Studies on Indus Script

Conference on Indus Script
Mohenjodaro 2020

Studies on Indus Script

Conference on Indus Script
Mohenjodaro 2020

National Fund for Mohenjodaro

Culture, Tourism, Antiquities and Archives Department
Government of Sindh

Published Provisionally 2020

Publisher
National Fund for Mohenjodaro

Publisher asserts the Intellectual Rights of Contributors and Publisher

Conference Committee

Syed Sardar Ali Shah
Patron

Kaleemullah Lashari
Convener

Dr. Jonathan Mark Kenoyer
Member

Dr. Asma Ibrahim,
Member

Mr. Ghulam Akbar Laghari
Member

Mr. Manzoor Ahmed Kanasro
Member / Secretary

Mr. Sajid Hussain Khan
Staff Officer / Liaison

Printed By: *SEAS; Art & Design*
Designing and Formatting By: *Faraz Nazar*
Title by: *Zahid Hussain Dethro*

Composed on Core i7,
Fonts - Garamound Premier Pro
Point size - *Headline 24pt, Sub Headline 18pt, and 14pt, for Text 11pt*

CONTENTS

Introduction

The '*most deciphered script*,' as the Indus Script is referred to so often, due mainly to a large number of decipherments available, is still evading all attempts at its decoding. The decades of work has helped in developing some understanding about the Indus Civilization, but the reading of the Indus signs remains a difficult task.

The signs found on the seals, ivory, copper, bronze and other objects, at times are accompanied with images of animals, mythical figures, geometric and other abstract motifs, which also have distinct iconographic representation. The quality of these productions, and uniformity in the representation of iconography or signage indicates to a well-regulated and highly managed process, the fact that renders a greater complexity to the issue.

It is not easy to attempt reading of an ancient writing, especially when there exists a great disconnect with the present and the distant past, to which the writing belongs. However it becomes easier if there exists knowledge about the language used by ancient people, the understanding of the belief system and its practices, and above all the knowledge of the dynasties and stories related.

When such means are not available it brings one to point zero, back to basics: questioning begins why those people felt the need to write, what was the purpose of writing?

The discovery of seals from a large number of sites, spread over to a vast area having morphometric coherence in iconography and inscriptions, prompted many questions. The time span of the presence and use of these seals is considered to be about six centuries, it becomes an enormous puzzle if it is stated that the writing system emerged in its fully developed form.

A large number of the seals coming from the huge digs during the nineteen twenties and nineteen thirties, were not reported with their respective secure stratigraphy, it may add complexity to the understanding of possible development of signs, and relative preference of different texts over others.

If the signs were meant to communicate, and there is no reason to deny it, then there was a requirement to have a widespread knowledge and training of those

who were to inscribe accurately and produce the highly homogenized characters; above all education of those who were supposed to be reading or using these.

The range of the inscriptions, their association with the iconography, and the material with which these are made, is quite wide. This variety can possibly indicate if not equally wide range of purpose, a diversity of uses that may not be very limited.

The questions regarding the control over production and the system of regulating it in the ancient period, where the means of communication though sustainable, were not at all ideal, are very important, and are required to be answered.

The interest in the writing was prompted by the publication of the results of the excavations by Sir John Marshal in the *Illustrated London News* on 20th September 1924, where the photos of Indus seals were also part of the write up. Ever since multiple attempts at the decipherment of the Indus Script has been made. This enigmatic writing has generated many a good works, which have been very befittingly reviewed, especially by Gregory Possehl (Possehl, 1996).

The study of the Indus writing has many low and high points; some of the efforts at collecting and providing information helped in building up the means augmenting further studies. The first image of a seal from Harappa came out in 1875; publication of the images of the seals from Mohenjodaro was considered great help. Since that time the interest has continued to grow. Sir John Marshal's *Mohenjodaro* (Marshal, 1931) formed the major source on the Indus seals, but it too was a partial story; later this was in a way covered by preparation of the concordance by Mahadevan.

As for as the efforts directed at the decipherment of the Indus script are concerned, one major contribution in this direction was made by Asko Parpola. Here I am referring to the concept and production of the three volumes of *Corpus of Indus Seals & Inscription* (CISI). The compilers state that 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 with Harappa."

Its publication in international collaboration was first proposed to *29th International Congress of Orientalists'* meeting in Paris in 1973.

The Archaeological Survey of India (ASI) and the Department of Archaeology & Museums (DoAM) of Pakistan agreed to collaborate with University of Helsinki, the *Finish Academy of Science & Letters* agreed to publish it in its *Annals*. An application was submitted to the *International Union of Philosophy & Human Studies* (CIPSH) for financial assistance for this project.

The General Assembly of UNESCO meeting held at Nairobi in 1976 agreed to support the Corpus as *scholarly project of a confirmed international character and of major importance* (Parpola, A. 1987).

But it was not that easy to get the work started as the seals and artifacts having script had to be photographed; the material was lying in the museums, and offices of the ASI, and archaeology related departments respectively in India and Pakistan, and these were to be published in 1st and 2nd volumes of the CISI.

Photography began in India for the volume I; at that time B K Thapar was the DG of ASI. Work was very slow, he objected to the handling of the seals on account of these being fragile. Seeing delays the Government of Finland sought and made an agreement of cooperation in the field of Culture with India (1984-86). The corpus project was included in that exchange agreement (Parpola, A. 1987).

When the photographers of ASI were working on the material in India during the years 1978 to 1983, and later the Finnish photographer during 1984-85, all the material was not accessible, thus by the time the first volume was going to the press some of the seals and inscribed artifacts were left out. But the printing couldn't be delayed any further due to the financial arrangements.

The story of the photographing of the material in Pakistan, despite the best efforts of every one was not much different, however the publication of the second volume comprising of the seals and inscriptions available in Pakistan became possible in the year 1991 (Parpola, and Shah, 1991).

The third volume was published subsequently in 2010, it comprised of the new material, untraced objects, and collections outside India and Pakistan (Parpola, Pande, and Koskikallio, 2010).

In the recent years interest has been regenerated and some good attempts at the understanding of the nature of the signs have been made. Heated debates have also been noticed, while the importance of the data relevant to the archaeological context has been largely recognized.

The idea of causing an occasion to discuss the issues pertaining to the Indus Script and reviving the interest in its decipherment is multifaceted; the review of the present position of the work is the one aspect, to find out what could be the best strategy to revamp the efforts in the desired direction, and above all to think of and build up such an environment where the work on it can be expanded. The call for the papers to be read in the Conference on Indus Script at Mohenjodaro planned to be held in January 2020 was floated in the mid of the year 2019, it

generated positive response. These papers are being published provisionally on the eve of Conference; to enable more learned interaction during the *Workshop Sessions* of the Conference.

Presenters have discussed their recent work on the Indus Script and have brought focus on various aspects of the Script and Seals. Attempts have been made to review the recent work by the scholars that is bound to generate good discussion. The *Workshop Sessions*, while discussing the work in detail may attempt to formalize recommendations, if possible, to generate a chain of events for coming year, aiming at sustaining the interest in the on-going work.

The papers received have discussed at length diversified topics, while looking at the observations made by some of the recent works on the script, for instance where linguistic structure have been under discussion, it led to the realization of presence of the formal arrangement in the inscriptions, it is considered to be the indicator of society that uses these signs having agreed grammar, or cryptic writing known to many.

The structure of the script has been under focus of not only the linguists but the scholars of various disciplines other than archaeology and scripture, such as mathematics and computer science.

Use of Seals is obviously linked with sealing purpose, archaeological evidences from *Lothal* (Frenez, D and M Tosi, 2005) and other sites show that the seals were used for sealing the tags for securing goods / storage of trade goods. Possibly the seal impressions were for identification of the artisan, or guilds of artisans, or workshops / manufacturers; someone thought the marks on the pottery to be the potters' marks. The seals might have been used as exchange tokens, sort of ancient coinage, or some sort of receipts. Even its use to register authority has been referred (Frenez, D. 2018). The cultic or religious role of some of these had also been part of strong speculations.

New light is shed by Dennys Frenez on the meaning and purpose of use of clay Sealings, he thinks that it was to regulate access to the containers and commodities, 'rather than authenticate the integrity of the *shipped cargo*.'

This doesn't necessarily be taken as a remark to limit the use of the script to the trade related activities, possibilities of its larger scope cannot be ruled out, given the highly developed culture of Indus Basin in Bronze Age.

The possibility of the numerical value depiction in text (Fuls, 2015) has been viewed with due indulgence by Dr. Andreas, by attracting the information

made available by modern technologies. He has been working on the Interactive Concordance of Indus Texts (ICIT); it is made available through a web-interface (Wells 2015).

The work on Indus Seals and the material associated with these coming from the Middle Eastern context has broken new grounds. Earlier Parpola also discussed the sequence of the inscriptions on the *Gulf Type* seals, which were available to him, as well as Indus inscription found on other artifacts in the Gulf. Steffen Terp Laursen's paper provide 'an informed update on recent advances in the investigation of the *Dilmun Culture* (Kuwait, Saudi Arabia and Bahrain) and beyond.' His involvement with the subject is long; he has worked on the spread of Indus Seal technology westward (Laursen, 2016). He has assigned an interpretation to certain Indus signs, used in the Gulf Type seals. He is of the view that the last Indus inscription in *Dilman* probably dates from 2000-1950 BC, and the Indus weight were under use there till at least 1800 BC.

