality, selectiveness about the data to extend the arguments, their challenge to refute the argument in linguistic terms, and their inability to demonstrate their own thesis. Vidale refutes FSW's claim that sufficient cross-cultural comparative work has not been performed with other non-linguistic sign systems contemporary to the Harappan culture. He provides preliminary comparison with around ten such systems from central and South Asia, and suggests it to be a better model than FSW's idea of comparison of the signs with airport tags. On their claim of Indus signs being non-linguistic sequences due to brevity, Vidale notes that length has to do with context of use and not the amount of information. Short texts on shipping jars are very much indicative of substantial information or key instructions. Vidale observes that FSW do not "... think like archaeologists... " and hence "...miss ....many fold implications of contextual meanings".[187] FSW's comparison of MHA signs with Egyptian Cartouches mentions that some signs have phonetic value due to their repetition being six to seven times more frequent than Harappan; it does not hold when the long inscriptions of Greek-Roman period (which contain Greek and Latin names too) are excluded. Vidale demonstrates the possibility of unique and rare signs to have a different explanations. The urban growth model seen from Harappan sites and newer interpretations of structures from Mohenjo-daro is different than "... traditional univocal dichotomy (of) citadel-lower town"[188] concept. He also explains the lack of standardisation as a possibility for independent workshops or craft families which produced the seals. In Mesopotamia, the need of standardisation of cuneiform script arose from the need to store, retrieve, and exchange information in

184. Massimo Vidale, "The Collapse Melts Down: A Reply to Farmer, Sproat & Witzel," *East and West* 57, nos. 1/4 (2007): 333–366.

185. Vidale, 334.

186. Vidale, 361.

187. Vidale, 336.

188. Vidale, 351.

the wider contexts. In case of the Indus, all these activities were probably limited to the control of craft and trade within the urban compounds and social groups. It resulted into sets of individual signs in the frame of unified tradition.[189]

In his comparison of deciphered and undeciphered scripts, Wells demonstrates that there exist logical criteria such as corpus, context, bilingual evidence, language, and pictures,[190] for the possible co-existence of the script in the past and its decipherment in the present. However he argues that it is not necessary that those which fulfil all the criteria will surely be deciphered. On the contrary, some scripts get deciphered even if they do not meet many conditions. The comparison can be seen in the following table 2.2 compiled by Wells (based on Houston and Coe).[191]

Script	Type	Period	Signs	Con text	Corpus	Langu age	Billing ual	Pict ures
Deciphered								
Egyptian	Sp. L-S	3500 - 300 BC	800	X	X	/	X	X
Proto-Cuneiform	L	3600 - 3000 BC	600	/	X		X	
Akkadian	L-S	2334 - 2154 BC	600	X	X	X	X	/
Cypriot	S	650 - 150 BC	56	/	X	X	X	X
Luvian	L-S	1500 - 700 BC	497	X	X			X
Linear B	L-S	1900 - 1400	87	/	X			
Isthmian	L-S	250 - 500 AD	210	.	X	/		

189. Vidale, “The Collapse Melts Down: A Reply to Farmer, Sproat & Witzel,” 351.

190. Wells, *Epigraphic Approaches to Indus writing*, 79.

191. Wells, 80.

Mayan	L-S	250 - 1400 AD	1000+	X	X	X	/	X
Undeciphered								
Meroitic	A	712 - 656 BC	25	X	X		X	/
Etruscan	A	700 - 500 BC	24	X	X		X	
Linear A	L-S?	1750 - 1450 BC	418	/	/			X
Proto-Elamite	L-S	3050 - 2900 BC	~1000	X	X	X		
Linear Elamite	S	~ 2150 BC	80	/	/	X		
Rongo rongo	?	Before 1600 AD	120	X	X	X		
Zapotec	L?	600 - 400 BC	90	X	X	X		/
Indus	L-S	2600 - 1700 BC	700	X	X			/
Phaistos	?	1850 - 1600 BC	56					/

Table 2.2: Scripts and their characteristics as possible drivers for decipherments - by Wells

Another critical response comes from a group of scholars - computer scientist, astrophysicist, linguist, and statistician. Their publications in 2009-2010 highlight the use of statistical techniques to establish the linguistic nature of the script. Their main response is formulated around the entropic evidence demonstrated by the script. They use conditional entropy as an evidence for the presence of language in this writing system.[192] With the aid of N-gram and Markov models, they propose to have achieved a

192. Rao et al., "Entropic evidence for linguistic structure in the Indus script."

stage where even if they are unable to read or decipher the 'script', they can successfully construct the potential sequences by using those signs. The sign sequences have been observed as predictable and having a pattern.[193] Their following paper builds on this using n-Grams methodology.[194] In both studies, they have used modified version of M77, called EBUDS - Extended Basic Unique Data Set. TIFR team had described the creation of EBUDS in an earlier work. It is created by elimination of all texts which contain lost, damaged, illegible or doubtfully read parts, multiple lines, and multiple occurrences of a single sequence.[195] Also, they state that "Variations due to the archaeological context of the sites, stratigraphy, and type of object on which the texts are inscribed are, at present, not taken into account in the interests of retaining a reasonable sample size".[196] M77 and EBUDS can thus be summarised for their shape as follows:

- M77 - 417 signs; 3573 lines of 2906 texts (artefacts)
- EBUDS - 377 signs; 1548 lines (1302 occurring once, 245 more than once)

It is important to note that number of signs is reduced by ~10%. The number of lines is reduced by more than ~50%. It must be highlighted that majority of the studies (as listed below) which perform advanced statistical analysis on the M77 dataset, use the EBUDS version.

- Yadav et al., "Segmentation of Indus Texts"
- Yadav et al., "A statistical approach for pattern search in Indus writing"
- Sinha et al., "Network analysis reveals structure indicative of syntax in the corpus of undeciphered Indus civilization inscriptions"
- Rao et al., "A Markov model of the Indus script"
- Rao et al., "Entropic evidence for linguistic structure in the Indus script"
- Yadav et al., "Statistical analysis of the Indus script using n-grams"

193. Rao et al., "A Markov model of the Indus script."

194. Yadav et al., "Statistical analysis of the Indus script using n-grams."

195. Yadav et al., "A statistical approach for pattern search in Indus writing," 3.

196. Yadav et al., "Statistical analysis of the Indus script using n-grams," 14.

• Yadav, Salgaonkar, and Vahia, "Clustering Indus Texts using K-means"

This systematic way of data cleaning, has effectively glossed over the interpretative power of those variations which are a product of complex processes of archaeology itself. It is worth questioning whether this data machining process has gotten rid of the inherent archaeological ambiguities in pursuit of certitude?[197] In that case, it is important to observe how these studies shape further interpretation of the data and contribute in MHA epistemology.

Sproat responds to these claims with an argument that conditional entropy is only suggestive and not definitive.[198] For the linguistic claims, the data needs other supporting evidence. He mentions that success of use of N-gram language models in speech recognition systems relies on data-set of millions or billions of tokens. He also takes a stand that identification of patterns of signs as syntactic structure of a linguistic system, is not substantiated by the data which the authors present in all these papers. In the very next issue of the same journal where Sproat had published this disagreement, a reply from Rao et al. is published. They argue that their "... result increases the evidence for the linguistic hypothesis ... ."[199] They emphasis that block entropy results observed for Indus script go well with other linguistic systems and hence increase the evidence against FSW's claim to have a proof of non-linguistic hypothesis.[200] Rao and others enlist the characteristics of Indus script based on prior work: linearity, directionality, use of diacritical marks, Zipf-Mandelbrot law, syntactic structure, diverse usage, and use in foreign land.[201] Their final argument is "... it would be highly unusual for a non-linguistic system to exhibit a confluence of all of these properties",[202] more so with the additional evidence of entropic scaling. They note that "... showing a poste-

197. Gero, "Honoring ambiguity/problematizing certitude."

198. Richard Sproat, "Ancient symbols, computational linguistics, and the reviewing practices of the general science journals," *Computational Linguistics* 36, no. 3 (2010): 585–594.

199. Rajesh P. N. Rao et al., "Entropy, the Indus script, and language: A reply to R. Sproat," *Computational Linguistics* 36, no. 4 (2010): 796.

200. Yadav et al., "A statistical approach for pattern search in Indus writing," 798.

201. Yadav et al., 799.

202. Yadav et al., 800.

rior probability of zero for the linguistic hypothesis"[203] is now a requirement to reject the language argument. After making a reference to Vidale's work about non-linguistic systems and positional regularities in those contemporary systems,[204] the authors talk about the implications of both the linguistic and non-linguistic hypothesis. However, their own archaeological argument is frail. They continue to refer to a single most popular object type i.e. seal and its probable use by its comparison with the other bronze age cultures. There is no mention of other object types, iconographic relationships, form and material variation, and possible implications of these in the linguistic meaning of sign sequences. On another note, though they appreciate the flexibility of the script for probably being used to write different language in West Asia, they do not hypothesise a possibility for a non-linguistic yet syntactic usage of the same signs. In this context, there is no response from these or other scholars to the 2019 study discussed earlier which had proposed partial non-linguistic reading.[205]

2.5.1 Linguistic comparison via script

For linguistic analysis studies mentioned earlier, the sequences were compared by Rao and his team to scripts of different datasets of both linguistic and non-linguistic nature.[206] For linguistic datasets, despite the supposed diversity of the content, each of those still have a well defined overarching context.[207] The extent of their collective randomness can be debated. For each of these datasets, I briefly mention the factors which can contrast with MHA dataset (discussed in chapter 4) and hence pose question to their linguistic comparison with MHA.

- The Brown University Standard Corpus of Present-Day American English - Printed in the United States in 1961.[208] - This is a time and location specific data. American

203. Yadav et al., "A statistical approach for pattern search in Indus writing," 800.

204. Yadav et al., 802.

205. Mukhopadhyay, "Interrogating Indus inscriptions to unravel their mechanisms of meaning conveyance."

206. Rao et al., "Entropic evidence for linguistic structure in the Indus script."

207. Cited based on information from Rao's supplementary material shared with the mentioned paper

208. W. Nelson Francis and Henry Kucera, "Brown Corpus Manual," 1979, accessed January 10, 2022, http://icame.uib.no/brown/bcm.html.

English also means that there are peculiar vocabulary and spelling differences when compared to the 'British' English.[209] It is composed of all long texts which belonged to permanent print material. Harappan sign sequences are short, the regional expanse questions uniformity of language, and their span of existence is not comparable to a single year.

- Hymns from the Rig Veda (Sanskrit text)[210] - These are codified forms of oral verses which most likely went through numerous modifications before their emergence in the written form. There are specific subjects for which these verses were created. In case of MHA, there is still no confirmed understanding about the function of artefacts or the subject of sign sequences. Also, if this content was ever used in oral communication and if those are verse or prose are distant questions.

- Electronic Corpus of Sumerian Texts - These are contemporary long texts in Sumerian, which was also the spoken language. Interestingly this corpus also mentions that two varieties of Sumerian have been used.[211]

- Eight Sangam Era Tamil Texts (Ettuthokai)[212] - This is again time and location specific data in old verses. Also there are issues related to the script being used and entropy as a measure. These are discussed below.

A methodological aspect needs to be considered and compared. As per Rao et al., if they write the Sanskrit as alphabetic (instead of alpha-syllabic), then the entropy goes below alpha-syllabic Tamil and closer to English characters.[213] As per image 1B, that is

209. "Differences between British and American English | British Council Foundation Indonesia," 2023, accessed January 10, 2022, https://www.britishcouncilfoundation.id/en/english/articles/british-and-american-english.

210. "The Rig Veda in Sanskrit Index," 2004, accessed May 10, 2021, https://www.sacred-texts.com/hin/rvsan/index.htm.

211. University of Oxford Faculty of Oriental Studies, "ETCSLhomepage," 2016, accessed May 10, 2021, https://etcsl.orinst.ox.ac.uk/.

212. "Sangam Tamil Literature - The Eight Anthologies," 2009, accessed March 9, 2021, https://tamilnation.org/literature/anthologies.htm.

213. "Entropic Evidence for Linguistic Structure in the Indus Script - Supplementary Material," 2009, 10, accessed January 17, 2023, https://www.science.org/doi/suppl/10.1126/science.1170391/suppl_file/rao.som.pdf.

exactly where the Indus script is shown.[214] The bar-chart of relative conditional entropy values for different writing and non-writing systems is thus closely tied to the kind of script that is being used. This shows that entropy as a measure is sensitive to the script which is used to represent the linguistic content. Experimental work on Telugu script shows that entropy changes when a Telugu word, which is written by using Roman script, is split in different ways e.g. as per English alphabets or as per Telugu letters.[215] The study further shows that entropy continues to change as we use two or more Telugu syllables at a time.

Despite the knowledge of entropy being sensitive to the script, its use to propose MHA's sign sequence patterns as 'linguistic', to be specific 'Old Tamil', may not be a substantial argument. In the history of origin of Tamil script it is argued that language of earliest inscriptions in Tamil is of a 'peculiar kind' and not that of Sangam literature which is treated as classical Tamil. Siromony shows the existence of three orthographic systems - Tamil-Brahmi I, Tamil-Brahmi II, and the Tamil Pulli. He has proposed that Tamil-Brahmi I predates Ashokan Brahmi and then based on few more corroborations, "... Tamil Nadu would be the original home of the Brahmi script ... ."[216] If Rao's analysis based on entropy is to be accepted, i.e. around 2500 BCE, a writing system which was well adapted to Dravidian languages existed in the form of Harppan signs in Indus valley and surrounding area, then Siromony describes a similar scenario in south India during the centuries around the beginning of common era. If the language persisted for this entire period, there is a lack of robust evidence that depicts movement, traces, or evolution of the script/s or systems across this expanse of space and time. Possehl's review and analysis of scholarship that deals with association of Brahmi script with Harappan signs leans towards rejecting the possibility of Dravidian connection.[217]

In the 2014 paper, Sproat demonstrates that conditional entropy is also affected by the size of the corpus.[218] In his earlier response, he had already raised questions to Rao's

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214. Rao et al., "Entropic evidence for linguistic structure in the Indus script."

215. Venkata Ravinder Paruchuri, "Entropy of Telugu" (2011).

216. Gift Siromoney, "The origin of the Tamil script," *Tamil Studies* 2, no. 1 (1982): 8–23, https://www.cmi.ac.in/gift/Epigraphy/epig_tamilorigin.htm.

217. Possehl, *Indus Age: The Writing System*, 69–72.

218. Richard Sproat, "A statistical comparison of written language and nonlinguistic symbol systems," *Language*, 2014, 457–481.

identification of type-1 and type-2 systems.[219]

Finally, interpretation of the closeness of these writing systems to each other as representatives of same/similar languages is extremely risky. The scaling of X axis of this graph and level of separation of each bar from the neighbours need further explanation. If this conditional entropy bar-graph is to be accepted, then Indus script being closer to English characters should be considered more of alphabetic than alpha-syllabic or logo-syllabic. At present, it is not identified as alphabetic because the signs are a lot more complex and are more in number than such systems.

It is thus critical to note that (i) documentation of archaeological artefact for linguistic interpretation, (ii) identification of signs and sign patterns without context, (iii) hypothesis about patterns as linguistic, (iv) association of vocal sounds of a language to the signs and sign patterns, and finally (v) assignment of a cultural meaning to signs and sounds are interconnected and extremely nuanced processes. There is a cascading effect of each on all the following processes. Rao agrees that to identify

> ... linguistic affinity of Indus texts requires a more sophisticated approach, such as statistically inferring an underlying grammar for the Indus texts from available data and comparing the inferred rules with those of various known language families including Dravidian and Indo-European.[220]

Finally, to put the ideas of script, language, and content in a comparative context, there are two relevant case studies in different intersection of space and time. These are the examples of bi-lingual content being represented in two or more different writing systems. Rosetta stone which played a key role in the decipherment of hieroglyphs, has three scripts. Out of these, Egyptian hieroglyphs and Demotic are logo-graphic, and Ancient Greek is alphabetic. In case of Indo-Greek coins, the Greek script is alphabetic and Kharoshti is Abugida or alpha-syllabic.

2.5.2 Take-aways from the debates

There are some important points to be observed in this debate.

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219. Richard Sproat, "Commentary and Discussion: Reply to Rao et al. and Lee et al.," *Computational Linguistics* 36, no. 4 (2010): 807–816.

220. "Entropic Evidence for Linguistic Structure in the Indus Script - Supplementary Material," 10.

It is important to note that to extract a meaning does not necessarily mean linguistic analysis. A surprising observation emerges by co-relating these arguments with Mahadevan's work. In his publications from 1970 till 2015, the script is not interpreted for trade related activities as hypothesised by multiple scholars. Also, he has solidified his Dravidian argument right from his very initial publications of 1970s and he does not seem to have gradually arrived there. The non-linguistic probability hardly emerges in his work. In the studies by TIFR scholars or by Rao et al., they do not refer to Dravidian hypothesis, except for a remark about Old Tamil and Indus script with similar conditional entropy.[221]

FSW highlight the lack of finds related to writing material in Harappan sites.[222] To use this to reject the linguistic argument is a philosophically problematic proposition. The absence of evidence cannot be an evidence of absence. In his response, Sproat points out to statistical and interpretational issues but does not comment about the archaeological insufficiency in the conditional entropy argument.[223]

Rao and others do not respond to all issues raised by FSW in the 2004 paper but propose a different evidence for the language hypothesis. This is partly due to paucity of archaeological data. Rao's response is to close the arguments with Sproat about the method. He demonstrates that their exercise truly fits into a computational linguistic domain with valid supporting data. Though he often refers to Parpola, Soviet team, and Mahdevan as a priori work, earlier sections in this chapter describes how loosely these 'priori' have been established. Basic archaeological properties such as diverse contexts of the artefacts, their material details, usage patterns are nowhere to be seen, analysed, or used in the interpretation. Thus, the artefacts have been muted.

From the entire debate, it is seen that the two camps of scholars are solidified and there is very little movement between the camps, perhaps Fairservis being the only exception. The 'language' camp is stronger in terms of number of scholars, academic publications, and buyers of the argument. Unfortunately, archaeological characteristics

221. Rao et al., "Entropic evidence for linguistic structure in the Indus script."

222. Farmer, Sproat, and Witzel, "The collapse of the Indus-script thesis: The myth of a literate Harappan civilization."

223. Sproat, "Ancient symbols, computational linguistics, and the reviewing practices of the general science journals."

of the artefacts do not contribute to the strength of their argument. It is heavily impacted by the predisposition and preconception by the linguistic studies school. As explained in chapter 3, in the recent past, the decipherment of this script has become more like an agenda of national identity and antiquity.

Witzel agrees with the complex linguistic situation in northern South Asia and indicates "... many waves of immigration and amalgamation..."[224] swept the Indian subcontinent. Quoting Kuiper, he also mentions that "... even the hieratic and highly poetical language of the Rgveda has been influenced by acculturation and, therefore, by substrates, in the form of loan words, calques or in syntax".[225] Southworth corroborates that "For those items referring specifically to South Asian flora, fauna, or people, the probability is that these names entered OIA (or in some cases, proto-Indo-Iranian) from languages spoken by groups which preceded the arrival of Indo-Iranian speakers into the subcontinent and its borderlands."[226]

Last but not the least, numerous scholars proposed possible decipherments and tried to read the signs in different languages. However, none other than Rao's team have responded to FSW's non-linguistic hypothesis. On the other hand, Rao and other TIFR scholars have not responded to Wells's sign-list or to his objections to Mahadevan's and Parpola's sign-lists.[227] His work almost goes unattended.

In retrospect, persistent use of M77 sign-list and sequences for the use of statistical analysis by multiple scholars has apparently given it a *de-facto* standard and authenticity for the decipherment project. Starting with Mahadevan's own preliminary study, the results continue to support other observations performed on the same dataset. Every research paper continues to refer to previous work to solidify the argument and thus authenticates the use of M77. The underlying assumption is about the unambiguity of its sign-list. Even while creating the 'formalised data carrier' and 'partially non-linguistic' arguments, the scholar has accepted and used same sign encoding. Though the study

224. Witzel, "Central Asian roots and acculturation in South Asia: linguistic and archaeological evidence from Western Central Asia, the Hindukush and northwestern South Asia for early Indo-Aryan language and religion," 163.

225. Yadav et al., "A statistical approach for pattern search in Indus writing," 165.

226. Franklin Southworth, *Linguistic archaeology of south Asia* (Routledge, 2004), 88.

227. Wells, *Epigraphic Approaches to Indus writing*, 47–56.

partially deviates from earlier studies, the use of M77 (IDF-80 version as mentioned above) itself is playing a role in partially ratifying Mukhopadhyay's claims.[228] As seen in earlier sections, the electronic version of M77 was built with the help from the TIFR and this is the only corpus that TIFR team has used for their analysis. Along with Rao, they are the co-authors responding to FSW's claims. On this backdrop, the debate can also be seen as an inadvertent defence of M77 corpus by its *de-facto* users and custodians.

2.6 Causes and consequences of linguistic hypothesis

In all the cases mentioned above, the expanse of proposed language in space and time, reasons for its uniformity in huge geography, and continuity for more than seven centuries is rarely justified or questioned. Besides, the prerequisites, effects, and associated phenomenon of the existence of writing systems such as literacy, writing material, schooling systems, life-cycle of written material, mechanism of passing of knowledge to next generations, and pre- and post-remains of the system are devoid of equivalent attention within this discourse.

Linguistic studies have significantly benefited because of the borrowings from historical linguistics. Southworth has made a thorough review of language families in South Asia. He studies contemporary people's knowledge of foreign people who spoke different languages but they did not necessarily grasp the distinction among those.[229] In his concluding remarks about the linguistic scene, he argues:

> It seems probable.... that there was a good deal of bilingualism and diglossia in ancient India, with those non-Aryan groups who dealt with the Aryan Brahmans being obliged to learn some form of Indo-Aryan (Sanskrit or Prakrit) for day-to-day communication. On the other hand, the presence of many words of foreign origin in Vedic from the earliest times indicates that this was not a one-sided process.[230]

228. As per personal communication with authors of ICIT, Mukhopadhyay was offered data from ICIT to be used for her study. However she chose to stick to M77 for signs and main texts, and ICIT was used only to a limited extent.

229. Southworth, *Linguistic archaeology of south Asia*.

230. Southworth, 58.

He also hypothesizes that "All authorities acknowledge that the earliest Indo-Aryan language contained lexical elements derived from other languages."[231] Thus, the premise of the majority of ED studies about uniformity or consistency of language across the subcontinental expanse and over hundreds of years can be seriously questioned. It is important that this enquiry is assisted by the archaeological material.

2.6.1 Purpose of written material

The discovery of these objects into distant lands, away from known Harappan influential territories, and the material remains of impressions called sealing, initiated a discussion about the purpose. These phenomena have dominated the imagination of academia and have mostly restricted the purpose to trade or economy related functions. The idea is supported by similar looking artefacts from Mesopotamian contexts where their use for economic activities or administration has been validated and established.

A rare example to relate the signs with affordance of the object can be seen in the study by Wells.[232] He has tried to identify numeric signs and understand their implication for quantitative purposes in the Harappan culture; correlate numeric signs to the possible volume quantities of the jars on which they appear. If such correlations are found consistently, these essentially indicate functions of these signs which are tightly bound to their immediate local context rather than abstract global meanings.

Ameri's observations about the form and iconography of the 'moulded tablets' showcase that ignorance to the typology is causing a serious damage to MHA's ontology, and is thus impacting our interpretation of Harappan society at large. She extends Meadow and Kenoyer's argument about the seals being probably used as amulets. However, she also differentiates in their manufacturing process such as intentional firing versus not being impressed by existing set of seals.[233] At a chronologically controlled excavated site

231. Southworth, *Linguistic archaeology of south Asia*, 88.

232. Bryan K. Wells, "The Volumetric System of Harappa," in *Walking with the Unicorn: Social Organization and Material Culture in Ancient South Asia (Jonathan Mark Kenoyer Felicitation Volume)*, ed. Dennys Frenez et al. (Archaeopress Archaeology, 2018), 623–627.

233. Marta Ameri, "Letting the Pictures Speak: An Image-Based Approach to the Mythological and Narrative Imagery of the Harappan World," in *Seals and Sealing in the Ancient World: Case Studies from the Near East, Egypt, the Aegean, and South Asia*, ed. Marta Ameri et al. (Cambridge University Press, 2018), 146, https://doi.org/10.1017/9781108160186.012.

of Harappa, it was observed that these tablets first appeared in period 3B (2450-2200) and continued till 3C (2200-1900).[234] Ameri notes that a different category of scenes on these tablets is seen only in the later part of the Mature period. Incised tablets are similar to moulded in terms of being multi-sided and having duplicates. Meadow and Kenoyer propose that these two groups are contemporary, probably around 2350-2300 BC i.e. the middle of period 3B, and also note that the usage of both seals and tablets was valid only if they were 'current'.[235] They argue that this was a period of 'urban renewal' at Harappa and it coincided with the rise of Akkadian Empire in Mesopotamia. They suggest that the two groups of artefacts discussed here need to be studied as a possible manifestation of these phenomena and the interaction with Mesopotamia.

Frenez's study on seal impressions is an interesting example. For the sealings found in Lothal, Rao had documented those as being accidentally burnt when the warehouse caught fire.[236] Frenez has proposed intentional firing or baking of those for preservation and storage purposes.[237] Based on the morphological analysis, he has divided approximately 90 sealings into more than 6 functional and morphological categories such as pegs on wall for doors, pegs for structures, lockers, parallel cane, wooden surface, and pottery. His interpretations are more nuanced based on the form differences observed in the entire collection.

In the latest work, Mukhopadhyay describes the 'Semantic scope' of MHA and reiterates multiple earlier studies which propose the use of these objects in activities of trade and economic control. Based on sign graphic details, following are the examples which the author has tried to solidify: (i) Based on Kenoyer's work at Harappa - verification of tax payment and fulfilment of tax regulations near the city gate-ways as the commodities moved in and out of the city "(customs or octroi type)",[238] (ii) Based

234. Meadow and Kenoyer, "The 'tiny steatite seals' (incised steatite tablets) of Harappa: Some observations on their context and dating," 14.

235. Meadow and Kenoyer, 16–17.

236. S. R. Rao, *Lothal: A Harappan Port Town (1955-62)*, vol. I, Memoirs of The Archaeological Survey of India 78 (Archaeological Survey of India, 1985), 319.

237. Frenez and Tosi, "Lothal Sealings: Records from an Indus Civilization town at the eastern end of the maritime trade networks across the Arabian Sea," 71.

238. Bahata Ansumali Mukhopadhyay, "Semantic Scope of Indus Inscriptions Comprising Taxation, Trade and Craft Licensing, Commodity Control and Access Control: Archaeological and Script-Internal

on Laursen's work at Bahrain - "co-occurrence of gulf-seals and Indus-type weights in Bahrain's tax-collection-center ",[239] (iii) Based on Shamasastry's work on *Arthashastra*, seal impressions to be checked at toll houses to verify, measure, and tax the material, (iv) Based on Kenoyer, Mackay, Vats, Bhan's studies - seals near craft production areas to collect excise-type taxes (v) Based on the works by Jamison, Green, Mackay, Kenoyer, Wells - coexistence of seals and weights indicative of revenue related purpose,[240] (vi) Based on the studies by Frenez, Parpola - sealing inscriptions conveying trade or craft rules, taxation/licensing rates,[241] (vii) Based on Kharakwal's study - tablets as entry pass or for access control.[242] Though these have remained the most accepted hypotheses, the following purposes have also not been outrightly rejected or disproven. Also, the extensive generalisation of commercial contexts can be seen feeding into the framework as described in the figure 3.4 and is then subsequently challenged in the analysis and interpretation chapters of this thesis.

Another main purpose identified is related to the religious activities.[243] 'Religion', at a conceptual level, evinces our present day anxieties. Based on his deduction of early form of Dravidian as the language spoken by Harappan people, Parpola has drawn several inferences about the belief systems.[244] Some of these examples are fish signs as indications of names of divinities,[245] Proto-Shiva seals associated with Vedic god Varuna,[246] red painted circles on priest-king statue as a representation of fire,[247] depiction of trees with railing as a precursor to the continuation of tree worship tradition of

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Evidence," *Humanities and Social Sciences Communications* 10 (2023): 27, https://doi.org/https://doi.org/10.1057/s41599-023-02320-7.

239. Mukhopadhyay, "Semantic Scope of Indus Inscriptions Comprising Taxation, Trade and Craft Licensing, Commodity Control and Access Control: Archaeological and Script-Internal Evidence," 27.

240. Mukhopadhyay, 29.

241. Mukhopadhyay, 31.

242. Mukhopadhyay, 35.

243. Parpola et al., *Decipherment of the Proto-Dravidian inscriptions of the Indus civilization: a 1st announcement*, 1:V.

244. Parpola, *Deciphering the Indus script*.

245. Parpola, 180.

246. Parpola, 188.

247. Parpola, 216.

today,[248] and identification of a sign for deity named Muruku.[249] It is interesting to see the extent of extrapolation of signary into the meanings of an intangible belief system, where its existence is still conjectural. The purpose of actual artefacts has been hypothesised as votive, ritualistic, or even as charms to be worn in.

Shendge[250] made an effort to study a specific type of artefact like incised or moulded tablets - calculi[251] and proposed their possible use as tokens. Though the assignment of meaning is relatively limited and also based on limited data, Possehl recognises it as a possible direction for future.[252] In her later work, she proposed that the signs simply indicated the list of things being handed out, counted, weighed, or measured[253] and hence probably did not need a bilingual.[254] Her perspective about the possible relationship of signs to the day-to-day needs of common people is an interesting one as opposed to trade which is a very specialised occupation mostly limited to a small subset of people, locations, and goods.

It is pertinent to note that interpretation of identical objects, mostly bas-relief tablets and incised tablets, has posed persistent challenges. In linguistic studies, as seen earlier, those have been completely ignored as they do not seem to add any linguistic value. McIntosh, extends the existing postulate of use of sealings in trade related activities and argues that multiple identical sealings discovered at Lothal are probably indicative of a big shipment where information about same goods, quantity, sender or recipient is copied multiple times on different containers or single large container.[255] Based on the distribution of broken objects across the city but their complete absence in burial contexts, he suggests that these "... were not personal possessions but objects related to some official role, disposed of when the holder left office."[256] Expectation to find an

248. Parpola, *Deciphering the Indus script*, 229.

249. Parpola, 230.

250. Malati J. Shendge, "The inscribed calculi and the invention of writing: the Indus view," *Journal of the Economic and Social History of the Orient* 28, no. 1 (1985): 50–80.

251. Identified by her as calculi based on similarity of artefacts found at Susa

252. Possehl, *Indus Age: The Writing System*, 147.

253. Shendge, *Unsealing the Indus Script. Anatomy of its Decipherment*, 216.

254. Shendge, 217.

255. Jane McIntosh, *The ancient Indus Valley: new perspectives* (Abc-Clio, 2008), 172.

256. McIntosh, 256–257.

artefact in a burial context demonstrates Egypt-centric hypothesis but there is no cultural similitude to expect such finding. On the contrary, based on (i) the discovery of Su-i-li-su's cylinder seal in Mesopotamia, (ii) the comparison of the 9th cen. BCE cultural contexts in Akkad and Sumer, and (iii) identification of Assyrian merchants' place in Kanesh in Anatolia based on the cuneiform tablet which describe their trade related activities, McIntosh speculates that smaller objects such as dice and seals could be personal possessions.[257] In the similar context, Subramaniyan cites Hunter's proposition for copper tablets with same signs as the name of ruler.[258]

It is prudent to note that artefact typology plays a crucial role in many of these varied ontological propositions and its subsequent interpretation.

Based on historical studies in ancient Greek and Roman culture, Harris identifies close to forty functions of writing.[259] Some of these like ownership, labels for commodities, indicating weights or measures, can be seen been postulated and thoroughly discussed in this section. However, many other functions from Harris's list are indicative of the specific social practices which are product of that culture. Some such examples are instructions to a subordinate, wills, casting a vote, records of birth or death, names of magistrates, record a magic spell, and curse. It is worth noting that the nature of these writings demand variety in material, method, preservation, and each have purpose-specific life-cycles. Similarly, many of these could be profane or mundane and hence are part of everyday lives of majority of common people which is unlike trade, economic control or administration.

2.6.2 Literacy

Literacy is probably the least discussed theme in the MHA discourse. Intangible nature of this social phenomenon poses a challenging situation. To initiate any work in this direction, it requires a definition of literacy at a conceptual level, specifically for the society that belonged to 2500 BCE. It's worth, power-relation, and need in the past play vital role to understand how it might have been perceived, evolved, and contributed to

257. McIntosh, *The ancient Indus Valley: new perspectives*, 183.

258. Subramanian, "The Contribution Of Indus Text Corpora / Concordances To The Textual And Contextual Analysis Of The Indus Script: A Comparative Study," 54.

259. William V. Harris, *Ancient literacy* (Harvard University Press, 1991), 26–27.

the contemporary society. Harris questions the perception of mass literacy in ancient Greek and Roman cultures. He addresses some key questions around the definitions of literacy, its relation to power, societal differentiation in the degrees of literacy, production, modernisation, and functions. He has also discussed literacy and its association with the notions of development. He notes, "There is in fact nothing to predict for us the likely long-term effects of literacy on a population ..... This problem is beyond the limits of comparative history... ."[260] He also mentions that its Greek who provide some evidence for such studies, if any. It is important to note that the extrapolation of these themes to Harappan culture will pass through multiple known and unknown stages. However, it must be noted "That literacy is shaped by its social context has been irrefutably established."[261] Thus, the change in context tends to reform the literacy, both as a concept and as a construct.

Possehl has highlighted the need to investigate who were literate, how were they trained, if a special class of scribes existed, partial literacy as seen through graffiti on pottery, and most importantly how the contemporary definition of literacy affected the society.[262]

In Harappan sign studies reviewed in this chapter, 'Literacy' as a concept, is limited to the 'mechanism to capture human vocal sound in a written form'. It is a result of our constant belief into the teleological progression and consideration of this form of literacy as a legit feature of linear societal development.

2.6.3 Before and after the 'writing system'

There are few efforts to understand how the evolution of the 'script' happened. Some point to the origin from potters' marks or ceramic graffiti and evolution into a full-fledged 'writing system'.[263] The current understanding is that these "... were related on

260. Harris, *Ancient literacy*, 42.

261. Kate Vieira, "On the social consequences of literacy," *Literacy in Composition Studies* 1, no. 1 (2013): 30.

262. Possehl, *Indus Age: The Writing System*, 14–15.

263. Wells, *Epigraphic Approaches to Indus writing*, 42–43; Possehl, *Indus Age: The Writing System*, 55–57

a regional level with major differences in sign inventories occurring between sites."[264] Both Wells and Kenoyer[265] demonstrate pottery graffiti as an initial stages of Harappan script. About the rejection of potters' marks role in developmental sense, Wells concludes that "Rather, they developed along autochthonic trajectories, drawing on local symbolic traditions for inspiration."[266]

Theory about continuation of Harappan signs' evolution into later scripts has an impediment of time. Almost hiatus like situation of 'written' material evidence exists following the late Harappan periods until the appearance of first concrete evidence of Brahmi and Kharosthi in the early historic period which is not before sixth or fifth century CE.

To conclude this section with an overarching perspective about the emergence and cessation of Harappan signs, two parallel studies deserve a mention. Kelly observes evolution of three African scripts within the last couple of centuries; all were invented by illiterate people.[267] Many indigenous groups in west Africa came up with new scripts, but many of them did not last for more than a couple of generations. His observations from Morgan's literature underline the fact of notional supremacy of the society with script: "'Without literary records,' Morgan argued, 'neither history nor civilization can properly be said to exist' (Morgan 1877, 31)".[268] Kelly concludes that emergence of scripts in sub-Saharan West Africa was "... a response to a set of shared historical circumstances framed by globalisation, colonial contact, missionary evangelisation, and subsequent grassroots struggles for autonomy."[269] This is interesting and contradictory on the backdrop of the continuous debate that Aryans displaced the indigenous Dravidians where Dravidians were the originators of the Harappan signs. Kelly's later work is an insight into the transition of one of the above three scripts i.e. Vai, its standardis-

264. Wells, *Epigraphic Approaches to Indus writing*, 45.

265. Kenoyer, "Origin and Development of the Indus Script: Insights from Harappa and other sites."

266. Wells, *Epigraphic Approaches to Indus writing*, 46.

267. Piers Kelly, "The invention, transmission and evolution of writing: Insights from the new scripts of West Africa," *The Invention, Transmission and Evolution of Writing: Insights from the New Scripts of West Africa*, 2018, 189–209.

268. Kelly, 198.

269. Kelly, 206.

ation, and compression within a span of 177 years.[270] It reduces the visual complexity of signs over the period of time and thus supports the simplification hypothesis. However, according to him, this is a not only a result of standardisation or changes in writing technique but result of "systematic compression".[271] In the light of the absence of chronological control for Harappan signs, these observations illustrate the possible methodological limitations MHA continues to face.

Regarding the disappearance of scripts, Baines observes that "Writing absorbs great cultural energy. Once it is set up as a working system, it must be learned and transmitted."[272] As he looks at the historicity of various scripts being employed for writing languages, his crucial observations are: "If a script is closely identified with a language, the latter's disappearance may condemn the former to the same fate. ...writing is used for symbolically important purposes for which the everyday language would be inappropriate... ."[273] For this and other reasons, he objects to the idea of written and spoken languages being same and in fact it belonging to a different language family. Baines argues that loss of script, language, culture, and polities are closely linked to each other and cannot happen in isolation. As per his analysis, language is closely associated with the identity of ethnic groups, but script mostly relates with complex cultural systems.[274] These propositions, if extended to MHA, create a challenging position for any linguistic argument.

2.7 Material studies

As seen in the previous section, despite the rarity of studies on causal and consequential aspects of the writing systems, the present day dominant argument is about a script and a language. Typological studies which deal with the materiality of MHA have gained

270. Piers Kelly et al., "The predictable evolution of letter shapes: An emergent script of West Africa recapitulates historical change in writing systems," *Current Anthropology* 62, no. 6 (2021): 669–691.

271. Kelly et al., 683.

272. John Baines, "Writing and its Multiple Disappearances," in *The Disappearance of Writing Systems: Perspectives on literacy and communication*, ed. John Baines, John Bennet, and Stephen D. Houston (Equinox, 2008), 349.

273. Baines, 350.

274. Baines, 354.

lesser traction compared to the ED research. This section elaborates on this latent aspect of MHA.

2.7.1 Iconographic analysis

CISI volumes are indispensable datasets, especially because MHA are distributed in the museums all over the world. Next to the excavation reports, this can be considered as a primary documentation of MHA. It is structured and it uses a typology definition which was chosen by the editors. It is based on the general understanding, appearance, and terminologies which were already in use based on excavation reports and other literature. The volumes are organised based on sites, typology, iconography (specifically for unicorn symbols), size categories (only square unicorn seals and rectangular ones), and shapes. The classification of unicorn iconography is based on Paul Rissman's work.[275] Along with pointing out varied decorative patterns, it was also valued for having a chronological significance. He had proposed certain combinations of animal and stand design on 'unicorn seals' as more common in some periods. He had thus hypothesised a chance of stylistic development across time.

Dr. Ute Franke-Vogt has conducted one of the detailed studies of the stylistic patterns on a subset of MHA.[276] Parpola wrote a detailed review article on it. Dr. Franke's assumption is stated as "The inscribed objects played a central role in the exchange and control of information in the Indus Civilization. This function they have, of course, mainly fulfilled through their written messages."[277] Main body of her work claims that the symbolic messages were conveyed through iconographic form and seals functioned as means of identification. She restricted herself to the site of Mohenjo-daro and carried out more detailed stylistic analysis than that of Rissman's on unicorn seals. She has

275. Rissman, "The organization of seal production in the Harappan Civilization."

276. Ute V. Franke, "Die Glyptik aus Mohenjo-Daro: Uniformität und Variabilität in der Induskultur: Untersuchungen zur Typologie, Ikonographie und räumlichen Verteilung" (PhD diss., Freie Universität Berlin, 1991); The original thesis is in German. Only a small portion of it was translated with the help from colleagues. Dr. Franke's articles and reviews of her work which are available in English were used more extensively.

277. Asko Parpola, "Review of: Ute Franke-Vogt, Die Glyptik aus Mohenjo-Daro: Uniformität und Variabilität in der Induskultur, I-II. (Baghdader Forschungen 13.) Mainz, 1991 (1992)," *Studia Orientalia* 70 (1993): 125.

argued that she tests the general notions of homogeneity and variation of seals, and their implications for interpretation in space and time.[278] She did not venture into the possible linguistic interpretation of the script.

In yet another study, Wells has created basic object typology based on the form such as seals (square, rectangular, or other shapes), ceramics, bangle, bead, implements, and variety of tablets.[279] His basic classification of iconography, called as 'field symbols' by him, adheres to the taxonomy (e.g. *Bos indicus*, *Bos gaurus*) and then the decorative pattern, if any. However, certain non-uniform strategies are implemented in these schemes. The taxonomic criteria is seen applied only for bull or unicorn images but not for others. For example, goat motif is not sub-classified as *Capra nubiana* or *Capra pyrenaica* despite the visible zoomorphic variations of the icons. In case of tabs, 'copper' is seen as a subcategory based on material but bas-relief-tablets and incised-tablets are separated based on the technique of sign creation. Those are not merged on criteria of common material such as terracotta or faience. This unevenness introduced in the classification schemes is probably a result of the skewed dataset, and our inherent tendency to search and comprehend common patterns.

Few points must be noted here about the use of 'unicorn' terminology. Marshall proposes this as a mythical animal based on the comparison with other animal motifs. He identifies the stand like motif as incense-burner.[280] On the contrary, based on earlier work of Friederichs F. Heinz, Mackay identifies it as a real animal, 'Urus Bull'.[281] The stand is identified as manger or food-vessel. Possehl has referred to multiple earlier works by Grigson, Mackay, McCrindle, and Schlingloff who underline the possibility of it being a real animal, mostly *bos taurus* or *bos primigenius*, shown in profile. How-

278. Ute V. Franke, "Inscribed objects from Mohenjo-Daro: Some Remarks on Stylistic Variability and Distribution Patterns," ed. Catherine Jarrige, John P. Gerry, and Richard H. Meadow, *South Asian Archaeology, 1989: Papers from the Tenth International Conference of South Asian Archaeologists in Western Europe, Musée National Des Arts Asiatiques-Guimet, Paris, France, 3-7 July 1989*, no. 14 (1992): 103–112.

279. Wells, *Epigraphic Approaches to Indus writing*.

280. Marshall, *Mohenjo-daro and the Indus Civilization: Being an Official Account of Archaeological Excavations at Mohenjodaro Carried out by the Government of India between the Years 1922 and 1927*, 1:68–69.

281. Mackay, *Further Excavations in Mohenjo-daro*, I:326–328.

ever, a single horn bull or donkey like figurines, which Mackay found at Chanhu-daro has become a determinative artefact in solidification of this as a 'unicorn' or a single horned animal/bull only. Possehl has discussed multiple references of this identification including that of Ctesias. He prefers to retain the ambiguity in interpretation of this motif as real or mythical.[282]

2.7.2 Signs and context in M77

As discussed earlier, M77 has been used for the site and type related analytical study.[283] The authors use these two as contextual attributes for sign sequence length and most frequent signs. This is an important step in order to contextualise the signs. However, the sign-centric approach, loose typology definition, and skewed data has constrained the main objective of the study. For multi-line MHA, consideration of each line as a separate text entity breaks down the primary context and content. Broad observations about West Asian sites have been made to highlight their separate characteristic from the core Indus region, such as "In relative terms, West Asian sites have significantly large number of texts of length five."[284] When checked in M77 dataset, the observations are as follows: Total lines of text in west Asian sites is 18. Graph shows text length 8 at ~10% i.e. max 2 records. Mohenjo-daro has 5% lines with length 8. Now 5% of 1716 is ~85 lines with length 8. This observation refers to their own previous work. Subsets of signs following other signs and represented in a transition matrix were interpreted as different contents because of grammar rules as one of the causes.[285] The definition of 'grammar' and its implication of MHA signs can be a highly contested issue in such studies.

The whole exercise of labelling sign sequences of West Asian sites as distinct from Indus region is based on M77.[286] From statistical data analysis point of view, sites with very few artefacts have been grouped together in the Indus and non-Indus domains. The number of objects at these sites are - Mohenjo-daro (MD) - 1540, Harappa (HP) - 985,

282. Possehl, *Indus Age: The Writing System*, 27–31.

283. Yadav, "Sensitivity of Indus script to site and type of object."

284. Yadav, 79.

285. Rao et al., "A Markov model of the Indus script," 13687.

286. Mahadevan, *The Indus script: texts, concordance, and tables*.

Lothal (LL) - 165, Kalibangan (KB) - 99, Chanhu-daro (CH) - 66, Other 15 Harappan sites (OH) - 34, and five West Asian sites (WA) - 17. For the West Asian sites, the sites are spread across more than thousand square kilometres of area. For example, Susa is more than 400 km away from Kish. This is more than the distance between Harappa and Kalibangan or Mohenjo-daro and Chanhu-daro.

With respect to typology, there is an interesting observation in the above mentioned article: "... sealings... were created using seals... in terms of text length distribution and usage of signs, seals and sealings are significantly different... This implies that the seals used to make these sealings are not present in the set of objects that have survived and discovered from various sites."[287] M77 has described sealing as "... positive impressions in relief made by seals or special moulds on impressionable material like clay, faience, or metal."[288] It is critical to note that a type identified in CISI as tablet in bas-relief with different shapes bears a 'positive impression in relief' but it is different than the object where a seal impression is seen impressed on a lump of clay. Those tablets are probably made by the 'special moulds' mentioned in M77 but none of those have not been reported and documented in the excavations till date. Both these artefacts with positive impressions have been identified as 'Sealings' in M77 and thus forms a dubious typology. If the bas-relief tablets were not created by seal impression method and were made with a different technique for a different purpose (as suggested by their forms like twisted or cylindrical) than the sealings, then to expect the similarity of excavated seals and their sign sequences with those of tablets may not be rational. It is possible that the tablets and seals/impressions might have been used for different systems. Though the signs belong to the same superset, the peculiar sequences or their patterns used on tablet vs seals/impressions could be different based on their intended usage for the system which they manifest. The inhabitants would understand the meaning of both since they are the users of those possible different systems which are unique to their culture.[289] Marta

287. Yadav, "Sensitivity of Indus script to site and type of object," 97.

288. Mahadevan, *The Indus script: texts, concordance, and tables*, 7.

289. As mentioned, this possibility is drawn based on earlier observation by Yadav about seals used to make sealings being absent in the set of survived objects and by Ameri (discussed in previous section) that appearance of impressions on clay lumps and tablets being different and thus tablets not impressed by any of the known seals. A very basic example in present day context could be multiple identification numbers which use different alphanumeric sequences for different systems. E.g. for PAN card - ABCDE1234Z

Ameri's work in this regard is discussed below. In another study which involves seal impressions or sealings from Lothal, Frenez and Tosi have identified many example of multiple impressions possibly created by a single seal.[290] At Lothal and in other places, many of these artefacts have been found in broken state or have worn out. This thus renders the impression unrecognisable and the sign sequences are not fully recoverable.

This discussion indicates that the difference observed in terms of text length distribution and usage of signs within MHA and across the sites can be a result of mixed typology, broken artefacts, skewed and insufficient data, or a culmination of all. This issue of mixed typology has also been highlighted by Possehl with an example of an object, again known as seal from Rehman Dheri. This is a tiny plaque with carving on both sides, without boss but two perforations through face - "... pretty inconvenient if it were to be used as seal.... may have been button, amulets, jewellery or decoration."[291]

Based on their analysis of M77, Vahia and Yadav have published 3 articles about different aspects of engravings observed on MHA.

Vahia's work is an interesting discussion about MHA with depictions of geometric or symmetric patterns.[292] However, in the absence of cultural understanding, relationship of the observed numeric information from these patterns to concepts like four seasons, seven planets, or a quarter of the month appears too confirmatory. Also, in conclusion, the authors draw it only over the engravings and do not associate it with other aspects of the artefacts such as material or provenance which are immediate contextual attributes.

As the same authors look at the patterns on MHA, they discuss the identification of 12 basic patterns and their quantification.[293] Though existence of these 12 patterns is

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but the car registration number plate is AB12CD3456. On the contrary, national identification or SSN uses only numerals (without any quantitative meaning attached to it). Another example could be in case of car number plate 12 in MH12 indicates Pune but as airport identifier, it is PNQ. To add a dimension of time, within the span of 1300 years, the city or the geographical place on the confluence of rivers Mula and Mutha has changed its names from Punnaka, Punakavishaya, Punawadi, Kasbe Pune, Muhiyabad, Poona and then to present-day Pune.

290. Frenez and Tosi, "Lothal Sealings: Records from an Indus Civilization town at the eastern end of the maritime trade networks across the Arabian Sea."

291. Possehl, *Indus Age: The Writing System*, 23.

292. Mayank N. Vahia and Nisha Yadav, "Harappan Geometry and Symmetry: A study of geometrical patterns on Indus Objects," *Indian Journal of History of Science* 45, no. 3 (2010): 343–368.

293. Nisha Yadav and Mayank N. Vahia, "Classification of patterns on Indus objects," *International*

used as a beginning argument, it is nowhere mentioned as to how the authors arrive at this list. It thus seems like an empirical observation. Ironically, one of the conclusions of the paper is about the existence of 12 patterns, which makes this a circular argument. The quantification of representation of patterns on the inscribed surfaces is a misleading method since these categories are not mutually exclusive. Also segregation of these patterns has already been observed in MHA based on the broad artefact typology.[294] The correlation matrix for co-existence of multiple patterns is not provided, which would have been a critical output of this study. An analytical problem is encountered where the script is identified as the most frequent component of the inscribed surfaces. There are objects which do not contain iconography at all or some only with graphical engravings and devoid of signs. These essentially demonstrate different functions of variety of MHA. If the signs were expected to serve some purpose, the objects without signs are not serving it and are clearly meant for something else. Also, for objects which contain both signs and iconography, these might be combined pieces of information, separate contents, or iconography could be entirely redundant. Thus statistics of components which occupy inscribed surfaces such as Indus script (67%), animal motifs (35%), and the decorated object or manger (22%) could be misleading.[295] A small methodological glitch is a frequent use of % in cases where the actual observed data is smaller than 100. The use of % in such cases inflates the result. Finally, except for a small note,[296] any relationship or lack of it has not been proposed between these iconographic motifs and the signs. Whether these convey any complementary meaning about the object is still a debated topic.

The third article is about classification of signs into basic and composite. "Basic signs are signs that cannot be decomposed further into simpler signs and/or form elements of composite signs."[297] The composite signs are made of combination of basic signs, provisional basic signs, and modifiers. Needless to say that the basic signs are a subset of 417 signs encoded in M77. When S. R. Rao had used the same logic, Ma-

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Journal of Dravidian Linguistics 40, no. 2 (2011): 89–114.

294. Possehl, *Indus Age: The Writing System*, 23.

295. Yadav and Vahia, "Classification of patterns on Indus objects," 25.

296. Yadav and Vahia, 22–23.

297. Yadav and Vahia, "Indus script: A study of its sign design," 8.

hadevan had refuted it and argued that the definition of 'Basic' was very subjective and hence could not form a basis for the identification of signs as basic or composite.[298] In the present paper under discussion, the authors have also come up with a new list titled 'provisional basic signs' and 'modifiers' based on their graphical interpretation. Table 13 in their paper is interesting since it shows signs with same components but different design configurations.[299] However, there is no further analysis except a note that the location of the constituent components is vital in sign design.[300] The detailed analysis or the description of their role is not articulated. Their concluding remark, already referred elsewhere, is an archaeologically problematic proposition:

> The Indus civilisation was spread over an area of about a million square kilometres and yet, the sign-list over the entire civilisation seems to be the same indicating that the signs, their meaning and their usage were agreed upon by people with large physical separation. This arrangement worked satisfactorily for about 700 years. Hence the understanding of Indus signs and their meaning must have been robust and yet versatile and easy to use.[301]

The scarcity of data regarding stratigraphy and specific provenance is a constant challenge for Harappan archaeologists. Thus, our understanding about the chronology of these objects is still incomplete. With that background, such conclusions bring unwarranted closure to the otherwise open questions in archaeological datasets.

2.7.3 Recent studies

The above argument about the agreement on the usage of signs across space and time brings us to selected latest studies. At the recent international Conference on the Indus Script, held in Mohenjo-daro, Pakistan in January 2020 (hereafter Mohenjo-daro conference), some of the latest studies were presented by acclaimed scholars.[302]

298. Mahadevan, "S R Rao's Decipherment of the the Indus script," 62.

299. Yadav and Vahia, "Indus script: A study of its sign design," 32.

300. Yadav and Vahia, 34.

301. Yadav and Vahia, 37.

302. Department of Antiquities & Archaeology Government of Sindh, "International Conference on the Indus Script, Mohenjodaro - YouTube," 2020, accessed April 20, 2023, https://www.youtube.com/playlist?list=PLGeRmxZkJJallb3ThrWUo5x_1bH7MDUHf.

Based on the data excavated from initial phases at the Harappan site from Ghaggar basin, Konasukawa has correlated the iconographic motifs of seals with the cultural periods.[303] This is in-line with his earlier work on the classification of Indus-type seals based on their carving techniques.[304] He had used SEM and (PEAKIT) 3D analysis methods. In his recent study, the initial findings indicate that a right facing animal motif has a possible affinity with Harappan 3A period whereas left facing motives belong to Harappan 3B and 3C. Period 2 is characterised by geometric patterns.[305] These observations are mostly based on data from the pre or early Harappan sites such as Kunal, Banavali, Kalibangan, Fermana, and Bhirana. In the mentioned conference talk, he has also discussed a limited sign inventory that appears on these artefacts, which indicates a probable early phase of Harppan signs. In his doctoral research, Konasukawa has identified three of the above sites where the evidence of majority of their seals (24 out of 32) has the right facing animals.[306] It is also observed that it is not only unicorn that is seen as right facing but other animals such as the goat too. Along with the possibility of these belonging to an early period, the author has also mentioned a chance of these being a regional variation. 74 seals with right facing animal motif have been excavated from the initial phase and these seem to depict a subset of 71 signs from the entire Indus signs corpora. Author thus argues that initial phase of urbanisation shared a set of signs. He ascribes discovery of common motifs to "... common ideas, symbolic meaning and beliefs that were shared among all the people ... ."[307]

Extending a part of his doctoral work in a thematic research, Konasukawa has published his observations about the significance of size for the square seal objects.[308] It is

303. Konasukawa, "Indus Scripts Incised on the Seals Discovered from the Initial Phase of Harappan Period."

304. Ayumu Konasukawa, "Comparative Analysis of the Seals in the Pre/Early Harappan Period and Harappan Seals through SEM and PEAKIT (3D) Analyses," *Puratattva* 45 (2015): 143–153.

305. This periodisation is based on Kenoyer's studies in HARP cited elsewhere.

306. Konasukawa, "Diversity of Harappan civilization: a case study of the Ghaggar basin with special reference to seals."

307. Konasukawa, 106.

308. Ayumu Konasukawa and Manabu Koiso, "Size of the Indus type seals and its Significance," in *Walking with the Unicorn: Social Organization and Material Culture in Ancient South Asia (Jonathan Mark Kenoyer Felicitation Volume)*, ed. Dennys Frenez et al. (Archaeopress Archaeology, 2018), 292–

an important step that the size of the object is being used as an important characteristic to understand the meaning of the object. He has separated out size varieties across different motifs.[309] A summary of total of 1597 artefacts into 20 size groups is as follows (Groups - N=count) - A:1 to A:5 - N=1123; B:1 to B:3 - N= 48; C:1 to C:4 - N=127; D:1 to D:6 - N=154; E:1 to E:2 - N=145. Based on the evidence of a large seal at the site of Chanhu-daro and by referring to Mackay for the site being identified as carnelian bead manufacturing centre, the author argues that "The owner of this large unicorn seal must have been posted at this site to supervise carnelian trade."[310] His interpretation of the sizes are from the lens of existing narratives of social hierarchy, urbanisation, and trade. In the absence of knowledge of whether these objects were of an individual ownership or not, to correlate the owner of bigger size seal to the higher status in the consumer system is a conjectural relationship.

In another research where right facing unicorn on a single seal object has been used as a case study, authors had already argued that comparing this seal with similar objects from other sites shows "... evidence of shared carving styles that may represent temporal or social affiliations that require further testing... ."[311] In addition to right facing unicorn, the uniqueness in style was observed in steeply carved outline and flat bottom for the body, absence of offering stand, and patterns of incised lines on the body. The study also indicates that this may be a specimen of an early type based on the seals from Harappa and Farmana. However, Konasukawa observes that "In comparing with the Harappan scripts engraved on the Harappan seals having a left-facing animal, it is most likely that the scripts engraved on the Harappan seals having a right-facing animal are not expressed in reverse."[312] It is interesting to note that Soviet scholars had observed that for right facing animals, the signs are found written in both from right to left (common)

317.

309. Konasukawa and Koiso, "Size of the Indus type seals and its Significance," 130.

310. Konasukawa, "Diversity of Harappan civilization: a case study of the Ghaggar basin with special reference to seals," 100.

311. Akinori Uesugi et al., "A Study on the Stylistic and Technological Aspects of Indus Seals with a Focus on an Example from Bhirrana," *Heritage Journal of Interdisciplinary Studies* 4 (2016): 6.

312. Konasukawa, "Diversity of Harappan civilization: a case study of the Ghaggar basin with special reference to seals," 139.

and from left to right (rare).[313]

Uesugi, in the above mentioned study, has also analysed the carving sequences of artefacts by observing those under scanning electron microscope to reconstruct the carving process.[314] Extended analysis of carving process can be seen in two notable doctoral studies viz. by Green and Jamison. Green has proposed to establish and correlate context groups, motif groups, and Analytical Carving Groups (ACG).[315] ACGs are a 'typological product' which group MHA based on carving sequences as observed under H-160 3D microscope. Based on the sign alignments, Green has also argued for the possibility of multiple people working on the seals as carvers and scribes. It thus creates a staged process where the motif or the signs have followed specific sequences of carving in different seals. In this context, Possehl also describes observations by Gadd about crowding and alignment of signs and those by B. B. Lal about overlap of signs to infer the carving sequence.[316] Jamison has conducted an ethnographic study that included carving experiments with carvers in Rajasthan, India. He has calculated and compared the metric attributes as well as style parameters derived by him.[317] It has helped him hypothesise that there were probably multiple carving schools or groups and each followed their own standards, traditions, and styles of carving. He has also argued that these probably functioned in a decentralised manner. Collective analysis of Uesugi, Green, Konasukawa, and Jamison may help solidify the carving groups postulate. Their affinity to specific sites, motifs, and artefact forms will need more study which may add rationale for these groups. Given a low stratigraphic control in the majority of the historic excavations and ambiguous documentation of the artefacts therein, explanation of their possible relationship with a specific cultural period is difficult yet crucial.

What these studies essentially indicate and Uesugi notes is that "In the absence of

313. G. V. Alekseev, "The characteristics of the Proto-Indian script," in *The Soviet Decipherment of the Indus Valley Script: Translation and Critique*, ed. Arlene R. Zide and Kamil V. Zvelebil (Mouton, 1976), 20.

314. Uesugi et al., "A Study on the Stylistic and Technological Aspects of Indus Seals with a Focus on an Example from Bhirrana."

315. Green, "Stamp Seals in the Political Economy of South Asia's Earliest Cities."

316. Possehl, *Indus Age: The Writing System*, 59.

317. Jamison, "The organization of Indus unicorn seal production: A diachronic comparative study of style, skill, and sociopolitical organization."

good stratigraphic control, this can help provide information on chronology and potentially different workshop or artisan carving styles."[318] Thus, there is a chance to speculate that particular seals could be markers of a specific cross-section of space and time in the cultural sequence.[319]

Laursen attempts to understand variation of object shapes within Dilmun culture and possibility of use of the same signs for writing a different language or a dialect.[320] At the fag end of the urbanisation phase of Harappan culture in the Indus valley, Dilmun had emerged as a state. Laursen hypothesises the script adaptation within the administrative protocol of Dilmun and also its abandonment based on recent excavations in Kuwait and Bahrain.

In the multitude of these studies dedicated to script, language, typology, iconography, and production mechanisms, few scholars like Randall Law have paid detailed attention to the raw material of the artefacts, steatite to be specific. Based on the presence and proportion of dolomite, he has identified possible sources in Muslimbagh region of Zhob district in N Baluchistan, Kurram Agency in the F.A.T.A., the Hazara District of the N.W.F.P,[321] and the area of shrine of Shah Bilwal Noorani in southern Baluchistan.[322] For the seals found at Dholavira, Nagwada, and Bagsara, he has also proposed regional source from Sabarkantha District of NE Gujarat.[323] This insight into possible

318. Uesugi et al., "A Study on the Stylistic and Technological Aspects of Indus Seals with a Focus on an Example from Bhirrana," 15.

319. Chapter 5 discusses the possible relationships into carving techniques and sign sequences.

320. Laursen, "The westward transmission of Indus Valley sealing technology: Origin and development of the 'Gulf Type'seal and other administrative technologies in Early Dilmun, c. 2100–2000 BC"; Steffen Terp Laursen, "Seals and Sealing Technology in the Dilmun Culture: The Post-Harappan Life of the Indus Valley Sealing Tradition," in *Seals and Sealing in the Ancient World: Case Studies from the Near East, Egypt, the Aegean, and South Asia*, ed. Marta Ameri et al. (Cambridge University Press, 2018), 204–226, https://doi.org/10.1017/9781108160186.015; Flemming Højlund, "The formation of the Dilmun state and the Amorite tribes," in *Proceedings of the Seminar for Arabian Studies* (JSTOR, 1989), 45–59

321. Law, "Regional interaction in the prehistoric Indus Valley: initial results of rock and mineral sourcing studies at Harappa."

322. Randall W. Law, "Moving Mountains: The trade and transport of rocks and minerals within the greater Indus Valley region," *Space and spatial analysis in archaeology*, 2006, 301–312.

323. Randall W. Law, "The important stone and metal resources of Gujarat during the Harappan period," *Heritage: Journal of Multidisciplinary Studies in Archaeology* 1 (2013): 319–343.

variation in steatite at different sites or even for different social groups opens a new area of enquiry. To source the material from the nearest site is a logistic choice but not to do so demonstrates a demand of a specific quality, either for a specific purpose or for a group.

The studies reviewed in this subsection demonstrate possibilities of more nuanced observations which use state of the art technologies, ethnographic approaches, and a granular outlook as opposed to generalisation, simplifications, and creation of a single grand narrative.

2.8 Contemporary material cultures

The least discussed cultural contacts are those with present day Horn of African continent which was probably reachable by a mix of land and sea routes. At the site of Chanhu-daro, Kennedy and Possehl postulated African origin of a young female, discovered in a secondary burial during the excavations in 1935-36.[324] This was supported by comparisons with multiple cranial bearings from ancient and modern South Asia and the unique nature of funerary practice. Though these do not hold as theories today due to methodological pitfalls, the most robust discovery is that of the three millets of African origin. Sorghum or jowar (*Sorghum bicolour*), pearl millet or bajra (*Pennisetum typhoides*), and finger millet (*Elleusine coracana*) are all present in Harappan archaeobotanical context.[325] For the representations in the material remains, During Caspers thought of dancing girl of possible Nubian origin or as per Piggott, that of Proto-Australoid.[326] In the recent article, Rowland and Fuller have painted a complex picture of contact with African region in terms of food traditions, cooking, and rituals.[327]

Within the Indian subcontinent, the Ahar-Banas cultural complex has been identified

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324. Kenneth A. R. Kennedy and Gregory L. Possehl, "Were there commercial communications between prehistoric Harappans and African populations?," *Advances in Anthropology* 2, no. 04 (2012): 169–180.

325. Kennedy and Possehl, 176.

326. Kennedy and Possehl, 176–177.

327. Michael Rowlands and Dorian Fuller, "Deconstructing civilisation: A 'Neolithic'alternative," in *Trade and civilisation: economic networks and cultural ties, from prehistory to the early modern era*, ed. Kristian Kristiansen, Thomas Lindkvist, and Janken Myrdal (Cambridge University Press, 2018), 172-194–12.

as a contemporary chalcolithic culture with its early phases in the third millenium BCE and the end of late phase by round 1700 BCE.[328] Based on the similarities in motif found on the impressed sealings, a contact has been proposed between this and BMAC.[329]

Harappan culture's contacts with regions such as West Asia, Mesopotamia, and other contemporary chalcolithic culture have been revealed based on material studies, mostly those of ceramics and inscribed objects. The conjecture about identification of Harappan region as Meluhha is based on a written evidences from Mesopotamia. With the confirmed identification of Dilmun with Bahrain, and Magan with Oman, Harappan region matches the textual references of Meluhha such as it being farthest and exporter of carnelian and ivory.[330] The presence of Harappan artefacts in Mesopotamian sites and the discovery of cylindrical seal (hallmark of Mesopotamian material culture) in Harappan sites strengthen this hypothesis. It is possible that pre-Harappan contacts between Southern Iran and Mesopotamia facilitated these later connections.[331] In a similar discussion in reference to Sargon geography, while identifying Meluhha with the correct region, Potts navigates through multiple possibilities based on geographical descriptions and distances.[332] In their article from 1977, Parpola and colleagues propose a process of acculturation of Harappan trading community in Mesopotamian geography base with possible existence of Meluhhan village.[333] The trade contact can be seen supported since earlier studies.[334] Julian Reade has an entire volume of edited essays which discuss the

328. Vasant Shinde, Gregory L. Possehl, and Marta Ameri, "Excavations At Gilund, 2001-2003: The seal impressions and other finds," *South Asian Archaeology 2003*, 2005, 159–169.

329. Gregory L. Possehl, Vasant Shinde, and Marta Ameri, "The Ahar-Banas complex and the BMAC," *Man and Environment* 29, no. 2 (2004): 18–29.

330. McIntosh, *The ancient Indus Valley: new perspectives*, 183.

331. Thapar, "A Possible Identification of Meluhha, Dilmun and Makan*."

332. Daniel Potts, "The road to Meluhha," *Journal of Near Eastern Studies* 41, no. 4 (1982): 279–288.

333. Simo Parpola, Asko Parpola, and Robert H. Brunswig Jr, "The Meluḫḫa village: evidence of acculturation of harappan traders in late Third Millennium Mesopotamia?," *Journal of the Economic and Social History of the Orient/Journal de l'histoire economique et sociale de l'Orient*, 1977, 129–165.

334. Carl C. Lamberg-Karlovsky, "Trade mechanisms in Indus-Mesopotamian interrelations," *Journal of the American Oriental Society*, 1972, 222–229; Carl C. Lamberg-Karlovsky and Maurizio Tosi, "Shahr-i Sokhta and Tepe Yahya: tracks on the earliest history of the Iranian Plateau," *East and West* 23, nos. 1/2 (1973): 21–57

antiquity and contact around the Arabian sea.[335] These and several other studies have now accepted the identification of Meluhha as the Harappan geographical region.

Contemporary material evidences from Mesopotamia and Oman reveal various types of seals, sealings, and similar objects. While investigating the Akkadian period sealing practices in Mesopotamia, despite being able to read these, Rakic illustrates a vivid picture of their use in day-to-day life such as management of land and animals, production and distribution of food, storage, and transactions.[336] Author concludes that to interpret various scenes for their possible use in political or social systems is complicated; thus it is not always easy to differentiate between private and state functions. She identifies these imageries and objects as innovative modes of communication over greater distances - "....glyptic imagery may have participated in systems of visual communication during a time of increasing administrative centralization... ."[337] A comparative iconographic analysis of seals from Konar Sandal demonstrates possibilities on contacts between the Harappans and Iranian borderlands along with movement of seals.[338]

In the iconographic similarities which appear on the Mesopotamian artefacts, the contest scene has been the topic of scholarly discussions. A scene of a standing human figure holding two animals, most probably that of a feline family, is seen on MHAs: M-306, M-307, M-308 in the first CISI volume.[339] Parpola argues that this definitely is an adoption of a Mesopotamian 'contest' scene.[340] However, many of such depictions in Assyrian-Babylonian context are from the early first millennium BCE. As described by Glenn, seals from late 3rd millennium period ".... typically reversed the positions of

335. Julian Reade, *Indian Ocean in Antiquity* (Routledge, 2013).

336. Yelena Z. Rakic, "Sealing Practices in the Akkadian Period," in *Seals and Sealing in the Ancient World: Case Studies from the Near East, Egypt, the Aegean, and South Asia*, ed. Marta Ameri et al. (Cambridge University Press, 2018), 81–94, https://doi.org/10.1017/9781108160186.008.

337. Rakic, 93.

338. Holly Pittman, "New evidence for interaction between the Iranian Plateau and the Indus Valley: Seals and sealings from Konar Sandal South," *Connections and complexity: New approaches to the archaeology of South Asia*, 2013, 63–89.

339. Joshi and Parpola, *Corpus of Indus seals and inscriptions - Collections in India*, 1:76.

340. Asko Parpola, "Indus Seals and Glyptic Studies: An Overview," in *Seals and Sealing in the Ancient World: Case Studies from the Near East, Egypt, the Aegean, and South Asia*, ed. Marta Ameri et al. (Cambridge University Press, 2018), 135, https://doi.org/10.1017/9781108160186.011.

the figures, requiring two heroes to wrestle a single beast.[341] She mentions that this is still a contest, sometimes interpreted as controlling the evil forces. Many of these are seen on cylinder seals in Mesopotamia but in Harappan context, the scene is commonly depicted on the square seals. The recent discoveries of geoglyphs at Barsu[342] on the western coast of India shows intriguing similarity with the concept of contest scene. Separated by a vast geographic region, possibly belonging to a different time frame, and probably having no contact with Harappan or Mesopotamian cultural contexts, this geoglyph raises question about the hypothesis of adoption, especially of this scene.

In case of MHA, it is seen that archaeologically challenging propositions have emerged from statistical analysis of signs. It is critical to see how such material evidence has been analysed for the other contemporary writing systems. Cuneiform clay-tablets have invaluable significance in the decipherment of cuneiform script. Based on Veldhuis' work, Mathews touches upon two critical aspects such as levels of literacy and representativeness of the sample.[343] How the scribes of various functional, technical, and scholarly levels catered to different needs and varieties of cuneiform writing and how the proportions of these levels varied for hundreds of years is still a topic of research. The other aspect reiterates the ever-intriguing problem of archaeology about the uncertainties around the proportion of excavated material. It directly impacts our ability to make meaningful interpretation about the original unknown population ('Population' as a statistical term). These perspectives thus prove that despite successful decipherment of these texts, numerous ontological constructs still need further investigation.

In another case that completely rejects the homogeneity argument, Sparks investigates diverse purposes of writing based on the contexts and styles in Bronze age southern Levant. Limited dataset, bias in material, different languages (six), and multiple scripts are the main characteristics which need to be correlated with the writings in those spe-

341. Anna Glenn, "Assyro-Babylonian Contest Scene - JHU Archaeological Museum," 2021, accessed December 10, 2022, https://archaeologicalmuseum.jhu.edu/the-collection/object-stories/cylinder-seals-from-the-ancient-near-east/assyro-babylonian-contest-scene/.

342. "Geoglyphs of Konkan Region of India - UNESCO World Heritage Centre," 2022, accessed February 20, 2023, https://whc.unesco.org/en/tentativelists/6605/.

343. Roger Matthews, "Writing (and Reading) as Material Practice: The world of cuneiform culture as an arena for investigation," in *Writing as Material Practice: Substance, surface and medium*, ed. Kathryn E. Piquette and Ruth D. Whitehouse (Ubiquity Press, 2013), 69.

cific contexts.[344] The purpose of writing is identified as a tool for the analysis viz. administration, education, propaganda, funerary, votive, protection, and ownership. Multiple relationships such as script and context, script and technique, and technique and material have been analysed and these reveal information about the usage pattern and general practices about writing. Similar approach for a recent period is taken by Cessford for "... the materiality of writing in 18th-20th century Britain... ."[345] He observes that paper becomes a norm for writing, but hardly any of it survives. To emphasise Waal's point, he mentions "Archaeologically, this scenario where the dominant medium for writing is the least likely to survive is paralleled in other cultures."[346]

Finally, Piquette and Whitehouse inspect materiality of writing. They do not interpret the written material solely based on the content, linguistics, and semantics but within its inherent and acquired context. They argue that "... archaeological thought on decision-making processes, choice and intentionality also stands to contribute to research on the selection of writing materials, and the choices past people made for how to write, read, view or otherwise engage with written surfaces."[347] They thus touch upon the affordances of the artefacts bearing written content. With a representative example of Khipu, Soloman illustrates how signs being used in complex mediums can possibly possess semiotic heterogeneity.[348]

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344. Rachael Thyrza Sparks, "Re-writing the Script: Decoding the textual experience in the Bronze Age Levant (c. 2000–1150 bc)," in *Writing as Material Practice: Substance, surface and medium*, ed. Kathryn E. Piquette and Ruth D. Whitehouse (Ubiquity Press, 2013), 75–104.

345. Craig Cessford, "Different times, different materials and different purposes: writing on objects at the Grand Arcade site in Cambridge," in *Writing as Material Practice: Substance, surface and medium*, ed. Kathryn E. Piquette and Ruth D. Whitehouse (Ubiquity Press, 2013), 289.

346. Cessford, 312.

347. Kathryn E. Piquette and Ruth D. Whitehouse, eds., *Writing as Material Practice: Substance, surface and medium* (Ubiquity Press, 2013), 6.

348. Frank Salomon, "The twisting paths of recall: khipu (Andean cord notation) as artifact," in *Writing as Material Practice: Substance, surface and medium*, ed. Kathryn E. Piquette and Ruth D. Whitehouse (Ubiquity Press, 2013), 39.

2.8.1 Comparative material

As mentioned earlier, the interpretations of seals as objects for creating impression for the purpose of economic or administrative activities, and that of signs for depicting the information in the contemporary language are mainly based on the Mesopotamian culture. Its contemporaneity to the Harappan culture has created the basis for this interpretation. A brief review of existing literature about inscribed Mesopotamian artefacts demonstrates confirmatory usage in the functions of trade, administration, and control.[349]

The Electronic Text Corpus of Sumerian Literature (ETCSL),[350] hosted by the University of Oxford allows a search for many specific occurrences of different terms. It is important to note that these are literary compositions between the late third and early second millennia BCE. A cursory look at the collections in Cuneiform Digital Library Initiative (CDLI),[351] hosted in collaboration by multiple institutes, shows that at least 10 languages were being written by using the cuneiform script. Meluhha can be found written in both Sumerian and Akkedian. This is important on the background of monolingual claims for Harappan signs. In a recent article by Possehl, he describes a journey of tracking down and reappraising of a cylindrical seal, popularly known as 'Shu-ilishu's Cylinder Seal'. The original Sumerian message is translated as 'Su-ilisu, translator (of the country) of Meluhha'.[352] This happens to be the critical artefact for the postulates of language of Meluhha or that of Harappan culture.

In the light of close contact with Mesopotamian culture, identification of Meluhha, and evidence of similar artefacts, direct parallels have been drawn between the artefact

349. Holly Pittman, "Administrative Evidence from Hacinebi Tepe: an Essay on the Local and the Colonial," *Paléorient* 25, no. 1 (1999): 43–50; Holly Pittman, "Administrative role of seal imagery in the Early Bronze Age: Mesopotamian and Iranian traders on the plateau," in *Seals and Sealing in the Ancient World: Case Studies from the Near East, Egypt, the Aegean, and South Asia*, ed. Marta Ameri et al. (Cambridge University Press, 2018), 13–35, https://doi.org/10.1017/9781108160186.008; Rakic, "Sealing Practices in the Akkadian Period"

350. Faculty of Oriental Studies, "ETCSLhomepage."

351. "Cuneiform Digital Library Initiative," 2023, accessed November 10, 2022, https://cdli.mpiwg-berlin.mpg.de/.

352. "CDLI seals 014339 (physical) (P525331) - Cuneiform Digital Library Initiative."

typologies and their interpretation in these two material cultures. It is worth noting that in the Akkadian region of influence, the administrative role of seals becomes a strong hypothesis only due to sheer number of sealings of contemporary period which have been impressed with those seals.[353] A volume dedicated to excavations at Arslantepe has several mentions about quantity of sealings and their usage. Though the material pre-dates Harappan artefacts, it is important to understand how usage pattern continued over the period of time:

> Thousands of cretulae were found both in the smaller storeroom, together with one hundred mass-produced bowls, and in various spaces in the palace, among which the well known narrow room A 206 where over 2,000 sealing fragments bearing the impressions of 211 different seals had been dumped in successive piles (fig. 10). This was the result of the final disposal of a sort of 'archive', after the final control and accountability.[354]

Or "The thousands of discarded sealings found in the two stairway deposited were used in an elaborate system of food distribution in exchange for labor or commodities."[355] However, a look into the usage pattern and available artefacts in Harappan culture, a contradictory picture is seen. Frenez notes that quantity of sealings from Lothal are "... comparable to collection in a house at Shah-i-sokhta".[356] Against the background of these incomparable artefact evidences, it is worth mentioning that Fairservis had demonstrated presence of territory based attributes of Mesopotamian and Egyptian counter-

353. Rakic, "Sealing Practices in the Akkadian Period," 85;Robert K. Englund, "Seals and Sealing in CDLI files," *Cuneiform Digital Library Notes* 2014, no. 4 (2014)

354. Marcella Frangipane, "The rise and development of a political centre: from temple to palace to a fortified citadel," in *Arslantepe. Proceedings of the I. International Archaeology Symposium, 4-6 October 2018 Malatya*, ed. Neslihan Durak and Marcella Frangipane (İnönü University / Roma La Sapienza University, 2019), 79.

355. Holly Pittman, "Glyptic art from Arslantepe: interregional styles, imported seals and local seals," in *Arslantepe. Proceedings of the I. International Archaeology Symposium, 4-6 October 2018 Malatya*, ed. Neslihan Durak and Marcella Frangipane (İnönü University / Roma La Sapienza University, 2019), 137.

356. Frenez and Tosi, "Lothal Sealings: Records from an Indus Civilization town at the eastern end of the maritime trade networks across the Arabian Sea," 82.

parts, and their absence in Harappans culture.[357]

2.9 Contextual studies

In this thesis, besides attribute analysis, a separate case study is proposed to inquire into the physical context of the intaglio artefacts. While explaining the fundamentality of the space, Hillier has explained that "... Spatial configuration is..non-discursive. ...space and spatial relations are so fundamental to our ability to cognise the world around us, ...they form part of the ideas we think with, rather than those we think of."[358] Baur, on similar lines, stresses on the space being a social construct. More specifically: "Over time, local practices and knowledge are solidified via the physical (especially: built) environment."[359] Allison conducted a spatial analysis study at the site of Pompeii.[360] The aim was categorisation of rooms across multiple houses and study of their artefact assemblage to understand the purpose of the area. It is theorised that the physical context, in terms of time and space, will offer an insight into understanding the spread, movement, associations, and rationale of the existence of these objects at those intersections.[361] As mentioned by Craig, "...Quantitative spatial analysis does not yield a direct definitive answer regarding the activities that produced the artefact distribution.

357. Walter A. Fairservis, "Cattle and the Harappan chiefdoms of the Indus Valley," *Expedition* 28, no. 2 (1986): 43.

358. Bill Hillier, "Spatial analysis and cultural information: the need for theory as well as method in space syntax analysis," in *Spatial analysis and social spaces. Interdisciplinary approaches to the interpretation of prehistoric and historic built environments*, ed. Paliou Eleftheria, Lieberwirth Undine, and Polla Silvia (De Gruyter, 2014), 20.

359. Nina Baur et al., "Theory and methods in spatial analysis. Towards integrating qualitative, quantitative and cartographic approaches in the social sciences and humanities," in "Spatial Analysis in the Social Sciences and Humanities. Towards Integrating Qualitative, Quantitative and Cartographic Approaches," ed. Cornelia Thierbach et al., *Historical Social Research/ Historische Sozialforschung (HSR)* 39, no. 2 (2014): 16.

360. Penelope M. Allison, "Artefact distribution and spatial function in Pompeian houses," in *The Roman Family in Italy: Status, Sentiment, Space*, ed. B. Rawson and P. Weaver (Oxford University Press, 1997), 321–354.

361. Penelope M. Allison, "The household in historical archaeology," *Australasian Historical Archaeology*, 1998, 16–29.

Contextual information is clearly critical for robust interpretation."[362]

The artefact distribution thus can be seen as a result of their functionality, complemented by space which hosts those functionalities. Analysis of how closely these two integrate will contribute in epistemological questions of archaeological interpretation. In day-to-day life, the activities and behaviours are shaped by these spaces, and over a period of time the spaces are reshaped by artefacts and their functions. In an interesting study about association of space to human interaction, Wheatley gives an example of 'proxemics', originally defined by Hall in 1966: ".... different spatial scales tend to afford different sensory engagements... ."[363] He notes that these are not abstract but are rather affordances as defined by Gibson in 1977.[364] Thus, the affordances of the artefacts are also a result of the spaces which they are part of during their life-cycle. Another overarching attribute is that of time. Since archaeological mounds are formed over hundreds of years if not less, with possible phases of settlement and abandonment, how overlapping structural activities continue or distort the previous layouts becomes an important phenomenon. This is a prominent situation especially at the DKGS mound of Mohenjo-daro.

Signifying the importance of spatial analysis, Thierbach and Lorenz emphasise on the role of maps and argue that "... maps are socially constructed... ."[365] While using historical, especially colonial sources in the present work, this argument is important. For the geospatial case-study in the present thesis, it relies on the physical maps created by Mackay during 1927 and 1931 seasons of Mohenjo-daro excavations. Though this period was a peak of colonial rule in India, this was also the time of the birth of Indian

362. Nathan Craig, Mark Aldenderfer, and Holley Moyes, "Multivariate visualization and analysis of photomapped artifact scatters," *journal of archaeological science* 33, no. 11 (2006): 1624.

363. David Wheatley, "Connecting landscapes with built environments: visibility analysis, scale and the senses," in *Spatial analysis and social spaces. Interdisciplinary approaches to the interpretation of prehistoric and historic built environments*, ed. Paliou Eleftheria, Lieberwirth Undine, and Silvia Polla (De Gruyter, 2014), 125.

364. Wheatley, 127.

365. Cornelia Thierbach and Alexandra Lorenz, "Exploring the orientation in space. Mixing focused ethnography and surveys in social experiment," in "Spatial Analysis in the Social Sciences and Humanities. Towards Integrating Qualitative, Quantitative and Cartographic Approaches," ed. Cornelia Thierbach et al., *Historical Social Research/ Historische Sozialforschung (HSR)* 39, no. 2 (2014): 144.

archaeology at the hands of British themselves. The excavation reports published by Marshall, Mackay, and others document the site and artefacts along with plans, drawings, and photographs. This may appear to be a very standardised process with least possible chances of subjectivity that may appear in mere documentation of the objects and physical remains. However, even 'to document' the raw data, a number of negotiations are required to be done at several levels. Beyond that, though the maps are expected to depict the structural remains for the identified periods, the 'reading' of these structures by the contemporary excavators introduce unavoidable ambiguities. Both these aspects create the possibilities for investigation in the recorded data. The data preparation elaborates on this topic.