Another work is also touching the Indus weight system; Bryan Wells has it with reference to the usage of "Fish" sign. The weights used in the Indus system have been largely praised for it being well defined, having and variety of weight types. A very gainful insight becomes available through an interesting discussion (Wells *et al.* 2018) that has been initiated in a paper by Bryan Wells; his submission to the Conference refers to the instances of possible correlation of the weights and particular seals.

Some of the recent papers have contributed greatly to substantiating the idea of the use of a developed language(s) in Indus Civilization, capable of conveying complex information. A team of scholars working on the structure of language, with statistical approach, and the positional assessment of the characters / signs observed that the use of signs is highly uniform; there was the feeling that the grammar of the writing is standardized: an ordered text, where the placement of signs show flexibility similar to linguistic writing.

It is observed that the 'machine learning can predict missing signs with more than 75% accuracy suggesting that the rules are not writer dependent but are defined in absolute terms.'

One of the contributors commented on a set of positions taken with respect to the Indus signs, which stated, 'Generic models suggesting that the Indus script may be a random scribble or, are purely numeric or, a writing in one of the later scripts.' This observation can not be agreed upon, it can be refuted by the statistical patterns of sign usage (Yadav *et al.* 2010).

It is possible to use the computational and statistical linguistics to go for wide range of explorations in the format, structure and sequencing of the script, especially processing huge data. Such work has been quite gainfully undertaken, and rationalized conclusions obtained (Yadav *et al.* 2010; Yadav and Vahia, 2011a,b; Bottero, 2004; Coe, 1992;).

The inscriptions comprising number of signs, mostly are described as formal, as many of the signs require a number of strokes to inscribe, thus these cannot be evolutionary in nature. The study in the structure of the Indus writing, by machine assisted computations have yielded concrete information on some of the aspects, the positional placement and pairing of signs, the frequency of some particular sign appearing at the end and other at the beginning of the texts, sequencing and segmentation etc. That further confirms the writing to be well arranged and formal. The model developed by computing the probabilities of the signs following each other can help in reading the illegible, or the damaged or missing texts (Yadav *et al.* 2010).

The enquiring in to sequencing among the signs has helped in observing the flexibility in use of signs, in the Indus texts. Thus the results of quantification takes one to be able to make comparison with the 'linguistic and non-linguistic domains such as English, Sanskrit, Old Tamil, Sumerian, DNA, Protein, and Fortran' (Rao *et al.* 2009), and the results found the Indus script closer to the linguistic systems.

M N Vahia; Rajesh P N Rao & Nisha Yadav contributing to this volume are of the view that the nature of majority of the objects where the inscriptions appear are formal, suggesting 'a specificity which adds significantly to the knowledge.' It may be taken as the 'writing was a highly coordinated activity with the centralized teaching centers which trained the writers to provide the standardized exchange of information.'

A group of scholars believed that the presence of developed language of Harappa was just an abstract idea, it was not 'a true writing code.' These critics were of the view that there was no plausible evidence to support the literate nature of the Indus society (Farmer et al. 2004). The thought floated by these that a highly codified system of 'use of Iconography of the Indus stamp seals, linked with a wide array of signs loosely signifying mysterious religious or clan references' was refuted by one of contributors to this volume, thought that this kind of interpretation 'simply made no sense' (Vidale 2007).

Massimo Vidale believes that by keeping the speculations at very low ebb one can say that the Indus system was 'a standardized information technology whose signs conveyed meanings in forms of phonemes and / or ideograms, like was happening at the same time in Egypt, Mesopotamia, on the Iranian Plateau.'

The seals and the script on these have a greater level of similarities and at times one tends to believe that there is a duplication of the seals, to a larger degree. It prompted the idea that there might have been a very restricted production of these items and that too was limited to a small number of production centers.

If the production was under taken by a large number of artisans at widely distributed workshops, what ensured the awe-inspiring accuracy of the productions?

Analyses of the production, cutting and carving of the seals have remained under focus; it prompted many interesting papers in the past. The work carried out by Dr. Greg Jamison is particularly of interest; he has committed considerable number of years to the study of the production methodology of these seals (Jamison, 2017). In his most recent attempt at analyzing the stylistic seal groups, which contain those seals that have shared inscribed characters; he has found evidence of morphometric coherence as well as variations.

The seals falling in the identified stylistic groups from one site, and those from multiple sites & regions were also analyzed. To see, among other things, if it is possible also, to find out that the seal production was limited to a strictly controlled small number of centers and sites, or it was widespread and was done in multiple workshops by a larger number of engravers. Admittedly the sample size is not that large, but these results are preliminary and show efficacy of the pilot study.

He discusses his findings in a very interesting way, his line of argumentation is convincing. It paves the way for further work to strengthen or refute these provisional interpretations.

Even though the photographs of good resolution are a great help in such studies, there is possibility of finding more information if the seals themselves are analyzed, it can add few more indicators such as 'investigation of tool marks, raw materials and other signatures of production.'

Dr. Konasukawa has studied the chronology sequence of the seals from *Ghaggar Basin* (Konasukawa, 2013), by comparing these with the seals from the Harappa excavations, and made certain interpretations, it shall help deepen our knowledge of the chronological context of the seals and the text.

The work carried out by Asko Parpola has been available for a long time; it has been brought under the review of most of the scholars in the field. He and his team has gone to lengths to try to achieve a break through. He is published extensively; his recent write-up on the crocodile cult practices and its correlation with the representations of crocodile with in the Indus writings is very interesting. He has once again brought it up for discussion, having raised new questions. It may generate a discussion towards further speculation upon the cultic practices in ancient societies, through its present day concepts. It may help in understanding certain belief system of the Indus cultures.

The potentials of the Bronze Age site of Lakhanjodaro are slowly coming to the light; various artifacts with inscriptions were unearthed from this site, these are discussed by Prof. Qasid Mallah, in his submission. The new material from this site is bound to fetch good attention.

Dr. Kenoyer's involvement in the Indus Civilization goes back to several decades. Through his years of work in Harappa he has gained an insight that is rare, he has directed research on the Script also, his contribution to this volume is of pivotal importance. It is going to pave way for the greater understanding on the script, its evolution and development and possibly help set the direction of the future studies.

Keeping in view the present conference's primary concern, and in order to provide some good relevant material to the interested public and scholars his recent contribution to the *Shanghai Archaeological Forum* (SAF) in December 2019, which is scheduled to be published later by the SAF, has been included in the present volume, for ready reference.

Atta Muhammad Bhanbhro, a local scholar did attempt at the decipherment, results of his work (Bhanbhro, 2012) might have not convinced many, but these generated a great deal of interest in the younger generation of the scholars. Unfortunately due to the limiting factors, associated with advanced age, his participation in the Conference is not possible.

The papers submitted to this Conference are published provisionally, as the time in between deadline fixed for the submission of full papers and actual happening of the conference was very short, it was not possible to consider bringing out an edited volume, however the publication of the compilation of these papers was a race against time, which might have caused certain lapses, however its meeting the time line have been made possible by the team assisting the Conference, for which they deserve compliments.

References / Bibliography:

Bhanbhro, Atta Muhammad (2012), *Indus Script*, Department of Archaeology & Anthropology, University of Sindh, Jamshoro.

Bottero, F (2004). Writing on Shell and Bone in Shang China. In *The First Writing: Script Invention as History and Process*, S D Houston (ed.), Cambridge

Coe, M D (1992). *Breaking the Maya Code*, New York

Frenez, D and M Tosi, 2005. "The Lothal Sealings: Record from an Indus Civilization Town at the eastern end of the maritime trade networks across the Arabian Sea." In M Perna (ed.), *Studies in Oman di Enrica Fiandra. Contributi di Archaelogia Egea e Vicinorientale* (Studi ehei e Vicinorientali, 1) Paris: De Boccard, 65-103

Frenez, D. 2018. "Private Person or Public Persna? Use and significance of Standard Indus Seals as Markers Formal Socio-Economic Identities." In *Walking with the Unicorn: Social Organization and Material Culture in Ancient South Asia; Jonathan Mark Kenoyer Felicitation Volume*, Dennys Frenez, Grgg Jamison, Randall W Law, Massimo Vidale and Richard H Meadow (Eds).

Fuls, Andreas (2015). "Appendix I: Automated Segmentation of Indus Texts." In Bryan K. Wells, *The Archaeology and Epigraphy of Indus Writing*. Archaeopress, Oxford.

Jamison, G (2017). *The Organization of Indus Unicorn Seal Production: a diachronic Comparative Study of Style, Skill, and Sociopolitical Organization*. PhD Thesis; University of Wisconsin.

Konasukawa, Ayumu. 2013. "Diversity of Harappan Civilization: A case Study of the Ghaggar Basin (with Special Reference to Seals)." PhD diss., Deccan College Post Graduate & Research Institute.