Majority of the above arguments concur that the concept of "spatially neutral" does not exist.[366] Thus, the purpose of indulging into the archaeological context in the present case is not to treat space as an "independent variable" but "...a frame of reference in which social (inter)action takes place."[367] The non-neutrality and spatial association can be analysed and used for interpretation of the current or past societal processes when the scales of spatial unit and the system or process under investigation are relevant to each other. The changes in room sizes, spaces with in-situ objects, and the stratigraphic correlation to periods act at various scales, create ambiguities in observations, and hence impact the analysis. Chan-Tack defines this relevance as "ecological validity".[368] The MAUP i.e. Modifiable Areal Unit Problem presents itself as a prerequisite in social studies because the scale of study can dramatically change our observations and thus the interpretation of the data. The challenges in resolving the MAUP involve availability of quantitative or qualitative data with geospatial referencing. In order to experiment with

366. Nina Baur, "Comparing societies and cultures. Challenges of cross-cultural survey research as an approach to spatial analysis," in "Spatial Analysis in the Social Sciences and Humanities. Towards Integrating Qualitative, Quantitative and Cartographic Approaches," ed. Cornelia Thierbach et al., *Historical Social Research/ Historische Sozialforschung (HSR)* 39, no. 2 (2014): 262.

367. Baur et al., "Theory and methods in spatial analysis. Towards integrating qualitative, quantitative and cartographic approaches in the social sciences and humanities," 29.

368. Anjanette M Chan-Tack, "The case for spatially-sensitive data: How data structures affect spatial measurement and substantive theory," in "Spatial Analysis in the Social Sciences and Humanities. Towards Integrating Qualitative, Quantitative and Cartographic Approaches," ed. Cornelia Thierbach et al., *Historical Social Research/Historische Sozialforschung (HSR)* 39, no. 2 (2014): 318.

scales, this data needs to be flexible which can be merged or separated for analysis. Thus the availability of spatially sensitive data directly influences the nature of analysis and quality of interpretation thereafter.[369] This provides a rational to reconstruct a micro-context for MHA and then compare the observations at different scales.

The geospatial datasets of these studies have played a pivotal role in the analysis and interpretation. Observation of the artefacts and structural remains in their excavated contexts is one of the primary tenets of archaeological methodology. However, as the excavation progresses, spans over multiple seasons, and the overlapping layers get removed during the process, there is no way to retain the context and thus study the material in-situ. Thus, while the excavation is practically an unavoidable destruction of the context, it is imperative that it gets recorded. Depending on the objectives of the excavation, nature of sites, available technologies, time, and budget constraints, multiple methods are employed at various sites. The most commonly observed practice is providing the coordinate information within the grid which gets laid down for planning the trenches. With technological advances over time, survey techniques such as plain table, theodolite survey, total station, aerial photos, satellite imageries, drone photography, GPR, GPS, and LiDAR have been used for spatial documentation of archaeological sites. Though some of these were not available in the past, they have not completely replaced the old techniques.

2.9.1 Archaeological contexts of MHA

There are a few notable studies, which reveal that geospatial analysis is inevitable for meaningful archaeological interpretation of MHA.

In stylistic analysis of square unicorn seals from different mounds, Dr. Ute Franke maps these and other artefacts to their respective locations within the mound.[370] Though this is a very primary study of actually locating MHAs on surveyed maps, it is important for two reasons. It acknowledges the fact that such mapping should be done, because it actually helps visualise the provenance of the artefact from the time of excavation.

369. Chan-Tack, "The case for spatially-sensitive data: How data structures affect spatial measurement and substantive theory," 318–322.

370. Franke, "Die Glyptik aus Mohenjo-Daro: Uniformität und Variabilität in der Induskultur: Untersuchungen zur Typologie, Ikonographie und räumlichen Verteilung."

Secondly, Franke tries to relate the artefact types to their findspot and create an interpretative space. Patterns of types may spread across the space. This distribution can create some insight about their significance, contribution, and meaning in the contemporary culture.

Green's work from his doctoral thesis is a huge next step.[371] As described earlier, based on the analysis of carving strokes and sequences of square unicorn seals, he theorised the existence of ACG - Analytical Carving Groups, style groups, and context groups. He proposed one-to-one and one-to-many relationships between ACGs and context groups. The concept of context groups is rooted in the physical archaeological context of artefacts at multiple scales. His emphasis on the role of context in understanding the seals and their association with ACGs is seen throughout his work. He has tried to extract the relationship between the carvers and prospective users of these artefacts. He has contextualised this relationship within the framework of the context groups. At a regional scale, ACG7 which is most dominant in Indus plains or Sindh, is completely absent from Ghaggar basin. At a local scale, he observes distinction between the two-stage sequences (Animal-Inscription or Inscription-Animal) within the blocks of DKGS.[372] It can greatly benefit our know-how about the creator-user persona of the seals. More data on these lines will lead to a statistically significant observation. This analysis is an example of significance of scale discussed above.

Current work at LIAVH[373] research lab at Pratt Institute, New York is a state of the art implementation of reconstruction of multidimensional archaeological context.[374] It can be thought of as a next step of Franke and Green's work. For the site of Mohenjodaro, the team at LIAVH is working on the documentation of the artefacts from published materials as well as field records, and linking those to their precise findspots. The web-based system is helping to visualise this data along with artefact metadata and photographs.

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371. Green, "Stamp Seals in the Political Economy of South Asia's Earliest Cities."

372. Green, 127, 289.

373. "The Laboratory for Integrative Archaeological Visualization and Heritage (LIAVH) - Pratt Institute," 2020-2023, accessed July 1, 2022, https://www.pratt.edu/work/the-laboratory-for-integrative-archaeological-visualization-and-heritage-liavh/.

374. Uzma Z. Rizvi, C. Sucuoglu, and R. Daniell, "Documenting MohenjoDaro: Digitization and Visualization of Architecture, Infrastructure, and Artifacts from DK-G South" ().

The documentation of structural remains at Mohenjo-daro inevitably record the architectural features of these structures. Since the architecture defines our perception of space, two earlier studies on these lines are worth mentioning. Sarcina's work from 1978 is probably one of the early approaches which has acknowledged architectural features in archaeological context.[375] The author documents the characteristic attributes, and thereby groups the structures in architecturally meaningful categories. Identification of these categories as "residential models" is mainly based on the area of the courtyard and its position with respect to rooms in the particular dwelling.[376] It should be noted that the excavators' identification of house has played a major role in this study. Sarcina could assign only 60 out of 108 structures (houses/dwellings) to one of the five models which she had defined. In the first interim report published by Jansen, the team has performed a detailed analysis of the structural remains to understand the nature and function of the spaces.[377] He has grouped those into only three subgroups. The 'public' and 'private' distinction is made based on the accessibility of the spaces. An in-depth analysis of a single house in HR-A area demonstrates reassessment of the humongous data. Kenoyer's detail review creates an overarching picture of how the space creation and utilisation could have evolved since the Mehrgarh phase of Early Food-Producing Era.[378] He proposes a constant overlap of domestic and craft production in the structural complexes. It is interesting that despite a large scale excavation of Mohenjo-daro and more than 100 'houses' identified by earlier studies by Sarcina and Jansen, Kenoyer sparsely describes, compares, and interprets those in his entire discussion about households and neighbourhoods.[379] With technological advances demonstrated by LIAVH

375. Anna Sarcina, "A Statistical Assessment of House Patterns at Moenjo Daro," *Mesopotamia Torino* 13 (1978): 155–199.

376. Sarcina, 158.

377. Michael Jansen and Günter Urban, *Interim Reports, Reports on Field Work Carried Out at Mohenjo-Daro, Pakistan, 1982-83 by the IsMEO–Aachen University Mission*, vol. 1 (Estremo Oriente–Rheinisch-Westfälische Technische Hochschule, Rome–Aachen, 1984), 39–62.

378. Jonathan Mark Kenoyer, "Households and neighborhoods of the Indus tradition: An overview," in *New Perspectives on Household Archaeology*, ed. Bradley J. Parker and Catherine P. Foster (Eisenbrauns, Winona Lake IN, 2012), 373–406.

379. In fact, on page number 399 of the mentioned article, Kenoyer mentions that only Harappa and Kalibangan show evidence of neighbourhoods divided by streets, lanes and perimeter like thick walls.

lab, it is worth exploring if the 'house' definitions by the then excavators can be further improved upon based on such studies.

Mosher's doctoral work tries to bridge the gap between Sarcina's work from four decades ago to LIAVH's state of the art visualisation.[380] He has suggested improvement over Sarcina's typology by identification of particular architectural attributes such as doorways, stairways, column bases, buttresses, open spaces, corridors, thick walls, and more. He has used a combination of these attributes to propose architectural types of the houses. Finally, he has proposed the existence of six types of structures with multiple forms within each type.

At a regional level, geospatial analysis of Harappan sites has mostly been done for site catchment analysis or to know their locational subordination to the closest urban site. The latest study by the Landscape Archaeology group from Catalan Institute exploits the power of Google Earth Engine to locate the Harappan culture mounds in Cholistan dessert.[381] It has used ground survey data documented by Mughal from the 1970s and various other geospatial datasets in digital form. These datasets have been used to identify and create a geospatial signatures of the known sites. The signature is essentially a geospatial context of the location of the site. The complex algorithms implemented in the Google Earth Engine use these signatures and 'detect' the potential mounds with similar contexts. The history of Indus floods has played a major role in the creation of a significant geographic feature used in this study: saline mud flats i.e. dahars.[382] Density of sites is high in these areas. In a related study by Garcia et al., they analyse the Indus flood event in 1909 and its extent that completely damaged the cite of Dera Gazhi Khan in Punjab, Pakistan.[383] The most relatable aspect of this study in the present thesis

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It must be noted that blocks defined by Mackay at DKGS mound of Mohenjo-daro were based on exact these three parameters.

380. Matthew S. Mosher, "The Architecture of Mohenjo-Daro as Evidence for the Organization of Indus Civilization Neighbourhoods" (PhD diss., University of Toronto, 2017).

381. Hector A. Orengo et al., "Automated detection of archaeological mounds using machine-learning classification of multisensor and multitemporal satellite data," *Proceedings of the National Academy of Sciences* 117, no. 31 (2020): 18240–18250.

382. Orengo et al., 2.

383. Arnau Garcia et al., "Remote sensing and historical morphodynamics of alluvial plains. The 1909 Indus flood and the city of Dera Gazhi Khan (Province of Punjab, Pakistan)," *Geosciences* 9, no. 1 (2018):

is the contribution of such phenomenon in the archaeological site formation processes. The photograph of the site shows how the flood can lead the settlement totally unusable for reoccupation.[384] The washed out part of the mound and the dilapidated structures demonstrate the extent of damage a flood can cause. In the light of this recent work, it is worth looking at Possehl's work from 1967.[385] He has responded to the theories related to the floods being caused because of a natural dam in the lower reaches of the Indus river. He reviews multiple flood studies and observations at different sites. He reiterates that silts have been found in almost every excavation of the Harappan culture sites, which was mainly 'riverine' and Harappan people were used to the events of flooding.[386] He has noted observations from Dales and Raikes where the silt levels were observed above the present flood plain. His objection was taken seriously by the duo and they published a response.[387] They focus on the explanation for the presence of flood plain - at least 40 feet of silt covered with clay "... at the time of founding of Mohenjo-daro."[388] These studies show differential behaviour and intensities of floods across the time. Also, its impact on habitation and response from the occupants could be extremely diverse. These observations are critical for the GIS case study in this thesis, planned for the DKGS mound of Mohenjo-daro.

2.10 Note about Voynich manuscript

In the context of the lack of success of the decipherment studies, it is worth mentioning about an early twentieth century discovery of Voynich manuscript, known after its first historian Wilfrid Voynich from 1921. The manuscript likely belonged to 14th-15th cen-

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384. Garcia et al., "Remote sensing and historical morphodynamics of alluvial plains. The 1909 Indus flood and the city of Dera Gazhi Khan (Province of Punjab, Pakistan)," 7.

385. Gregory L. Possehl, "The Mohenjo-daro Floods: A Reply," *American anthropologist* 69, no. 1 (1967): 32–40.

386. Possehl, 32.

387. George F. Dales and Robert L. Raikes, "The Mohenjo-Daro Floods: A Rejoinder!," *American Anthropologist* 70, no. 5 (1968): 957–961.

388. Dales and Raikes, 958.

tury.[389] It is a roughly 200 page (considering both sides of a page) handwritten document with long text like body and multiple botanical illustrations. It is believed to contain scientific or magical text.[390] The tentative date is based on C14 analysis of the vellum. The script remains undeciphered and language of this manuscript is also unknown. Scholars from Yale university compared this content with 311 language samples.[391] They note that the highly predictable nature distinguishes it from entire corpus because the "... character placement is highly constrained within the word, and this may indicate the loss of phonemic distinctions from the underlying language."[392] For corpus compilation, they used subjects like magic or astronomy which is similar to presumed content of the manuscript. Along with articles from Wiki, the authors also included content from historical manuscripts (400-1600 CE) of multiple scripts and written in different languages. They mention that conditional character entropy is affected by document length, character set size, types of scripts, typographical conventions, and encoding processes. There are some who believe that this was probably a fraud or hoax document created around 16th-17th century CE. Lindermann and colleagues already denied that possibility in their published work.[393] Based on some initial observations, it is assumed that there are 2 languages in the manuscript due to the difference in varieties, content, and word frequency. Despite this being a single document with long text, having illustrations which can be presumed to be closely related to the topic, and with relatively fair dating, is yet unanimously believed undeciphered. It is interesting that they identify it as "non-language-like at the character level"[394] but close to natural language at word and line level comparison.[395]

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389. René Zandbergen, "Voynich MS - History of the MS," 2023, accessed December 10, 2022, http://www.voynich.nu/history.html.

390. "Cipher manuscript - Yale University Library," 2023, accessed December 16, 2022, https://collections.library.yale.edu/catalog/2002046.

391. Luke Lindemann and Claire Bowern, "Character entropy in modern and historical texts: comparison metrics for an undeciphered manuscript" (2021).

392. Lindemann and Bowern, 1.

393. Claire L Bowern and Luke Lindemann, "The linguistics of the Voynich manuscript," *Annual Review of Linguistics* 7 (2021): 285–308.

394. Bowern and Lindemann, 288.

395. Bowern and Lindemann, 306.

Factors such as (i) the choice of subjects for corpus compilation based on the possible similarities of the content, (2) effect of various parameters on the conditional character entropy, (3) possibility of two languages in a single manuscript, and (4) idea about presence of linguistic and non-linguistic nature at different levels demonstrate a methodological superiority than the Harappan sign study discussed above. The ambiguities have been made part of the analytical process rather than reducing those to fixed notions. This analysis is thus more nuanced than the conditional entropy study.[396] Simultaneously, its almost a linguistic content like appearance, illustrations providing possible context, and statistical patterns seem to have created a ideal setup for decipherment but it remains unread. It thus creates an interesting contrast and comparison for the Harappan signs.

2.11 Epilogue

The complete isolation of decipherment studies within the larger discourse of MHA is now evident through this chapter. The later sections provided a glimpse of how a scrutiny into the material aspects can unravel more meanings about the artefacts and the signs. These are otherwise invisible and inaccessible when signs are thought of as a statistical or a linguistic dataset. From meaning making point of view, Hodder has noted that "... metrical symbol has considerable durability as compared to spoken word".[397] He warns that over a period of time even if the meaning changes, words might still be in use. On similar lines, extended or continuous usage of physical artefacts indicates that their significance persisted over a long period of time or could be changing with time. In either case, their use or possession could be an effective social strategy. However, as archaeological artefacts, there is always a risk of them being out of their original context. Thus the ambiguity is an inseparable characteristic of such archaeological inferences.

As I enter the problem definition stage, it is prudent to highlight the extremes of academic opinions ranging from signs as representation of words from Dravidian languages,[398] versus the signs "not even evolving in linguistic directions after at least 600

396. Rao et al., "Entropic evidence for linguistic structure in the Indus script."

397. Hodder, *The meanings of things: material culture and symbolic expression*, 73.

398. R. P. N. Rao, "A Rosetta Stone for a lost language."

years of use".[399] Through the literature review, it is observed that the preceding opinion dominates the scholarship and creates a foundation to confirm a narrative of 'developed, literate, 'state' like Indian society since 2600 BCE'. It is important to probe into the causality of such a narrative. Are we trying to extrapolate modernist preconceptions and present day anxieties in the reverse direction and impose those on the past?

As I finalise this thesis for submission as of July 2023, I have received a communication from Steve Bonta about possible decipherment of the signs. The work is yet to be published. He has proposed early form of Indo-Aryan or Sanskrit as an underlying language of the script. He has used Mahadevan's sign-list. With reference to figure 2.2, the *palace* sign has been interpreted as full names, honorifics, titles such as pati, lord, or husband. The *exclusive quarters* sign has been interpreted as śri or suri, an honorific title.

399. Farmer, Sproat, and Witzel, "The collapse of the Indus-script thesis: The myth of a literate Harappan civilization," 33.

Chapter 3

Problematising the Narrative

The review of present scholarship reveals that studies in ED, material, and typology provide many insights into different aspects of MHA. However, comprehension of the functions of the variety of artefacts, relationship of signs and non-signs attributes, and the notional value(s) of MHA in the contemporary material culture is still incomplete. The literature demonstrates a total disconnect between ED studies and material analysis. These neither challenge nor borrow from each other.

Every decipherment effort has proposed the most probable language or language family depicted by Harappan signs. The overwhelming ambiguities which surround the stagnation of language over subcontinental scale for centuries are almost invisible. In Rogersdotter's words, "We arrive at 'flat' time - and space reconstructions: we conflate something into an outstretched, descriptive moment that has little to do with the fluidity and continuity of life in reality."[1]

Major proponents of the Dravidian affinity of Harappan signs arrive at the conclusion via separate routes and provide different readings for the same signs. To situate the argument about different representations for the term 'Muruku' mentioned in the previous chapter, it can be compared to the example of Proto-Siva seal discussed by Possehl.[2] It is seen that all those scholars agree to the signs as representation of linguistic components. However, it has not been validated by any internal or external evidence. Also, whichever language(s) were spoken by the Harappans, the 'same' is depicted by the signs is a speculation.

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1. Elke Rogersdotter, "Gaming in Mohenjo-daro – an Archaeology of Unities" (PhD diss., Department of Historical Studies, Institutionen för historiska studier, 2011), 66, https://gupea.ub.gu.se/handle/2077/24042.

2. Possehl, *Indus Age: The Writing System*, 163.

3.1 Need of new problem definition?

Except for a few case studies mentioned in the previous chapter, none of the decipherment exercises account for the variety of artefact forms. This non-recognition has established the insignificance of the immediate context, and thus the deception of homogeneity in the MHA dataset. Muting of artefactual properties has thus assigned entire power to signs. As a result, signs themselves have evolved into a set of 'artefacts'.[3] From an archaeological point of view, there is an uneven exploitation of attributes. With this background, this section elaborates on the need for new problem definition.

While dealing with the inherent uncertainties and ambiguities of archaeological data, it is inevitable to make choices. Hodder notes that academia employs "common sense"[4] while making these choices. At times, this transforms into 'academic common sense'; to name a few examples such as choice of excavation methods, standards of measurements, attributes to measure, attribute values to record, and techniques of analysis. Many examples discussed in compilation of Kampsville's seminars of 1970s demonstrate that despite the application of this 'academic common sense' and adherence to the current 'standards' and 'methods', the 'real' interpretation of the objects and the societies remains to be discerned.[5]

Often, the present day practices of measurements or descriptions drive the methodologies for documentation of the past. Our mechanisms to choose what to document, why, and how to quantify the aspects of materiality are influenced by our world-view. In case of the extrinsic archaeological contexts, those are defined in the geographical space of excavation. It can extend from a room or a trench to a vast geographical region. Also, it spans from a single identified cultural period to the entire volume of stratigraphy. Detailed contextual documentation is also a result of available tools and technologies applicable at the given scale. Over a period of time, with changes in methodologies and in the standards of documentation, the archaeological knowledge production processes have evolved. For excavation projects and associated studies which span over decades,

3. Pallavee Gokhale, "Attribute OR Artefact OR Attribute of Intangible Artefacts – A Case of Indus (Harappan) Script," 2021, https://youtu.be/zzc4EBI-p6g.

4. Hodder, "Postprocessual archaeology," 12.

5. Whallon and Brown, *Essays on Archaeological Typology*.

the documentation of excavated data passes through this churn of changing 'standards' and 'methods'.

It must be noted that the definition of attributes (both intrinsic and extrinsic) and typologies, and the assignment of their values involve abstraction. As seen from the previous chapter, sign on MHA itself is an attribute that has passed through levels of abstractions, revisions, and analyses. These are the results of 'choices' embedded in the 'common sense' employed by the scholars at multiple levels. The 'choices' in this process result from our own biases and conditioning. These choices play a significant role at all the stages of any study. Having said that, it is evident that it is impossible to perform any analysis on any kind of data if such abstractions and choices in terms of encoding, quantification, or classification are not performed. To mitigate the problems which arise due to these choices and the resultant inevitable lack of consensus, it is necessary to first acknowledge the subjectivity introduced in such methodologies and datasets. At a later stage, it is important to shed away perceived values of the attributes and formulate a strategy to realise their significance or insignificance in the contemporary societal framework.

3.1.1 What is 'type'?

In addition to archaeological context, the attribute space can be conceptualised as an abstract context of artefacts. Diversification of the concept of context creates an opportunity to extract relations and thus strategise typology definitions, which are not limited by the excavated context. In this regard, Whallon expounds on creation of typologies based on discontinuities:

> Perhaps the best way to begin discussion of the relationships among variables and typologies is with the point that we seldom, if ever, theoretically see typologies as based ultimately on the specific variables used in analysis, but rather on one or more underlying dimensions of variability. ...typology thus can be thought of essentially as the search for, or the discovery of, discontinuities in the distribution of data along one or more dimensions.[6]

The difference between variable and dimension is explained by him in a simple example

6. Whallon, "Variables and dimensions: The critical step in quantitative typology," 130.

where length and width are 'variables' which essentially help us measure the 'dimension' of size. It is evident that different variables can form numerous dimensions, but only some being discernible.

For MHA, Possehl has created five broad categories i.e. seals, seal impressions, sealings and mouldings, other objects, and miscellaneous.[7] He has subdivided those based on different criteria for each group such as (i) shape and form for seals, (ii) material for seal impression, (iii) existence of writing and iconography for sealings, and (iv) size, material, and graffiti for other objects. Authors of CISI volumes have kept it broader to only 4 categories - seals and sealings, tablets, pottery graffiti and miscellaneous.[8] These are further arranged according to size, condition, shape and so on. Wells' typology is more granular and it also accounts for the technique of creation e.g. bas-relief tablets, incised tablets, potsherds with paints, and intaglio seals.[9] Parpola, on the other hand has created only three major categories viz. seals, sealings, and inscribed objects other than seals.[10] Mahadevan has roughly borrowed the classification scheme based on Marshall and Mackay's excavation reports.[11] All later research which has used M77 concordance has thus used the same without any modifications.

These foundational studies provide a very fluid definition of the most popular MHA, i.e. seal. Presence or absence of signs, iconography, boss, perforation, other intricacies in the form, material, size, shape, provenance, period, have unevenly contributed in the definition of this 'type'. It is almost omnipresent across different 'dimensions'. There is no definitive boundary to the definition of this type and yet it has achieved a universal approval. The only unique attribute unanimously assigned by the entire scholarship is its prospective use to create an impression of the signs or icons present on it. It is presumed that whatever is engraved on it is a 'negative'. So when impressed against a soft material, it would create a 'positive' impression of the seal surface. All the objects created with such impression are identified as sealings or seal impressions. This means that the type definition is a result of its deemed use in the past. This use could be perceived only due

7. Possehl, *Indus Age: The Writing System*, 23.

8. Joshi and Parpola, *Corpus of Indus seals and inscriptions - Collections in India*, 1:XXXVIII.

9. Wells, *Epigraphic Approaches to Indus writing*, 5.

10. Parpola, *Deciphering the Indus script*.

11. Mahadevan, *The Indus script: texts, concordance, and tables*, 6–7.

to the discovery of impressions; though very few were found as compared to the seals and to their counterparts in the contemporary cultures.

Essentially, this definition of seal is dependent on the existence of another artefact i.e. sealing, though found very few in number and, as seen in the previous chapter, also comparatively much smaller than their counterparts in the Mesopotamian and Iranian cultures. Surprisingly, there are many MHA which have been carved on multiple sides and the boss is absent which otherwise affords to create the impression. Also, there are hardly any impressions which can be definitively mapped to rectangular seals. Though the intaglio form of the seal indicates this possible use, the standardisation of Cunningham's experimental creation of 'positive' impression (Fig. 3.5) to produce entire volumes of non-existent hypothesised artefacts creates multilevel bias for the study. The reversal of direction of sign sequence is an unavoidable consequence.

Table 3.1 below describes how MHA, particularly seals, have been separated into multiple 'types' by different scholars. It must be noted that Mackay identifies all these as amulets, Mahadevan and Franke document these as seals, Fairservis as seal tablets, and Parpola as Stamp seals.

Marshall **1931**	**Possehl** **1996**	**Wells** **2011**
Seal S - perforated boss	Seal - boss	Seal S
Seal S - no boss, 2 sided	Seal - boss	Seal S
Seal R - no boss	Seal - bar	Seal R
Seal R - perforation	Seal - bar	Seal R
Seal R - perforated boss	Seal - bar	Seal R
Seal Cy	Seal - cylinder	Seal Cy
Seal Cr - perforated boss	Seal - round	Seal Cr
Seal Cr - no boss, 2 sided	Seal - round	Seal Cr
Cube seal	-	-
Button seal	-	-

Table 3.1: Diversity within seals - types or just descriptions?

Table 3.2 describes varied descriptions by these scholars for non-seal MHA. Parpola

has identified most of these as tablets but Fairservis distinguishes between sealings, clay tokens, and pottery graffiti.

Marshall 1931	**Mackay 1938**	**Mahadevan 1977**	**Franke 1991**	**Possehl 1996**	**Wells 2011**
-	Stamped amulet	Sealing	Sealing	Seal Impression - uneven clay	tag
Round Tablets	-	-	Clay lens	Seal Impression - sq clay with cr stamp	tag
Seal Impression - pottery	-	-	Indus Goblets impression	Seal Impression - pottery	pot:t:s
Seal Impression - pottery	-	-	Indus Goblets incision	Seal Impression - pottery	pot:t:g
-	Amulet of unusual material	Miniature stone tablet	-	Miniature inscriptions	In Tablets
-	Amulet of unusual material	Miniature faience tablet	-	Miniature inscriptions	In Tablets
Tablets S & R	Stamped amulet	Miniature TC tablet	clay tablet	Sealings and Moldings (writings)	BR Tablets
-	-	-	clay tablet	Sealings and Moulding(narratives)	BR Tablets
Irregular prisms	-	-	-	-	BR Tablets
-	-	Pottery graffiti	sherds	Graffiti	pot:t:g/M/D

-	Copper tablet	Copper tablet	copper tablets	Copper tablet	Copper Tablet
Unusual character	-	Bronze implement	copper blades	Inscribed copper artefact	Impl
-	-	Ivory or bone rod	Ivory sticks	Inscribed Ivory or bone object	Rod
-	-	Misc	Stoneware bangles	-	Bangle

Table 3.2: Non-seal artefacts and their descriptions by different scholars

Like sealings, the impressions in bas-relief are also seen on ceramic or clay lumps of irregular shapes, not necessarily being accounted as sealings. For the clay lumps, Possehl identifies these as 'seal impressions', Mahadevan as 'sealings', and Wells as 'tags'. The objects which Possehl and Mahadevan describe as 'sealings', Well identifies those as 'tablets'. In case of tablets, Mahadevan has a category called 'miniature' and 'copper tablets' whereas Wells has categories called 'bas-relief tablets', 'incised tablets', and 'copper tablets'. Possehl has these type of objects under 'sealings' and 'mouldings' with writing and narratives, and 'copper tablets'. These are mostly rectangular in shape, with signs, and narrative scenes all depicted in a sequence. This is unlike a square seal where spaces have been allocated for signs and iconography on the surface of the artefact. The tablets with signs and iconography in relief, are assumed to carry positive impression. It is worth noting that despite some objects being identified as inscribed or incised, those are not known as seals (negatives). This is because relatively shallow engraving i.e. incised versus that of seals which is intaglio; incised artefact is not perceived for making an impression.

Though most of the seals are made of steatite stone and have intaglio kind of carving instead of incised, a seal from Allahdino, Ad-8 showcases an interesting exception.[12] It is a terracotta object (possibly with boss). The signs and icon are incised which are too shallow for to create an impression. Possehl uses this as an example to counter current

12. Shah and Parpola, *Corpus of Indus seals and inscriptions - Collections in Pakistan*, 2:388.

assumptions about similarity between text and seal based administration of West Asia and Harappan culture.[13] Another such exceptional example is K-39 seal from Kalibangan with left facing rhino.[14] The iconography and signs are in relief.[15] The artefact is made of terracotta with boss and perforation. In this case, the form is forcing the object to be identified as seal and thus the sign sequences is documented in reverse, i.e. its prospective impression. This shows that boss+perforation is acting as a more powerful attributes than technique (intaglio vs. moulded) or material (steatite vs. clay). However, if the boss and perforation are such powerful attributes in the definition of type, then multi-sided intaglio steatite MHAs which are devoid of boss and perforation needed to be interpreted differently.

It appears that with decipherment as a primary aim, the current scholarship shows some preconceived and fluid notions about the typology. The object typologies have flexible definitions, they overlap in different dimensions, and rarely correlate with properties of signs or other attributes. This has brought overall latency in the refinement of typology.[16] Whatever contrasting opinions and uncertainties around the decipherment have arisen, are only because of the sign properties discussed in chapter 2. Ironically, typology relates with the 'Reading direction' of the signs based on the assumption about the purpose of the artefact. It can be inferred that materiality of the artefacts has neither been a pre-requisite nor has it contributed to the ED discourse. Possehl has cautioned that "Context of Harappan writing is an important element in the decipherment, a typology of inscribed objects is needed."[17]

3.1.2 Systemic limitation of encoding systems

The previous chapter provided an overview of major ED studies. Though each research is significant in its own scope, each is limited by the underlying encoding systems. Hence any decipherment is as good as the underlying encoding system. As mentioned

13. Possehl, *Indus Age: The Writing System*, 26.

14. Joshi and Parpola, *Corpus of Indus seals and inscriptions - Collections in India*, 1:305.

15. Marta Ameri, "The Sincerest Form of Flattery? Terracotta Seals as Evidence of Imitation and Agency in Bronze Age Middle Asia," 2018, 22.

16. Gokhale, "Linguistic Hegemony and Latent Typology: The Case of Harappan Script Scholarship."

17. Possehl, *Indus Age: The Writing System*, 23.

above, encoding itself is a process of abstraction. Identifying unique signs across the available artefactual dataset and encoding them forms the first logical step in sign decipherment projects. Rationality of this step and the underlying logic (by disregarding the possible variation across space, time, and type) has been handled differently by different scholars.[18] Positional frequencies within texts,[19] graphic variants and their resemblance,[20] and interchangeability of signs and their ligatures occurring in the textual contexts[21] have been considered as deciding factors by different authors. It's worth noting that Possehl calls such decisions as "... far short of certainty."[22]

Any statistical or linguistic decipherment, or semantics study based on a certain encoding system essentially assumes the validity of that system and thus the logic of abstraction implemented in encoding. Unless the research problem also questions the formation of the sign-list itself and acknowledges its limitations, its inferences about the signs or sequences contribute in establishment of the sign-list as a priori. Encoding approximates signs to a common graphic form, and thus reduces the granularity across the signs. As a consequence of such strategies, heuristic differences employed by different scholars into building of these systems can be unearthed. For example, observation of 26 pairs of mirror signs with a distinguished pattern in their frequencies is possible only in the encoding system defined by Wells and not in Parpola's or M77.[23] Significant differences are seen in the frequencies with which a particular sign and its mirror sign appear across all texts (Figure 3.1).

In a recent publication, Daggumati and Revesz propose to merge the mirror signs to optimise or normalise the sign-list for the purpose of decipherment.[24] They provide reasons such as morphing of signs due to space issue, mirrored without underlying meaning,

18. Subramanian, "The Contribution Of Indus Text Corpora / Concordances To The Textual And Contextual Analysis Of The Indus Script: A Comparative Study," 187–188.

19. Wells, *Epigraphic Approaches to Indus writing*.

20. Parpola, *Deciphering the Indus script*.

21. Mahadevan, *The Indus script: texts, concordance, and tables*.

22. Possehl, *Indus Age: The Writing System*, 77.

23. Wells and Fuls, "Online Indus Writing Database."

24. Shruti Daggumati and Peter Z. Revesz, "A method of identifying allographs in undeciphered scripts and its application to the Indus Valley Script," *Humanities and Social Sciences Communications* 8, no. 1 (2021): 1–11, https://doi.org/https://doi.org/10.1057/s41599-021-00713-0.

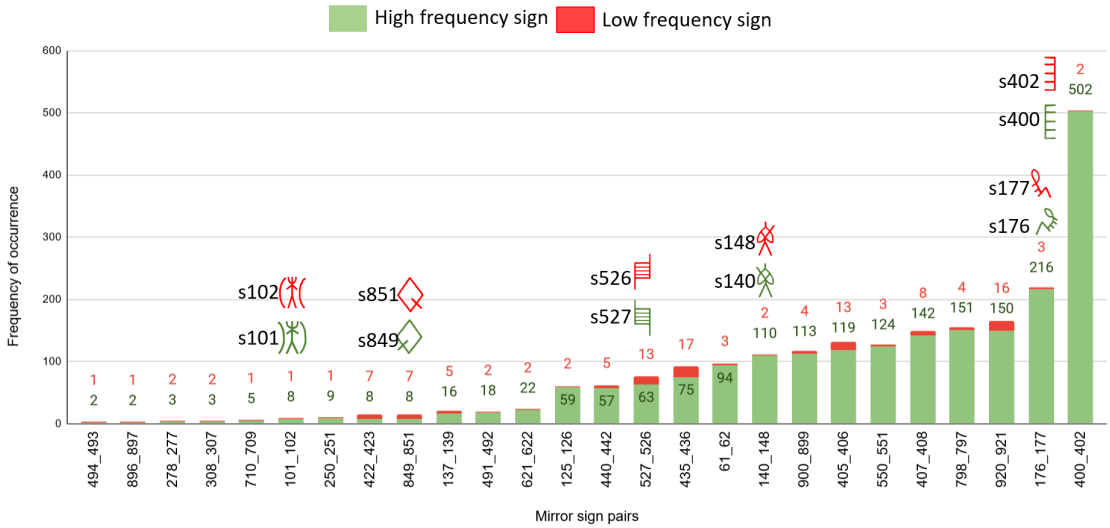


Figure 3.1: Pairwise frequencies of mirror signs as observed in ICIT

same sequence of other sign in the pair, location anomaly, visual similarity, and documentation error. They identify 50 redundant signs and highlight the importance of this work as "...reduction in the search space for phonetic assignments to the Indus Valley Script signs."[25] With decipherment as the main purpose, authors propose that mirror sign being a variant of main sign, potentially has identical vocal or phonetic value. They thus categorise above reasons as accidental or deliberate in order to merge the signs. Though such exercises would be critical, it is not necessary that mirroring as a phenomenon would be completely irrelevant in the past cultural context. As already described in the preceding chapter, in terms of iconography, the right facing unicorn motif is being hypothesised as characteristic of Ghaggar basin and period 3A.[26] Also, the signs on these are found written in both direction.[27] It is thus crucial to investigate whether the mirror signs contribute in the epistemology for such tangible interpretation. Intangible relations such as similar signs possibly having different phonetic value or those being carved by a left handed artisans can be explored only if those are retained in the data and not merged as suggested in the mentioned article.

As seen in the chapter 2, Repeated use to Mahadevan's sign concordance and sign

25. Daggumati and Revesz, "A method of identifying allographs in undeciphered scripts and its application to the Indus Valley Script," 10.

26. Konasukawa, "Indus Scripts Incised on the Seals Discovered from the Initial Phase of Harappan Period."

27. Alekseev, "The characteristics of the Proto-Indian script," 20.

database by scholars has created a notion of legitimacy for both the research work and the data itself.[28] The statistical methodology has created a 'scientific' and hence 'objective' perception of this sign-list. In a recursive fashion, the data is preferred due to its prior use and the research is perceived 'rational' due to the use of the well-recognized dataset. The acceptance to the sign-list is thus teleological. The circularity generated through this process is not allowing for any new ontologies to surface. With the increasing use of statistical techniques, there is an emphasis on the normalised sign-list but consensus on it is still a distant dream.

3.1.3 Excavate more!

In the keynote speech at Mohenjo-daro conference, Kenoyer mentioned that the Harappan script cannot be deciphered unless there exists a bi-lingual text.[29] He then strongly recommended and iterated the need for taking up new excavations. This conference had showcased state of the art research which is happening on MHA.[30] The sessions had demonstrated more room for work beyond ED studies. As seen in the previous chapter, even for fully deciphered scripts, the material remains provide avenues for understanding the use of writing in diverse societal contexts, perception of writing, and their relationship with the other material remains in the cultural context, not to exclude their association with the producers and consumers of the text.[31] The archaeological case studies in the mentioned conference, in fact, demonstrated the same. Kenoyer's remarks thus juxtapose the studies presented in the conference. Those can be pursued in different ways such as - (i) the presently available excavated data has been exploited from all perspectives and now, to learn more, new data must be excavated, (ii) Harappan script was being used in contexts or for functions which required bi-lingual or bi-scripture depiction, or (iii) high probability exists that newer excavation will fetch a bi-lingual

28. As seen through his articles, Mahadevan was already in partial agreement with Soviet and Finnish scholars with their hypothesis of the Dravidian language family as the most probable candidate.

29. Jonathan Mark Kenoyer, "Keynote address at International Conference on the Indus Script," 2020, https://www.youtube.com/watch?v=5eMpXWpB-xs.

30. Some of it has been reviewed in the previous chapter.

31. Piquette and Whitehouse, *Writing as Material Practice: Substance, surface and medium*.

evidence which will help decipher the script. [32]

Regarding the need for more data, though more data can help strengthen the quantitative argument, it may not necessarily improve interpretative power. If the population (statistical) is extremely homogeneous then even a small sample is enough. For a heterogeneous population, the chosen sample and the set of attributes may not ever be enough to represent the population. This is because the phenomenological model in this case is limited by the variables in use. Reduction in accuracy can be hypothesised in sparse cases where either the sample or population contains majority of the outliers, or newly added data has a completely different attribute association. Gero articulates this in two ways - (i) our inability to account for all the relevant variables into our interpretation, and (ii)

> .... we may not recognize all the factors that are conditioning what we see, especially when we are trying to explain circumstances in the past that are unfamiliar to us and do not easily correlate with contemporary analogs, or which are shaped by logics and sensibilities entirely alien to twenty-first century middle-class academics.[33]

This is an epistemological issue "... that arise from what researchers themselves bring to knowledge-making."[34] Thus, though the 'Law of Large Numbers' holds true and hence Kenoyer's appeal for more excavations is theoretically, statistically,[35] and emotionally valid, one must ask 'whether' and 'how' it will help create more meaningful interpretation about these artefacts, the culture, and the society(s) they represent. Unless new mechanisms of analysis are devised, the newly excavated material will be subjected to the same existing methodologies and will continue to render the observations in the same framework. Those may not take our archaeological understanding to the next level

32. Questions such as what if newer excavations do not render any qualitatively significant data or what if a bilingual text contains Harappan and Proto-Elamite signs where both are undeciphered always remain unanswered.

33. Gero, "Honoring ambiguity/problematizing certitude," 316.

34. Gero, 317.

35. On a side-note, the scholars using statistical methods treat this dataset as a population and not as a sample - Interaction with a scholar during ICIT online training workshop held by Dr. Andreas Fuls on 23rd Feb 2023.

unless those are not exposed to different epistemologies. It is inevitable to accept that the archaeological data is a subset of what could have existed in the cultural past. It is often impossible to know whether the excavated data can be treated as a representative sample. Discussing this dilemma of representative sample, population, past reality, and our perceptions, Voorrips makes an interesting note:

> (while) structuring archaeological data..... truth as an absolute and independent entity does not exist or ...cannot be found or used. ... This means that the search for and the use of natural classifications - ....a concept that presumes an order in the environment of a system ....is fruitless and fallacious respectively. ...We should.... Consider any collected data as a sample from a larger population. On this sample we impose a structure. When we generalise this structure as being valid for the whole population, we always make a probabilistic statement and never an absolute one - probabilistic not in the sense of measuring the chance that the proposed order is the true one, but ..... The structure we derive from the sample might be useful in a wider context.[36]

Voorrips's theory manifests into bias-variance trade-off theory in the Data Science field (DS). From DS point of view, the closest possible model that can be defined for the data at hand, is good only for that dataset in that particular context. As one moves away from it in any dimension, subjectivity outside of one's control is added and the model weakens. To accommodate and interpret the data within the extended or newer contexts, it necessitates changes in the model. This means that the model, which was otherwise the best explanation of the specific data at hand, cannot be so any more. However, the incorporated changes help it fit to the extended dataset by accommodating more variations in the data.

Finally, while considering the assumptions about the possible existence of bi-lingual text,[37] it must be realised that it posits the purpose for such existence. Examples such

36. A. Voorrips, "Mambrino's helmet: a framework for structuring archaeological data," in *Essays on Archaeological Typology*, ed. Robert Whallon and James A. Brown (Center for American Archaeology Press, 1982), 98.

37. "Multilingual inscription - Wikipedia," 2023, accessed October 17, 2019, https://en.wikipedia.org/wiki/Multilingual_inscription.

as Rosetta stone,[38] bilingual or bi-scripture coins,[39] or Ashokan edicts,[40] demonstrate a specific purpose of both the artefact and the scripts. In these cases, it is imperative to our understanding that whatever was the content and its meaning, it was required to be conveyed to the people beyond the jurisdiction (in terms of script and language) of the respective authorities. At the same time, the chosen object is a manifestation of the then existing socio-political or economic systems. In case of MHA, integration era represents the intense cultural contact and interaction between different social groups.[41] However, a direct reflection of this process in the usage of signs or artefacts has not been deduced. Indus script chronology observed by Kenoyer does not reflect the implications of changing societal fabric or needs of emerging social systems.[42] Thus the causal reasoning for possible existence of bi-lingual/bi-scripture evidence needs more corroborative interpretation of existing material. If the script development and use was purely meant for internal systems within the society or for a specific subset of the society, the possibility of such existence reduces.

On the other hand, scholarly research on contact between Indus and Mesopotamia, representative examples being works by Collon,[43] Possehl,[44] and Parpola[45] produces a possibility for presence of bi-lingual artefacts in the regions outside the core place of origin of MHA. Thus a probabilistic approach is required when new excavations are

38. "Everything you ever wanted to know about the Rosetta Stone | British Museum," 2017, accessed November 17, 2019, https://www.britishmuseum.org/blog/everything-you-ever-wanted-know-about-rosetta-stone.

39. "The COININDIA Coin Galleries: Indo-Greeks: Menander I," 2015, accessed November 17, 2019, https://coinindia.com/galleries-menander.html.

40. "Greek and Aramaic inscriptions by king Ashoka (Illustration) - World History Encyclopedia," 2012, accessed November 17, 2019, https://www.worldhistory.org/image/259/greek-and-aramaic-inscriptions-by-king-ashoka/.

41. Kenoyer, "The Indus valley tradition of Pakistan and western India."

42. Kenoyer, "Origin and Development of the Indus Script: Insights from Harappa and other sites."

43. Dominique Collon, "Mesopotamia and the Indus: The evidence of the seals," in *The Indian Ocean in Antiquity*, ed. Julian Reade (Routledge, In Association with The British Museum, 1996), 209–225.

44. Gregory L. Possehl, "Meluhha," in *The Indian Ocean in Antiquity*, ed. Julian Reade (Routledge, In Association with The British Museum, 1996), 133–208.

45. Parpola, Parpola, and Brunswig Jr, "The Meluḫḫa village: evidence of acculturation of harappan traders in late Third Millennium Mesopotamia?"

being proposed with the hope of finding the bi-lingual artefacts.

In the light of urge for new excavations, chapter 2 discussed the recurrent use of M77. Even after more than three decades of its creations, many scholars continue to use the same dataset (i) without updating or adding the information of more than 1500 artefacts, and (iii) without the addition of new signs recorded thereafter. M77 contains 2906[46] MHA as against ICIT with 4650.[47] The scholars using Mahadevan's sign concordance and artefact data thus use the dated database to form the hypothesis and extend their arguments. This was acknowledged by some of the scholars few years ago.[48] M77 has only CISI 1 and 2 and old data from CISI 3. However, the authors rationalised it by mentioning that very few new signs have been added to the sign-list and most of the new artefacts belong to the existing categories only. "This amounts to about 15% of the data available till date and introduces corresponding uncertainty in the conclusions. However, the present study is indicative of the broad trends in the Indus writing."[49] In the earlier publication about sign design[50] the authors justify this by suggesting that Parpola also suggests ~400 signs.[51] The EBUDS version of M77 discussed in the previous chapter eliminated all the multiline texts and duplicate copies of texts which further reduced the data from 2906 to 1548 lines.

Possibility of encountering different sign sequences in new data is not acknowledged in these studies which is rather a prerequisite. Thus, in retrospect, the new excavations and data has remained futile in studies which use M77 or any of its version. Since many studies are being conducted on this dataset, it is a point of concern.

The figures 3.2 and 3.3 show amount of data excavated since 1920s till 2020.

Total count for individual decades is shown at the top of the bar with colour-coded types and sites. HARP excavations which began in 1986 produced huge amount of data from Harappa adding approximately 1000 new MHA. The data within the blue dashed-line region is not part of M77.

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46. Mahadevan, *The Indus script: texts, concordance, and tables*.

47. Count as of January 2023

48. Yadav, "Sensitivity of Indus script to site and type of object," 69.

49. Yadav, 70.

50. Yadav and Vahia, "Indus script: A study of its sign design."

51. Yadav and Vahia, 5.

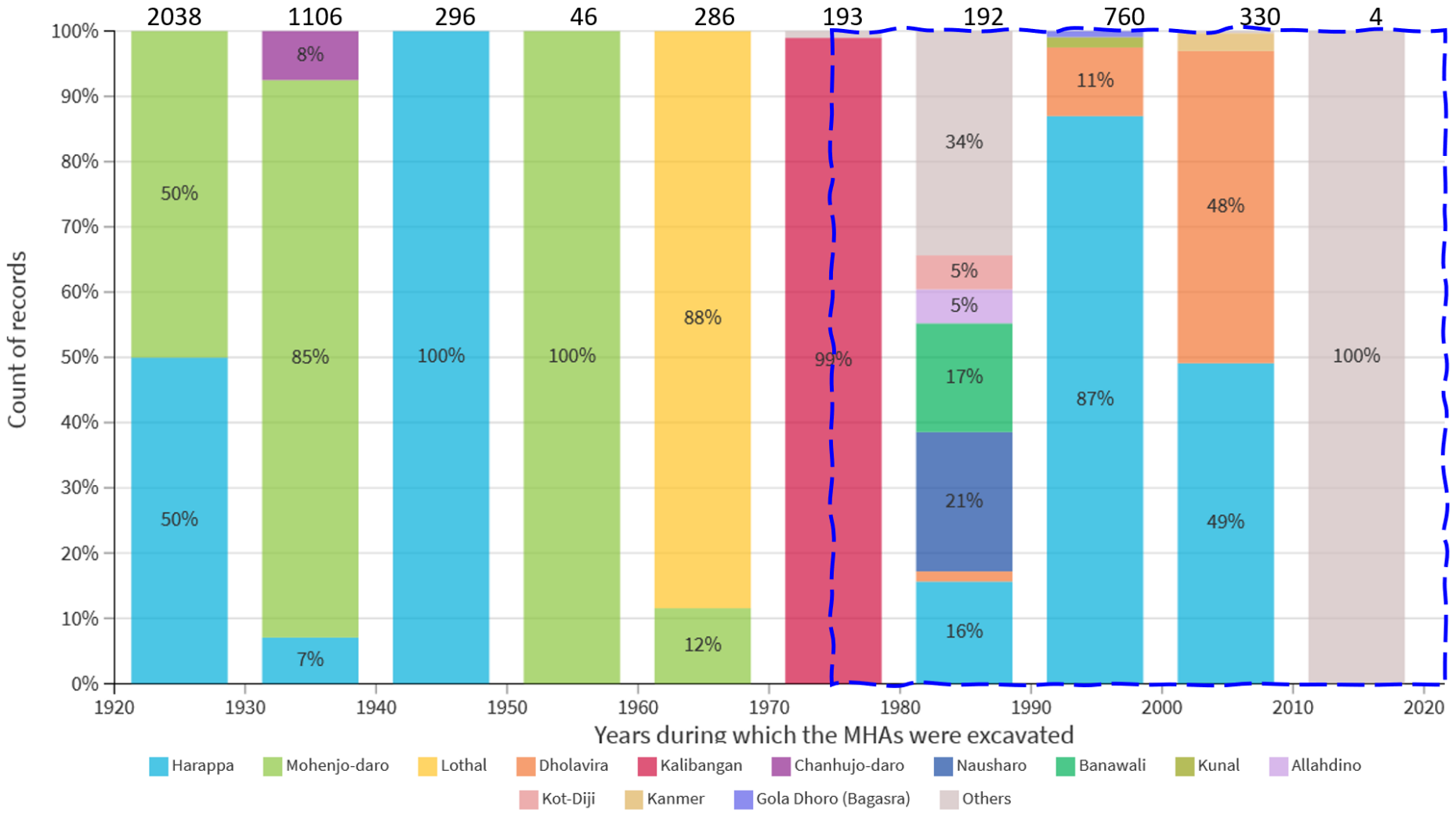


Figure 3.2: MHA excavated from different sites since 1920 till 2020 - coloured by sites

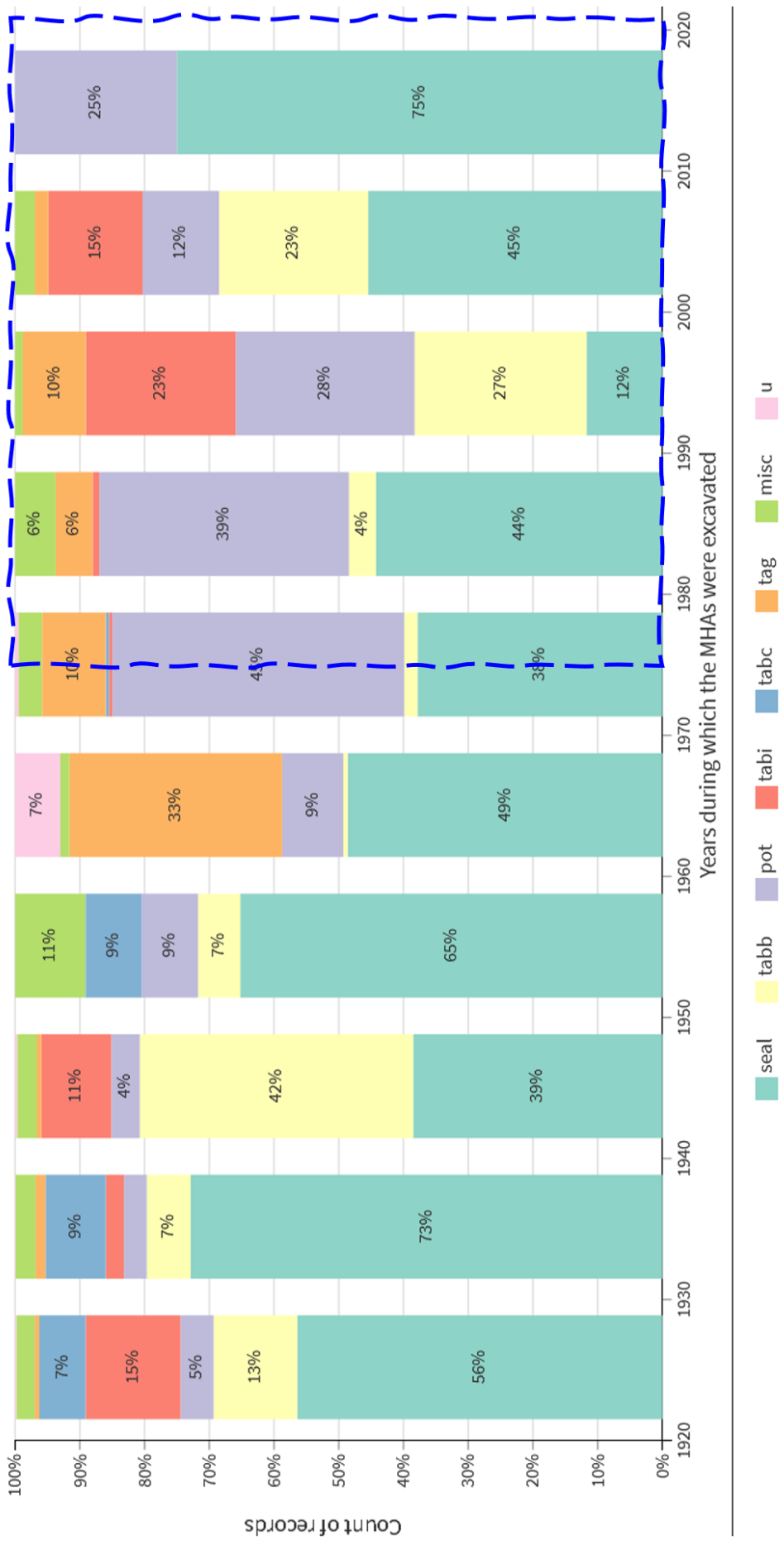


Figure 3.3: MHA excavated from different sites since 1920 till 2020 - coloured by subtypes

It is also worth noting here that the revised granular periodisation,[52] especially for that of integration era, is solely based on the excavations conducted at Harappa under Harappa Archaeological Research Project (HARP).[53] Detailed analysis of excavated material and structural remains was conducted for chronological changes and the same was corroborated with the C14 dates. However, it is yet to be seen how these narrow time periods within the integration era (3C: 2200-1900 BCE, 3B: 2450-2200 BCE, 3A: 2600-2450 BCE), solely defined based on material remains from Harappa, corroborate with other excavated sites. Contemporaneity of such material culture across different sites is crucial in terms of archaeological interpretation. Especially for the site of Mohenjo-daro, where the cultural periods were identified as Early, Intermediate, and Late,[54] and the largest pre-HARP artefact discovery is from that site, it is critical that tentative corroboration of these different cultural periodisations is done and clues are identified for possible contemporaneous time-frames.

3.2 Epistemological problem - Situating the research

As described above and in the previous chapters, the attributes which are defined and documented are intellectual products. This includes both signs and form attributes. Hence the subjectivity is an inbuilt characteristic. The key is being aware of the choices which have played a role in these definitions, and incorporating that understanding in the analysis and interpretation of the data.

Majority of the scholarship has currently demonstrated a verisimilitude about the linguistic nature of signs and its closest match with the Proto-Dravidian language group. However, besides all the critique discussed above, the instructor of the Harappan Script course and co-author of many papers by TIFR team mentions - "... Dravidian hypoth-

52. Kenoyer, "Origin and Development of the Indus Script: Insights from Harappa and other sites," 219.

53. Jonathan Mark Kenoyer, "Urban process in the Indus tradition: a preliminary model from Harappa," *Harappa excavations* 1990 (1986): 39–40; Jonathan Mark Kenoyer and Richard H. Meadow, "Inscribed objects from Harappa excavations 1986–2007," in *Corpus of Indus seals and inscriptions - New material, untraced objects, and collections outside India and Pakistan, Part 1: Mohenjo-daro and Harappa*, vol. 3.1 (2010)

54. Mackay, *Further Excavations in Mohenjo-daro*, I:xiv–xv.

esis is accepted because it is a least weak model."[55] On similar lines, during the panel discussion of Harappan script session in the recent conference at IIT Gandhinagar,[56] a query was raised regarding the 'interpretation of the sign sequences as linguistic only'. One of the panel members responded to it that it is the easiest way to move forward because the rejection of all other probable interpretations is not possible.[57]

Despite any explanation for basic questions regarding artefact typology and function, evolution of script, and stagnation across space and time, the academic community appears obligated to accept the 'easy and least weak model'. The reason can be illustrated in Moreland's words as "We inhabit a logocentric world, the world of the Word.... it is common sense that words speak louder than things... more informative... represent the voices of the past speaking directly to us in the present."[58] It also reflects an urge to reach closure and form a confirm narrative. It perfectly fits into the positivist notion of philosophy. The power of language narrative, in association with the script, establishes the literate society, which is 'an attribute' of civilisation. In this case, it also characterises 'developed' state of the past. It then does not remain limited to the realms of academic research. It becomes a part of the active politics and a topic of discussion of national identity. In February 2020, the Indian Finance Minister endorsed on the decipherment during her speech at the annual central financial budget. "The guilds of Saraswati-Sindhu civilization & the Harappan seals are remarkable... Words from the Indus Script-hieroglyphs have been deciphered". A list of words is also appended such as "Takara Kolimi = Tin smithery, Sreni = Guild, Sethi = wholesale merchant, Poddar = Assayer of metal into treasury"[59]

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55. Mayank N Vahia, "Indus Scripts Incised on the Seals Discovered from the Initial Phase of Harappan Period," 2021, https://instucen.org/courses/harappan-script/.

56. "International Colloquium on the Emerging Perspectives of the Harappan Civilization - YouTube," 2023, accessed June 21, 2023, https://www.youtube.com/playlist?list=PLRfu94TCePTtUXpBcWVptiH7sZq2uXPM6.

57. List of people scholars who contributed in different sessions can be seen at https://asc.iitgn.ac.in/assets/events/training_workshop/Colloquium_Schedule.pdf

58. John Moreland, *Archaeology and text*, Duckworth debates in archaeology (Duckworth, 2001), 33.

59. "Deciphered: FM Nirmala Sitharaman stands by her remark on Harappan script- The New Indian Express," 2020, accessed February 20, 2020, https://www.newindianexpress.com/nation/2020/feb/03/deciphered-fm-nirmala-sitharaman-stands-by-her-remark-on-harappan-script-2098182.html.

After more than a century of research, more than ten sign encodings, numerous decipherment claims, data excavated from more than 80 sites, area spanning across more than a million sq km, and more 5000+ MHA excavated, besides 'trade' and 'seals used for impressions', no other 'purposes' or 'usage patterns' of diverse MHA have been identified with equivalent credence. Instead of hypothesising a multitude of prospects with diverse data, narrowing down of the scope is observed; mostly for interpretation in search of certitude. This has resulted into a 'Single Story'[60] scenario and is posing the accompanying dangers in front of the academia. I believe that confirmation bias restricts the imagination within certain illusory limits impeding the academic growth. This requires an inquiry into possible causes.

Gero in her aptly titled paper 'Honoring Ambiguity/Problematizing Certitude', argues and questions,

> (in archaeology) Most often, the confusion, uncertainty and ambiguity are left out of our conclusions, overlooked, ignored, forgotten or erased. .... I will urge that we resist imposing meanings on our subjects: modern, disciplinary, uniform and universalist, and move instead towards honoring (instead of erasing) the evidence that will not yield to closure. Toward these ends, I begin by examining how the status quo rule-bound archaeological practice eradicates ambiguity in favor of a construction of certitude: In service to whom? To what ends? And at what costs?[61]

Uncertainty and ambiguity is introduced in archaeological data at various levels, right from site formation process itself to our knowledge production methodologies. In the quest of exploring these issues for the present thesis, I have argued that the linguistic scholarship has achieved and is maintaining a hegemonic status, eventually causing latency in typological studies.[62] The introductory chapter illustrated how the phases of research, resulting from the milieu of socio-political and theoretical environments have shaped this scholarship. As demonstrated in chapter 2, the 'sign-bearer' role assigned

60. Ngozi Adichie Chimamanda, "Chimamanda Ngozi Adichie: The danger of a single story | TED - YouTube," 2009, accessed October 28, 2018, https://youtu.be/D9Ihs241zeg.

61. Gero, "Honoring ambiguity/problematizing certitude," 312–313.

62. Gokhale, "Linguistic Hegemony and Latent Typology: The Case of Harappan Script Scholarship."

to a vast variety of artefacts has kept the thought about typology in latent state. It has thus rendered the physical artefacts passive and mute. As the sign and typology studies do not corroborate, contradict, or critique each other's findings, it becomes difficult to weave a collective narrative. The artefact studies either do not take a stand or prefer to adhere to common consensus on language hypothesis. As a result, isolated interpretations and individual claims continue to form. Though the sign and material attribute definitions have been precise in their academic contexts, their functional value in the archaeological past cannot always be validated or falsified in isolation. It is not possible to accept or reject the individual claims. This highlights the need for the triangulation of these multiple studies. Thus the prospects for academic progress lie in problematising the artefacts. It may be difficult to break away from the preconceived notions of language, but it is always possible to seek around those. Needless to say that the results need to be rooted firmly in the materiality, and informed by it. This may improve our ability to perceive patterns in MHA dataset.

Majority of the decipherment studies which have gained traction in recent years, definitively demonstrate the positivist approach. These continue to emphasise on evidence of sign sequence patterns by using quantitative techniques. They then interpret these patterns as representation of the linguistic evidence from the contemporary culture. It arises from comparatives studies of other contemporary cultures where the urban phenomenon is presumed incomplete without a script that encodes the spoken word. This is a perfect example of processual approach towards the dataset. The force behind these initiatives in Harappan archaeology has been analysed by Chadha where he compares the decipherment studies to cryptography.[63] He describes this transformation from essentially 'epigraphic' studies into 'cryptographic' ones. He points out that the most prominent scholarships viz. Soviet and Finnish believed that "The decipherment of this code required a cryptographic formula rather than an epigraphic cognate to comprehend it."[64] Since the cryptographic analysis helped break codes like Enigma, it appeared like a *de-facto* method to treat the sign sequences as encrypted codes and then use cryptographic techniques to decipher those. In a comparison of these studies from 1960s and

63. Ashish Chadha, "Cryptographic imagination: Indus script and the project of scientific decipherment," *The Indian Economic & Social History Review* 47, no. 2 (2010): 141–177.

64. Chadha, 145.

1970s to the recent state of the art research by the scientific community, it is seen that the similar approach is solidified with the new keywords of AI (Artificial Intelligence) and ML (Machine Learning).[65] The solidification is processed through the techniques such as 'prediction' of sequences by using AI and ML algorithms. The 'ability to predict' is considered as one of the most important characteristic of a 'scientific' study. In case of Harappan signs, it eventually translates into an epistemologically challenging but ontologically satisfying situation - Unable to read, yet able to write the signs![66]

Like ED scholarship seen earlier, let us look at the overarching epistemic fabric of these individual scholarships from typology studies. Though these work on the same superset of MHA, their interpretations provide different perspectives, not necessarily always complementary with ED studies. These shed light on different aspects of the artefacts such as production, usage, style, and context by both qualitative and quantitative methods. They investigate different aspects of the past such as art, styles, religion, communication, craftsmanship, tools and technology, carving groups, trade, and urbanisation. All these studies speak different jargon and can be seen created and consumed by scholars from different contexts. From a theoretical perspective, their collective epistemic endeavours can be treated as post-processual experiments on MHA.

On the background of 'individual context' in the post-processual theory, many earlier decipherment studies were not recognised as scientific but rather intuitive or heuristic. These had resulted in the reading of MHA signs into several different languages. These had specific constraints such as limited data, location of the scholars and their academic conditioning, socio-political environment, technological constraint, and individual motives. Due to the preordained subjectivity, these attributed to the characterisation of 'non-scientific' studies. However, these are exactly the tenets of post-processual archaeology. On the other hand, it is seen in the previous chapter that scientific and statistical studies with a processual outlook can be a cause and consequence of hegemony. I argue that one must be critical in acceptance or rejection of certain studies based on the merits and demerits of their theoretical framework. It must be highlighted that the

65. R. P. N. Rao, "A Rosetta Stone for a lost language" - Rao's TED talk from 2011 has gained 2.2 million views and 68K likes. TED is one of the most noted platforms of 21st century for dissemination of innovative, valuable, and well researched topics by noted scholars from the diverse

66. Rao et al., "A Markov model of the Indus script," 13688.

idea of 'theory being universally applicable' may not apply in human or social science. To define normative questions in archaeology is thus paradoxical. The layered, diverse, and heterogeneous spatio-temporal contexts of the domain do not allow it. With MHA at hand, an overarching separation can be observed in ED and typological studies (Table 3.3).

This comparison demonstrates epistemological debate. The studies juxtapose each other in terms of choice of dataset, objectives, theories, and methodologies. Since ED studies have isolated the signs, the underlying lacunae in typology do not matter in their analysis and interpretation of signs. On the other hand, typological studies are neutral to the linguistic character of the signs. Those are not impacted by whether the signs represent language or not. Here is a representative example from a typo-technological study: "Since my main interest is not the Indus script, and others have already created detailed sign-lists (Mahadevan 1977; Parpola 1994), I chose to omit inscribed characters from the stylistic analysis."[67] The corresponding example from ED studies is: "In M77, the objects classified as sealings may include potentially more than one category of objects with possible differences in distribution... ."[68] ICIT dataset and other studies have revealed that moulded tablets and sealings are entirely different in form, content, and provenance. Possehl had separated these into seal impressions (on clay or pottery) and sealings/mouldings.[69] In fact, it is unlikely that the seals used for creating the sealings (mostly found in Lothal) were also used for creating the moulded tablets (majority found in Harappa).[70]

In present day social lives, multiple systems exists which manifest well defined sign-symbol-alpha-numeric sequences but are all non-linguistic. For example - debit/ credit cards, SSN, PAN card, driving license, vehicle number plates, student or employee IDs and many more. In addition to these modern day systems, there are examples of Panini's *Shivsutras* from the early century CE, musical notes *swaras*, Braille letters, or DNA

67. Jamison, "The organization of Indus unicorn seal production: A diachronic comparative study of style, skill, and sociopolitical organization," 306.

68. Yadav, "Sensitivity of Indus script to site and type of object," 74.

69. Possehl, *Indus Age: The Writing System*, 41–47.

70. Ameri, "Letting the Pictures Speak: An Image-Based Approach to the Mythological and Narrative Imagery of the Harappan World," 146.

ED Studies	**Typology Studies**
ED studies main objective is to search for linguistic patterns.	Typology studies search for patterns in aspects such as iconography, form, and material and then interpret those as a possible representation of some tangible or intangible cultural system.
They use a fixed defined sign-list as an 'accurate' and 'precise' dataset.	They define their own attributes and dataset based on empirical observations.
They tend to work with all possible sign sequences in order to have a large dataset.	They generally use a very small subset of all MHA due to the limited access to actual artefacts, availability of high resolution photos or specific category under study
They employ quantitative methods which involve state of the art statistical techniques.	They employ qualitative, ethnographic, historical methods and supplement those with quantitative methods.
In argumentation and knowledge production, they move from general (all available sign sequences) to specific (predict a specific one).	In argumentation and knowledge production, they move from specific (limited dataset) to general (extrapolate observations entire cultural complex).
Theoretically, they work with processual mindset with an aim to find general laws and patterns which can be derived about the signs.	Theoretically, they work with post-processual mindset with an aim to find peculiar contextual patterns which can be derived from artefacts based on their dataset.

Table 3.3: Contrasts between ED studies and typological studies

sequences. Studies by Rao et al.[71] use entropy as linguistic evidence whereas Ashraf and Sinha[72] use directional symmetry as evidence. However, the non-linguistic systems mentioned above demonstrate at least one of these.

Last but not the least, the significance of attributes is culture specific phenomenon. Harappan culture is separated from us both in space and time. It must be noted that "Meaning is always constructed by humans using methods such as association, difference and context. This external, objective knowledge must be part of our methodology."[73] Here is an experimental example of possibilities of documenting the animal motifs seen on MHA.

- Herbivore/ Carnivorous
- Domestic/ Wild
- Real/ Mythical
- Small/ Big
- Stylistically good/ Bad
- Decorated/ Undecorated
- One/ Many
- Simple/ Complex

The level and depth of abstraction in such exercises is subjective and also serves the needs of specific objectives in different studies. Each such study results in 'scientific analysis' of these precisely defined attributes. Understanding whether these attributes and patterns play a role and have a functional use in the contemporary society are epistemological questions.

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71. Rao et al., "Entropic evidence for linguistic structure in the Indus script."

72. Ashraf and Sinha, "The "handedness" of language: Directional symmetry breaking of sign usage in words."

73. Hodder, *The meanings of things: material culture and symbolic expression*, 75.

3.3 Submission to grand narratives

The individual contexts of the typological studies mentioned till now are important. However whether these create incremental and coherent archaeological knowledge is the larger question. If and how these studies support or contradict to existing knowledge, or create new ontologies needs to be analysed.

Previous chapter and sections above reveal that in the individual choice of problems, primary aim, data creation, methodologies, and observation, majority of the typological studies start as post-processual projects. However, in the interpretation phase, they seem to fit their work in the loosely defined scope of existing theories. This section illustrates that all these theories are not necessarily grounded in the Harappan material but are sustained by borrowings, notions, and intuitive understanding. Those are also a result of contemporary socio-political environment and need revision. Though they have been proposed at different moments in Harappan scholarship, some of these carry the baggage of colonial and positivist ideas. Those theories have helped Harappan civilisation to be recognised as the equivalent of or even a better counterpart of the Egyptian, Mesopotamian, or Chinese civilisations in South Asia.

I argue that their collective synthesis nurtures confirmatory narratives of the past. The studies submit to some grand narratives of the Harappan culture. Their search of multiple realities or plurality of past is confounded by a framework of hypotheses. Thus the MHA data continues to get interpreted in that notional framework only. This "... rule-bound archaeological practice eradicates ambiguity in favour of a construction of certitude... ."[74] Figure 3.4 shows these interconnected theories which build the overarching narrative of Harappan materiel culture. Since each of these hypotheses are the topics of vast scholarly literature and have also been discussed in other contexts in this thesis, I only briefly touch upon their place in MHA scholarship. The idea is to demonstrate that as the scholarship has evolved over time, these hypotheses enjoy a more or less symbiotic relationship. However, when isolated and analysed for their individual merit, they show fragility of different degrees.[75]

74. Gero, "Honoring ambiguity/problematizing certitude," 313.

75. Though some repetition of what has already been covered in chapters till now, this is a culmination of a conceptual framework within which present day scholarship can be firmly situated.

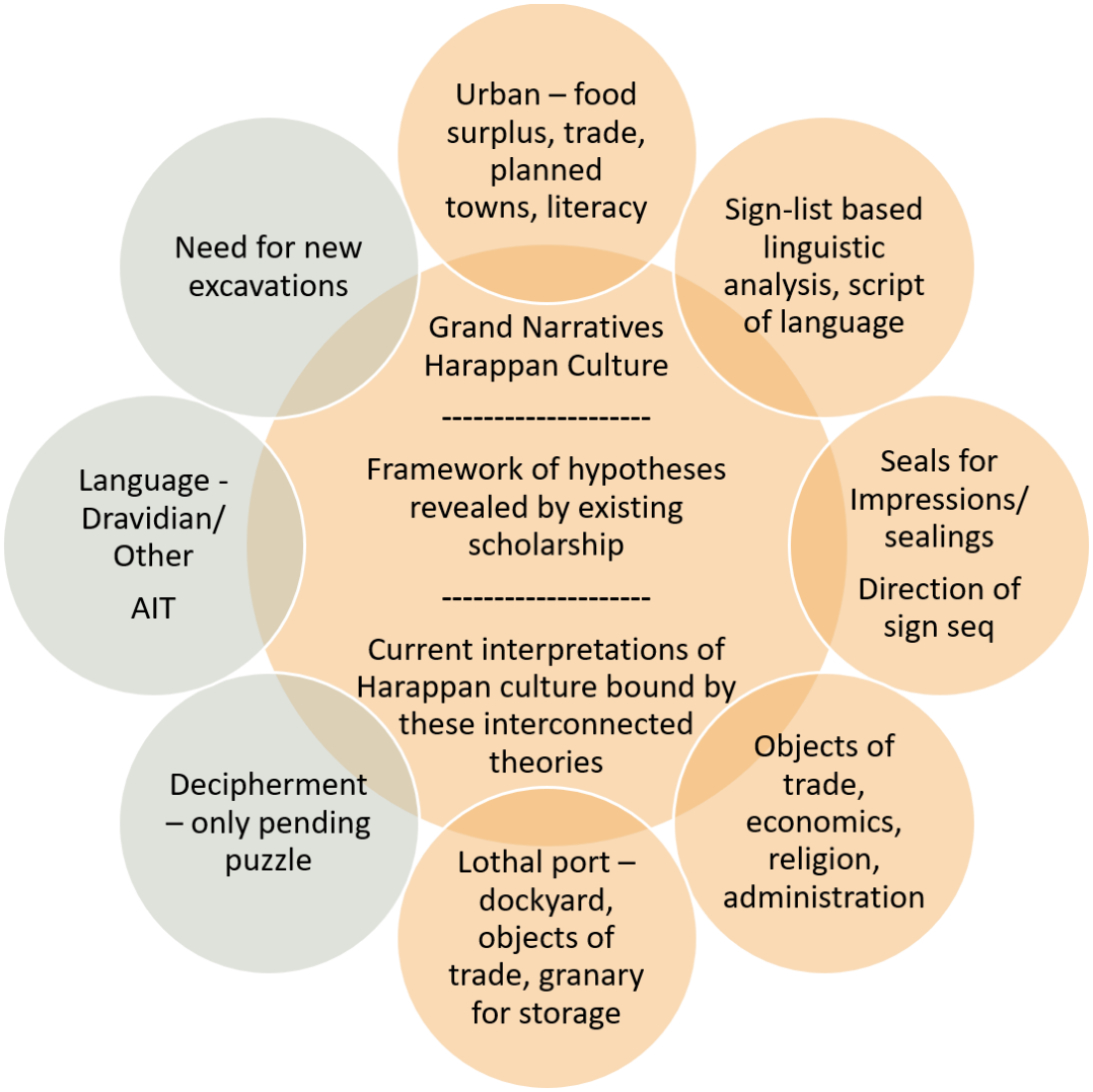


Figure 3.4: Framework of hypotheses - Systemic view of scholarship

3.3.1 Harappans were urban

Harappan civilisation is now an established phenomenon of the urbanisation in the pre-historic past of the Indian subcontinent.[76] The normative expectation is that it demonstrates all the characteristics of the same. The material remains demonstrate existence of settled population which is involved in secondary or tertiary occupations. This could have been possible only because of the surplus agricultural production. While describing the emergence of urbanisation in Harappan culture, Possehl articulates aspects such as writing, town planning (brick platforms, well-digging, drainage systems, grid plans), weights (showing mechanisms of standardisation), and generally less linked features

76. Possehl, "Revolution in the urban revolution: The emergence of Indus urbanization."

such as ceramic assemblage.[77]

Along with the sites identified as urban centres, there are sites identified as factory or manufacturing sites e.g. Chanhu-daro,[78] satellite settlements e.g. Kotada Bhadli,[79] trading posts e.g. Lothal,[80] craft production sites e.g. Bagasara,[81] industrial emporium e.g. Kuntasi,[82] and rural settlement e.g. Rojdi.[83] However, these interpretations are based on their teleological relationship with the urban centres where those urban sites occupy nodal position in the notional hierarchy of sites.

I do not object to the urbanisation as a phenomenon. The evident characteristics described above do showcase collective efforts of the society, population involved in non-agricultural activities, specialised art and craft, intercultural contacts, and infrastructure for a better life. Advanced application of urbanisation is seen to the theories of production such as Jamison's theory of 'decentralised mode of production'. As mentioned by him, its a long way from Marshall's opinion about the similarity within the seals.[84] However, his concept of multi-site or multi-regional production groups[85] relies on the assumptions about effective communication across space and time, systematic exchange mechanisms about sophisticated technology, and rationale for such systems to exist. It thus calls for a explanation about the need, strategies, and sustainability of

77. Possehl, "Revolution in the urban revolution: The emergence of Indus urbanization," 268.

78. Ernest J. Mackay, "Excavations at Chanhu-daro by the American School of Indic and Iranian Studies and the Museum of Fine Arts, Boston: Season 1935-36," *American School Of Indic And Iranian Studies and Museum Of Fine Arts, Boston*, American Oriental Series, 20 (1943).

79. Prabodh Shirvalkar, "A Preliminary Report of the excavations at Kotada Bhadli, Gujarat: 2010-11," *Bulletin of the Deccan College Post-Graduate and Research Institute* 72 (2012): 55–68.

80. S. R. Rao, *Lothal: A Harappan Port Town (1955-62)*, vol. I.

81. Brad Chase, "Social change at the Harappan settlement of Gola Dhoro: a reading from animal bones," *Antiquity* 84, no. 324 (2010): 528–543.

82. Jang-Sik Park and Vasant Shinde, "Characterization and comparison of the copper-base metallurgy of the Harappan sites at Farmana in Haryana and Kuntasi in Gujarat, India," *Journal of archaeological science* 50 (2014): 126–138.

83. Mark James Manuel, "Hidden agendas: testing models of the social and political organisation of the Indus Valley tradition" (PhD diss., Durham University, 2008), 197, http://etheses.dur.ac.uk/1899/.

84. Jamison, "The organization of Indus unicorn seal production: A diachronic comparative study of style, skill, and sociopolitical organization," 556.

85. Jamison, 402.

this system. On the other hand, identification of multiple groups in single site needs external validation about the caving details as being intentional systemic markers vis-à-vis accidental routine strokes. Besides these, as discussed elsewhere in the thesis, factors such as (i) expected wear and tear of seals due to their intended use, (ii) its contribution in the microscopic measurements, and (iii) findsites of artefacts need further explanation since they form the basis of 'decentralised production hypothesis'. Having said that, it is not necessary that all the material remains have to be interpreted within some fixed realms of urbanisation. I wish to highlight uncertainty existing at multiple levels of archaeological knowledge production and to underline the importance of acknowledging ambiguity in the archaeological exercise.[86] Gero has warned against this urge of certitude by identifying strategies routinely employed by archaeologists to reach closure. As she discusses the strategies employed by archaeologists to build the datasets and dependent knowledge, it is realised that eventually it creates a customised representation of the past. There are debates about whether specific definitions or characteristics of the civilisation and urbanisation can exist based on archaeological data, and whether Harappan culture fits into those definitions.[87] MHA scholarship is less cognizant about these theoretical upheavals till recent times. The notional class of 'seals' with fluid definition has virtually transcended these interpretations in solidifying the 'Urban character' of Harppan culture. Only some divergence is seen in case of artefacts with geometric designs and some without script where those are interpreted as probably some clothing attachments, jewellery equivalents, amulets, or ritualistic objects.

86. Gero, "Honoring ambiguity/problematizing certitude," 320–321.

87. Hans Blumenfeld, "On a Peculiar Feature of the City Plan of Mohenjo-Daro," *Journal of the American Society of Architectural Historians* 2, no. 1 (1942): 23–26; Lawrence S Leshnik and K. H. Junghans, "The Harappan "Port" at Lothal: Another View 1," *American Anthropologist* 70, no. 5 (1968): 911–922; Coningham and Manuel, "Priest-kings or puritans? Childe and willing subordination in the Indus"; Adam S. Green, "Killing the priest-king: addressing egalitarianism in the Indus civilization," *Journal of Archaeological Research* 29, no. 2 (2021): 153–202

3.3.2 Seal and seal impression hypothesis

Even before any impressions in the clay were discovered, the very first MHA artefact that was reported in the 1870s was called as 'seal'.[88] In the description, Cunningham describes it as "... a bull, without a hump, looking to the right... ."[89] It is seen as a right facing animal figure in the sketch.[90] However, in actual photograph indexed as H-1048,[91] it is a left facing animal. Cunningham's report has thus documented and produced the sketch of the perceived impression only. The figure 3.5 illustrates documentation of this seal. It has since then become a common practice to document the seal impression along with the seal, where the impressions is believed to be the 'actual' object of consumption. Discovery of sealings at different sites, especially at the site of Lothal in 1960s substantiated this seal-sealing relationship. With established usage of seals and sealing practices in Mesopotamian culture[92] and its contemporaneity and contact with Harappan culture,[93] the association between seal and impressions has supported the equivalence of artefact meanings and interpretations for intaglio carved steatite seals in Harappan material culture.

This preconceived notion has transcended in the documentation of the signs by reversing it than what is seen on the seals. All the sign encoding and decipherment studies have created or used the sign sequence concordances where this is implemented. As mentioned in the previous chapter, Meadow and Kenoyer had strongly objected to this practice which creates a bias at the stage of documentation.[94] All non-seal artefacts

88. Major Clark's seal, presently on display at British Museum, London"Stamp-seal | British Museum," 2023, accessed August 1, 2021, https://www.britishmuseum.org/collection/object/A_1892-1210-1

89. Cunningham, *Archaeological Survey, Report 1872-1873*, 108.

90. Cunningham, XXXIII.

91. Parpola, Pande, and Koskikallio, *Corpus of Indus Seals and Inscriptions - New material, untraced objects, and collections outside India and Pakistan, Part 1: Mohenjo-daro and Harappa*, 3.1:145.

92. Rakic, "Sealing Practices in the Akkadian Period"; Pittman, "Administrative role of seal imagery in the Early Bronze Age: Mesopotamian and Iranian traders on the plateau"

93. Mortimer Wheeler, *The Indus Civilization*, vol. 1 (1968); Elisa Cortesi et al., "Cultural relationships beyond the Iranian Plateau: The Helmand civilization, Baluchistan and the Indus Valley in the 3rd millennium BCE," *Paléorient*, 2008, 5–35; Ameri, "Letting the Pictures Speak: An Image-Based Approach to the Mythological and Narrative Imagery of the Harappan World"

94. Meadow and Kenoyer, "The 'tiny steatite seals' (incised steatite tablets) of Harappa: Some obser-



Figure 3.5: First seal reported by Cunningham and its documentation

are assumed to be consumed or used as they are hence those sign sequences have been documented as seen on the original artefact.

As already discussed, when compared with Mesopotamian datasets, the amount of seals and seal impressions discovered in Harappan context are miniscule and have skewed proportions.[95] Despite the sealings being made of clay in both the geographies and assumed to be participating in similar administrative systems, these survival differences have not been discussed or analysed for interpretation of MHA. Also, the observations related to wear and tear of the seals further question this generic idea of creation of impressions.

3.3.3 Confirmed Sign-list

Despite having choices available of those of other sign-lists and datasets, majority scholars prefer to use M77 sign-list. It is dated and possesses problems as described earlier. Despite that, it is persistently used by scholars. This essentially serves two purposes - (i) authenticate the sign-list, and thus (ii) establish credibility of research by using a known and established dataset. The supposedly fix number of signs i.e. 417 documented in M77 has helped drive the interpretation with assumption of logo-syllabic nature of signs. Any significant change in this number would question that assumption. A sign-list from ICIT database offers close to 700 signs. By separating multiple similar looking signs, it retains the ambiguity in the data which can then lead to newer interpretations.

vations on their context and dating," 18–19.