Laursen, Steffen Terp 2016. "The westward Transmission of Indus Valley Sealing Technology – Origin and Development of the Gulf Type Seal and other Administrative Technologies in Early Dilmun 2100-2000 BC." In *Arabian Archaeology and Epigraphy* 21:2: 96-134

Marshal, Sir John (1931). *Mohenjo-Daro and the Indus Civilization*, 3 vol. Arthur Probsthain, London.

Marshal, Sir John (1924), *Illustrated London News* on 20th September 1924.

Parpola, Asko and Joshi, Jagat Pati, (1987), *Corpus of Indus Seals & Inscription: 1. Collections in India*, Helsinki.

Parpola, Asko and Shah, G M, (1991), *Corpus of Indus Seals & Inscription: 2. Collections in Pakistan*, Helsinki.

Parpola, Asko (1994), *Deciphering Indus Script.* Cambridge University Press, Cambridge.

Parpola, Asko, Pande, B M, and Koskikallio, Petteri, (2010), *Corpus of Indus Seals & Inscription: 3. New material, untraced objects, and collection outside India and Pakistan*, Helsinki.

Possehl, Gregory (1996). *Indus Age: The writing System*, Oxford & IBH Publishing Co. New Delhi

Rao, R P N, Yadav, N, Vahia, M N, Joglekar, R, and Mahadevan I, 2009. 'Entropic Evidence for Linguistic Structure in the Indus Script,' in *Science*, vol. 324, p.1165 Vahia, M N and Yadav

Vidale, M. (2007). "The Collapse Melts Down. A reply to Farmer, Sproat & Witzel." In *East and West* 57, 1-4, 333-366

Wells, Bryan (2015). *The Arcaheology and Epigraphy of Indus Writing.* Archaeopress, Oxford.

Wells, Bryan 2018. "The Volumetric System of Harappa." In *Walking with the Unicorn: Social Organization and Material Culture in Ancient South Asia; Jonathan Mark Kenoyer Felicitation Volume*, Dennys Frenez, Gregg Jamison, Randall W Law, Massimo Vidale and Richard H Meadow (Eds.).

Origin and Development of the Indus Script: Insights from Harappa and other sites

Jonathan Mark Kenoyer

Origin and Development of the Indus Script: Insights from Harappa and other sites

Introduction

The origin of the Indus script has been a source of considerable discussion ever since the discovery and excavation of the Indus cities of Mohenjo-daro and Harappa in the 1920s to 1930s (Marshall 1931; Vats 1940). When the Indus civilization was discovered the only other early civilizations known to have writing in the Old World were the ancient Sumerians along the Tigris and Euphrates Rivers in southern Mesopotamia (Nissen 1993), the ancient Egyptians along the Nile (Baines 2004) and the ancient Chinese along the Huang He (Yellow) River in north central China (Haicheng 2015). The oracle bone inscriptions at the site of Yinxu in Anyang were being discovered around the same time that Mohenjo-Daro and Harappa were being excavated (Bagley 1999, 127). Although at first some scholars thought that there might be some influence from Mesopotamian writing systems, in the first major report on the excavations at Mohenjo Daro in 1931, Gadd clearly states that there was no connection between the Indus script and the writing of Sumer or for that matter Egypt (Gadd 1931, 411). Surveys and test excavations in Baluchistan (Stein 1929; Hargreaves and Sewell 1929 (reprint 1981); Stein 1931) and Sindh (Majumdar 1934; Stein 1942) had recovered pottery that appeared to be older than that found at Mohenjo Daro, but little attention was paid to the presence of potter's marks or graffiti on these different types of pottery. It was not until the 1950s, after surveys of the Quetta Valley, Zhob and Loralai Districts, that Fairservis proposed that the earlier graffiti on pottery found in the regions of Baluchistan and the wider Indo-Iranian region might have some influence on later Indus writing systems (Fairservis 1959). B. B. Lal was among the first to argue that the origins of the Indus script were local and that the script continued to be used into the Late Harappan as seen on OCP pottery and on later Megalithic pottery (Lal 1975). However, many scholars

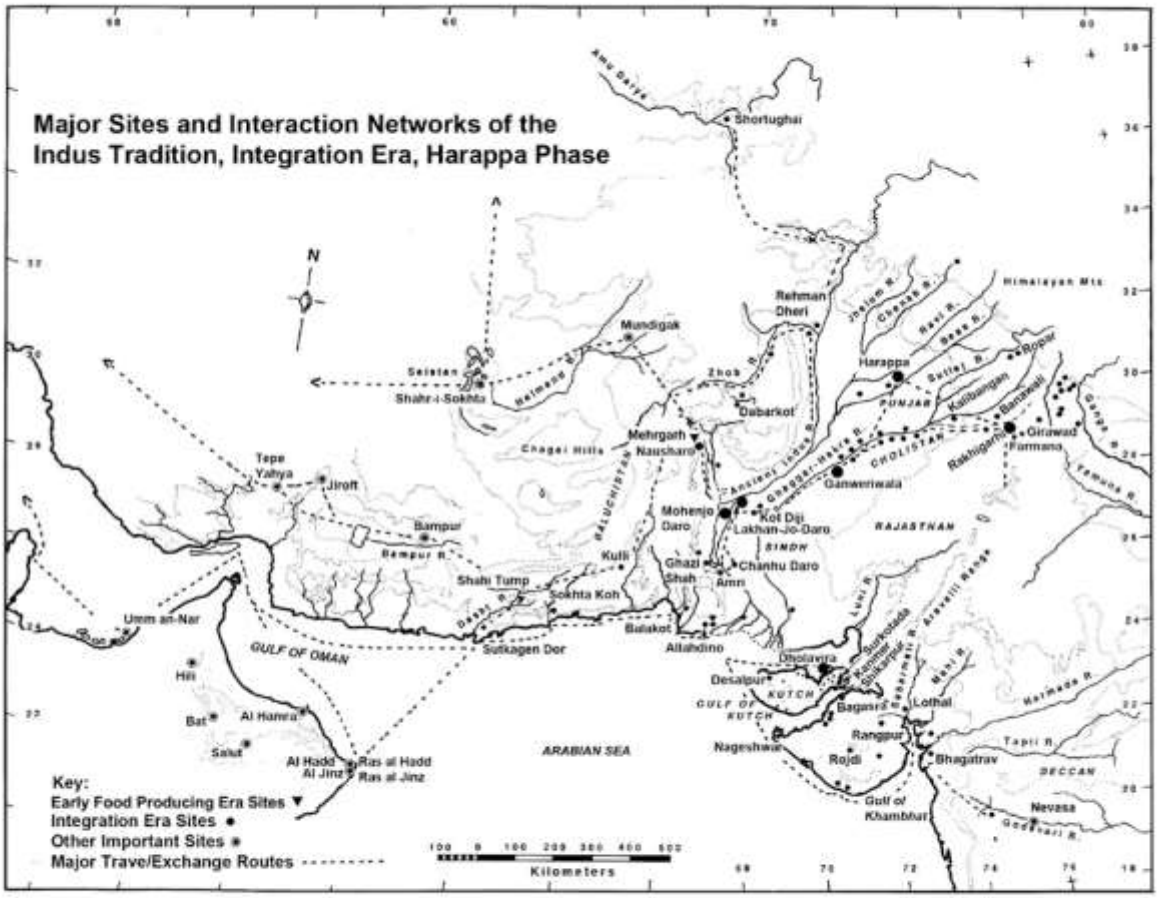


Figure 1. Map of the Indus

were not convinced with the scattered evidence of earlier writing and even after the discovery of Early Harappan writing Rehman Dheri and other sites (see discussion below), some scholars still assumed that the script appeared relatively fully formed around 2500 BCE (Possehl 1990; Possehl 1996).

At present, however, on the basis of numerous excavations and analyses of earlier survey materials there is increasing evidence that the Indus script did in fact evolve in the Indus and Ghaggar-Hakra River Valleys and Baluchistan (Figure 1) beginning in the Early Harappan Period, between 4000 and 2600 BCE (Table 1)(Kenoyer 2006). It is possible that Kutch and Gujarat also played an important role in terms of specific regional styles of graphic symbols, but more research needs to be done in these regions to determine the chronology and continuity of specific symbols. As will be discussed below in more detail, the regional and chronological changes in types of symbols and how there were used suggest that there were significant changes in the writing system over time (Kenoyer and Meadow 1997; Kenoyer and Meadow 2008; Kenoyer and Meadow 2010). Since the script has not yet been deciphered it is not

possible to understand the details of these changes, but comparisons can be made with the evolution of proto-cuneiform and cuneiform to determine some of the general processes of change (Damerow 2006,7). During the Harappa Phase, circa 2600-1900 BCE, the Indus script was used throughout the Indus and even adopted for use in the Gulf region, which suggests that it was used to write names and commodities in many regional dialects and even different languages (Kenoyer and Meadow 2010). The question of whether it was simply a system of notation rather than a writing system has been effectively addressed in other publications (Vidale 2007; Parpola 2008). Today, most scholars implicitly or explicitly agree that the Indus script was a distinctive and unique writing system indigenous to northwestern South Asia or the greater Indus Valley region (Parpola 1994; Possehl 1996; Wells 1998; Kenoyer and Meadow 2010; Yadav *et al.* 2012; Mahadevan and Bhaskar 2018; Rao 2018).