95. Frenez and Tosi, "Lothal Sealings: Records from an Indus Civilization town at the eastern end of the maritime trade networks across the Arabian Sea," 67.

On the other hand, S. R. Rao had proposed only 62 signs[96] as basic signs where rest of the signs could be explained as some combination of these signs. Thus, ICIT has almost ~66% increase in total signs over M77 and Rao's list is just ~15% as that of M77.

Lack of confirmed sign-list is a hurdle for any decipherment effort. To achieve that, a consensus has been built around the confirmed sign-list of 417 signs of M77.[97] A number close to 400 signs is optimum for a logo-syllabic kind of script.[98] This essentially supports Mahadevan's approach[99] or majority of the scholars who had earlier proposed different decipherment models.[100]

Against this background, the impact of the strategies implemented in identification of unique signs and regular updates to the ICIT database can be seen in following comparison of sign-lists. Figures 3.6 and 3.7 show signs from ICIT database which are absent from Mahadevan's and Parpola's sign concordances respectively.[101]

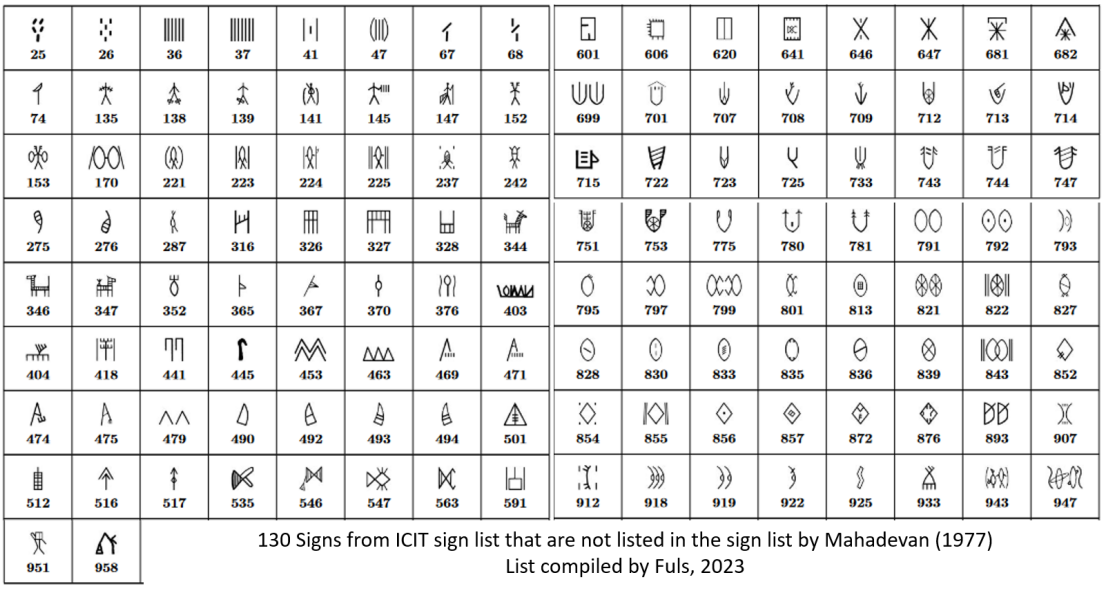


Figure 3.6: ICIT signs missing from Mahadevan's sign-list - Compiled by Fuls in 2023

96. S. R. Rao, "Indus Script and Language."

97. R. P. N. Rao, "A Rosetta Stone for a lost language."

98. Mahadevan, "An encyclopedia of the Indus script," 10.

99. Mahadevan, *Claims of decipherment of the Indus Script: Some objective methods to test their validity*, 4.

100. Gokhale, "Linguistic Hegemony and Latent Typology: The Case of Harappan Script Scholarship," 7.

101. Fuls, *A Catalog of Indus Signs*, 43–44, 50–51.

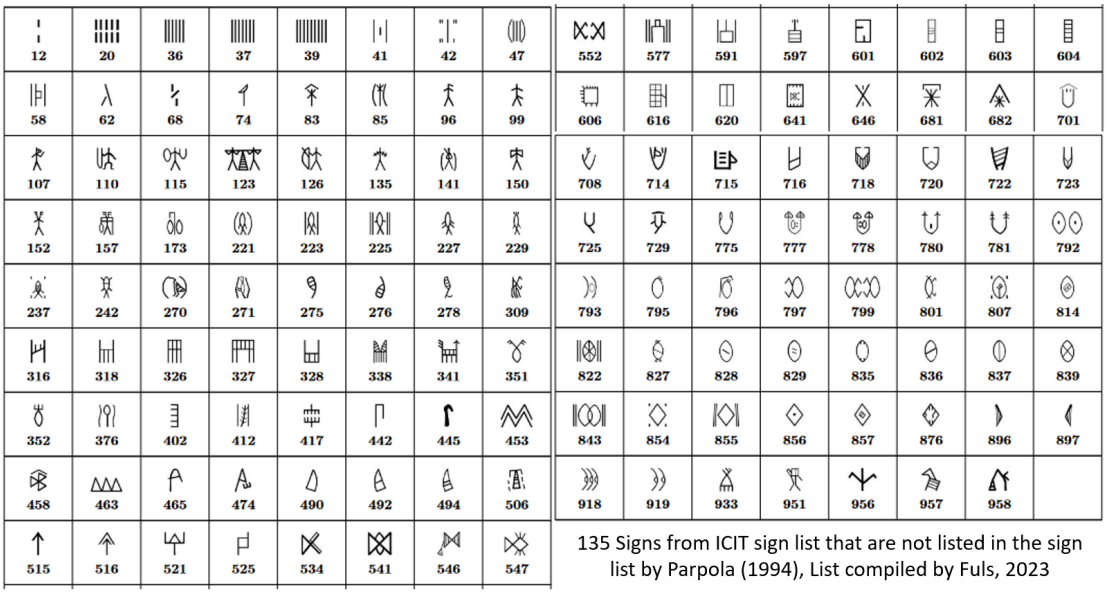


Figure 3.7: ICIT signs missing from Parpola's sign-list - Compiled by Fuls in 2023

It is now clear that the encoding efforts have treated the signary as independent of its archaeological context.[102] The scholarly opinions such as 'Dravidian as a least weak model' and 'practical impossibility of rejecting all non-linguistic possibilities' discussed in the earlier section can be treated as subsequent reciprocal arguments of a supposedly fixed sign-list phenomenon.[103]

3.3.4 MHA as objects of trade

What is concerning is that majority of the MHA recovered from different sites have always been regarded as some manifestation of urban phenomenon such as trade, administration, accounts, taxation, or in some cases as representations of some ideological concepts.[104] As discussed in chapter 2, notions about association between development and literacy have been established since historic times. As explained above, urbanisation being a developed stage of the society, presence of MHA indicate that they (i) possess ability to create impressions which is similar to the artefacts from urban cen-

102. Gokhale, "Attribute OR Artefact OR Attribute of Intangible Artefacts – A Case of Indus (Harappan) Script."

103. Parpola's sign-list consists of 386 signs. However, his sign-list and concordance has not been subjected to statistical analysis by external scholars.

104. Joshi and Parpola, *Corpus of Indus seals and inscriptions - Collections in India*, 1:XV–XVII.

tres of Mesopotamian culture, and (ii) possess a fixed sign-list which is indicative of the script of a language being used for functions related to urban needs. Based on concerns raised in this and previous chapter, Possehl's warning about this comparison and assumption of "... the same kind of text and seal administration"[105] in Harappan culture ought to be taken seriously.

On a side note, as seen from the literature review and even from the rest of the scholarship at large, 'intaglio carved square steatite stamp seals' are the most widely studied category of MHA. There are studies about seal impressions, copper tablets, or ceramic graffiti but the number is significantly small. Besides the variation in form, there is no functional dichotomy established between seal and other non-seal artefact categories. These non-seal MHA rarely participate in the prominent narratives. Because of their close notional relationship with seals, Possehl has referred to these as "pseudo-seals".[106] Thus the discovery of any kind of MHA at different sites persuasively assigns those to urban Harappan cultural complex.[107] A recent article by Davis has proposed an idea of 'Harappaness'. Author's conceptual framework to identify material markers indicative of political, economic, and ideological integration may help to asses the degree of 'Harappaness' from this otherwise plural material culture..[108]

3.3.5 Decipherment is the only pending puzzle

As seen through the literature review, decipherment projects portray a picture that all the archaeological, contextual, and documentation problems with the inscribed objects have been dealt with. Some scholars believe that it's now for the computer scientists and computational linguists to take up the task of further research.[109] Because of the perceived value of text (confirmed) over material (open to interpretation), the bias to-

105. Possehl, *Indus Age: The Writing System*, 26.

106. Possehl, 23.

107. There occurred a small debate during the international colloquium held in IIT Gandhinagar during Feb 2023. It was mentioned by a noted archaeologist, that, an otherwise properly identified chalcolithic site suddenly becomes a 'Harappan' site when a seal or objects of MHA category are identified.

108. Mary A. Davis, "How Harappan is a Harappan Site?," *Heritage: Journal of Multidisciplinary Studies in Archaeology* 3 (2015): 300–329.

109. Recent comment by an eminent scholar in S.R. Rao Memorial Seminar held by ASI in Feb 2023

wards the ED studies is at play in the present day scholarship. It is believed that once the signs are read, the people and the culture can be understood. Coningham, despite exploring the contrast between "... traditional Eurocentric normative models of social organization and those derived from south Asian cultural traditions."[110] could not resist to mention that:

> However, until its script is deciphered, or more rigorous archaeological methodologies are adopted, the very nature of the Indus Civilization's social and economic infrastructure and framework will be unclear, allowing successive generations of archaeologists to reflect their own ethnocentric ideals and values upon this silent Bronze Age world.[111]

In the introductory essay of CISI volume 3.1, Kenoyer mentioned that decipherment was given lot of attention rather than treating the artefacts as archaeological material. He had also suggested that chronological attention needs to be given to sign sequences on different MHA.[112] However, as seen earlier in this chapter, his latest remarks at the 2020 Mohenjo-daro conference highlight the fascination of decipherment to the academic community.

It is noteworthy that archaeologists, whose occupational bias should be towards material than the text, also support the quest to 'read' the signs.[113] On the contrary, material remains are highly likely a reflection of a cross-section of the society, require tangible material and efforts, and are thus more difficult to replicate than the textual evidence.[114]

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110. Coningham and Manuel, "Priest-kings or puritans? Childe and willing subordination in the Indus," 1.

111. Coningham and Manuel, 15.

112. Kenoyer and Meadow, "Inscribed objects from Harappa excavations 1986–2007," lvi.

113. The recent advancement in the AI is being used to create(!) fake historical events in the past - https://www.vice.com/en/article/k7zqdw/people-are-creating-records-of-fake-historical-events-using-ai. Technology is just the 21st century manifestation of forging the textual evidence. Some earlier similar events can be read at http://iancpilarczyk.com/10-historical-documents-proven-to-be-fake/

114. Though the material can be thought of as more tamper-proof than the text, there have been several events across the world where something called as 'Time Capsule' has been buried. Most of the times it has carried documents and some other objects on rare occasions. A debated example from India can be read athttps://www.news18.com/news/india/a-fort-a-time-capsule-a-secret-the-many-mysteries-of-indira-gandhi-1280368.html. However, even in these examples, material is used to protect the 'word'.

In this context, a set of nine copper plates published by Shinde and Willis is an otherwise inconsistent set of finds in MHA.[115] The provenance is unknown as these are held in private collections in Pakistan. The authors have already mentioned that these are larger than the presently know copper tablets from Harappan material and also possess signs and symbol on same side unlike those from earlier excavations which are bi-face. The XRF results show that there are significant amounts of non-metallic content and its not consistent in all nine artefacts. However, this is interpreted as an agreement with existing studies by Miller.[116] Based on the identification of sequence of the Harappan signs, these have been hypothesised as having reverse sequence and hence equivalent to seals in their function.[117] However, it is also mentioned that "The copper plates do not seem to bear many character sequences that closely resemble those found on seals."[118] Again, in spite of lack of similarity of sign pairs on these plates to those on seals, the authors argue that "The reversed script means that the plates were designed to leave an imprint: i) either directly on clay, which seems unlikely, or ii) or on a different medium through the transfer of pigment, i.e. printing."[119] In addition to the differences of form, size, and sign sequences observed by the authors, it is seen that there is a distinct difference in the iconography. The elephant motif, with a very different style, is left-facing where as on Harappan copper tablets it is right-facing. The horned tiger and antelope (as identified by the authors) do not match the styles on either seal or tabC. All tiger motifs in MHA, except one, has a trough in front of them. Also, there are no multi-line sign sequences in the existing copper tablets from Mohenjo-daro but it is observed on four out of nine artefacts in this case. They conclude that these are important because these bear "inscriptions in Indus script... and ... one plate ... bears the longest known single inscription in Indus characters".[120] What is startling is that in the absence of any contextual information, history of discovery, provenance, and functional

115. Vasant Shinde and Rick J. Willis, "A new type of inscribed copper plate from Indus Valley (Harappan) civilisation," *Ancient Asia* 5 (2014): 1–10.

116. Shinde and Willis, 4.

117. Shinde and Willis, 7.

118. Shinde and Willis, 7.

119. Shinde and Willis, 8.

120. Shinde and Willis, 9.

aspects, the authors are certain about their association with Harappan culture, especially the mature phase of 2600-2000 BCE for the purpose of printing.[121] This is based on the visible superficial similarity in the overall form, content, and metal composition. They do not raise a possibility of these being any kind of imitation or copies either during the Harappan cultural period itself or later. Moreland's comments in this context cannot be ignored: "The reality is that people in the past, as in the present, made and manipulated objects (and text) as projections of their views about themselves and their place in the world."[122] Ameri is cognizant of this fact when she speculates imitation of seals at Tepe Hissar, Kalibangan, and Lothal.[123]

3.3.6 Debate between Dravidian and Vedic interpretations

The causes for linguistic hegemony in the MHA scholarship have been illustrated in detail till now. With respect to prominent language possibilities, Dravidian and Indo-Aryan are the two opposing and strong proposals. Any interpretation from the lens of Vedic texts or Indo-aryan linguistic approach proposes indigenousness of this material culture and its owners.[124] It thus leads to Harappan script and the language being interpreted as Proto-Indo-European. In that process it goes against the Aryan invasions theory and Proto-Dravidian hypothesis. It thus proposes least or no influence of people, culture, or language from the west and no movement of people or languages to the south. Based on the studies in historical linguistics,[125] theories of acculturation,[126] and prehistoric population studies,[127] these interpretations have come under heavy criticism. Juxtaposed to this, despite the lacunae in the datasets, methods, and even presumptu-

121. Shinde and Willis, "A new type of inscribed copper plate from Indus Valley (Harappan) civilisation," 9.

122. Moreland, *Archaeology and text*, 80.

123. Ameri, "The Sincerest Form of Flattery? Terracotta Seals as Evidence of Imitation and Agency in Bronze Age Middle Asia."

124. Talageri, *Genetics and the Aryan Debate:" Early Indians", Tony Joseph's Latest Assault*.

125. Southworth, *Linguistic archaeology of south Asia*.

126. Witzel, "Central Asian roots and acculturation in South Asia: linguistic and archaeological evidence from Western Central Asia, the Hindukush and northwestern South Asia for early Indo-Aryan language and religion."

127. Joseph, *Early Indians: the story of our ancestors and where we came from*.

ous extrapolations (discussed at length in chapter 1 and 2), there is hardly any criticism for the Proto-Dravidian arguments. Unlike interpretative processes implemented in non-Dravidian studies, the Proto-Dravidian arguments are extended and sustained using advanced statistical techniques.[128] These methodologies are viewed as mechanisms to produce objective scientific knowledge and thus support the positivist epistemology. If this debate could be healthier and on equal grounds, it may bring more value in the current scholarship. Despite this, as discussed in the previous chapter, both Dravidian and Vedic readings have failed the tests of cross-validation, external evidence, or falsifiability.[129]

This debate is inevitably linked to the now debunked theory of Aryan Invasion. Though the theory of Aryans' entry in India was conceived by Max Mueller, it was strengthened during the colonial period.[130] It worked as a convenient argument for British to justify their rule in the following centuries.[131] This has been a critical building block of proto-Dravidian linguistic argument for interpretation of Harappan signs.[132] Besides the Vedic textual interpretations, perceived similarities between Rigveda and Avesta, and the confusion between language and race,[133] one of the material evidences which had upheld the idea of 'invasion' was that of human remains found at Mohenjo-daro, being called as 'Massacre'. Dales objected to it in his long article.[134] Numerous studies in the recent past have demonstrated that:

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128. Rao et al., "Entropic evidence for linguistic structure in the Indus script."

129. Unfortunately, both models are used with varied political interests.

130. Romila Thapar, "The theory of Aryan race and India: History and politics," *Social Scientist* 24, nos. 1/3 (1996): 3–29; Subrata Chattopadhyay Banerjee, "The acceptance and proliferation of the Aryan invasion theory in India" (PhD diss., RWTH Aachen University, 2017)

131. Thomas R. Trautmann, *Aryans and British India* (Yoda Press, 2005), 174.

132. Possehl, *Indus Age: The Writing System*, 16–18; Iravatham Mahadevan, *Vestiges of Indus Civilisation in Old Tamil* (Tamilnadu Endowment Lecture, Tamilnadu History Congress, 16th Annual Session, 9-11 October 2009 - Tirucbirapalli, Tamilnadu, 2009); Parpola, "The Indus script: A challenging puzzle"; Parpola et al., *Decipherment of the Proto-Dravidian inscriptions of the Indus civilization: a 1st announcement*, 1:4–5; Zide and Zvelebil, *The Soviet Decipherment of the Indus Valley Script: Translation and Critique*, 66

133. Thapar, "The theory of Aryan race and India: History and politics," 15.

134. George F. Dales, "The mythical massacre at Mohenjo-daro," *Expedition* 6, no. 2 (1964): 36–43.

- movement of people, language and culture should not be treated as one and the same[135]
- identification of race and language group are different from each other[136]
- there have been multiple occasions when people have migrated to and from core regions of Harappan culture[137]
- no material evidence of war, destruction, physical oppression, or invasion has been found[138]
- no material evidence is found of a coercive urban-rural relationship or ruling class as a prerequisite for social complexity[139]

Though the theory created a conducive environment for the colonial rule, even after seven decades of independence, its ramifications are still visible in the present day Indian subcontinent[140].

Recent work on ancient DNA has taken a much stronger stance that people who occupied the Harappan regions were mostly natives.[141] The study questions movement of people which could have contributed in indigenous claims for emergence of agriculture in South Asia and thus the composition of the Harappan population. However, the study suffers from its own problems of extrapolation of evidence.

These studies culminate into the modification of the original theory of invasion into that of migrations of different scale in multiple directions. This dilution of original theory automatically weakens its support for Proto-Dravidian linguistic argument.

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135. Peggy Mohan, *Wanderers, kings, merchants: The story of India through its languages* (Penguin Random House India Private Limited, 2021).

136. Southworth, *Linguistic archaeology of south Asia*.

137. Joseph, *Early Indians: the story of our ancestors and where we came from*.

138. T. R. S. Prasanna, "There is no scientific basis for the Aryan Invasion Theory," *Current Science* 103, no. 2 (2012): 216–221; David Frawley, *The myth of the Aryan invasion of India* (Voice of India New Delhi, 1994); Green, "Killing the priest-king: addressing egalitarianism in the Indus civilization"

139. Green.

140. Joseph, *Early Indians: the story of our ancestors and where we came from*; Talageri, *Genetics and the Aryan Debate:" Early Indians", Tony Joseph's Latest Assault*

141. Vasant Shinde et al., "An Ancient Harappan Genome Lacks Ancestry from Steppe Pastoralists or Iranian Farmers," *Cell* 179, no. 3 (2019): 729–735.e10, https://doi.org/10.1016/j.cell.2019.08.048.

3.3.7 Lothal port hypothesis

The port hypothesis[142] about the site of Lothal is mainly based on the rectangular structure identified as dockyard, the square block remains identified as granaries, and the largest ever collection of sealings which was already part of the trade narrative with seals as their production mechanism. There are other studies, especially geomorphological ones which agree to Lothal as a possible location of port.[143] Gupta's yet unpublished work also suggests possible flow of former course of river Sabarmati to the north of Lothal and seasonal connectivity to Nal sarovar.[144] It thus shows connectivity of Gulf of Khambhat with Little Rann of Kachchh. However, the material remains can be questioned for their interconnected interpretation. The tank identified as a dock or mooring station for ships has been seriously questioned for its design[145] and purpose.[146] The seal and seal impression hypothesis has already been described above. Finally, about the structure identified as granary, those were also identified at the sites of Harappa, Mohenjo-daro, and Dholavira but none of these have structural similarities with the one at Lothal. The figure 3.8 shows these granaries or warehouses from different sites. For the granary structure at Lothal, its interpretation as a warehouse or granary has been questioned by Frenez based on his discussion with Kenoyer.[147]

142. S. R. Rao, *Lothal: A Harappan Port Town (1955-62)*, vol. I.

143. Archana Das et al., "Evidence for seawater retreat with advent of Meghalayan era (4200 a BP) in a coastal Harappan settlement," *Geochemistry, Geophysics, Geosystems* 23, no. 6 (2022): 1–14, https://doi.org/10.1029/2021GC010264; A. Sundaresh Gaur and K. H. Vora, "Ancient shorelines of Gujarat, India, during the Indus civilization (Late Mid-Holocene): A study based on archaeological evidences," *Current Science*, 1999, 180–185

144. Personal communication during International colloquium hosted by IIT Gandhinagar. Gupta presented a poster on this topic.

145. Leshnik and Junghans, "The Harappan "Port" at Lothal: Another View 1."

146. Frenez and Tosi, "Lothal Sealings: Records from an Indus Civilization town at the eastern end of the maritime trade networks across the Arabian Sea," 69.

147. Frenez and Tosi, 70.

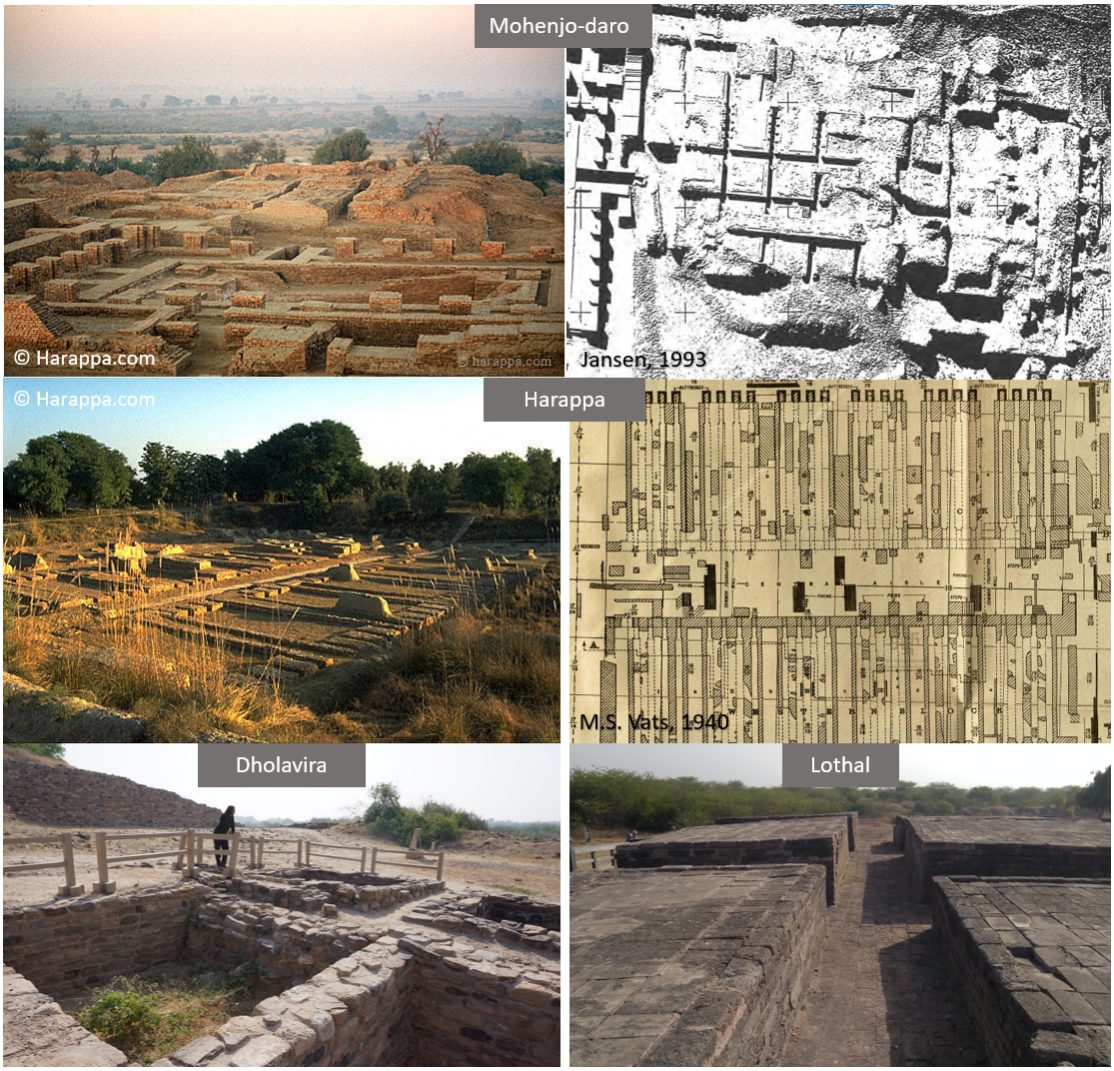


Figure 3.8: Granary – Contextualising the terminology at different sites

3.3.8 Established need for new excavation

The earlier section in this chapter described the scenario for demands of new excavations and more data. As described there, the prospect of recovery of possible bi-lingual or bi-scripture have been created based on the breakthroughs of other decipherment events where activities such as trade, economics, and expansion of political rule created a need for those. The message was required to be communicated to the groups of people who used different language or different scripts, and were within the corresponding political or administrative areas of influence. Such needs and relevant mechanisms to fulfill it are required to be identified to hypothesise the probability of bi-lingual or bi-scripture artefacts in Harappan culture. Contrary to this, the study mentioned above in the 'Excavate more!' section already declares that "Inclusion of the new data will further improve the

statistical significance of the results presented here."[148] This is in reference to the exclusion of data of the HARP seasons and other sites excavated after 1977. Above statement claims that even if new data is analysed, the observations from older dataset will only persist and strengthen. A counter-intuitive argument could be that if a drastically different data i.e. a new body of evidence is available, present observations may change leading to new interpretations. Unfortunately, as of today, there is no probabilistic study to know (i) whether to expect the data which strengthens existing arguments, or (ii) if there is a chance that artefacts can be found which disrupt the current understanding of this material culture.

3.4 Redefining the problem

Based on the literature review, constraints around the present-day narratives, and possibilities of multiple contexts for interpretation, post-processual theory creates a conducive framework to situate the problem. However, each MHA study can then be justified in its own context. Though the epistemic canvas is enriched because of these discrete studies, from a coherent knowledge production system point of view, it becomes a "...convoluted epistemic universe".[149] Simultaneously, despite fragmented understanding of the artefacts and contrary to the post-processual idea, the studies continue to fit themselves within the framework discussed above. Thus, it can be said that despite the presence of post-processualism at the conceptual level, positivist archaeological scholarship is constructed in our interpretations. A post-processual approach cannot be practised if the interpretative thought process is bound by this framework of hypotheses. Though there lies a baggage of borrowed terminology and ideas,[150] this hypotheses framework appears robust because the subtext is supported by the processual archaeological theory.

A cursory review of other deciphered scripts' scholarship highlights the fact that knowledge about bi-lingual texts, long texts, language groups, historical and archaeo-

148. Yadav, "Sensitivity of Indus script to site and type of object," 70.

149. Phrase extracted from the review comments received for Gokhale, "Linguistic Hegemony and Latent Typology: The Case of Harappan Script Scholarship"

150. Ajay Pratap, "Indian Archaeology and Postmodernism: Fashion or Necessity?," *Ancient Asia* 5 (2014).

logical context, and contemporary literary tradition have played a significant role in the decipherment. The MHA dataset is devoid of all these. In his latest article, Green has elaborated the tangible differences between Harappan and other contemporary material cultures. He has concluded that ruling class is not a prerequisite for social complexity and "The Indus civilization was perhaps the world's most egalitarian early complex society, defying long-held presumptions about the relationships between urbanization and inequality in the past."[151] Thus a critical approach is needed when the patterns observed in material culture are mapped to social identities or stratification.[152] It is thus important to strategise a methodology which takes advantage of the essence of the present dataset.

In this study, I wish to address the functional use question of MHA attributes. It creates an ontological premise for further study of the society and its systems. I argue that it can be addressed by possible triangulation within the attributes, attribute values, and respective interpretations. The scale of observation matters in this exercise. These triangulation efforts are not intended to approve or disapprove individual studies. The aim is to understand whether and how these corroborate, contradict, or critique each other. It will lead to more logical understanding of this material. The corroborations will assist to strengthen the propositions. Contradictions can demonstrate gaps related to the cultural significance problem. Lastly, critique can help in more meaningful enquiries rooted in the materiality of the artefacts. It is inevitable to check if the findings of this exercise fit into the framework of hypotheses described above or create new narratives. The broad research questions which emerge are as follows.

- What is the relationship between various MHA attributes of artefact form and their context -

  Some existing biases in the dataset are already known. For example majority seals are from Mohenjo-daro, tabI are found in Harappa, tabC are only from Mohenjo-daro, and majority of tags are from Lothal and Dholavira. However beyond these primary observations at artefact acquisition level, analysis of whether and how different inherent attributes correlate with each other and their external context is important.

- Whether signs have immediate contextual relationship with artefact form/type and

151. Green, "Killing the priest-king: addressing egalitarianism in the Indus civilization," 185.

152. Davis, "How Harappan is a Harappan Site?"

with the extended context such as mounds, sites, and regions -

Through multiple examples in chapter 2, it is demonstrated that sign decipherment and analysis studies are completely isolated from artefact typologies and archaeological context. Though some recent studies look into earlier unexplored characteristics of the artefacts such as carving techniques and sequences, possible periodisation, and material sourcing, the sign studies remain inert to these archaeological developments. Through this analysis, decipherment scholarship's presumptions such as (i) the sign sequences being a random homogeneous samples, and (ii) being unaffected by its immediate and extended contexts, need to be validated.

- How the scale of observation can impact the interpretation -

  The scale of observation essentially means the resolution at which the data is observed. Observations at all-sites-civilisational level or at a mound level may lead to different interpretations. Similarly, measurements limited to centimetres or inches vs. SEM measurements may result into differently nuanced observations. Whether those should be treated as intentional and systemic variations is a critical question.

- What are the challenges, negotiations, and outcomes of analysis of data at a micro-contextual level: GIS case study of DKGS mound at Mohenjo-daro -

  Local archaeological context (or micro-context) essentially means a findspot that encompasses the static and loose artefact and ecofacts. For contextual analysis of MHA within a century old excavation of DKGS mound, the analysis relies on precise findspot descriptions and interpretation of the excavation report. As seen in chapters till now, the excavation report needs to be read as a 'historic document' to extract and build a context. In addition to the quantity or quality of MHA, this is an equally important prerequisite.

- Do we have an ability to predict -

  Recent advances in machine learning and its applications to prediction of sign sequences are interesting methodologies for MHA study. However, the datasets used in any such studies directly impact the possibility and quality of actual predictions. I thus explore the extent of this technique for its application to different aspects of MHA.

As I design the problems or statistical tests, the null hypothesis is based on either the existing studies about the attributes or perceived constraints based on basic artefact form.

The problematisation and possible triangulations are proposed on the backdrop of philosophical proposition attributed to Aristotle: 'Whole' is greater than the sum of its parts. Behavioural archaeology, which developed as a branch of anthropology, dealt with human behaviour, material culture, and the role of objects in human activities. Thinking of humans as agency and relating their behaviour with material in the past and present was described with the use of four strategies. This was more of an extension of processual archaeology. However, significance of the present was equally recognised in the understanding of the past. Reid and colleagues note that 'A behavioral archaeology must exceed the sum of its parts since it depends upon the interaction among all four strategies.'[153]

As discussed till now, Harappan archaeology continues to experience the paradigmatic shifts within the archaeological theories. These theories are essentially the changing perceptions of academia towards the material culture. Since there is no external entity that can validate 'our way of doing archaeology', and each of these theories expand our knowledge of the past in certain way, it may not be possible to outrightly reject the older theories due to newer ones. It is thus interesting to observe different academic viewpoints irrespective of the prevalent paradigm of the time. In a utopian world, though we expect to know the past the way we know present, it is realised that even in the present, we are limited by our own thought processes and perceptions. Acknowledgement of this 'self' context is also acknowledged in this thesis.

3.5 Hypothetical situation of decipherment

In the initial phase of ED studies, the attitude in this scholarship was 'to decipher' the script. However, now the approach has moved to 'until the script is deciphered'. It simply then underestimates the archaeological material evidence and emphasises on the written record for understanding the past. The issue is discussed in the earlier section.

153. J. Jefferson Reid, Michael B. Schiffer, and William L. Rathje, "Behavioral Archaeology: Four Strategies," *American Anthropologist* 77, no. 4 (1975): 866.

However, in his doctoral work of analysing the carving techniques of square unicorn seals, Jamison mentions "As the script has not been deciphered, detailed studies of craft production have proved the most useful methods for understanding the organizational dynamics of the Indus civilization."[154] It is rather counter-intuitive to think that if the script is deciphered, excavations and analysis of the material will stop. As an archaeological principle, this will not happen.[155] Even if we are able to read, decipher, or interpret signs on MHA, studies like Jamison's must be undertaken as they analyse the form and material, and go beyond the boundaries of readable signs. As discussed in the previous chapter, in regions or for cultural periods where the scripts have been read, deciphered, or interpreted to understand the 'history', majority of those cases demonstrate that the written record is always just one perspective of that cultural context. Within the framework of literacy, development, ruling class, social hierarchy, and urbanisation, the text could be a prerogative only of a particular class. It is thus important to critically analyse the material and understand as to what extent the written evidence could be reflective of the past. Also, the subtext and extra-text information needs to be interpreted from the associated material remains only. Despite reading the detailed inscriptions in numerous caves in India, or Ashokan edicts spread over the subcontinent, the search for narratives about the motives, artisans, funding, technology, conflict, possible coercion, societal context, and subaltern groups continues through the material remains.

154. Jamison, "The organization of Indus unicorn seal production: A diachronic comparative study of style, skill, and sociopolitical organization," 103.

155. Pallavee Gokhale, "37 | The Indus script (signs): Inputs from archaeology | Pallavee Gokhale - YouTube," 2023, accessed May 10, 2023, https://youtu.be/SAjYpd6OMV8.

Chapter 4

Data Preparation

Based on the review of studies on MHA and the need of new problem statement, broad research questions have been defined and illustrated in the previous chapter. To address these questions, suitable data needs to be acquired in three main areas: (i) form and context related aspects of MHA, (ii) signs on all MHA in specific encoding system, and (iii) geospatial information for GIS case-study. In terms of data-types, the first two are non-spatial and the third is spatial i.e. related to the findspot of an artefact. The geospatial data creation and its analysis has been described separately in chapter 7

4.1 Data creation

This chapter describes the data acquisition, conversion, and preparation along with the nuances of these processes. It is experienced that on several occasions, we are forced to apply 'mechanisms of closure'[1] so that the data becomes appropriate for quantitative or comparative studies. These methodologies offer significant advantages for analysis of different attributes. However, in order to avail those benefits, we ought to 'clean' and 'measure' the data.

For geospatial analysis of MHA, description of the actual archaeological context is crucial. This is directly impacted by the details and precision with which the site and artefacts are recorded in the excavation reports or other primary documents. The plans which depict the excavated structures and the artefacts documented with their location within these structures are outputs of an intellectual exercise. There is no naive representation of the site. Thus the data is already measured, cleaned, and prepared to a certain extent. Conversion of this data into digital format further normalises it.

In either case of spatial and non-spatial handling of the data, it is negotiated at every level.

Earlier studies which dealt with typology, styles, iconography, or carving technique, those have created well defined datasets. The studies essentially extrapolate their obser-

1. Gero, "Honoring ambiguity/problematizing certitude," 320–322.

vations to explain the entire MHA compendium. CISI volumes which are considered as the most authentic sources of these objects, also include artefacts which are completely devoid of Harappan signs or typical iconography associated with signs. These depict simple geometric symbols such as swastikas, concentric circles or even simple lines. Presence of perforated boss and their findspot are the driving factors for their inclusion in this otherwise 'inscription' dominated corpus.[2]

Another significant data is a standardised encoding of the sign sequences. The chapters till now discussed various systems defined by different scholars. Besides identification new signs, the major reason for variation amongst these sign concordances is lack of consensus on distinction between unique signs and their allographs. Possehl has already described a single example which demonstrates the problem.[3] Here is a quick summary of the negotiations that have gone into sign encoding. Most popular sign-lists such as those published by Mahadevan, Parpola, and Wells also document the allographs (sign variants) but majority of those are merged with the respective single sign code.[4] S. R. Rao has proposed more of a reductionist approach and has a very small number of signs (22-62) compared to these three scholars. His idea is to identify a minimal core set of basic signs so that other signs can be explained as a graphic combination of these signs.[5] On the other hand, Wells' sign-list with ~700 signs is probably the longest one which avoids conflation as far as possible.[6] Mahadevan[7] and Parpola[8] have also used a similar logic but came up with 417 and 396 signs respectively. They also list the variants which have been merged, however, many of their decisions are seriously contested by Wells.[9]

The present scope of work does not aim to create a new sign-list. Instead, it investigates appropriate sign-list to understand the artefacts. Also, it creates a master dataset of all available published MHA. The following sections describe the basic raw data and

2. Joshi and Parpola, *Corpus of Indus seals and inscriptions - Collections in India*, 1:XXVII.

3. Possehl, *Indus Age: The Writing System*, 163.

4. Mahadevan, *The Indus script: texts, concordance, and tables*, 785–792.

5. S. R. Rao, "Indus Script and Language," 158.

6. Wells and Fuls, "Online Indus Writing Database."

7. Mahadevan, *The Indus script: texts, concordance, and tables*.

8. Parpola, *Deciphering the Indus script*.

9. Wells, *Epigraphic Approaches to Indus writing*, 55.

the processes employed to select, procure, clean, and prepare the data to suit the requirements of the present project. This data preparation has followed some basic procedural guidelines as follows:

- The hypotheses to be tested follow a data-centric rather than notion-centric approach. Thus the framework of existing narratives discussed in the previous chapter is disregarded in the hypothesis formation process. It is important to note that as far as possible, the data is treated as notion-neutral. The hypotheses being tested will later be checked for their fit in the framework.

- Since this is not a decipherment project but rather the 'material-meaning-making' project, it is directly impacted by the 'mechanisms of closure'.[10] The decision to 'honour ambiguity'[11] at each step has many positive consequences. Both of these were discussed in the chapter 3. As a result, I retain the possible ambiguities in the data at different stages. For example, as I describe the attributes of MHA, multiple viewpoints are documented, both from the existing studies and my own analysis.

- These multiple attributes create opportunities for triangulation from those studies and situate those in an overarching framework.

- Same approach is employed for geospatial database of the DKGS case-study area. Findspot locations are considered as probabilistic locations for the artefacts.

- Finally, for the choice of sign encoding, the most inflated sign-list automatically retains the ambiguities since it conflates minimum allographs into a unique sign graph. Such a list can circumvent the masking effect to some extent.

4.2 MHA Attributes

Identification and compilation of attributes for MHA is a gigantic task because of the quantity of the artefacts, the form variations, and their spread across international borders in multiple sites and museums. The CISI project was incorporated for this very purpose. With close to four decades of international and inter-institutional collaborative

10. Gero, "Honoring ambiguity/problematizing certitude," 320.

11. Gero, 323–324.

work, five volumes have been published. Their aims and objectives for the photographic corpus, methodologies of data acquisition, and strategies for organising the volumes can be read in the preface and introduction of the first volume.[12] Another such effort was put in by Bryan Wells as part of his postgraduate thesis.[13] He later extended it during his doctoral work.[14] At present, this work can be found in the form of an online database, titled 'Interactive Corpus of Indus Text' (ICIT), maintained by Andreas Fuls from TU Berlin.[15] Though most of the records are based on published CISI volumes, ICIT has additional records from excavation reports and other published articles along with metadata for majority of MHA. Strategies employed to identify the attributes and their sets of values are described in Wells' masters' thesis and doctoral work mentioned above. The CISI volumes and ICIT database[16] have been used to build the MHA dataset for the present work. Though Wells himself agrees that he does not provide complete analysis of iconographic elements and types since his main focus is on the script,[17] his is probably the best starting point for the artefact-centric study. In addition, datasets from published studies which deal with iconographic and typological aspects have been used for the triangulation exercise. This section describes the data compilation process which also includes modifications to existing attributes and addition of new ones. Since ICIT is an online database and is being updated on a regular basis, the database schema information for the present work is recorded as of June 2021 and the number of artefacts for the current project have been last updated in May 2022. A bird's eye view of his dataset as of February 2023 can be seen in table 4.1.

Besides these, ICIT also has other artefacts (non-MHA) for the DKGS mound in Mohenjo-daro. These non-MHA artefacts from Mackay's excavation report include objects such as beads, spindle-whorls, dishes, cones, figurines, bracelets, hooks, masks, gamesmen, bangles, chisels, and querns.

There are various ways in which the data has been cleaned and prepared by Wells

12. Joshi and Parpola, *Corpus of Indus seals and inscriptions - Collections in India*, vol. 1.

13. Wells, *An introduction to Indus writing*.

14. Wells, *Epigraphic Approaches to Indus writing*.

15. Wells and Fuls, "Online Indus Writing Database."

16. MoU signed with Dr Andreas Fuls

17. Wells, *Epigraphic Approaches to Indus writing*, 23.

Total artefacts	5538
Inscribed artefacts	4650
Total texts	5643
Signs	709
Total sites (73 sites with signed artefacts; 41 sites with signed and non-signed artefacts; 14 sites with only non-signed artefacts)	86
Database version since the preliminary dataset compilation in 1990	11th

Table 4.1: Basic overview of ICIT database as of Feb 2023

for building the computerised database. However, to use it for 'contextual analysis' in the present work, several negotiations, deliberations, and subjective decisions have been made. These are mostly related to attribute handling such as type, technique, iconography, sign sequences, boss, and multi-side properties. The problem of defining 'type', which began since the first ever excavation, persists till date. The tables 3.1 and 3.2 in the previous chapter illustrated the inconsistent definitions. For the iconographic decorations, though the decorative motifs of unicorn were documented by Wells,[18] Rissman,[19] and Franke,[20] their attribute identification and logic for stylistic grouping is different from each other.

In the recent studies dealing with typo-technological analysis,[21] though they take due note of these studies, they do not necessarily build on the earlier attribute defini-

18. Wells, *Epigraphic Approaches to Indus writing*.

19. Rissman, "The organization of seal production in the Harappan Civilization."

20. Franke, "Inscribed objects from Mohenjo-Daro: Some Remarks on Stylistic Variability and Distribution Patterns."

21. Green, "Stamp Seals in the Political Economy of South Asia's Earliest Cities"; Jamison, "The organization of Indus unicorn seal production: A diachronic comparative study of style, skill, and sociopolitical organization"; Konasukawa, "Diversity of Harappan civilization: a case study of the Ghaggar basin with special reference to seals"; Konasukawa, "Comparative Analysis of the Seals in the Pre/Early Harappan Period and Harappan Seals through SEM and PEAKIT (3D) Analyses"; Frenez and Tosi, "Lothal Sealings: Records from an Indus Civilization town at the eastern end of the maritime trade networks across the Arabian Sea"

tions or groupings nor are they seen impacted by them. They generate new attributes as per their own objectives with the use of state of the art instruments such as SEM and document microscopic measurements. These studies cater to the larger goal of situating archaeology in the realm of the 'science' through the use of precise measurements, statistical analysis, and strong perception of objectivity employed in these methods.

4.2.1 Locations and periods

The MHA have been recorded from numerous sites spanning across Harappan cultural domain as well as West Asia, Mesopotamia, Persian Gulf, and south India. In addition to actual site name, ICIT has categorised those based on broad geographical regions. For recording horizontal findspots, Mohenjo-daro excavation reports record an immediate spatial context in the form of block-house-room within different cultural periods.[22] Chanhu-daro report records the antiquities in mound/trench-grid-location-depth reference system.[23] At Harappa, provenance is recorded in the form of area, trench or even house numbers.[24] Dholavira report records the artefacts and structural remains in the grid reference system[25] whereas at Lothal excavators use phase-locality-grid-layer-depth scheme.[26] Due to these inconsistencies in the format of recording, all these have been accommodated in ICIT in limited attribute columns. This also shows limitations imposed in the choice of site for the GIS case-study. This information for the sites has been retained as is from ICIT. Modifications to DKGS have been explained in separately in chapter 7.

Cultural period is probably the most critical yet least consistent attribute for the entire MHA dataset. This attribute and its values are result of stratigraphic understanding of the excavator for the specific site, overall perception about the cultural sequence

22. Mackay, *Further Excavations in Mohenjo-daro*, vol. I.

23. Mackay, "Excavations at Chanhu-daro by the American School of Indic and Iranian Studies and the Museum of Fine Arts, Boston: Season 1935-36."

24. Madho Sarup Vats, *Excavations at Harappa: Being an Account of Archaeological Excavations at Harappa Carried out between the Years 1920-21 and 1933-34*, vol. 1 (Manager of Publications, 1940).

25. R. S. Bisht, "Excavations at Dholavira (Draft published for limited period, now under publication)" (2015).

26. S. R. Rao, *Lothal: A Harappan Port Town (1955-62)*, vol. I.

of Harappan culture in the contemporary academic community, and application of this perception to the stratigraphy at sites. In cases where the excavation report or other published texts mention the period or cultural phase, it has been captured in ICIT. However there has been no consistency in recording these in the excavation reports and it has also evolved over the past century. Thus we find attributes such as time, period, phase, and depth[27] being intermittently used to record this information at different sites. Depth is an actual measurement of where the artefact was discovered under the surface, generally measured with reference to the datum point. However, artefacts recovered from similar depths are not necessarily contemporary. Undulation of mounds, differential occupation and abandonment of the site, and site formation processes directly impact these observations.

The discovery of radiocarbon dating has brought clarity about absolute time-frame of Harappan culture. However, it is realised that different stages of material culture could be contemporaneous at multiple sites. Also, it is not necessary that all the sites experienced all the stages in their total life-span. Thus, to correlate the cultural sequence of all sites to absolute dates from specific sites could be an unrealistic exercise. This has created a major roadblock to assign MHA to any specific cultural period. The chronological development of MHA described by Kenoyer is solely based on his excavations from Harappa.[28] Wells points out that the excavations under HARP mission haven't been able to rectify the problems from the past.[29] Despite defining a very systematic stratigraphy[30] at Mohenjo-daro mounds, Mackay did not hypothesise the developmental chronology of MHA. Mahadevan and Parpola haven't proposed such chronology nor have they acknowledged its existence and significance in their respective ED studies.

There have been several efforts to corroborate the cultural stratigraphy from different

27. Excavators often use different units at different sites.

28. Kenoyer, "Origin and Development of the Indus Script: Insights from Harappa and other sites"; Kenoyer and Meadow, "Inscribed objects from Harappa excavations 1986–2007"; Jonathan Mark Kenoyer, "The origin, context and function of the Indus script: Recent insights from Harappa," in *Proceedings of the Pre-symposium of RIHN and 7th ESCA Harvard-Kyoto Roundtable*, ed. Toshiki Osada and Hase Noriko (2006), 9–27

29. Wells, *Epigraphic Approaches to Indus writing*, 12.

30. Though erroneous as per later studies, Mackay has described a stratigraphy for DKG based on identification of floods, absolute depths, and cultural deposits

Harappan sites. However, despite numerous excavation in both India and Pakistan over the last 100 years, there is no consensus regarding mapping of different cultural phases from these sites on the scale of absolute time. As already discussed, there is a granular slicing of time intervals done by Kenoyer for the site of Harappa.[31] In addition to this, there are overarching chronological sequences described and discussed by Possehl[32] and McIntosh.[33] The most simplified version has bee adopted by Green based on Meadow and Kenoyer's work.[34] Cultural Periodisation by Vats, Marshall, and Mackay[35] at the site of Mohenjo-daro, and by Kenoyer's at the site of Harappa[36] can be treated as two important exercises in the definition of cultural periods of Harappan culture. Separated by almost six decades, they contrast each other in terms of excavation strategies, scale of excavation, approaches, socio-political environments, prevalent theories, technologies at hand, and maturity of overall academic research in Indian, especially Harappan archaeology. During the 1980s, Michael Jansen and his colleagues carried out work at Mohenjo-daro through the IsMEO-Aachen University mission. It has demonstrated the scope for revising the chronological understanding based on the connection of houses with drainage systems.[37] His remark about Mohenjo-daro is important in this regard - "Since the excavations yielded no cross sections, a revised stratigraphy for the architecture can be developed only through structural analysis within an interconnected cluster."[38] At Harappa, on the contrary, there are multiple vertical sections at different mounds[39] and the expanse of horizontal excavation is not comparable to Mohenjo-daro. Wells has reviewed the factors which have given rise to the problems of chronological

31. Kenoyer, "Urban process in the Indus tradition: a preliminary model from Harappa," 40.

32. Possehl, *Indus Age: The Writing System*, 9.

33. McIntosh, *The ancient Indus Valley: new perspectives*, 419.

34. Green, "Stamp Seals in the Political Economy of South Asia's Earliest Cities," 9.

35. Kenoyer, "Urban process in the Indus tradition: a preliminary model from Harappa," 32.

36. Kenoyer, "Origin and Development of the Indus Script: Insights from Harappa and other sites," 219; This is an evolved version based on HARP.

37. Michael Jansen, "Mohenjo-Daro, city of the Indus valley," *Endeavour, New Series* 9, no. 4 (1985): 161–169.

38. Michael Jansen, "Mohenjo-daro: Type site of the earliest urbanization process in South Asia," *Studies in the history of art* 31 (1993): 41.

39. Kenoyer, "Urban process in the Indus tradition: a preliminary model from Harappa."

understanding.[40] Despite these issues, ICIT demonstrates an experimental corroboration between different cultural periods. Thus sites and artefacts can be tentatively associated within them. The table 4.2 is a compilation of this experimental chronology mapping.

Era	Time (HARP)	Begin (BCE)	End (BCE)	~No. of arte-facts	Sample site	Mohenjo-daro Chronology	Dholavira Chronol-ogy
Regionali zation Era	1	-3700	-2800	1	Kanmer	-	-
	1B	-3000	-2900	1	Dholavira	-	1
	1C	-2900	-2800	3	Dholavira/ Harappa	-	2
Transition A	2A	-2800	-2700	4	Kanmer	-	-
	2	-2800	-2600	36	Dholavira/ Harappa	-	2
	2B	-2700	-2600	3	Kanmer	-	-
Integration Era	3A	-2600	-2450	2	Dholavira/ Harappa	-	3
	3B-1	-2450	-2350	49	Dholavira	-	4
	3B-2	-2350	-2250	232	Harapa	Early I	-
	3B/C	-2250	-2150	370	Dholavira/ Harappa	Intermediate III	4 / 5
	3C-1	-2150	-2100	264	Harappa	Intermediate II	-
	3C-2	-2100	-2000	290	Dholavira/ Harappa	Intermediate I	5
	3C-3	-2000	-1950	255	Harappa	Late III	-
	3C-4	-1950	-1900	136	Dholavira/ Harappa	Late II	5 / 6
Transition B	4	-1900	-1800	128	Dholavira/ Harappa	Late I	6

40. Wells, *Epigraphic Approaches to Indus writing*, 11–12.

Localization Era	5A	-1800	-1550	5	Harappa	-	-
	5B	-1550	-1300	3	Harappa	-	-

Table 4.2: Tentative mapping of chronological periods from different sites - based on ICIT

Mackay had hypothesised a tentative time-span of 2750 to 2500 BCE for the upper levels of the mound and 2800 BCE for the lowest period; thus "... three hundred years between the uppermost and the lowest attainable levels of Mohenjo-daro."[41] However, when correlated with Kenoyer's chronology from Harappa, there is an offset. When compared to Possehl's timeline described in the first chapter, it is observed that the Integration era overlaps with what Possehl has defined as Mature Harappan. Intermediate I-III of Mohenjo-daro's DKGS fit in the middle of this mature phase. Such a comparison and mapping across these sites, especially with older excavations is extremely difficult due to inappropriate stratigraphic understandings and lack of radiocarbon dating. The inconsistent spatio-temporal attributes have heavily impacted the choice of case study for geospatial analysis.

In the present MHA dataset, the attributes mentioned above cannot be converted across the sites or even across the mounds within a site due to the mentioned problems. Only the depth values have been converted to centimetres for all the records.

4.2.2 Constitutive attributes

In 1990, as the first version of ICIT was prepared by Wells, the data was compiled from the excavation reports available by then. Wells had created his own database schema. He defined form related attributes such as material, colour, shape, size, boss, perforation, and iconography. Because this is a relational database, it saves information for signs as well as artefacts. Shape has been recorded inconsistently in the original sources so it is populated with the use of basic identifiable shapes. For size measurements, those are either in mm or inches in excavation reports and are thus populated as per the original source. Iconography has been split into multiple attributes of symbol, cult object,

41. Mackay, *Further Excavations in Mohenjo-daro*, I:7.

and animal facing direction. In addition, scattered details such as notes and references from excavation reports, and museums which hold the artefact have been added.[42] The significant value addition in ICIT over the existing MHA scholarship, is the cross references added from multiple sources. This includes (i) artefact identification numbers and images from CISI volumes, (ii) artefact identifiers from the excavation reports, and (iii) Parpola and Mahadevan's signs mapped to Wells' signs wherever possible. Most importantly the database contains mapping of sign sequences from M77 to those of ICIT. These references turn this simple database into a powerful tool for quick visual inspection of images and signs, comparison, and analysis.

- **MHA identifiers**

  Since the present MHA data has been compiled from multiple sources, it is important to retain those references. These include CISI reference, ICIT identification number, and excavation report references (retained from ICIT). Besides these some additional metadata is documented - (i) CISI volume number, (ii) presence or absence of signs, and (iii) presence or absence of iconography.

- **Excavation year**

  It has been repeatedly argued that new excavations are required, especially to solve the decipherment problem. In an ideal case, it is hoped that a bi-lingual or bi-scripture artefact would be recovered from new excavation.[43] However, as discussed in the earlier chapters, despite newer excavations and data being made available through publications such as excavation reports and CISI volumes, scholars have continued to use dated corpus built by Mahadevan in 1977.[44] On another note, despite several excavations over the last 100 years, Mohenjo-daro and Harappa still dominate the overall artefact statistics. The trends of data recovery need to be analysed to know

42. Museum data is important because it easily assists to trace the object and access it. Museums information is almost completely documented in CISI volumes. However, not much is populated in ICIT except for some objects which belong to the National museum. Present MHA dataset is limited to what ICIT records.

43. Kenoyer, "Keynote address at International Conference on the Indus Script."

44. Yadav et al., "A statistical approach for pattern search in Indus writing"; Yadav, Salgaonkar, and Vahia, "Clustering Indus Texts using K-means"

if there exists a probability of acquiring more diverse data which may lead to newer interpretations. On the other hand, repetitive data may strengthen the existing hypothesis. Based on the excavation identifiers, reports, and information in CISI, excavation years for a majority of the data have been populated.

In many cases, it was also observed that there is a huge gap between the excavation and actual publication of the report. For example, excavations at Kalibangan continued from 1960 to 1969 and the report was published in 2003. In case of Dholavira, excavations happened from 1990s to 2005. The draft of the excavation report was made available by ASI for a few days in 2015. The final report is yet to be published. Rakhigarhi excavation is another example of delay where the combined report of three seasons from 1997 to 2000 was published in 2014 but it is called out as 'draft' and 'incomplete' in the introductory letter by the lead excavator. The final and complete report is awaited. There have been more excavations at this site by Deccan College (Pune, India) during 2012 to 2016 and again by ASI after 2020. However comprehensive reports are yet to be published. It thus creates a practical problem that even if data has been excavated, it is not available to the larger academic community. Such delays are surprising when many of these excavations were and are essentially motivated by the post-independence nationalist thought process of discovering the roots of Harappan civilisations in the Indian geographies.

- **Technique**

  This is a newly introduced attribute. Though signs and iconography are important and commonly seen characteristics, how they appear on different objects varies significantly. Whether this impacts the usage pattern, affordances, and their purpose in the contemporary culture requires in-depth investigation. Following list documents 'technique' as a 'production process' that creates signs and iconography on these artefacts. Positive and negative indicate the norm of how the sign sequences have been documented and interpreted across different concordances for decipherment studies.

  – IC: Intaglio Carved (stamp - negative) - This is generally observed on square or rectangular steatite objects, often identified as seal. The carving is bolder, deeper, and prominent than incisions. It is thus important to differentiate between these and incised artefacts. These are assumed to be used to create an impression.

- IN: Incision - (positive) - This is seen on ceramic, copper, some other materials, and very rarely on stone. Such artefacts have been identified as miniature tablets and copper tablets by Mahadevan. For ceramics, this can be both pre- or post-firing.
- IP: Impression (positive) - This is seen on sealings, pottery, or tags. In pre-firing or pre-baking stage, a harder object like seals (MHA with IC) is used to impress against it.
- BR: Bas Relief (positive) - This is mostly seen on terracotta and faience objects. This can be considered similar to IP but a major difference is that these artefacts appear to be created by moulds or impressions which are different than IC or IN MHA. These are identified as tablets by Wells, as mouldings by Possehl, and documented as sealings by Mahadevan.
- PT - Painting - (positive) - This is seen on ceramics and is in a relatively small quantity.

- **Colour, material, and shape**

For present work, colour could not be populated for missing data records since the CISI volumes are printed in black and white, with only a few colour plates at the end of each volume. Material has been recorded as steatite in case of most of the 'seal' category objects. However, this information is not consistently updated in CISI. Some of these objects are also of agate, limestone, faience, ivory, and other material. Bas-relief tablets and sealings are mostly in terracotta as well as faience. Thus besides what is documented in CISI and ICIT, no new additions or major changes are done.

There are about 25 shape categories used in ICIT. These mostly correspond to the shapes described in the CISI volumes. Some complex and relatively smaller number of shape categories are absent in ICIT such as wedge, lanceolate, twisted, and shield. These have been updated by referring to artefacts in the CISI volumes. An attribute that describes a cross-section of shape is not populated for around 80% of the artefacts in ICIT. In case of rectangular seals with plano-convex cross-section, considering their quantity, those are recorded as RTCX in the shape attribute itself. There are miscellaneous ceramic objects in mostly broken state with signs incised, impressed, or painted

on them. If these could be identified as part of pot, plate or without any specific shape, these have been attributed as C-POT or C-Plate, and C-MISC in the MHA dataset.

Due to time and administrative constraints to access actual physical artefacts, many of these could not be populated solely based on the photographs. Besides a few exceptions mentioned above, no updates have been made to ICIT for these attributes. The recorded information was cross verified by Wells and Fuls at multiple occasions since 1990s and the missing informations is mostly a result of unavailability or inaccessibility of the data. Despite this, multiple systematic checks have been performed on present MHA dataset to validate the information against the excavation reports and CISI volumes.

- **Boss and perforation**

Boss or knob is a peculiar feature, mainly that of the seals or IC category objects. It creates a specific handling affordance for the object. For the rectangular intaglio artefacts, this purpose is served by the perforation through convex shape on the opposite side of the signs. The perforation across the boss or sometimes across the object itself creates a possibility of tying these in a thread to attach to something or to carry along. This information was populated in ICIT at a later stage by Dr Fuls. The information is in a single attribute called 'boss', coded in a four letter combinations, for example: N/P-B/N-SG/CG/RF. N/P depicts the existence of perforation. B/N stands for boss or its absence. The last two or three letters are inconsistent with respect to the information which they code. SG is a single groove seen on the boss, RF is a 'right facing' animal depicted on the obverse side of the artefact. Grooves, e.g. central groove (CG) has also been coded for different varieties but are few in number. This, being an important character of the artefact form, needs to be coded precisely and populated for as many artefacts as possible. The precision can be achieved only if there is no mixing of properties and it is least abstracted. This attribute from ICIT is thus split into three attributes viz. boss, perforation, and boss-other-side. Boss and perforation have been made as boolean type and thus have values only Y or N. Boss-other-side is a more flexible attribute since it captures anything specific which exists on the reverse side. These are grooves, signs, icons, both signs and icons, scenes with multiple icons and so on. What is interesting is that, only one of these can exist on the reverse and hence

can be coded distinctly. There are rare examples where sign appears on a boss with a groove (M-1203). On the contrary, though the obverse and reverse are evident in case of intaglio objects, many bas-relief or incised artefact have icons or signs on multiple sides. Handling of these cases is described below in the iconography section.

As I describe the form related attributes, it must be reiterated that (i) the intaglio characters, (ii) existence of boss or convex shape for handling, and (iii) discovery of impressions of these kind of objects on softer material have created an ontological premise of these objects being used as seals for creating a positive impression i.e. sealing in soft material like clay or wax. The exceptional artefact from Kalibangan (K-39) was mentioned in chapter 3. This is a terracotta artefact which has signs and icons in relief and with a perforated boss. Both M77[45] and ICIT (ICIT ID 1907) treat this as seal and thus record the sign sequence in reverse.

- **Artefact and sign sequence preservation**

With respect to condition of the artefact and signs, ICIT has created three attributes: 'completeness of sign sequence', 'text condition', and 'preservation status'. It is observed that if the sign sequence is incomplete, it is depicted in the sign sequence by encoding the missing or unidentifiable signs as 000. In present MHA data, I thus use only the 'completeness' attribute with boolean values, N corresponds to presence of at least one 000 in sign sequence (which represents 'text condition' as well).

In general, properties such as shape, iconography, and even signs cannot be documented if the object is broken or in poor condition. From a quantitative analysis point of view, a higher proportion of such objects will significantly impact the confidence in the overall inference. It is thus important that this status of preservation is documented. It is thus coded without much granularity - I: Intact, C: Chipped (at least 2 or more corners visible or >50% object preserved), and F: Fragment (1 or no corners or <33% object preserved).

- **Iconography**

Iconography can be broadly defined as any graphical, symbolic, or iconic representations seen on the artefact besides those recognised as a sign or script in Wells' sign

45. Mahadevan, *The Indus script: texts, concordance, and tables*, 25.

concordance. Prominent examples are a single horned animal motif named as unicorn/bull/*bos*, other faunal and floral representations such as rhino, elephant, tiger, hare, pipal leaf, and phytoliths. It also extends to anthropomorphic figures, geometric designs such as swastika motif, triangles, grid, discrete depictions such as loops, hourglass motif, and scenes which contain floral-faunal-anthropomorphic combinations. On majority of the seals, there exists a second graphic of a stand-like object in front of the unicorn motif. All these icons are often accompanied by signs on the same or the other side of the iconography, or on both sides in relatively few cases. There are a number of objects which do not have signs but only icons and vice versa.

Recording this variety in a systematic schema is challenging. Wells has two attributes, one dedicated to the main icon, which he calls as 'symbol' (~70 possible values) and the stand-like motif as 'cult object' (~50 possible values). For the main icon, he has classified single horned unicorn motifs based on their body decorations. Other animals are identified based on actual similarity with the natural species e.g. bulls with hump (*bos indicus*), gaur (*bos gaurus*), Indian Buffalo (*Bubalus sp*) and goats (*Capra*). Some other classes are masked animals, compound or complex animals, and imaginary animals such as tigers with horns. The stand-like object is described based on the combination of decoration on the upper and lower part and other details. Besides stand, there are other graphics which appear in its place such as trough, sun, or fork and those are also recorded by Wells. The different classes in the main icon are documented as Bull:i:V, Bull:i:W, Bill:ii, Goat:2, Goat:3 or follow a well-defined sequence for cult objects such as RBN, SAF (R-round/S-square shape of upper part, A/B as shape of bottom part, F-frill/N-No Frill).

Having said that, here is an example that shows how challenging an attribution process can be. It essentially demonstrates our academic conditioning. For example, if tiger and elephant are to be recorded, there are multiple ways in which similarities and differences can be captured - real/real, carnivore/herbivore, forest/grassland, wild/tame, 4-legged/4-legged, mammal/mammal, no trunk/trunk, small/big, striped/plain. With addition of mythical animals like unicorns, horned tigers, floral motifs, complex animals with trunks, anthropomorphs, and geometric figures, the attribution strategy is further complicated. Out of these, which characteristics are to be captured and which are to be ignored is a subjective decision. This choice directly impacts (i) the corre-

lations we can observe in the data, (ii) the model which we can build for predictions or classifications, and (iii) the interpretations which we make. This problem was discussed in the previous chapter. It is evident that there is no single right or wrong answer to this problem. However, the methodological approach for the least level of abstraction can assist to form a strategy. It must be noted that the use of a single attribute restricts the properties which we can encode. On the other hand, too many attributes will add too much granularity, at times redundant, and hence may reduce the statistical significance of some of the values. For unicorn or a single horned bovine like animal, it being the most frequent (almost 50% of the icons) and with variety in decoration, it would be unjust to ignore those details.

In present case, hierarchical attributes have been created as follows:

- SYM0 - This documents the primary identification of the motif and is borrowed from ICIT. In cases where some iconographic differences cannot be discerned, those are merged into a single category. For example, Bull:i:S is merged with either of the remaining categories. Some of ICIT's original attributes have been changed for ease of reading or to bring standardisation in the naming. For example - Bull:2i:a, Bull:2i:b, Bull:2i:M have been replaced by TWO_U, TWO_P, and TWO_M respectively. For complex motifs having combinations of different plants, animal, or anthropomorphs, FL (flora), FU (fauna) or AN (anthropomorph) have been used.
- SYM1 - This records an overarching category of the iconographic motif. For example, (i) all unicorns with different varieties are identified as U, (ii) *bos* family motifs such as gaur, buffalo, and humped bull are recorded as UX, (iii) scenes with multiple components are recorded based on whether those are attached to each other or are separate, and (iv) all geometric motifs have been grouped as GEOM.
- SYM2 - This records any additional information about the iconography.

Wells' attribution for cult object[46] could be mapped to that of Rissman's scheme of attributes.[47] However, his method to classify unicorn images based on body decora-

46. Wells, *Epigraphic Approaches to Indus writing*, 6–10.

47. Rissman, "The organization of seal production in the Harappan Civilization."

tion is entirely different from Rissman's strategy to use neck decoration. Ute Franke has questioned the stagnant and homogeneous character of these artefacts and thus investigates the stylistic details.[48] She identifies ~20 decorative patterns for unicorn neck, ~30 for body and ~100 for stand-like object. She identifies some combinations of these which have more affinity in lower levels and other in upper levels. However, granular classes compared to the sample size have reduced the statistical significance. In addition, her objective was to study the glyptic styles, thus the signs are not part of her analysis.

In the present research, the methodology employs 'basic' i.e. least complex attributes with minimal abstraction. However, 'basic' is also defined based on individual's perception and context, and is thus a subjective choice. Wells' attributes of granular details for unicorn and other primary icons are populated in the first phase. Those are modified where the details were not discernible in the available photographs. In addition to decorative patterns, another recorded property is the direction in which the animal is facing. Some example attributes are - L: left facing; R: right facing, LR: animal is facing left but head is turned right, RL: animal is facing right but head is turned left, L-R: multiple animals facing different directions, R2: animal with two heads facing right.

Rissman's attributes for unicorn decorative patterns are newly documented for MHA which have the specific iconography.[49] Some of Franke's granular classes are covered in either Wells' or Rissman's scheme. Addition of all of Franke's classes to the database was not practical since all the photographs do not necessarily help differentiate the minute decorative detail. (Refer to figure A2.1)

- **Size**

In ICIT, size is documented in either mm or inches based on the excavation reports. Size includes three measurements viz. - horizontal, vertical, and thickness and is generally available in a more standardised manner for square and rectangular IC artefacts. For broken, miscellaneous, and discrete objects, these measurements become redun-

48. Franke, "Inscribed objects from Mohenjo-Daro: Some Remarks on Stylistic Variability and Distribution Patterns."

49. Rissman, "The organization of seal production in the Harappan Civilization."

dant because comparative study cannot be performed, for example, (i) bangle and implement or (ii) MHA in various shapes with IN or BR.

Based on the actual measurements in mm, CISI volumes describe six size categories for square unicorn IC artefacts and three for RT/ RTCX artefacts. The CISI size group is mentioned in Roman numbers.

- For square seals (all in mm) - I: 43.5 and more, II: 35 - 43, III: 29 - 34.5, IV: 23 - 28.5, V: 17.5 - 22.5, VI: 17 or less
- For rectangular seals as per CISI-II (all in mm) - I: L >= 4.5 mm, II: H > 12.5 mm, III: H <= 12.5 mm;

Though such categorisation is useful, the editors do not elaborate on the reasoning behind the bin sizes and also consider only unicorn seals for size consideration. In the case of rectangular seals, categorisation based on two different measurements is problematic. There is also an inconsistency in first and second volume.[50] CISI-I creates three groups - 18.5 mm, 13-18 and 12 or less. As per CISI-II, the groups are - longer than 4.5 cm, bigger than 12.5 mm and smaller than 12.5 mm. Footnote in CISI-II mentions an oversight in CISI-I regarding the first group.[51]

However in order to understand whether these categories adhere to the natural breaks in the data or whether these correlate with any other attributes of the seals, those must be recorded for the majority of artefacts. All the units were converted into mm and CISI group was populated by correlating those measurements to CISI groups. For seals where actual measurements were not available but the size group could be identified in the CISI volumes, average for each size group was calculated based on square steatite artefacts with all motifs and not just unicorn. In order to add some redundancy, the averages were calculated separately for three subgroups within each size group viz. Mohenjo-daro, Harappa and rest of the sites. The difference in these three subgroups is observed in decimal values (less than 1 mm) only. For example, for size IV, the average horizontal measurements are 26.05, 25.61, and 25.64 for Mohenjo-daro, Harappa

50. Shah and Parpola, *Corpus of Indus seals and inscriptions - Collections in Pakistan*, vol. 2, XXXI - note 105.

51. Shah and Parpola, 2:XXXI.

and rest of the sites respectively.[52] Ideally, both horizontal and vertical measurements should be same for a square shape but there are minor differences in these measurements in the primary sources and those have been retained. Hence the averages have been calculated separately for these two attributes in above mentioned groups. There are cases where both CISI group information and artefact measurements are available but both do not correlate with each other. Those have been kept as is and are possible errors. Finally, though thickness is a size related attribute, it hasn't been consistently documented in all excavation reports. Hence, it is used as is from ICIT. Assuming that the thickness would be directly proportional to the size, the average of thickness values for each size group are calculated separately.[53]

- **Carving attributes**

As already discussed in the literature review, scholars such as Uesugi,[54] Konasukawa,[55] Green,[56] Law,[57] and Jamison[58] have studied stylistic and production details of unicorn motifs such as material used, carving strokes, sequence of carving, style of body

52. It is possible not to create such site based subgroups and calculate only single average for each size or even use some other aspect for adding variation within missing values. Choice of sites is a result of presumed spatial association of artefacts with their archaeological context. This may need revision in the light of Jamison's theory of decentralised production or Green's hypothesis of carving sequence.

53. For thickness measurement, the data is sparse as compared to other two measurements. The estimation is not done for rectangular seals. In some cases, As per personal communication with Dr Fuls, if a single value is present it probably includes boss. In some cases, he had tried to use the CISI photograph scale to tentatively calculate the min-max thickness, i.e. without and with boss, based on the cross-section of the photograph. In present average calculations, some cases such as M-87 were treated as outliers and were not included in the average calculations. There is a scope to investigate every case and create better estimates for missing values.

54. Uesugi et al., "A Study on the Stylistic and Technological Aspects of Indus Seals with a Focus on an Example from Bhirrana."

55. Konasukawa, "Indus Scripts Incised on the Seals Discovered from the Initial Phase of Harappan Period."

56. Green, "Stamp Seals in the Political Economy of South Asia's Earliest Cities."

57. Law, "Regional interaction in the prehistoric Indus Valley: initial results of rock and mineral sourcing studies at Harappa."

58. Jamison, "The organization of Indus unicorn seal production: A diachronic comparative study of style, skill, and sociopolitical organization."

features such as horns, eyes, ears, and also microscopic measurements of these features. They have hypothesised affinity of certain artefacts to a cultural period, artisans' groups, or geographical regions. For their respective studies, they have used different subsets of MHA. Some of these attribution schemes have been borrowed from their studies and have been applied to the MHA dataset. However, unlike unicorn motif details documented by Franke or Rissman, these other high precision attributes (e.g. measurements done under SEM or properties identified based on chemical analysis) could not be observed by using the photographs of MHA. Hence these are populated only for MHA which are part of there dataset.

4.2.3 Type

Type is a contentious attribute and it has been described in detail in the previous chapter. The ability to define meaningful individual types and the typological scheme is crucial in all the domains of natural and social sciences, and archaeology is not an exception to it. Despite creation of archaeological theories and frameworks for interpretation, typology definition has been a combination of methodological and heuristic approaches. Identification of attributes and their values involve abstraction and those are constrained by our own senses and conditioning at the primary level. Thus, our perspectives are already loaded with values which we perceive. Since there can be multiple ways to attribute, classify, and group the archaeological data, there lies the power and the weakness simultaneously. Power exists due to different aspects of artefacts and weakness lies due to our inability to choose and define overarching structures for the data and produce coherent knowledge.

Wells has acknowledged the problems in the typology definition and notes that most of the terminologies are borrowed from Mesopotamia and Egypt, e.g. sealing or tablet.[59] These are meaning loaded terms in those cultural contexts and thus narrate specific function or use. In Harappan context, when MHA are identified with similar borrowed terminologies, there is a teleological roadblock. Possehl has warned against the interpretation which such terminologies lead to.[60] He hints at potential for improvements in the typology. Identification of a culturally significant 'type' is thus a convoluted quest.

59. Wells, *Epigraphic Approaches to Indus writing*, 16.

60. Possehl, *Indus Age: The Writing System*, 26.

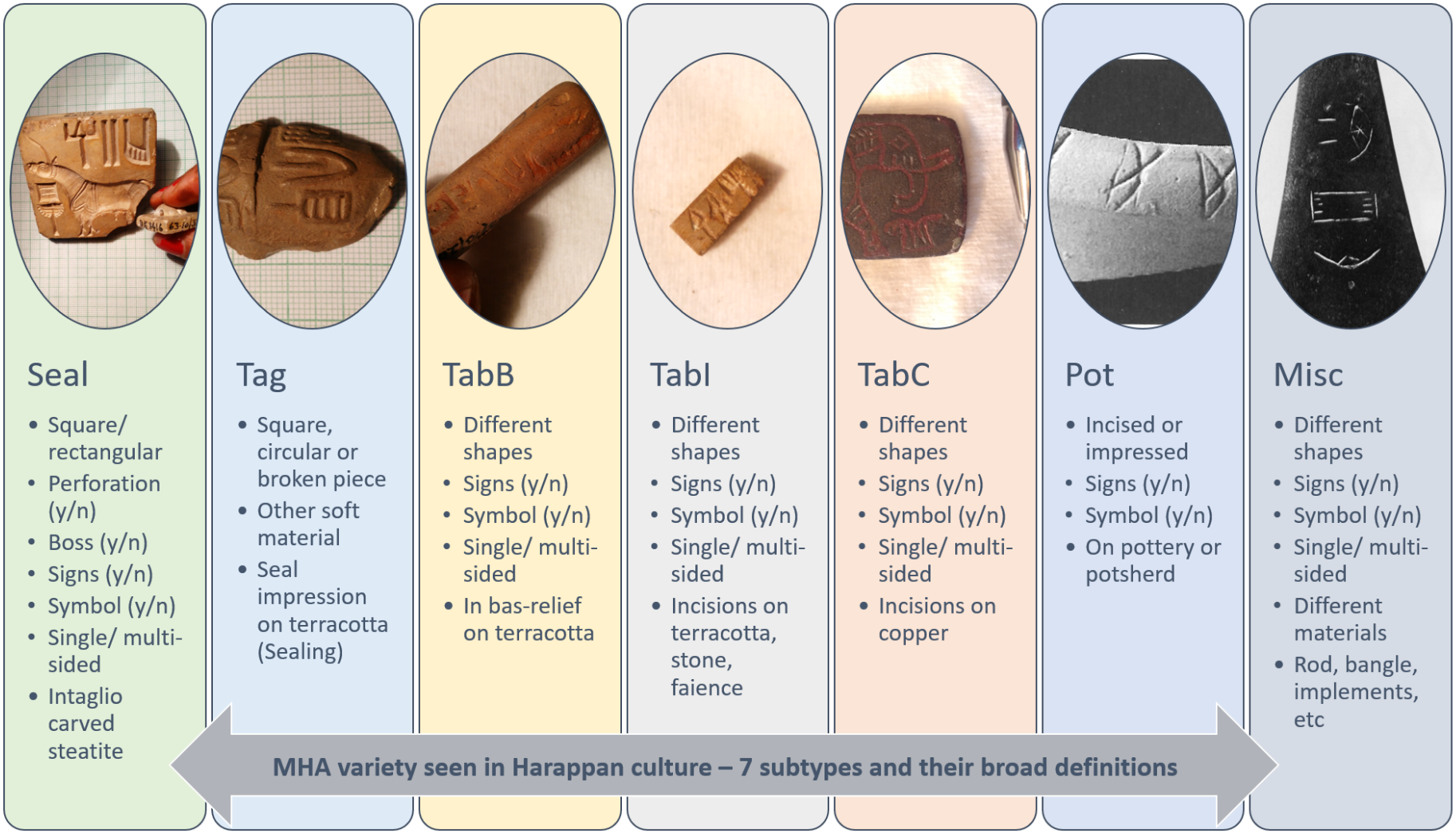


Figure 4.1: Subtype definition - Broad categories of MHA

It is observed that there is no strict methodology applied in the decision making process. It's mostly intuitive or based on the most prominent characteristics of the artefacts. Based on a few selected consensual attributes, I have merged multiple 'artefact types' defined by Wells into fewer substitute types - 'subtypes'.[61] Their granularities are retained in other attributes, for example shape, technique, or material. Thus the strategy used is (i) to use the existing understanding and incorporate statistically significant form or material discontinuities, (ii) to avoid granularity of type definition and move it into attributes, and (iii) to avoid too broad definitions which mask the significant discontinuities. Figure 4.1 illustrates the subtypes with representative images.

To reiterate, this scheme serves the data documentation and analysis purpose in the present project by overcoming some of the earlier observed lacunae. I do not propose that this typology explains the meaning of artefacts in the archaeological past.

4.2.4 Absence of attribute values

Since the dataset is compiled based on multiple sources, the absence or non-existence of attributes needs to be documented explicitly. This helps to handle these 'no-data' cases in data analysis. There are three possible values to depict this.

- N - This means the attribute is relevant or applicable to the object but the applicable values are are observed. This has been mostly used in boolean attributes.
- NA - This means that the value for that attribute is not available either because the object is in poor state or we do not have access to photographic or other descriptive record of the object.
- None - This depicts the irrelevance or inapplicability of the attribute itself for that artefact. This situation has arisen due to the decision to organise all the artefacts in a single table.

Finally, as I acknowledge the basic diversity of artefact forms and yet aggregate all the diverse forms under single terminology of MHA, it is emphasised that this is done to

61. Wells, *Epigraphic Approaches to Indus writing*, 6–10.

avoid any type or form specific characterisation of these artefacts and to have a meaning-neutral term as far as possible. MHA articulates the presence of specific signs or icons in any form on any artefacts associated to Harappan material culture.

All the attribute schemes discussed here and in later sections are the cautious and subjective choices of individual scholars. Association of these attributes with trade, religion, or identity has emerged from the need to interpret these material remains for their significance in the contemporary socio-cultural systems. The purpose of incorporation of multiple attribution schemes is to bring out the multi-vocal nature of these artefacts. Triangulation of these attributes may bring more robust strategies for interpretation.

4.3 Sign encoding

Earlier chapters and the 'Data creation' section above described the availability of multiple sign encoding schemes or sign concordances. Based on comparisons with respect to (i) least conflation of sign variants, (ii) data-centric justification for conflation, and (iii) most updated set of MHA that documents all possible signs and sequences, Wells' sign-list is chosen for sign encoding scheme.[62] It is the most extended sign-list amongst all. As of February 2023, the total number of signs is 709.[63] This means ICIT has at least 284 or 68% more signs than the previously recognised largest and widely used sign-list of M77. There are various reasons for this large difference in the numbers.

For ICIT sign-list, Wells has provided steps and the relevant examples of all possible cases where signs can be conflated and his decisions on a case-to-case basis.[64] Wells is cognizant of the fact that one cannot bring confirmatory closure to the ambiguousness in the dataset.[65] His decisions to identify similar signs as variants or separate signs are based on detailed analysis of graphical similarity, presence of similar signs in same sign sequence, direction of writing, TAB effect, and similar signs in shared or mutually exclusive context. Also, he does not merge those based on temporal variation because he recognises the persistent problems in stratigraphic understanding of the Harappan

62. Wells and Fuls, "Online Indus Writing Database."

63. Sign numbers from other concordances for quick comparison: M77 - 417, Parpola - 396, Fairservis - 419, Rao - 20-62

64. Wells, *Epigraphic Approaches to Indus writing*.

65. Wells, 47–77.

sites. Contemporaneity of Harappan cultural phases is still a vastly debated topic and hence to consider that as an ontological premise for further interpretation would be inappropriate.[66] As mentioned in the earlier section, the online ICIT database has a menu where a direct comparison between M77 and Wells' signs can be performed. In many cases, where the signs are not clearly visible or are ambiguous, Wells keeps those as unrecognised. Wells narrates this decision as "It's better to have less or no information than probable wrong information."[67] Wells' sign-list is thus exhaustive compared to Mahadevan and Parpola. There are chances that there is a redundancy in this extended list. Wells' purpose behind expansion of the sign-list is to acknowledge the granularity seen in the graphic details, codify those, and thus not bring closure by accepting the uncertainty. It can be seen in his detailed analysis for sign pairs s920 - s921 i.e. 𒋛 - 𒋜 and s527 - s526 i.e. 𒉻 - 𒉼.[68] Another significant reason to prefer ICIT sign-list over others is continuous update of the signs and artefact dataset by extracting the data from the ongoing publications. The lack of updates to M77 has been described in earlier chapters.

The preference for ICIT over M77 in the present research does not claim that ICIT is more accurate or better suited for decipherment. It fits in the theme of this thesis which emphasises on the retention of ambiguities in the dataset and has resisted employing "mechanisms of closure".[69]

For each signed artefact, sign sequences are recorded by Wells. If multiple sides bear the signs then multiple records have been created and linked to the same artefact. It also records total number of signs, missing signs, direction of reading, number of inscribed sides, sign height, and alignment. These can be seen defined based on empirical observations of artefacts. Wells has defined an abstract attribute called 'sign-class' based on structural analysis of the sign sequences. This can be treated as their typology based on characteristics in their content and organisation.[70] These are identified as segments, patterned, complex, unclassified, and numerals, all in long or short lengths. From a documentation point of view, sign encoding is the first level of abstraction and this can be

66. Wells, *Epigraphic Approaches to Indus writing*, 70–76.

67. Personal communication, June 2021.

68. Wells, *Epigraphic Approaches to Indus writing*, 49–54.

69. Gero, "Honoring ambiguity/problematizing certitude," 320.

70. Wells, *Epigraphic Approaches to Indus writing*, 93.

thought of as the second level of abstraction. Similar abstractions performed by Bonta and Mukhopadhyay have been discussed in the preceding chapter.

As MHA dataset is prepared, each artefact was observed in ICIT, and if required, corrections were made to number of sides, number of signs, number of lines, and actual sign codes. No changes have been made to attributes such as sign-class, sign height, sign alignment, direction of reading because these are considered as interpretative value additions by Wells. A quality check was performed to ensure accuracy of the sign sequences and actual depiction on the artefact photographs. Wells has adopted a methodology to encode 999 for a gap in sequences or different lines of sequences on the same side of the artefact. CISI identifiers have been extensively used to complete the missing information related to intrinsic attributes. The current MHA table thus records each side of the artefact as a separate record. Multiline sign sequences have been merged into a single record with 999 as a line separator character. Total number of sides, side identifier, total number of lines on each side, and total number of signs on each side have been recorded.

To record the order of sign sequences, ICIT database follows a policy to record sequences on hypothetical seal-impressions in cases on 'seal' type of objects. It is thus a reverse sequence of what is seen on the actual object. For the rest of the objects, it is recorded as seen. This is based on the present day consensus over usage of seals to create impressions. Thus the seals are presumed to bear a 'negative' and the impression would be a 'positive' rendering. All non-seal objects are assumed to be created in a positive form only. This method is followed by all the sign concordances including M77. Various issues have been discussed in this thesis regarding the presumptions about the conceptualisation of this generalised usage, practice of publishing impressions (which creates a bias in researcher's mind), unused nature of IC artefacts, and statistically problematic data to uphold the seal-sealing relationship. The disparate views of scholars related to sign sequences on seals with right facing animal motifs have also been discussed. I thus propose to document the sign sequences without the assumption about the seal-sealing relationship. Thus, in addition to present practice of recording the order of signs, the MHA dataset also records the sign sequence as seen on all the MHA; the attribute termed as 'ASIS'.

As an extension of the logic of impressions, all the BR artefacts are assumed to be created using some moulds which belonged to an entirely different set of objects than

seals. None of the seals depict the form, scenes, or other details observed on the BR artefacts and thus these were probably created using moulds from perishable materials like wood.[71] To account for this hypothetical case, in addition to recording 'ASIS' order of signs, reverse order of all sign sequences for non-seal artefacts is also recorded; it is termed as 'REV'. It thus inherently records the sign sequence of hypothetical moulds which could have been used for producing the bas-relief MHA. Technically speaking, this logic is equivalent yet juxtaposed to creation of sign sequences of hypothetical sealings or impressions from existing seals. Thus ASIS records the sign sequence as seen on the original artefact, REV records the reverse order.

I thus have three attribute columns which record the sign sequences in three different ways -

- **ICIT** - With traditional assumption of seals being used for impression thus for IC artefacts, its recorded in reverse than what is observed. On all other artefacts it is recorded as seen.
- **ASIS** - Without the presumption about usage of seals for impression, the sign sequences are not reversed and are interpreted as seen on IC artefacts. This attribute records the order of sequence as seen on the original MHA.
- **REV** - To create hypothetical sign-sequences of moulds of BR artefacts, the ASIS sequences have been reversed and recorded.

An example of these sign sequences can be seen on a seal and tabB in figure 4.2. It must be noted that in both cases where seal is to be used for impression and tabB is to be formed from a mould, the vertically asymmetric signs create vertical mirror images on the tag or on tabB. This also highlights the significance of documentation of mirror signs described in the previous chapter.

Despite the lack of quantitative and qualitative parallels with Mesopotamia, the present-day method has forced an interpretative framework on sign analysis by reversal of sign sequences on seals. Like the use of extended sign-list, this strategy to encode the sign sequences in different orders breaks away from the frameworks and adheres to retain the ambiguity in the data.

71. Ameri, "Letting the Pictures Speak: An Image-Based Approach to the Mythological and Narrative Imagery of the Harappan World," 146.

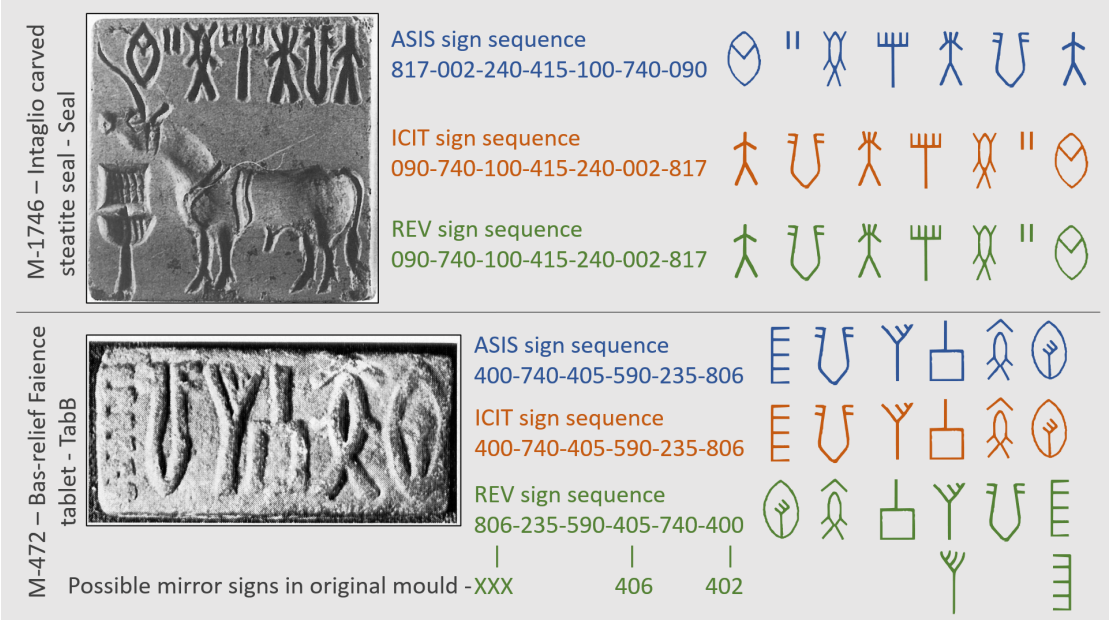


Figure 4.2: Examples of ASIS, ICIT and REV sign sequences on seal and tabB

Entire ICIT sign-list with sign identifiers and graphics can be seen in table A3.1. Besides these properties, borrowed or modified from ICIT, few more have been documented. These are described as follows.

- **Frequent sign properties** - For frequently occurring and some other signs which showcase graphically interesting characteristics, their presence, absence, or repetition has been recorded. This is based on the sign functions defined in ICIT. Some examples of these signs can be seen here -
  - Human representation - Many signs within the codes s090 to s161 such as -
  - Sign doubling -
  - Signs in enclosure -
  - Fish sign and variants -
  - Signs identified as numerals -
  - Jar sign -
  - Signs with mirror pairs -
- **N-grams** - For the analysis of signs and other attributes, each sequence has been split into N-grams of length 2 and 3. This has been done for ICIT, ASIS and REV. Table

4.3 shows examples for seal M-1746 (seen in figure 4.2).

ICIT Pairs	ICIT Triplets	ASIS Pairs	ASIS Triplets
			

Table 4.3: N-gram Pairs and Triples example

4.4 Boolean properties

It is now evident that because of lack of understanding about the systemic use and life-cycle of MHA, a meaningful typological classification is yet to be devised. There are some obvious discontinuities in the dataset which none of the scholars have been able to ignore. Those can be defined as boolean attributes and the values can be documented as binary Y/N for MHA. I identify these discontinuities in terms of following characteristics:

- Existence of signs
- Existence of icons - unicorn, other, multiple, or none
- Whether the MHA is incised or impressed
- Whether the MHA object is square and of a specific size
- Whether the MHA is of stone, metal, or clay
- Whether the MHA has signs and icons on single side or multiple sides
- Whether the MHA has boss and/or perforation

Combination of these boolean properties help us define most of the variety of these artefacts. The table of relationships of these boolean properties can be seen in appendix 1 (Figure A1.1).

The reviewed scholarship shows that these highly likely contribute to systemic semantics of the artefacts and also form an inherent context for the artefact in the abstract

attribute space. I thus propose to use these discontinuities to create multiple partitions in the dataset (Table 4.4); these later lead to more finer attribute definitions used by scholars.

signs	boss	perf	incised	ms icon	ms signs	-
Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	-
sym	unicorn	rt	other	clay	stone	size
Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N

Table 4.4: Properties used to define boolean attributes

- Signs - Presence or absence of signs or script. Even if the signs are unidentifiable and hence recorded as 000, their presence is acknowledged in this attribute.
- Boss, perforation - Combination of these two leads to the variety of seals in MHA dataset.
- Incised - Absence corresponds to tabB, tags, or impressions on ceramic/soft material. The presence combines tabI, tabC, seals, incised ceramics, miscellaneous artefacts which have signs or icons incised into those. Though seals are assumed to be intaglio carved to create impressions and all other incised objects are interpreted as for direct use, this attribute does not distinguish this presumed purpose.
- Multi-side icon, Multi-side signs - Combination of these two leads to single sided or multi-sided MHA.
- Icon, Unicorn - Combination of these two leads to MHA with or without unicorn, with other icons, or total absence of icons. There is a huge variety in terms of decorative details on unicorn, stand, other floral and faunal motifs, scenes, anthropomorphs, complex animals, and geometric pattens. However, out of 5442 unique MHA, the unicorn is seen on 1565. Though this is purely dominated by seals (1429), even within seals, it is present on ~50% objects (1429 out of 2733). It is thus treated it as a discontinuity parameter.
- Rt, other - Combination of these two leads to MHA in square shape, rectangle, any other, or undefined such as that of a potsherd. There are many more shapes but basic statistics shows that these are specific to tabB only.

- Clay, stone - Combination of these two leads to MHA made up of steatite, copper, ceramic, or faience. Materials besides these could not be accommodated in this optimisation scheme.

- Size - Presence indicates MHA with surface area larger than 400 sq mm and absence indicates equal or smaller than 400 sq mm. Physical observation of these artefacts at ASI's Central Antiquity Centre facility allowed close handling. It was realised that many small artefact are so difficult to handle that those create basic affordance constraint. 400 sq mm is an intuitively defined value based on these observations, recorded sizes of seals, and size variation in other non-seal artefacts.

4.5 MHA attribute data overview

As discussed in earlier sections, the basic dataset of the current study has been referenced with ICIT records. The last update to the data used in current thesis was done by February 2023. All the attributes used in the present study are listed in appendix 2.

For the scope of this project, a single table of all the records has been created. Each record documents a side of an artefact. It thus creates multiple records for an artefact which has signs on multiple sides. The artefact ID in a separate column retains the association of sides to the actual artefact. This is similar to Mahadevan's concept of recording "... line of text as the unit ... ."[72] However, when M77 is subjected to linguistic analysis, each unit is an independent entity irrespective of the side or the artefact it appears on. In the present case, though there is no objective to perform linguistic analysis, the aim is to retain the context. However, multiple lines from different sides of the artefact have not be combined together because different sides also depict varied iconographies detail. Thus by separately documenting sign sequences on multiple sides along with other details appearing on respective sides, the inherent context of the sign sequences is preserved to an extent. A summary of this data can be seen in the table 4.5.

The names of 13 top sites are as follows : Mohenjo-daro(MJD), Harappa (HRP), Dholavira (DLV), Lothal, Kalibangan, Chanhu-daro, Nausharo, Banavali, Lakhanjo-daro, Allahdino, Kunal, Kanmer, and Kot diji.

72. Mahadevan, *The Indus script: texts, concordance, and tables*, 3.

Basic distribution of total artefacts (with signs) across these sites can be seen in following table 4.6.

Table 4.7 shows a summary of total records based on artefacts with different number of sides and corresponding records.[73]

Besides these, a significant portion is also of MHA without signs. Table 4.8 shows their distribution for top 13 sites.

It is important to acknowledge that even the subtypes defined here follow collective boundaries of technique and material, it is a reflection of evident separation of properties described in boolean format. This split based on boolean properties can be seen in table 4.9.

In addition to ICIT, attributes and relevant data was also extracted from research work from different scholars. As described earlier, the aim is to enrich the artefact dataset with different contexts which essentially help create nuanced and multifaceted interpretations. A summary of their dataset and attributes can be seen in table 4.10. The detail descriptions of these studies are available in their individual studies.

Figure 4.3 is a combined visualisation of boolean properties and subtypes of MHA records.

Total artefacts	5442
Artefacts with signs	4562
Artefacts without signs	880
Total size of dataset (each side as a separate record)	6403
No. of records (sides) with signs	5523
No. of records (sides) without signs	880
Total sites	82
Top sites (with more than 10 records)	13
Other sites	69

Table 4.5: MHA dataset - overview

73. A small error was identified at a later point but it is retained as is for the time being.

	Subtypes								-
Sites	seal	tabB	tabI	pot	tabC	tag	misc	u	Total
Harappa	635	643	579	369	0	16	52	1	2295
Mohenjo-daro	1504	118	5	66	254	25	84	4	2060
Dholavira	150	2	18	1	0	67	3	0	241
Lothal	120	1	0	16	0	94	2	20	253
Kalibangan	73	4	1	85	1	19	7	1	191
Chanhu-daro	67	3	0	5	0	2	5	1	83
Nausharo	18	0	0	21	0	2	0	0	41
Banavali	22	1	0	7	0	1	1	0	32
Lakhanjo-daro	8	2	0	3	0	5	0	0	18
Allahdino	7	0	0	2	0	1	2	0	12
Kunal	11	0	0	0	0	1	0	0	12
Kanmer	3	0	0	2	0	4	0	0	9
Kot diji	1	0	0	9	0	0	0	0	10
Others	114	5	1	46	0	14	4	1	185
Total	2733	779	604	632	255	251	160	28	5442

Table 4.6: MHA artefacts with signs across sites and subtypes

No. of sides with signs	Records	No. of artefacts
1	3683	3682
2	1628	814
3	177	58
4	20	5
5	15	3
Total	5523	4562

Table 4.7: MHA dataset overview - For number of sides

	Subtypes								-
Sites	seal	tabB	tabI	pot	tabC	tag	misc	u	Total
Harappa	209	65	93	25	0	2	9	1	404
Mohenjo-daro	190	12	0	2	70	10	1	4	289
Dholavira	16	0	0	0	0	1	0	0	17
Lothal	33	0	0	0	0	24	0	20	77
Kalibangan	15	0	0	0	0	1	2	1	19
Chanhu-daro	8	0	0	1	0	1	0	1	11
Nausharo	3	0	0	0	0	0	0	0	3
Banavali	7	0	0	1	0	0	0	0	8
Lakhanjo-daro	4	0	0	0	0	0	0	0	4
Allahdino	0	0	0	0	0	0	0	0	0
Kunal	11	0	0	0	0	1	0	0	12
Kanmer	2	0	0	0	0	0	0	0	2
Kot diji	1	0	0	0	0	0	0	0	1
Others	27	0	0	0	0	5	0	1	33
Total	526	77	93	29	70	45	12	28	880

Table 4.8: MHA artefacts without signs across sites and subtypes

	signs	boss	perf	incised	ms-icon	ms-signs	sym	unicorn	rt	other	clay	stone	size
	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N
Y	5523	1961	2288	4791	687	1840	3360	1612	4511	4349	2114	4442	2186
N	880	3627	3306	1563	2463	3683	3043	1315	1892	2054	3920	1656	1216
No Value	0	815	809	49	3253	880	0	3476	0	0	369	305	3001

Table 4.9: Boolean properties in MHA - Overview

Scholar	Perspective	Data size	Attributed or grouped	Number of attributes (used)	Number of groups
Rissman (1989)	Stylistic	601	592	5 (4)	4
Rissman's attributes - unicorn head or neck decoration, stand upper part, stand lower part, flow, lip of stand lower part (correlated with rounded cage so hence disregarded)					
Franke (1991)	Stylistic	818	431	4	6
Franke's attributes - unicorn head or neck decoration, stand upper part, stand lower part, lip (body decoration used intermittently)					
Green (2015)	Style and sequence	185	81	5	18
Green's attributes - nose sequence, nose strokes, eye sequence, eye strokes, carving sequence					
Jamison (2017)	Style and technique	511	180	20	55
Jamison's attributes - high rank style - stand, ear, halter, neck, eye, head; low rank style - horn, leg, pizzle, tail, hoof; high rank metric - length, width, pizzle, ear; low rank metric - body, neck, head, us, ls					
Konasukawa (2018)	Size	1597	1597	3	20
Konasukawa's attributes - motif, length, width					

Table 4.10: MHA dataset overview - Other scholars' work

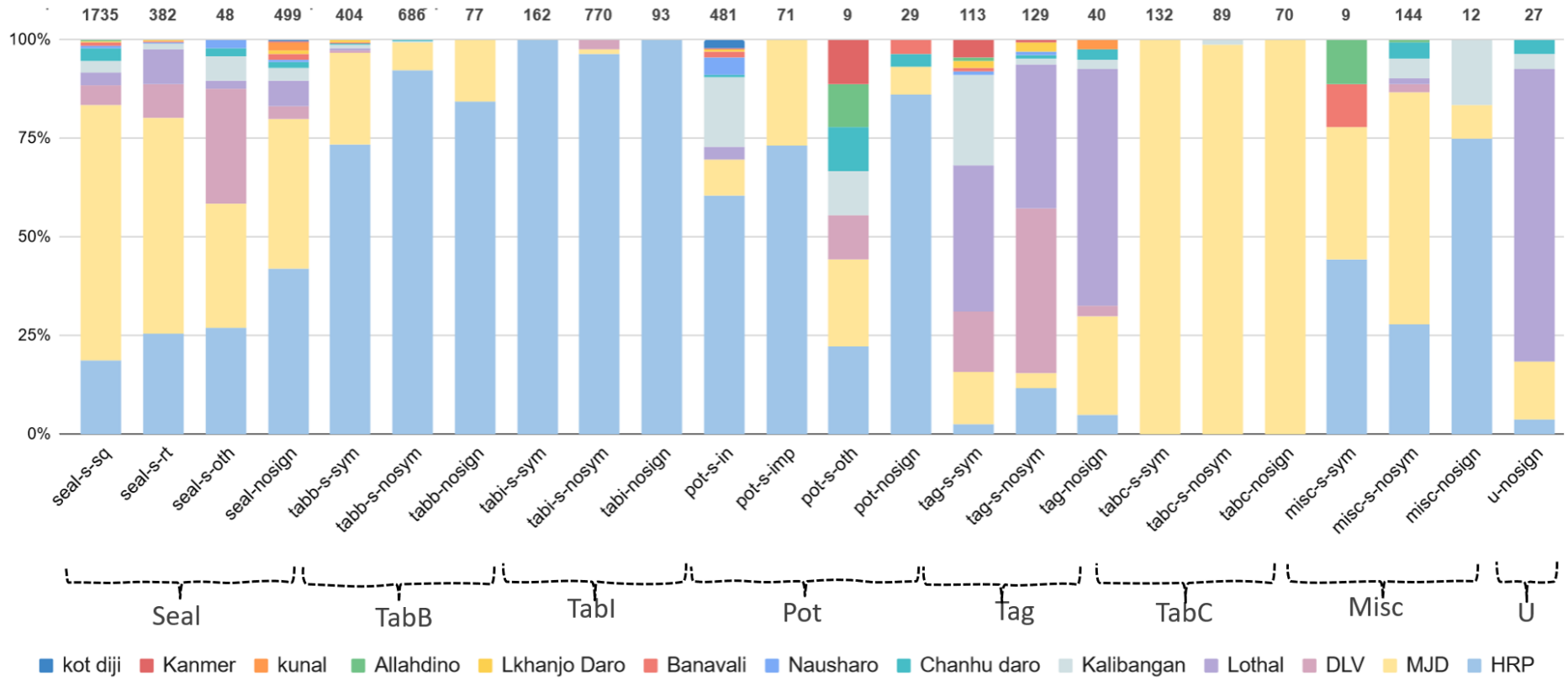


Figure 4.3: Distribution of subtypes and boolean properties across sites

Though this data can be stored more effectively and optimally in a Relational Database Management System like ICIT (which will avoid redundancies, facilitate faster access, will become more optimal), to simplify the data handling, analysis, and visualisation, this thesis has used a single table.

4.6 Experiencing the artefacts and sites

4.6.1 Affordances of MHA

MHA and their context are the central topic of this thesis. These are stored in different university collections, museums, and excavation branches of both ASI and state archaeology facilities. Many objects also reside in museums outside India. As seen in this chapter, there is a huge variety in the form of these artefacts and hence they offer diverse affordances. It is beyond the scope of this project to physically see all or even half of those. Also, it is clear from the discussions in earlier chapters that these artefacts enjoy a special status within Indian archaeology and are treated as the most valued manifestations of the 'proto'-historic past. Though few are available for viewing at the National Museum, New Delhi or Indian Museum, Kolkata, one does not get to see all the possible varieties. At site museums like Dholavira, the display shelves host only the replicas of the artefacts due to security reasons. The site museum at Lothal was closed due to repair works. Having said that, in all these places, handling of the objects requires special permissions from the concerned authorities. After a detailed review of the material available within India, permission for handling was obtained for MHA at Central Antiquity Centre in Purana Qila, New Delhi. The main purpose of the visit was to physically see, touch, and experience a variety of objects within MHA. A total of 61 artefacts were observed, handled, photographed, weighed, and documented. Handling of a variety of objects and the overall tactile experience highlighted following points -

- Seal and its perceived use - When the square or rectangular steatite seals were observed with a presumption about their use for impressions, the most interesting observation was regarding this very speculated use. As per current understanding, seals were used to create an impression in soft clay or other material for different purposes.[74] The typo-technological studies suggest the extent of efforts taken to produce these artefacts. It

74. Frenez and Tosi, "Lothal Sealings: Records from an Indus Civilization town at the eastern end of

includes sourcing of the material from different geographical regions[75] and firing at specific temperatures to harden them.[76] It indicates that it was done to extend their life for the frequent use in the production of impressions. A dedicated section in the chapter 2 described recovery of the sealings or impressions in hundreds or even thousands in the preceding or contemporary cultures. Despite the persuasively analogous usage practice, many Harappan seals observed in Central Antiquity Centre appeared rarely used and carefully preserved. Their intricate carving of signs and decorative patterns of animals or other motifs looked almost intact. The wear and tear was minimal in most of the objects. Had these been used hundreds of times 4500 years ago, and then abandoned or discarded till ~1930 CE, they would have appeared in a more weathered state. Based on their proposed use-case, the surface abrasion should have been more prominent in most of the seals. However, in some cases, it appeared like peeling off of the coating layer and it suggested ageing. Also, in the light of the assumptions about frequent handling of these objects, breakage of the boss needs further assessment.

- Boss and perforation - Though perforation indicated the use of a string/ thread/wire, the groove created friction while handling and thus appeared to avoid slippage. The base of perforation through the boss was deeper in the seal surface. This was a design aspect for longevity of the boss and to avoid accidental damage. Like carvings on the seal surface, creation of this perforation would have also needed specialised tools and skills.

- Weight of the seals - The bigger seals weighed significantly more than the smaller ones. These weights do not seem to be directly proportional to the sizes/volumes. These need to be corroborated with speculated values calculated using the steatite density and volume measurements. Also, whether materials with different mineral compositions are being used for different sizes can be checked.

- Carving - The carvings indicated specialised tools; the relevant studies were discussed

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the maritime trade networks across the Arabian Sea."

75. Law, "Regional interaction in the prehistoric Indus Valley: initial results of rock and mineral sourcing studies at Harappa."

76. Jamison, "The organization of Indus unicorn seal production: A diachronic comparative study of style, skill, and sociopolitical organization."

in the second chapter.[77] It could be important if these tools were associated with the quality of steatite that was being carved. Even if symbolic, the detailing on the images was intricate, especially hooves and eyes of the unicorn. Jamison has used some of these stylistic features to hypothesise the decentralised production groups.

- Seal content and sequence - It was evident that planning was required in order to fit the signs and icons on the surface of the artefacts. This was especially critical for artefacts with presence of both on the same side. As already discussed there are studies which hypothesise the carving sequence of these two main components on the square steatite seals.[78] Whether these different sequences were used to cater to alternating priorities between signs and symbols or due to different available working spaces on smaller and bigger seals is a possible point of investigation.

- Small artefacts - Small seals without boss and perforation were difficult to handle. Other objects such as terracotta tablets, both incised and in bas-relief, were extremely small in size. Seals with perforation and without boss were generally observed in smaller sizes. Since handling of small objects was challenging, their usage needs a systemic explanation.

- Copper tablets - Handling and documentation of these tablets was critical to compare those to the recently published nine tablets, discussed at length in the earlier chapter.[79] Besides the observation made earlier, it was seen that ageing was significantly different in these tablets as opposed to those from the mentioned study. Despite the variety in existing copper tablets,[80] the sign engraving styles, especially the widths of the strokes were uniform across these types. On the contrary, in the mentioned set of nine copper plates (as the authors call it), the style and strokes of signs on plates three and four (which possess only signs) are significantly different than the rest which have both signs and a symbol.

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77. Konasukawa, "Comparative Analysis of the Seals in the Pre/Early Harappan Period and Harappan Seals through SEM and PEAKIT (3D) Analyses"; Jamison, "The organization of Indus unicorn seal production: A diachronic comparative study of style, skill, and sociopolitical organization"

78. Green, "Stamp Seals in the Political Economy of South Asia's Earliest Cities."

79. Shinde and Willis, "A new type of inscribed copper plate from Indus Valley (Harappan) civilisation."

80. Parpola, "Copper tablets from Mohenjo-daro and the study of the Indus script."

- Breakage - Some objects appeared to be broken due to fall or snapped due to unknown reasons. Whether such broken objects were considered useless or not is unknown.

A sample of above observations of breakage, size as a significant attribute, weathering of artefacts, and handling difficulty due to size can be seen in the figure 4.4 below.



Figure 4.4: Handling of artefacts and their affordances - examples

Diverse systems for the different objects can also be hypothesised based on the constraints of the available material, and the technology to create signs or symbols on these materials. Today we see a variety of material such as plastics, papers, metals, rubber, and polymers which are utilised by the techniques such as writing, printing, embossing, hologram, and QR codes. Each of these have a different purpose. Some evolved over time and hence were replaced by more effective, efficient, and sustainable techniques. The choice of a particular material and technique indicates their authenticity and vitality in a particular system. With Harappan artefacts, the material is mainly limited to terracotta, stone, faience and copper. Ivory, bones, and other metals are not observed as frequently. Engraving or impressing are the only two techniques used with variation in their intensities. Painting is not observed as a preferred choice and is only seen on ceramic.

At the souvenir shop in National Museum Delhi, one can buy MHA like objects as souvenirs. Interestingly, only the seal impressions are sold and not the replicas of actual intaglio carved seals (Figure 4.5).



Figure 4.5: Souvenirs of Harappan seals from National Museum Delhi

4.6.2 Site visit

The site visit of Mohenjo-daro could not be achieved during the time stipulated for this doctoral research. However, fieldwork at previously excavated Harappan sites in Gujarat provided a visual and geographic context for present MHA study. Lothal, Bagasara (Gola Dhoro), Shikarpur, Deshalpar, Bhadali, Khirsara, Surkotada, and Dholavira were selected for site visit. Out of these, Lothal, Surkotada, and Dholavira have structural remains that continue to be exposed after the excavations were closed. At the other sites, the trenches were backfilled and thus these do not have visible remains. Some overarching observations which help contextualise MHA at these sites are summarised in following sections.

Lothal

Lothal was excavated from 1955 to 1962 by S. R. Rao and two volume report was published in 1979.

The drainage lines in the citadel area are interesting. The brick lined drainage system at Lothal, which is connected with bathing platforms like structures (Figure 4.6), is

strikingly similar to those seen in the excavation reports of Mohenjo-daro. The private drains are connected to main public drain and the slope can be deduced accordingly. Other components such as soak pits, chutes and covering of the drainage line demonstrate highest level of planning in sanitation.

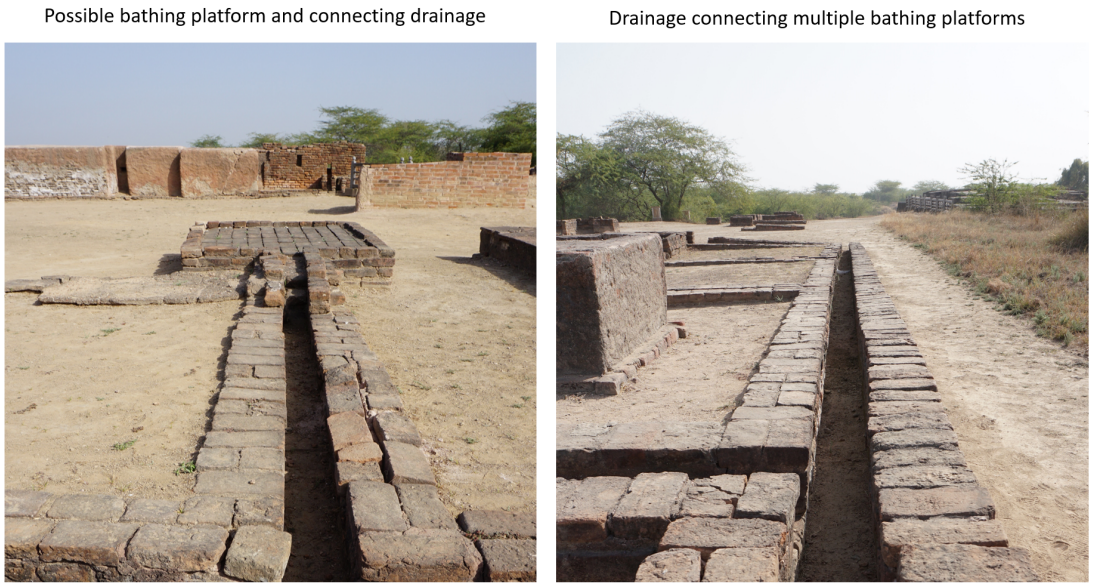


Figure 4.6: Drainage at Lothal

In the context of the present work, the structures identified as dockyard[81] and warehouse[82] at Lothal are two major tangible contributors to the hypothesis of a port-city. These have directly influenced the interpretation of the sealings found here as trade related objects. In this regard, some interesting observations were made at the site.

As proposed by Lothal excavator, interpretation of platform structures as granary was confirmed by low height of the peripheral platform which would have aided to create a ramp as an approach from the dock.[83] However, Kenoyer's opinion about the passages between the platforms as a result of brick-robbing creates a problem for interpretation of these structures.[84] The 'warehouse' or granary is entirely different than those

81. S. R. Rao, *Lothal: A Harappan Port Town (1955-62)*, I:123–125.

82. S. R. Rao, I:111–114.

83. S. R. Rao, I:111.

84. Frenez and Tosi, "Lothal Sealings: Records from an Indus Civilization town at the eastern end of the maritime trade networks across the Arabian Sea," 70.

identified as granaries at Mohenjo-daro[85] and at Harappa.[86] The granary at Dholavira shows an entirely different architectural feature having four squarish excavated compartments with inner surfaces finished with masonry stone. The figure 3.8 in the preceding chapter demonstrated these structural and architectural differences. Undulation of the mound raises questions about possible existence of more number of such platforms in the past.[87] Also the platforms show rebuilding activity.[88] Though the hypothesis of placing the goods' bag from the backs of the laborers on the platforms is also plausible. it is tighly linked to the water structure being used as dock so that the ships could reach that point.

As for the dock (Figure 4.7), the inspection of the structural details of the tank and present day undulations surrounding the tank show that the overall slope is from S to N. As such, it is difficult to conclusively say that the outlet in the southern was used to drain the excess water out and to maintain the level. The northern ends of the tank are not perfect right angles. On eastern wall, small curvature is observed, may be for adjusting to meet the other end. Since the walls have also been rebuilt, the main arguments about the inlet and outlet to the tank can not be observed. Secondly, in an area possibly surrounded by sea or creek waters, a tank provisioned for drinking water appears to be a more practical hypothesis. As discussed in the previous chapter, alternate views have posed serious challenges to the interpretation of the tank as a dock or mooring station.[89]

However, the public drain, to the south of Lower Town and parallel to Street 6, flows towards east and empties into the dock structure probably through its western wall. Had the tank been meant for potable water, this would not have been designed. Scholarly work by Nigam demonstrate higher sea level during mature or urban phase

85. Mortimer Wheeler, *Civilizations of the Indus Valley and beyond* (Hudson & Thames, 1966), 20.

86. Vats, *Excavations at Harappa: Being an Account of Archaeological Excavations at Harappa Carried out between the Years 1920-21 and 1933-34*, 17–18; Madho Sarup Vats, *Excavations at Harappa: Being an Account of Archaeological Excavations at Harappa Carried out between the Years 1920-21 and 1933-34*, vol. 2 (Manager of Publications, 1940), IV–VII

87. S. R. Rao, *Lothal: A Harappan Port Town (1955-62)*, I:111.

88. On-site personal discussion with a conservation architect Mrudula Mane

89. Leshnik and Junghans, "The Harappan "Port" at Lothal: Another View 1"; Frenez and Tosi, "Lothal Sealings: Records from an Indus Civilization town at the eastern end of the maritime trade networks across the Arabian Sea"



Figure 4.7: Lothal - Structure identified as dock or mooring station

of Harappan culture and also the possibility of the structure as dockyard based on the sediment analysis and foraminifera studies.;[9091] In a yet unpublished recent studies by Gupta and Prabhakar,[92] they have proposed that the Nal lake corridor probably linked Lothal to sites in Kachchh including Dholavira. In the light of these and earlier studies, even if Lothal was accessible by sea/creek/river route, the role of the water tank deserves a more plausible explanation.[93]

90. Rajeev Nigam, "Was the large rectangular structure at Lothal (Harappan settlement) a" Dockyard" or an" Irrigation Tank," in *Proc. 1st Indian Conf. On Marine Archaeology of Indian Ocean Countries* (1988), 20–22.

91. Rajiv Nigam and N. H. Hashimi, "Has sea level fluctuations modulated human settlements in Gulf of Khambhat (Cambay)?," *Geological Society of India* 59, no. 6 (2002): 583–584.

92. Poster presented at conference - Emerging Perspectives of the Harappan Civilisation, Feb 2023, Poster title - Exploring the role of river Sabarmati and NAl corridor in Harappan trades; Paper presented at conference - CAA2023, April 2023, Paper title - Mapping paleo-landscape of Harappan port Lothal using cloud-computing and multi-platforms

93. Also, during a discussion with Dr Tejas Garge, he opined that as of today, the Lothal area is only 18 m above sea level. Since it is a relatively flat land, if the sea level was assumed to be higher, it would not have been impossible for the boats to sail upstream at high tide.

Dholavira

Dholavira is the only site in India which has exposed excavated remains which can be compared to Harappa or Mohenjo-daro. The excavated water tanks on the southern and eastern side and the proposed ones towards north and west showcase the need of storing water in this geography. Excavations at Dholavira happened from 1989-90 till 2004-05. The excavation report that has been cited in this thesis was a temporary draft put out by ASI for receiving comments and suggestion. Final report is yet to be published.

The draft report provided an overarching understanding about the site and multiple visits with our local guides Ravjibhai Solanki and Jaimal Makwana gave more insights into the local context. Though the tanks have been proposed to be water storage structures, Jaimal suggested that Manhar nullah probably diverted near the south-east corner of the site. Its basin was deep enough to create the tank and check-dam. Based on the depth and cross sections of the tanks, the theory is plausible. Those could have been shaped, finished from the inside but the basic excavated area was probably available due to the course of the nullah. A deeply dug well within the eastern reservoir demonstrates effort to access the water from the possible spring in the drier seasons. Though this site also has a elaborate drainage system, it has a design difference. The middle and lower town the dwellings on either side of the road have proposed bathing/washing platforms with a drain like opening which empties towards the road. However, in this case, these do not have a common drainage line like one seen in Mohenjo-daro or Lothal. Many show remains of in-situ pot/soak pits. This is probably because of the scarcity of water where extra water could not be spared just to drain the waste (Figure 4.8). On another note, the draft report mentions that the site was probably accessible by waterways through the rann of Kachchh.[94]

On the citadel area, the circular structures are hypothesised to be that of the later period but the other rectangular structures as that of the earlier period. The citadel itself is supposed to have consisted of six to seven stages of occupation. The eastern and northern gateways apparently indicate narrowing down of the entrance width. The northern gate is the location of the popular sign board with gypsum pieces inlay in a wooden

94. Bisht, "Excavations at Dholavira (Draft published for limited period, now under publication)," 56–63.



Figure 4.8: Drainage at Dholavira - architectural differences

frame.[95]

The main source of the building material at Dholavira was probably a nearby stone quarry, today known as a factory site. The present day quarry does not have many big/standing rocks and the surface is relatively flat. However, many places do indicate the existence of huge rocks which could have been cut, possibly worked at the same site, and then transported to the construction site. The masonry work could have been done in the same place because the transport of the worked pieces of stone would be easier than the movement of the odd shaped heavy rocks. On the citadel near Northern gate, there is a slab which could have been directly brought and put here.

On the MHA aspect, it is important to note that after Lothal, second largest collection of impressions has been recovered from this site. All those have been identified as intensionally baked[96] unlike Rao's suggestion at Lothal of those being accidentally fired.[97] In addition, this site has the third largest collection of seals (225 as per the draft report) after Mohenjo-daro (>1500) and Harappa (>600). Within such a small set, it has a variety of seals of different sizes, with and without signs, rectangular seals, and also multi-headed and right facing animals. Despite being a very small dataset, right-facing animal motif has made its was in this relatively small collection at Dholavira.

95. Bisht, "Excavations at Dholavira (Draft published for limited period, now under publication)," 229.

96. Bisht, 308.

97. S. R. Rao, *Lothal: A Harappan Port Town (1955-62)*, I:113.

4.6.3 Derivative archaeology - context of time

Though the two sites described above were more prominent, the entire fieldwork has created a cumulative derivative experience. 'Derivation' in this context entails a similar phenomenon being experienced by different people who are separated in space and time. It can be seen that this separation leads to differential interpretation of these phenomenon and also changes their significance in human lives and academic exercises.

At the previously excavated sites such as Bagasara, Khirsara, and Shikarpur, discarded artefacts (mostly ceramics), could be seen in huge quantities at particular locations. After the material was excavated, observed, documented, and collected by the archaeologists, all was not deemed important to be included in the sample collection and were discarded at the site itself. These were the actual disposal areas for this discarded material. As one traverses the archaeological sites, it is realised that even through the modern day academic actions like these, site formation process is continuously underway. From a habitation point of view, whenever a site is abandoned, either gradually or suddenly, the natural processes may precede the anthropogenic ones. With rare exceptions of sites like Pompeii, majority of the sites begin the process of transformation into 'archaeological site' due to the gradual abandonment. The people probably carry the valuables with them or the population ceases to exist who values those. Else, anything that isn't significant any more in their lives, is left behind. As archaeologists, when one encounters these piles of discarded ceramics, it creates a deja-vu experience of 'academic' site formation process because of the intentional and accidental deeds of the recent predecessors.[98]

Unlike prominent Harappan sites which are built in bricks, Dholavira is built in masonry stone. The stone is locally available. As informed by the local site guide (who earlier worked on the site as labour during 12 seasons of excavation), during the devastating earthquake of Bhuj 2001, in a desperate need to rebuild the houses, the locals took away the stones from the eastern tank and reused those for the repairs. On similar lines, the quarry site mentioned above, is used even today to source stones for local needs.

When it is about the 'usage' of the site, 'site' itself is a primary stage and also an act

98. Paper presented on this concept at WAC9, August 2022

in archaeology. From an archaeologist's point of view, it should be 'used' for its study. However, the line between use and misuse of the site is often blurred. A look into the past shows that these actions appear like present day manifestations of persistent human tendencies.

The materially and logically identical events can be observed repeatedly at Harappa before the site was acknowledged for any archaeological significance.

Before the Lahore-Multan railway came into existence, which eventually brought Harappa to the world, Burnes, in his travels during 1831-1833, had visited Harappa. He observed removal of bricks and being reused '... to build a small place of the old name hard by.'[99]

Official correspondence regarding the survey and planning of this railway line was included in the Punjab Railway publication of 1857. As the author documented survey findings and plans for the railway line, he mentioned that using limestone from the Doab (area between Satluj and Ravi) for the ballast of railways would "... render its use too costly…" (so) "...substitute hard burnt bricks broken to size; either of these materials will form excellent ballast."[100] Also, his survey mentioned that "between Mooltan and Lahore, a distance of 240 miles, the country is a dead level, hard and waste. … There are no engineering difficulties whatever to be met with anywhere between Lahore and Mooltan."[101] In the same context, he also assured that if need be, there are many brick manufacturing facilities in the area.[102]

Cunningham had visited Harappa at least twice during the 1850s but in the 1872-73 visit, he reported removal of bricks from the south face of the southern mound.[103] He, in fact, tried to gauge the size and extent of the mound based on the 'fact' that "... they have more than sufficed to furnish brick ballast for about 100 miles of the Lahore and Multan

99. Alexander Burnes, *Travels Into Bokhara: Being the Account of a Journey from India to Cabool, Tartary, and Persia: Also, Narrative of a Voyage on the Indus, from the Sea to Lahore, Performed Under the Orders of the Supreme Government of India in 1831, 1832, 1833*, vol. 3 (EL Carey & A. Hart, 1834), 137.

100. W. P. Andrew, *The Punjab Railway* (WMH Allen / Co., 1857), 16.

101. Andrew, 30.

102. Andrew, 31.

103. Cunningham, *Archaeological Survey, Report 1872-1873*, 106–107.

Railway."[104] Though he conducted a small excavation, published a site plan, and also published a seal after this visit, he did not raise concerns about this 'brick robbing'..[105] It must be noted that this railway track of the then Punjab Railway was already completed and operational by 1861.

Despite several visits by different scholars during following years, apparently there wasn't any action taken against this movement of bricks.[106] A few decades after the construction of the railway, the same incidents were reported by Rai Bahadur Daya Ram Sahni in 1917. He describes these ruins as being used as '... quarry for building materials ...'[107] However, at this point in time, he expresses an urge to save the site by approaching the government and to protect these ruins under the provisions of the Ancient Monuments Preservation Act of 1904.

Further back in time, as the excavations progressed in Mohenjo-daro during 1930s, Mackay makes numerous mentions of brick-robbing. A stack of bricks which was found in Block-1 in the Intermediate-I Phase, showed traces of mud mortar.[108] It was thus hypothesised as a reuse of building material which was salvaged from the structures of earlier periods or other abandoned ones.

These incidents can be seen, contextualised, and interpreted differently by different stake-holders. The stacks of bricks at Mohenjo-daro are within the realms of archaeological excavations, material culture, and Harappan civilisation discourse. The events at Harappa formulate into a colonial history of discovery of Harappa whereas the removal of stones from the tanks at Dholavira becomes an act of destruction of a world heritage site. A persistent human tendency transcends through these events which spans more than four millennia. These incidents provide a window into the timeless human behavioural aspect. Most of these material reuse cases are in response to need or desperation. From an academic lens, these can also be interpreted as reuse of material due to incomprehension of its contextual significance. The academic lens or archaeological

104. Cunningham, *Archaeological Survey, Report 1872-1873*, 107.

105. Possehl, "A short history of archaeological discovery at Harappa," 6.

106. Possehl, 6.

107. Daya Ram Sahni, *Harappa, District Montgomery. Annual Progress Report of the Superintendent, Hindu and Buddhist Monuments, Northern Circle, for the Year Ending 31st March 1917* (Suprintendent, Government Printing, Punjab, 1917), 7.

108. Mackay, *Further Excavations in Mohenjo-daro*, I:53.

importance are recent phenomenon that have emerged out of our modern world philosophy to 'understand the past'. Subsequently, based on our positions and vantage points, we continue to label these as use or misuse of the site (Harappa and Dholavira) or the characteristic of site (Mohenjo-daro).

4.7 Summary

This chapter thus described the data creation process for the analysis of MHA. Various constraints and nuances of the data creation process reveal that these are inherent and thus unavoidable. Our choices directly impact our analytical capabilities and the possible interpretations. The "... mechanisms of closures ..."[109] have been employed by earlier scholars and also by myself. Despite the impact of these closures on the dataset and subsequent interpretations, it is a mandatory step to transform the data from its descriptive form to a standardised, quantitative, categorical, and analysable format. As far as possible, present MHA dataset tries to knit these mechanisms with the nature of the artefacts. Archaeologists thus continuously practise the strategies described by Gero[110]-

- **'Data cleaning'** to reduce the ambiguities and to bring order to the data - This is prominently seen in sign encoding efforts. The seals' size groups defined in CISI are also a result of this process.

- **'Machining the data'** to measure and record different empirical and abstract attributes - This is seen in typological or iconographic studies which employ equipment such as SEM. The differences may not have been culturally significant but may be incidental or accidental consequence of the hand-made phenomenon becoming a routine. Based on our present-day standards of measurements, the use of mm or inches to measure the sizes of the seals for further analysis is also an example of the same strategy.

- **'Pushing the data'** in order to extend our tentative observations as a basis for the next level hypothesis building - This has been observed in the formation of Dravidian/ Proto-Dravidian language hypothesis, initially rooted in the 'Aryan Invasion theory'.

109. Gero, "Honoring ambiguity/problematizing certitude," 320.

110. Gero, 320–322.

- **'Stretching the data'** with the use of specific and local observations on a limited dataset to interpret global phenomena - This is seen in carving studies where statistically insignificant datasets (180 objects, 20 attributes, attribute values ranging from 5 to 114, 55 groups) are interpreted to hypothesise 'decentralised production'. The narrative is demonstrated to support the existing theories of urbanisation of the past civilisations. It has already been discussed that having generic definition of 'urbanisation' is challenging.

- **'Going small'** in analysis of patterns - In an example discussed in chapter 2, the qualitative study[111] begins with the description of 12 patterns observed on the MHA data. It then provides statistics of the number of inscribed surfaces per CISI volumes.[112] As already described above, the volumes probably have no logic of grouping MHA besides those being located in India or Pakistan. In the conclusion section, the very first conclusion is about existence of 12 patterns.[113] It thus began with 'unambiguous' observations of the data and reached the same conclusion with the use of 'ambiguity-reducing strategy'.[114]

- **'Providing visual focus'** - It is evident when a 'square steatite intaglio carved unicorn seal' is shown as a representative artefact of the diverse MHA set. The diversity in form and the summary statistics was discussed in earlier sections. It is seen that only this specific kind has received an incomparable visual focus and it has almost masked all the remaining variety. Similarly, the 17.5 cm tall statue, identified as 'Priest-king' has been the hallmark figure of the perceived social hierarchy of the Harappan culture. The recent work by Green and Coningham have posed serious questions to these perceptions.[115] However, the best example of visual focus could be unanimous approval and the acceptance to the publication of seal impressions even when those are not actual archaeological finds. This and earlier chapters elaborated on why and how this practice has created a hypothetical data and has introduced a bias at documentation

111. Yadav and Vahia, "Classification of patterns on Indus objects," 5.

112. Yadav and Vahia, 18–19.

113. Yadav and Vahia, 25.

114. Gero, "Honoring ambiguity/problematizing certitude," 321.

115. Green, "Killing the priest-king: addressing egalitarianism in the Indus civilization"; Coningham and Manuel, "Priest-kings or puritans? Childe and willing subordination in the Indus"

level. It has also employed 'cleaning', 'machining', and 'stretching' mechanisms on the data since it fits a particular narrative. In the hindsight, for the discovered sealings or impressions, no hypothetical seal images have been published which would have generated those artefacts in the archaeological past.

Though the analysis and interpretation can be seen impacted by the above strategies, it can also be equally informed by the nuances of the data only if those are allowed to be documented and acknowledged as part of the methodology. In the data preparation process, space must be created for these ambiguities to seep in. To continue with Gero's argument, as she emphasises to address and acknowledge the ambiguities and uncertainties, she also illustrates the fruitful outcomes of this exercise.

- **Multiple questions and models -** Gero urges to pose different questions and explore multiple models because generalised models or rules will not help us understand the complex social lives. If the attribute boundaries could be tackled and altered within the scope of the datasets, data can be interpreted differently.

- **Diverse interpretations through a less hierarchical team structure -** This is similar to post-processual thinking. This will automatically be a reflection of individual contexts of the observers or the team-members. It will allow the same set of dataset to be interpreted from multiple standpoints.

- **Insight into epistemological steps of knowledge construction -** This is a critical point. Gero argues that " ... the history of not only each interpretation, but also each refusal to interpret should be discussed... ."[116] In the context of the present project, this is probably the least discussed but most crucial point. As mentioned in the previous chapter, the acceptance of linguistic model as 'easiest' and Dravidian hypothesis as 'least weak model' completely overlook and contradict Gero's suggestion.

- **Reward for preserving subtleties that allow varied readings of the evidence -** Gero has highlighted the significance of field notes or minute observations which often get masked in the overarching project objectives.

- **Reduced competition to reach premature conclusion -** Lack of attention to unpublished or already excavated data and demands for new excavations are major concerns.

116. Gero, "Honoring ambiguity/problematizing certitude," 324.

Gero has argued that the race to dig more but not publish the adequate details must be addressed. Also, always aiming to reach a 'conclusion' could be counter-productive and detrimental in the ambiguity laden domain of archaeology. Hodder's comments mentioned in first chapter need be iterated in this context - "..reading of an event is never finished.. Continuously open for interpretations."[117]

Note -

Though the present MHA dataset is rooted in ICIT, it is a result of multiple edits. Though few minor edits were done in late 2022 or early 2023, there is no significant change in the number of records since it was last updated in 2022. ICIT is being continuously updated by Dr. Fuls and is actively maintained. There are additions of new records, updates to schema including existing attributes, and also addition of new attributes on a regular basis. As a result, the present MHA dataset is not a replica of ICIT but a version adopted for the present study.

117. Hodder, *The meanings of things: material culture and symbolic expression*, 70.

Chapter 5

Contextual Analysis

The preceding chapters discussed MHA scholarship, demonstrated its linguistic bias, and pointed out consequential latency in typology definition. This historiographic analysis also revealed the epistemological debate within the MHA discourse. This has led to problematisation of the existing concepts about the signs and artefacts. I have argued that imposition of notions of urbanity and language on this material culture has given birth to an 'apparently robust' framework of hypotheses. Bound by this framework, the MHA scholarship has almost reached a 'closure'.[1] The broad research problems have been defined against this backdrop. To address those, one must disregard the seemingly obligatory comparison of this material culture to other contemporary civilisations. The notion that there exists a set of 'necessary and sufficient conditions' of 'urbanity' and Harappan culture satisfies those needs to be questioned. In his 2021 article, Green concludes:

> The Indus civilization lacks evidence of palaces, elaborate tombs, aggrandizing monuments, and significant discrepancies in grave goods. At the same time, Indus cities boast considerable evidence of sophisticated technologies, commodious houses, large-scale non-residential architecture, and long-distance interaction. The Indus civilization was perhaps the world's most egalitarian early complex society, defying long-held presumptions about the relationships between urbanisation and inequality in the past.[2]

Chapter 4 dealt with the data preparation process at length, lacunae in existing datasets and limitations imposed by them, collation of multiple datasets, creation of new attributes, and finally formation of geospatial contextual dataset for reconstruction of virtual archaeological context.

Based on the research problems outlined in chapter 3, multiple smaller hypotheses are proposed in the following sections. These are tested on newly customised MHA

1. Gero, "Honoring ambiguity/problematizing certitude."

2. Green, "Killing the priest-king: addressing egalitarianism in the Indus civilization," 185.

dataset with the use of multiple statistical techniques. Thus the contexts get defined by the interrelationships amongst the attributes. The hypotheses are based on the present-day knowledge produced by the existing studies. Since these have created the present state of understanding, it is rational and formal to use those as starting points. In some cases the hypotheses are formed based on logical constraints of the form, material, or the attributes being analysed. This means that from an affordance point of view, people from archaeological past could have experienced certain generic limitations with respect to these attributes. Synthesis of all the hypotheses results and their interpretation is discussed in chapter 8.

Because of the diverse nature of these artefacts, as discussed in the previous chapter, the entire dataset cannot be used for all analyses. Thus multiple subsets have been defined. The observations are thus constrained by the amount of data in each of these subsets. Here, the appropriate size of sample in each analysis could be a topic of debate but it is also a function of domain of study.[3] In some cases, the tests are rendered unreliable due to inadequate sample size. For example, warnings such as "Chi-squared approximation may be incorrect because more than 20% of expected counts are < 5" or "Chi-squared approximation may be incorrect because some expected counts are < 1" appear during the analysis.[4] Thus, in addition to statistical tests, multiple visualisations and contingency tables are also used for insight into the data. Following sections define these different analyses, datasets incorporated, and the observations therein.

5.1 Basic MHA statistics by sites and type

Previous chapters discussed the intricacies in the identification of artefact type. It is one of the critical questions about MHA. Typological definitions of archaeological material are often derived based on their perceived form attributes, the patterns within them, and their prospective use based on our cultural understanding of the specific space-time slice. Despite the aim for an 'objective' study, we are often constrained by our own views and notions when we identify these attributes, patterns, and usages. Our own context does play a role. The collection of essays dedicated to typology in archaeology

3. Pramod P. Joglekar, *Research Methodology for Archaeology Students* (Gayatri Sahitya, 2014), 81.

4. "Install Dataiku DSS Using Virtualbox or VMWare | Dataiku," 2013-2023, accessed June 25, 2023, https://www.dataiku.com/product/get-started/virtualbox/1.

articulates it best.[5] In addition to it, Gero's work which is prominently cited in earlier chapters, elaborates on the ambiguities which persist in our documentation of the material. Regarding the bias of artefact distribution in sites, it has already been observed by early excavators and the later scholars that the artefact distribution is not homogeneous. One of the unavoidable and confirmed external causes is varied extents of excavations at different sites. Thus some sites contribute to the majority share of some artefacts and many sites report a miniscule quantity. Chapter 4 described basic statistics of the dataset in terms of number of artefacts, their diversity in terms of number of sides, types, and their distribution across 13 top sites. Despite this, there are some interesting observations within this imbalanced dataset. For example, 880 MHA have signs on multiple sides of the artefact and 3683 are single sided. However at Harappa, where the majority of tabB and tabI are found, multi-sided tabB and tabI are more in number than single sided artefacts. This distribution of side is exactly opposite for tabC which are prominently found in Mohenjo-daro (Table 5.1). In case of seals, which is one of the most prominent categories, Mohenjo-daro has 1293 seals. This is almost triple the number of single sided 415 seals at Harappa. However, for multi-sided types, Mohenjo-daro is only double in number than Harappa.

5.1.1 Sides as record with attribute discontinuities

During the dataset creation process, the attributes such as presence and absence of signs or symbols and the number of sides have played a crucial role in the perception and understanding of these artefacts at a primary level. Shape has also played a role in the content of the seals. On the other hand, technique of sign creation is diverse for ceramics despite their shapes and utility. Collectively, these create very sharp boundaries in formal differences within MHA's variety. These could have contributed to MHA's cultural affordances, i.e. "... what kinds of activities and interactions it invites and what types of meanings it sustains."[6] These are seen being used by multiple scholars in their typology definitions. In the presently compiled MHA dataset, there are more multi-sided records at Harappa than Mohenjo-Daro. As mentioned above, this is evidently

5. Whallon and Brown, *Essays on Archaeological Typology*.

6. Susana Alves, "Affordances of Historic Urban Landscapes: an Ecological Understanding of Human Interaction with the Past," *European Spatial Research and Policy* 21, no. 2 (2014): 16.

because of the huge number of tabB and tabI. Table 5.1 shows that at Harappa, these two contribute more than 60% in overall records along with 20% of seals. At Mohenjo-Daro, single sided records are dominated by seals, almost triple in size than those at Harappa.

-	Multi-side records		Single sided records	
Subtype	Harappa	Mohenjo-daro	Harappa	Mohenjo-daro
seal	11	21	415	1293
tabB	344	30	234	76
tabI	383	4	103	1
pot	1	0	343	64
tabC	0	36	0	148
tag	3	2	11	13
misc	1	5	42	78
u	0	0	0	0
Total	743	98	1148	1673

Table 5.1: Single and multi-sided MHA in Harappan and Mohenjo-daro

5.1.2 Quantification of uneven distribution

The literature review (chapter 2) and overview of dataset (chapter 4) shows that distribution of MHA across sites and subtypes is not homogeneous. This observed heterogeneity is quantified in terms of the ubiquity and diversity indices for subtypes and sites. These quantification techniques have been previously used in faunal studies.[7] The ubiquity index (UI) creates a quantitative measure for the most ubiquitous type only based on presence or absence and irrespective of its quantity. Diversity index (DI) provides a measure of the variety of artefacts found in a given site, again only based on presence or absence and not based on the quantity of the material recovered (Table 5.2).

Ubiquity index i.e. UI (in %) = n/s * 100 (n = non-0 sites for given type, s = 13 (total number of top sites, group of 'Other' sites are not included in this count))

7. Pramod P. Joglekar, C. V. Sharada, and G. S. Abhayan, "Faunal diversity during the Harappan period in Haryana: a review," *Heritage: Journal of Multidisciplinary Studies in Archaeology* 1 (2013): 262–287.

Diversity index i.e. DI (in %)= n/s * 100 (n = non-0 types for given site, s = 8 (total number of subtypes))

It is seen that seals are the most ubiquitous of MHA followed by pots and tags. Kunal and Kot Diji are exceptions where MHA are unsigned. TabI are rarer than tabB across the major sites even if both are prominent only at Harappa. In terms of diversity, as expected, Mohenjo-daro is the most diverse site, followed by Harappa. On a side-note, even if Harappa, Mohenjo-daro, Dholavira, Lothal, and Kalibangan are quantitatively most significant sites, Chanu-daro needs special attention. In terms of the proportion of seals in total excavated MHA for any given site, it is the highest; higher than Mohenjo-daro. Also, in the diversity within sub-types, the diversity of 'Other sites' is 87%. However, if the diversity is calculated based on the categories within the subtypes (by using boolean attributes described in the previous chapter), the collective diversity goes down to 58% - compared to 91% of Mohenjo-daro and 87% of Harappa.[8] This shows that despite combining 69 sites from a huge geographical spread in a single group, there are very specific kinds of MHA (14 out of 24) which are found in these sites; seal being one of them.

As against this, there are at least 49 out of 82 sites which have at least 1 'signed seal'. This essentially means that the ubiquity observed in the 13 most MHA populous sites is not limited to those but extends beyond it. Thus the artefact which is considered as material manifestation of trade and/or economic activities[9] is present in all top sites and collectively at many other sites.

5.2 Ambiguities with basic provenance

At present, as a basic starting point for archaeological data, we associate artefacts to the respective findsites. However, in case of MHA, with potent theories of production mechanism, trade, primary/secondary functions, movement of people and goods, and inter/intra-cultural contacts, it is very likely that small handheld objects were also mobile. However, yet there is no systemic explanation or a plausible archaeological evidence to explain these cases for most of the MHA.

8. See table A1.1 in appendix 1

9. Phenomena tightly related to urbanisation of Harappan culture and society's ability to be literate

Type	seal	tabB	tabI	pot	tag	tabC	misc	u	Total	n	DI
Harappa	646	996	997	370	20	0	53	1	3083	7	87.5
Mohen jo-daro	1534	154	9	67	30	290	89	4	2177	8	100
Dhola vira	150	2	18	1	72	0	3	0	246	6	75
Lothal	124	2	0	16	113	0	2	20	277	6	75
Kaliba ngan	73	6	1	86	29	1	9	1	206	8	100
Chanhu-daro	67	3	0	5	2	0	6	1	84	6	75
Nausha ro	18	0	0	21	2	0	0	0	41	3	37.5
Banavali	22	1	0	7	1	0	1	0	32	5	62.5
Lakhan jo-daro	8	3	0	3	5	0	0	0	19	4	50
Allahd ino	7	0	0	2	1	0	2	0	12	4	50
kunal	11	0	0	0	1	0	0	0	12	2	25
Kanmer	3	0	0	2	6	0	0	0	11	3	37.5
Kot diji	1	0	0	10	0	0	0	0	11	2	25
Other	115	7	1	46	18	0	4	1	192	7	87.5
Total	2779	1174	1026	636	300	291	169	28	6403	-	-
n	13	8	4	12	12	2	8	5	-	-	-
UI	100	61.53	30.76	92.31	92.31	15.38	61.53	38.46	-	-	-

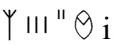
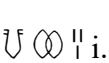
Table 5.2: Ubiquity and Diversity index for subtypes and top 13 sites

For seals, there are evidences of unfinished seals and related debitage at few sites. These possibly indicate the manufacturing locations. Some examples of unfinished seals from Mohenjo-daro and Harappa have been documented in CISI volumes under the category 'unfinished'.[10] In case of Lothal, even if not noted in CISI, some seals can be observed to be unfinished or too weathered.[11] In the excavation report, Mackay had also identified some as examples of reused seals in addition to unfinished seals.[12] However, relationship of such scarce examples with majority of MHA is yet to discerned. Thus the findsites have been treated as the primary locations in the present study.

In case of tags, present comparative understanding about their use-case inherently indicates their movement; that is, those were mostly created by impression of a seal on a soft clay tag at a particular site and then moved/transported along with the goods or container at the site of archaeological discovery. This could be the process-flow with associated complexities of real life. However, Frenez's work discussed in earlier chapters, paints a different picture based on the morphological differences of the tags, their functional use, and associations within the findsites.[13]

In case of tabB, where the artefact is seen to be moulded, there are examples of seemingly identical artefacts, i.e. possibly moulded from the same moulds but recovered from distant sites.[14] For example, there are at least seven tabB from Harappa and one from Mohenjo-daro which have identical sign sequence and lack of any symbol. Figure 5.1 shows these samples with sign sequences based on ICIT sign encoding.

It must be noted that there are examples of square seals with iconography which possess identical sign sequences but are at different sites.

-  i.e. 390-003-002-817 on C-66, H-407, M-32
-  i.e. 390-003-002-820 on H-1680, M-1729, M-1806, Ns-7
-  i.e. 740-840-013 on L-22, M-1915, M-1774

10. Shah and Parpola, *Corpus of Indus seals and inscriptions - Collections in Pakistan*, 2:148–156, 310–312.

11. Joshi and Parpola, *Corpus of Indus seals and inscriptions - Collections in India*, 1:241, 250, 255.

12. Mackay, *Further Excavations in Mohenjo-daro*, I:345–347.

13. Frenez and Tosi, "Lothal Sealings: Records from an Indus Civilization town at the eastern end of the maritime trade networks across the Arabian Sea."

14. Mackay, *Further Excavations in Mohenjo-daro*, I:349; Possehl, *Indus Age: The Writing System*, 44



Figure 5.1: Identical tabB kind of artefacts from Harappa and Mohenjo-daro

- 𒄰𒌋𒐈 i.e. 740-900-005 on H-512, M-138, M-1852

Also, as per the data catalogued in ICIT, there are 21 incised tablets from Harappa having identical sign pairs on 3 different sides and one more with a slight variation. The artefacts can be seen numbered from H-2218 to H-2239.[15]

Chapter 7 that deals with the GIS case study, possible scenarios for movement of MHA within a mound of site have also been discussed. These can be attributed to archaeological processes related to movement of people, reoccupation of mounds, or abandonment. These are inter-cultural or transitional processes where the artefacts are moved irrespective of their intended function. These are different from socio-economic or cultural systems described earlier such as trade, identity markers, locking mechanisms, and administrative control. Many such ambiguities thus enforce the use of findsites as MHA's primary contexts.

An interesting analogy could be those of the present day terms such as 'Made in –' or 'Product of –' which indicate the site of manufacture or origin for the given object. Presence of these objects at different locations besides the place mentioned on these tags is a result of trade or export for different reasons. From archaeological point of view, these are findsites. Ironically, the 'readable text' points to different sites which have a causal relationship with the findsites. In other words, the 'readable text' is a manifestation of the system, because of which the product is present at a particular location. With respect to MHA, association of signs with findsites needs to be explored with these

15. Parpola, Pande, and Koskikallio, *Corpus of Indus Seals and Inscriptions - New material, untraced objects, and collections outside India and Pakistan, Part 1: Mohenjo-daro and Harappa*, 3.1:291–292.

possible systemic and cultural explanations.

5.3 Formal attributes and contexts

Size of the artefact creates one of the basic affordances. Within MHA, the diversity of size is seen amongst all broad types such as seals, tablets, and tags. This section elaborates on aspects of artefact size and their significance for MHA's contextual interpretation.

5.3.1 Size groups

In case of seals, the size grouping implemented in CISI volumes is discussed in the previous chapter. Though these groups tend to follow natural breaks in the data, and thus help in documentation and organisation of the volumes, whether this is the optimum grouping scheme of MHA is a primary question. Also, the size group definition becomes an ambiguous exercise when the purpose of the grouping is teleological rather than causal. Unless the size groups help to understand their functional value for MHA, the grouping scheme is a purely statistical exercise.

Figure 5.2 shows this increase in a graphical format with generally observed iconographic motifs observed in those ranges of surface area. These CISI size ranges for square unicorn seals are as follows: I - > 43.5 mm, II - 35-43 mm, III - 29-34.5 mm, IV - 23-28.5 mm, V - 17.5-22.5 mm, VI - < 17 mm. The basic maths of increase in both length and the proportional area is interesting. Within a single CISI group, seal area is seen varying with almost 40 to 60 percent.[16]

It can be seen that in case of seals or all other MHA, it is not the linear measurement but the actual surface area which matters for intaglio carvings, incisions, or for creation of a mould, or an impression. From an artefact production point of view, size creates a physical constraint. The available surface area may limit the amount of detailing and the information to be created. Thus the size grouping based on actual surface area of the artefacts[17] is a more rational parameter than the linear measurements. Of course this constrained could have been overcome with more precise tools and highly skilled

16. See table A1.2 in Appendix 1.

17. Surfaces which have been prominently used for creating signs or icons.

artisans.

It is thus proposed here to use surface area as a unit of measurement for sizes of the seals. The ideal clustering scheme should render each cluster as a homogeneous group and separated from the nearby clusters. In the present work, instead of only square unicorn seals, I use all square seals to divide those into size groups to understand if the non-unicorn seals fit into a similar clustering scheme. Since there are both the unicorn and non-unicorn motifs present on the tags, it is evident that both were being used for impressions. Konasukawa's study[18] reviewed in chapter 2 has already shown that majority of the non-unicorn seals fall in his A2 size group which mainly defines unicorn seals. It is thus imperative to consider all of them to create area based clustering.[19]

The k-means clustering technique is implemented to for these surface-area based clusters. It essentially partitions the data in the specified number of clusters/groups such that each observation belongs to the cluster of nearest mean. It is unsupervised learning algorithm thus it handles the data based on attributes to be used for clustering and is not dependent on user-provided labels to assign the observations to the clustering. The artefacts will thus be assigned to clusters irrespective of their presently assigned CISI size groups.

18. Konasukawa and Koiso, "Size of the Indus type seals and its Significance."

19. Only square unicorn seals have also been experimented to create 5 clusters, same as CISI grouping strategy. The model was then applied on all the square seals. This was to check if non-unicorn seals show any variation when they are grouped based on only unicorn seal sizes. There is no significant difference.

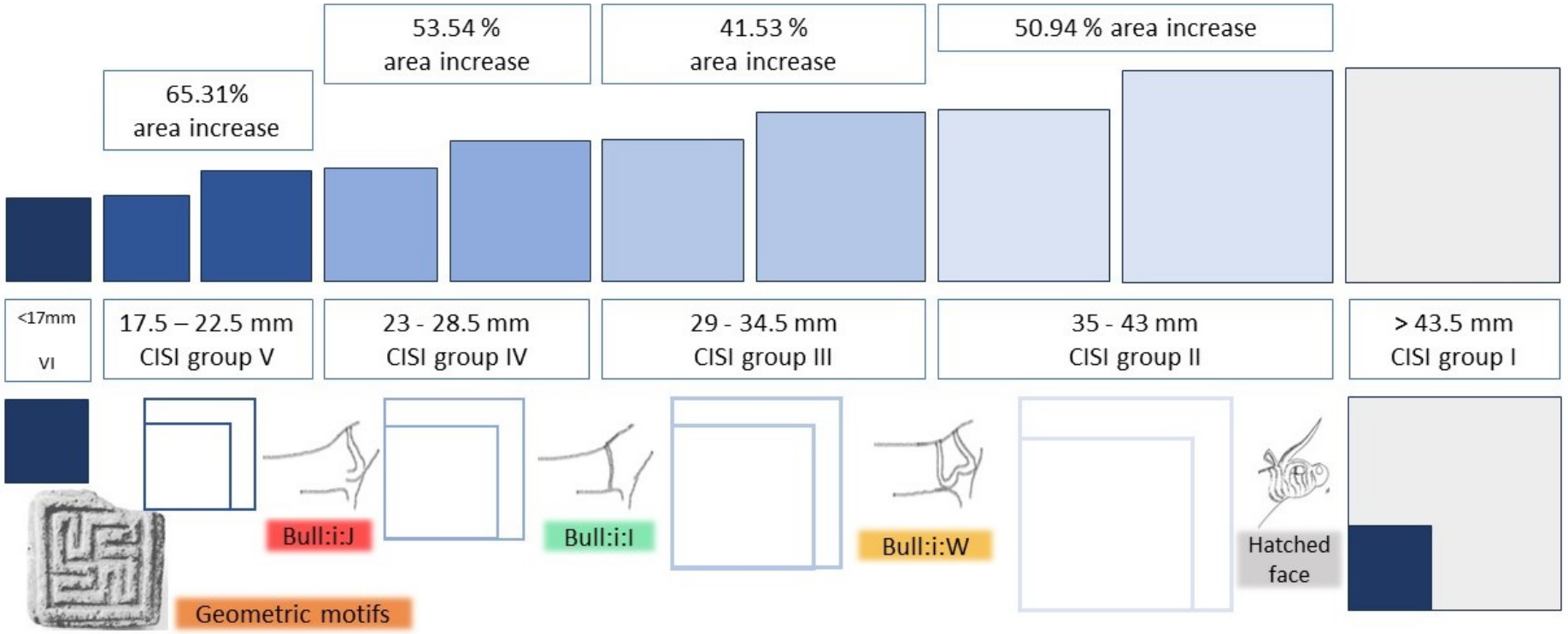


Figure 5.2: CISI size groups with surface area variation within and across groups

For k-means clustering technique, 2 to 10 clusters have been tried. It is observed that 10 seals are being consistently identified as outliers in each of these clustering schemes. These are significantly bigger than the rest. When these clusters are compared with those of CISI groups, diagonal heavy clustering is not obvious. Diagonal heavy clustering essentially means evidence of mapping of each CISI group to a newly defined area-based cluster and vice versa. When area is used, five clusters and an outlier model demonstrates the best possible diagonal than the rest (Table 5.3). For comparison, results of 4 and 6 clusters can be seen for in table A1.3 and table A1.4 in appendix 1.

-	Clusters						
CISI Size Group	cluster_0	cluster_4	cluster_2	cluster_1	cluster_3	outliers	Total
1	0	2	0	4	60	9	75
2	1	5	8	177	1	0	192
3	4	27	301	5	0	0	337
4	70	568	23	1	0	1	663
5	418	5	1	0	0	0	424
6	147	7	1	0	0	0	155
Total	640	614	334	187	61	10	1846

Table 5.3: Distribution of artefacts in five k-means clusters and six CISI size groups - Square seals

Based on this, for 1846 artefacts (square seals only), the CISI groups of square seals map to area based clusters as seen in table 5.4.

CISI Groups	1	2	3	4	5 and 6	-
K-means cluster	~ Cluster 3	~ Cluster 1	~ Cluster 2	~ Cluster 4	~ Cluster 0	Outliers
Number of artefacts	61	187	334	614	640	10

Table 5.4: Relationship of five k-means clusters with 6 CISI size groups

When the results of these grouping mechanisms are compared, k-mean clusters are more precise in their definition than CISI groups. This can be visualised in the frequency charts for linear measurements (for CISI groups - Figure 5.3) and surface area (for k-means clusters - Figure 5.4) as well as box-plots.

For CISI groups, overlaps could also be a result of data cleaning and machining processes. These can be improved by further inspection of the data. However, based on following observations, whether that scheme of grouping is contextually meaningful is a critical point.

- CISI group 4 is split but this is the best segregation that could be achieved when compared to different number of clusters. It indicates that group 4 is probably more heterogeneous than the rest.
- On the contrary, CISI groups 5 and 6 almost entirely map to the same cluster indicating a more homogeneous range of areas.
- If six clusters are created to split CISI groups 5 and 6 then groups 3, 4 and 5 get split. This dilution of groups lowers the quality of clusters in terms of their homogeneity.
- In all above cases, a consistent observation is that CISI groups 1, 2, 5 and 6 are more homogeneous and indicate better class boundaries than groups 3 or 4.
- The exercise thus reveals the ambiguity, more specifically in the definitions of the CISI groups 5 and 6 when the size is considered in terms of surface area than the side length.
- The outliers are distinctly larger than the all seals in cluster-3.
- Smaller seals, that is clusters 0, 4, 2 have least standard deviation, that is they are highly standardised. These are also the most populated clusters.

Bar graphs and scatter plots - Collective visual comparison of area-based clusters to those of CISI groups based on horizontal measurements shows that except for cluster 4, area is a better measurement for size-based grouping. This clustering strategy is evaluated across iconographies. As the surface area is compared across unicorn (Figure 5.5) and other iconographies (Figure 5.6), the non-unicorn iconographies are seen restricted to specific areas and also smaller than overall unicorn group.

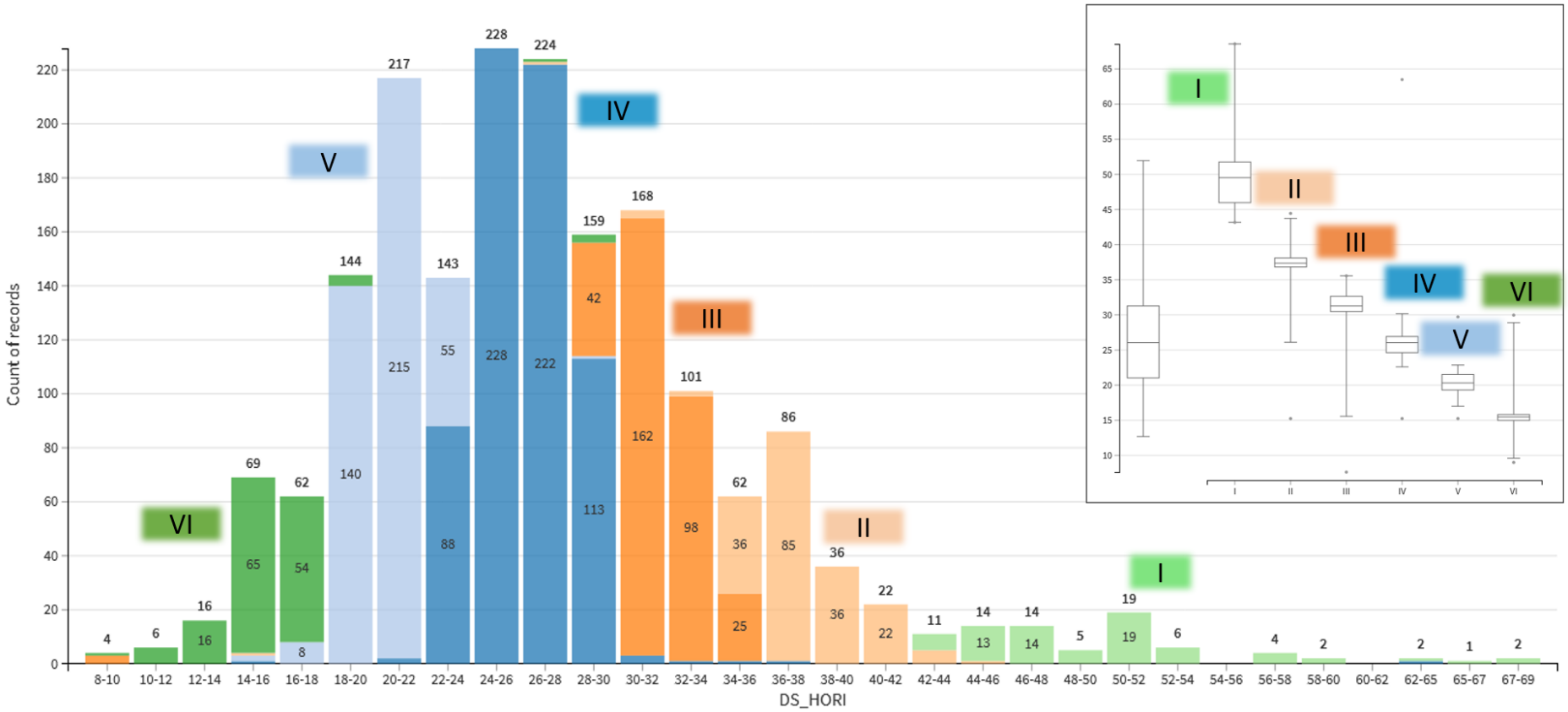


Figure 5.3: Spread of CISI size groups on length measurements of square seals

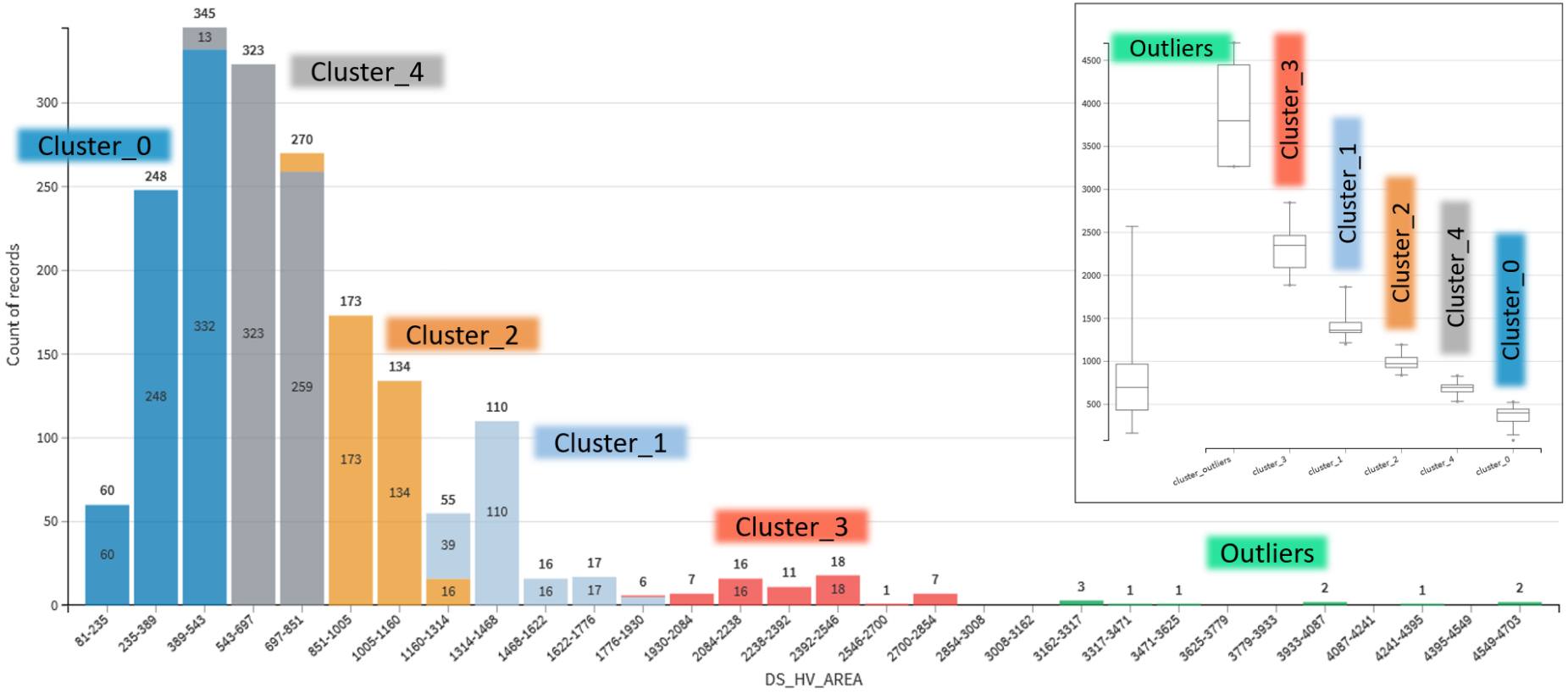


Figure 5.4: Spread of k-means clusters on surface area measurements of square seals

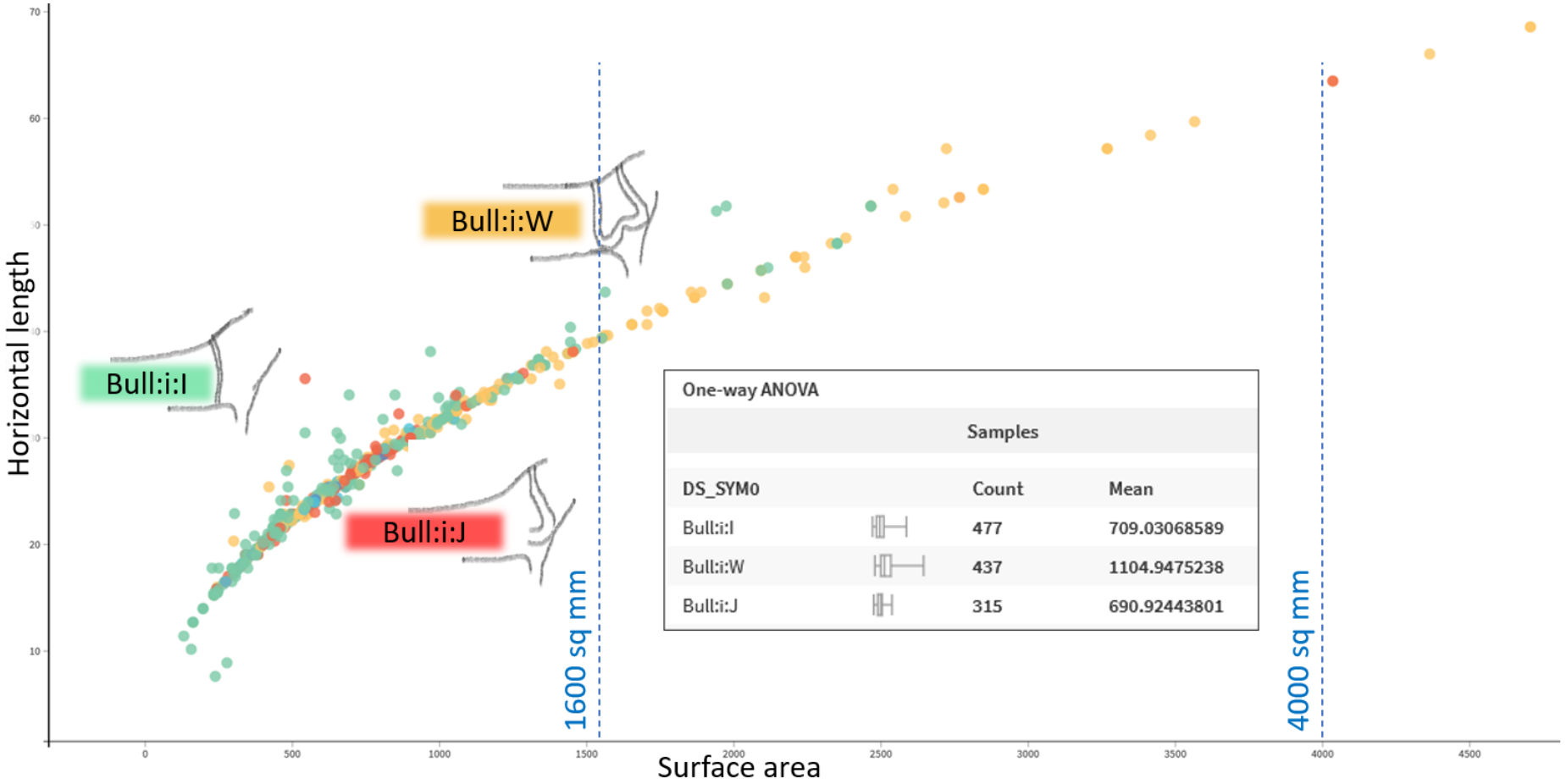
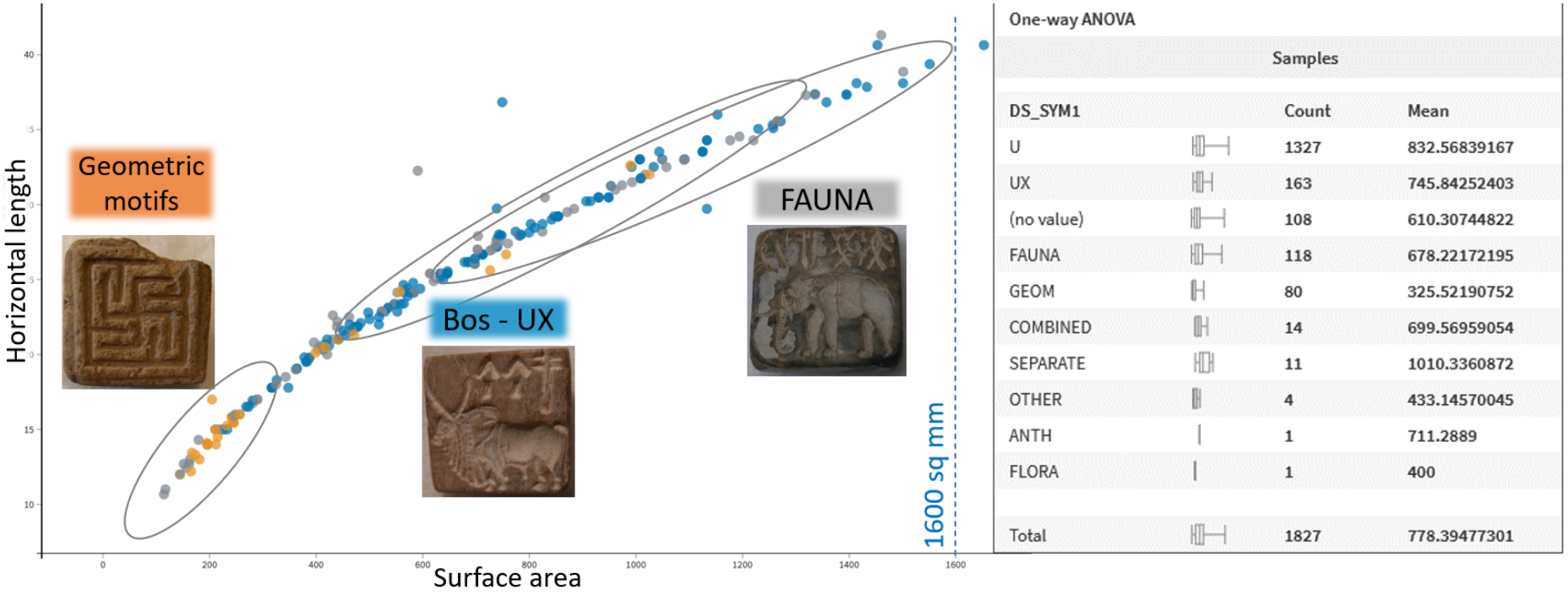


Figure 5.5: Iconography and surface area - unicorn motifs



One-way ANOVA

Samples

DS_SYM1	Count	Mean
U	1327	832.56839167
UX	163	745.84252403
(no value)	108	610.30744822
FAUNA	118	678.22172195
GEOM	80	325.52190752
COMBINED	14	699.56959054
SEPARATE	11	1010.3360872
OTHER	4	433.14570045
ANTH	1	711.2889
FLORA	1	400
Total	1827	778.39477301

Figure 5.6: Iconography and surface area - non-unicorn motifs

In different size clusters, unicorns are generally the largest seals and their sizes span entire range of other iconographies. Within these body decorations Bull:i:J appears on very restricted size range. Zebu, elephant, tiger, and rhino have very rare occurrences on large seals. For geometric motifs, Konasukawa's observations that these mostly belong to smallest groups are corroborated by the clusters too. To understand the relationship of sizes with motifs, he also independently proposed five size groups in the mentioned study. His observations about only the unicorn and zebu being the largest seals or Chanhu-daro being the most diverse smaller site are notable.[20] In addition to his observation of iconographic diversity, MHA data also shows formal diversity at Chanhu-daro with highest DI.