Table 1. Chronology of the Indus Tradition (Possehl 1994; Meadow and Kenoyer 2005; Kenoyer 2015).

Early Food Producing Era (Neolithic)	ca. 7000 to 5500 BCE
Mehrgarh, Period IIa - Ceramic	*6000-5500 BCE*
Mehrgarh, Period 1, Aceramic	*7000-6000 BCE*
Regionalization Era (Chalcolithic/Bronze Age)	
Early Harappan Phase ca.	5500 to 2600 BCE
Harappa: Period 2, Kot Diji Phase	*2800-2600 BCE*
Harappa: Period 1,A &B, Ravi Phase	*>3700-2800 BCE*
= Mehrgarh, Period IV to V	*3500-3000 BCE*
Mehrgarh, Period III	*4400--3500 BCE*
Mehrgarh, Period IIb	*5500-4400 BCE*
Integration Era (Indus Civilization) (Bronze Age)	
Harappan Phase	2600 to 1900 BCE
Harappa: Period 3C, Final	*2200-1900 BCE*
=Nausharo, Period IV	*2100-2000 BCE*
Harappa: Period 3B, Middle	*2450-2200 BCE*
=Nausharo, Period III	
Harappa: Period 3A, Initial	*2600-2450 BCE*
=Nausharo, Period II	
Localization Era (Bronze Age)	
Late Harappan Phase	ca. 1900 to 1300 BCE
Harappa: Periods 4 and 5	*1900- 1700 BCE*
= Mehrgarh Period VIII	*2000-1700 BCE*
Jhukar, Rangpur, Cemetery H Phases	

Stages of Indus Writing Development

Based on the current archaeological evidence the development of writing in the Indus region can be divided into four major stages that can be correlated to the major chronological Phases at Harappa and other sites (Table 2). During the Regionalization Era, Early Harappan Phase there are two stages of script development. The first stage, which dates to around 4000-2800 BCE, sees the widespread and regionally diverse use of pre-firing potter's marks as well as post-firing graffiti. These single and sometimes multiple graphic symbols may represent a form of proto-writing similar to that seen in other world regions. These symbols continued to be used throughout the later periods in some sites, indicating that they reflect a parallel use of symbols that did not cease to function even with the introduction of a more complex writing system. The fact that they continued to function does not preclude the possibility that they also provided some form of stimulus to the development of specific signs that became incorporated into the writing system. During this first stage, geometric button seals were produced using terracotta, bone and eventually carved steatite and fired and glazed steatite (Kenoyer 2009). There is considerable regional variation in the types and designs of button seals during this early phase and to date no seals with what could be identified as script have been reported.

The second stage of development during the Early Harappan Phase, dating from around 2800-2600 BCE sees the continuation of pre-firing potter's marks, and the first use of pre-firing inscriptions that include multiple graphic symbols (Kenoyer 2006). Post-firing graffiti also continue to be used but there are more examples of the use of one or more symbols that are definitely found in the later Indus script. For the first time, there is evidence for the use of script on seals that were impressed into clay, as well as script combined with motifs on carved bone pendants as seen at the site of Rehman Dheri (Kenoyer 2020). This second stage has been referred to as Early Indus script since it develops during the last part of the Early Harappan or Early Indus period.

The third phase of writing development is sub-divided into three phases that will be discussed in more detail below. This is the more commonly known Indus Script that is seen inscribed on pottery, seals and a wide range of other items (see Table 2). The fourth and final phase of Indus script is during what is commonly referred to as the Late Harappan Phase. There is no evidence for the use of writing on seals and geometric seals become widespread once again. Some evidence for graffiti on pottery is reported from Late Harappan and post-Harappan sites during this time period, but there is no regional pattern of writing use and the dating of some sherds with graffiti is problematic. However, during this transition phase there is evidence for the use of post-firing graffiti on non-Indus pottery in peninsular India broadly associated with Megalithic cultures that extend into the southern and central Deccan Plateau (Lal 1962; Lal 1975).

Table 2: Chronology of Indus Script and Seal types from Harappa and other major Indus Sites - modified from (Kenoyer 2020)

Harappa - Period 1- 3700-2800 BCE
Seals:
-Button seal with geometric design, no clear evidence for script

Positive script
-Inscribed pottery – post-firing graffiti, one to three signs, pre-firing potter's marks
-Pre-firing potter's marks, include some signs that later become incorporated in Early Indus Script

Period 2 – 2800-2600 BCE
Seals: inverse script
-Square steatite seal – animal motif facing left, irregular carving, irregular script placement (1 or 2 signs), seal boss is circular or square
-Steatite button seal – symbol, no script, seal boss is circular or square
-Sealing – square seal with script, plant motif and ladder motif

Pendant or Ornament with Script
-Carved ivory pendant (Rehman Dheri) with motifs and script signs

Positive script
-Inscribed pottery – post-firing graffiti, pre-firing script?, one to three signs

Period 3A – 2600-2450 BCE
Seals: inverse script
-Square steatite seal – angular carving of animal predominantly facing right, linear script placement (1 to 3 signs), curved script above animal motif, one script sometimes below animal head, seal boss is square

Positive script
-Inscribed pottery – post-firing graffiti, pre-firing script (1 to 3 signs)

Period 3B – 2450 -2200 BCE
Seals: inverse script
-Square steatite seal – animal motif predominantly facing left, linear but irregular script above animal motif, seal boss is circular, domed with single or double groove
-Square steatite seal – only with script, linear regular script size
-Steatite button seal – symbol, no script

Positive script
-Incised steatite tablets - regular and irregular script, motifs and symbols
-Molded faience tablet - script, motifs and symbols
-Molded terracotta tablet - seal impression with animal motif and script

-Inscribed pottery - post-firing graffiti, pre-firing script (1 to several signs, sometimes in more than one line)

Period 3C – 2200-1900 BCE

Seals – inverse script
-Square steatite, copper and silver seals – animal motif facing left, bold, rigid, regular script, seal boss is circular, domed with single, double or triple groove
-Long rectangular steatite seal – no animal motif, bold, rigid, regular script
-Terracotta seal – regular script
-Faience button seal – symbols, no script

Positive script
Trade and Accounting devices
-Incised steatite tablets - script, motifs and symbols
-Incised terracotta tablets/ shaped sherds – incised irregular script

-Molded copper tablets – regular script, raised in positive
-Molded faience tablet – narrative scenes, script, motifs and symbols
-Molded terracotta tablet – narrative scenes, seal impression with animal motif and script
-Molded terracotta token – circular with script on one or both sides, low fired
-Terracotta flat sealing – molded script from various types of seals
- Inscribed terracotta conical sealing – irregular script

Pottery
- Pointed base goblets – impressed with script seal
- Inscribed pottery – large and small, generally irregular post-firing graffiti, large and small refined and regular pre-firing script (1 to several signs, sometimes in more than one line)

-Inscribed stone vessel – bold regular script

Architecture
- Inlaid signboard with large script (Dholavira)
- Inscribed ringstone – regular script

Tools / weapons
-Inscribed copper tools / weapons – bold, rigid, regular script
-Inscribed bone point – irregular script

Ornaments
-Inscribed gold jewelry – miniature irregular script
-Inscribed stoneware bangles – miniature irregular script
-Inscribed shell bangle – irregular script
-Inscribed terracotta bangle
-Molded terracotta bead – irregular script
-Molded faience bead (or perforated tablet) – regular script

Domestic, ritual and other
-Inscribed bone and ivory dice – irregular script
-Inscribed terracotta conical object / gaming piece – irregular script
-Inscribed terracotta top, wheel, figurine
-Inscribed terracotta triangular cake
-Inscribed pebble – irregular script

Late Harappa Phase
-Inscribed pottery - post-firing graffiti,

Pre-Firing Potter's Marks and Post-Firing Graffiti
The use of pre-firing symbols on pottery, which I will refer to here as "potter's marks" is a technology that is found throughout the world in regions that have never developed any writing system. In most early reports both pre-firing marks as well as simple post-firing marks are sometimes lumped together and referred to as "potter's marks" but this conflation needs to be avoided in the future to determine, which marks were made by the producer of the vessel and those that were added by the user or consumer. Some potter's marks may simply be symbols used to distinguish the identity of the vessel maker or batch of vessels that were being produced and not be linked to a specific name or commodity. When multiple pre-firing marks are found on a vessel, it is more likely that they reflect a more complex message that could indicate a name or specific ritual or function that would also have been expressed verbally. Post-firing graffiti are incised with a stone or metal tool into the fired surface of the vessel, usually on the shoulder, rim or occasionally the lower body and under the base. Some graffiti are made with a single stroke, others include multiple strokes to create unique shapes, and then there are more complex graffiti that include more than one set of symbols. The longer the sequence of symbols the more likely that these graffiti reflect complex forms of communication that represent names, commodities or ritual formulae.