To summarise, creation of five size groups based on seal-surface area could be an improvement over six intuitively defined size groups based on length. The strong association between surface area and iconography supports this grouping.

Note -

As the entire unicorn repertoire is compared with non-unicorn motifs, the *bos* family motifs such as zebu, gaur, and buffalo (DS_SYM1 = UX) are on smaller artefacts and have stringent range of size than other faunal motif. There are various iconographic motifs which appear on different types within MHA. Seals are mainly dominated by unicorn, zebu, elephant, buffalo, gaur, goat, rhinoceros, and tiger. For non-unicorn iconography in square seals, the mean surface areas are statistically different for all the listed icons. Out of other significant depictions of zebu, tiger, gaur, elephant, goat, buffalo, rhino - goat and buffalo size distributions are significantly restricted and different than the rest.[21] Copper tablets, with few shared icons with seals (such as elephant or gaur), have hare or other complex faunal or anthropomorphic image repertoire. Their analysis can be seen in following sections.

5.3.2 Seal thickness

In addition to horizontal and vertical measurements, thickness is another important measure of size. However, it has been inconsistently documented across the excavation reports. For example, Marshall's reports from 1931 do not record it but Mackay's report

20. Konasukawa and Koiso, "Size of the Indus type seals and its Significance," 314.

21. See figure A1.2 in appendix 1

of 1938 does record it.[22] Harappa excavation report from 1940s does not mention it at all.[23] In the light of the documentation challenges discussed earlier. with materials like steatite and faience, different material thickness directly impacts the strength of the object and thus its overall lifespan. In stylistic, typological, and ethnographic studies, this property is not being prominently used. In the light of these material specifics, it is hypothesised that thickness is significantly different for different sizes of the artefacts. To be specific, it is expected that it increases with the increase in size.

The scatter plot (Figure 5.7) shows that the majority of the data supports the hypothesis. Further analysis in the scatter plot shows that artefacts from Chanhu-daro show higher thickness in all size clusters. It appears like a remarkable site specific phenomenon. With excavation reports and typo-technological analysis by Green[24] and Jamison,[25] Chanhu-daro has been identified as an important seal production site. Also, since this is a prominent site of finds of Jhukar material culture, there is a possibility of a site or period specific variation in the basic form of seals which is directly related to their production. Also, Chanhu-daro is the only small site with the largest proportion of signed seals. In fact, if the overall proportion of signed seals is compared across all the sites, then 70% of Chanhu-daro finds are signed seals (Mohenjo-daro 61%, Harappa 14%).

However, a closer look into the documentation shows that these Chanhu-daro seals (and may be some more from other sites too) are probably documented with boss. This has led to the increased values of thickness in the data. The excavation reports do not always mention whether the thickness is measured with or without consideration of the boss.

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22. John Marshall, ed., *Mohenjo-daro and the Indus Civilization: Being an Official Account of Archaeological Excavations at Mohenjodaro Carried out by the Government of India between the Years 1922 and 1927*, vol. 2 (Arthur Probsthain, 1931), 402; Mackay, *Further Excavations in Mohenjo-daro*, I:49

23. Vats, *Excavations at Harappa: Being an Account of Archaeological Excavations at Harappa Carried out between the Years 1920-21 and 1933-34*, 337.

24. Green, "Stamp Seals in the Political Economy of South Asia's Earliest Cities," 300.

25. Jamison, "The organization of Indus unicorn seal production: A diachronic comparative study of style, skill, and sociopolitical organization," 133.

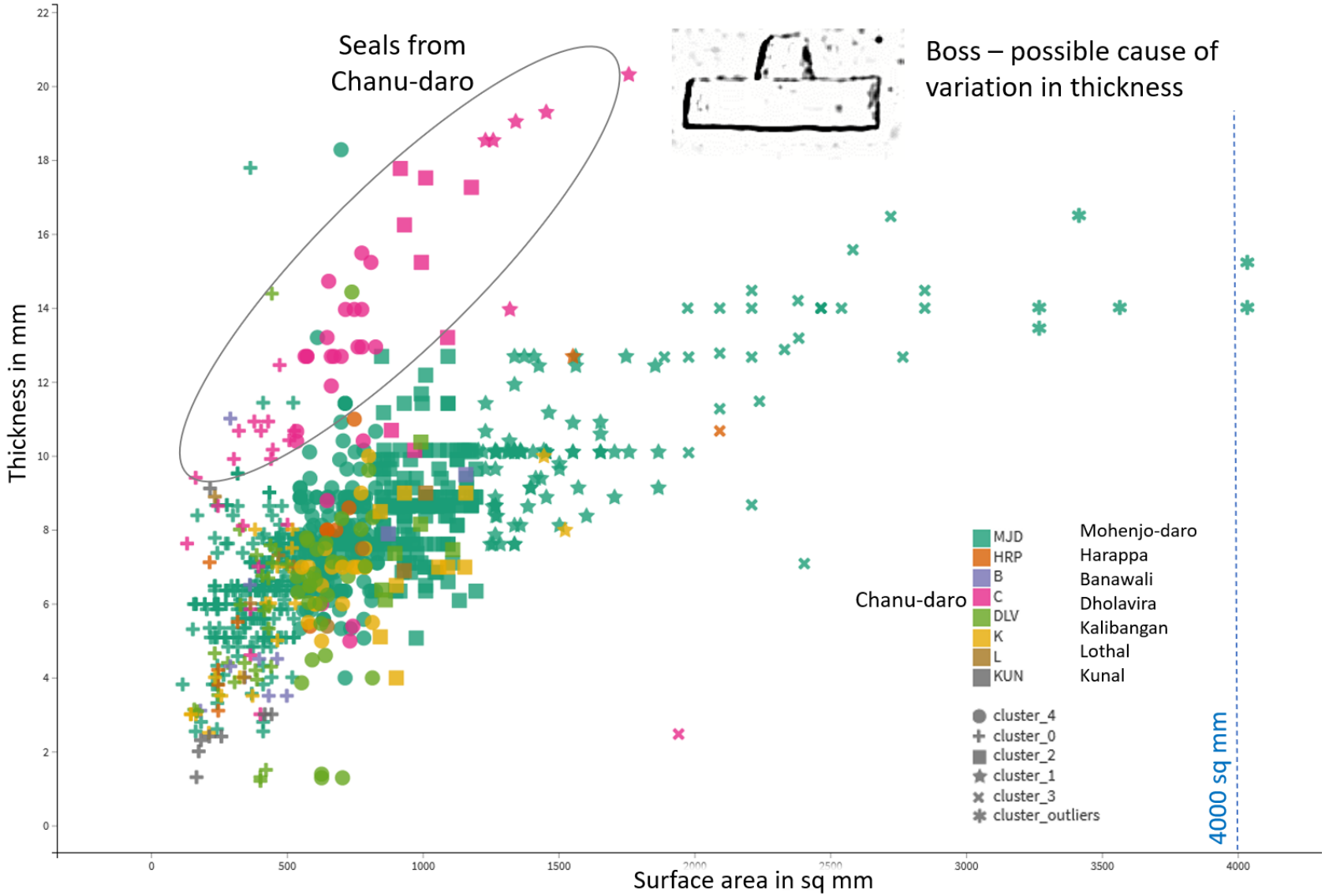


Figure 5.7: Relationship of surface area and thickness - square seals from multiple sites

Thus, despite preparation and cleaning of the dataset with multiple iterations, appearances of such anomalies demonstrate the inconsistency of source datasets.[26] Except for Chanhu-daro seals, even if the above graph suggests that seal area and thickness are proportionate, the box plot shows that thickness is less controlled for different size categories of square seals. It essentially means that the artisans probably had a better control on length and width than the thickness, or surface area was a more critical systemic attribute (and thus being more standardised) than the thickness.

5.3.3 Rectangular seals

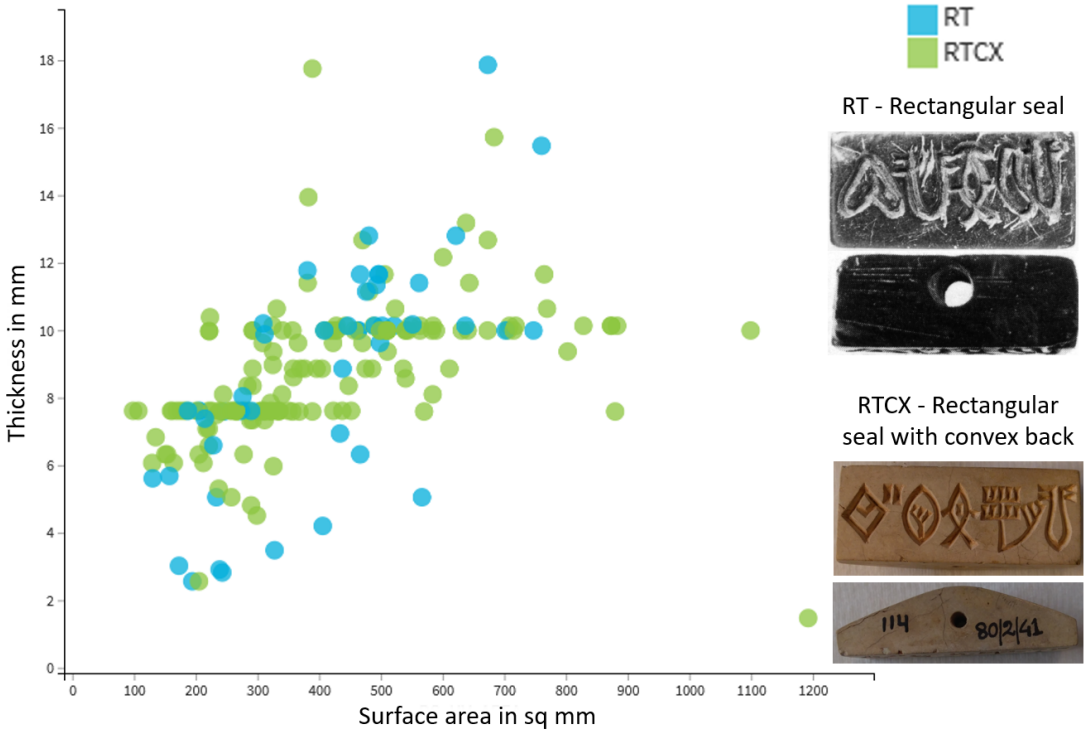


Figure 5.8: Rectangular seals with shape variation

As described in previous chapter, the size groups of rectangular seals are inconsistent across the CISI volumes. Also, there is a form variation of convex back with perforation in some of these seals (Figure 5.8). As the length and heights both vary, in absence of any insight about their purpose, consideration of two different measures for a single grouping

26. The boss and body thickness can be measured if actual artefacts can be accessed or scaled standardised photos are available. Also, there will be a change in both as the size of the artefact changes. Dr Andreas Fuls did some experiments around this but I have not incorporated those here. The graph demonstrates non-standard documentation practices which can lead to erroneous interpretations.

scheme may create more confusion. There are examples where even the shorter seals are broader. Thus, similar to square seals, surface area based clustering is performed. In this case, two size groups and an outlier group are formed as seen in figure 5.9.

In the present dataset, measurements for rectangular seals are available mostly for Mohenjo-daro and Dholavira. Though there is some mapping of CISI groups II and III to clusters 0 and 1, many objects from the first group are identified as outliers. If we try to create three or more clusters, CISI group II gets split beyond recovery. Thus only two groups with detected outliers explain the size variation in this subset. Conditions discussed here create a problem for standardisation of the thickness measurements and thus grouping of rectangular seals based on its overall size is more complex than square seals.

5.3.4 tabB, tabC and tabI

Besides seals, copper tablet is a notable type where size can be measured and analysed in a standardised way. For bas-relief and incised tablets, due to the variation in shapes and twisted forms, standardised measurements cannot be easily devised. Different methods need to be applied to 'measure' these artefacts for understanding the significance of their size. Despite this, basic length (longer extent) and width (smaller side) measurements of the artefacts lead to three broad clusters which are identifiable with tabB, tabI, and tabC. For each of these three types, their affinity to specific sites has already been described.

As we look at comparative surface areas and number of signs in figure 5.10, following observations can be made.

TabI are restricted to a small size with lesser number of signs compared to tabC. Within restricted vertical measurements, tabB artefacts vary in length and also have the presence of an entire range of number of signs. It is important to note that with respect to both size and shape, these are disconnected from each other. In addition, majority of tabB and tabI either have symbols on the reverse side (other than signs) or have signs on multiple sides.

TabC, though collectively visibly bigger than most of tabI and tabB, are divided in three visible size groups. Parpola categorises these in three types based on their shape. Besides the description of the icons, he interprets these as amulets and continues with

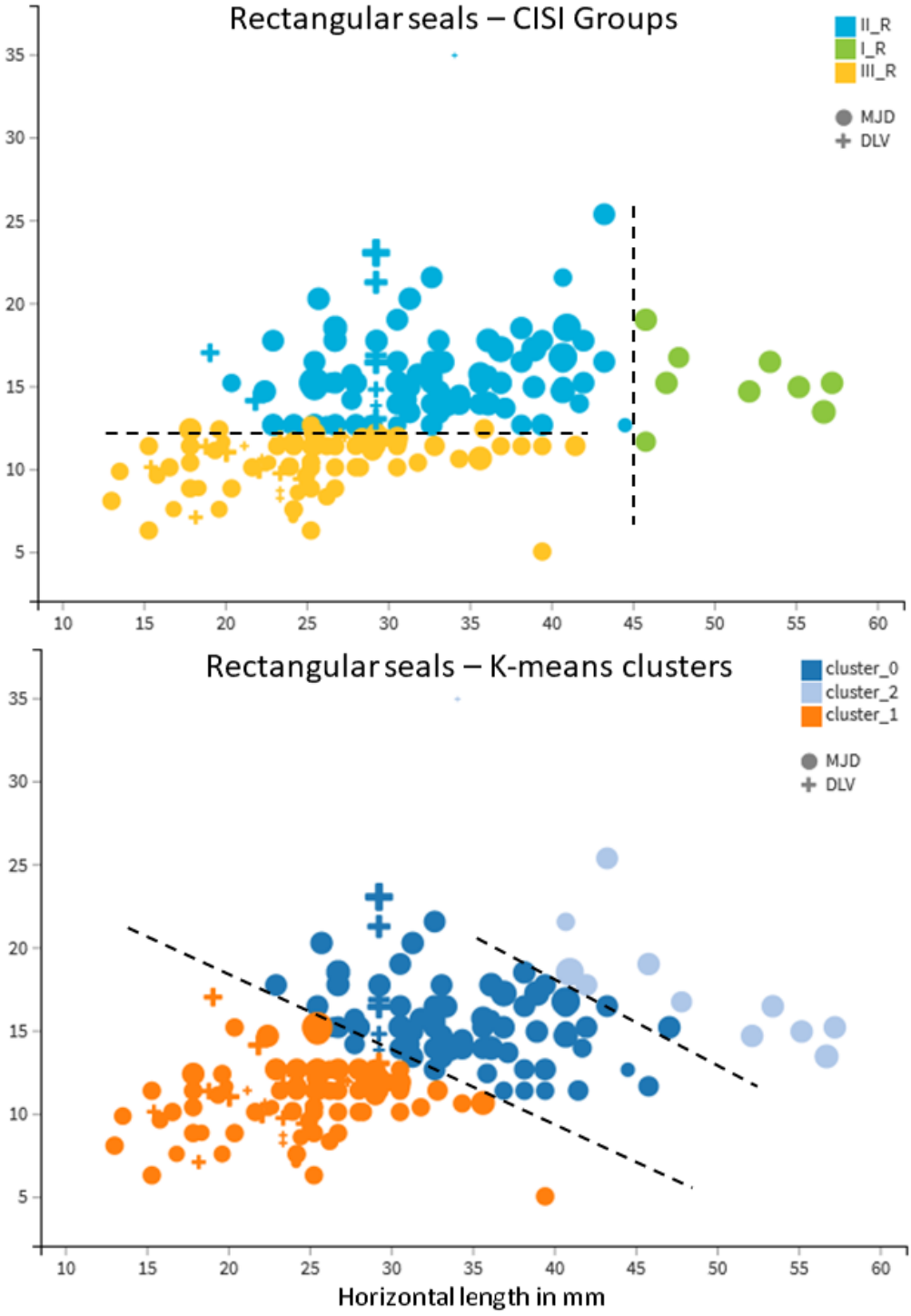


Figure 5.9: Distribution of artefacts in three k-means clusters and three CISI size groups - Rectangular seals

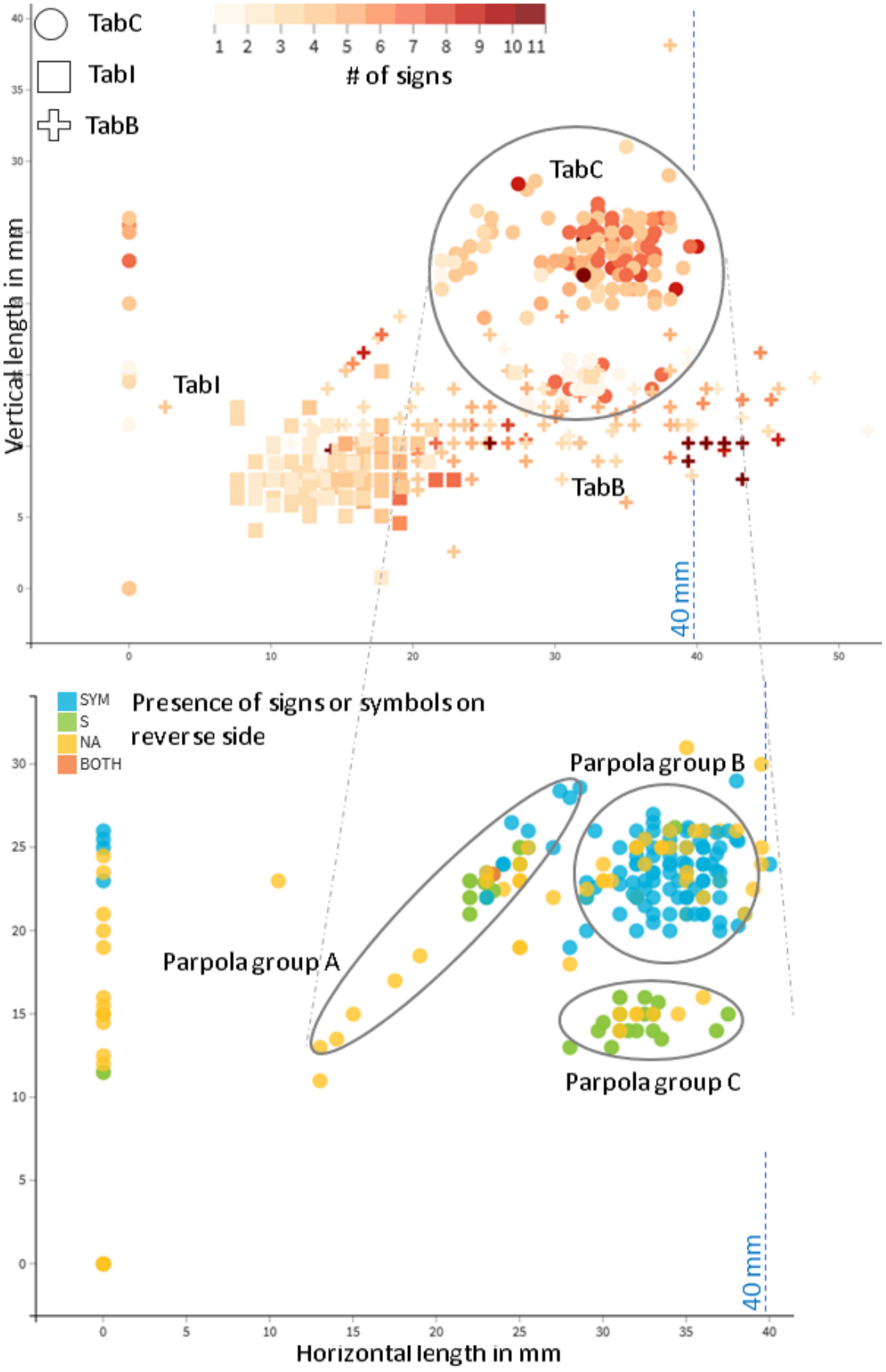


Figure 5.10: Distribution of tabB, tabI and tabC - Relationship with size, number of signs, and presence of signs on symbols on obverse side

Mackay's thought.[27] There is no particular stratigraphic information of these artefacts with respect to their appearance in a particular cultural period. Parpola describes the issues regarding periodisation and problems in identification of their stratigraphic contexts along with a note from Mackay[28] There is a preceding remark by Marshall that these were "... chiefly belonging to the Later Periods."[29] Besides the shapes, it is also seen that Parpola's group B has symbol on the reverse side whereas many in group C have signs on both sides. Group A is a mix of these two. In terms of presence of signs and iconography, tabC can be juxtaposed with seals. Like seals, the majority of sign sequences on tabC appear with animal motifs but these are on the reverse side and facing right. The copper plates discussed in chapter 3 are significantly and consistently larger than all the tablets discussed here.[30]

5.3.5 MHA weights

Consideration of thickness leads to another possible parameter which directly relates to form. Weight of the seal is a result of volume and density of the source material. However, this parameter has not been documented in major excavation reports or other later studies on MHA. Though the source material is steatite in most of the cases, multiple studies by Law[31] demonstrate that it was probably sourced from different mines with varied mineral composition. In Jamison's ethnographic study of seal carving process, the source material was provided by Randell Law from surface collections at Harappa.[32] However, the firing experiment was done based on samples from Daradar Valley. He

27. Parpola, "Copper tablets from Mohenjo-daro and the study of the Indus script," 136.

28. Parpola, Note 3, 37.

29. Marshall, *Mohenjo-daro and the Indus Civilization: Being an Official Account of Archaeological Excavations at Mohenjodaro Carried out by the Government of India between the Years 1922 and 1927*, 2:398.

30. Shinde and Willis, "A new type of inscribed copper plate from Indus Valley (Harappan) civilisation."

31. Law, "Regional interaction in the prehistoric Indus Valley: initial results of rock and mineral sourcing studies at Harappa"; Law, "Moving Mountains: The trade and transport of rocks and minerals within the greater Indus Valley region"; Law, "The important stone and metal resources of Gujarat during the Harappan period"

32. Jamison, "The organization of Indus unicorn seal production: A diachronic comparative study of style, skill, and sociopolitical organization," 256.

observed a reduction in weight from 0.04% to 0.1% for different sizes of the seals and different duration of firing.[33] Whether the mineral content also impacts this reduction in weight needs to be investigated. However, if majority of the seals at a site are assumed to be produced locally, the material could have been sourced from a preferred single locations. Now, in absence of this precise information about actual primary location of seals and provenance of raw material, weights of accessible seals can be measured and modelled with size proportions. Even if the thickness data is inconsistent due to boss, it is hypothesised that weights can be modelled based on surface area measurements. If this modelling is possible and any specific correlations or patterns are observed, those could be indicators of varying densities resulting out of varying mineral composition of original source/raw material. This may indicate that raw material of different qualities could have been used (intentionally or unintentionally) or was sourced from different mines for different artefacts - may be based on their use, owner, or significance. This will need more work to hypothesise any of these relationships.[34]

For 39 seal like MHA observed and documented at Central Antiquity Center, relationship of surface areas and weights is analysed (Figure 5.11). As evident from the figure, this is not a grouping exercise but a simple correlation experiment. Except for broken object H-97, there are two seals M-57 and M-130 which are outliers in a general trend of weights being directly proportional to surface areas. Broken boss could be a possible reason but also if the steatite used in these has a different mineral composition also needs to be checked.

33. Jamison, "The organization of Indus unicorn seal production: A diachronic comparative study of style, skill, and sociopolitical organization," 270.

34. A communication with Adam Green is in progress for collaborative work on weight measurements. For ~180 artefacts that he documented for his doctoral study could be analysed further for more insights into their weight and size relationship.

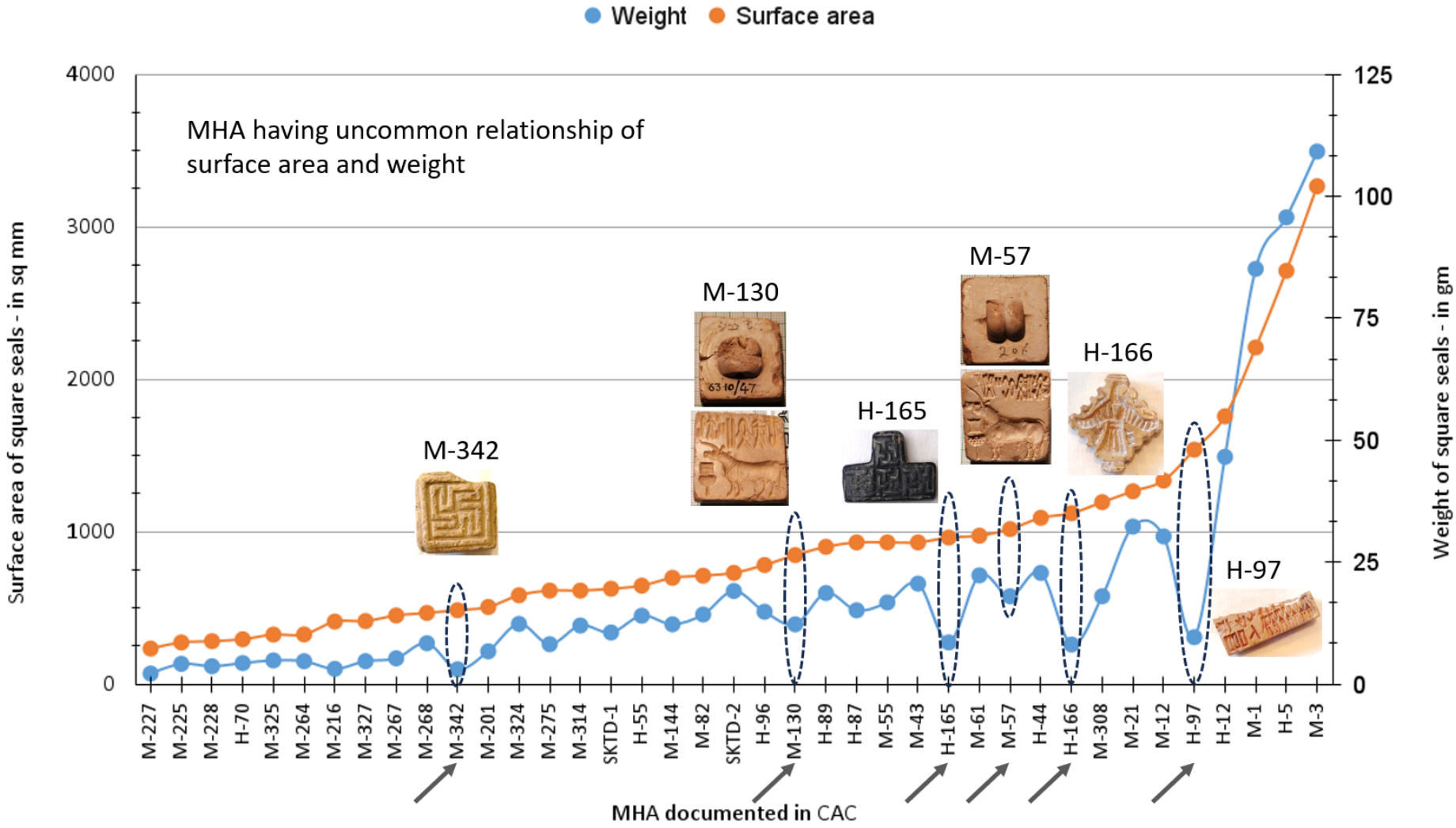


Figure 5.11: Seals from ASI's Central Antiquity Center - Relationship of Surface area and weights

Square seals of same surface area but with and without boss could be analysed further to gauge an approximate weight of boss for respective size groups. For the remaining three artefacts which do not have typical signs and iconography, raw material itself is a most plausible cause. However, as of now, the material is documented as steatite and needs further verification. Though H-165 is an exception to the surface area calculation, these and previous two examples collectively indicate some cultural cause for the observed behaviour of weights.

An interesting but often undermined data point is that steatite, like many other materials, was being used for production of multiple objects such as beads, weights, vessels, figurines, buttons, whorl, inlay, and pin-heads.[35] Thus, its use for seals needs to be contextualised in variety of these other artefacts with possibility of different qualities of steatite being used. Its quality of getting hardened seems to play a role in these objects and so in the seals too.

5.3.6 Shape

With respect to shape, some basic observations can be discussed here. There are variety of shapes in some subtypes such as tabB and tabI. These can be seen in CISI volumes. Rectangular shape is the most ubiquitous shape present in all types except tabI. Though the idea of use of seals and seal impression for trade or economic activities was borrowed and modelled for intaglio carved square unicorn seals, here are some interesting observations with respect to shape.

The cylindrical seals recovered from Harappan context do not possess unicorn motif. There is only one intact seal similar to Mesopotamian art form but it has only two signs in vertical direction.

None of the circular seals, identified as 'Gulf Type',[36] depict unicorn. These mostly

35. Marshall, *Mohenjo-daro and the Indus Civilization: Being an Official Account of Archaeological Excavations at Mohenjodaro Carried out by the Government of India between the Years 1922 and 1927*, vol. 2; Ernest J. Mackay, *Further Excavations in Mohenjo-daro*, vol. II (Manager of Publications, 1937)

36. Laursen, "The westward transmission of Indus Valley sealing technology: Origin and development of the 'Gulf Type'seal and other administrative technologies in Early Dilmun, c. 2100–2000 BC"; Laursen, "Seals and Sealing Technology in the Dilmun Culture: The Post-Harappan Life of the Indus Valley Sealing Tradition"

come from Bahrain and Iraq. These do possess Harappan signs and based on the sign sequence analysis, these probably depict a different language than those in core Harappan region.[37] It must be noted that there are following occurrences of circular seals within Harappan sites - Mohenjo-daro - 7, Chanhu-daro - 1, Dholavira - 1. Except for one seal at Chanhu-daro - C-32, none depict a unicorn motif. Assuming these as specimen of varieties of circular seals (Harappan or Gulf type), there exists only single affirmative circular seal impression or tag at Mohenjo-daro - M-1387. In rest of the cases, though the lump of clay is of uneven shape, the visible impression is by square or rectangular seals.

In rectangular seals, even if the width of the seal increases, we never find multi-line sign sequences.

5.3.7 Seal size and iconography

Size is a result of varied amount of material that conforms to a specific shape. The shape may thus take precedence in attribute hierarchy over the size. For a given shape, the required material and skill for creation of signs and symbols on different sizes could have been employed based on their systemic demand. Thus, the size is used to assess its relationship with sign properties and iconographic attributes.

Carving sequence

Square seals which possess both iconography and signs, occasionally showcase crowding of signs on either of the end. As described by multiple scholars, this is probably due to the carvers running out of space.[38] To record this unevenness, Wells and Fuls[39] have described attributes called sign-height and sign-alignment, populated based on empirical observations of actual artefacts or their photos. Together they indicate the degree of unevenness in the arrangement of signs in relation to themselves and iconography on the same surface. Green translates this variation to “The Two-Stage Sequence: Scribes and

37. Laursen, “The westward transmission of Indus Valley sealing technology: Origin and development of the ‘Gulf Type’seal and other administrative technologies in Early Dilmun, c. 2100–2000 BC.”

38. Possehl, *Indus Age: The Writing System*, 59.

39. Wells and Fuls, “Online Indus Writing Database.”

Carvers" and identifies it as one of the contributors in the identification of ACGs.[40] He defines Type1 for the artefacts which were likely carved without any space restriction; the signs were carved prior to the iconographic motif; hence those are more uniform and are evenly spaced. Type2 has the crowded signs which were probably inscribed after the motif was in place. Green has proposed that inscription of signs and carving of motifs was done by multiple artisans.[41] Some examples of possible Type1 seals are H-611 and H-688[42] as opposed to possible Type2 M-1208 and H-612.[43] In present dataset, the square seals with valid size measurements, roughly 50% (782 out of 1578) have 'Equal' sign-height and more than 65% (1081 out of 1577) have 'Linear' sign alignment. Also, it is observed that Type2 is most common in Green's dataset (126 out of 188) and is seen on relatively smaller seals. In Green's type1, proportion of larger seals is higher than that in type2.[44]

Unicorn motif

The hatched face unicorn motif mostly appears on larger seals (Figure 5.12). It is a characteristic of second group of Franke's stylistic grouping scheme[45] and Rissman's second group.[46]

40. Green, "Stamp Seals in the Political Economy of South Asia's Earliest Cities," 127.

41. Green, 145.

42. Shah and Parpola, *Corpus of Indus seals and inscriptions - Collections in Pakistan*, 2:301, 312.

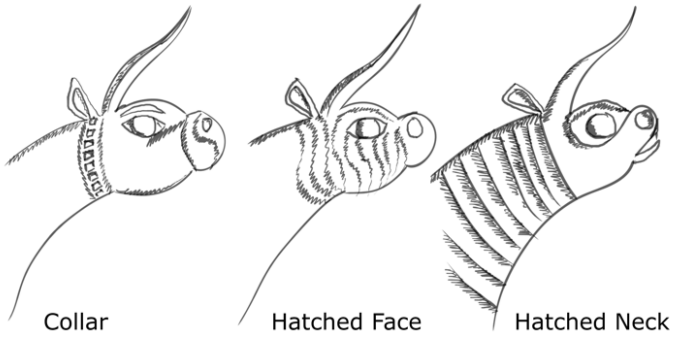
43. Shah and Parpola, 2:148, 312.

44. This characteristic is used only for primary observation. Sign-height attribute if used from ICIT to speculate about the tentative proportions of two sequences of carving. Green has used this as a foremost major dimension of variability in the operational sequence. He notes that in the multi-staged process, prioritisation of carving of signs or symbol was the primary task and those could have been carved by different artisans.

45. Franke, "Inscribed objects from Mohenjo-Daro: Some Remarks on Stylistic Variability and Distribution Patterns," 104.

46. Rissman, "The organization of seal production in the Harappan Civilization," 164.

Unicorn decorative motif and their relationship with surface area



DS_UNICORN	Count	Mean
(no value)	673	717.84341281
Collar	531	781.32325856
Hatched N	490	693.17410878
Hatched F	117	1475.5716372
PL	14	719.18130911
Hatched FN	2	885.125
Total	1827	778.39477301

Ute Franke's iconographic groups and their relationship with surface area

FRK_30SEPT_GRP	Count	Mean
1.0	214	819.99474961
1.1	131	826.20734447
3.3	124	678.11211168
3.2	110	667.37605456
3.1	52	853.91406624
2.0	36	1998.785936
Total	667	835.93572943

Paul Rissman's iconographic groups and their relationship with surface area

RISS_30SEPT_GRP	Count	Mean
1	399	780.45375795
4	118	687.33603057
2	48	2000.0493356
3	35	875.10992662
Total	600	865.22986095

Figure 5.12: Relationship of surface area with Unicorn decoration and iconographic groups

Besides those, each of the iconographic groups defined by them have specific size range and the relationship is statistically significant. It thus indicates possible intentional choices of size for peculiar motif combinations. As per Franke's analysis, hatched face motif is in higher proportion than expected (normal distribution) in DK-C, HR, VS and Late period at DK-G. Besides the unicorn neck decoration, the lip and flow characters for the stand like object are least granular, i.e. with only two possible values for each; peaked or flat for lip and Y or N for flow.[47] For the same object, mentioned as offering stand by Jamison, he has defined 114 types.[48] He has created 'types' of almost all possible 126 combinations of Rissman's attributes. Jamison may have some more variants due to separation of decorative details and/or variety due to cumulative addition of new data. However, Rissman's attributes for lip and flow continue to be valid due to the visible separation of carving style. Based on the observations of these decorative motifs, lip and flow require more detailing and hence it might be easier to carve these features on larger surface area.

Non-left facing faunal Motif

The area-thickness range for all non-left facing animals is restricted to the lowest range in the available spectrum. This includes unicorn as well as goat or three headed animal. However total count is significantly small than the left-facing motifs. Jamison identifies seals of this peculiar iconography as associated to period 3A.[49] His proposition is based on earlier work by Kenoyer.[50] Kenoyer had hypothesised this chronological variation based on his observations of artefacts at Harappa. This needs to be checked in micro-contexts in different sites such as Banavali, Dholavira, Kalibangan, and Mohenjo-daro which are major contributors to these finds. In doctoral work by Konasukawa,[51] his analysis concludes that seals with right-facing animal motif are prominent feature for

47. Rissman, "The organization of seal production in the Harappan Civilization."

48. Jamison, "The organization of Indus unicorn seal production: A diachronic comparative study of style, skill, and sociopolitical organization," 322.

49. Jamison, 394.

50. Kenoyer, "The origin, context and function of the Indus script: Recent insights from Harappa," 18 (possibly incorrectly cited by Jamison).

51. Konasukawa, "Diversity of Harappan civilization: a case study of the Ghaggar basin with special reference to seals."

the region of Ghaggar basin.

	Face direction of animal motifs on seals							
Site name	L	R	R3	RL	L-R	LR	L3	R2
Mohenjo-daro	1065	18	1	1	1	3	2	1
Harappa	344	4	0	0	0	0	0	0
Dholavira	71	6	3	1	0	0	0	0
Chanhu-daro	49	4	1	1	0	0	0	0
Lothal	51	1	0	0	0	0	0	0
Kalibangan	34	13	1	2	0	1	0	0
Banavali	2	15	0	1	0	0	0	0
Nausharo	11	4	0	0	0	0	0	0
Others	57	24	2	0	3	0	0	0

Table 5.5: Distribution of seals in sites based animal facing direction

Though the higher % could also be a result of unequal excavations, strikingly low proportions in Gujarat, Sindh, Baluchistan, and Punjab region do highlight the regional characteristic. It is important to triangulate these observations which may lead to spatio-temporal-typological interpretation of these artefacts.

Carving - Possible constraints

The next analysis deals with the typo-technological attributes. As discussed in chapter 2, different scholars have investigated production techniques of seals. Based on the carving sequences and number of eye and nose strokes, collectively termed as operational carving sequence, Green has proposed a scheme of ACGs.[52] He has identified the groups purely based on these attributes. For those groups, he has made several observations regarding the size ranges of seals within each group and at times possible reasons for variations - “A social constraint ..... impetus to fit a certain motif .... into a carving field ... .”[53] He has also observed carving quality being impacted due to size; “Sloppy carving sequences correlate with the size of a seal. Smaller seals were more difficult to

52. Green, “Stamp Seals in the Political Economy of South Asia’s Earliest Cities.”

53. Green, 188.

carve, and tend to have more overlapping or extraneous strokes."[54] Observation related to size of the seals as becoming more standardised from Intermediate III to Late II-I has been interpreted as "Emerging links between carvers may have helped them regulate the size and shape of seals."[55]

Green comments about possible sharing of the size and shapes by carvers but he has not accounted for those in actual group formation.[56] The previous section has demonstrated that there is a close relationship of stylistic attributes and size. I thus propose that the thickness, size, and overall strength of the artefact will influence carving. Green's data published in his doctoral work allows to conduct this test.

Association of surface area and thickness within Green's ACGs

GREEN_ACGRP	Count	Mean	GREEN_ACGRP	Count	Mean
1	13	638.18176674	1	13	7.7312495385
2	9	1002.3356286	2	9	8.4808184444
4	8	729.13340915	4	8	7.68767075
3	7	515.289292	3	7	6.7707317143
7	6	815.28743593	7	6	8.1847073333
9	5	804.4374256	9	5	7.4344488
Total	48	743.15391012	Total	48	7.7502205417

Figure 5.13: Association of surface area and thickness (both in mm) within Green's ACGs

Statistical tests which compare area and thickness for Green's ACGs show that those are not same amongst all the ACGs (Figure 5.13). Due to the small group membership of ACGs, only the first six ACGs are considered for this analysis. Area is more significantly different than thickness. It thus demonstrates that carvers who employ specific carving techniques and sequence, probably work on seals in a specific size range only. It must be noted that due to small dataset, the tests have rendered invalid. However, the specific ranges of sizes are evident from the box-plots.

54. Green, "Stamp Seals in the Political Economy of South Asia's Earliest Cities," 172.

55. Green, 342.

56. Green, 114.

5.4 Signs and their context

The academic gap between the decipherment and typologies was described at length in chapters 2 and 3. In addition to it, the data preparation chapter also discussed advantages and rationale for the use of Bryan Wells ICIT sign-list[57]. In the present project, the data is enhanced to record the sign sequences in a different order. Though the current project is not aimed at decipherment or reading of the signs, one of the main aims is to understand the sign sequences in their immediate and extended contexts. In this case, context is a framework of attributes that can help compare these signs and hence help interpret their possible meanings. It must be realised that at any given point in time, several contexts are at play. From the example analyses in earlier sections, the seals can be thought of in different contexts such as (i) artisanal manufacturing context, (ii) motif group representing a probable symbolic context (iii) repetitive use for impressions within the usage context, or (iv) steatite sourced from different geographies as a pre-production context. On the similar lines, signs appear in multiple contexts. Acknowledgement of these contexts, their relationships with each other, and their contribution to the possible emergent properties of signs is discussed in this section.

Many of following analyses have been performed on MHA records. As described in the earlier chapter, the increased number of records is a result of multi-sided artefacts and their documentation. In some analysis, MHA themselves have been used.

5.4.1 Sign presence

To begin with, a bird's eye view is taken for the presence and absence of signs on different artefacts, total number of signs appearing in different sequences, and solo signs. There are 880 artefacts without signs; seals contribute to almost 60% of those. Though entire dataset is dominated by single sided artefacts, tabI, tabB and tabC have significant contribution of 2-sided objects.

Single signs, which appear in isolation, may indicate a semantically complete content in the given context (Figure 5.14). There are 627 occurrences of solo signs on diverse MHA (66 are rendered non identifiable, thus the number brought down to 561).

57. Wells, *An introduction to Indus writing*; Wells, *Epigraphic Approaches to Indus writing*

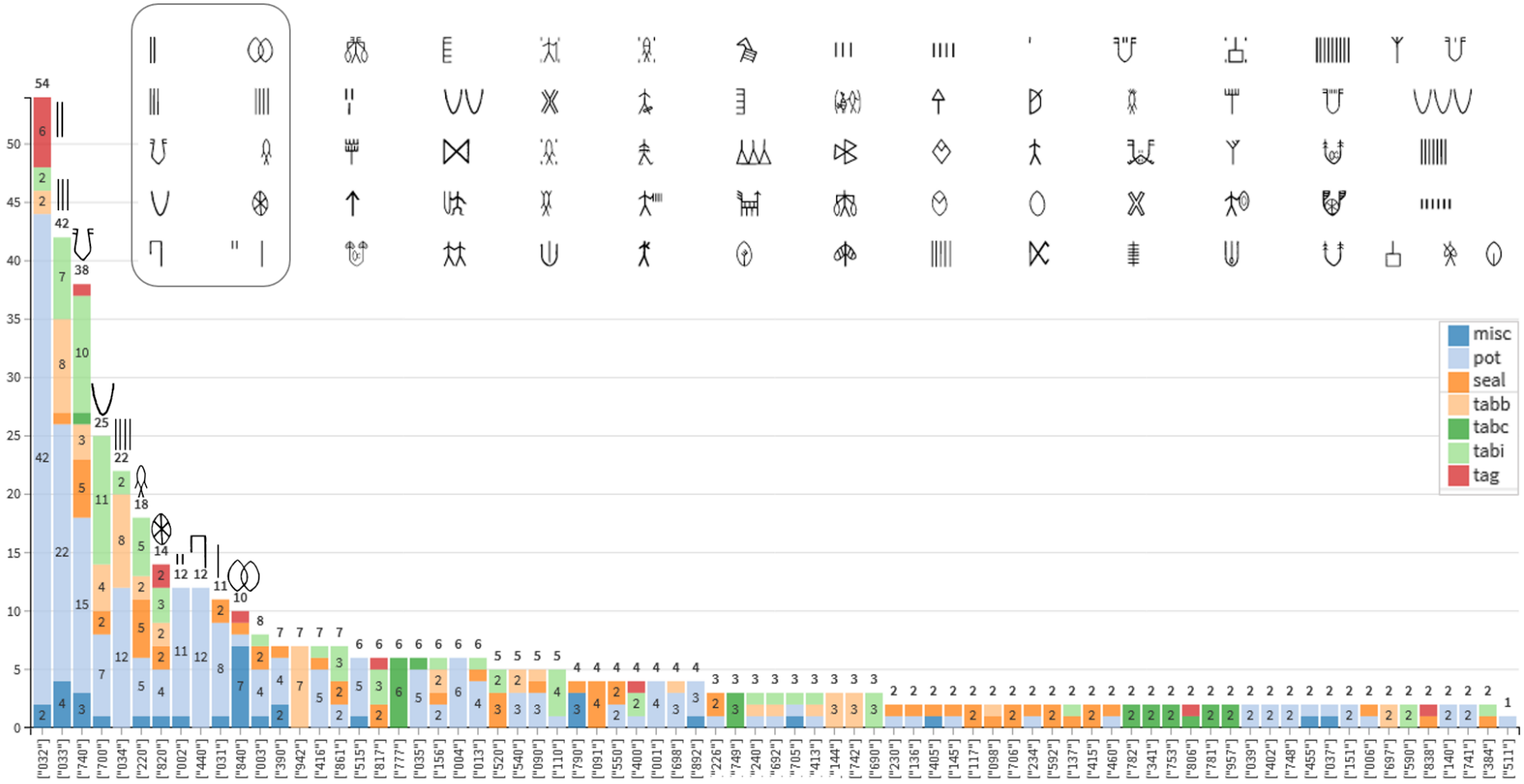


Figure 5.14: Appearance of solo signs on different subtypes

In these total occurrences, there are 161 distinct signs which have different repeating frequencies. Out of these, 87 appear only once across the artefact types. In the basic subtypes, pot and tabB have repetition of a small number of unique signs but their total occurrences are more than the combined numbers of seals and tabI objects. Ceramic marks have been analysed in multiple ways such as location of marks, pre- or post-firing mark, painted and their possible connotations in contemporary cultural contexts.[58]

	Misc	Pot	Seal	tabB	tabC	tabI	Tag	Total
No of Unique Solo Signs	6	23	34	5	4	9	6	87
Total MHA with Solo Signs	39	245	94	59	26	78	20	561

Table 5.6: Solo signs across subtypes

These solo signs thus demonstrate a systemic significance based on these parameters. Seals on the other hand, have a large number of unique signs with very few repetitions showcasing their tendency to be unique (Table 5.6)

As seen in figure 5.14, the most frequent solo signs and their counts are 𝍣 - 54, 𝍤 - 42, 𝍥 - 38, 𝍦 - 25 and 𝍧 - 22. First four out of these are also from a list of top most frequently occurring signs.[59] Harappa is the major contributor due to pot and tabI quantities. TabC, tabB, and tabI have majority of the single signs on two-sided objects, where as for seals, tags, pots and miscellaneous artefacts, single sign appears rarely on multi-sided artefacts.

For total number of signs, they roughly correlate to the artefact type they appear on. Seals are the only major contributors for longer sequences. Two-sign sequence is most common in pots, tabB and tabI, but seals have an almost uniform preference for up to six signs. Seals and tags are tightly linked to each other because of their perceived use but longer sequences on tags are very rare. TabC are the only MHA category where longer sequences of four, five or seven signs are more frequent than short sequences of two or three signs.

58. Nicolle Hirschfeld, "How and why potmarks matter," *Near Eastern Archaeology* 71, nos. 1-2 (2008): 120–129.

59. Wells, *Epigraphic Approaches to Indus writing*, 69.

5.4.2 Sign sequences - Immediate context

Though the above data showed preference for number of signs by types, it is already observed that unlike seals which are more unique in nature, tabI or tabB have many duplicate sequences amongst themselves irrespective of the total number of signs.[60] Figure 5.15 shows the ICIT sign sequences in descending order of total occurrences and visualise by subtype.

Both tabB and tabI share many sequences which are duplicate across both types. Even if tags follow the same order of sign sequences (reversed from seals due to impression and thus for use like tabB or tabI), they rarely share sequences with other subtypes and tend to be unique. TabC has many duplicates within its own subtype and does not share the sequences with any other subtype. Seals share sequences with tabB and tabI to certain extent (mostly limited to smaller sequences only) but rarely with pot or tag. In fact, pot and tag are two subtypes which are presumed to be created using the seal impressions, and tabB by using moulds different than the seals.[61] When checked in ASIS, the seal sign sequences are almost unique. This combined quantitative observation severely constraints the seal-sealing hypothesis.[62]

Different orders of sign sequences in MHA dataset can be compared to see which peculiar sequences are duplicated across the subtypes. With ICIT sequence, there are 25 repeating sequences within the seal subtype and 1288 are completely unique to those. Since this order of sign sequences depicts proposed impressions, those sequences could be found on other subtypes. However, their absence indicates either the content of seals (impressions) and other subtypes is totally different or it is not necessary to assume the reversal of sign sequence. The observation is statistically against the seal-sealing theory. The numbers again show the tendency of seals to be unique.

60. Kenoyer and Meadow, “Inscribed objects from Harappa excavations 1986–2007,” xlix.

61. Ameri, “Letting the Pictures Speak: An Image-Based Approach to the Mythological and Narrative Imagery of the Harappan World,” 146.

62. Joshi and Parpola, *Corpus of Indus seals and inscriptions - Collections in India*, 1:xv.

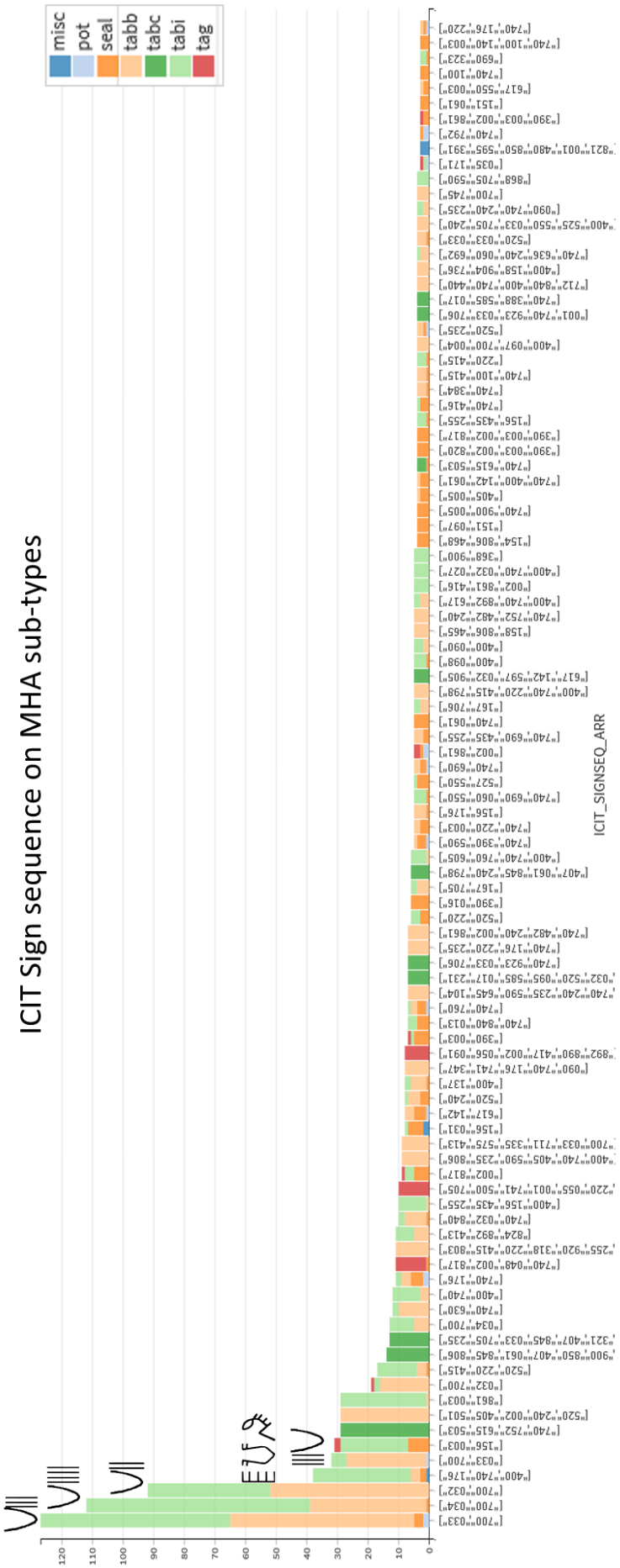


Figure 5.15: ICIT sign sequences across subtypes

Besides this small number, there are following examples which duplicate on tags and only four out of these could be possible pairs of seals and impressions (Figure 5.16 - Seal numbers from L to R - M-179, M-1697, H-499, M-122).

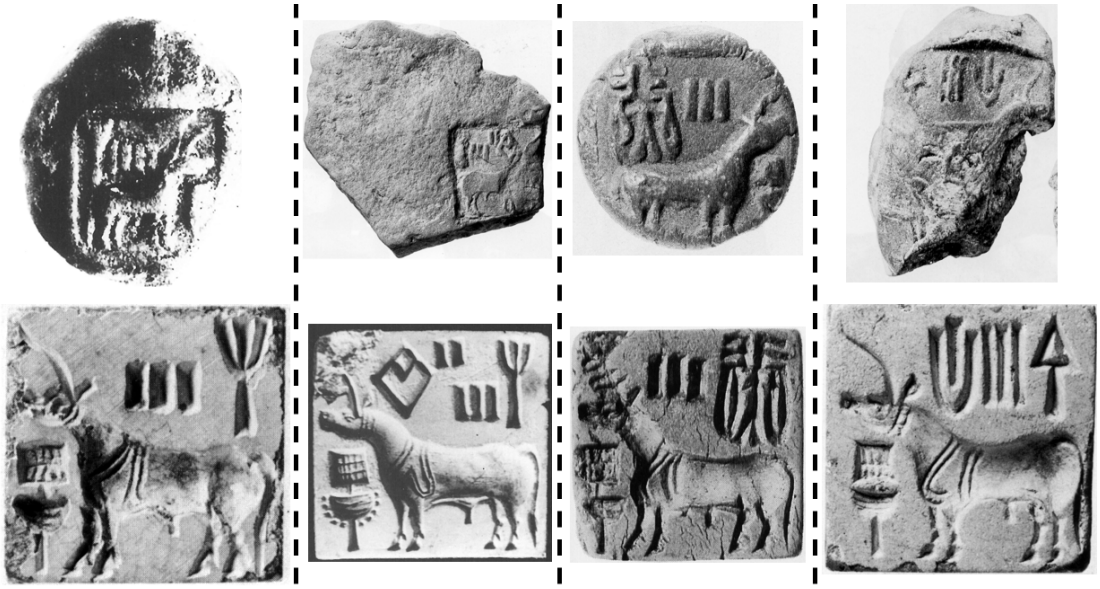


Figure 5.16: Possible examples of pairs of seals and impressions

- 002, 861 - " 𒄯 - There are two pot graffiti, two impressions and 1 seal. However these can not be confirmed as pairs due to the state of preservation.
- 740, 048, 002, 817 - 𒍪 (𒐈) " 𒁲 - One seal and 10 impressions with matching sign sequence but icon mismatch.
- 740, 585, 017 - 𒍪 𒂗 𒐈 - One seal and one impression but graphic details do not match.
- 002, 817 - " 𒁲 - Five seals and one broken impression
- 390, 003, 002, 861 - 𒀸 𒐈 " 𒄯 - There are two seals and one impression and is a possible example of pair
- 520, 033, 705 - 𒀀 𒐉 𒌋 - Only one broken seal but is a possible example
- 156, 003 - 𒌨 𒐈 - Seven seals and 2 impressions - possible example
- 390, 003 - 𒀸 𒐈 - Two seals and 1 impression - possible example

ASIS sequences have many duplicates within subtypes, 1319 sequences are completely unique to seals. There are examples where common sign sequences are found on seals and non-seal MHA. Whether it means that those sequences on seals may not be interpreted in the impression but as seen on the original object?

In ASIS sequences, there are following sequences which duplicate mostly on tabI or tabB - 400, 156, 384, 031 - 𒂗𒍪𒄿 ; 740, 388, 031 - 𒌅𒄿|; 840, 032, 740 - 𒀀𒉿𒌅; 033, 700 - 𒉿𒌋; 156, 003 - 𒍪𒁹; 323, 690 - 𒃻𒀯; 390, 003 - 𒀸𒁹; 617, 142 - 𒊹𒊹𒀭.

Figure 5.17 shows samples of few more cases where those also duplicate on seals. (Seal numbers from L to R - M-673, H-441, M-37, M-208):

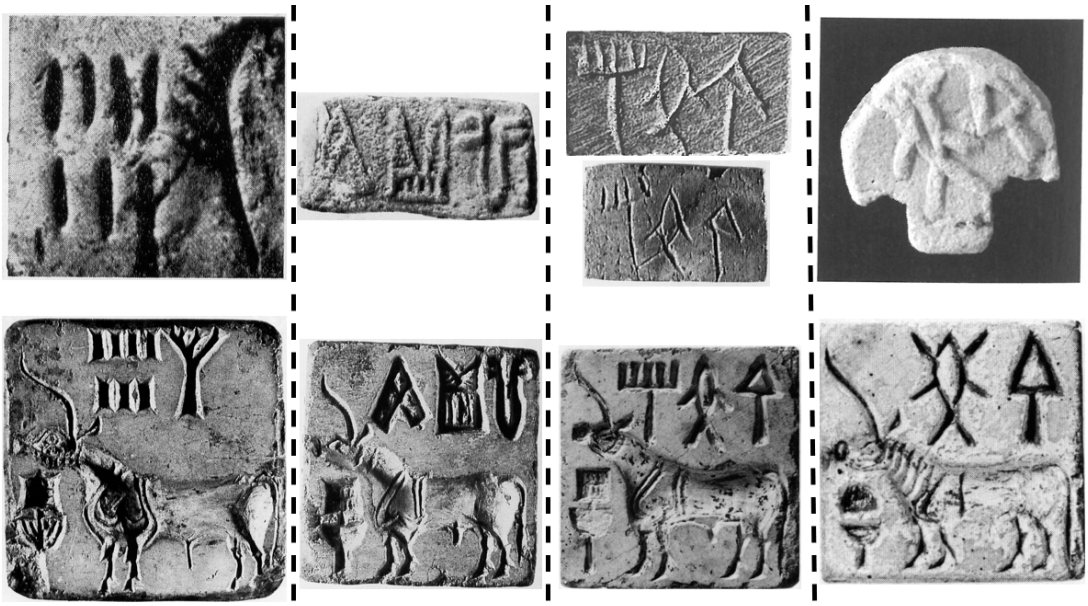


Figure 5.17: Possible examples of seals not used for impressions

- 415, 220, 520 - 𒀸𒄑𒄠
- 484, 337, 740 - 𒀊𒃻𒌅
- 017, 405 - 𒁹𒀸
- 240, 520 - 𒄑𒄠

M-176 and K-61 are examples of square and rectangular seals with same signs, i.e. (𒀯 and 𒌅) in 2 different orders. It shows that reverse sequence can also appear on seals. The uniqueness of sign sequences in seals is further investigated by splitting those into multiple sites. In both ICIT and ASIS, longer sequences in seals tend to be more unique across the sites (Figure 5.18).

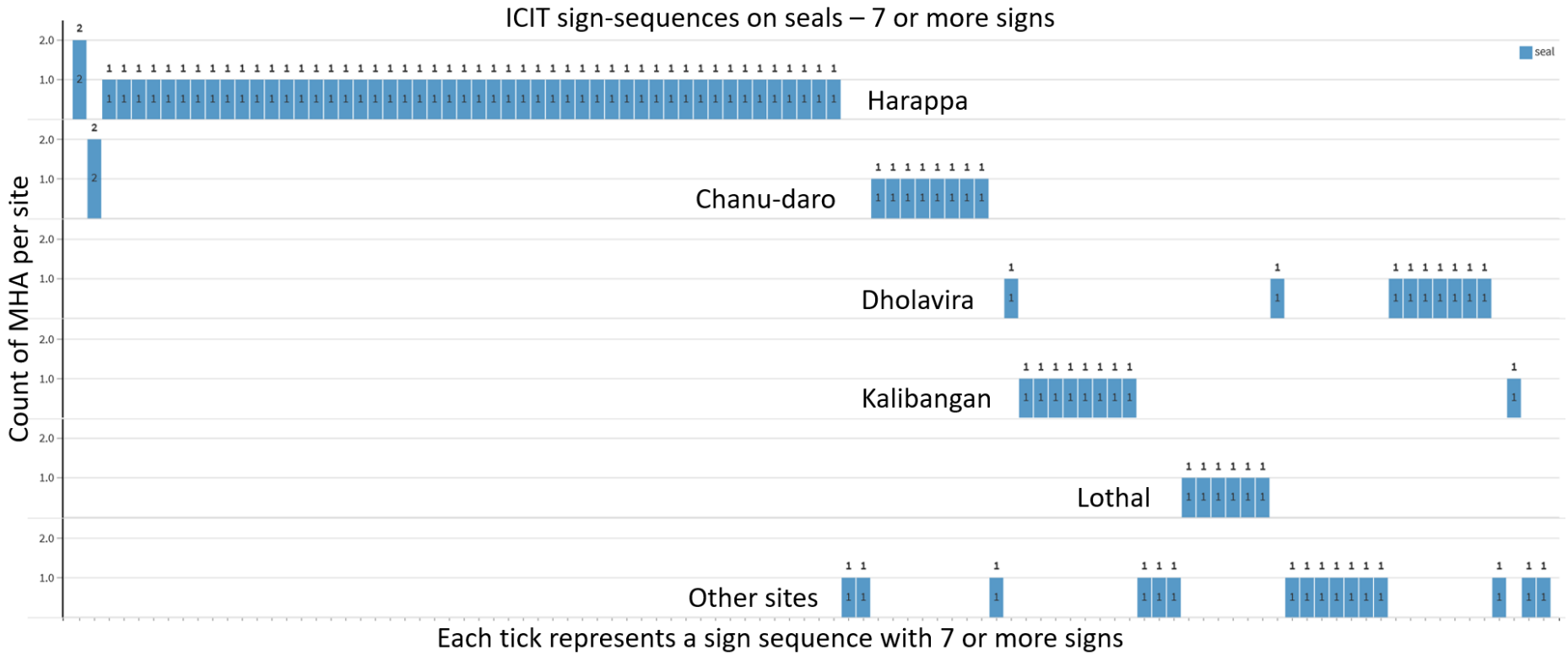


Figure 5.18: Uniqueness of long sign sequences on seals across sites

5.4.3 Utilitarian contexts

In the more utilitarian category than seals, such as ceramics or pots, it is possible to explore if the uniqueness of signs has propagated further within that subtype. On ceramics, the signs appears in three main techniques - incised (generally post-firing), impressed (pre-firing, possibly by a seal like object) and painted (relatively rare).[63] The visualisation of most common sign sequences of ceramics based on their technique of production across sites offers some interesting observations -

- For tags, despite the same technique of impression, they are almost unique in all major sites. - Figure 5.19
- The sequences marked on pots differ based on the technique such as incisions or impressions or painting. Even for a given technique, there is almost no repetition amongst multiple sites. - Figure 5.20
- In addition, for a specific technique like impression, what is impressed on pot is different than that of tag and also varies across sites. - Figure 5.21
- Another aspect which is critical for content, placement, and type is number of sides on which the signs appear. Depiction of signs and symbols on single or multiple sides is a choice because it facilitates or restricts certain usage of the artefact. For example, artefact without boss and multi-side engraving makes it difficult to handle the object. For tabB, tabC, and to some extent for tabI, it is observed that based on whether the artefact is single sided or multi-sided, the choices of sign sequences are different. This observation is directly related to the content and consumption of MHA, and shows the sensitivity of content to seemingly less prominent aspects of the artefact from its consumption point of view.

63. Kenoyer, "Painted Indus Script on Ceramics and Steatite:: New Insights on Indus Script Calligraphy and Function."

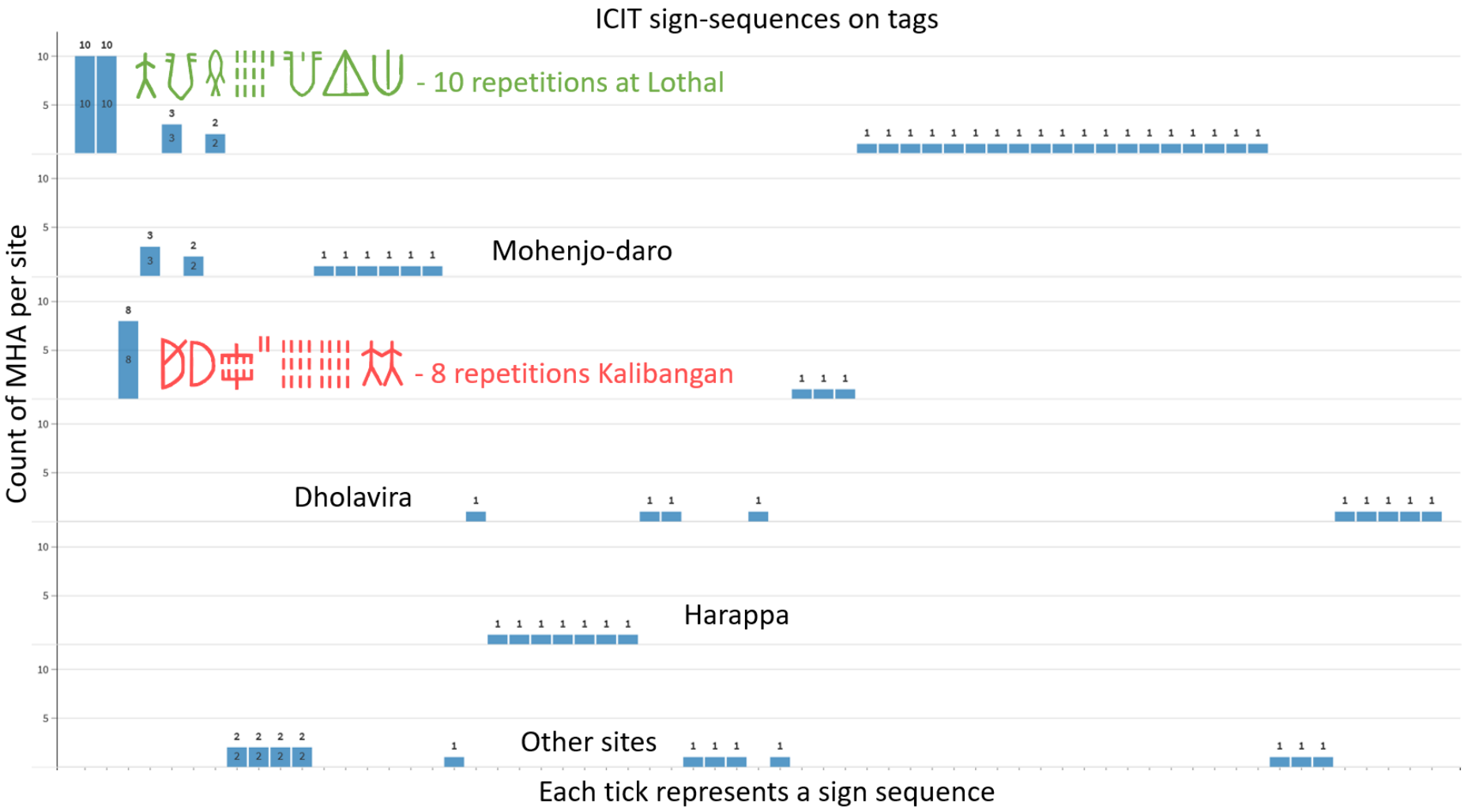


Figure 5.19: Uniqueness of sign sequences on tags across sites

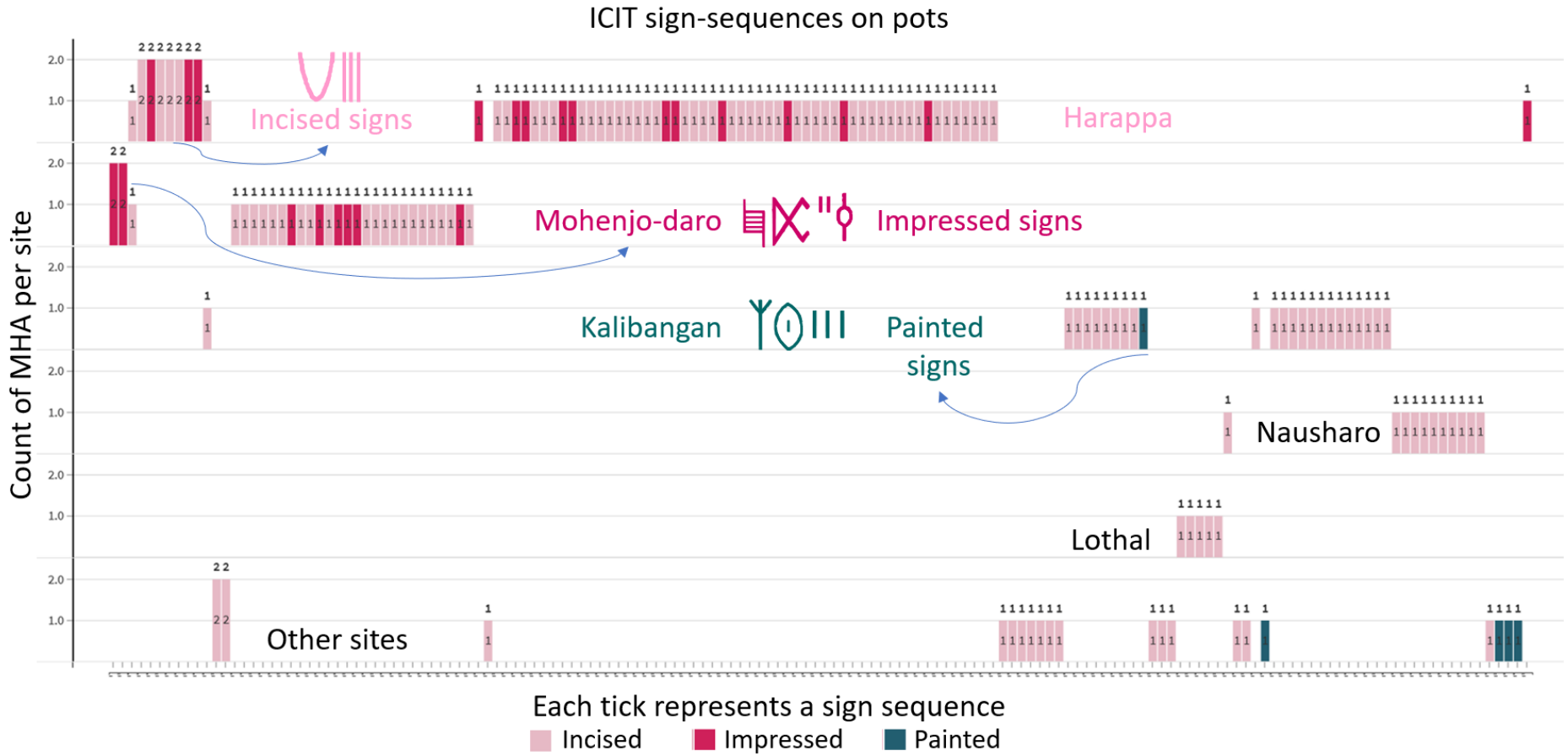


Figure 5.20: Uniqueness of sign sequences on pots across sites - based on technique of sign production

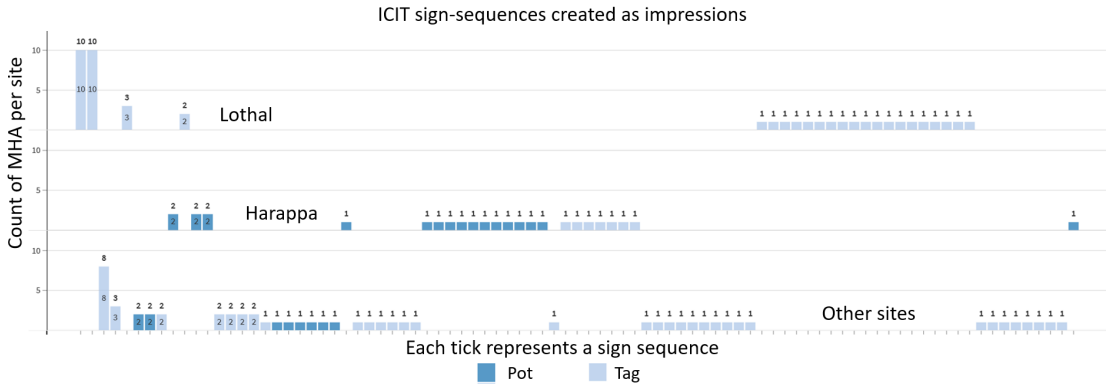


Figure 5.21: Uniqueness of sign sequences on tags and pots across sites - Created using impression in both cases

With the earlier observations about lack of pairs of seals and tags, these points create a possibility that only a few seals may have been used for impressions. The experiment to create ASIS sequence for seals and these observations about sensitivity of sign sequence to types, technique, sites, and sides indicate that uniqueness of sign sequences could have a systemic reasoning. Uniqueness of seal and non-seal types to sites indicate that the content is sensitive to its immediate and broader context. Thus, accumulation of all sign sequences as a statistical sample for prediction may be unwarranted.

5.4.4 Space and signs

The analysis of artefact size from the previous section is used here to correlate the available carving space with the occurrence of signs. A foremost logical space constraint that can be hypothesised is that a higher number of signs will be seen only as the size of the seal increases. It is important to observe if the data shows space as a limiting factor or skills and tools overcome it. When this hypothesis is tested on both square and rectangular seals, slightly different trends are seen. Direct correlation of increasing number of signs to the increasing area is more evident in rectangular seals than those of square seals. In both cases, four or five are the most frequent number of signs. Also, frequency of artefacts with six or more signs significantly drops (Figure 5.22).

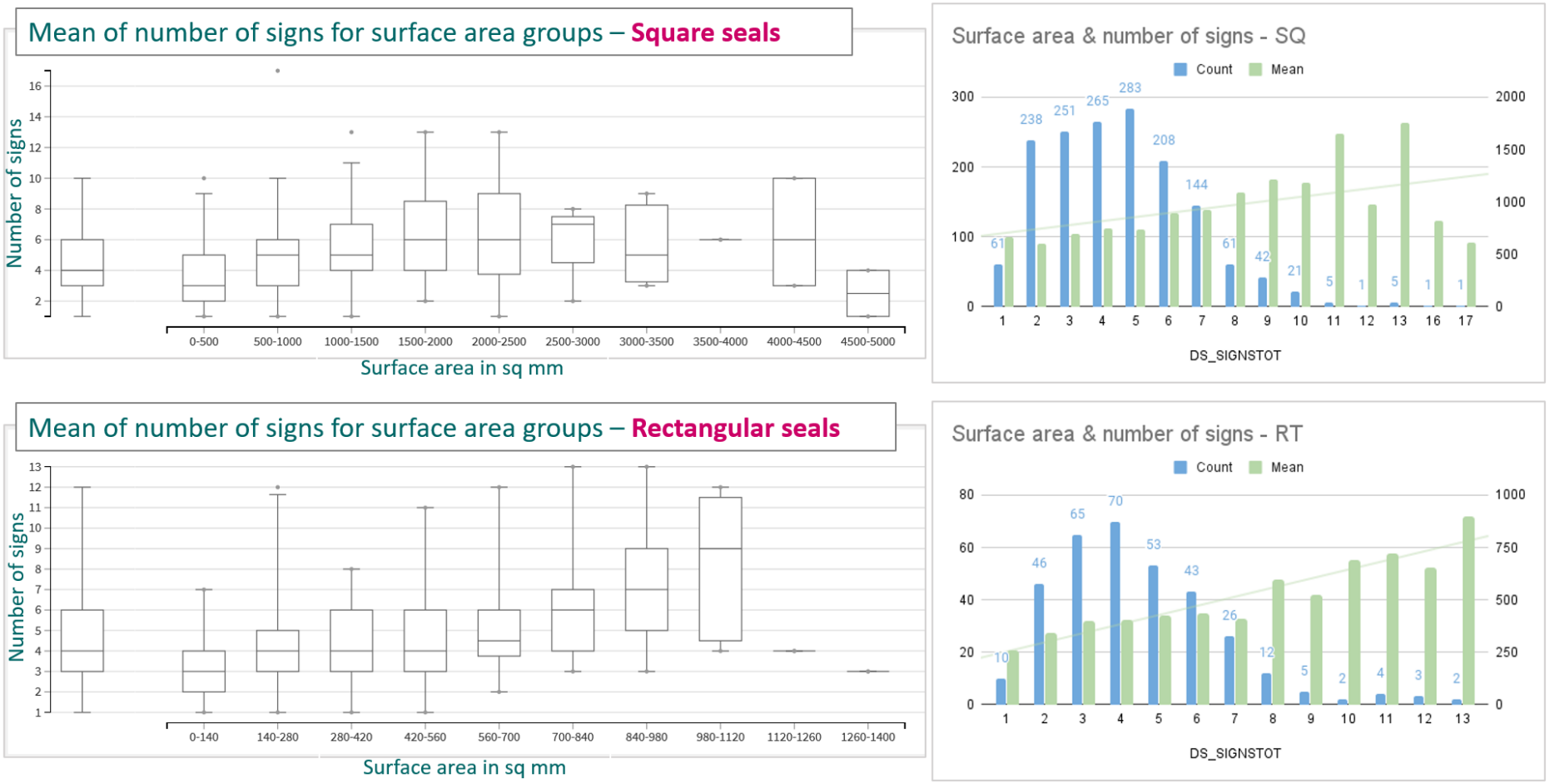


Figure 5.22: Relationship of number of signs with surface area - Square and Rectangular seals

In rectangular seals, even if there is an increase in the width, there are no multi-line rectangular seals. A parallel observation regarding alignment of signs and their carving sequence with respect to icon can be correlated here.[64] Non-alignment of signs can be perceived as a compulsion of fitting the signs in the available space after the icon was already carved. This observation is meaningful only for square seals with icons as rectangular seals are devoid of icons. Rectangular seals show a form variation in terms of convex (RTCX) or flat (RT) back side. RTCX are almost triple in number than RT seals and these are the longest seals in the rectangular category.

5.4.5 Iconography and signs

Besides basic contexts of sites and subtypes in which MHA are situated, iconography appears to be the next most important attribute. As the primary analysis shows, out of the total number of 5442 MHA, ~2840 possess some form of iconography and ~2602 are completely devoid of it. The literature review (2) and this chapter demonstrate that iconographic attributes in seals follow peculiar patterns and combinations. It is then a critical step to assess their relationship with signs. This can also be a small step towards filling the gap in this scholarship as identified and described in earlier chapters. In ASIS sequences, when the presence of signs on artefacts both with and without iconography is compared, the commonality is limited only to the first two or three signs. As one moves forward in the sign sequences, those become more and more unique. Thus, shorter the sign sequence, higher is the chance that it will appear both with and without iconography, but the longer sequence would be restricted to either of them.

Sign-class, total signs, and iconographic groups

As discussed in the previous chapter, sign-class is an abstract attribute defined by Wells which operates at multiple levels of sign length, site, and broad type. He proposes that "... like artefacts will have similar subject matter because they have the same function, and consequently similar sign inventories will occur if the underlying language is the same."[65] This and earlier observations of selective signs that repeat with and without

64. Green, "Stamp Seals in the Political Economy of South Asia's Earliest Cities," 127.

65. Wells, *Epigraphic Approaches to Indus writing*, 93.

icons, indicate that rectangular seals which are devoid of any motif may not manifest the same purpose and therefore act differently when compared to square seals with iconography. Thus the relationship of sign-class and total signs with iconographic groups is analysed. The statistical tests such as Chi-squared tests render invalid due to many expected counts being too small and some being less than one. Only contingency tables can be used and observations can be listed as follows (Figure A1.5 in appendix 1).

The most frequent five sign-classes i.e. PP (Partially Patterned), SS (Short Segment), LP (Long Patterned), SC (Short Complex), and SP (Short Patterned) are consistent in both Rissman and Franke groups. The two line sequences are seen on relatively rare icon groups and generally on smaller seals. Franke's group 2 and Rissman's group 2 are similar in terms of iconography (hatched face/upper neck and dotted bowl) and also show comparable proportions of sign-class SC. Franke's group 3.3 was devised to acknowledge Rissman's group 4[66] and both are thus almost identical in terms of sign-class distribution. In terms of number of signs, longer sequences (LP - Long Patterned/ LC - Long Complex) are restricted to only one or two groups in each grouping scheme.

When similar relationships and a general statistics about the number of signs are investigated amongst the ACGs defined by Green, they mimic observations made earlier with respect to the area and thickness of seals within these small groups. Each group sign average is distinctly different than the others. More than eight signs exist on MHA in only six out of 18 groups. Like the Franke and Rissman groups, though the similar sign-classes are common in these groups too, PP is present in at least 12 out of 18 groups.

Animal direction

Out of the iconographic motifs which appear on seals, let facing animal motifs are the most common. CISI volumes depict impressions of all these artefacts which then appear as right facing motifs. Juxtaposed to this, as discussed in earlier section, there are non-left facing motif varieties present on the seals. Out of these 49 records with right facing animals, 22 have only two signs. These just 22 artefacts are seen spread over nine sites - Banavali - seven, Kalibangan - three, Mohenjo-daro - three, two each at Chanhu-daro, Farmana, Harappa, and one each at Dholavira, Karanpura, Nausharo. On

66. Franke, "Inscribed objects from Mohenjo-Daro: Some Remarks on Stylistic Variability and Distribution Patterns," 110.

the other hand, left facing animal motif with two signs is a major phenomenon on seals only at Mohenjo-daro - 122 records and Harappa - 41 records.[67] The 22 artefacts, thus demonstrate a relatively smaller phenomenon where the larger geography is covered. While describing the characteristic nature of right facing animals, Konasukawa[68] has proposed a restricted set of signs which accompany these motifs. For the combinations of pairs of signs on either ends of the sign sequences, those are unique to right facing motifs and thus support Konasukawa's observation. However, some of the earlier observations with respect to contexts of the signs also demonstrated usage of specific signs or sign sequences for particular techniques, types, or sites. Thus, Konasukawa's observation about the use of a subset of signs with right facing animals rightly fits into the presently evolving observations about context specific sign usage. It's association with specific cultural period or region needs to be investigated further. Alekseev's[69] observations in this regard are interesting: "For right facing animals, the signs are found written in both from right to left (common) and from left to right (rare)."

5.4.6 N-grams and contexts

As mentioned during the problem definition stage, the aim of this project is not to decipher the signs but understand their contexts. Analysis till now shows how the sign sequences are impacted due to their immediate and broader contexts. In this part, N-gram pairs and triplets on either side of the sign sequence are analysed. The question here is - for different broad types, is one end of the sign sequence more diverse than the other? This might give an insight into the kind of content the signs may represent. Ashraf calls this 'directional asymmetry'. Based on the frequencies of occurrences of signs in different scripts, he observes that information content in the beginning is higher than the end. "In other words, the choice of letters that can occur as the final character of a word is more restrictive... ."[70] For example, in case of place names in a certain re-

67. Besides these two, ten sites have single digit artefacts.

68. Konasukawa, "Indus Scripts Incised on the Seals Discovered from the Initial Phase of Harappan Period."

69. Alekseev, "The characteristics of the Proto-Indian script," 20.

70. Ashraf and Sinha, "The "handedness" of language: Directional symmetry breaking of sign usage in words," 2.

gion in India, common endings could be Nagar, Gaon, or Pur but in some other regions it could be Abad, Sarai, Ganj, Gadh, and Thal. On the other hand, the beginnings of these place names could be more context specific and thus may not repeat much. For example Bhugaon, Shrirampur, Auragabad, Pahadganj, and Mitathal. Though the observations in the mentioned paper discuss this as generic behaviour of any language, specific contexts may show slightly different behaviour. For example, majority of the antonyms in English may have few common beginnings such as un, a, non, anti, or dis. Similarly, due to a huge following of saints like Sai Baba,[71] the name 'Sai' can be seen as a prefix in millions of proper-nouns of people, shops, companies, and for different entities across the country. These examples help imagine the difference between the frequencies of beginning and ending sequences, and how it can change depending upon the context.

Count of unique N-gram pairs and triplets are tabulated for the ASIS and REV columns for different subtypes (Table 5.7). It must be noted that for seals, REV sequence indicates how it would appear in the impression. ASIS, on the other hand records the sequence as seen on the original artefact without prejudice of its supposed use.

- For both pairs and triplets in all artefacts except for seals, the right side has more unique sequence than the left. For seals this is exactly opposite. Ashraf and Sinha correlate the relationship of this asymmetry and direction of writing.[72]

- In terms of absolute numbers and also based on percentage, seals and tabB show significant increase in number of unique sequences as one moves from pair to triplets on the left side. Seals continue with that trend even on the right side but not tabB.

Thus, if the order of sign sequences is critical to the meaning, this variation in N-gram frequencies on either ends may indicate beginning or ending of the semantic content. I do not intend to comment on the linguistic nature of these sign sequences or the 'reading' direction if any. Therefore I do not identify any end as beginning or ending sequence. However, multiple studies, even on different sign corpora, indicate that there

71. Shri Saibaba Sansthan Trust, Shirdi is a registered organisation which appoints CEO for their working: https://sai.org.in/.

72. Ashraf and Sinha, "The "handedness" of language: Directional symmetry breaking of sign usage in words," 8.

Subtypes with unique number of N-gram pairs and triplets							
	misc (47)	pot (68)	seal (1374)	tabB (487)	tabC (163)	tabI (265)	Tag (79)
	NG0 for pairs - ASIS and REV						
Left NG2_ASIS_0	36	63	788	170	36	96	44
Right NG2_REV_0	40	64	585	223	45	131	36
% change from L to R	111.111	101.587	74.238	131.176	125	136.458	81.818
Abs	4	1	-203	53	9	35	-8
	NG0 for triplets - ASIS and REV						
Left NG3_ASIS_0	39	67	1115	253	45	135	47
Right NG3_REV_0	40	67	962	270	50	145	46
% change from L to R	102.564	100	86.278	106.719	111.111	107.407	97.872
Abs	1	0	-153	17	5	10	-1
	% Change						
% rise from pair to triplet - L	108.333	106.349	141.497	148.823	125	140.625	106.818
% rise from pair to triplet - R	100	104.687	164.444	121.076	111.111	110.687	127.777

Table 5.7: N-gram pairs (NG2) and triplets (NG3) in ASIS and REV sequences

are specific signs or sign pairs or triplets which occur more frequently on either of the ends than the rest of the signs.[73] For multi-line sequences or non-linear arrangement in some MHA, the sequence is still questionable.

With Ashraf's argument discussed here, there is some strengthening of the seal-sealing hypothesis, i.e. sign sequences of seals (ASIS) when used in impressions (ICIT) as a final product, fit into this directional asymmetry argument observed in other artefacts, and in other languages and writing systems. However, the nuances brought by specific contexts raise questions. Also, it must be remembered that tendency of seal sequences being more unique than other types can also contribute to observed behaviour of signs on seals.

Asymmetries in context

Till now it is observed that sign sequences and the N-gram pairs or triplets have a contextual relationship with their types, sites, and also utilitarian characteristics such as techniques of sign creation, number of signs, and the number of sides. Table 5.7 above shows existence of asymmetric distribution of unique number of N-gram pairs and triplets on either ends for different subtypes. For a given sign sequence, if the order of signs is important, then the signs on either end bind the sequence to its semantic content. I thus combine these observation for comparison of the possible semantics of these sign sequences.

In all the graphs in this and following subsection, the N-gram pairs on either side of the sign sequence have been arranged in the order of total frequency. Thus, as one moves away from the origin on both X and Y axes, the frequency of pairs which appear on either ends decreases and hence their combinations too.

Figure 5.23 depicts seals with more than two signs from the sites viz. Kalibangan, Chanu-daro, Dholavira, Lothal and Nausharo. NS-11 is a sample seal from Nausharo. It bears 817-002 i.e.  as its first two signs in ASIS sequence. These are frequently seen on many other artefacts. However, the last two signs in ASIS sequence i.e. 740-222 - 

73. Yadav et al., "Segmentation of Indus Texts"; Yadav et al., "Statistical analysis of the Indus script using n-grams"; Fuls, "Positional Analysis of Indus Signs"; Kondratov, "The Positional-Statistical Analysis of the Proto-Indian Texts"; Parpola et al., *Decipherment of the Proto-Dravidian inscriptions of the Indus civilization: a 1st announcement*, 1:19

𒀭 are rarely seen on other artefacts besides this one. Figure 5.24 depicts seals with total number of signs between three to seven from the sites of Mohenjo-daro and Harappa.[74] Same pattern, as seen in the other sites, is now more prominently seen with these two sites. This can be discussed as follows.

There is a very small proportion of N-gram pairs on either sides which are frequent across all the sites (grouped in a black dotted outline). Otherwise, each site (major or minor) has sets of unique sign pairs for either end, can be seen grouped in different colours. For all the sites, there are multiple patterns of sign pair occurrences - (i) frequent presence of some signs on either ends, (ii) some only on one of the ends, and (iii) many pair combinations which are completely unique to the sites.

As the N-gram pairs for different categories of MHA are compared within a site of Mohenjo-daro (with three or more signs), artefacts such as ceramic pots, rods, or a miscellaneous collections have a distinctly different pair combination than those of square seals (Figure 5.25). These types indicate utilitarian objects such as rods, bangles, implements, and more. The limited pair combinations is also a result of these generally having shorter sign sequences or a very small number of artefacts compared to seals. However, what is also important is that these combinations are almost absent from SQ shapes. Within Mohenjo-daro seals also, for square, rectangular, and convex rectangular shapes, the square seals have different combinations than the other two shapes (Figure 5.26). This possibly highlights a purpose specific content depicted by the signs.

74. The number of records are limited only for the sake of clarity of the graphic. Otherwise the observation persists for different number of signs.

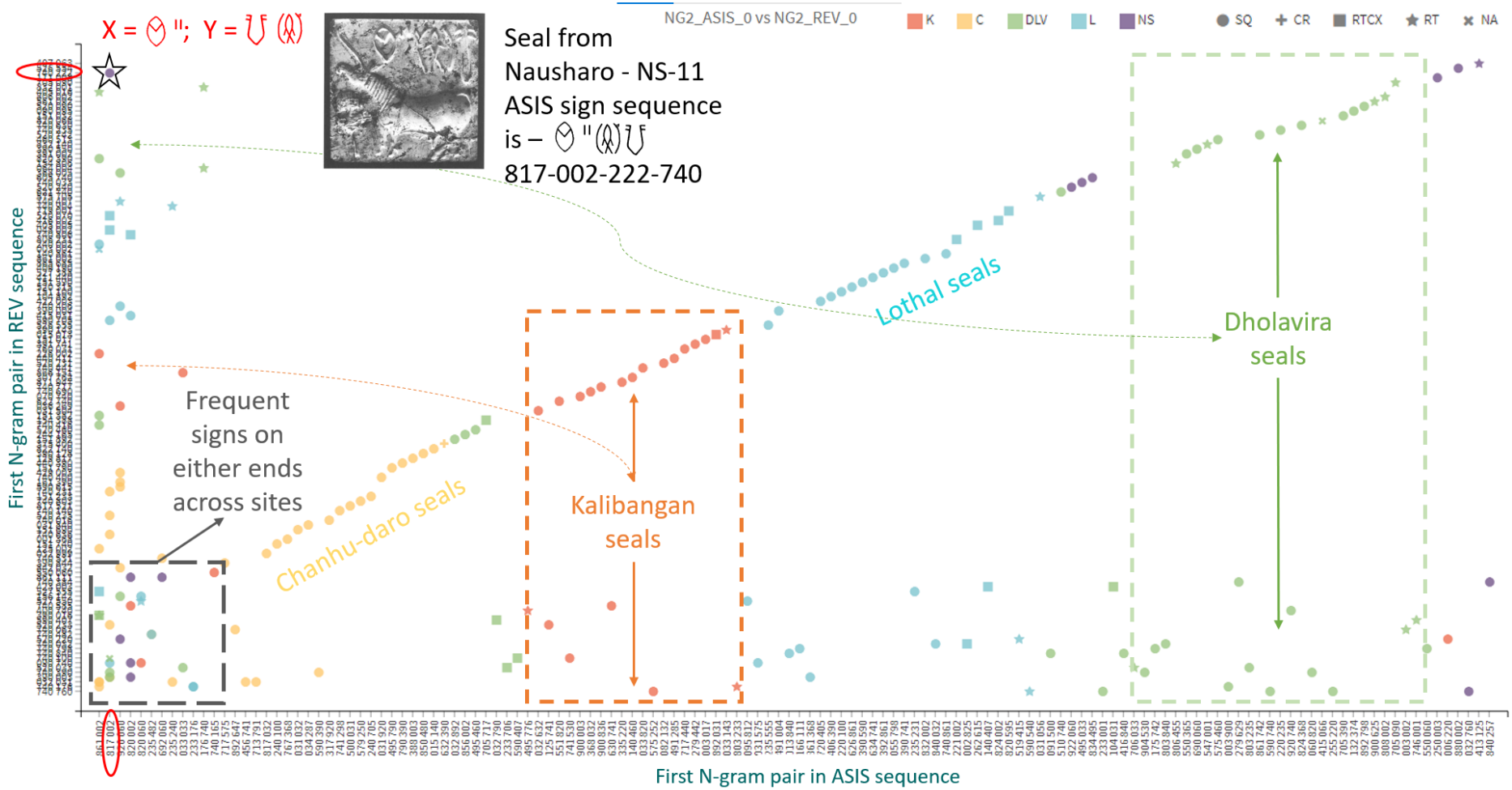


Figure 5.23: Sign pairs on either ends of sign sequences on seals - five sites

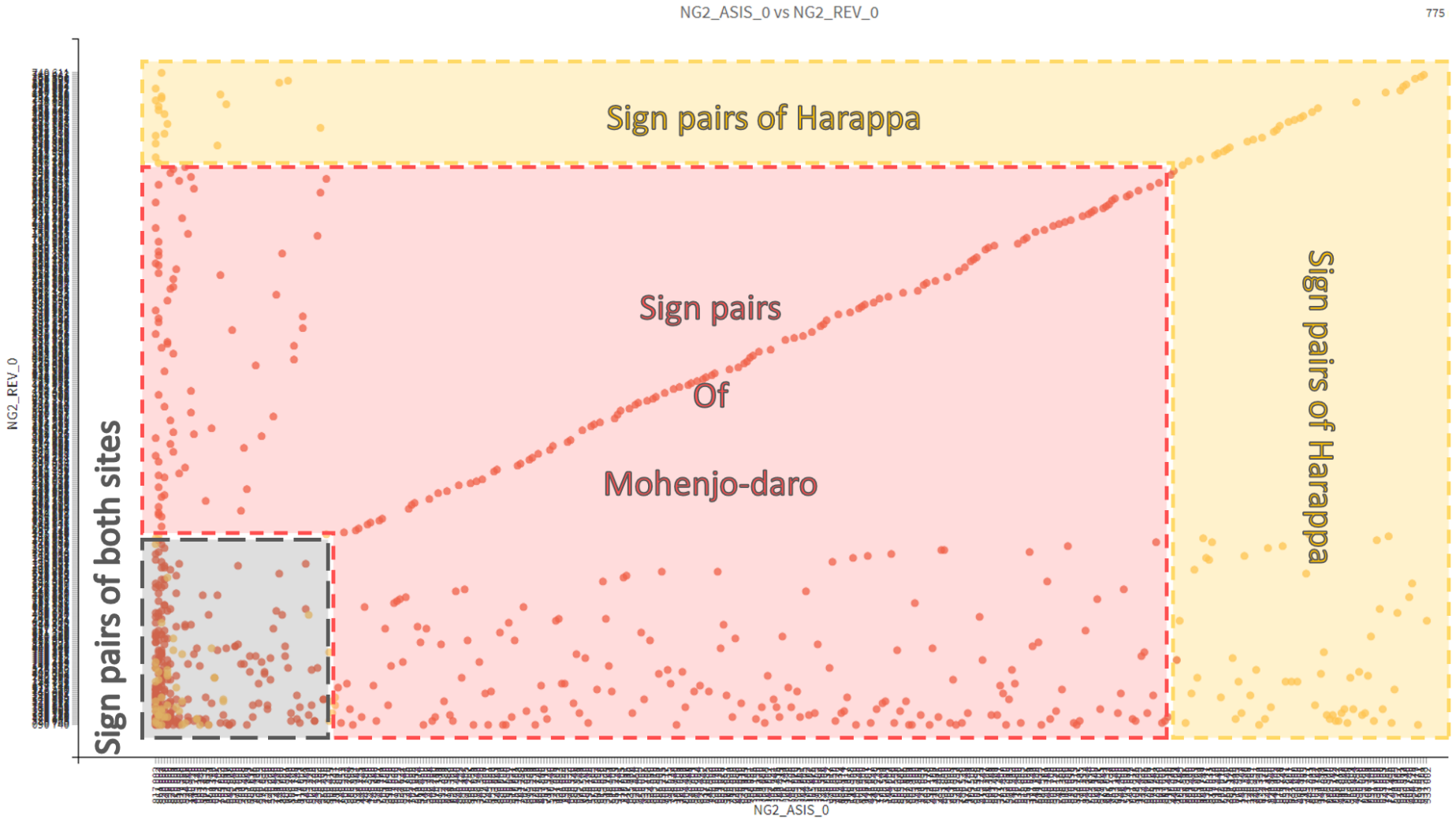


Figure 5.24: Sign pairs on either ends of sign sequences on seals - Mohenjo-daro and Harappa

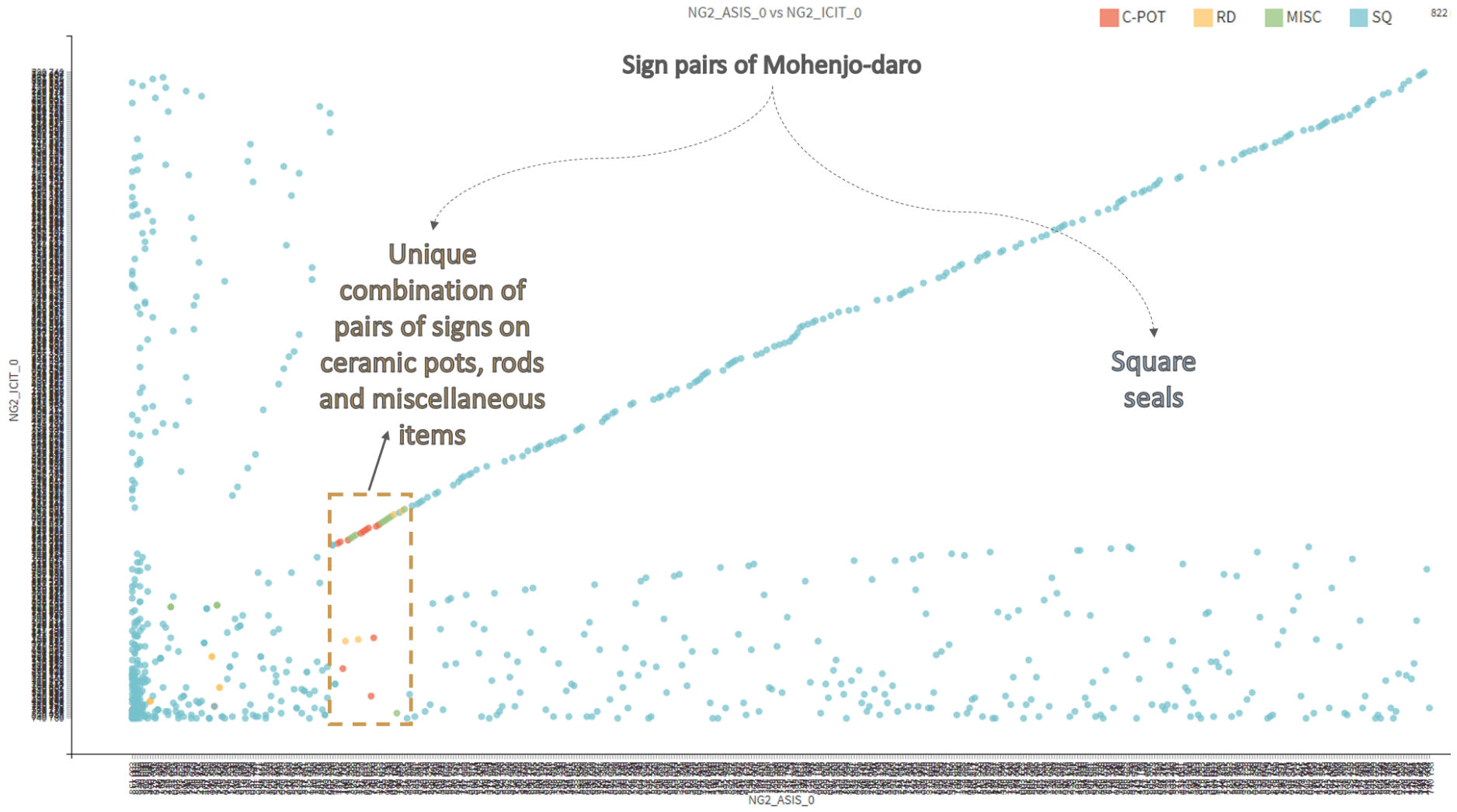


Figure 5.25: Sign pairs on either ends of sign sequences at Mohenjo-daro - square seal and other MHA

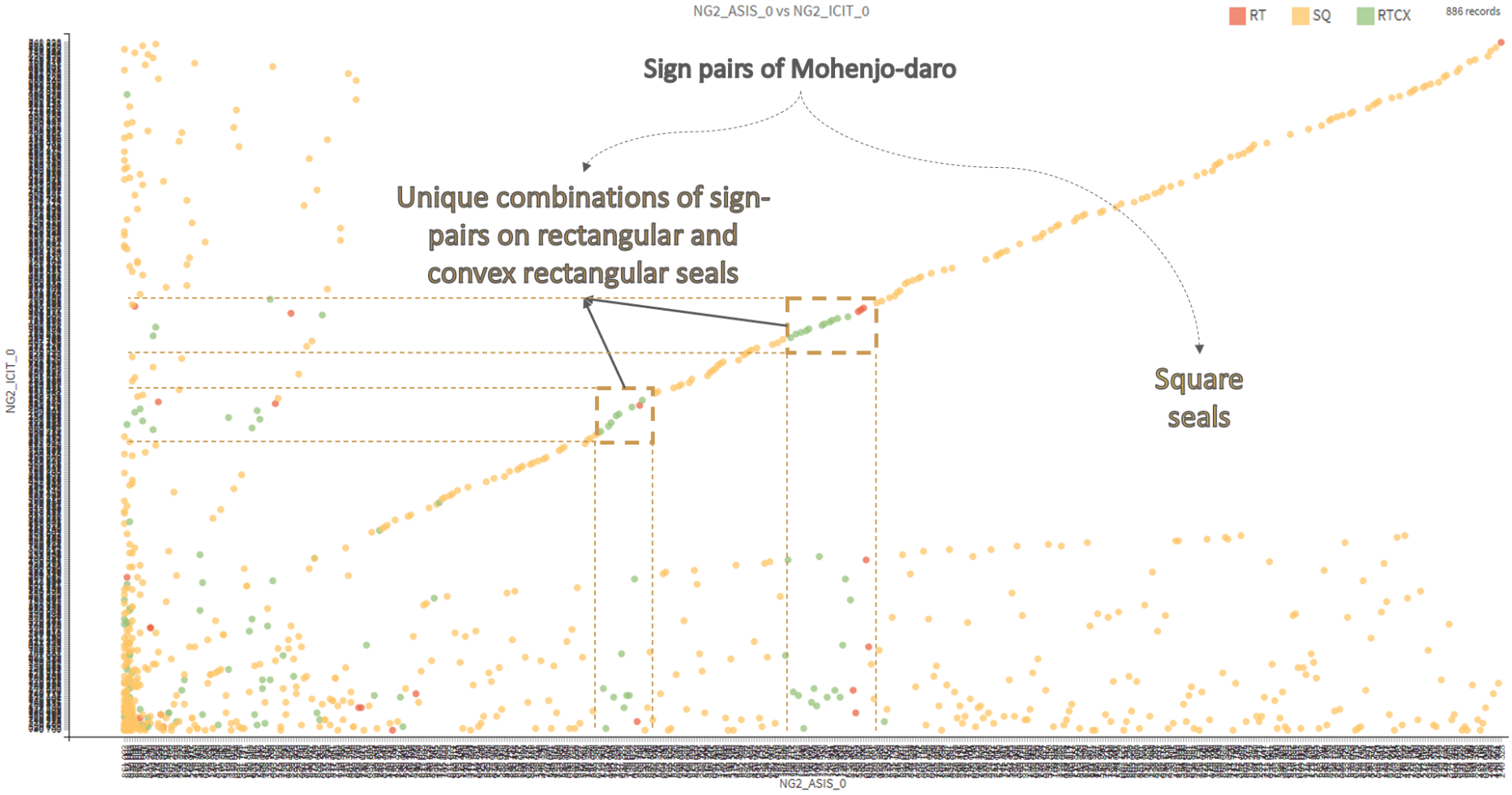


Figure 5.26: Sign pairs on either ends of sign sequences at Mohenjo-daro - square and rectangular seals

Tablets and Signs

Earlier in this chapter, it is observed that tabB, tabC, and tabI form distinct groups with respect to size and also belong to specific sites only. I thus propose that these may have context specific sign sequences. In comparison of N-gram pairs in ASIS sequences, the sharing of frequent pairs is seen amongst tabB and tabI but rarely on tabC (Figure 5.27). However moving forward to N-gram triplet, the sharing is significantly reduced or almost absent (Figure 5.28). That is, uniqueness of sign sequences for the given subtype significantly increases as one moves forward in the sequence. It is also observed that majority of the repetition in pairs is correlated to the short sequences of length two to three across tabB and tabI. With four signs, repetition is comparatively more on tabC. Combining earlier observations about size and iconography, and now about the sign sequences, tabC shows an interesting combination of characteristics.

- From ASIS sign sequence point of view, the common sequences are generally observed mostly up to the first two signs in both tabC and seals (to a small extent) but it happens only within their own subtype.
- For tabB and tabI, they share many initial N-gram pairs of ASIS sequence amongst each other.
- Even if tabC are found only at Mohenjo-daro, tabC and seals do not share any complete sign sequence.
- In terms of overall shape-size combination and presence of peculiar motifs, Parpola's class A and B of tabC are similar to seals.[75]
- As N-gram pairs on tabs are observed, out of the 18 most common sign pairs present on tabs, in addition to their association with either of tabB, tabC or tabI, specific choices are observed with respect to size (Figure 5.29).
- From form point of view, elongated shape with signs on both sides, Parpola's class C are similar to tabB or tabI.[76]

75. Parpola, "Copper tablets from Mohenjo-daro and the study of the Indus script," 133.

76. Parpola, 133.

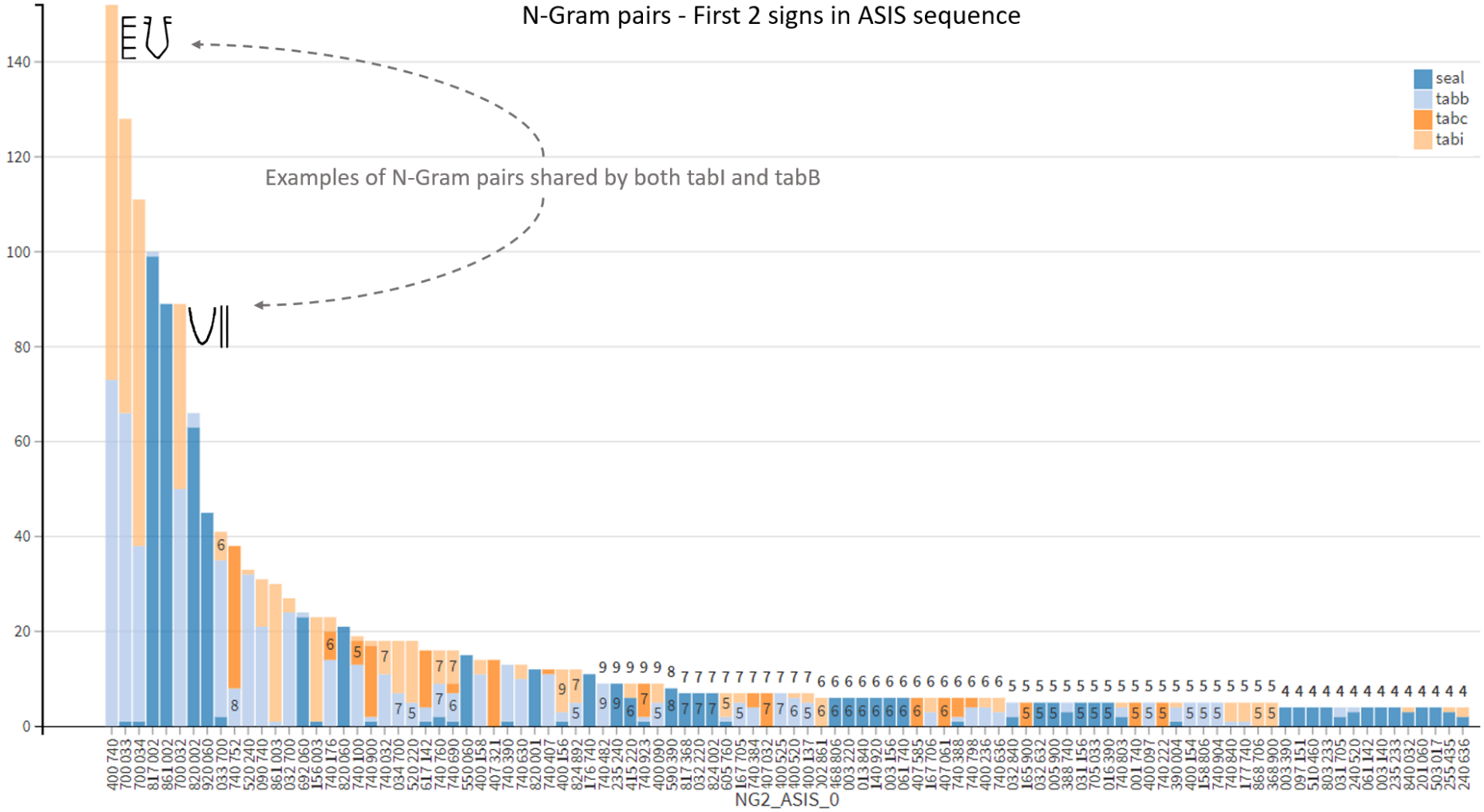


Figure 5.27: ASIS sequence first sign pairs - seals and tabs

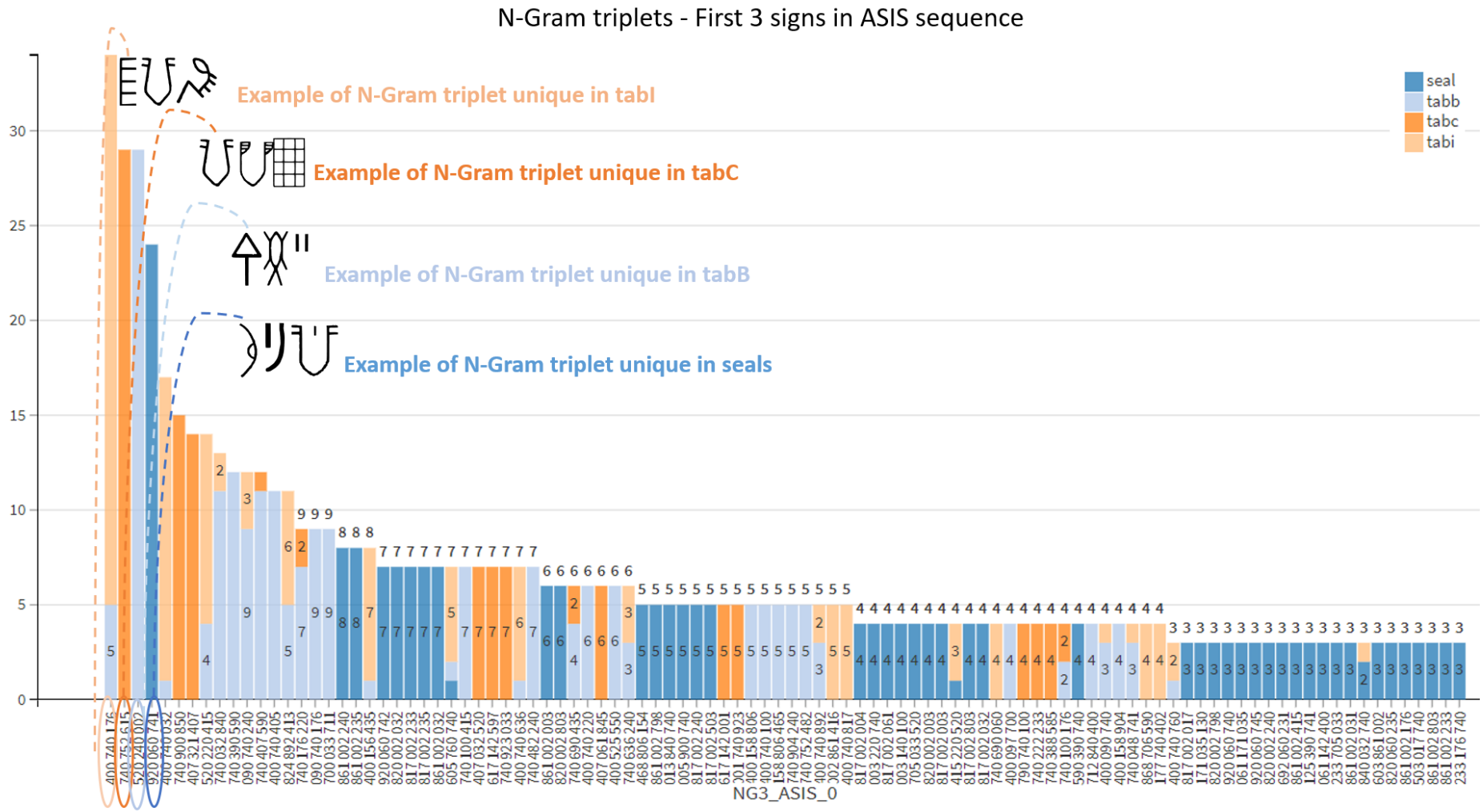


Figure 5.28: ASIS sequence first sign triplet - seals and tabs

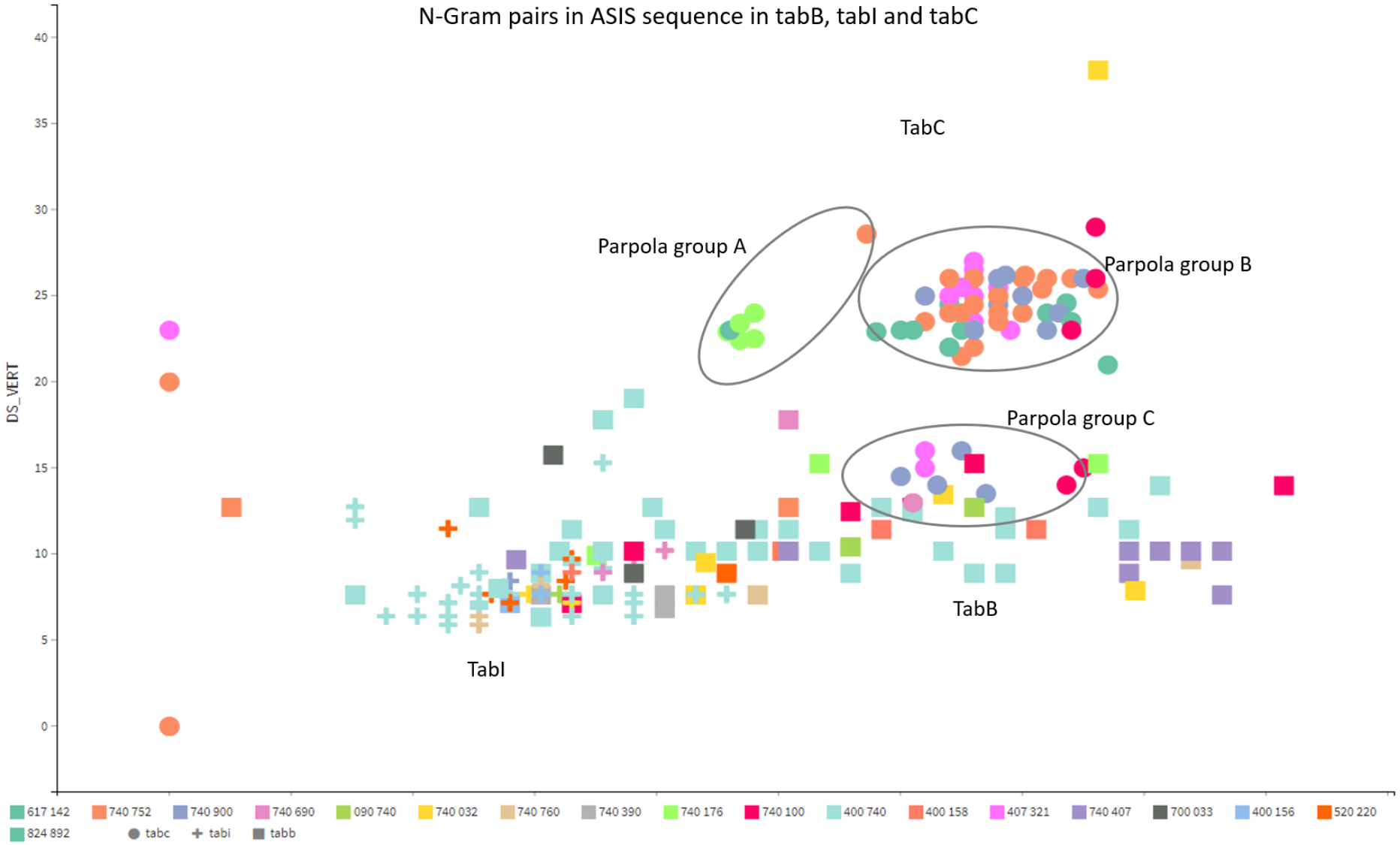


Figure 5.29: Sign pairs on either ends of sign sequences - tabB, tabC and tabI

These similarities and contrasts may further help with the functional aspects of the artefacts in comparison with each other.

5.5 Experimental typology

In the preceding chapter, 13 attributes were identified to document as Boolean properties for each artefact. Boolean value combination of these 13 attributes can essentially define $2^{13} = 8192$ 'boolean-types'. However, because of pairing of these attributes in these type definitions and due to the inherent limitations imposed by the object itself, these many combinations cannot exist in reality (A1.1). When present MHA dataset is populated, these attributes are recorded separately for each side due to variations seen. There are records where Y or N could not be populated (either data is not available or the attribute is not applicable) and hence was kept as NA. With this, the total boolean-types are 627. If the 'boolean-types' having NA are ignored, statistically there are only two quantitatively significant 'boolean-types' (4.3) - one overlaps with subtype seal (n=985) and other with tabC (n=98). The boolean combination of seal is a square, bigger than two cm in size, of steatite material, with unicorn motif, single sided, and perforated boss at the back. The tabC boolean combination mostly overlaps with Parpola's class B with a rectangular size of around 33.8 x 26.5 mm, and with signs and iconography on either side of the tablet.[77] These are probably the most 'pure' and 'consistent' 'types' based on above binary partitioning of the attributes. This exercise demonstrates that identification of a type based on form related empirical attributes may lead to inexplicable number of types. Unless we are able to identify and interpret systemic significance of these attributes, our typology definitions are just one out of these 627 'boolean-types'.

All the above observations demonstrate that sign sequences ought to be correlated to MHA attributes and the site of discovery. Also, if the analysis is performed for MHA at Mohenjo-Daro, it will be dominated by single sided seals but if performed for those from Harappa, it will be dominated by multi-sided tabB and tabI. However, for all the sites in the study, single sided records are most frequent (seal, tabB, and pot). Parallelly, should the analysis be carried on seals or tabC, it will be influenced by the finds at Mohenjo-Daro but if done on tabB, tabI or pot, it will be heavily influenced by finds

77. Parpola, "Copper tablets from Mohenjo-daro and the study of the Indus script," 133.

from Harappa.

Along with biases in distribution across sites, significant separation in terms of material, production technique, and iconography between sub-types indicates potentially different usage or purpose of objects. In the light of the variations added due to multi-side MHA and presence or absence of boss and perforation, the heterogeneity within this data and non-random patterns become evident. It thus overrides any supposed, assumed, or expected random nature of this dataset.

5.6 Note about statistical tests

For the statistical tests conducted in this chapter, table 5.8 summarises the datasets and the p-value results for One-way ANOVA tests performed in these cases. All tests were conducted at significance level of 0.05. As I test not just one but many hypotheses, I essentially make multiple comparisons of attributes. Thus, in many cases, same MHA records may get used in different subsets of the data. With the increasing number of hypotheses, there is a higher probability that one of the null hypothesis may get incorrectly rejected. It may lead to a Type-I error i.e. mistaken rejection of actual null hypothesis. In other words, with many hypotheses, there is an increased probability of inferring something which is not true; that is incorrect identification a pattern or a relationship which may not exist in reality. Significance level for a particular statistical test indicates a probability of observing a rare event or extreme value by chance. Since there are multiple such tests in this study, adjustment to avoid incorrect rejection of null hypothesis must be made. I thus apply Bonferroni correction where the significance level is lowered in proportion to the number of hypotheses being tested. The standard statistical significance level of 0.05 is reduced to 0.005 which is in proportion to 10 hypotheses being tested and summarised in the table below. For this reduced significance level, the last two tests in the table, viz. relationships of thickness and number of signs to first 6 ACGs defined by Green do not reject the null hypothesis. However, all the rest of the tests reject the null hypothesis at significance level of 0.005. Thus, as per this exercise, given the presence of the first eight attribute relationships, the null hypothesis persists for the last two relationships.

Dataset	**Data size (valid for use)**	**Relationship in attributes**	**p value**
Square seals with valid size attributes	1846 (1827)	Surface area and SYM1	1.590712e-18
Square seals with valid size attributes	1846 (1734)	Surface area and SYM0	1.995129e-55
Square seals with valid size attributes and non-unicorn iconography	1846 (323)	Surface area and non-unicorn motifs	2.879723e-16
Square seals with valid size and thickness attributes	1846 (1396)	Thickness and k-means clusters formed using surface area	2.96271e-160
Square seals with valid size attributes Unicorn neck motif	1846 (1827)	Surface area and Unicorn neck decoration	2.606197e-55
Franke Groups and surface area	1538 (667)	Surface area and Franke group	2.215171e-44
Rissman Groups and surface area	1538 (600)	Surface area and Rissman group	1.573947e-50
Green groups and area	188 (48)	Green groups and area	0.0005335535
Green groups and thickness	188 (48)	Green groups and thk	0.0277777626
Green groups and number of signs	188 (52)	Green groups and number of signs	0.0441135795

Table 5.8: Oneway ANOVA tests for attribute relationships and their p-value results

Chapter 6

Data Science Approach

Existing literature shows that there is a huge gap in terms of comprehending the relationship of form/material attributes with signs. Analysis presented in this thesis shows existence of relationships amongst different attributes including sign sequences. However, questions such as (i) how meaningful these relationships are to infer the cultural meaning, and (ii) whether these persist even beyond the data at hand continue to challenge the scholarship. Different analyses and visualisations in the previous chapter demonstrate that there is a scope to implement DS techniques on this dataset. These questions can be addressed to some extent with the help of advanced DS techniques such as predictive modeling. Before applying these to MHA dataset, it is critical to understand how earlier experiments have been conducted which use similar techniques on Harappan signs.

'Ability to predict' has been identified as a key feature of the recent advances in ML/AI/DS techniques. In Harappan archaeology domain, it has primarily been used to predict the signs in the sequences seen on the artefact. In the study by Rao and team, the table S1 (in supplementary information of the main paper) shows a list of Indus texts with missing signs and their probable substitutes based on the Markov model devised in their paper.[1] It must be underlined that the ability solely depends on the 'nature' of the labelled dataset fed to the training algorithm which eventually predicts the outcomes. In the light of possible contextual nature of the signs, the core characteristics of M77 used in Rao's study are worth investigating.

- Dated and smaller dataset - When Rao's study was published in 2010, ICIT dataset had gone online just a year before that. It had accounted for 3898 inscribed artefacts as against 2906 of M77 from 1977. Even in the recent papers about clusters of signs[2] and interpretation of signs for economic activities,[3] authors continue the use of same M77 dataset.

1. Rao et al., "A Markov model of the Indus script."

2. Yadav, Salgaonkar, and Vahia, "Clustering Indus Texts using K-means."

3. R. P. N. Rao, "The Indus Script and Economics. A Role for Indus Seals and Tablets in Rationing and Administration of Labor."

- Changes in size of data - The data cleaning and machining[4] processes in Rao et al.'s study have reduced the 'archaeological' or 'material' character of the dataset. They have excluded all texts with ambiguous or missing signs and multiple lines on a single side. For duplicates, single copy is retained. Thus the size of the dataset is reduced to 1548 lines of text and 377 signs. Formation of this dataset from M77, known as EBUDS was described in chapter 2.

- Changes in shape of data - Lack of updates to dataset essentially excludes data from HARP excavations which contain majority of tabB and tabI, and results in different shape of the dataset than what is presently available (Figures 3.2 and 3.3). In addition, though some cleaning mechanisms are always required in order to fit the dataset in the quantitative analysis framework, elimination of multiple lines and duplicates, and reduction of total sign numbers from 417 to 377 (which is rather close to Parpola's 386 signs), have also modified the composition of the core data itself. Dr Fuls' work on identification of signs which are present in ICIT but are absent from Mahadevan and Parpola's sign-list must be highlighted here.[5] The causes and consequences of this variation have been discussed in chapters 2 and 3.

- Rao and team have acknowledged the problem of sign variants being masked in single sign graphs in Mahadevan's concordance. However, they have chosen to use the same without any corrections, modifications, or additions to it.[6]

- The composition of their training dataset can be described as follows:

  – The removal of duplicates (which are prominently seen amongst the tabB and tabI i.e. type-2 and type-3 as per M77[7]) has made the dataset more biased towards the type-1 artefacts i.e. seals, that are predominantly from Mohenjo-daro. This has also eliminated the inherent higher probability of repetition of those sequences.

  – The test dataset where the prediction is being exercised, 14 out of 15 test sequences are of seals from Mohenjo-daro.

4. Gero, "Honoring ambiguity/problematizing certitude," 320–321.

5. Fuls, *A Catalog of Indus Signs*, 43–44, 50–51.

6. Rao et al., "A Markov model of the Indus script," 13686.

7. Mahadevan, *The Indus script: texts, concordance, and tables*, 7.

The processes such as (i) decrease in records due to elimination of multiline texts, (ii) removal of duplicates, (iii) multiple possible variants masked in a single graph, (iv) shrinking in total number of signs, and finally (v) small dataset have resulted into the reduction of possible learning paths. This can lead to spurious and higher prediction rates.

The preliminary contextual analyses described in the previous chapter demonstrate that -

- Reduction in data size led to statistical tests becoming invalid for their interpretation.
- Sign sequences and many MHA attributes are highly correlated.
- There are clear discontinuities in the form attributes of MHA.
- Some subtypes are biased towards specific sites. Besides archaeological probability, its systemic explanation is yet to be discerned.

In addition to it, the conditional entropy, its implementation for Harappan sign studies, and the lacunae have been discussed at length in chapter 2. The subsequent section has also illustrated the datasets used for linguistic comparison, their contextual nature, methodological issues in using different scripts, and Rao's urge to use "... sophisticated approach, such as statistically inferring an underlying grammar... ."[8] Based on the observations made in chapter 5, I extend the argument to emphasis inclusion of 'context' of the underlying material. The analyses demonstrate that it is unwarranted to combine and analyse all these non-random sign sequence occurrences to solve a presumed linguistic problem. In this scenario, their context cannot be ignored. As Possehl has rightly mentioned - "When an analysis of the script is undertaken, these glyptic material should be handled separately and not mixed, which would compromise the special context of each class of message."[9] Hence I argue that prediction of signs might be more appropriate and meaningful in very specific contexts. The contextual nuances may create hurdles in making these prediction more generic or overarching but those nuances are indispensable and intrinsic to the dataset. I propose to extend the scope of prediction

8. "Entropic Evidence for Linguistic Structure in the Indus Script - Supplementary Material," 10.

9. Possehl, *Indus Age: The Writing System*, 52.

experiments for (i) iconography, (ii) subtypes, (iii) sites, (iv) signs, (v) cultural periods, and (vi) future finds.

6.1 Iconography

Decorative variation of unicorn motif, both in terms of style and technique, led to stylistic studies as discussed in chapter 2. In most of these cases, the scholars independently identify attributes, their scaling or values, and propose their grouping which in-turn tries to explain an aspect of the cultural system. Since all the decorative motifs and techniques describe the same icon that appears on the same artefact, found within same material culture, I propose to use those for prediction of different iconographic groups.

6.1.1 Decorative styles and experimental prediction

In case of Franke[10] and Rissman,[11] their grouping schemes are somewhat parallel due to the consideration of same major decorative attributes of collar, hatched face or neck, and stand. Though both of them considered different aspects of the stand, their attributes and methodologies go hand in hand. However in four groups defined by Rissman and six by Franke, none of them explicitly considered body decorations seen on unicorn. Though Franke documented it in detail, in the final broad style categories, those are not necessarily accounted for. On the contrary, Wells[12] did not document collar or hatching on face or neck but identified various body decorations. Based on the frequency tables, he identified most prominent combinations of body decoration and stand patterns. Since, Rissaman's and Franke's studies have demonstrated prominent grouping, I hypothesis that Wells' body decoration attribute is correlated to the attributes defined by Franke and Rissman. Further I design an experiment to predict Franke or Rissman groups with Well's attribute[13] and surface area parameter. Both have not played any active role in either of these grouping schemes.

10. Franke, "Inscribed objects from Mohenjo-Daro: Some Remarks on Stylistic Variability and Distribution Patterns."

11. Rissman, "The organization of seal production in the Harappan Civilization."

12. Wells, *Epigraphic Approaches to Indus writing*.

13. Wells' other attribute called cult-object captures the combinations of stand patterns described by Rissman and hence it is not considered independently here

The train and test sets are defined as follows -

- **Train** - Since the the number of artefacts in each iconographic group are significantly different, the class re-balance ratio method is used to compose the training set which is proportional to the number of MHA in these groups. Since both of them have extensively used data from Mohenjo-daro we use this class-rebalanced set from only that site.

- **Test** - The model is tested on artefacts from sites besides Mohenjo-daro.

Five algorithms such as DT (Decision Tree), RF (Random Forest), GB (Gradient Boosted Trees), LR (Logistic Regression) and SVM (Support Vector Machine) are tested (Table 6.1). The first three explain the attribute contribution and these clearly show that surface areas has a major role in both grouping schemes. It must be noted that group 10 is just a collection of all ungrouped artefacts. Thus, it will not contribute in identification of a diagonal-heavy confusion matrix.

Style groups and ROC-AUC Metric values for prediction algorithms					
Iconographic grouping	LR	SVM	RF	GBT	DT
Franke (Train - 902, Test - 725)	0.744	0.752	0.694	0.688	0.653
Rissman (Train - 458, Test - 725)	0.807	0.79	0.73	0.717	0.679

Table 6.1: Distribution of seals in sites based animal facing direction

In case of Rissman grouping, even if LR scores best on the ROC-AUC matrix, it has significantly miss-classified group-4. Group-10 has the highest i.e. 66% classified to it. SVM, in that case, has less MHA assigned to Group-10 and is diagonal heavy compared to other algorithms.[14]

In case of Franke grouping, SVM scores best on the ROC-AUC matrix. Though group-10 proportion is higher, this algorithm is probably the best when compared to the relative correct classification of other groups in other algorithms.[15] SVM is not necessarily a clustering algorithm. It rather works on identification of boundaries of separation of the classes. It thus may not have a class representative example or a cluster

14. See figure A1.3 in appendix 1.

15. See figure A1.4 in appendix 1.

centre which is generally an ideal definition of the class. Instead, the support vectors define a tentative separation between two or more classes.

These prediction results demonstrate a significant relationship of seal surface area and Wells' decoration attribute with the iconographic groups defined by Franke and Rissman.

6.1.2 Carving measurements - systemic or spatial?

Jamison's work has been reviewed in an chapters 2 and 3.[16] As the sourcing of precious material often happened from distant, remote, and "fairly restricted geological deposits",[17] it possibly meant that raw material sourcing through trading contacts was a very specialised activity. However, absence of archaeological sites near these areas is interpreted by Jamison as no evidence of contemporary geopolitical conflict. Jamison interprets it as " ... access to the raw material would have been less difficult to control than more locally available raw materials."[18] His identification of multi-site groups and also multiple groups within a site is based on nine metric and 11 style attributes. He has also ranked these attributes based on their variability. He has proposed to use high variability attributes for the grouping exercise because they help identify more granular differences.

Based on different combinations of metric attributes, he makes preliminary observations such as (i) body and neck ratios do not cluster based on sites,[19] (ii) Mohenjo-daro and Harappa have different proportions for the stand's upper and lower parts,[20] (iii) head, ear, and pizzle do not have site based differences,[21] and (iii) no clear trends in multi-site groups.[22]

It must be noted that the metric measurements inherently account for the possible

16. Jamison, "The organization of Indus unicorn seal production: A diachronic comparative study of style, skill, and sociopolitical organization."

17. Jamison, 109.

18. Jamison, 109.

19. Jamison, 415.

20. Jamison, 416.

21. Jamison, 417.

22. Jamison, 428.

wear that the artefacts underwent. If the usage involved making frequent impressions on a material, then the wear would have gradually increased. Thus the grouping logic should either assume uniform wear or not at all. Both these are unrealistic given the ambiguity around the usage pattern and life-cycle of seals, and hence a mix of these should be assumed. Also the wear is of varying natures and degrees: functional in the cultural past and then post-depositional deterioration until its recovery. These raise questions regarding the use of microscopic metric measurements (however precise they may be) in the analysis of seals. In addition to this, Jamison also identifies several occasions of deliberate or intentional carving choices by artisans.[23] These observations thus pose additional constraint on the extent of use of metric measurements to hypothesise 55 groups within a set of 180 artefacts.[24]

With the background of these presently indiscernible systemic constraints, Jamison's attributes are analysed in multiple combinations with some other attributes and PCA is performed on metric attributes of his entire dataset (Figure 6.1).

As observed in figure 6.1, PCA on his high ranked metric attributes (pizzle and ear) do not show distinguishable difference between Mohenjo-daro and Harappa but PCA on his low ranked metric attributes (neck and head) clearly separate these two sites. When these two low rank attributes are combined with seal area and total number of signs, separation persists. When a combination of high and low rank attributes (neck, head, us, ls, pizzle and ear) or all low rank attributes (body, neck, head, us, ls) are used, PCA still separates the two sites. These multiple combinations of Jamison's attributes essentially demonstrate that at a more foundational level, there is a presence of some site specific phenomenon. This observation is in line with basic principle of GIS - the closer the things, its more likely that they are related.[25] This could be in terms of production, use, discard, movement, or finally even probabilistic finds. These explanations also follow principles of Occam's razor. Jamison's work suggests that it may not always be so and the phenomenon is defined by him as 'decentralized form of unicorn seal

23. Jamison, "The organization of Indus unicorn seal production: A diachronic comparative study of style, skill, and sociopolitical organization," 446, 454, 509.

24. Jamison, 388.

25. Ambiguities with basic provenance have already been pointed out in chapter 5. However, in absence of more robust explanation for the artefact spread, we continue to use find-site as MHA's primary context.

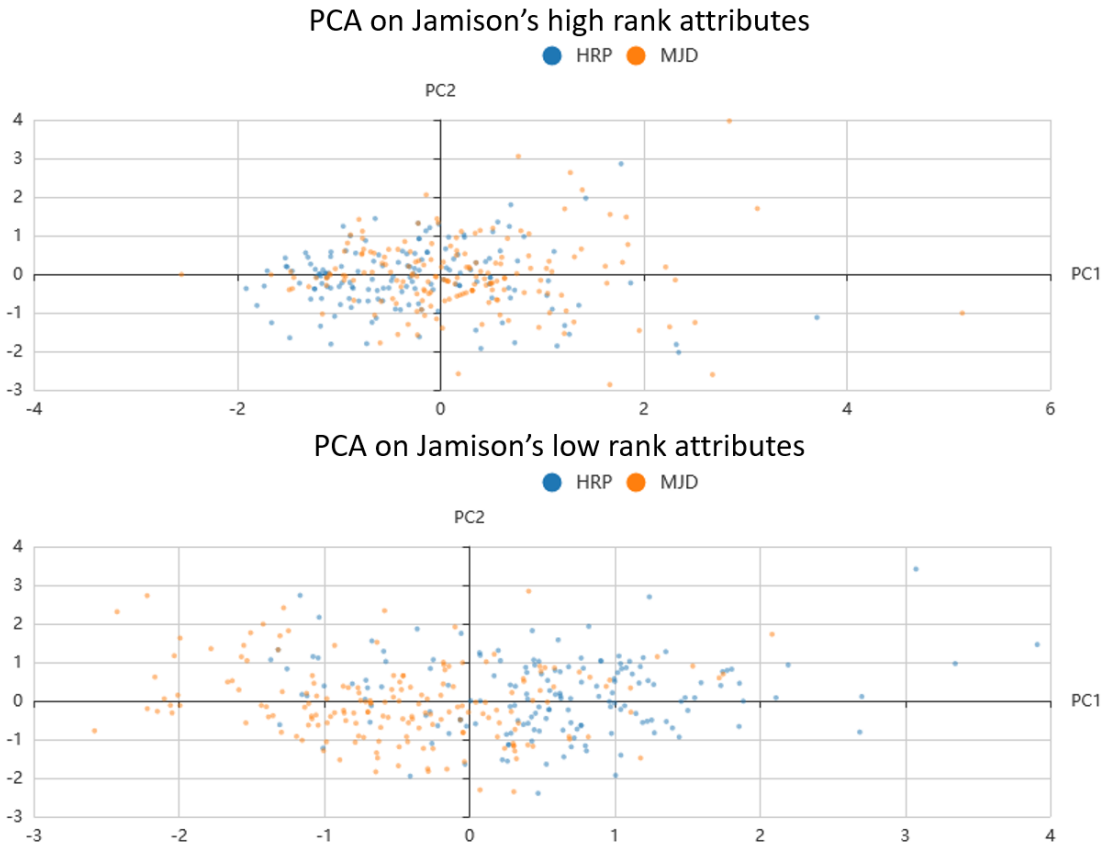


Figure 6.1: PCA on Jamison's high rank and low rank attributes

production'.[26] However, in the light of (i) differential wear and tear phenomenon, (ii) Jamison's average group membership ratio (less than 3), and (iii) PCA analysis, it needs a more robust and material-centric explanation about 'why' and 'how' the concept of 'decentralised production' is a better explanation than rest of the possibilities.

6.2 Subtypes and sites

The experimental typology in chapter 5 showed that seal is probably the most consistent subtype in terms of the broad binary definitions. It is seen that each boolean combination prominently maps to one of the eight subtypes. It has also demonstrated that MHA attributes and signs are correlated and definitive patterns exist among them.

An experiment is designed to predict the subtypes based on boolean attributes, total number of signs, and n-grams. As anticipated, the boolean attributes significantly

26. Jamison, "The organization of Indus unicorn seal production: A diachronic comparative study of style, skill, and sociopolitical organization," 10.

impact the prediction. What is interesting is that, when only individual signs are used instead of N-gram pairs or triplets, the prediction results are still viable (ROC-AUC metric 0.826 for Logistic Regression algorithm). There is difference in proportion of correct predictions for different subtypes; seals and tabC have more than 60% correctly predicted. Thus, to some extent, signs have a specific association with the sub-types and are thus in a position to predict the subtype on which they may appear.

With respect to sites, various studies have demonstrated site specific phenomenon in terms of styles,[27] production,[28] signs,[29] and artefact diversity based on ubiquity and diversity indices calculated in this thesis. Like in case of subtypes above, individual signs and boolean attributes are used in order to predict the sites. Due to a known bias in the data towards Mohenjo-Daro and Harappa, only these two sites are used for independent prediction of each and employ two-class classification. It is observed that when boolean attributes are used, as expected, majority artefacts get correctly assigned to either of the sites with few false positives. However with individual signs, despite high true positives, some models show an increase in false positives too. This can be related to earlier observations regarding repetition of pairs in sites, and pairs vs. triplets behaviour in types. Even if sign pairs have affinity with sites to some extent, presence of signs which appear later in the sequence (from either of the ends) is not necessarily site specific.

6.3 N-grams

As discussed in chapter 3, though the decipherment studies have created their special scholarship within the Harappan archaeological discourse, their position has strengthened in recent years due to their methodological approach of using advanced quantitative techniques to predict the signs. However, the introductory part of this chapter has summarised the lacunae in the design and implementation of these experiments. In the light

27. Konasukawa, "Diversity of Harappan civilization: a case study of the Ghaggar basin with special reference to seals"; Rissman, "The organization of seal production in the Harappan Civilization"; Franke, "Inscribed objects from Mohenjo-Daro: Some Remarks on Stylistic Variability and Distribution Patterns"

28. Jamison, "The organization of Indus unicorn seal production: A diachronic comparative study of style, skill, and sociopolitical organization."

29. Yadav, "Sensitivity of Indus script to site and type of object."

of the existing knowledge about relationships amongst (i) MHA attributes, subtypes, sites, and signs, and (ii) non-random distribution of the data in sites and subtypes, it is important to see if this knowledge can improve our sign prediction capabilities. I thus propose prediction experiment for the second sign in the sign sequence. Following data preparation steps have been implemented in the prediction exercise:

- Keep all repeating instances of sequences
- Keep all multi-line and multi-side sequences
- Remove records without any signs (880)
- Remove records having single sign (627)
- Remove records with ambiguous signs (1259)
- Use larger dataset with 3637 (= 6403-(880+627+1259)) records as against 1548 lines[30]
- Use expanded sign-list of ~700 signs over 377 (subset of 417 as discussed above)
- Use different combinations of data in terms of subtypes and sites for both train and test
- NG_* contain 1st and 3rd to 6th single signs.
- Use RF algorithm with 80:20 train:test ratio and implement class-rebalance for optimum representation of all subtypes. This is required because all eight subtypes are not equally represented in the dataset.

The experiment explores following cases (Table 6.2) for prediction of the second sign in both ASIS and ICIT sign sequences. In Rao's prediction experiment discussed above, they have used ICIT like sequences for all artefacts based on M77 corpus. Both M77 and ICIT presume the 'use' of seals through impression only. Thus, as already discussed in chapter 4, in those datasets, all the sign sequences of seals are documented in reverse direction as they would appear on the tag. I also use ASIS sign sequence in the present prediction experiment.

30. Rao et al., "A Markov model of the Indus script," 13690.

Experiments	Predictors	Data	N	Train	Test
Case 1	NGs	All	3637	2914	723
Case 2	NGs, sites, subtype	All	3637	2914	723
Case 3	NGs, sites, subtype	seals	1660	1334	326
Case 4	NGs, sites, subtype	non-seals	1977	1580	397
Case 4.1	NGs, sites, subtype - no class bal	non-seals	1977	1580	397
Case 5	NGs, sites, subtype	seals	1660	MJD+HRP 1357	OTH 303
Case 6	NGs, sites, subtype	seals	1660	MJD+OTH 1349	HRP 311

Table 6.2: Multiple cases for prediction second sign in both ASIS and ICIT sign sequences

Now based on the observations from the directional asymmetry study mentioned above (which uses ICIT sequences), the predictions for either ends may have different accuracy.[31] Higher accuracy of predictions is expected with ICIT sequences. I thus independently predict second signs in sequence from either ends. In all the cases below, wherever mentioned as signs, first and third to sixth signs are used (Table 6.3).

Experiments	ROC-AUC - ASIS	ROC-AUC - ICIT	Correct Prediction - ASIS	Correct Prediction - ICIT	% Correct Prediction - ASIS	% Correct Prediction - ICIT
Case 1	0.672	0.697	181	221	25.0345	30.5670
Case 2	0.686	0.706	190	219	26.2793	30.2904
Case 3	0.639	0.682	26	63	7.9754	19.3251
Case 4	0.743	0.762	182	195	45.8438	49.1183
Case 4.1	0.736	0.751	102	109	25.6926	27.4559
Case 5	0.647	0.649	29	47	9.5709	15.5115
Case 6	0.659	0.676	14	73	4.5016	23.4726

Table 6.3: Multiple cases for prediction of second sign in both ASIS and ICIT sign sequences - results

For each of the mentioned case, table 6.4 describes the expectations about the prediction and actual prediction for both ASIS and ICIT. The observations describe if and how the additional context and train/text split has impacted the prediction experiments.

31. Ashraf and Sinha, “The “handedness” of language: Directional symmetry breaking of sign usage in words.”

Experiments	Expectations about prediction	Actual Prediction for ASIS	Actual Prediction for ICIT
Case 1	Similar to Rao's prediction exercise but Rao has used only seals for train and test for signs without site context. So his experiment is a combination of Case 1, Case 3, 5/6)	Train data imbalance in terms of presence of NGs, small size of test data	Better than ASIS
Case 2	Expected prediction to be better than Case 1 due to addition of context information	Very slight improvement	Very slight improvement
Case 3	Expected prediction to be lower than Case 1 due to earlier observation about signs of seals being more unique	As Expected - Significant reduction	As Expected - Significant reduction and better than ASIS
Case 4	Expected prediction to be better than Case 1 and 2 due to earlier observation about signs on non-seal MHA being more repetative	As Expected - Significant improvement	As Expected - Significant improvement and better than ASIS

Case 4.1	Expected prediction to be better than Case 4: With an assumption that all non-seal types are similar in terms of sign sequences (orders being opposite to seals so more consistent), so elimination class-rebalance will create more random train data	Not as Expected - Significant reduction than Case 4 - Indicates that each variety in non-seal class has definitive choices of signs	Observation similar to ASIS and better than it
Case 5	Expected prediction to be lower than Case 3. This is due to the observation about seal sequences being more unique with sites	Not as Expected but very small increase or almost same as Case 3	As Expected - reduction and better than ASIS
Case 6	Expected prediction to be lower than Case 3; This is due to the observation about seal sequences being more unique with sites	As Expected - Significant reduction	Not As Expected - Better than Case 3

Table 6.4: Multiple cases for prediction of second sign in both ASIS and ICIT sign sequences - discussion

Observations about prediction cases (Table 6.4)

- Case 1 is purely sign based. Though the ROC-AUC performance is fair, only 25% of the test records could be predicted correctly. The performance in ICIT is better than that in ASIS sequence.

- Case 2 includes basic context. As we move from only signs to inclusion of sites and subtypes as contributors for prediction, the ROC-AUC metric and correct predictions show a nominal increase. Thus, even though we could see association of sign pairs to subtypes and sites, their impact is limited on the prediction results. However, what is interesting is that site variable takes precedence over all other in the prediction exercise.

- Case 3 is performed by using only seals in the training and test sets. The performance has lowered in both ASIS and ICIT and the correct predictions have significantly reduced. This could be a result of tendency of seal sequences being more unique in nature and not repetitive.

- Case 4 as compared to Case 2 and 3, stands out with percentage of correct predictions being close to 50%. It also corroborates preliminary observations regarding non-seal MHA tending to be more repetitive than seals and hence being more predictable than seals. However, a variant of this case, i.e. case 4.1 shows a significant decrease in both ASIS and ICIT if class rebalance is not incorporated during the train-test partitioning stage of the dataset. This is a result of non-random distribution of artefacts within subtypes and each having specific tendencies of sign repetition or non-repetition.

- Case 5 and Case 6 are variants of case 3 but the train and test datasets are strictly site specific. For case 5, the model is trained on data from Mohenjo-daro and Harappa. It is then tested on data from other sites. For case 6, the model is train on all data except Harappa and then tested on Harappa. The behaviours for both ASIS and ICIT are different and are difficult to explain. Case 6 prediction for ICIT sequences is significantly higher than ASIS case. Some site specific observations have already been made in this and previous chapter. Those, combined with the directional symmetry study mentioned above are the likely contributors for the results of these two cases.

More contextual information can be added in above cases such as total number of signs, size, or iconography, or signs which appear later in the sequence may also be predicted. However, a look at total records of 6403 shows that there are 3563 distinct sign sequences, and only 37 out of these repeat more than 10 times. As seen in the preceding chapter, tabB and tabI, followed by pot, mainly contribute to the repetition. There is thus significant limitation of data in terms of sign sequences. At this point, it is concluded that signs have context specific behaviours of varying degrees. As these contexts play a role in the function of these signs, the sign prediction is simultaneously constrained and benefited by them.

In addition to these, REV sign sequence is also used for prediction of signs on non-seal MHA (Table 6.5). These are essentially the sequences of hypothetical moulds which would have been used for creation of tabB. These are the reverse orders of ASIS sequences. Since ICIT predictions are better than ASIS especially for seals, this is expected to be lesser than the Case 4 discussed above. As expected, significant reduction is seen in the prediction rate and thus it supports the directional asymmetry study discussed earlier.

REV	Predictors	N	Train	Test	ROC-AUC	Correct Prediction	% Correct Prediction
Case 1R	NG pairs - non-seals	1110	888	222	0.725	65	29.2792

Table 6.5: Prediction of second sign in REV sign sequences

6.4 Cultural period

In the light of the earlier discussed issues of stratigraphy, chronology, and definitions of cultural periods, Jamison's proposition of decentralised production based on seal carving style and metric attributes is reassessed. He has extended his data to map the seals

to tentative cultural periods based on empirical observations used by Kenoyer. For his dataset, he has identified carving styles of animal motif and inscription. Also, he has used attributes which describe orientation of inscriptions using Kenoyer's key. Interestingly, he mentions that these are "... critical for determining whether these groups were contemporaneous or simply represent changes over time."[32] There are a few caveats to this. There is still a gap in understanding the contemporaneity of cultural periods of Harappa with those at Mohenjo-daro and other sites. In terms of number of seals recovered, 635 are from Harappa and 1504 are from Mohenjo-daro (2273 total seals from all sites). Jamison's dataset consists of 193 from Harappa, 191 from Mohenjo-daro and 116 seals from 17 other sites.

Due to these reasons it is critical to evaluate whether Jamison's style and metric attributes can be independently related to cultural periods irrespective of Kenoyer's attributes. The use of Kenoyer's chronology and attributes for extended dataset could be a valid proposition if statistically significant relationships are observed in the following triangulation exercise -

- Jamison's attribute/s and Kenoyer's period/ attribute/s
- Jamison's attribute/s and other MHA attribute/s
- Kenoyer's period/attribute/s and respective MHA attribute/s

In the distribution of Kenoyer's cultural periods in Jamison's data, there is a high class-imbalance. Out of 500 seals observed, Jamison grouped only 180 in 55 groups. Within these 180, ~70% are from Mohenjo-daro and Harappa. Cultural period 3C is assigned to 105, 3B to 59, and eight are assigned to 3A and 3A-3B each.

Observations on Jamison's grouped data - 180 seals

Since there is a high class imbalance in the data, two-class classification is performed. I try to classify Jamison's records in Kenoyer's cultural period as 3C or non-3C based on the attributes defined by Jamison.

For his own grouping scheme, Jamison had devised a strategy of high rank and low rank attributes based on the range of variability in that attribute. The present interest is

32. Jamison, "The organization of Indus unicorn seal production: A diachronic comparative study of style, skill, and sociopolitical organization," 151.

to build a model where majority of 3C are correctly predicted. I thus perform prediction experiments with two different sets of attributes (i) high rank and (ii) low rank.

Observations on Jamison's entire data - 500 seals

- Low rank - Decision tree - 22/32 Correct prediction - 0.638 ROC - AUC Score
- High rank - Logistic regression - 24/32 Correct prediction - 0.715 ROC - AUC Score

Though promising results are seen even with low rank attributes, these are the ones which are not used by Jamison for identification of the groups as he was more interested in granularities i.e. high rank attributes than the overarching similarities.[33] Irrespective of the problems stated in earlier section about the use of metric attributes and small size of the dataset under study, both high rank and low rank attributes are seen to have independent capabilities to distinguish the 3C period artefacts from the rest.

Now, in order to triangulate, it is important to identify attributes which have significant contribution in this prediction and whether it is correlated to any other attribute.

Triangulation

- Though statistically insignificant N, Leg=4 is a major contributor in Low rank - Decision tree prediction for period 3C.
- Out of 73 Hatched-F artefacts in Jamison's data, 34 i.e. ~50% have Leg=4
- Out of 73 Hatched-F artefacts in Jamison's data, 37 i.e. ~50% have Kenoyer Period = 3C

For the seals with Hatched-F unicorn motif, Rissman has suggested that these were probably carved at Harappa and then traded or carried to other sites.[34] He has also observed higher proportion of these in late levels in Sindh/ Mohenjo-daro.[35] Franke has observed very high proportion of these motifs in the late levels at Mohenjo-daro.[36] It

33. Jamison, "The organization of Indus unicorn seal production: A diachronic comparative study of style, skill, and sociopolitical organization," 320–321.

34. Rissman, "The organization of seal production in the Harappan Civilization," 168.

35. Rissman, 166–167.

36. Franke, "Inscribed objects from Mohenjo-Daro: Some Remarks on Stylistic Variability and Distribution Patterns," 109.

must be noted that in the previous chapter, it is observed that Hatched-F seals have larger surface areas compared to other unicorn iconographies.

This indicates that there exists a possibility to triangulate such studies to identify specific artefact markers for a spatio-temporal cross-section. It can be summarised as - the relatively large seals with Hatched-F unicorn motif have a peculiar carving style for the leg portion and were mostly carved at Harappa in the later phases of occupation. Jamison has already explored triangulation in his own work. A group of right-facing animals has been associated with cultural period 3A.[37] He associates this with Kona-sukawa's observation of these being a regional variety and thus identifies those as a material marker for a spatio-temporal cross-section. On the lines of the present exercise, these correlations also need to be substantiated with more data. Also, the metric-measurement validity issue raised in earlier sections needs to be addressed. Finally, if and how to interpret this data laden observation to understand the intangible societal system/s is an epistemological challenge.

6.5 Future finds

At the present stage of MHA scholarship, despite ~5000 artefacts have already been excavated during the last 100 years, the persistent demand is to excavate more. From a decipherment point of view, this is in order to find the bi-lingual/bi-scripture artefact.[38] However, a look at the dataset from artefact form and content point of view shows that a huge variety already exists in terms of presence or absence of signs, number of signs, iconography, material, shape, size, boss-perforation, multi-sided artefacts, and more such characteristics. HARP project, which happened during 1986 to early 2000s, is probably one of the few excavations in the recent past which has excavated and published significant amount of material. In the light of the present demand to excavate more, a hypothetical prediction exercise is run. It is evaluated if there exist any significant differences in the data excavated before and after 1985. Dummy attribute is populated as 'new' for data excavated after 1985 and 'old' for the previous data. Such experiments can be improved further to assess the probability of excavating either more

37. Jamison, "The organization of Indus unicorn seal production: A diachronic comparative study of style, skill, and sociopolitical organization," 394.

38. Kenoyer, "Keynote address at International Conference on the Indus Script."

diverse artefacts than present or the repetitive ones. To take it one more step forward, will such data be recovered from newer/less excavated sites or different periods (depths) of existing sites can be hypothesised.

- **Case 1 - Consistency of subtype definition** - All data excavated up to 1985 is used as training set and remaining as test set. Subtypes are predicted based on site, class, total sides, total signs, total lines, NGs, height, alignment, and other sign properties. Thus, if the subtypes were defined based on the data till 1985, are the definitions still valid? The observations are as follows -
  - Seals, tabI and pot are consistently well predicted.
  - tabC are absent from test data because all were recovered from Mohenjo-daro up to 1985 and none after that.
  - tabB accuracy is low mostly because only small training data was available up to 1985, mostly from Mohenjo-daro.
  - In terms of sign properties used, those vary quite a lot, especially for tabB.
- **Case 2 - Predict old or new based on sign properties** - Random split of 75% data is used for training with class-rebalance on subtypes. The attributes used are as follows - sign-class, total sides, total signs, total lines, NGs, height, alignment, and sign function properties. In other words, the case tests whether the combination of these sign properties is different in new excavations than the old. Site is not included because it is already known that lot of data from Harappa is 'new' and Mohenjo-daro is mostly 'old'. The observations are as follows -
  - There is relatively better prediction for new (excavated after 1985) artefacts than old (excavated before 1985).
  - Total number of signs and sides are playing a role.
  - Majority of tabB and tabI were excavated from Harappa only after 1985. Many of these have restricted number of signs and are multi-sided. This explains the significant contribution of number of signs and sides in overall better prediction for 'new'.
- **Case 3 - Predict old or new based on form and icon properties** - Random split of 75% data is used for training with class-rebalance on subtypes. The attributes used

are as follows - boss, perf, boss other side, shape, size, sym0, sym1, sym2, Rissman attributes, and animal face direction. In other words, whether the combination of form and icon properties is different in new excavations than the old. Observations are as follows -

- The predictions are almost similar in proportion for old and new.
- Though old is mostly dominated by seals, and new dominated by tabB and tabI artefacts, there is a variety in terms of form and iconography within seals and within tabB/tabI.
- Both old and new are thus impacted by inherent varieties of dominant artefacts.
- This was also seen in boolean artefact definition.

These cases are heavily impacted due to some subtypes being prominent to some sites and being found during certain periods only. Though this can be thought of as archaeological probabilities and metadata of the existing artefacts, it is critical to acknowledge that such trends exist in data recovery, and these significantly impact our observational, theorisational, and interpretative capabilities. It is important to reiterate that the probabilistic approach is required when new excavations are being planned, especially in the hope of bi-lingual artefacts.

6.6 t-SNE experiment

MHA data analyses performed in sections till now are based on the use of basic statistics and visualisation techniques. Based on the discussion of various attributes and their values, MHA can be treated as a multi-dimensional dataset. In the upcoming fields of AI and ML, multi-dimensional datasets are now more commonly handled than before. Gene-expression datasets or stock market data are key examples of such datasets. There are specialised techniques developed for analysis, visualisation, and description of these datasets. PCA i.e. Principal Component Analysis and t-SNT i.e. t-Distributed Stochastic Neighbour Embedding are the most widely used techniques for such datasets. The use of PCA was discussed in the earlier part of this chapter. In this section, without going into the technical details, an experimental implementation of t-SNE on this dataset

is discussed. Some basic understanding about this technique was developed based on the discussions with RAC committee member and with the help of online material.[39]

The main objective of t-SNE is to bring high dimensional data into two or three dimensions so that it can be visualised and perceived by human eye. In that process, the technique tries to preserve the local or neighbourhood relationships rather than the global structure of the dataset. This is unlike PCA. Also it is a non-linear technique as opposed to PCA which is linear. The benefit of t-SNE over SNE is that it uses t-distribution instead of normal distribution. It pushes the neighbouring points from higher dimensions closer and moves farther points away in the lower dimensions. The most important hyper-parameter is called perplexity. In simpler terms, it helps decide how much importance is to be given to the neighbourhood relationships as against the global structure of the dataset. It significantly changes the embedding of the data in the lower dimensions. There are no specific rules about which value should be used and it is thus data specific. For given perplexity value, the resultant visualisation needs to be interpreted with great caution. As explained in the NPTEL lecture mentioned above, it is not possible to deduce original compactness, size, or distance between the clusters in original data based on the t-SNE graphs.

In the present experiment, scikit-learn[40] implementation of t-SNE is used. For MHA dataset, different combinations of attributes can be analysed for different subsets of data. Also, multiple visualisations can be generated for varied perplexity values and by using different attributes to colour-code the data. For MHA dataset used in present experiment, each record is a side of the signed artefact. Empty records have been excluded. Out of numerous possible combinations of attributes, subsets, and perplexity values, following are used for the present experiment:

- Attributes - total number of signs, technique, first sign pairs in ASIS, ICIT, and REV sign sequences.