Some scholars suggest that there cannot be any link between these early potter's marks and later writing because they were used for such a long time and continue after the introduction of writing (Boltz 1986,430-432). Boltz's main arguments against the link between early potter's marks in Neolithic China and later writing during the Shang Period include the following points; 1) that most of the potter's marks are very simple graphic symbols and there is no way to link the form with meaning in the later writing system, 2) that most early writing that emerges starts first as pictographic images, and 3) the long time during which the potter's marks were used before the development of writing precludes their link to the later writing. "On the face of it, it would appear virtually impossible that the nascent seeds of writing could have germinated in the mid-fifth century B.C. but not grown into anything approaching a real writing system until more than three thousand years later. Writing systems do not evolve that way. If a potential for writing arises in the form of graphs or marks standing for names or works, no matter of what kind or how limited, that potential must either fulfill itself apace, culminating in a viable full-fledged system, or wither and die. A 'half-way' writing system is no system at all, and there is not way it could remain in a kind of 'limbo' or 'suspended animation' for such a long time. If it did not develop into a real writing system reasonably expeditiously, there would be

no reason for people to preserve its embryonic bits and pieces. As a practical matter a writing system is something that is achieved either relatively quickly, or not at all "(Boltz 1986,430-432).

This argument is flawed in assuming that all writing systems evolved in the same way or had the same function. The Indus script clearly functioned very differently than the writing systems of other early urban societies. From its use in the Early Indus Period and during the beginning of the Harappa Period it was dominated by short inscriptions on both pottery and seals. In later periods it was never used to write long inscriptions, and it does not appear to have been limited to only one community in that we see it associated with trade, ideology, personal identification and common materials (Parpola 1994; Kenoyer 2020). In contrast the earliest writing in Mesopotamia started out being used for basic accounting and was strongly associated with ideology and political power (Michalowski 1996; Cooper 2004; Damerow 2006); in Egypt the earliest writing was associated with royal burial offerings and continued to be used almost exclusively by elites for ritual and ideological purposes(Baines 2004), and that of ancient China was linked to recording communication with ancestors and was also strongly linked with elite culture and legitimation of both ideology and political authority (Keightley 1989; Boltz 2000; Haicheng 2015).

In terms of the discoveries of potter's marks and graffiti, the earliest surveys that drew attention to these were made by Walter Fairservis in the Quetta Valley as well as in the Zhob and Loralai regions of Baluchistan (Fairservis 1956; Fairservis 1959). Fairservis also excavated at the important pre-dynastic site of Hierakonpolis in Egypt where he also noted the importance of graffiti and its link to later Egyptian writing (Fairservis 1983). The only published images for the potter's marks from Fairservis' surveys are the ones from the surface of the site of Periano Ghundai (Fairservis 1956, Fig. 59). These few sherds have signs that are similar to ones found at the site of Mehrgarh and also other later Indus sites, but do not really provide any clear pattern or provide any chronological information. Nevertheless, they show that these types of marks were found in Baluchistan and that detailed excavations could provide more detailed information in the future.

Other early excavations that provided additional evidence for potter's marks and graffiti come from the site of Mundigak, Helmand Valley, Afghanistan, excavated by J. M. Casal (Casal 1961; Casal 1961). Again the symbols found at Mundigak pre-date the Indus script but there is no clear pattern or link that can be shown between these signs and those of later Indus writing. Even further to the west, excavations at the site of Tepe Yahya, Iran revealed similar use of potter's marks and graffiti that was summarized in a study by D. Potts (Potts 1981). However, most of the potter's marks found at the site date to the time period of the Indus cities and only a few simple signs were found in the earlier periods the site (Potts 1981). The study has a major flaw in that it combines all signs from the period prior to emergence of the Indus Script and those that are contemporaneous with the Indus script. Consequently the comparative tables are not that useful. It can be noted that none of the signs found in the phases that predate the Indus appear to have any similarity with later Indus signs. Some of the potter's marks found in Period IVA3-1 are similar to ones found

in the Indus as well as Proto-Elamite. So far there is no evidence for any connection between potters at Tepe Yahya and Indus pottery traditions or Proto-Elamite scribal traditions, so we can assume that the similarities in design are simply coincidental.

Excavations at Mehrgarh by J.-F. Jarrige (Jarrige 1991) provided additional evidence that there were earlier periods where graphic symbols were incised on pottery. The comprehensive study of potter's marks from the first several seasons of excavations at Mehrgarh by G. Quivron (Quivron 1980; Quivron 1997) was perhaps the most important development that drew attention to the extensive use of graphic symbols on pottery. He was one of the first to argue that perhaps the early pre-firing making on pottery at Mehrgarh might be a predecessor to the later Indus script (Quivron 1980). Most of the signs studied by Quivron were clearly used as potter's marks, incised on the pottery prior to firing and he does not identify any signs that were post-firing graffiti. Additional post-firing graffiti were identified in the course of later excavations at Mehrgarh and additional discoveries were made in the course of excavations at Nausharo (Quivron 1997). Excavations at Amri by Casal also identified the presence of earlier pottery styles that had evidence for the use of potters' marks and post firing graffiti (Casal 1964).

The site of Kot Diji, Sindh originally excavated by F. A. Khan (Khan 1964; Khan 1965) has one of the most important chronological sequences beginning with the Early Harappan occupation and ending with the Harappan occupation. Only one shed with graffiti was published in the original report (Khan 1964, Fig 14) but it is not unlikely that more sherds would have had both potter's marks and graffiti. This site is significant because the reanalysis of the pottery and other artifacts led to the initial definition of the Early Harappan, Kot Dijian Phase (Mughal 1970; Shaffer 1992). Another important Early Harappan settlement is the site of Rehman Dheri, in the Gomal Valley. First excavated extensively by F. A. Durrani, this settlement provided numerous examples of both potter's marks as well as graffiti on pottery, and the first example of script on a bone pendant combined with antelope and scorpion motifs (Figure 2)(Durrani 1976; Durrani 1986). Durrani identified numerous signs on the pottery and pendant from Rehman Dheri that he felt were linked to the later Indus script, but unfortunately, no detailed quantification of the signs were provided or their chronological context, and it was not always clear if the signs were pre-firing potter's marks or post-firing graffiti. Future reanalysis of the signs from Rehman Dheri is needed to develop a more robust study and determine which signs may have some linkage to the later Indus script.

The site of Kalibangan, Rajasthan also revealed the use of both potter's marks and graffiti during the Early Harappan Period. In some of the earlier publications, Lal identified some sherds as coming from the lower levels of the site, which presumably referred to the Early Harappan (or pre-Harappan) levels. Three sherds had the single sign that is the most common sign found in the later Indus script (Mahadevan 342) (Figure 3) (Mahadevan 1977; Lal 1979,33). In the more comprehensive publication of the Early Harappan levels of the site, there is no mention of these sherds so it is possible that they actually date to the Harappan period (Lal *et al.* 2003, 243-245).

The other symbols found on pottery during the Early Harappan period do include several signs that might be linked to later Indus script, but unfortunately there is no quantification of how many sherds were found or their specific chronological context. Overall the potter's marks and especially the graffiti from Kalibangan are extremely significant and deserve to be studied in more detail in the future. The site of Kunal also has revealed a number of graffiti from the Early Harappan occupation that could provide some important clues regarding the development of the Indus script (Khatri and Acharya 1997; Khatri and Acharya 2005) and hopefully more detailed information will be available in the near future.

The discovery of very distinctive graffiti signs on pottery from the Early Indus levels at Balakot, Period 1, has provided some of the first evidence that signs related to the Indus script were found as post-firing graffiti on pottery dating to the time period prior to the emergence of the Indus script (Figure 4)(Dales 1974, Fig. 11). Symbols painted on the Early Indus pottery could also reflect the use of special graphic symbols but not enough study was carried out on these symbols or their occurrences throughout Baluchistan. This is an area that deserves much more research. In one example, there is a complex symbol inscribed before firing on the concave surface of a specially fashioned terracotta scraping tool that may have been used for shaping pottery or some other scraping activity (Dales 1974, Fig. 14,C). Dales noted that a similar sign has been found on the interior of pottery vessels from the Early Indus site of Jalilpur, in the Punjab. He noticed these similarities when examining the pottery recently excavated by Dr. M. R. Mughal, but unfortunately these sherds from Jalilpur have not yet been published.

Figure 2. Rehman Dheri Ivory Pendant (redrawn by Kenoyer)

Figure 3. Mahadevan sign 342

Further studies of the graffiti from Balakot Period I were carried out by Ute Franke-Vogt in her doctoral dissertation (Franke-Vogt 2001). Her exhaustive study provided detailed chronological associations between different types of potter's marks, painted motifs and post firing graffiti. Many of the signs found on the Balakot Period 1 pottery have clear links to later Indus script and among them the most important sign is the symbol (Mahadevan 342) (Figure3)(Mahadevan 1977) that was first reported from Kalibangan by Lal (Lal 1979,33). All of these scattered discoveries have provided clear indication that earlier communities were beginning to use graphic symbols on pottery, both as pre-firing potter's marks or painted motifs as well as post-firing graffiti. With this general background regarding earlier discoveries we can now review the discoveries from the recent excavations at Harappa to better contextualize the development of the writing system during the Early Harappan Phase and trace its development and changes in the Harappa Phase.