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39. NPTEL lecture on this topic was extremely useful for overarching understanding of this topic: Guwahati, "Lec 47: t-SNE - YouTube." Besides that following links have been useful for general understanding: "T-distributed Stochastic Neighbor Embedding(t-SNE) | by Renu Khandelwal | Towards Data Science" and Wattenberg, Viégas, and Johnson, "How to Use t-SNE Effectively"

40. F. Pedregosa et al., "Scikit-learn: Machine Learning in Python," *Journal of Machine Learning Research* 12 (2011): 2825–2830.

- Data size - In the process of t-SNE, as it transforms unique values of each attribute into a separate column, the size of the data grows multifold, in this case 3421 rows * 3802 columns.
- Perplexity values of 5, 10, 30, 50, and 100 are used in this trial.

t-SNE experiment is performed to verify earlier observations about sign sequences and possible limitations in their predictions. At perplexity values 10 and 30, there are recognisable clusters belonging to different subtypes (Figure 6.4 and Figure 6.5) and sites (Figure 6.2 and Figure 6.3). Also, within the seals or large sites like Mohenjo-daro and Harappa, there are multiple smaller groups which need further investigation. It demonstrates a plausible separation of these groups based on the presence of signs. It thus questions the prediction experiments conducted without the context of the sign sequences.

Future Prospects

Though this and the previous chapter have produced multiple observations about MHA dataset, there is still a vast scope to refine these analytical techniques based on different algorithms and their parameters.

If more accurate information can be gathered about the individual stratigraphic contexts, the correlation of cultural periods can be improved. This will also involve understanding the site formation processes at different sites and their contribution in our understanding of the stratigraphy. The triangulation exercises performed in the previous chapter could be more meaningful with such data at hand.

For the continuos discussions and demands regarding new excavations, the prediction experiments discussed in this chapter shows that excavation of different site/mound added to the diversity of the data (tabI and tabB from HARP). However, in terms of seal iconography, there is not much of a difference. Also the relationships amongst sites and subtypes demonstrate that there is a scope for predictive modelling for future excavations.

t-SNE has provided a robust observation regarding contextuality of this data at multiple levels. Within same site or subtype, there are more possible subgroups which result due to correlations between total number of signs, technique, and sign pairs on either

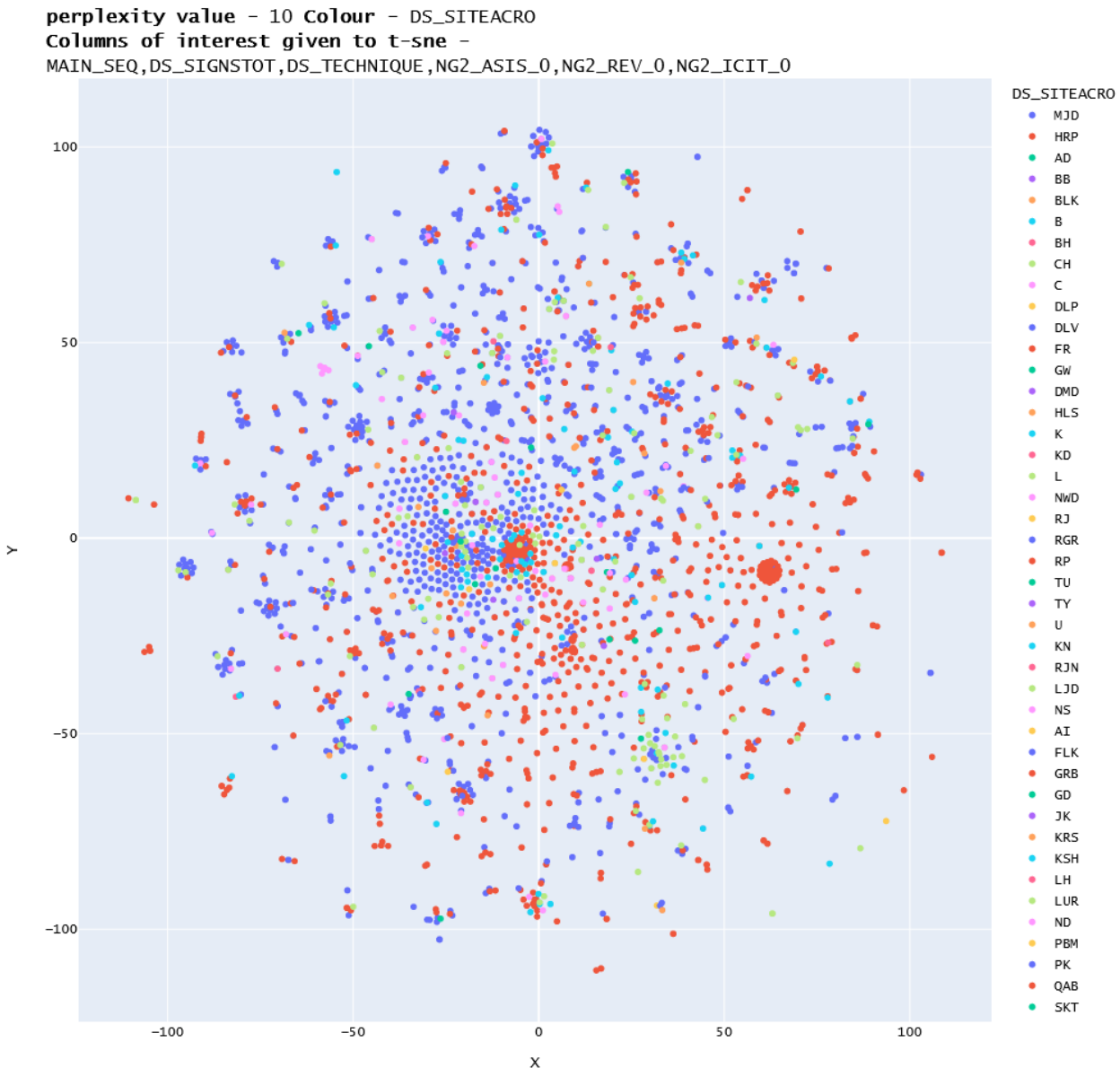


Figure 6.2: MHA colour-coded by sites (perplexity value 10)

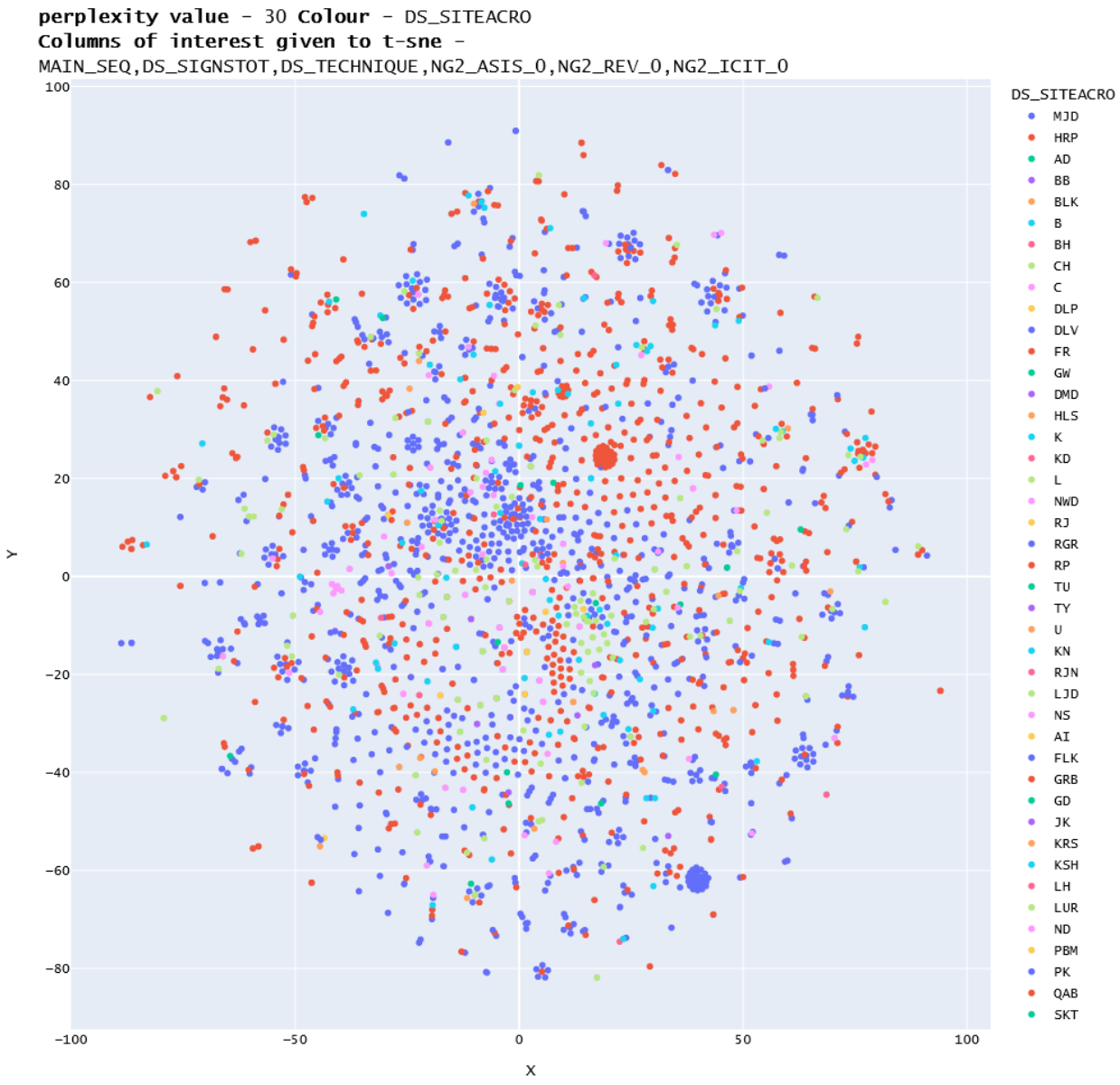


Figure 6.3: MHA colour-coded by sites (perplexity value 30)

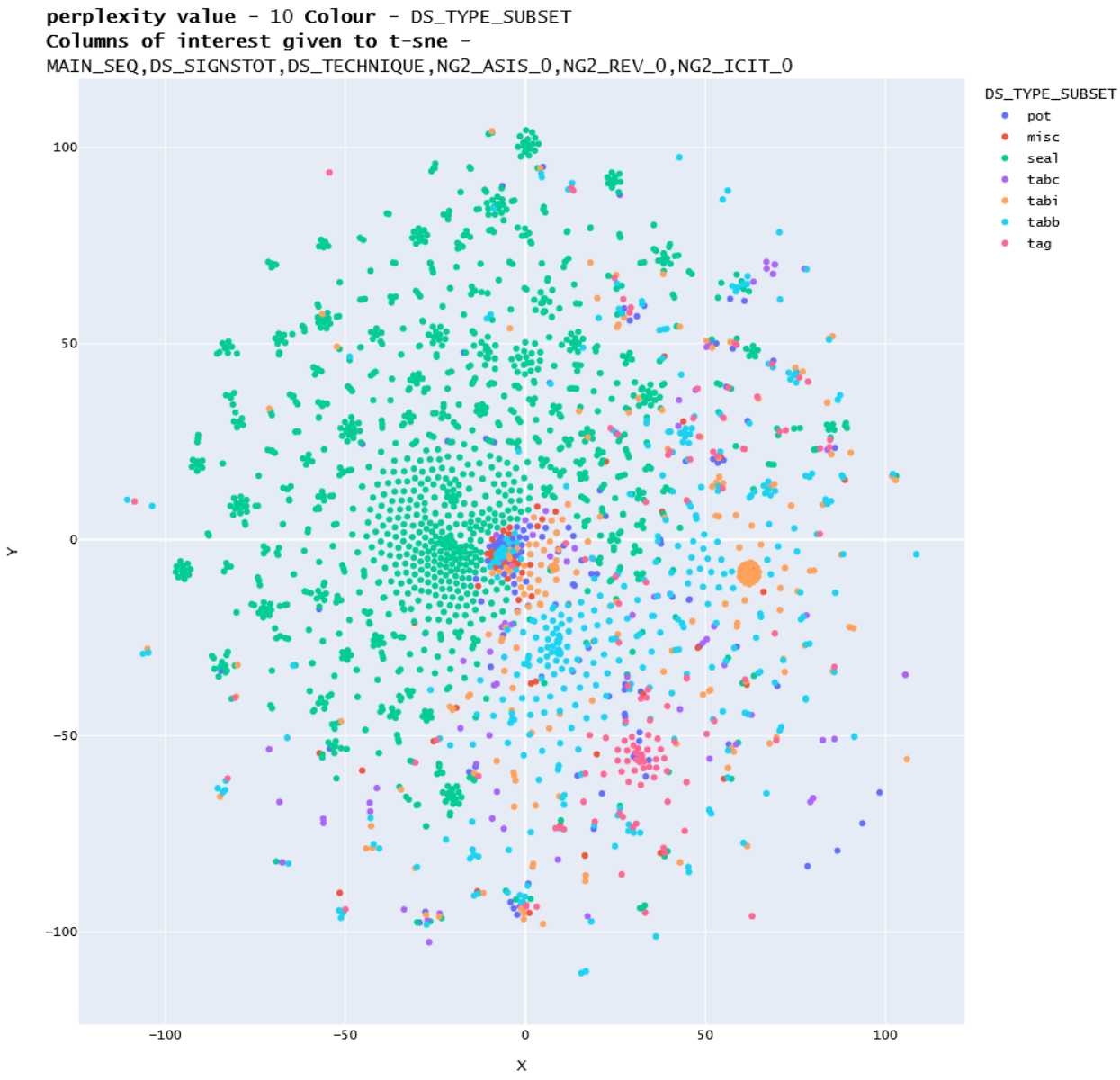


Figure 6.4: MHA colour-coded by subtypes (perplexity value 10)

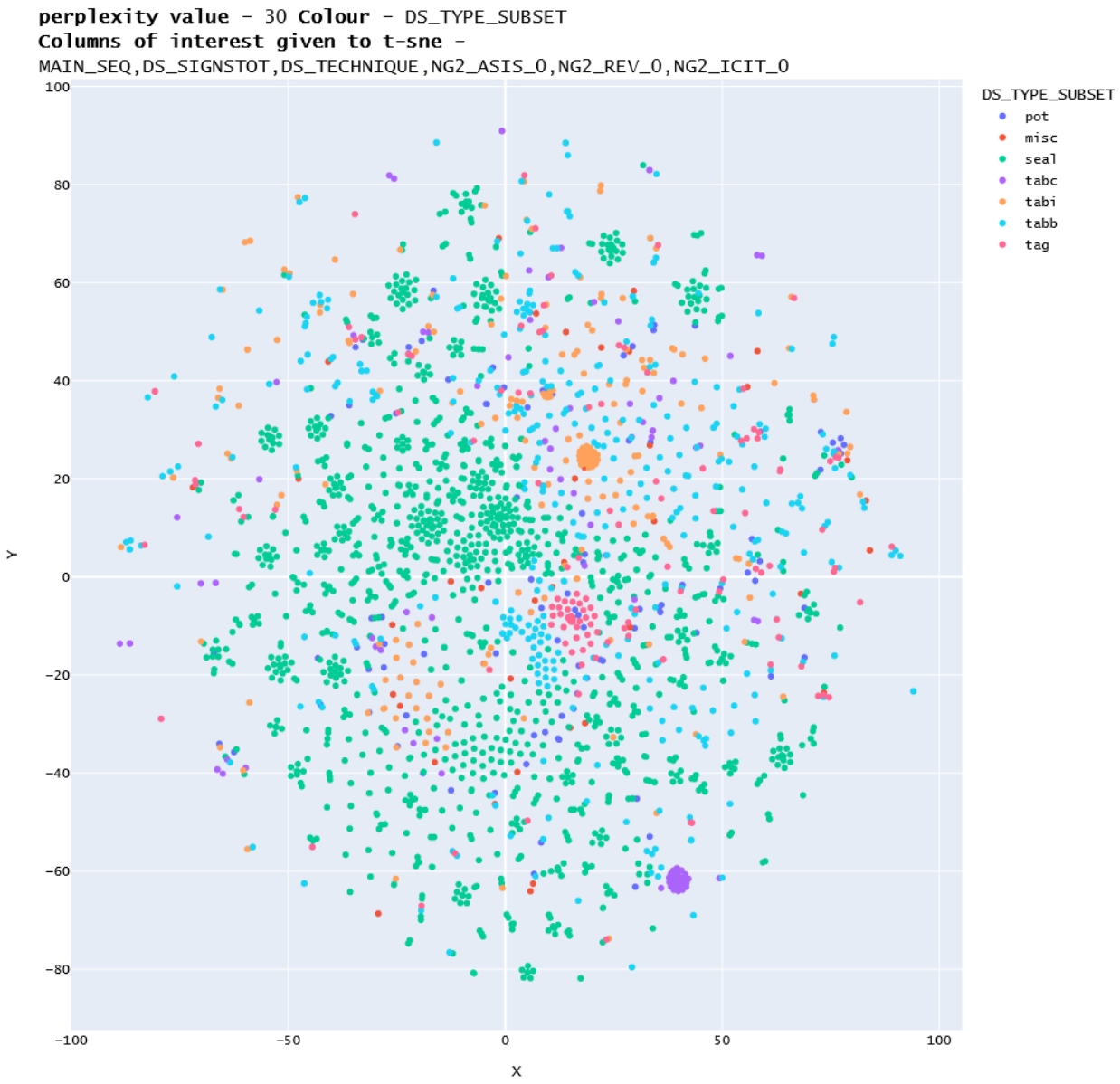


Figure 6.5: MHA colour-coded by subtypes (perplexity value 30)

ends. Creation of more of these visualisations based on different parameters and archaeological explanation of possible existence of these subgroups could be the next logical steps.

Implementation of many of these techniques is often limited by the amount of data. Archaeology does not allow to draw more samples from the population, hence one has to rely on what is excavated. Bootstrapping in DS is often used as a resampling technique to handle similar situations. While creating ensembles with replacement, we can create sample sets with assumption that population has a tendency to have duplicate objects. In case of sign sequences of MHA, this may also need a class-balance approach because the tabI and tabB have a higher tendency to repeat the sequences than the seals. For other attributes, this technique can help create virtual samples of yet unexcavated data.

Chapter 7

Geospatial Analysis

The Geographic Information System (GIS) framework has been used in this project as a case-study for artefact analysis. In addition to the attributes described and analysed in previous chapters, a specific MHA subset is extended by addition of geospatial information. It contains the findspot of the artefact in the context of the excavated site. As seen in chapter 4, the archaeologists broadly define ways to capture this information but there is no fixed standard. This can be exemplified with the examples of prominent sites. The excavations of Mohenjo-daro and Harappa roughly happened in similar time frame and their excavators were in contact with each other. However, they follow totally different methods to document the findspot information. At Harappa, Vats has mostly used the grid method where subdivisions of a larger grid unit are used to denote the location of the artefacts.[1] At Mohenjo-daro, Marshall and Mackay both have consistently used the Block-House-Room naming system for artefact location information. Mackay mentions about trenches but those are not used in the findspot naming convention.

In the present project, for the choice of case study for building a geospatial contextual data set of MHA, there are multiple constraints at play. These can be described as follows. Irrespective of the methods and technologies used, the excavation report must have the details of the structural remains and precise findspot information of loose artefacts within them. The report must elaborate on the excavation process. The most crucial part is that the report must have published detailed site plans or maps which can be co-referenced with descriptions of artefacts and excavated structures. For the needs of the present project, the crucial part is that the site must have rendered statistically significant amount of artefacts, both MHA and non-MHA. These constraints have emerged from the initial problem definitions and rationale for this study. Amongst the Harappan culture sites, there are only a couple of sites which meet the majority of these criteria. The list of extensively excavated sites is limited to Mohenjo-daro, Harappa, Dholavira, Lothal, Surkotada, Kalibangan, and Rakhigarhi. Amongst other, sites excavated to a

1. Vats, *Excavations at Harappa: Being an Account of Archaeological Excavations at Harappa Carried out between the Years 1920-21 and 1933-34*, 8–9.

sizeable extent are Mada, Ropar, Banavali, Mitathal, Chanu-daro, Lahunjo-daro, and Kot diji. Sites such as Ganweriwala have been hypothesised to have a comparable expanse as that of the Mohenjo-daro and Harappa but are unexcavated. Now considering the sheer volume of MHA excavated from any of these sites, two sites dominate the entire collection, viz. Mohenjo-daro and Harappa. Though the total artefact data increases over a period of time, Mohenjo-daro and Harappa followed by Lothal and Kalibangan still dominate the overall statistics of MHA. As understood from the CISI volumes and the history of excavations, it is evident that physical access to many of these artefacts from specific sites cannot be managed within the stipulated time-frame of the present work.

The earlier discussed problems of publication for many sites further restrict the choice. Based on the comparison of the sites discussed above, contextual mapping and analysis of MHA is practically possible only for a couple of sites.

Comparison of excavation reports shows that the wealth of excavated structural remains depicted on the maps is more granular in DKGS. In case of John Marshall's report of Mohenjo-daro excavated during 1922-27,[2] and M. S. Vats's account of Harappa excavated during 1921-22 and 1933-34,[3] a single plan for each mound depicts multiple stratum identified by the excavator. From a digital mapping point of view, it poses a challenge to understand which structures have continued across different periods. On the contrary, Ernest J. Mackay's report of SD and DK-G mounds of Mohenjo-daro, excavated during 1927-31 has detailed plans for each cultural periods, especially for DKGS.[4]

7.1 DKGS - Decision and drawbacks

This step-by-step selection process has led to choose DK-G mound as a case study site for contextual analysis of MHA. DK-G is named after its lead excavator Rao Bahadur

2. John Marshall, ed., *Mohenjo-daro and the Indus Civilization: Being an Official Account of Archaeological Excavations at Mohenjodaro Carried out by the Government of India between the Years 1922 and 1927*, vol. 3 (Arthur Probsthain, 1931).

3. Vats, *Excavations at Harappa: Being an Account of Archaeological Excavations at Harappa Carried out between the Years 1920-21 and 1933-34*.

4. Mackay, *Further Excavations in Mohenjo-daro*, II:XIV–XX.

Kashinath Narayana Dikshit. In the thesis dedicated to gaming objects recovered at Mohenjo-daro, the author describes the horizontal and vertical orientation systems employed by Mackay and Dikshit at these mounds.[5] At the time of excavation and documentation, the DK-G mound was divided into north and south sections due to the extent of the mound, volume of excavation, and probably also due to an existence of a road like separation, later named 'Central Street' by the excavators. The northern portion has rendered less than half MHA as that of the southern section. The present case-study thus uses the DK(G)-South i.e. DKGS mound of Mohenjo-daro.

Besides the systemic issues in site formation such as N-transforms,[6] Mackay tries to provide an insight into C-transform. For example, he mentions: "In removing bricks from earlier structures to build their own dwellings, it is quite likely that the people of Mohenjo-daro dropped seals and other objects, with the result that the low level at which an object lies may be no criterion as to its age."[7] His comment is in relation to his observation of people's actions from the past in DKGS mound. They were supposedly reusing the bricks of abandoned structures from earlier cultural periods. It is also possible that when they salvaged the bricks, artefacts like MHA were also collected, possibly reused, or were just repossessed by the people without active use. Kenoyer interprets that diverse contexts of writing which have been recovered throughout the sites in earlier excavations could be a result of disturbances like erosion and rebuilding.[8] However, at Harappa, He notes that the distribution indicates "... restriction of seal-users to certain areas-along major access routes and main streets."[9] Being more specific, he illustrates the findings as "Devices for control of trade, such as seals and weights, are concentrated near gateways and in craft areas located near the gateways or along major streets."[10] However, the specific mounds where recent excavations of

5. Rogersdotter, "Gaming in Mohenjo-daro – an Archaeology of Unities," 102–104.

6. Michael B. Schiffer, "Archaeology as behavioral science 1," *American Anthropologist* 77, no. 4 (1975): 836–848.

7. Mackay, *Further Excavations in Mohenjo-daro*, I:325.

8. Kenoyer, "Urban process in the Indus tradition: a preliminary model from Harappa," 35; Kenoyer, "The Indus valley tradition of Pakistan and western India," 363

9. Kenoyer, 364.

10. Jonathan Mark Kenoyer, "Measuring the Harappan world: insights into the Indus order and cosmology," *The archaeology of measurement: comprehending heaven, earth and time in ancient societies*,

Harappa took place, Kenoyer also identified many occasions or places of disturbances in stratigraphy caused due to brick robbing.[11] Chapter 3 has described the extent of brick robbing at Harappa in detail. It is then important to understand how the findspot of an artefact is inferred as a primary or secondary context against the possibilities of its movement and redeposition due to several reasons, and on several occasions in the archaeological past.

Mackay had identified the cultural periods at DKGS as Early, Intermediate, and Late with multiple phases within them. There have been multiple debates about (i) choice of fixed depths as basis for identifying the cultural periods, (ii) consistency within each period and rationale to split into multiple phases (iii) overlaps between periods and phases, and (iv) contemporaneity of these phases and periods across different mounds and sites. A crucial issue of stratigraphic control of DKGS excavation and Mackay's solution to directly correlate the depths and cultural period irrespective of their complex relationships is highly criticised till date. The contemporaneity issue has impacted present unidirectional temporal perception about the 'cultural development'. The three interim reports published by the German Research Project during 1982-86 have shown various complexities present at the sites, problems in excavation methods, and culmination of these reflected in the interpretations of the site.[12] Mackay's straightforward relationship of 'depth to period' is problematic for the following reasons. The first and foremost is that the undulation of the mounds cannot allow uniform digging and hence the absolute depths and their correspondence to tentative cultural periods is questionable. He does mention the identification of flood and alluvial soil which leads to separation of cultural periods between Intermediate II and III, and thus identification of Intermediate III as the last phase of early periods.[13] However that does not guarantee correlation of average depths to these phases. The second problem is that even if the mound is relatively flat, the entire area need not have been occupied and abandoned in an identical fash-

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2010, 109.

11. Kenoyer, "Urban process in the Indus tradition: a preliminary model from Harappa," 56; Jonathan Mark Kenoyer, "Changing perspectives of the Indus Civilization: new discoveries and challenges," *Puratattva* 41 (2011): 12

12. Jansen and Urban, *Interim Reports, Reports on Field Work Carried Out at Mohenjo-Daro, Pakistan, 1982-83 by the IsMEO–Aachen University Mission*, vol. 1.

13. Mackay, *Further Excavations in Mohenjo-daro*, I:xiv.

ion. The contemporaneity at fixed depths across the mound is a challenging proposal. His definition of house, changing composition of rooms, and the room connectivity also needs a revision.[14] Jansen's work from 1970s and 1980s highlights the problems with earlier assumptions about vertical growth of the settlement and ignoring the contributing structural remains such as drainage.[15] In Rogersdotter's work about gaming objects found in Mohenjo-daro and the place of game is past social life, the author has illustrated the nuances of defining stratigraphy over different excavations which happened at Mohenjo-daro.[16] She has also delved into the academic upbringing and approaches of work of those of Marshall, Mackay, and Wheeler.

Two major hurdles to proceed with the choice of DKGS mound are the difficulty in visiting the site and actual access to MHA. The sites of Mohenjo-daro and Harappa are in present day Pakistan, and visa acquisition for an Indian national is a tedious process. Though I continue my efforts to visit the site, I carried out fieldwork within Indian borders to get an overall geographical experience of the sites. It was summarised in chapter 4. About the artefacts, Lahiri describes the fate of these artefacts that unfolded in a political drama around the time of independence and partition of India and Pakistan in 1947.[17] The artefacts of present interest were divided amongst India and Pakistan. The division was a total compromise to the integrity of the collection and their collective value in terms of archaeological wealth. It poses new questions such as (i) whether the context is lost at the secondary or tertiary stage of artefacts' existence, and (ii) whether the loss of integrity and limited access defy further studies of these objects. Having said that, the politics in the following decades has unfolded into such an environment that to have even random collections of these artefacts on either side has turned out to be a boon. Though it does not compensate for the access to the entire MHA collection, it allows at least partial 'experience' of the artefacts. As a result, this project relies on doc-

14. Jansen and Urban, *Interim Reports, Reports on Field Work Carried Out at Mohenjo-Daro, Pakistan, 1982-83 by the IsMEO–Aachen University Mission*, 1:47–51.

15. Jansen, "Water Supply and Sewage Disposal at Mohenjo-Daro."

16. Rogersdotter, "Gaming in Mohenjo-daro – an Archaeology of Unities," 25–30.

17. Nayanjot Lahiri, "Partitioning the Past: India's Archaeological Heritage after Independence," in *Appropriating the Past: Philosophical Perspectives on the Practice of Archaeology*, ed. Geoffrey Scarre and Robin Editors Coningham (Cambridge University Press, 2012), 307–309, https://doi.org/10.1017/CBO9781139026932.019.

umentation available in excavation reports, articles, CISI volumes, the ICIT database, and physical observations of small set of MHA from ASI's collection.

Now, despite the issues of DKGS excavations, to recognise contexts from these earlier excavations as erroneous can neither be an escape nor a solution to our inability to interpret those. Though the recent excavations at Harappa are stratigraphically more consistent and methodical, chapter 3 notes that the granular periodisation from HARP project is yet to be corroborated with many other sites. Those levels/ finds/ material/ chronologies are yet to be consistently mapped to other major and minor sites including the mound of DKGS. Also, though the further interim reports pointed out certain lacunae in the methodologies of Mohenjo-daro excavations, reading the excavation process for each block reveals that despite imprecise assumptions, those have been systematically standardised. Even if the stratigraphic sequence is unreliable for the cultural chronology, the systematisation has opened an opportunity to create a digital twin and then investigate for the possible solutions to rectify the problem. It is thus suggested to use this material itself to understand the possible errors within it.

After a multitude of these considerations, DKGS happens to be a relatively ideal case to build GIS and then use it for contextual analysis of MHA. The limitations faced in this process, methodologies implemented to generate the dataset, and the resultant geospatial data will create a learning experience for more such experiments in archaeological studies. As mentioned in chapter 2, multiple scholars such as Frake, Green, Sarcina, and Mosher have used this mound as a case study for different aspects of spatial analysis. Within their specific scope of study, they demonstrate the opportunities to perform further analysis on the material remains of this mound. Table 7.1 shows the number of MHA which have been excavated and recorded from DKGS mound. Out of total 5442 artefacts, 5257 belong to 13 major sites and 185 to all other remaining sites. It is seen that DKGS alone contributes to more than 10% of total MHA count (Table 7.1).

7.2 GIS Data creation

Geospatial data creation solely relies on the quantity and quality of the source data material created during the excavation process. All the observations, possible analyses, and inferences are directly impacted by these. For DKGS, Mackay has published 5 different

Site	DKGS	Rest of MJD	Harappa	Dholavira	Lothal	Kalibangan	Chanhu-daro
MHA	562	1498	2295	241	253	191	83
Site	Nausharo	Banavali	Lakhanjo-daro	Allahdino	Kunal	Kanmer	Kot Diji
MHA	41	32	18	12	12	9	10

Table 7.1: Proportion of MHA in DKGS compared to other major sites

plans and each refers to a particular cultural period at the site as identified by him.[18] Thus the structural remains depicted on each plan are supposed to be reminiscent of the respective cultural period. Each of this plan also has a grid of 100 Ft * 100 Ft.[19] The grid provides a common frame of reference for all the five plans. This is critical because this practically helps to overlay all the maps on each other and thus virtually rebuild the entire stratigraphic and structural sequence as recorded by the excavator. The artefacts recovered from this area are attributed with cultural period, phase, and the absolute depth measurements.

It is important to note that though this grid was laid down and was being subdivided, as the excavation progressed in the depths of the mounds, it became practically impossible to use it to record horizontal location information of the artefact findspots or the structures. Mackay thus decided to use the room numbers as location identifiers. Despite this decision, issues such as changing room extents and house locales needed to be negotiated. He has described these problems in the introductory chapter of the excavation report.[20]

The source material for building the GIS is thus available in the form of these plans and artefact lists. Though all the maps are referenced to each other with the grid, it was important to georeference those. This is essential to correlate any relevant data of the mound in the future. This grid of 100 sq ft cell size was initially defined by Marshall.[21]

18. Mackay, *Further Excavations in Mohenjo-daro*, II:XIV–XX.

19. Mackay, *Further Excavations in Mohenjo-daro*, I:xiii.

20. Mackay, I:xi–xvi.

21. Marshall, *Mohenjo-daro and the Indus Civilization: Being an Official Account of Archaeological Excavations at Mohenjodaro Carried out by the Government of India between the Years 1922 and 1927*,

In the first volume of Marshall's report, the site location is mentioned as 27d 19m N and 68d 8m E. Mackay continued the excavation by taking the charge from Marshal. The specific location can be correlated in the grid used in the five maps produced by Mackay. This location tentatively maps to the SW corner of the present day demarcated site. The grid point 20Z i.e. the SW corner of DKGS is identified as 27°19'34.7"N and 68°08'11.0"E. The elevations refer to the benchmark level of 178' 7" above msl (=54.47 m above msl) as marked in Block 9, House I, Room 27.[22] All the levels of cultural periods which were recorded in feet below msl, are converted into m and cm below sea level. This depth or height from msl has been used for respective digitised plans of the structural remains. This data is also corroborated with Jansen's reports.[23] Based on Mackay's table,[24] the levels can be summarised in table 7.2.

As already mentioned, the present study does not necessarily assume these periods to be rational or accurate; it's perhaps a starting point to delve into the possibilities to improve our understanding. There are no definitive phases of early period whereas Intermediate (Int) can be seen divided in three phases. When all five plans were geo-referenced, an offset was observed in the room and house boundaries across the plans. There could have been different reasons such as:

- Offset could have been introduced in the actual structures as the brick alignments might have changed or even the wall thickness could have been modified over the period of time. Based on the actual measurements of these offsets and their comparison to the standard brick measurement from Mohenjo-daro, it might be possible to isolate these cases for future studies.

- In addition to this or even in absence of this, the equivalent other possibility is that of errors being introduced during the measurements at the time of excavations itself. The excavations extended over multiple seasons with seasonal rainfalls and summers. This could have deferentially eroded the excavated surfaces. Though the grid points

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22. Mackay, *Further Excavations in Mohenjo-daro*, I:xiv.

23. Michael Jansen, "Mohenjo-Daro, Indus Valley Civilization: Water supply and water use in one of the largest bronze age cities of the third millennium BC," *Geo: A new world of knowledge*, 2013, 67.

24. Mackay, *Further Excavations in Mohenjo-daro*, I:xiv–xv.

Strata/ period	Depth information as per Mackay	Depth in m wrt MSL Benchmark of 54.47 m -	Plates avail-able	Map ID	Time ID
Late Ia	Owing to denudation is very rarely represented in the DK Area. Ranges from 0.86 ft. above to 3.2 ft. below datum level	54.71	Plate XX	1	1
Late Ib	Door-sills and pavements aver-age 5 ft. below datum	53.49	Plate XX	1	1
Late II	Average 7 ft. below datum	52.645	Plate XX	1	2
Great Flood					
Late III	"Average 9·9 ft. below datum. Uppermost stratum of the Inter-mediate Period"	51.45	Plate XIX	2	3
Int I	Average 13 ft. below datum	50.51	Plate XVIII, Plate XIX	3	4
Int II	Average 15.9 ft. below datum	49.99	XVII	4	5
Flood					
Int III	"Average 20.4 ft. below datum - Last phase of the Early Period"	48.25	XVI	5	6
Early I	Average 24 ft. below datum	47.15		-	7
Early II	Not known	47.15		-	7
Early III	Not known	47.15		-	7

Table 7.2: Cultural periods and stratigraphy as described by Mackay, with reference to survey plan Ids and depths converted in m.

offer unique advantage, there is a chance that the original plans, produced over multiple years, themselves have a offset and it persists in the geo-referencing. Also it must be noted that the measuring instruments, skill, and persistence in recording the measurements over multiple seasons could also contribute to these errors.

- Finally, the more proximate cause is introduction of error at the time of geo-referencing of these plans in the present work.

Effort to reduce the combined effect of these multiple factors has been implemented by the use of maximum common grid points from all the plans. Also their overlap with what is currently present at the site as seen in the satellite imagery is also checked.

7.2.1 Digitisation of structural remains

The next step is to capture the structural information in digital vector format from these georeferenced raster maps. Andreas Fuls has shared the vector data for block boundaries which he had developed along with grid points and room points. The present project scope is limited to the plan or 2D view of the structural remains of five cultural periods. However, the depth information was also captured such as depths of the door sills, drainage lines, individual artefacts, any other remains where the depths were specifically mentioned in the excavation report. It is hoped that this will eventually assist in the improvement of the presently understood stratigraphy. In the process of digitisation, the point, line, and polygon datasets have been created separately for each plan. Based on the scale of the maps and nature of the remains, following decisions were taken for the data types to be handled in GIS.

Since the plans have a very large scale i.e. 1 inch: 10 feet, it is equipped to depict variation of wall thicknesses in many areas. These are critical in order to analyse the purpose of the dwelling and its perceived hierarchy in contemporary culture. However, in the present scope, I have chosen to use polygons to capture inner area of rooms as they depict the main findspot of the artefacts across the depths. Polygons are also used for other specific areas described in the report such as pavements, brick platforms, and staircases. Features with in-built linearity such as roads (streets, lanes, alleys) and drainage lines are captured as line features. Though both these possess significant widths, those are not captured in the primary data creation. Point data is probably the most hetero-

geneous in terms of nature of features captured e.g. artefacts, room or house entrances, wells, water chutes, soak pits/cesspits, in-situ remains such as pots, burials, and other specific mentions. In the excavation report, many of these have not been depicted on the plans but are mentioned in the block-wise description. Digitisation process of these features posed some constraints and also provided certain learnings as follows:

- Room - Room is captured as a polygon but sub-features. such as entrance to the house, door between two rooms, or niches on the vertical wall were captured by point data.To link the artefacts, centroid was generated and attributed for each room. Association of the rooms with the house and demarcation of houses is mapped as described by Mackay.[25] As the excavation progressed deeper and where the walls did not align with earlier masonry at deeper levels, Mackay had to remove the walls but he continued to take the wooden pegs down with the same room labels. Thus he continued to refer to those areas with the same room numbers.[26] This created additional point data in plans even if the structures are absent. However, on completion of digitisation of rooms and their attribution of house and blocks for all five periods, it was observed that there were many occasions when the artefacts were found in such locations. For the structural remains, many rooms or houses showed architecturally specific features such as courtyards, thick walls, passages, stairways, and arched doorways. It is possible that these manifest some societal phenomenon related to social structure, occupations or some well defined systems of usage of space.

- Houses - Rooms associated to specific houses have been identified based on the survey plans, description in the excavation report, and the location information described for artefacts at the end of the report. It is seen that the house layouts have modified in different periods because the room sizes or association between rooms and houses have changed. Other common spaces such as streets are seen narrowed down; for example Fore lane is seen being obstructed due to structural additions. Thus, in the present work, the definition of house is constrained by the descriptions and plans published in the excavation report. As described chapter 2, these definitions can be further refined by incorporation of architectural studies such as those by Mosher and Sarcina.[27]

25. Mackay, *Further Excavations in Mohenjo-daro*, I:xiii.

26. Mackay, I:xiii.

27. Sarcina, "A Statistical Assessment of House Patterns at Moenjo Daro"; Mosher, "The Architecture

- Brick platforms, pavements - These have been depicted in the map but also described in detail in the text so both were analysed in parallel to capture these.

- Drainage lines - These became the most prominent features as the digitisation progressed. Jansen's study on the drainage line documentation and their levels is critical in this case.[28] These lines are mostly parallel to the streets and connect the individual drain outlets from the house complexes. These connections eventually assist to trace the slope. During digitisation, their depths were also captured from the report. These are tightly associated with the presence and layout of the houses. So the drainage lines traced across multiple plans can be related to the structures to hypothesise their presence.

- Wells - Jansen estimates more than 700 wells at Mohenjo-daro.[29] Some are visible on the plans and are captured. Many of these wells continued across multiple cultural periods. Their height above the ground increased with the rising ground level during different phases. At many locations, wells are seen standing like tall towers. This depicts removal of the upper material, either soil or structures, in the surrounding areas of the well but the well not being cut down to that excavated level. The level and diameter information of wells in this locality were captured from Jansen's report.[30]

- Block - The block boundaries were initially shared by Dr Fuls. Based on the georeferencing exercise and the creation of digital dataset, these were later modified as and where needed. These blocks are imaginary neighbourhoods which separate groups of houses by thick walls or alleys. The excavation report is segregated based on these blocks where cultural periods and the remains are described in the context of each block. Mackay also describes extent of excavations for each block and thus provides some idea about uneven excavations of the mound.

Figure 7.1 shows a composition of Late III+Intermediate I period plans.[31]

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of Mohenjo-Daro as Evidence for the Organization of Indus Civilization Neighbourhoods"

28. Jansen, "Water Supply and Sewage Disposal at Mohenjo-Daro."

29. Jansen, 180.

30. Jansen, "Mohenjo-Daro, Indus Valley Civilization: Water supply and water use in one of the largest bronze age cities of the third millennium BC," 56.

31. Mackay, *Further Excavations in Mohenjo-daro*, II:XIX.



Figure 7.1: DKGS - Late III+Intermediate I period plan with GIS layers of blocks, wells and drainage

As the structural remains in the form of rooms, houses, and other features such as brick platforms, pavements, or cesspits are captured, each plan shows different number of rooms. It thus leads to variation in house numbers and their layouts which can be identified across different cultural periods. A summary of this can be seen in the table 7.3. The depth values are in feet below the datum point as described in the report.[32]

Map	Period	Depth	Roompoints	Roompolygon	Houses
1	Late I-II	3-7	707	511	54
2	Late III - Int I	9.9	711	223	53
3	Int I	13	612	302	52
4	Int II	15.9	604	365	54
5	Int III	20.4	587	137	31

Table 7.3: Number of Rooms and houses in different cultural periods of DKGS

7.2.2 MHA and non-MHA in geospatial context

The virtual 'reconstruction' of DKGS in the GIS space creates a basic archaeological context. The MHA and non-MHA of this particular mound are linked to relevant find-spot rooms in this GIS. Thus, for the plan of each cultural period, artefact findspot in the format of block-house-room is documented. This essentially also means that if multiple artefacts were recovered at different depths in a specific block-house-room, those will be linked to the same horizontal findspot. In the 2D or plane view, these appear as single points but in a 3D space, these appear at different depths. This is thus an approximation of the archaeological context of MHA. It creates their individual and collective association with structures, stratigraphy, non-MHA, and each other. In DKGS, there are 613 records of MHA (each side as a separate record, 570 actual MHA) and 2073 non-MHA artefacts. These records are linked to the corresponding room number for each cultural period.

In the cases discussed in earlier section, where artefacts are located in the absence of encompassing structure, those were assigned the location of a virtual house or room

32. Mackay, *Further Excavations in Mohenjo-daro*, I:xiv–xv.

which was noted on the plan based on the on the peg brought down from the upper levels.

Often, even if the exact depth of the artefact was documented or the cultural period was specified, the findspot was loosely defined e.g. between the two blocks, on the street, or in the drainage. These artefacts could not be linked to a specific block-house-room location within the GIS. All these are depicted by points outside the boundaries of digitised archaeological remains. As such, 117 out of 613 records are denoted outside the blocks and only segregated by cultural period.

The basic summary of this data can be seen in the table 7.4. 'Artefacts - XY' mean that it could be located both in space (x) and time (~depth-y) whereas 'Artefacts - Y' mean that though the depth value is available, the location is either vague or unavailable.

Map	Period	Records - XY	Records - Y	MHA records	MHA count	Seal count
1	Late I-II	59	10	69	66	56
2	Late III - Int I	106	13	119	107	94
3	Int I	108	27	135	127	116
4	Int II	89	19	108	104	90
5	Int III	134	48	182	166	134
Total	-	496	117	613	570	490

Table 7.4: MHA and linked to their tentative spatio-temporal context

Based on the (i) systemic problems of archaeological site formation, (ii) academic hypothesis about those problems, and (iii) resultant perception about material similarity or dissimilarity, it is evident that association of tangible material to intangible cultural phases is a complex process. For example, with respect to chronology of MHA, it is seen that based on excavations in Harappa, geometric button seals have been assigned to the early period - Period 1 - 3700-2800 BCE[33] and late period - 1900-1700 BCE.[34] The late phase assignment is also correlated to the lack of evidence of writing. This is a

33. Kenoyer, "Origin and Development of the Indus Script: Insights from Harappa and other sites," 219–220.

34. Kenoyer, "The origin, context and function of the Indus script: Recent insights from Harappa," 20.

result of several revisions to understand the chronology of the writing system.[35] In the light of the possible stratigraphic issues described above, evidence of geometric seals from more than 20 sites and almost a similar number of same from Mohenjo-daro and Harappa[36] call for more investigation.

Existing literature and preliminary data compilation reveals few important aspects of the DKGS mound -

Mackay notes a period of three hundred years for the mound to gain the height of 20ft from the lowest occupational levels. Further, the relation of fixed depths with cultural periods is a problematic assumption. Combining this with uneven excavations of the the mound and lack of vertical section to compare it with other sites like Harappa, it creates an interpretation impediment. With respect to artefacts, out of 5442 unique records in MHA dataset, 2060 are from Mohenjo-daro. Out of these ~560-570 are in DKGS. That is, despite 86 sites in present dataset, almost 10% of total MHA are accumulated in single Mohenjo-daro mound DKGS. 490 out of these are intaglio carved seals (square or rectangular). These artefacts in DKGS are seen spread across the rooms in the house, in different blocks, and through the excavation depths. These are not seen accumulated in a specific small area of the mound. This ubiquity must be addressed on the background of their current interpretation which associates them to specialised and less common occupations such as trade, administration, or economic activities. Compared to seals, there are hardly any records of tags from this otherwise artefact rich mound. Non-seal artefacts are also present but those are less than 15%.

At this point, it might be worth recollecting Mughal's objection to the data published from the HARP seasons at Harappa. He mentions that 'Hakra' wares at Harappa were being labelled as 'Ravi' "... as if something new was discovered."; these were originally distinguished as "... wheel made and handmade vessel forms, painted designs and surface treatment ... ."[37] These sets of claims and objections are similar to identification of six ceramic types by Thapar at Kalibangan but later those being reappraised by Nigam

35. Kenoyer, "The origin, context and function of the Indus script: Recent insights from Harappa," 18; Kenoyer, "Origin and Development of the Indus Script: Insights from Harappa and other sites," 221–223

36. Konasukawa and Koiso, "Size of the Indus type seals and its Significance," 296.

37. Mohammad Rafique Mughal, "Cultural Continuity of the Indus Valley Civilization in Sindh, Southern Pakistan," *Studies in Heritage of South Asia (Essays in Memory of Dr Harunur Rashid)*, 2012, 230.

as Sothi pottery.[38]

Both these examples demonstrate that such revisions and interpretations from diverse perspectives bring out the value of otherwise mute archaeological material. However, it is important to note that identification of new characteristics, typologies, or perspectives carry a baggage to situate those in the existing ontologies and bring coherency. Otherwise it is then critical to substantiate the existence of new claim in the present philosophy as seen in the above debates. Identification of Hakra ware or granular periodisation at Harappa will become robust claims when their presence can be independently demonstrated at other sites and those phenomena can be interpreted in association with other cultural traits at multiple sites.

7.2.3 Inconsistent excavation across blocks

The plans produced by Mackay depict specific cultural phases, the block-by-block and period-by-period description of the mound. They reveal that entire mound has not been excavated uniformly. The following table shows this inconsistency across the blocks. It also shows that the present day excavated mound that we see and experience is possibly a fusion of time in the given space. The blocks in the table 7.5 are arranged as per their geographical locations from N to S.

The chronological correlation exercise was discussed in the data preparation chapter. For the GIS case study of DKGS, it is extended to MHA within this mound. This excavation history along with the tentative corroboration of Kenoyer's cultural periods can be seen in figure 7.2

Mackay's excavation strategies and documentation impact our overarching interpretation of the site and the academic outcomes there of. These can be described in the order of time from earliest to latest as per Mackay's convention of cultural periods.

Map 5 - INT III - Early - Only southern and western part of the mound is occupied. The drainage on E flows from N to S.[39] The one on W side drains out to W. For the Early period, horizontal drain in Fore-lane in the centre is not captured in any of the

38. Tejas Garge, "Sothi-siswal ceramic assemblage: a reappraisal," *Ancient Asia* 2 (2010).

39. Drainage lines belonging to different cultural periods can be seen in figure 7.3

Mackay's report descriptions of excavations for different blocks: Little Left or Excavated - 2; Excavated - 3; No remains - 0; Not excavated - 1						
-	-	Oldest to Latest period				
Tentative direction within the mound	Block	Int III	Int II	Int I	Late III	Late II-I
Northmost	6A	1	1	1	3	3
Northmost	8A	NA	NA	NA	3	3
Northmost	9A	NA	NA	NA	3	3
Northmost	12A	3	3	3	0	2
West-North-Mid	11	3	3	3	NA	NA
West-mid	10A	3	0	2	0	0
Mid	12	3	3	3	2	2
Northmost/ North/mid	9	NA	3	3	3	3
North	8	NA	3	3	3	3
North-mid	6	1	1	1	3	3
Mid	5	2	3	3	3	2
Mid	4	3	3	3	3	3
Mid	7	3	3	3	3	3
Mid	10	3	3	3	3	3
South	1	3	3	3	3	3
Southmost	1A	3	0	0	0	0
Southmost	2	0	3	3	3	3
Southmost	3	2	3	3	3	2
Like 1A, where Mackay mentions 'no remains' or like 6/6A of not excavating further; he does not mention either of it for blocks 8, 8A, 9, 9A, and 11. So these are noted as NA. He calls this the last phase of the city. For simplification of the mapping exercise, I treat these as 'No remains - 0', assuming that if Mackay had decided not to excavate, he would have called it out explicitly. Thus in the GIS layer of block, all NA will be recorded as 0.						

Table 7.5: Uneven excavation of the blocks in DKGS

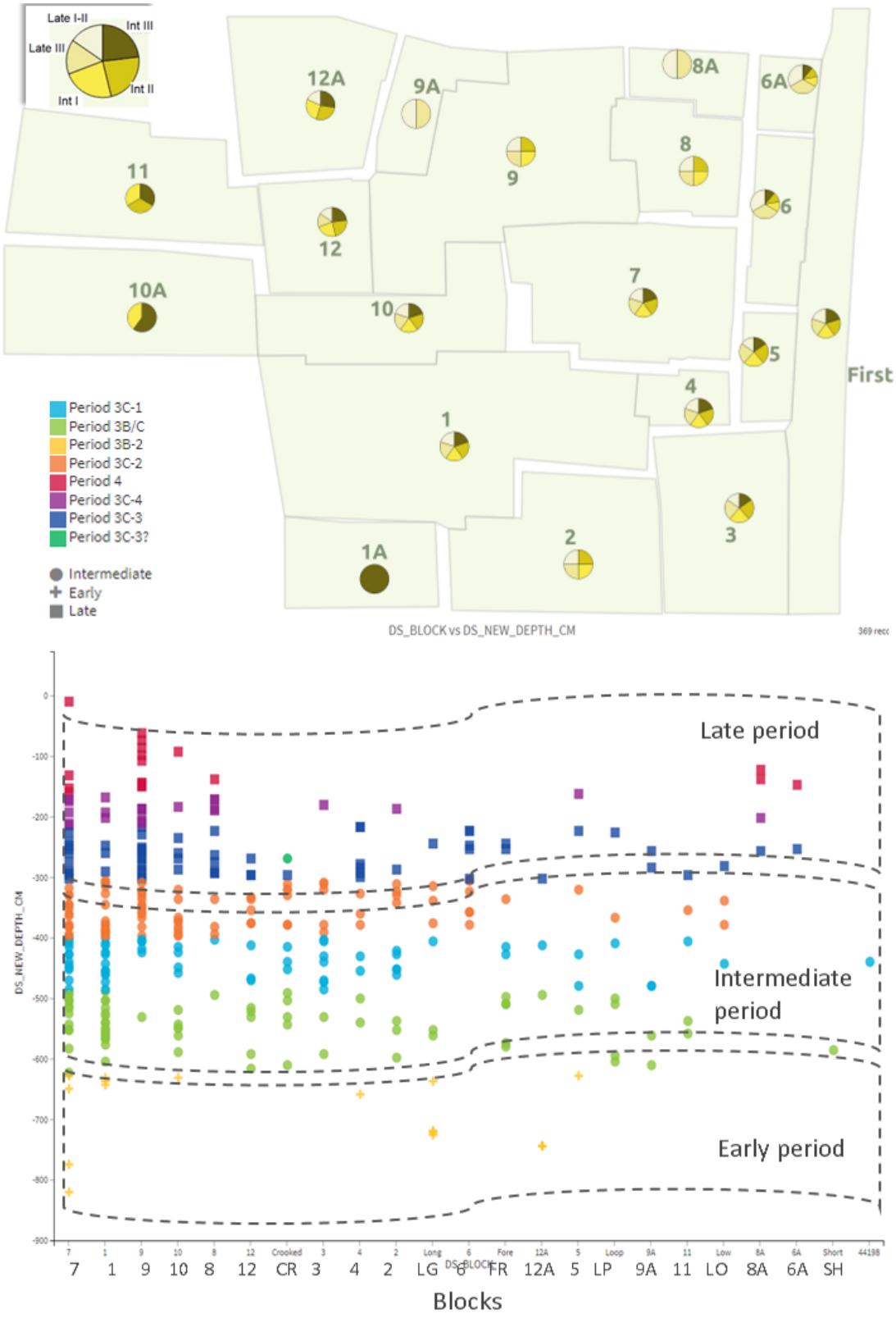


Figure 7.2: Uneven excavation of DKGS mound and artefact distribution across the blocks

plans but is described in the text[40] and shown in the photograph.[41] The W side drain has multiple water chute which connect to it but no structure or room are seen which drain into these chutes. Also the First street drain extends towards the north which does not depict settlement around it. For long lane drain in the W and fore-lane drain in the centre, we do see structures captured in INT II plan. However, for block 6 and 6A, the interiors were cleared to floor level only up to Late III level.[42] Thus, from the excavation its not known whether these blocks were occupied in earlier levels. However, the long drain indicates it probably was.

Map 4 - INT II - Despite the occurrence of floods it can be hypothesised that people continued the use of drainage lines of previous period and added new to build the network that spanned the newly occupied area. The slopes mainly appear towards W (Long lane) and S (First street). New houses can be seen in block 8 which are not there in INT III. As already mentioned - either these houses were actually new and didn't have any structures in those areas prior to INT II or the excavator did not dig deeper beyond INT II.

Map 3 - INT I - Unlike transition from INT III to INT II, there aren't any new houses in newer areas of the mound. However, as per Mackay's plans, majority of the internal walls in the houses can be seen removed in the subsequent period. There is a reorganisation within the existing structures.

Map 2 - Late III - INT I - From the maps it can be interpreted that the NE corner of the mound is newly occupied in this period. Based on Mackay's description[43] about the direction of flow of the drainage lines, this area is on the higher ground. It is likely that the new occupations happened here in order to mitigate the risks from the Indus floods. Compared to INT I, many new drainage lines are seen laid out which connect to the existing network. Two new wells are also seen on either side of block 8A. This is a direct implication of infrastructure development for denser settlement or new area being occupied.

Map 1 - Late I-II - The room density increases in the Late I-II period in the NE area

40. Mackay, *Further Excavations in Mohenjo-daro*, I:43.

41. Mackay, *Further Excavations in Mohenjo-daro*, II:XV.

42. Mackay, II:72.

43. Mackay, II:26.

as well as on the remaining mound in the southern area which was occupied since Int III period. The newly occupied area which earlier had large enclosed areas e.g. blocks 6, 8A, 9, 9A can now be seen sub-divided in the rooms. From excavation point of view, this can also be interpreted as majority of the walls excavated in Late I-II were erased in order to dig deeper. As Late III was identified, only some of the enclosing and thicker walls were kept intact.

Collective assessment

Within the framework and constraints of excavation strategies, preliminary sequential comparison of these horizontal plans is performed. Continuity of structures, wells, and drainage is visible across the depths. Drainage lines slope towards the SE corner and E side of the mound. These drainage lines and wells indicate that the settlement probably gradually extended or moved from southern portion of the mound towards the N/NE (Figure 7.3). This could be associated with overall slope and geomorphology of the mound. Blocks in N/NE area, i.e. away from the river are identified as devoid of Intermediate III phase, i.e. the most prominent lowermost level. It is possible that with subsequent events of flood, the settlement slowly moved away from the river, towards a relatively higher ground of the mound in the N. Also, though most of the settlement was towards the south in the Int-III period, areas like block-7 and block-10 were probably continuously occupied for the entire duration from early to later periods. These blocks are at eastern and western side of the mound. The table 7.5 shows that for the northern blocks, Mackay has not excavated those or has not explicitly mentioned about their excavation status. This needs to be further associated/ analysed in relation with DKG(N) which is situated on the northern side of the DKGS which is present case study mound.

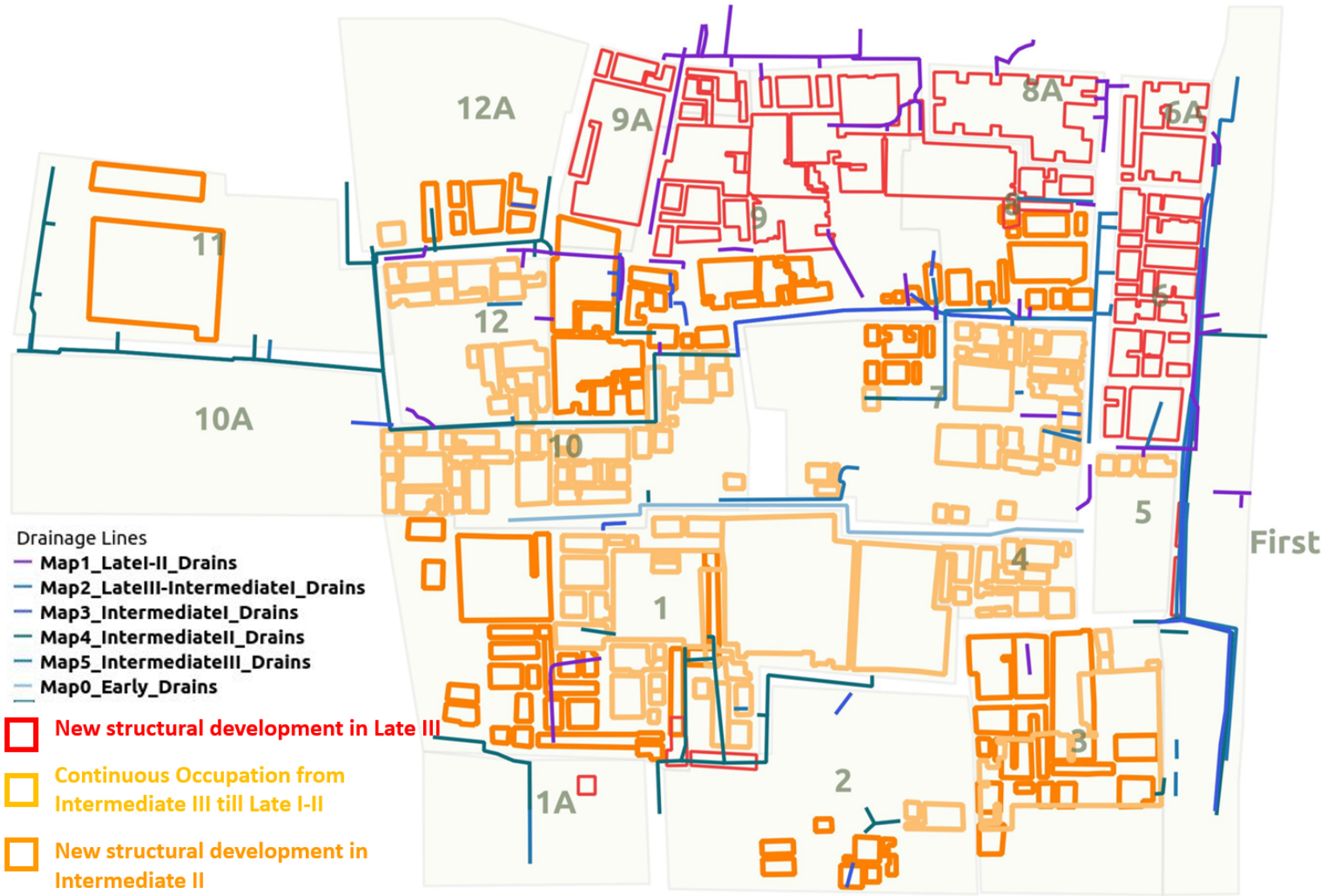


Figure 7.3: Possible movement of settlement from S to N on DKGS

7.3 MHA distribution in DKGS

Geospatial data creation for DKGS has created an opportunity to practically reconstruct the archaeological context of the artefacts, both in space and time. Though the data creation in this project is limited to two dimensional capture of the in-situ structures, the proposed depths for individual cultural periods by the excavator and documented depth of each artefact have created a virtual space-time point-cloud of the DKGS mound. In this analysis of spread of these artefacts within different rooms and houses located in different blocks, the spatial definition of house is borrowed as illustrated in the plans of the excavation report. The preliminary observations for MHA across the depths in the blocks of DKGS are as follows -

The preliminary data shows high concentration of seals. Interestingly, even if all 254 tabC (except one at Kalibangan) were recovered from Mohenjo-daro, only 17 can be confirmed to have been located in DKGS. For a subset of MHA with two or more recognisable signs, following observations can be made -

- Last phases of 3C are overlapping with late period.
- Intermediate period is a combination of 3B and 3C phases.
- Block 7 is rich in terms of amount of artefacts as well as their spread across the depths.
- Block 1 and block 9 show difference in terms of concentration of artefacts at different depths.
- Despite having fewer artefacts, block 5 shows a spread across 5 meters of depth.
- Quantity of seals is significantly higher than all other MHA artefacts.
- With respect to the hypothesised separation of R facing animals on seals, these appear in lowest strata in blocks 5 and 7.
- Though R facing animals are not seen mapped to period 3A as described above by Kenoyer and Jamison, their association with earliest possible period at this particular mound is visible.

- Another iconographic observation from the triangulation exercise performed earlier is about the Hatched-F unicorn motif. It is seen associated with late phases in cultural sequence, most likely 3C. Also the size analysis has shown that Hatched-F motifs are generally found on larger seals. At DKGS, though in small quantity and on larger seals, Hatched Face unicorn motif is seen spread across the depth range of roughly 4 to 5 meters of period 3C. It is also seen concentrated in Blocks 7 and 1.

The most striking observation is discovery of nine skeletons in Block 10A. These are assigned to Intermediate-III level, roughly between 18 to 23 ft. below datum, Mackay reports that these were "... 5.9 ft. below the surface of the mound... ."[44] There are hardly any remains from the upper level which Mackay documents. This could be because the location of the block is almost on the edge of the mound and probably led to erosion by water. There is no single MHA or non-MHA documented from this block. These points create doubt about the chronological association of these human remains.

Amongst MHA and non-MHA, a comparative observation is about animals depicted in the form of figurines and those on MHA. Variety of fauna is seen in the form of figurines such as antelope, bird, boar, buffalo, bull, dog, dove, elephant, fish, goat, goose, hare, monkey, rhino, squirrel, and turtle. There is a good overlap of these with animal motifs seen on MHA.

It is important to reiterate that steatite is not necessarily a seal specific material. In DKGS, objects such as weights, beads, whorl, pin-heads, bull and other figurine, bobbin, and vessels are seen made from steatite. This needs to be seen in the light of current theories regarding souring of steatite from distant lands for specific qualities and its use for 'seal-like' important objects. With respect to objects like weights, figurines, and implements, there is no specific segregation that is observed. To know more about their contribution for the existence and meaning of MHA, more micro level case specific analysis is needed.

The primary linking of MHA and non-MHA to their findspots creates some interesting observations on this mound.

- For single sided 512 signed MHA, the density of artefacts across the houses and the

44. Mackay, *Further Excavations in Mohenjo-daro*, II:116.

periods is interesting. Some houses have particularly high density than others, varying between min 1 and max 24. There are 14 houses with 10 or more artefacts, viz. 1_Court I (17), 1_Court III (11), 1_VI (10), 10_I (13), 12_V(14), 3_VI(10), 7_I (13), 7_III(24), 7_IX(13), 7_V(13), 7_VIII(10), 8_III(17), 9_VII(13), 9_VIII(16). These add up to 194 artefacts densely packed in the central portion of the mound (Figure 7.4).

- For the areas of artefact discovery, it is seen that Block-7 has multiple room areas where MHA are found across the entire depth of the excavation. It also shows the spread of artefacts in all houses within this block.

- Out of the 570 artefacts, 490 are seals. This is around 85% of the total MHA artefacts at DKGS. Except for the Late I-II period, on an average, each house has more than one seal in every cultural period.

- Despite possible issues of secondary deposits which also include accidental dropping or finding by Harappan people, this data shows that in the post-flood rehabilitation or other reoccupation events, even if the mound got occupied by same or different people, they continued using almost similar artefacts.

- There are only 10 tags recovered from this mound. To put it in perspective, these are approximately 30% of the total tags in Mohenjo-daro and ~1/2 of total tags in Harappa. The evidence of tags at Lothal (94) and Dholavira (67) has already been discussed in the earlier chapters. The proportions of seals and tags in almost all Harappan sites including Lothal are inverse in comparison to their Mesopotamian counterparts and their proposed use. This phenomenon is visible even at a single mound of DKGS. On another note, this count of tags is comparable to seals with geometric motifs. Seals with these motifs are generally devoid of signs.

- There are seals with different iconographies and without signs, for which exact find-spot locations within Mohenjo-daro or this mound could not be identified.

- Interestingly, though the plans by Mackay depict extensive areas excavated, artefacts are recovered only from a subset of rooms or locations across the depths. Certain areas continue to be devoid of MHA (Figure 7.5). This is important because it shows continuos use or possession of these objects by people in relatively similar areas. Or,

this can also indicate that despite the events of floods or reoccupations, similar areas were preferred by people who possessed MHA. Figure 7.6 shows structural remains of rooms which are devoid of MHA throughout the entire depth of the mound. On the other hand, in each period, many artefacts are found in areas where structural boundaries are not identified in that period and hence the block-house-room spatial context cannot bee defined.

- There are ~80 rectangular seals in DKGS between the depths of 47.03 to 53.86 msl which is roughly up to 7 mt depth just below the datum level. Amongst the square seals which are found in the same depths, 400 out of 490 are found within this depth range. Overall, the square seals with or without signs occupy entire depth of the mound. As per Kenoyer's analysis at Harappa, rectangular seals are more common in 3C i.e roughly around 2200-1900 BCE.[45] In his recent publication he observes that typical rectangular seal with only signs and square seals with left facing animal motif become common between 3B (2450 to 2200 BCE) and 3C (2200-1900 BCE).[46] In the figure 7.2, it is observed that with tentative correlations of multiple chronologies, Kenoyer's 3C almost occupies entire intermediate period. At DKGS, the square unicorn seals continue to exist with rectangular ones. There is no specific absence or decrease in the number of square seals when rectangular seals appear in similar depth ranges.

- For the spread of largest and smallest square seals (Figure 7.7), the smallest seals i.e. CISI group 6 and the bigger seals of group 1 and 2 occupy mutually exclusive locations across the mound. A relatively lower spatial segregation is seen in sizes 3 and 5. However, group 4 which has the highest number of seals, it is spread all over the mound. Only blocks 2 and 5 have a relatively small number of seals of this size. In rectangular seals, CISI sizes 12 and 13 which have comparable number of seals on this mound have a spatially exclusive distribution.

- The quantity of MHA without signs is too small to derive any specific meaning out of their spread within the mound. It is thus difficult to corroborate Kenoyer's observations from Harappa that those are common only in the initial and last phases of "..

45. Kenoyer, "The origin, context and function of the Indus script: Recent insights from Harappa," 19.

46. Kenoyer, "Origin and Development of the Indus Script: Insights from Harappa and other sites," 221–222.

writing development... ."[47]

- For 496 records with findspot location, a two mt buffer is created for MHA separately in each cultural period. This buffer creates an approximate 12.5 sq mt area. The average room size is around 11-12 sq mt and so this buffer area is chosen. Here, an inherent assumption (though unrealistic) is about artefact being found in the centre of the hypothetical room created by the buffer. This may essentially work as a probable findspot area. If it gets intersected by the structure, it may entail that the artefact movement was constrained in that direction due to the obstruction. However, in areas where the artefacts have been found in absence of definitive structures in respective periods, these buffers may help visualise the possible ambiguity of locating the artefact in XY plane. Figure 7.8 shows buffers intersecting the structural boundaries for remains in Mackay's Intermediate III period plan. For further analysis in depths, similar exercise can be created by creating a sphere of possible location in X-Y-Z space.

- On DKGS, ~288 MHA out of 570 depict unicorn and 57 are of zebu, buffalo, or gaur category. These together account for more than 60% and just unicorn seals are 50% of MHA on this mound. This ubiquity of iconography in Harappan culture is pervasive even at the local scale of DKGS mound.

Note - The architectural context of these findings would be an important next step for broader understanding of the findings. The analysis for block 7 was initiated but it could not be accommodated in the present scope. It can be taken up more effectively if supplemented with more photographs of the site, access to field notes, more in depth architectural analysis based on the descriptions and drawings, and access to site to understand the present day status of the remains (A1.6).

47. Kenoyer, "Origin and Development of the Indus Script: Insights from Harappa and other sites," 220.

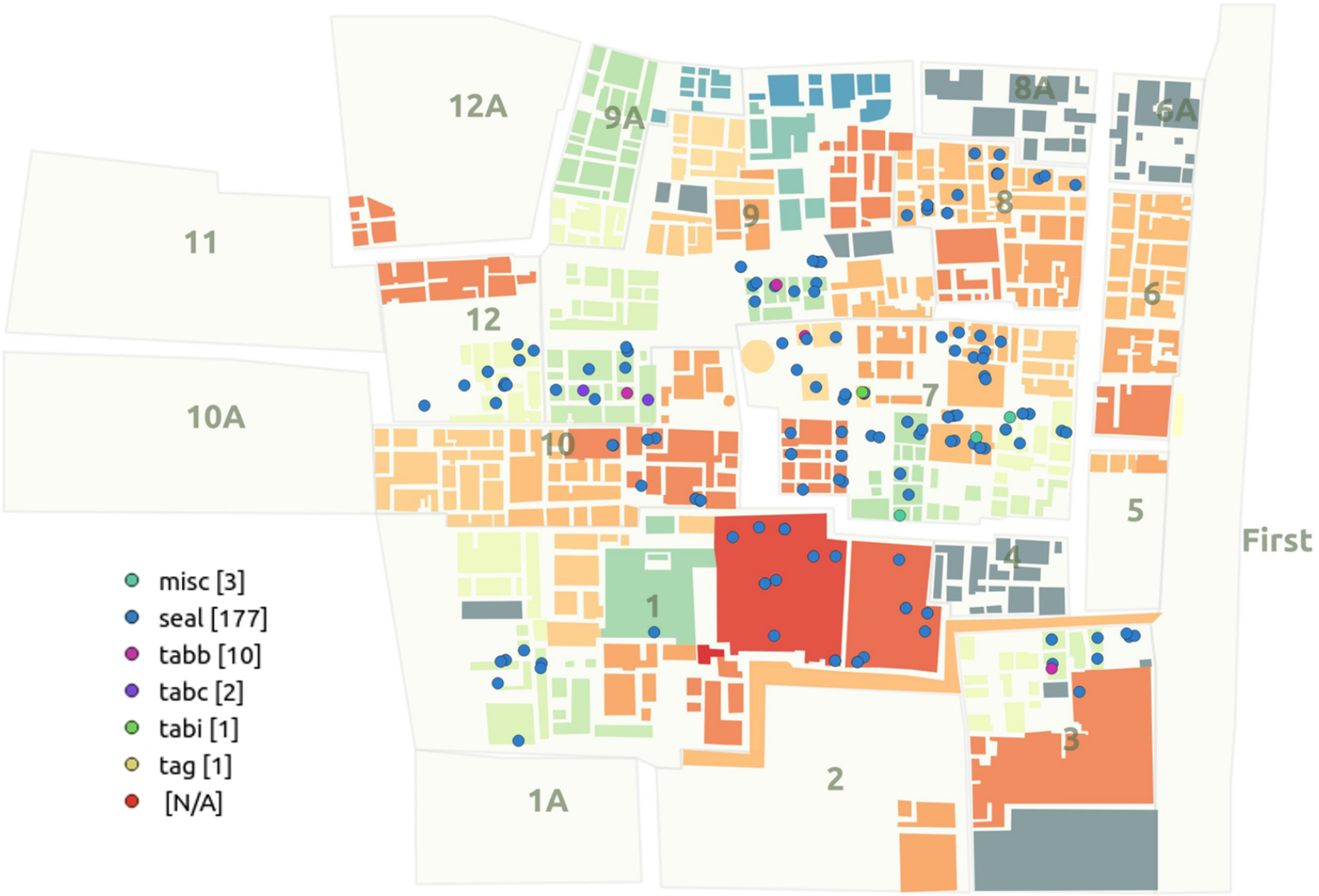


Figure 7.4: Densely pack artefacts in a the central portion of DKGS



Figure 7.5: Intermediate I period - Rooms with and without MHA



Figure 7.6: Rooms without MHA across all the cultural periods



Figure 7.7: Distribution of large and small seals in DKGS

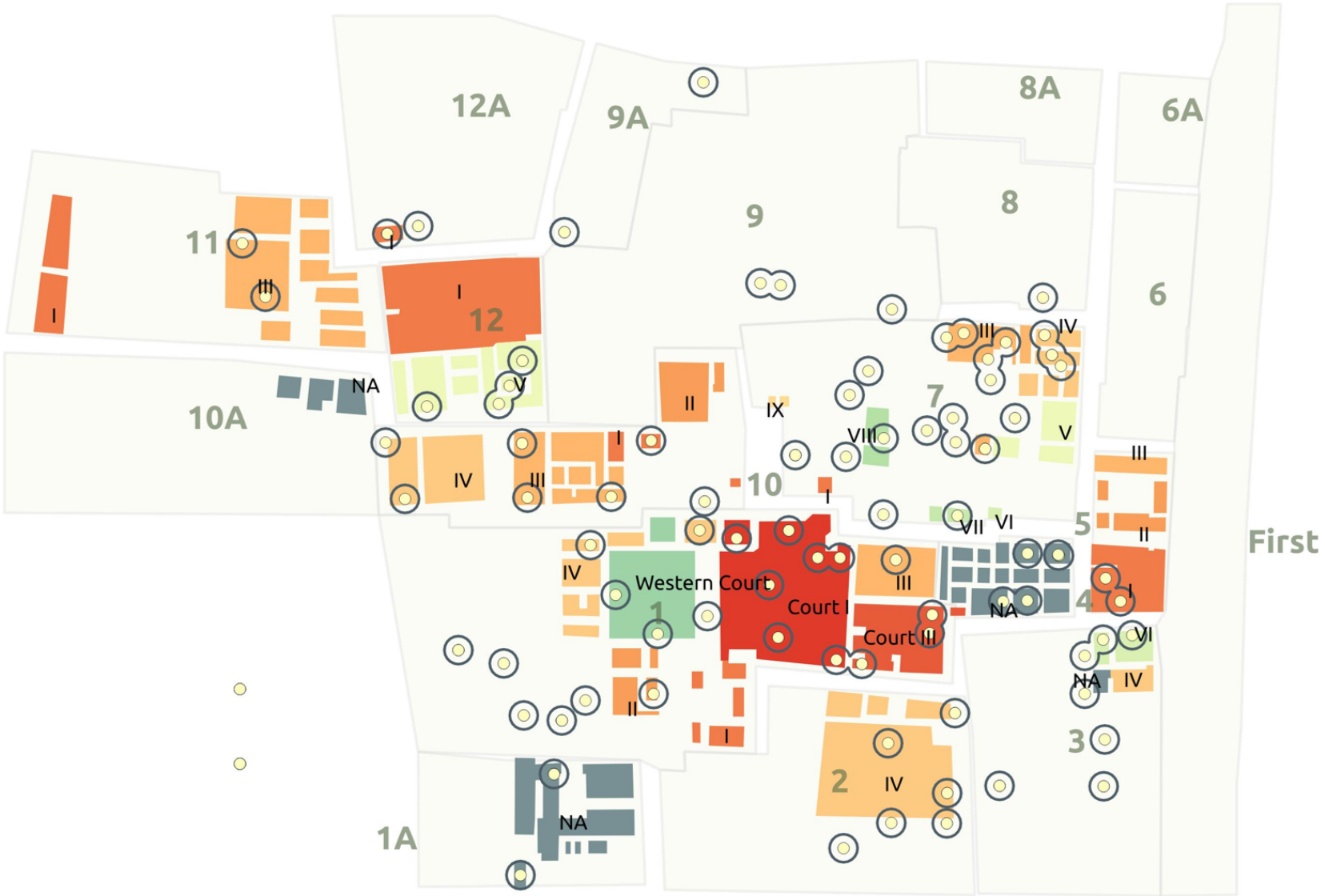


Figure 7.8: Buffers indicating probabilistic findspots for MHA in DKGS - Intermediate III period

7.4 Signs in space

Signs present on MHA at DKGS have produced following observations.

There are 23 solo-sign occurrences in 570 MHA. Out of these, 15 are single sided, others are multi-sided which have solo-sign on at least one side. Only two such objects are found in topmost layer which is identified as Late I-II. Amongst all the blocks, majority artefacts, i.e. 7 are found in block 7. If a sign in itself conveys a semantically complete message then their presence in majority needs to be addressed.

An interesting observation is made in the lowest levels of block 12A, the NW corner of the mound. There exist three implements m-2121, m-2118, 2368_mjd - all co-located in Intermediate III period - Block 12A - House I - Room 15. All these have the same sign sequence on one side of the implement -  (ICIT sign codes as 821-001-480-850-595-391). Other artefacts such as copper ingots and castings have been in the close vicinity of these implements. Surrounding artefacts include rectangular seals and seals with gaur in the same house in different periods. Gaur seals are relatively rare: total - 123, MJD - 73, DKGS - 25. In DKGS, these are mostly restricted to blocks 7, 8, 9, 9A, 10, 12, and 12A and are totally absent in blocks 1, 3, 4, 5, and 6. The partial sign sequence of the implements matches with the Dholavira sign board -  (ICIT sign codes as 798-821-001-480-850-820-388-611-820). Based on the combined graphical interpretation of these signs, Shendge had interpreted the board as place related to the production of metal objects.[48] This creates a prospective triangulation exercise for future work.

Sign sequences of seals and the sign pairs on either ends of the sign sequences show that repetitive pairs continue to appear at different depths and in different blocks (Figure 7.9). For the first two signs of ASIS sequence, the two most frequent pairs are concentrated in blocks 1, 7, and 9 in specific depth ranges. However, the data of the entire sequence length shows that there is almost no repetition of sign sequences on this mound. This observed repetition is thus limited to the pairs on either side of the sequence. This is inline with earlier observations about the sign sequences. These proximities in space, depth, and initial signs may help interpret the artefacts in terms of their users or functional life span.

48. Shendge, *Unsealing the Indus Script. Anatomy of its Decipherment*, 307.

Complete identical sequences on seals are found in two different areas and depths - 𒁹𒉿𒌋𒄑 (ICIT sign codes as - 592-741-060-920). M-1790 is in Block 10 - House I - room7 at the depth of 18.4 ft and M-854 is in Block 4 - room12 at 14.9 ft depth. Two more seals with almost matching sign sequences are found on this mound - 𒉿𒄬𒍝𒀀"𒁍 (ICIT sign codes as - 740-690-435-255-002-817) and 𒉿𒄬𒍝𒀀"𒁍 (ICIT sign codes as - 740-690-435-255-002-861). The second one is a unique type with signs on an elevated surface above the icon. However the almost matching sequence is engraved within the thickness of the seal and not on the primary obverse surface.

Incised tablets with following sign sequence is spread across the mound in blocks 1, 9, and in long lane - 𒉿𒄬𒌋𒅗 - (ICIT sign codes as - 740-690-060-550);

Identical copper tablets with following sequences are spread across the mound - 𒉿𒌆𒁍𒀀𒌑𒄿𒆳 - (ICIT sign codes as - 740-900-850-407-061-845-806); 𒉿𒉿𒇷𒉡 - (ICIT sign codes as - 740-752-615-503) - This sequence is seen on two MHA separated by approximately 4 m from the Late levels and Intermediate-III.

When the artefacts were documented in the excavation report, absolute depths with respect to the datum point were recorded. Despite the possibilities of errors in all these measurements, Mackay has used exactly these depths to assign both MHA and non-MHA to the cultural periods. These depths can be used for the creation of hypothetical surface of the cultural periods.[49] However, the relationship of depth values to cultural periods homogenises the development of mound in the archaeological past. It is the most ideal but least reasonable result to expect from the site formation processes.

49. Partial visualisations were presented at 9th World Archaeology Conference in 2022 (WAC9) and the 50th conference of Computer Applications in Archaeology (CAA) organisation, article is in progress.