Harappa Ravi and Kot Diji Phase Potter's Marks and Graffiti

The pottery found in the Ravi Phase occupation levels at Harappa are all made with hand building techniques and consist of small bowls, globular cooking pots, carinated pots with simple constricted rims, and a range of other relatively small constricted or straight sided vessels. Most were decorated with a red brown slip but some were also painted with white and various shades of red-brown to purple brown to black (Kenoyer and Meadow 2000). The area of excavation for the Ravi Phase, Period 1 and the Kot Diji Phase Period 2 at Harappa is very limited, but the preliminary quantification of potter's marks and graffiti show an important pattern. Based on the tabulation of pottery studied between 1986 and 2003, there are total of 1218 sherds with either simple incised marks or what with more complex signs that might be considered some form of script (Table 3). For the Earlier Periods, more detailed analysis of the sherds differentiated what are pre-firing and post-firing graffiti (Table 4). The percentage of pre-firing potter's marks from Period 1 and Period 2 are about the same. The total number of post firing graffiti from Period 1 is only 16 and while some of the graffiti are simple lines and designs that are not much different than the pre-firing motifs, others appear to be more complex and involve up to three combined symbols (Figure 5). During Period 2, there are 175 graffiti that include some relatively simple signs, but also more examples of multiple signs combined together. Perhaps the most important discovery from both the Period 1 (Figure 6a) and Period 2 (Figure 6b) is the discovery of the sign that later becomes the most common script sign of the Indus script, i.e. Mahadevan sign "342" (Figure 3). Furthermore, this sign is also combined with another sign (Mahadevan sign 347) in a sequence that also appears in later Indus seals and numerous inscriptions (Figure 7). Most of the inscribed pottery and all seals and other inscribed objects from the recent excavations at Harappa have been published in the major volumes edited by Asko Parpola and his colleagues (Shah and Parpola 1991; Parpola *et al.* 2010). The remaining objects founds since the last publication are being prepared for publication in the near future.

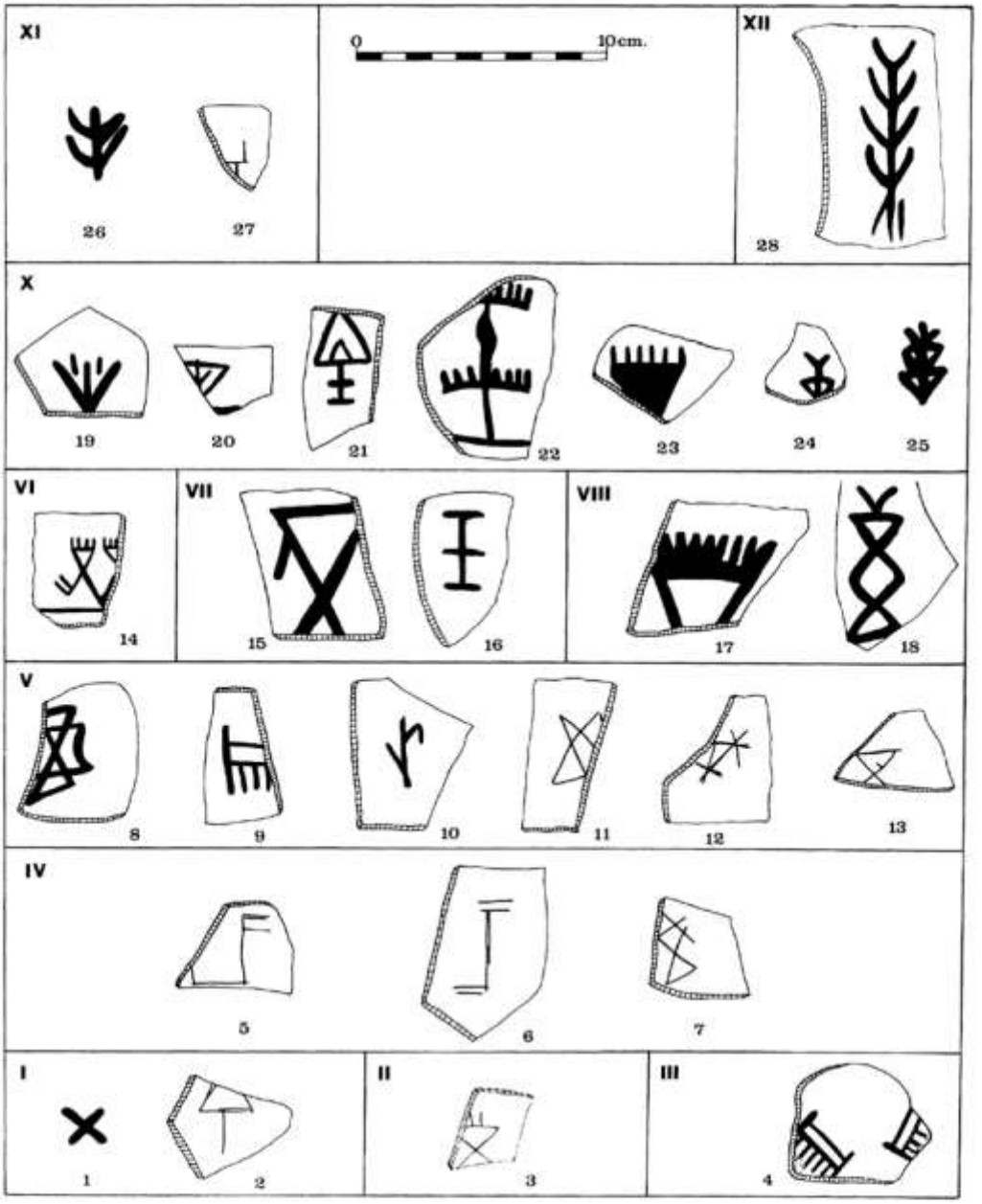


Figure 4. Balakot Potter's Marks, Graffiti and Painted motifs (from Dales 1974, Fig. 11)

Figure 5. Harappa, Ravi and Kot Diji Phase Potter's marks and post-firing graffiti

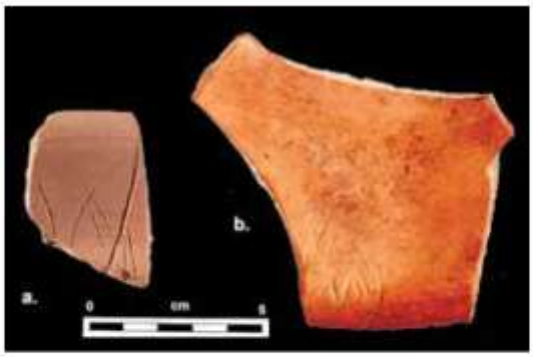


Figure 6. Harappa, a. Ravi sherd with graffiti (H98/8440-202), b. Kot Diji sherd (H99-4367/8946-37)

Figure 7. Harappa, Unicorn seal with Indus Script (H96-2736/7134-01)

Table 3. Harappa, All Phases, Potter's Marks and Graffiti

Harappa Graffiti	Total	%
Period 1, Ravi Phase	23	1.89%
Period 1/2	7	0.57%
Period 2, Kot Diji Phase	224	18.39%
Period 2/3	19	1.56%
Period 3, Harappa Phase	941	77.26%
Period 4/5, Late Harappa Phase	4	0.33%
Total	1218	100.00%

Table 4. Harappa, Period 1 and 2, Potter's Marks and Graffiti

Harappa Graffiti	Total	%
Ravi Phase		
Period 1 Pre Firing	7	30.43%
Period 1 Post Firing	16	69.57%
Total	23	100.00%
Kot Diji Phase		
Period 2 Pre Firing	49	21.88%
Period 2 Post Firing	175	78.13%
Total	224	100.00%

Conclusion

Based on the brief discussion presented above I feel that the evidence for a longer period of Indus script development is justified and encourage more extensive excavations of Early Harappan sites in order to increase the sample of early writing on pottery and other objects. More detailed recording and quantification of pre-firing and post-firing marks on pottery and other objects is needed to better understand the developments of these symbols in each major region of the greater Indus Valley.

It is not unlikely that once we have increased our data base it will be possible to link some specific signs to different regions and show how they came to play a role in the overall development of the writing system. The study of changes in the Indus script during the Harappa Phase is also something that needs more work. Future advances in the study of the Indus writing system and its development will only be accomplished through continued collaborations and publication of the data in ways that are easily accessible to interested scholars.

Acknowledgements

I would first like to thank the National Fund for Mohenjo Daro as well as the Culture, Tourism and Antiquities Department, Government of Sindh and all the people who were involved in organizing this conference for their invitation and hospitality. Special thanks to Dr. Kaleemullah Lashari and his staff for all their hard work to make this conference a success. I would especially like to thank the Department of Archaeology and Museums, Government of Pakistan, for letting me study materials at Harappa and other museums in Pakistan. I also wish to thank all the colleagues who have participated in the research at Harappa and have helped to collect and analyze data. In addition I want to thank the Archaeological Survey of India and all my colleagues in India who have been generous with their materials and shared their ideas with me. My ongoing research at Harappa and the Indus Valley Civilization has been supported by numerous organizations: the National Science Foundation, the National Endowment for the Humanities, the National Geographic Society, the Smithsonian Institution, the American School of Prehistoric Research (Peabody Museum of Archaeology and Ethnology, Harvard University), the University of Wisconsin, www.HARAPPA.com and private donors.

Bibliography

Bagley, R. W. 1999. Shang Archaeology. In *The Cambridge History of Ancient China: From the Origins of Civilization to 221 B.C.*, edited by M. Loewe and E. L. Shaughnessy, pp. 124-231. Cambridge, Cambridge University Press.

Baines, J. 2004. The earliest Egyptian writing: development, context, purpose. In *The First Writing: Script Invention as History and Process*, edited by S. Houston, pp. 150-189. Cambridge, Cambridge University Press.

Boltz, W. G. 1986. Early Chinese Writing. *World Archaeology* 17(3): 420-436.

Boltz, W. G. 2000. The Invention of Writing in China. *Oriens Extremus* 42: 1-17.

Casal, J. M. 1961. *Fouilles de Mundigak, Volume I: Texte*. Paris, Librairie C. Klincksieck.

Casal, J. M. 1961. *Fouilles de Mundigak, Volume II: Figures et Planches*. Paris, Librairie C. Klincksieck.

Casal, J. M. 1964. *Fouilles D'Amri*. Paris, Commission des Fouilles Archaeologiques.

Cooper, J. S. 2004. Babylonian Beginnings: the origin of the cuneiform writing system in comparative perspective. In *The First Writing: Script Invention as History and Process*, edited by S. Houston, pp. 71-99. Cambridge, Cambridge University Press.

Dales, G. F. 1974. Excavations at Balakot, Pakistan 1973. *Journal of Field Archaeology* 1(1-2): 1-22.

Damerow, P. 2006. The Origins of Writing as a Problem of Historical Epistemology. *Cuneiform Digital Library Journal* 1: 1-10.

Durrani, F. A. 1976. Excavations at Rehman Dheri, Department of Archaeology, University of Peshawar.

Durrani, F. A. 1986. *Rehman Dheri and the Origins of Indus Civilization* Ph D. Dissertation, Temple University.

Fairservis, W. A. 1956. Excavations in the Quetta Valley, West Pakistan. *Anthropological Papers of the American Museum of Natural History* 45 (part 2).

Fairservis, W. A. 1959. Archaeological Surveys in the Zhob and Loralai Districts, West Pakistan. *Anthropological Papers of the American Museum of Natural History* 47 (part 2).

Fairservis, W. A. J. 1983. *The Hierakonpolis Project, No. II, Hierakonpolis - The Graffiti and the Origins of Egyptian Hieroglyphic Writing*. Poughkeepsie, NY, Vassar College.

Franke-Vogt, U. 2001. *Balakot Periode I: Kulturelle Interaktion und Integration in Südostbalochistan während der Früh-Harappazeit (ca. 3100-2600 v.Chr.)* Habilitationsschrift, Freien Universiträt, Berlin.

Gadd, C. J. 1931. Sign-List of Early Indus Script. In *Mohenjo-daro and the Indus Civilization: Being an official account of Archaeological Excavations at Mohenjo-daro carried out by the Government of India between the years 1922 and 1927*, edited by J. Marshall, pp. 406-414. London, A. Probsthain.

Haicheng, W. 2015. Writing and the city in early China. In *Early Cities in Comparative Perspective: 4000 BCE - 1200 CE*, edited by N. Yoffee, pp. 131-157. Cambridge, Cambridge University Press.

Hargreaves, H. and S. Sewell 1929 (reprint 1981). *Excavations in Baluchistan Sampur Mound, Mastung and Sohr Damb, Nal.* New Delhi, Cosmo Publications.

Jarrige, J.-F. 1991. Mehrgarh: Its Place in the Development of Ancient Cultures in Pakistan. In *Forgotten Cities on the Indus*, edited by M. Jansen, M. Mulloy and G. Urban, pp. 34-49. Mainz am Rhein, Phillip von Zabern.

Keightley, D. N. 1989. The Origins of Writing in Ancient China: Scripts and Cultural Contexts. In *The Origins of Writing*, edited by W. Senner, pp. 171-202. Lincoln, University of Nebraska Press.

Kenoyer, J. M. 2006. The Origin, Context and Function of the Indus Script: Recent Insights from Harappa. In *Proceedings of the Pre-symposium and the 7th ESCA Harvard-Kyoto Roundtable*, edited by T. Osada and N. Hase, pp. 9-27. Kyoto, Research Institute for Humanity and Nature, RIHN.

Kenoyer, J. M. 2009. Indus Seals: An overview of Iconography and Style *Ancient Sindh* 9 (2006-2007): 7-30.

Kenoyer, J. M. 2015. The Archaeological Heritage of Pakistan: From the Palaeolithic to the Indus Civilization. In *History of Pakistan*, edited by R. Long, pp. 1-90. Karachi, Oxford University Press.

Kenoyer, J. M. 2020. The Indus Script: Origins, Use and Disappearance. In *Dialogue of Civilisation: Comparing Multiple Centers*, edited by H. Zhao, pp. in press. Shanghai, Shanghai Guji Press.

Kenoyer, J. M. and R. H. Meadow 1997. New Inscribed Objects From Harappa. *Lahore Museum Bulletin* IX(1 (1996)): 1-20.

Kenoyer, J. M. and R. H. Meadow 2000. The Ravi Phase: A New Cultural Manifestation at Harappa. In *South Asian Archaeology 1997*, edited by M. Taddei and G. De Marco, pp. 55-76. Rome/Naples, Istituto Italiano per l'Africa e l'Oriente/Istituto Universitario Orientale.

Kenoyer, J. M. and R. H. Meadow 2008. The Early Indus Script at Harappa: Origins and Development. In *Intercultural Relations between South and Southwest Asia. Studies in Commemoration of E. C. L. During-Caspers (1934-1996)*, edited by E. Olijdam and R. H. Spoor, pp. 124-131. Oxford, BAR International Series 1826.

Kenoyer, J. M. and R. H. Meadow 2010. Inscribed objects from Harappa Excavations: 1986-2007 In *Corpus of Indus Seals and Inscriptions, Vol. 3. New Material, untraced objects, and collections outside India and Pakistan, Annales Academiae Scientiarum Gennicae*, edited by A. Parpola, B. M. Pande and P. Koskikallio, pp. xliv-lviii. . Helsinki, Suomalainen Tiedeakatemia.

Khan, F. A. 1964. Excavations at Kot Diji. *Pakistan Archaeology* no. 1: 39-43.

Khan, F. A. 1965. Excavations at Kot Diji. *Pakistan Archaeology* no. 2: 13-85.

Khatri, J. S. and M. Acharya 1997. Kunal: The Earliest Pre-Harappan Settlement. In *Facets of Indian Civilization Recent Perspectives-Essays in Honor of B.B. Lal-*, edited by J. P. Joshi, pp. 87-91. New Delhi, Aryan Books International.

Khatri, J. S. and M. Acharya 2005. Kunal Excavations: New Light on the Origin of the Harappan Civilization. In *In Search of Vedic Harappan Relationship*, edited by A. Agrawal, pp. 104-117. New Delhi, Aryan Books International.

Lal, B. B. 1962. From the megalithic to the Harappan: tracing back the graffiti on the pottery. *Ancient India* 16 (1960): 4-24.

Lal, B. B. 1975. The Indus Script: Some Observations Based on Archaeology. *Journal of the Royal Asiatic Society*: 173-177.

Lal, B. B. 1979. On the Most Frequently Used Symbol in the Indus Script. *East and West* 29(1/4): 27-35.

Lal, B. B., B. K. Thapar, J. P. Joshi and M. Bala 2003. *Excavations at Kalibangan: the Early Harappans (1960-1969) (Memoirs of the ASI, No. 98)*. New Delhi, Archaeological Survey of India.

Mahadevan, I. 1977. *The Indus Script: Texts, Concordance and Tables*. New Delhi, Archaeological Survey of India.

Mahadevan, I. and M. V. Bhaskar 2018. Toponyms, Directions and Tribal Names in the Indus Script. In *Walking with the Unicorn: Social Organization and Material Culture in Ancient South Asia. Jonathan Mark Kenoyer Felicitation Volume*, edited by D. Frenez, G. Jamison, R. Law, M. Vidale and R. H. Meadow, pp. 359-376. Oxford, Archaeopress Archaeology.

Majumdar, N. G. 1934. Explorations in Sind: Being a report of the exploratory survey carried out during the years 1927-28, 1929-30 and 1930-31. *Memoirs of the Archaeological Survey of India* 48.

Marshall, J. H. 1931. *Mohenjo-daro and the Indus Civilization: Being an official account of Archaeological Excavations at Mohenjo-daro carried out by the Government of India between the years 1922 and 1927*. London, A. Probsthain.

Meadow, R. H. and J. M. Kenoyer 2005. Excavations at Harappa 2000-2001: New insights on Chronology and City Organization. In *South Asian Archaeology 2001*, edited by C. Jarrige and V. Lefèvre, pp. 207-225. Paris, Editions Recherche sur les Civilisations - ADPF.