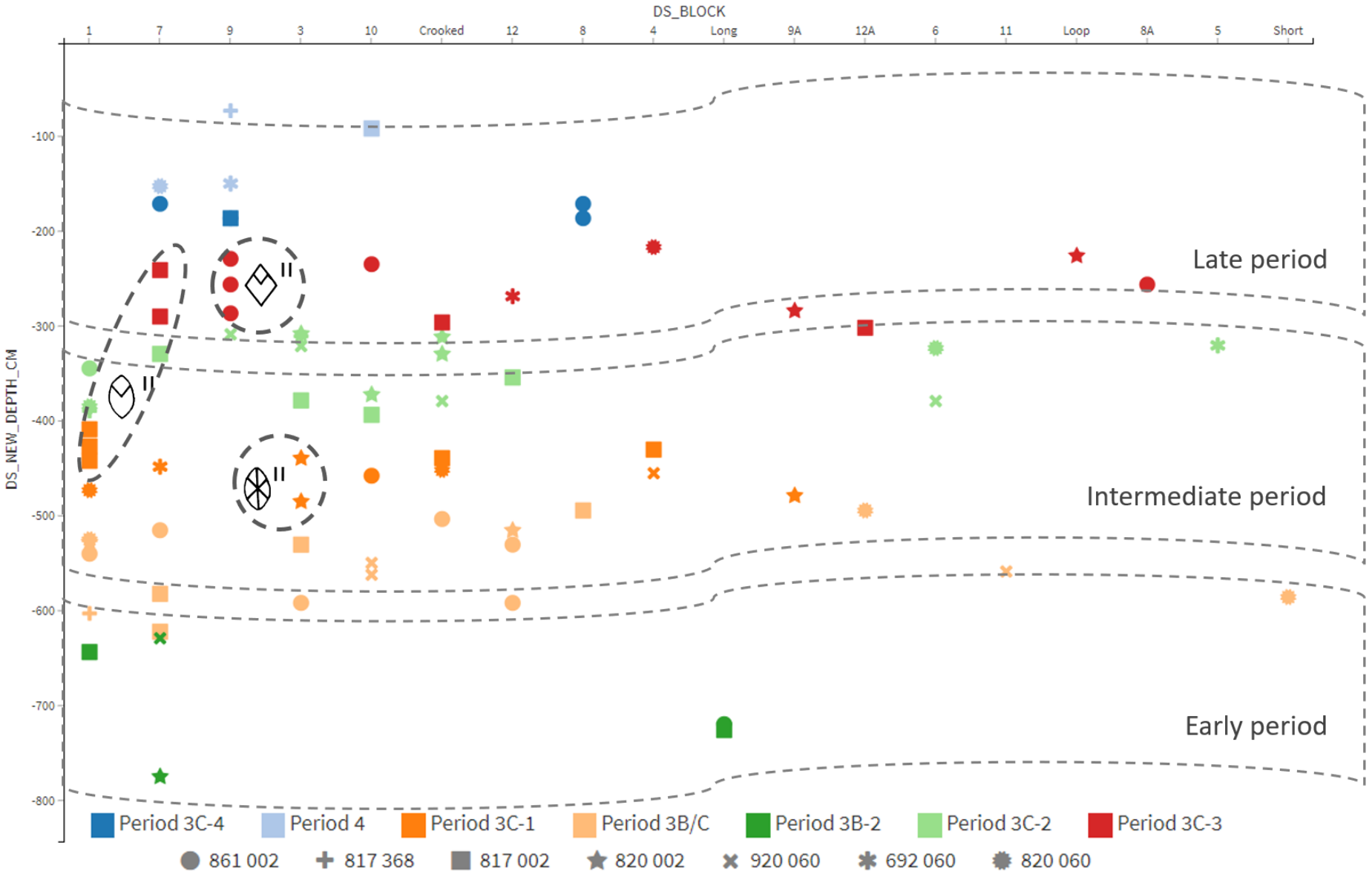


Figure 7.9: Repeated sign pair from ASIS sign sequence on MHA in DKGS

7.5 Who and how many of them?

Chapters 5, 6 and the present chapter have dealt with various properties of MHA such as their attribute interrelationships, archaeological context, and some insights into their overall distribution in space and time, which includes the micro-level GIS case study of DKGS mound of Mohenjo-daro. The characteristics such as sizes, boss-perforation, weights, and materials have also been analysed which significantly contribute to their overall affordance. The sign analysis studies reviewed from the existing literature and some experiments in the current work reveal and emphasise the fact that sign sequences are correlated with specific contexts. Studies related to tags, seal carving styles and techniques, and iconographic motifs shed light on possible users or producers of these objects. In addition to hypothesise and to define these individual personas, this section tries to contextualise these individuals or groups in the contemporary population. In the light of population estimate studies of Harappan culture, the aim is to situate our present knowledge about these personas within the DKGS mound and evaluate its fit.

Habib provides tentative population estimates as below[50] -

Occupied area in hectare	200
Occupied area in acre	494.21
Population at prosperity	85000
Population per hectare	425
Population per acre	171.99
Houses (2k-3k)	3000
Persons per house	~28

Table 7.6: Habib's population estimates (Estimated for Mohenjo-daro)

Thus, as per Habib's estimates, there are approximate 172 people per acre in Mohenjo-daro. However, prior to these broad estimates, Lahiri had published a detailed article about Harappan population estimates.[51] She triangulated multiple studies from archae-

50. Irfan Habib, *The Indus civilization: Including other Copper Age cultures and history of language change till c. 1500 BC*, vol. 2, Monographs in People's History of India series (Tulika, 2002), 37.

51. Nayanjot Lahiri, "South Asian demographic archaeology and Harappan population estimates: A brief reassessment," *The Indian Economic & Social History Review* 35, no. 1 (1998): 1–22.

ology such as those of Marshall, Jansen, Lambrick, Datta, and Chakrabarti to understand the overall demographic picture of major population centres of Harappan culture. Her analysis for Mohenjo-daro can be summarised as follows:

- Based on dietary intake and granary size at Mohenjo-daro, Datta estimates population size of 33469 spread across 640 acres (259 hectares), thus 52 people per acre (129 per hectare).[52]
- Area revisions by Marshal as 240-250 acres (97-101 hectares) and by Jansen as 247 acres (100 hectares) revise Datta's number from 52 to 133 people per acre.[53]
- Lambrick, based on earlier work by Postans on Shikarpur, revised it to a total population of 30,000 and then to 35,000 for unknown reason.[54] With tentative covered area of 458.18 acre (188 hectare), he estimated 76 people per acre.
- Several disputes are identified by Lahiri between Postans' and Lambrick's analysis.[55]
- Based on Lambrick's correlation and with some changes, Chakrabarti revised the estimate to 160 people per acre.[56]
- Fairservis' estimates are - 527.4 sq ft as area per house, 10,428 total houses, 55,00,000 sq ft area (126 acre) with 41,250 people, which takes the estimate to 327 people per acre.[57]
- Lahiri has also discussed Sarcina's estimates[58] - For the Intermediate phase with 36 houses, an average area of house of unit is estimated as 111.3 sq. m. or 1,197.58 sq. ft. Thus, for 36.35 houses per acre, if average of five persons per house is considered, we arrive at 181.75 people per acre. Based on the reconsideration of only area under the house units, it is revised to 90 people per acre.

52. Lahiri, "South Asian demographic archaeology and Harappan population estimates: A brief re-assessment," 10.

53. Lahiri, 10.

54. Lahiri, 11.

55. Lahiri, 12–13.

56. Lahiri, 13.

57. Lahiri, 16.

58. Lahiri, 21.

Based on the architectural analysis of houses by Sarcina, mean house area in DKG from Int III to Late III is 137 sq mt.[59] Larger houses in MJD's last period are not considered as evidence for increase in population.

In the present GIS case study of DKGS, the total area of blocks (excluding the First street) is approximately 14937.981 sq mt/160791.089291 sq ft/1.49 hectare/3.69 acre. Though most of these blocks have houses or residential structures, mound also has sparsely excavated and less populated blocks. Thus if blocks 10A (1154.143 sq mt) and 12A (972.559 sq mt) are excluded, the remaining occupational area is 12811.279 sq mt/137899.459479 sq ft/1.28 hectare/3.165 acre. Thus with an assumption of maximum of 50 houses in 12811.279 sq mt area, the average house area is 256.225 sq mt. This is significantly more than both the estimates by Sarcina discussed above. Also, Lahiri's estimate of five persons per house is based on the assumption that some structures which look like house may not be the residential areas and it fits with cities like Amritsar during 1881 and 1921.[60] However, in principle she has also agreed that the per house population could be more than Lothal since majority houses are double storied. In addition, analysis of structural remains and nature of artefacts suggest majority of the structures in DKGS to be residential than that of public use.

Different cultural periods have been identified and produced by Mackay in his survey maps.[61] Their conversion to digital form and segregation of linked rooms results into the following house data for each period - Table 7.7.

However, there are possibilities of miss-identification by Mackay. Also there are chances of errors in present data conversion such as inappropriate association of rooms to houses, and merger or separation of a single house into two or more. However, despite those issue, we still see presence of at least ~50 houses in DKGS, which occupy not less than 3.165 acre area at its peak period.

The tentative estimates of number of people per house can be made as follows:

Based on our identification of houses and Habib's population estimate of 172 people per acre, if DKGS area in the present study is estimated to be 3.165 acre, it would

59. Sarcina, "A Statistical Assessment of House Patterns at Moenjo Daro," 169.

60. Lahiri, "South Asian demographic archaeology and Harappan population estimates: A brief reassessment," 21.

61. Mackay, *Further Excavations in Mohenjo-daro*, II:XVI–XX.

Map	Period	Depth below datum - ft	Total rooms (roompoints)	Room-polygons captured	Houses
1	Late I-II	3-7	707	511	54
2	Late III - Int I	10	711	223	53
3	Int I	13	612	302	52
4	Int II	15.9	604	365	54
5	Int III	20.4	587	137	31

Table 7.7: Houses in Mohenjo-daro's DKGS mound - estimates from the GIS built based on Mackay's survey plans

accommodate ~544.38 people. With an estimate of at least 50 houses in the area, there would be 10.88 people per house.

However Habib's estimate of 2000-3000 houses in Mohenjo-daro[62] and Lahiri's estimate of 22,447 people in the city,[63] the number of people per house is 7.48 to 11.22.

Based on Lahiri's analysis of Sarcina's work and revised estimate of 90 persons per acre, if DKGS area in the present study is estimated to be 3.165 acre, it would accommodate ~284.85 people. With an estimate of at least 50 houses in the area, there would be 5.697 people per house. However, discussion above suggests that Sarcina's estimates could be on the lower side and may have a scope for increase based on other datasets.

Based on these multiple estimation methods, an average of 7 to 10 people per house can be hypothesised. However, there is still lack of information about the demographic profile or the family structure of the residents who were eventually the users, owners, or consumers of MHA and other artefacts.

As the number of artefacts from each cultural period are correlated with the respective houses, following statistics emerge about association of seals and houses - Table 7.8.

62. Habib, *The Indus civilization: Including other Copper Age cultures and history of language change till c. 1500 BC*, 42.

63. Lahiri, "South Asian demographic archaeology and Harappan population estimates: A brief reassessment," 22.

Map	Period	MHA XY	MHA Y	MHA records	MHA count	non-seal MHA	Seals	Houses	Seals per house
1	Late I-II	59	10	69	66	10	56	54	1.037
2	Late III - Int I	106	13	119	107	13	94	53	1.773
3	Int I	108	27	135	127	11	116	52	2.231
4	Int II	89	19	108	104	14	90	54	1.667
5	Int III	134	48	182	166	32	134	31	4.322
Total	-	496	117	613	570	80	490	244	-

Table 7.8: Number of artefacts and houses in different cultural periods of DKGS

(Note: MHA - XY: Artefacts with both horizontal (block-house-room) and vertical (depth) location information. MHA - Y: Artefacts with vague or unknown horizontal location but with relatively precise depth information.)

Table 7.8 indicates more than one seal per house in every cultural period. Even if the definition of cultural period is discarded due to the problems discussed earlier, it is evident that at certain depths, in seemingly connected rooms, more than one seals are found. As discussed in the previous section, there are cases where either the seals or other MHA are found even in absence of structures or even some reasonably well preserved structures do not render any of the artefacts. Thus the estimate of seals per house is a very tentative yet grounded in the excavated dataset. In addition to this, it is also observed that many seals or other MHA are consistently discovered from the same Block-House-Room findspot at different depths. This was interpreted earlier as continuos use or possession in that area or preference to area by the MHA bearers. Analysis in this section also shows that multiple occupants of a single household could have possessed MHA or these were used for multiple purposes hence many are found in a possibly single residential unit.

Chapter 8

Interpretation

The main aim of this dissertation has been to emphasise and analyse the materiality of MHA. History of the conditions under which the dataset and the scholarship has evolved, creates a convoluted picture of constraints and the rationale behind the current interpretations. The objective in this thesis is to acknowledge these nuances of dataset and literature, and reflect on those in the analysis and interpretation of the present work. Also, it is important to reiterate that this study is not driven by linguistic debate. No linguistic analysis of the signs has been performed to propose linguistic or non-linguistic nature of the signs or to suggest any particular language. It has been treated as an unresolved problem. Signs are thus treated as attributes of MHA with derivative attributes such as number of signs, number of lines and sides, class, and other described in the chapter 4.

8.1 Summary of the literature and problem definition

The first three chapters demonstrate some important characteristics of existing scholarship. These have directly impacted the problem definitions illustrated in chapter 3, and the following steps of data preparation and analyses chapters. These characteristics can be briefly summarised as follows.

It is observed that the scholarship is heavily biased and is more interested in the linguistic analysis of signs than the artefactual or material-centric studies. This is because of the belief that signs depict script of the then existing language(s) and the decipherment allows us to read it and thus understand the history; in John Moreland's words, it is - "... the epistemological priority accorded to written sources ... ."[1] The rationale for this priority can be seen in the status attained by the language itself in the state formation processes. In other words, it acts like a social construct and enables us to imagine a 'community' bound by it.[2] The logic for its ascent can also be seen in the theories of

1. Moreland, *Archaeology and text*, 13.

2. Anderson, *Imagined communities: Reflections on the origin and spread of nationalism*.

'societal development' where 'development' is a unidirectional positive movement of the society in both tangible and intangible aspects. Ability to represent the language or vocal sounds in the form of script essentially demonstrates literacy. This has been considered as one of the major characteristics of development. Based on civilisations which are contemporary to Harappan culture, it is seen that the need of record keeping of the surplus production gave birth to the writing systems. Consequently it got associated with the concept of urbanisation in the past. In case of Harappan scholarship, in the process of prioritisation of signs and their meaning, those have been isolated from there context. The ED studies have used the sign sequences as a statistical dataset uprooted from its archaeological context. Between the ED and artefactual studies, epistemological contrasts are observed. These juxtapose each other in terms of choice of dataset, objectives, theories, and methodologies. Despite working on the same set of artefacts, these studies rarely corroborate each other's findings and seldom complement in the coherent knowledge production. Perhaps, they also do not contradict or critique each other.

The linguistic hegemony in MHA scholarship is thus a cumulative yet complex outcome of (i) prevalent socio-political atmosphere from colonial times till recent period, (ii) archaeological theories from habitual antiquarianism to post-processual arguments, (iii) theoretical and technological innovations such as prediction and SEM observations respectively which build a perception of 'objectivity' and 'science', (iv) the notions of parallels with the contemporary cultures of the past, and (v) present day anxieties about possibility of a 'developed and indigenous past'.

Finally, it is seen that the narratives built by the existing studies are symbiont to each other and thus create a robust framework of hypotheses. Most of these hypotheses had emerged around the time of the first major excavations or in the beginning of this scholarship only. As described in the mentioned chapters, in the urge of reliable knowledge production and due to the constant inadvertent conditioning of the scholarship, majority of the research studies submit to this framework of interconnected theories. Their interpretations and resultant narratives continue to be constrained by this framework. In this thesis I examine whether the observations from my data analysis fit into this framework.

8.1.1 Individual context

While I situate this research, it is important that I contextualise my own thought process. As a result of space-time intersection that I reside in, I partially realise and acknowledge the conditioning that I undergo. Even though quite a few lacunae of DS studies in MHA have been pointed out, DS approaches have brought a paradigm shift in research in many fields, including non-academic mundane day-today processes in common lives. The readings and experiences of the DS applications in my everyday life persuade me to evaluate those techniques on my problem at hand. However, whether those are applied critically or not and without any preconception about their potential is a critical test. With respect to GIS, though it happens to be a core subject of my graduate studies, my interest in site visualisation has prompted the reconstruction of the excavated context of DKGS in GIS. Even though the input data has many ambiguities and bringing it into a systemic form requires negotiations at many levels, the GIS is being thought of as a step to visualise the problems in the data. This may give better handle to their resolution at a later stage. Having set the context of this thesis, following sections describe the critical outcomes of data analysis and their interpretation.

8.2 Outcomes of analysis

In this section, I discuss major observations from the data preparation (chapter 4) and analysis chapters (chapters 5, 6, 7). Later I explore if and how these get positioned within the framework of grand narratives illustrated in the third chapter.

8.2.1 Seals: usage and function

The observations related to seals and their relationship with tags, their perceived function, and their ubiquity are highly interconnected.

Usage: The present understanding about the usage of seals is to impress those against a soft material, mostly wet clay for creating a tag or sealing. This theory is based on evidence of impressions on tags and ceramic pots (or other utilitarian forms) but is also heavily influenced by Mesopotamian material culture. A related section in the literature review chapter highlighted the difference between the relative number of tags recovered from those sites and from Harappan culture. It is worth pointing out here

that in his very first excavation report of Mohenjo-daro, Marshall raised concern about classifying these objects as seals because no true sealing - that is impression on clay attached to a jar or object of merchandise - had been found. Majority of impressions on baked clay or faience made him identify those as amulets.[3]

For the seal-sealing hypotheses, it is obvious that sealings for every seal may never be recovered. However, the counts of signed seals as ~2253 and tags as ~255 are miniscule to interpret every seal as a mechanism to produce an impression. Ten identical tags with elephant motif and sign sequence were found at Lothal. A hypothetical assumption that these are 20% of the total tags impressed by the same seal, and each seal was used to create at least 50 tags if not more, there would have been at least 1,12,650 tags in the past for the present day number of recovered seals.[4] With total ~255 tags at hand, those are 0.226% of the possible population of tags. If each seal was used more than 50 times for the impression, this proportion would be even lesser. In the existing literature, major possible causes which have been hypothesised for a smaller number of sealings are: (i) material difference - seals were made of steatite stone and got baked during the manufacturing process; hence those became sturdy and more reliable than the impressions made on clay which might not have been routinely baked, or even on dung-ash mixture[5] and (ii) usage pattern - seals were expected to last longer for repeated use for impressions but clay objects were to be broken to open traded goods or locked doors, were discarded at the end of the transaction, or even reused in some cases. Based on these greater wear and tear possibility of tags and with a tag-centric view, there are only four possible matching pairs of seals and tags identified in chapter 5 (Figure 5.16). It is only 0.177% of seals of existing sample that are used for impression (4 out of 2253). In other words, out of ~255 tags, we do not have corresponding seals even of 2% of those (4 tags = 1.568% of 255). It must be noted that all these MHA observations are made collectively on all 82 sites. Cases of co-occurrence of seals and tags both at the same

3. Marshall, *Mohenjo-daro and the Indus Civilization: Being an Official Account of Archaeological Excavations at Mohenjodaro Carried out by the Government of India between the Years 1922 and 1927*, 2:380.

4. Twenty percent is an optimistic number because it is generally believed that its only a fraction that gets excavated of what might have existed in the past.

5. Frenez and Tosi, "Lothal Sealings: Records from an Indus Civilization town at the eastern end of the maritime trade networks across the Arabian Sea," 67.

site and at different sites will demand separate explanations. Juxtaposed to these seal and tag pairs, some of the ASIS sign sequences from seals exist on artefacts like tabs but not tags. If the sign order matters for its interpretation, then this shows a possibility of seals which couldn't have been used for impression.

Though it is agreed that clay sealings could have been more prone to deterioration or poor excavation in the early years cold not recover those, despite improvements in excavation strategies, we still do not find comparable amount of clay sealings from numerous sites which are being excavated, only exceptions being Lothal and Dholavira. In contrast to the minuscule number of sealings from Mohenjo-daro and Harappa, a prominent quantity of sealings recovered from Lothal is a more appropriate dataset for these hypotheses testing. 69 out of 90, which were found in the "... passage between the two bases of a warehouse" were identified as being "... burnt accidentally in the warehouse when it caught fire".[6] However, another sizeable find at Dholavira with 61 sealings, is identified as "... found in hard baked condition".[7] Unlike Lothal where the burnt or baked tags are found at a single findspot and hence may have a circumstantial interpretation, the hard baked sealings at Dholavira have been found at diverse localities such as castle, middle town, reservoir, lower town, bailey, annexe, and promenade.[8] Archaeological logic of findspot and contextual interpretation of tags accidentally catching fire at Lothal cannot be applied at Dholavira, and firing for tags is now believed to be an intentional process. Same can also be observed at Kanmer.[9] Irrespective of this comparison, Frenez's study discussed in the literature review has also proposed intentional firing of the sealings.[10]

Besides these numbers, another important observation is regarding expected wear and tear of seals. Even-if the seals were baked and hardened, if those were being repeatedly used against soft clay and other materials, different levels of deteriorations are anticipated on most of the seals. Possehl has noted that majority retain the "... crisp

6. S. R. Rao, *Lothal: A Harappan Port Town (1955-62)*, I:319.

7. Bisht, "Excavations at Dholavira (Draft published for limited period, now under publication)," 308.

8. Bisht, 308.

9. J. S. Kharakwal, Y. S. Rawat, and Toshiki Osada, "Excavations at Kanmer," *Research Institute for Humanity and Nature: Kyoto, Japan*, 2012, 484–490.

10. Frenez and Tosi, "Lothal Sealings: Records from an Indus Civilization town at the eastern end of the maritime trade networks across the Arabian Sea," 71.

edge of original carving. .... are unworn... In contrast the cylinder seals in Mesopotamia were intensively used and ... carved from hard stone.... many examples of heavily worn Mesopotamian seals... ."[11] By analysing the wear and tear of the seals, McIntosh has proposed possible use of wax for creation of sealings which would essentially cause lesser wear of the seal and create longevity for reuse.[12] In the presently available MHA dataset, there are hardly any objects of wax. On the other hand, Jamison identifies multiple examples of weathering,[13] wearing of copper tools,[14] and hypothesises possible wear for four seals at Lothal.[15] However, as he segregates 180 out of 500 seals in 55 groups, he mentions several cases of minimal wear to the seals in groups such as Harappa_Mohenjo-daro Group 1, Mohenjo-daro_Kalibangan_Nindowari Group 1, and Mohenjo-daro_Balakot_Banavali_Chanhu-daro Group 1. From the material and usage point of view, the carving is expected to be eroded with repeated use for impressions. For an instrument like SEM that measures the undulations at a very high resolution,[16] the wearing details would be inherently captured and accounted for in the carving measurements. These could also act as a parameter to understand the extent of weathering. Thus the metric observations which account for the workshop styles identified by Jamison in terms of carving skill, consequently and unavoidably also capture wear that would have happened during the seals' functional use and in post-depositional period. Though Jamison has made several observations about the presence of weathered seals of various degrees and their inclusions or exclusion in a group based on the ability to measure those, how a specific style has been identified in the presence of weathering and is further used to form precisely defined workshop groups needs more clarification.

Finally, my own observations at ASI's Central Antiquity Center show that out of 44 observed seals, many show damage that amounts to breakage of corners, partly broken with details of intaglio carving being intact, and breakage of boss. These appear to

11. Possehl, *Indus Age: The Writing System*, 26.

12. McIntosh, *The ancient Indus Valley: new perspectives*, 152.

13. Jamison, "The organization of Indus unicorn seal production: A diachronic comparative study of style, skill, and sociopolitical organization," 300.

14. Jamison, 268.

15. Jamison, 419.

16. Jamison, 257–259.

be caused due to handling issues. These also corroborate Kenoyer's remarks regarding possible causes and results of breakage of seals.[17] Only a few smaller seals show abrasion which possibly reflects intensive friction of carved surface due to repetitive use for impressions.

Function: In the light of these observations regarding ubiquity and usage of seals, the present day understanding about the purpose of seals needs to be reappraised. Its acknowledged function as objects related to economic or administrative systems has assigned these to the urban phase of the Harappan material culture. The interpretative consequences of this axiom can be listed as follows:

- The sites where intaglio carved seals are found, those played a role in trade or some kind of economic or administrative activity. These sites were thus occupied or visited by people such as 'traders', 'merchants' or 'administrators'.
- Such sites played a role in the urban character of the Harappan culture.
- On the contrary, tabC, followed by tabI and then tabB, are site specific phenomenon, their purpose could be much restricted than seals.

The functions like trade entail movement of goods but is always dependent on the movement of people and/or animals. It is thus possible that these objects moved as part of their function, with their holders or owners, or for other unknown reasons. For tags, with their present interpretation to close the container or jars of traded goods, if majority of the tags have completed their process flow, then their place of origin and discovery in archaeological context are bound to be different. About seals, Kenoyer mentions a possibility that majority were probably worn around the neck or waist by attaching a cord through the pierced boss.[18] Also, as mentioned in chapter 6, Rissman commented about Hatched-F seals, probably carved at Harappa and then traded or carried to other sites.[19] In addition to this, an example of identical tabB artefacts from different sites was discussed in chapter 5. These scenarios create a case for probable movement of seals and other subtypes as well. As a result, the whole idea of provenance or site

17. Kenoyer and Meadow, "Inscribed objects from Harappa excavations 1986–2007," lv.

18. Kenoyer, "The Indus valley tradition of Pakistan and western India," 363.

19. Rissman, "The organization of seal production in the Harappan Civilization," 168.

specific characteristics of the artefacts can be debated. Compared to the amount of excavated material and their spread across the sites, these possible movements are yet to be hypothesised and thoroughly studied. In that case, the present day interpretation of seals does not explain their ubiquity in space and time. For the tags, Frenez's work on their different possible functions has already been discussed in the literature review chapter. The identification of a type such as Pegs-on-Wall[20] indicates a local production and use whereas other types such as Lockers or Pottery[21] show plausible movement of MHA along with the containers which were possibly sealed with those or again a local use. However, even in that case, authors postulate that the movement of containers is not necessarily commercial. The use of local clay for sealings show local production and use of those. Thus the use of this system for a long-distance trade like activity may not have been a standard practice.[22] Also the examples from contemporary cultures discussed in chapter 2 demonstrate local function of seal impressions.

Regarding the spread of artefacts, out of all the artefact 'types' identified by earlier scholars or within the tentative subtypes defined in the present study, 'seal' is a the most ubiquitous artefact. As per present MHA dataset, 63 out of 82 sites have at least one seal (with or without signs). There are at least 49 sites from different geographic regions, i.e. 60% of the total sites, where at least one signed seal is obtained. This regional ubiquity persists at a site level in DKGS mound. Out of 2733 total seals in the present dataset, 490 could be located within DKGS mound only (470 with different precisions about their findspots). As discussed in the previous chapters, there are issues of stratigraphy and many seals have been located in areas devoid of structural remains. Despite this, at every cultural period identified by Mackay, more number of seals are found than maximum number of houses which the mound could accommodated. In other words, at any point in time, on an average each house could have had at least one or more than one seals. On another note, It was proposed by Mackay that the DKGS mound deposit was a result of three hundred years of occupation with some gaps due to flood or other reasons.[23] Thus,

20. Frenez and Tosi, "Lothal Sealings: Records from an Indus Civilization town at the eastern end of the maritime trade networks across the Arabian Sea," 73.

21. Frenez and Tosi, 77, 80.

22. Frenez and Tosi, 72.

23. Mackay, *Further Excavations in Mohenjo-daro*, I:7.

DKGS demonstrates presence or use of 490 seals over 300 years by a maximum 50-60 houses at any given time. A tentative distribution of seals across the cultural periods is as follows: Late I-II - 56, Late III - Int I - 94, Int I - 116, Int II - 90, Int III - 134 (Table 7.8).[24] Based on the tentative mapping of cultural periods defined by Kenoyer to the DKGS mound, 3C period (~300 years between 2200-1900 BCE) occupies most of its depth (Figure 7.2). This means that at least for couple of centuries, majority of the occupants of DKGS owned or used seals. Creation of a more reliable picture about the chronology and the tentative duration of the occupation on the mound can provide insights for collective interpretation of the artefacts.

At this point, two principles in the scheme of knowledge production which have been mentioned in chapter 1 must be reiterated: Once a set of axioms is accepted, its logical consequences also need to be accepted. Secondly, 'no body of knowledge should contain logically contradictory combinations of propositions' as they lead to convoluted theories. Those must be resolved in order to produce coherent knowledge.[25] In the present case, the evidence for consequences of the axiom 'use of seals to make impressions' is sparse and uncertain in terms of quantity of tags and wearing of seals respectively. Secondly, the proposed function of seals and their ubiquitous quantitative presence logically contradict each other. In the light of existing theories about the function of seals, the observations, especially from DKGS, imply that majority of the residents were involved in specialised and critical activities of economy, trade, or administration. The ubiquity, both at micro and macro scale essentially entails that large number of people undertook these activities. Given the nature of these activities, this may imbalance the occupational proportions in the contemporary demography. On another note, artefacts such as tabC are observed only at Mohenjo-daro and tabI mostly at Harappa. Their restricted presence possibly suggests a more specialised and space-time specific usage compared to seals. In order to proceed further in this archaeological knowledge production, these issues need resolution.[26]

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24. These numbers are based on depth and period data from excavation reports, ICIT data, and MHA linking exercise to match the records to locations within the plans. It is possible that these can be made more precise with the help of additional information.

25. Notes from Classes of Dr K.P Mohanan - Introduction to Research 001, Sept-Nov 2019

26. Holly Pittman, "The white obelisk and the problem of historical narrative in the art of Assyria," *The Art Bulletin* 78, no. 2 (1996): 334–355; Pittman's work on White Obelisk demonstrates possibilities of

8.2.2 Systemic significance of size and motifs

Size of seals, in terms of surface area, has been observed as a limiting factor for signs and iconography to certain extent. The outliers in square seals are the largest ones and majority have Hatched Face unicorn motif. These show very less wearing of the intaglio carved surface. Non-unicorn seals are restricted to medium or smaller sizes and thus depict very specific choice. However, as a deduction of these observations, Konasukawa's proposition to map it to merchant hierarchy, that is to interpret the owners of the big seals as the 'high ranked merchants'[27] is too conjectural. It essentially presumes the idea of trading community being the owners or holders of these artefacts. Earlier section discussed the problems with this functional proposition.

Though the thickness is directly associated with surface areas, it is observed to be less controlled. It could have contributed to breakage of artefacts near boss. However, the discrepancies observed in documentation need appropriate corrections for more stringent analysis.

In stylistic studies (i) by Franke where she analysed intra-site distribution of seal groups across depths,[28] (ii) by Rissman where he looked at inter site stylistic patterns,[29] or (iii) by Wells where he compared unicorn body design and stand patterns across sites,[30] none of them have affirmatively deduced systemic pattern but only statistical groups. Based on photographic observations, their style attributes could also be documented for the data outside their studies and thus see if their observations persist in the extended data. An experimental prediction exercise highlights that decorative attributes documented by these different scholars are related to each other and also to the size of the seals to a certain extent.

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alternative interpretations than its contemporary or formally similar monuments. Those are grounded in the material, its context, and its possible function in ancient Nineveh.

27. Konasukawa and Koiso, "Size of the Indus type seals and its Significance," 134.

28. Franke, "Inscribed objects from Mohenjo-Daro: Some Remarks on Stylistic Variability and Distribution Patterns."

29. Rissman, "The organization of seal production in the Harappan Civilization."

30. Wells, *Epigraphic Approaches to Indus writing*, 23.

Green[31] and Jamison[32] suggested much smaller groups not based on the decorative motifs but on the operational carving sequences, carving strokes, granular style attributes, and microscopic metric measurements of the motifs. They have theorised presence of 'analytical carving groups' and 'decentralised production' activity of seals respectively. Since these observations were done with specialised equipments and not all the style codes for the designs are available in the published thesis, these attributes could not be populated for MHA outside their specific datasets. These are ethnographic and qualitative studies which have heavily relied on microscopic observations and precise measurements for scientific analysis. Their studies have resulted into a statistically challenging group:member ratios -

- Jamison - 180 objects (out of a sample of 500), 20 attributes, attribute values ranging from 5 to 114, 55 groups - average group membership is ~3.
- Green - 80 objects (out of a sample of 185), 5 attributes, attribute values ranging from 5 to 54, 18 groups - average group membership is ~4.

Despite a small number of artefacts, Green's first six groups show definitive size restrictions. In Jamison's case, his hypothesis of decentralised production that results into possible multisite groups, rejects the basic GIS principles of spatial associations. It needs further explanations of a rationale for these groups and their long distance communication strategies which would have sustained them over multiple generations. Many combinations of his high rank, low rank, and a mix of both attributes show separation between Mohenjo-daro and Harappa. This possibly points towards a certain degree of site specific behaviour of these artefacts.

Besides these independent observations, a triangulation exercise has revealed a possible temporal relationship between stylistic and typo-technological grouping schemes, i.e. Hatched face unicorn motif (defined by Franke and Rissman) and leg style 4 (defined by Jamison) probably belonged to Harappa period 3C (Defined by Kenoyer). This is critical. With more detailed investigation, such phenomenon can be used to correlate the cultural periodisation across sites and then subsequently be treated as a cultural

31. Green, "Stamp Seals in the Political Economy of South Asia's Earliest Cities."

32. Jamison, "The organization of Indus unicorn seal production: A diachronic comparative study of style, skill, and sociopolitical organization."

marker.[33]

Unfortunately, irrespective of the signs, most of the tags have not retained the decorative details of the unicorn motif. It could have helped identify which seals were more often used for the impressions. However, as mentioned above, based on the surface abrasion and size of existing tags, smaller seals were probably more frequently used for impressions than the larger ones.

8.2.3 Context of signs

The analysis demonstrates that the sign sequences are contextual. Those are primarily seen related to material, site, subtypes, sides of artefact, and technique of production with varying intensities. Konasukawa's independent observations about limited signs being observed on seals with R-facing animal motif corroborates this proposition.[34]

Rare examples of seal-tag pairs and presence of identical sign sequences on tabs and seals have been discussed at length. In addition to it, uniqueness of sign sequences in seals and repetitive tendency in tabB and tabI indicate different functional aspects. The signs or sign pairs on either ends which repeat on different subtypes and sites are different. Besides some common signs, those are vastly context-sensitive. TIFR team's earlier work that on the M77 dataset partially aligns with this observations.[35]

Few prediction experiments demonstrate that there is some success when sites or subtypes are predicted based on signs. These corroborate earlier observations about contextuality of signs. However, the relationship is not bi-directional. Based on a quick search in ICIT as of April 2023 - out of 709 signs, 541 are present in Mohenjo-daro, 431 are present in Harappa and 309 are present in both the sites with varying frequencies. For the next top four sites, namely Dholavira, Lothal, Kalibangan, Chanhudaro, out of the 709 signs, 52 are common in all four and also seen at Mohenjo-daro and Harappa. This is especially interesting when number of artefacts at these four sites range between ~85 to ~250. The scatter-plots of MHA with sign pairs from either ends of the sequences show that for each site or subtype, some are shared across but there exists a set of exclusive

33. The relationship has been explained in chapter 6.

34. Konasukawa, "Indus Scripts Incised on the Seals Discovered from the Initial Phase of Harappan Period."

35. Yadav, "Sensitivity of Indus script to site and type of object."

sign combinations unique to each site or subtype. Thus the combined observations from the contextual analysis, prediction experiment, and basic statistics about the occurrence of signs in different sites demonstrate that there is a specific direction of information. This direction may help to determine the causality behind these relationships.

For non-seal artefacts, if data is trained along with site and subtypes instead of only signs, the prediction accuracy significantly increases. However, the same is not observed for the seal artefacts. It has already been observed that multiple copies of same sign sequences are seen more often in non-seal artefacts than seals. Also, as one moves further in the sign sequences i.e. from pairs to triplets or to the later signs, the repetition significantly drops. It indicates that as the semantic completeness of the sequence increases, the content tends to become sensitive to its context. Ability to predict the sign sequences is thus limited by the context as well as by MHA's own systemic behaviour to have different frequencies of sequences. The present study shows that context plays a dual role of constraint and contributor. Though specific contexts diminish the power of prediction, the total lack of context in the compilation of all artefacts and sign sequences in a single database may lead to unrealistic prediction experiment. In that case, such compilation must be justified for the intended use.

It is evident that ICIT has a significantly large amount of dataset than M77 and the subsets of M77 which have been used in the earlier prediction studies. There is a significant difference in the shape of ICIT/MHA dataset as compared to M77 in terms of number of artefacts, sites, types, sign sequences, and signs themselves. Also, the strategies implemented in the present prediction experiment are based on the accumulated evidence of non-random distribution and contextual nature of signs. Thus the predictions made based on the present MHA dataset are expected to be different than those of M77.

Within a narrower context of DKGS, MHA and signs produce some interesting observations. Out of 161 signs which appear solo in the entire dataset, 23 i.e. approximately ~14% are present amongst MHA in DKGS. This shows a significant importance of these solo appearances. Seals and tabC with identical sequences have been recovered from different parts of the mound. There is no observation about any specific spatial or vertical grouping amongst square and rectangular seals. A very preliminary observation of non-MHA do not show any particular pattern of spread on the mound. However,

the quantity and diversity of non-MHA points towards a mix demography, mostly a residential settlement.

8.3 Situate in grand narratives (?)

The final step in this thesis is to interpret these material observations as manifestations of tangible or intangible systems of past social lives. I try to situate those in the framework of grand narratives discussed in the third chapter. It results into following interpretations.

8.3.1 Language, writing, and movement

Chapter 3 discussed the basic idea of 'Aryan Invasion Theory', critique by multiple scholars, and it being replaced by the studies of much nuanced phenomena of movement of people, language, and cultures. Against this background, academic response from the proponents of Dravidian reading of MHA signs is still awaited. This theory has been one of the building blocks for Dravidian reading of these signs. In Mahadevan's own words, (i) the number of Aryans could have been few, (ii) their dominance was aided by already disintegrating Harappan polity, (iii) Aryan speech prevailed since majority switched to dominant language, (iv) "... most of the population stayed back, a substantial number of Harappans also migrated southwards...", and (v) migrated Dravidians "...achieved elite dominance over the local Late Neolithic people in South India ... ."[36]

The recently published volume about archaeology, genetics, and linguistics highlights the rejection of another theory called 'Out of India' theory.[37] However, one of the important cited reference also claims -

> The primary ancestral population of modern South Asians is a mixture of people related to early Holocene populations of Iran and South Asia that we detect in outlier individuals from two sites in cultural contact with the In-

36. Mahadevan, *Vestiges of Indus Civilisation in Old Tamil*, 7.

37. Kristian Kristiansen and Guus Kroonen, "Re-Theorizing Interdisciplinarity, And The Relation Between Archaeology, Linguistics, And Genetics," in *The Indo-European Puzzle Revisited: Integrating Archaeology, Genetics, and Linguistics*, ed. Kristian Kristiansen, Guus Kroonen, and Eske Willerslev (Cambridge University Press, 2023), 3–12, https://doi.org/10.1017/9781009261753.

dus Valley Civilization, making it plausible that it was characteristic of the Harappan culture.[38]

Thus, as per this study, from the earliest periods of Harappan culture until its disintegration in late phases, there was no significant movement of people towards South Asia. It was only after around 2000 BCE that people moved from this region in multiple directions. Whether to identify this primary ancestral population as Proto-Dravidian speakers and creators of a monolingual script is a point of concern.

It must be noted that the scholars who use Mahadevan's and Parpola's sign-lists without any scrutiny, unintentionally and inherently submit to their claims of Dravidian or Proto-Dravidian readings. This is the case for three reasons. First, they have not necessarily argued for multi-lingual possibilities of signs within the Harappan region except for west Asian artefacts. Secondly, they haven't posited the possibility of a different mono-lingual reading of signs which could be more plausible than Dravidian. Third, through their works of entropic evidence of closeness to Dravidian,[39] derivation and application of properties of linguistic systems,[40] and assignment of Dravidian meaning to Harappan signs,[41] they have created a quasi-quantitative and ostensibly scientific barrier for the non-linguistic interpretation of these sign-lists. Additionally, none of these decipherment studies are impacted by the changing views about people movement. If the scholars wish to propose new interpretations on these sign-lists, they will need to falsify the above claims of the sign-list authors and others who have used it. If not, the debate will land into the same present problem of lack of falsifiability in multiple readings of the sign sequences.[42] In the recent work by Mukhopadhyay, though the author has proposed existence of both linguistic and non-linguistic syntaxes, the study does not demonstrate how it rejects or at least questions the pure linguistic interpretations performed on the same sign-list and same sign sequence dataset. Again, it is not

38. Vagheesh M. Narasimhan et al., "The formation of human populations in South and Central Asia," *Science* 365, no. 6457 (2019): 1, https://doi.org/10.1126/science.aat7487.

39. Rao et al., "Entropic evidence for linguistic structure in the Indus script."

40. Rao et al., "Entropy, the Indus script, and language: A reply to R. Sproat."

41. Asko Parpola and Marjatta Parpola, "The Indus Script and Its Decipherment," *Ancient Pakistan* 16 (2005): 65–71.

42. Possehl, *Indus Age: The Writing System*, 163.

impacted by the issues related to different flows of people, language, and culture, and their complex reflections in the overall linguistic milieu.

Though there are many plausible claims about Dravidian loan-words in Indo-Aryan language, their correlation to the Harappan signs and their interpretation as terminologies from Rgveda such as *Agastya*, *Bharata*, *Pathaspati*/*Pusan*, *karambhad*, *Agohya*/*Ajasva* are unsubstantiated.[43] To draw these meanings, Mahadevan has applied bilingual parallels. His methodology is based on assumptions about content of the ideographic signs. His final result showing an evolution of a Indus sign phrase - "... through phonetic links between Indus-Dravidian and Old Tamil survivals, and semantic links between Indus-Dravidian and Indo-Aryan (RV) survivals through loan translations..." - is an extrapolation across different dimensions.[44] If the Harappan signs are accounted as archaeological material or their attributes, there is no corroboration as of now for these claims through any archaeological material, theory, or methodology.

8.3.2 All seals for impression?

Based on the quantitative analysis, iconographic and sign sequence comparisons, material observations, and comparative study with other contemporary material cultures, this thesis argues that all the seals might not have been used for impressions. Only some of these objects could have been used to make impressions for different possible purposes. Or, in other words, 'to impress' might not have been the only and primary use of seals. From the decipherment point of view, this means that to reverse the sign sequences of all the intaglio carved artefacts may not be an appropriate methodology. Because of this, if the direction of writing is one of the important characteristics in the presently dominant language hypothesis, then it needs a revision. Through the practice of publication of the photographs of impressions of the seals and documentation of their sign sequence in reverse order, hypothetical sealing/tag like artefacts have been documented which might not have existed in the past. This practice has introduced both methodological and interpretational bias at the stage of primary documentation itself. Additionally, quantitative and qualitative comparisons with contemporary cultures and also within the MHA dataset have shown that we cannot fully interpret these artefacts

43. Mahadevan, *Dravidian proof of the Indus script via the Rig Veda: a case study*.

44. Mahadevan, 37.

based on notional parallelisms of urbanisation, trade, and linguistic writing systems.

In an interesting observation from literature, Jamison excludes 119 out of 312 from Harappa because those were "... either broken, weathered, or otherwise damaged".[45] Whether this proportion of breakage is because of frequent handling for impressions or due to any other functional aspects needs further investigation. In addition, on the lines of ethnoarchaeological experiments of the seal production, their experimental microwear analyses are required to measure the wear or abrasion due to their repeated use for impressions.

8.3.3 Obligation of context

The data analysis shows that the context cannot be ignored in any case. Association of MHA and their characteristics demonstrate site and subtype specific behaviours. Having said that, as already discussed, the possible movement of artefacts due to their proposed functional use poses a challenge for this observation. However, as compared to Jamison's hypothesis of 'decentralised production', the phenomenon of movement of artefacts could afford a less complex or modest explanation.

The contexts of signs observed in this thesis demand that any linguistic/non-linguistic interpretation or decipherment must explain the context sensitive behaviour of signs. However, the linguistic decipherments have portrayed complete passiveness to these contexts. Most of those have monolingual assumptions about signs and have landed in non-verifiable stage of their individual claims. Even the ramifications of integration era are limited to broad variations in MHA seen only at Harappa[46] and are not reflected in its impact to sign inventory or sign patterns for centuries.[47] There are only two plausible exceptions of S. R. Rao and Konasukawa who discuss possible changes in signs over a period of time.[48]

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45. Jamison, "The organization of Indus unicorn seal production: A diachronic comparative study of style, skill, and sociopolitical organization," 302.

46. Kenoyer, "Changing perspectives of the Indus Civilization: new discoveries and challenges"; Kenoyer, "Origin and Development of the Indus Script: Insights from Harappa and other sites"

47. Yadav and Vahia, "Indus script: A study of its sign design," 37.

48. S. R. Rao, "Indus Script and Language"; Konasukawa, "Indus Scripts Incised on the Seals Discovered from the Initial Phase of Harappan Period"

Present analysis shows that sign prediction could be unwarranted without context, but it also poses a constraint on prediction. Quantity of data, inherent repetition of sequences, possible issues in order of signs based on above discussion, and yet unknown systemic significance of different sequences contribute as constraints. Sign prediction is thus an extremely onerous proposition to sustain.

Finally, with respect to archaeological context, if the people of Harappan times could salvage bricks at DKGS, it is highly likely that while doing so, MHA were not only dropped[49] but were also found, kept, used, reused, or misused.[50] Unless either of these continuously happened during multiple generations who had occupied the mound, MHA cannot be found across the depths.[51] With the advent of floods and rising water levels, it is likely that people carried the belongings and moved to higher grounds, and probably also partially returned as the water level receded. The reuse of seals seems plausible as the same varieties continue to be seen across the depth. Also, even if new ones were created in later periods, they continue to follow the overarching tradition. It indicates that the system/s for which these were being used were largely stable and probably continued for at least a couple of centuries. The carving techniques such as strokes and orders would have evolved into patterns as the artisans could have acquired different sets of skills and mastered certain techniques and tools over a period of time. Though their are patterns in decorative motifs as those probably became popular styles, whether they have any systemic significance or merely serve as decoration is yet unknown. It is seen that to a large extent, seals and even other MHA continue to follow their own overarching guidelines on form, material, and content.

In a most intriguing find, three metal implements with identical sign sequence from block 12A are surrounded by other metallurgy related finds. The partial sign sequence matches to that of Dholavira sign-board. Shendge's independent reading of these signs and interpretation of board as advertisement of metal manufactory[52] create an interest-

49. Mackay, *Further Excavations in Mohenjo-daro*, I:325.

50. Mackay's comment about people probably dropped the artefacts also has many other possibilities.

51. Though the stratigraphic issues at Mohenjo-daro stand unresolved, multiple layers of occupation are evident at DKGS. Their sequence, contemporaneity, coverage on the mound, and stratigraphic separation seed more work.

52. Shendge, *Unsealing the Indus Script. Anatomy of its Decipherment*, 307.

ing triangulation.[53] Outside DKGS, the complete sign sequence of implements is also seen as a partial sequence on two artefacts, seal M-1892 in the north part of DK(G) and M-1384 an unidentified area within Mohenjo-daro. These findings offer an excellent example where context demands explanation for the observed repetition of sign sequences.

8.3.4 Seals and their function

If the seals are tangible manifestations of systems such as trade, exchange, economic activities, administrative control, or belongings of certain class of society, the material analysis demonstrates robustness of the system(s) across multiple centuries and its commonality in space. In other words, if DKGS occupants showcase owner or user personas of these artefacts, then as per the present-day interpretation of these objects: (i) majority of the people at this mound were continuously involved in activities around economy, trade, or had administrative control, (ii) multiple generations were involved in the same occupation, (iii) these mechanisms persisted for multiple centuries without a significant change, and (iv) events such as floods or reoccupations due to different reasons and possibly by different people did not affect the systems. These are loaded and complex consequences. These presently hypothesised systems and occupations are specialised and authoritative. Also, those are secondary or tertiary occupations where only a small subset of population is ought to be involved. Observed ubiquity of seals across the sites and across the depths within a single mound is in stark contrast with these expectation. In addition, sustenance of such systems without any significant change across multiple generations and over long distances needs explanation.

A contrast in terms of sign sequences observed amongst seals and tabB/tabI can be interpreted as their functional use. Seals with more unique sequences could be the

53. In a recent talk by Rekha Rao in October 2023, organised by Fergusson College, Department of History, the speaker argued that this material culture is a Vedic civilisation. She has published a book titled 'Symbolography in Indus Seals'. As per her study, the sign-board depicts objects important for major *Yajna* rituals described in Vedic texts so that people could buy those there. She opines that the signs probably do not indicate language but the symbols need to be interpreted for their meaning. She could not explain how it compared with Shendge's interpretation but also mentioned that she does not deny any of the prior work. She has given her own Vedic perspective. This again shows isolated work which does not corroborate, contradict, or critique other studies to situate its own rationality.

objects of individual purpose such as ownership or identity. On the contrary, tabI and tabB could be objects of commodity which often change hands and do not have a fixed owner. Thus the seals could be personal belongings but tabB and tabI could have been the objects of systemic circulation. TabC artefacts at Mohenjo-daro which showcase mix attributes of seals and other tablets, could be local variations or enhancements of personal identities or systemic objects. Based on the DKGS data, there could have been multiple user personas of these artefacts within a small neighbourhood or even within a household.

The seals' data shows following characteristics - (i) present in greater number compared to hypothesised users or owners persona, (ii) uniqueness of sign sequences compared to tabI or tabB, (iii) patterned iconography, (iv) relatively stagnant overarching form, (v) ubiquity in space and time, (vi) rarity of seal-sealing pairs, (vii) unused nature of artefacts, and (viii) context sensitive signs. Seals probably manifest a more ordinary, utilitarian, and stable function than trade or administration. It is all-pervasive and robust to an extent that it is omnipresent. Parpola highlighted this presence of seals in almost every house and those being the most common type.[54] This also leads to hypothesise that these artefacts not necessarily manifest a class or occupational hierarchy but possibly represent some egalitarian aspect of the society.[55]

Though the chronology or exact duration for which MHA were active participants in the Harappan material culture is not known, based on the existing literature it is at least somewhere between 300 to 700 years. Even if the timespan is shorter, then ubiquity across the space cannot be neglected. It then becomes a more time specific yet common phenomenon, especially for seals, where majority of the society has participated in the system. For extended timespan, the ubiquitous system also becomes prevalent and persistent.

8.3.5 MHA and urbanity

Finally, the relationships amongst economic activities, exchange, writing systems, and language have dominated MHA's interpretation till date. It unequivocally projects these

54. Parpola et al., *Decipherment of the Proto-Dravidian inscriptions of the Indus civilization: a 1st announcement*, 1:13.

55. Green, "Killing the priest-king: addressing egalitarianism in the Indus civilization."

artefacts as reflections of the urban character of the Harappan culture. Discussions in this thesis show that this relationship is complex. Material diversity within MHA, ubiquity of artefacts like seals, paucity of tags compared to their proposed relationship with seals, and the role of context question this projection.

An example can be seen in case of Lothal. 'Port' as a concept strengthens the urban character of Harappan culture because port plays a vital role in trade. Earlier discussion in the thesis also mentioned the geomorphological studies which supported the idea of port to some extent. Along with other material remains, tags satisfy sealing mechanism idea of Mesopotamian trade. Tags and other signed-MHA demonstrate presence of writing system and a literate community. However, after a review of the studies related to tags and their possible different purposes besides trade i.e. local production and consumption, and doubtful identification of granary,[56] the port hypothesis may need more corroborative evidence. Also, as suggested in current thesis, if the theories of seal-sealing relationship and its close ties with concept of trade weaken, the port-centric material interpretation of Lothal may need a revision.

As mentioned in an earlier chapters, though urbanisation is a universally acknowledged concept, its constructs do not have to be identical and uniform in all archaeologies.[57] Thus interpretation of the data by drawing parallels from contemporary material cultures could be ineffective to certain extent if not detrimental.

To conclude -

Existing literature does not produce coherent knowledge about MHA types and signs. The scholarship is conditioned under socio-political environments, archaeological theories, and technological advances. Linguistic hegemony persists in this century old scholarship.

Existing studies submit to a framework of hypotheses. The framework is strengthened due to the symbiont co-existence of hypotheses. The robust framework then helps create unambiguous knowledge. However, the hypotheses themselves can be independently interrogated and contradicted to a certain extent. This weakens the framework and then the observations from this thesis do not necessarily fit into it.

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56. Frenez and Tosi, "Lothal Sealings: Records from an Indus Civilization town at the eastern end of the maritime trade networks across the Arabian Sea."

57. Green, "Killing the priest-king: addressing egalitarianism in the Indus civilization."

"A type is definable only with respect to a particular cultural system, and not in an absolute sense... ."[58] Thus context is indispensable in any interpretation. Multiple correlations exist amongst MHA attributes, signs, and their findsites/findspots which essentially manifest this context. However, due to the duality of the context described earlier, generic interpretations of these diverse correlations in the mentioned framework are challenging.

All seals might not have been used for impressions. Seals demonstrate a utilitarian, every-day, pervasive, and more egalitarian function. Some examples from the otherwise unlimited possibilities could be tokens, amulets, charms, souvenirs, identifiers, or votive functions. The uniqueness of sign sequences indicates more individualistic character.

Amongst non-seal MHA, repetitive sign sequences and duplicates of artefacts mostly indicate those as systemic commodities rather than objects of personal ownership.

Sign-list and sign sequences themselves are major constraints in the decipherment projects. If all the seals are not for impressions, then the order of signs currently used in all the studies needs a revision. At the present state, Dravidian or any other linguistic argument cannot be cross-validated by the means of any existing methodologies and with any available data.

Figure 8.1 shows outcomes of MHA analysis from the present thesis, weakening of the framework of narratives (as described in figure 3.4), challenges posed by the present observations, and interpretation of outcomes in the light of weakened framework.

Finally, our urge to produce unambiguous(!) knowledge must be interrogated for it's causes, methodologies, and consequences.[59] There still remains a vast domain of ethnoarchaeological studies to understand if and how any of the cultural traits have continued and persisted in different forms in the present day communities.[60] In other words, "Changing our perspectives on the knowledgeability and creativity of people in the past might allow us to hear them more clearly."[61]

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58. Dwight W. Read, "Toward a theory of archaeological classification," in *Essays on archaeological typology*, ed. Robert Whallon and James A. Brown (Center for American Archaeology Press, 1982), 64.

59. Gero, "Honoring ambiguity/problematizing certitude."

60. Mohanna tribe described by G. Mustafa Shar in the second volume of Interim report edited by Michael Jansen in 1987 and the presence of Kachi koli community in the present day Sindh could be the two most immediate examples of study.

61. Moreland, *Archaeology and text*, 80.

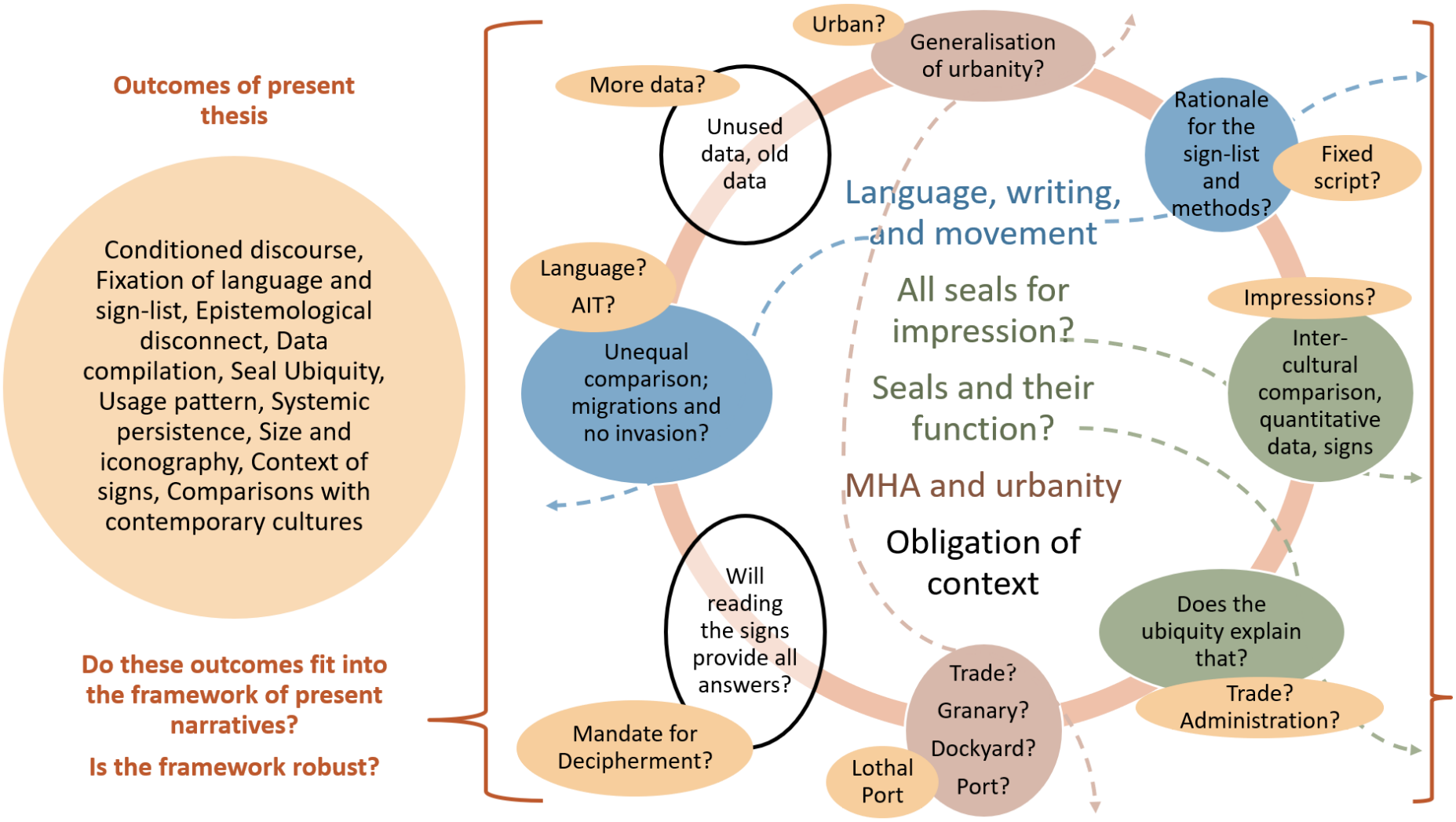


Figure 8.1: Interpretation of results in the light of weakened framework

8.4 Note about allied contributions

Besides the material centric interpretation of the data and an effort to locate those within the framework of prevalent dominant theories, other consequential tangible outputs of this research can be listed as follows:

- ICIT database can now be further enriched with additional attributes developed as part of this project.
- Based on ICIT sign-list, a font has been developed. Since this is probably the longest sign-list, it covers majority of the sign graphics documented by other scholars in their sign-lists.
- Geospatial database for DKGS has been developed which can be further used for visualisations and more granular analyses. The data creation process has been documented in detail. It thus helps for further improvements of this database and also implementing the same for other mounds or sites. Discussions are underway for hosting it at LIAVH[62] for archaeological visualization and also a GIS reconstruction of the northern portion of DK(G) mound.[63]
- The strengths and weaknesses of data documentation have been illustrated using the triangulation experiments and visualisations.
- Methodological vulnerabilities in the scientific rhetoric of the Harappan script scholarship have been discovered.

62. "The Laboratory for Integrative Archaeological Visualization and Heritage (LIAVH) - Pratt Institute."

63. Prospective post graduate project at TU Berlin under Andreas Fuls.

Appendix 1

Additional figures and tables.

Shape			Material			Technique		Size	
rt	oth	Variety	clay	stone	Variety	incised	Variety	size	Variety
n	n	pot sherd	y	y	faience	y	all other	y	> 400 mm
y	n	rectangula	y	n	ceramic	n	tabB, tags, impression	n	< 400 mm
n	y	other shape	n	y	steatite				
y	y	square	n	n	copper				

Multiple sides			Iconography			Boss and perforation			Presence of signs	
multisid e icon	multiside signs	Variety	icon	unico rn	Variety	bo ss	perfora tion	Variety	Sign s	Variety
y	y	tabB, seals	y	y	multiple with or w/out unicorn	y	n	only knob	y	MHA with signs
y	n	multiside icons, no signs	y	n	other, single	n	y	mostly two sided	n	MHA without signs
n	y	multiside signs, no icon	n	y	unicorn	y	y	typical seal		
n	n	1 side, with boss and perforation	n	n	no icon	n	n	nothing to hold/ misc object		

Figure A1.1: Combination of boolean properties leading to artefact description

	HRP	MJD	DLV	L	K	CJD	N	B	LJD	AD	KU	KN	KD	Other	Total	n	UI
seal-s-sq	326	1121	87	56	50	57	13	14	3	7	0	1	0	56	1791	11	84.62
seal-s-rt	98	208	33	34	5	1	1	1	1	0	0	0	0	8	390	9	69.23
seal-s-oth	13	15	14	1	3	1	1	0	0	0	0	0	0	24	72	7	53.85
seal-nosign	209	190	16	33	15	8	3	7	4	0	11	2	1	27	526	12	92.31
tabb-s-sym	297	94	2	2	4	1	0	1	3	0	0	0	0	3	407	8	61.54
tabb-s-nosym	634	48	0	0	2	2	0	0	0	0	0	0	0	4	690	4	30.77
tabb-nosign	65	12	0	0	0	0	0	0	0	0	0	0	0	0	77	2	15.38
tabi-s-sym	162	0	0	0	0	0	0	0	0	0	0	0	0	1	163	1	7.69
tabi-s-nosym	742	9	18	0	1	0	0	0	0	0	0	0	0	0	770	4	30.77
tabi-nosign	93	0	0	0	0	0	0	0	0	0	0	0	0	0	93	1	7.69
pot-s-in	291	44	0	16	85	3	21	6	3	1	0	1	10	31	512	11	84.62
pot-s-imp	52	19	0	0	0	0	0	0	0	0	0	0	0	0	71	2	15.38
pot-s-oth	2	2	1	0	1	1	0	0	0	1	0	1	0	15	24	7	53.85
pot-nosign	25	2	0	0	0	1	0	1	0	0	0	0	0	0	29	5	38.46
tag-s-sym	3	15	17	42	26	0	1	1	2	1	0	5	0	10	123	10	76.92
tag-s-nosym	15	5	54	47	2	1	1	0	3	0	0	1	0	3	132	9	69.23
tag-nosign	2	10	1	24	1	1	0	0	0	0	1	0	0	5	45	7	53.85

tabc-s-sym	0	132	0	0	0	0	0	0	0	0	0	0	0	0	132	1	7.69
tabc-s-nosym	0	88	0	0	1	0	0	0	0	0	0	0	0	0	89	2	15.38
tabc-nosign	0	70	0	0	0	0	0	0	0	0	0	0	0	0	70	1	7.69
misc-s-sym	4	3	0	0	0	0	0	1	0	1	0	0	0	0	9	4	30.77
misc-s-nosym	40	85	3	2	7	6	0	0	0	1	0	0	0	4	148	7	53.85
misc-nosign	9	1	0	0	2	0	0	0	0	0	0	0	0	0	12	3	23.08
u-nosign	1	4	0	20	1	1	0	0	0	0	0	0	0	1	28	5	38.46
Total	3083	2177	246	277	206	84	41	32	19	12	12	11	11	192	6403	-	-
n	21	22	11	8	15	13	7	8	8	6	2	6	2	14	-	-	-
DI	87.50	91.67	45.83	33.33	62.50	54.17	29.17	33.33	33.33	25.00	8.33	25.00	8.33	58.33	-	-	-

Table A1.1: Ubiquity & Diversity index - Subtypes & Top 13 sites

CISI Groups	length in mm	area in sq mm	length - % increase	area - % increase
I	43.5	1892.25	1.16	2.34
II	43	1849	22.86	50.94
II	35	1225	1.45	2.92
III	34.5	1190.25	18.97	41.53
III	29	841	1.75	3.54
IV	28.5	812.25	23.91	53.54
IV	23	529	2.22	4.49
V	22.5	506.25	28.57	65.31
V	17.5	306.25	2.94	5.97
VI	17	289	-	-

Table A1.2: Relationship of increase in area and length - for square seals

CISI Size	cluster_0	cluster_1	cluster_2	cluster_3	cluster_outliers
1	0	1	63	2	9
2	2	180	3	7	0
3	5	67	0	265	0
4	167	2	0	493	1
5	420	0	0	4	0
6	147	0	0	8	0

Table A1.3: K-means clustering for square seals - 4 clusters

CISI Size	cluster_0	cluster_1	cluster_2	cluster_3	cluster_4	cluster_5	cluster_ outliers
1	0	1	2	63	0	0	9
2	1	174	5	3	8	1	0
3	2	5	52	0	275	3	0
4	161	1	494	0	4	2	1
5	354	0	3	0	1	66	0
6	1	0	7	0	1	146	0

Table A1.4: K-means clustering for square seals - 6 clusters

Samples

DS_SYM0		Count	Mean
Gaur		78	666.51654009
Zebu		49	938.95784292
Swas		44	320.20955538
Elep		38	757.80831469
Tiger		28	763.94553436
Goat		22	384.41259291
Buffalo		19	651.89409154
Rhin		19	804.22319895
FAUNA		13	772.36364388
OTHER		13	521.92696042
Total		323	666.32420807

Figure A1.2: Surface areas for non-unicorn motifs

Predict Rissman iconographic groups using Wells' attribute and surface area

Display: % of actual classes

	Predicted					
Actual	10	4	2	3	1	
10	50 %	19 %	9 %	5 %	17 %	100 %
4	34 %	27 %	5 %	14 %	20 %	100 %
2	4 %	0 %	83 %	0 %	13 %	100 %
3	27 %	7 %	0 %	53 %	13 %	100 %
1	4 %	8 %	21 %	14 %	53 %	100 %

Display: Record count

	Predicted					
Actual	10	4	2	3	1	
10	275	105	50	27	95	552
4	15	12	2	6	9	44
2	1	0	19	0	3	23
3	4	1	0	8	2	15
1	4	7	19	13	48	91
	299	125	90	54	157	725

Figure A1.3: Rissman group prediction using surface area and Wells' attribute

Predict Franke iconographic groups using Wells' attribute and surface area

Display: % of actual classes

	Predicted							
Actual	10	1.1	3.3	3.2	3.1	2	1	
10	44 %	5 %	23 %	6 %	3 %	9 %	10 %	100 %
1.1	5 %	11 %	7 %	14 %	7 %	11 %	45 %	100 %
3.3	15 %	8 %	52 %	8 %	13 %	0 %	4 %	100 %
3.2	17 %	4 %	24 %	11 %	22 %	4 %	17 %	100 %
3.1	8 %	0 %	21 %	25 %	42 %	0 %	4 %	100 %
2	0 %	0 %	0 %	0 %	0 %	85 %	15 %	100 %
1	0 %	15 %	3 %	10 %	23 %	13 %	36 %	100 %

Display: Record count

	Predicted							
Actual	10	1.1	3.3	3.2	3.1	2	1	
10	223	24	120	29	14	48	53	511
1.1	2	5	3	6	3	5	20	44
3.3	7	4	25	4	6	0	2	48
3.2	8	2	11	5	10	2	8	46
3.1	2	0	5	6	10	0	1	24
2	0	0	0	0	0	11	2	13
1	0	6	1	4	9	5	14	39
	242	41	165	54	52	71	100	725

Figure A1.4: Franke group prediction using surface area and Wells' attribute

Sign class distribution in Rissman's iconographic groups

	1	4	2	3	
PP	100	33	3	11	**147**
SS	64	22	3	2	**91**
LP	60	14	15	2	**91**
SC	46	13	13	3	**75**
SP	53	13	0	5	**71**
LC	11	2	2	1	**16**
2L	4	3	0	8	**15**
MS	6	0	3	2	**11**
	344	**100**	**39**	**34**	

Total number of Signs (avg) in Green's ACGs

GREEN_ACGRP		Count	Mean
1		**17**	**5.7058823529**
2		**9**	**6.8888888889**
4		**8**	**3.75**
3		**7**	**4.5714285714**
7		**6**	**7.6666666667**
9		**5**	**6**
Total		**52**	**5.7115384615**

Sign class distribution in Franke's iconographic groups

	1	1.1	3.3	3.2	3.1	2	
PP	53	30	32	35	14	3	**167**
SS	35	25	22	14	4	3	**103**
LP	32	27	13	13	3	6	**94**
SC	26	17	15	20	6	10	**94**
SP	32	15	14	9	9	0	**79**
2L	2	0	3	10	12	1	**28**
LC	3	4	3	1	1	1	**13**
MS	2	1	1	0	2	3	**9**
	185	**119**	**103**	**102**	**51**	**27**	

Figure A1.5: Sign-class distribution in iconographic groups by Franke, Rissman and Green

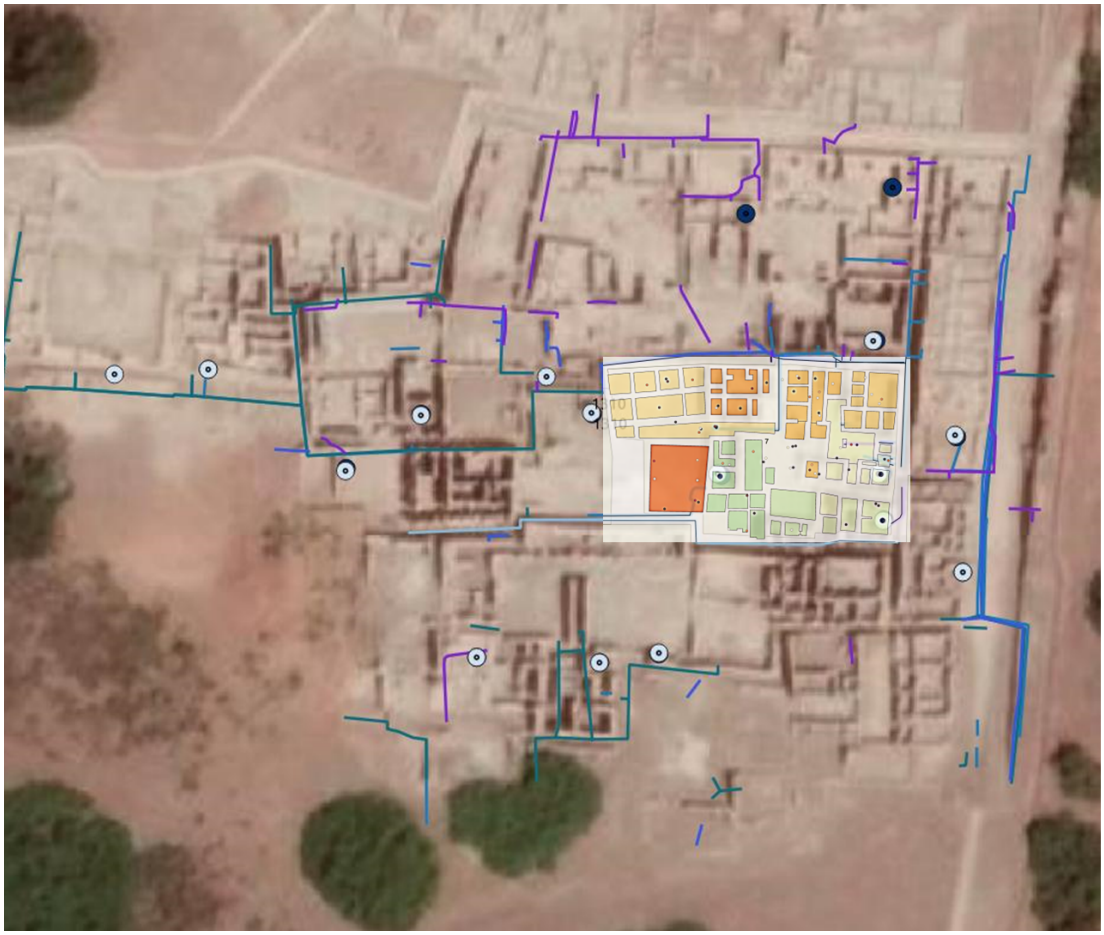


Figure A1.6: Block 7 in DKGS mound at Mohenjo-daro - wells and drainage captured from different plans

Appendix 2

Description of MHA attributes.

Provenance attributes and their description	
Attribute	Details
DS_SITE	Site of discovery (As per ICIT)
DS_SITEACRO	Acronym for site
DS_REGION	Broader geographic region of site (As per ICIT)
Area, Section, Block, Room	Specific findspot within the site - As per different excavation reports. Used only in case of GIS case study of DKGS mound of Mohenjo-daro. That database is separately created in GIS application.
DS_TIME	Absolute date or cultural period (As per ICIT)
DS_PERIOD	Cultural period (As per ICIT)
DS_PHASE	Phase within a cultural period or a stratigraphic layer (As per ICIT)
DS_NEW_ DEPTH_ CM	Findspot depth below the ground, generally measured from datum point. Different units used in different excavations. All converted to cm. (Modified from ICIT)

Table A2.1: Provenance information

Form and material attributes and their description	
Attribute	Details
DS_SHAPE	General shape of the artefact (Modified based on ICIT and CISI)
DS_MATERIAL	Raw material (Modified from ICIT)
DS_COLOUR	Colour (As per ICIT)
DS_BOSS	Knob on the reverse of many objects (Modified from ICIT)
DS_PERFO	Piercing across boss or artefact body (Modified from ICIT)
DS_BOSSOTHSIDE	Detailing on the reverse side of the objects or on the boss if it exists on the reverse. It is correlated with SYM ICIT, SYM1 and SYM2 attributes for information on the reverse side. To be described in detail at a later point.
DS_SIZE	Size categories as described in CISI - populated based on actual measurements and CISI information
DS_HORI	Horizontal measurement of the artefact - in mm (Modified based on ICIT and CISI)
DS_VERT	Vertical measurement of the artefact - in mm (Modified based on ICIT and CISI)
DS_THK	Thickness measurement of the artefact - in mm (Modified based on ICIT)
DS_VOLUME	Volume of the artefact - in cubic mm
DS_HV_AREA	Surface area measurement of the artefact - in sq mm
DS_TECHNIQUE	Technique of production of signs and iconography on MHA. Positive or negative indicate present day understanding about the order of sign sequence on MHAs IP - IMPRESSION (SEALING) - positive BR - BAS RELIEF - positive IN - INCISED - positive PT - PAINTING - positive IC - STAMP (INTAGLIO CARVED) - negative

Table A2.2: Form and material

Iconographic attributes and their details	
Attribute	Details
DS_SYM0	Primary identification of iconography - (Modified from ICIT)
DS_SYM1	Generalisation of the specific information in SYM ICIT
DS_SYM2	Extra information about SyM ICIT
DS_FACING	Direction in which the animal is facing - (Modified from ICIT)
Attributes defined by Paul Rissman and Ute Franke (Cited in the main text)	
DS_UNICORN	Decoration on the unicorn neck and face
DS_STDUP	Decoration on the upper part of a stand like object in front of the faunal image
DS_STDLOW	Decoration on the lower part of a stand like object in front of the faunal image
DS_FLOW	Flow like marking to lower part of a stand like object
DS_LIP	Lip detailing to lower part of a stand like object

Table A2.3: Iconographic details

Sign related attributes and their description	
Attribute	Details
DS_CLASS	Abstract definition of sign sequence patterns (as per ICIT)
ICIT_SIGNHT	Sign Height (as per ICIT)
ICIT_ALIGN	Text Alignment with respect to artefact (as per ICIT)
ICIT_DIR	Direction of reading (as per ICIT)
DS_SIDESTOT	Number of sides with signs (Modified from ICIT)
DS_SIDENUM	Sequence number of side (Modified from ICIT)
DS_LINESTOT	Total number of line of signs on given side
DS_SIGNSTOT	Total number of signs on a given side. If there are multiple lines, then the total number of signs in all lines is documented. In the sign sequence itself, all lines are appended to each other with a separation character 999. For unrecognisable signe, 000 is used. Both 999 and 000 are not counted in total number of signs in this attribute (Modified from ICIT).
DS_SEQASIS	Sign sequence as seen on the original MHA
DS_SEQREV	Sign sequence revered than one seen on the original MHA
ICIT_SIGNSEQ	Sign sequence as per ICIT. This is a combination of REV sequence for seal subtype and ASIS sequence for all non-seal subtypes.

Table A2.4: Sign properties

Sign with peculiar graphic details - As described in ICIT	
Attribute	Details
HUM	Signs having human like motif
DBL	Doubling of signs
ENCL	Signs with enclosure
FISH	Signs having fish motif
NUM	Signs identified as possible numerals in ICIT
JAR	Signs having jar motif
MIRR	Signs with presence of Mirror pairs

Table A2.5: Peculiar sign graphics

Attributes with boolean properties to describe MHA: Selected based on diversity of artefacts	
Boolean attributes	Presence or absence of following attributes
d_signs	Signs
d_sym	Sumbols
d_boss	Boss on obverse
d_perf	Perforation to the artefact
d_incised	Signs or icons created by incision technique
d_msicon	Icons on multiple sides
d_mssigns	Signs on multiple sides
d_u	Unicorn icon
d_size	Surface area of seal greater than 400 sq mm
d_rt	Rectangular shape
d_oth	Square shape
d_clay	Terracotta or clay or ceramic
d_stone	Stone or material other than clay

Table A2.6: MHA attributes with boolean properties



Figure A2.1: Documentation of iconographic attributes

Appendix 3

The table A3.1 contains the sign identification numbers of ICIT sign-list (as of February 2024) and sign graphics used in this thesis. Due to the revision over the years, some identification numbers are now unused and are denoted by empty spaces for respective signs. Online ICIT database can be referred for more information of these signs.[64]

												
s001	s071	s141	s211	s281	s351	s421	s491	s561	s631	s701	s771	s841
												
s002	s072	s142	s212	s282	s352	s422	s492	s562	s632	s702	s772	s842
s003	s073	s143	s213	s283	s353	s423	s493	s563	s633	s703	s773	s843
s004	s074	s144	s214	s284	s354	s424	s494	s564	s634	s704	s774	s844
s005	s075	s145	s215	s285	s355	s425	s495	s565	s635	s705	s775	s845
s006	s076	s146	s216	s286	s356	s426	s496	s566	s636	s706	s776	s846
s007	s077	s147	s217	s287	s357	s427	s497	s567	s637	s707	s777	s847
s008	s078	s148	s218	s288	s358	s428	s498	s568	s638	s708	s778	s848
s009	s079	s149	s219	s289	s359	s429	s499	s569	s639	s709	s779	s849
s010	s080	s150	s220	s290	s360	s430	s500	s570	s640	s710	s780	s850
s011	s081	s151	s221	s291	s361	s431	s501	s571	s641	s711	s781	s851
s012	s082	s152	s222	s292	s362	s432	s502	s572	s642	s712	s782	s852

64. Wells and Fuls, "Online Indus Writing Database."

												
s013	s083	s153	s223	s293	s363	s433	s503	s573	s643	s713	s783	s853
												
s014	s084	s154	s224	s294	s364	s434	s504	s574	s644	s714	s784	s854
												
s015	s085	s155	s225	s295	s365	s435	s505	s575	s645	s715	s785	s855
												
s016	s086	s156	s226	s296	s366	s436	s506	s576	s646	s716	s786	s856
s017	s087	s157	s227	s297	s367	s437	s507	s577	s647	s717	s787	s857
s018	s088	s158	s228	s298	s368	s438	s508	s578	s648	s718	s788	s858
s019	s089	s159	s229	s299	s369	s439	s509	s579	s649	s719	s789	s859
s020	s090	s160	s230	s300	s370	s440	s510	s580	s650	s720	s790	s860
s021	s091	s161	s231	s301	s371	s441	s511	s581	s651	s721	s791	s861
s022	s092	s162	s232	s302	s372	s442	s512	s582	s652	s722	s792	s862
s023	s093	s163	s233	s303	s373	s443	s513	s583	s653	s723	s793	s863
s024	s094	s164	s234	s304	s374	s444	s514	s584	s654	s724	s794	s864
s025	s095	s165	s235	s305	s375	s445	s515	s585	s655	s725	s795	s865
s026	s096	s166	s236	s306	s376	s446	s516	s586	s656	s726	s796	s866
s027	s097	s167	s237	s307	s377	s447	s517	s587	s657	s727	s797	s867

s028	s098	s168	s238	s308	s378	s448	s518	s588	s658	s728	s798	s868
												
s029	s099	s169	s239	s309	s379	s449	s519	s589	s659	s729	s799	s869
												
s030	s100	s170	s240	s310	s380	s450	s520	s590	s660	s730	s800	s870
												
s031	s101	s171	s241	s311	s381	s451	s521	s591	s661	s731	s801	s871
												
s032	s102	s172	s242	s312	s382	s452	s522	s592	s662	s732	s802	s872
s033	s103	s173	s243	s313	s383	s453	s523	s593	s663	s733	s803	s873
s034	s104	s174	s244	s314	s384	s454	s524	s594	s664	s734	s804	s874
s035	s105	s175	s245	s315	s385	s455	s525	s595	s665	s735	s805	s875
s036	s106	s176	s246	s316	s386	s456	s526	s596	s666	s736	s806	s876
s037	s107	s177	s247	s317	s387	s457	s527	s597	s667	s737	s807	s877
s038	s108	s178	s248	s318	s388	s458	s528	s598	s668	s738	s808	s878
s039	s109	s179	s249	s319	s389	s459	s529	s599	s669	s739	s809	s879
s040	s110	s180	s250	s320	s390	s460	s530	s600	s670	s740	s810	s880
s041	s111	s181	s251	s321	s391	s461	s531	s601	s671	s741	s811	s881
s042	s112	s182	s252	s322	s392	s462	s532	s602	s672	s742	s812	s882
s043	s113	s183	s253	s323	s393	s463	s533	s603	s673	s743	s813	s883

s044	s114	s184	s254	s324	s394	s464	s534	s604	s674	s744	s814	s884
												
s045	s115	s185	s255	s325	s395	s465	s535	s605	s675	s745	s815	s885
												
s046	s116	s186	s256	s326	s396	s466	s536	s606	s676	s746	s816	s886
												
s047	s117	s187	s257	s327	s397	s467	s537	s607	s677	s747	s817	s887
												
s048	s118	s188	s258	s328	s398	s468	s538	s608	s678	s748	s818	s888
												
s049	s119	s189	s259	s329	s399	s469	s539	s609	s679	s749	s819	s889
s050	s120	s190	s260	s330	s400	s470	s540	s610	s680	s750	s820	s890
s051	s121	s191	s261	s331	s401	s471	s541	s611	s681	s751	s821	s891
s052	s122	s192	s262	s332	s402	s472	s542	s612	s682	s752	s822	s892
s053	s123	s193	s263	s333	s403	s473	s543	s613	s683	s753	s823	s893
s054	s124	s194	s264	s334	s404	s474	s544	s614	s684	s754	s824	s894
s055	s125	s195	s265	s335	s405	s475	s545	s615	s685	s755	s825	s895
s056	s126	s196	s266	s336	s406	s476	s546	s616	s686	s756	s826	s896
s057	s127	s197	s267	s337	s407	s477	s547	s617	s687	s757	s827	s897
s058	s128	s198	s268	s338	s408	s478	s548	s618	s688	s758	s828	s898
s059	s129	s199	s269	s339	s409	s479	s549	s619	s689	s759	s829	s899

s060	s130	s200	s270	s340	s410	s480	s550	s620	s690	s760	s830	s900
												
s061	s131	s201	s271	s341	s411	s481	s551	s621	s691	s761	s831	s901
s062	s132	s202	s272	s342	s412	s482	s552	s622	s692	s762	s832	s902
												
s063	s133	s203	s273	s343	s413	s483	s553	s623	s693	s763	s833	s903
s064	s134	s204	s274	s344	s414	s484	s554	s624	s694	s764	s834	s904
s065	s135	s205	s275	s345	s415	s485	s555	s625	s695	s765	s835	s905
s066	s136	s206	s276	s346	s416	s486	s556	s626	s696	s766	s836	s906
s067	s137	s207	s277	s347	s417	s487	s557	s627	s697	s767	s837	s907
s068	s138	s208	s278	s348	s418	s488	s558	s628	s698	s768	s838	s908
s069	s139	s209	s279	s349	s419	s489	s559	s629	s699	s769	s839	s909
s070	s140	s210	s280	s350	s420	s490	s560	s630	s700	s770	s840	s910
s911	s912	s913	s914	s915	s916	s917	s918	s919	s920	s921	s922	s923
s924	s925	s926	s927	s928	s929	s930	s931	s932	s933	s934	s935	s936
s936	s937	s938	s939	s940	s941	s942	s943	s944	s945	s946	s947	s948
s949	s950	s951	s952	s953	s954	s955	s956	s957	s958			

Table A3.1: Signs used in the thesis - ICIT sign list

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