Michalowski, P. 1996. Mesopotamian Cuneiform: Origins. In *The World's Writing Systems*, edited by P. T. Daniels and W. Bright, pp. 33-36. New York, Oxford University Press.

Mughal, M. R. 1970. *The Early Harappan Period in the Greater Indus Valley and Northern Baluchistan* PhD, University of Pennsylvania, Dept. of Anthropology.

Nissen, H. J. 1993. The Context of the Emergence of Writing in Mesopotamia and Iran. In *Early Mesopotamia and Iran: Contact and Conflict 3500-1600 B. C.*, edited by J. Curtis, pp. 54-71. London, British Museum Press.

Parpola, A. 1994. *Deciphering the Indus Script*. Cambridge, Cambridge University Press.

Parpola, A. 1994. Indus Script. In *The Encyclopedia of Languages and Linguistics*, edited by R. E. Asher and J. M. Y. Sipson, pp. 1669-1670. Oxford, Pergamon Press.

Parpola, A. 2008. Is the Indus Script indeed not a writing system? In *Airavati: Felicitation volume in honour of Iravatham Mahadevan*, edited by Varalaaru.com, pp. 111-131. Chennai, Varalaaru.com.

Parpola, A., B. M. Pande and P. Koskikallio, Eds. 2010. *Corpus of Indus Seals and Inscriptions, Vol. 3. New Material, untraced objects, and collections outside India and Pakistan*. Memoirs of the Archaeological Survey of India, No. 96, Annales Academiae Scientiarum Gennicae 359. Helsinki, Suomalainen Tiedeakatemia.

Possehl, G. L. 1990. Revolution in the Urban Revolution: The Emergence of Indus Urbanism. *Ann. Rev. Anthro.*
Annual Review of Anthropology 19: 261-282.

Possehl, G. L. 1994. *Radiometric Dates for South Asian Archaeology*. Philadelphia, University of Pennsylvania Museum,.

Possehl, G. L. 1996. *Indus Age: The Writing System*. New Delhi, Oxford and IBH Pub. Co.

Potts, D. T. 1981. The Potter's Marks of Tepe Yahya. *Paléorient* 7(1): 107-122.

Quivron, G. 1980. Les marques incisées sur les poteries de Mehrgarh au Baluchistan, du milieu du IVe millénaire à la moitié du IIIe millénaire. *Paléorient* 6: 269-280.

Quivron, G. 1997. Incised and Painted Marks on the Pottery of Mehrgarh and Nausharo-Baluchistan. In *South Asian Archaeology 1995*, edited by B. Allchin and R. Allchin, pp. 45-62. New Delhi, Oxford & IBH.

Rao, R. P. N. 2018. 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*, edited by D. Frenez, G. Jamison, R. Law, M. Vidale and R. H. Meadow, pp. 518-525. Oxford, Archaeopress Archaeology.

Shaffer, J. G. 1992. The Indus Valley, Baluchistan and Helmand Traditions: Neolithic Through Bronze Age. In *Chronologies in Old World Archaeology (3rd Edition)*, edited by R. Ehrich, pp. 441-464. Chicago, University of Chicago Press.

Shah, S. G. M. and A. Parpola 1991. *Corpus of Indus Seals and Inscriptions. 2. Collections in Pakistan*. Helsinki, Suomalainen Tiedeakatemia.

Stein, M. A. 1929. An Archaeological Tour in Waziristan and Northern Baluchistan. *Memoirs of the Archaeological Survey of India* 37.

Stein, M. A. 1931. An Archaeological Tour of Gedrosra. *Memoirs of the Archaeological Survey of India* 43.

Stein, S. A. 1942. Survey Of Ancient Sites Along The "Lost" Sarasvati River. *The Geographical Journal* XCI(4): 173-182.

Vats, M. S. 1940. *Excavations at Harappa: Being an Account of Archaeological Excavations at Harappa Carried Out Between the Years of 1920-21 and 1933-34*. Delhi, Government of India Press.

Vidale, M. 2007. The Collapse Melts Down: A Reply to Farmer, Sproat, and Witzel. *East and West* 57(1-4): 333-366.

Wells, B. 1998. *An Introduction to Indus Writing* Master of Arts, University of Calgary.

Yadav, N., H. Joglekar, R. P. N. Rao, M. N. Vahia, R. Adhikari and I. Mahadevan 2012. Statistical Analysis of the Indus Script using N-grams. *PLoS One* 5(3 (http://dx.plos.org/10.1371/journal.pone.0009506)).

Mirrored signs. Administrative and scriptorial information in the Indus Civilization clay sealings

Dennys Frenez

Introduction

This paper summarizes the results of different studies that I conducted over the past ten years on Indus Civilization stamp seals and their impressions on clay for administrative purposes (Frenez and Tosi 2005; Frenez *et al.* 2016), with specific reference to their impact on our understanding of the Indus Script and its spheres of use.

Clay sealings are fundamental to understand several aspects of the social-economic organisation of the Indus Civilization. In fact, they allow understanding the main function and significance of stamp seals and other key-objects in the Indus society. Clay sealings can provide direct information about the Indus storage technology, including the types of lockers used to secure rooms and moveable containers. Moreover, by comparisons with better-known contexts in the Middle East, they allow to eventually infer information about the administrative organisation and bureaucratic procedures used to manage storerooms and goods controlled at a centralised level (Fiandra 1975; Ferioli and Fiandra 1983, 2000; Frangipane *et al.* 2007). In the research about the Indus Civilization, the study of seal impression throws light also on the use of the still undeciphered writing system developed in the Indus Valley during the first half of the third millennium BC (Mahadevan 1977; Parpola 1994; Wells 2015).

Notes on seal-based administration in antiquity

The formalised administrative management of rooms and goods was introduced to expand the economic control beyond kinship groups. Seals and their impressions on clay allowed, in fact, the bureaucratic formalisation of multi-tiered transversal associations (Frangipane *et al.* 2007). In the Middle East, a seal-based administrative technology was first used by the late Neolithic communities during the seventh millennium BC to control the redistribution of goods kept in communal storehouses. In the Neolithic communities of northern Syria, clay sealings were found inside collective storage buildings, while seals were in kept in private houses (Akkermans and Duistermaat 1997, 2004).

The social-economic stratification of the society occurred in the region during the following millennia completely changed the function of seals and clay sealings. In the Early Bronze Age, seal-based administration became, in fact, a powerful instrument used by the new centralised hierarchical structures of power to control the accumulation and redistribution of different resources, especially human workforce (Frangipane 2000, 2016). Both sealings and seals were then used inside predominant large houses, which soon developed into palaces and temples, indicating the presence of a hierarchical bureaucracy at the service of a local governor for the local administrative control of rooms and goods (Frangipane 1996).

Large clusters of clay sealings are quite a frequent discovery in Bronze Age sites throughout the entire wider Middle East (Fiandra 1982). In exceptional cases, they were found by several thousand, i.e. at the Minoan site of Phaistos in south-central Crete and the Uruk site of Arslantepe in Eastern Anatolia (Akkermans and Duistermaat 1997, 2004; Fiandra 1975; Weingarten 1986; Frangipane *et al.* 2007). The detailed study of the lockers and containers that were sealed, the frequent discovery of the seals used to stamp them, and chemical analysis of the clays used for sealing demonstrated that the seal-based administration system was not used to secure the integrity of shipped packages, but rather to manage and record the access to goods stored within storehouses under the responsibility of specific bureaucrats working under a centralized hierarchical institution, based either on kinship bonds or a political organization (Duistermaat and Schneider 1998; Fragipane *et al.* 2007; Pittman and Blackman 2016).

This fundamental concept was often neglected or misunderstood in most old works about the stamp seals and clay sealings found at Indus Civilization sites (Possehl 1996). A project is ongoing by the author, in collaboration with Jonathan Mark Kenoyer and Randall W. Law from the University of Wisconsin–Madison, to study of the clay sealings found by the Maharaja Sayajirao University of Baroda at the Indus Civilization sites of Nagwada, Bagasra and Shikarpur in Gujarat. The geochemical composition of the clays used for the administrative sealing of rooms and containers will be compared to those of clays exploited to produce artefacts that were presumably made locally, such as bangles, bricks, terracotta cakes, etc., using Instrumental Neutron Activation Analysis (INAA).

Pending scientific confirmation yet, there is, however a direct but robust indication for a comparable use of the seal-based administration also in the Indus Civilization. Asko Parpola (2007: 6–7 and figs. 1-4) noticed, in fact, that two of the seals found at the site of Lothal were used to stamp three of the clay sealings found in the same site: ivory seal L-6 stamped clay tags L-201 and L-208, while fired steatite seal L-37 stamped clay tag L-210 (Figure 1). This evidence most likely testifies to the use, also in the Indus Civilization, of seals and sealings mainly for the local management of goods and not for securing the shipping of packages.

Figure 1. Lothal (Gujarat, India). Clay sealings and seals that stamped them for the administrative control of rooms and containers (photographs by D. Frenez, courtesy ASI).

Seals and sealings in the Indus Civilization

Despite the frequent discovery of different types of stamp seals, in the Indus Civilization clay sealings are not as frequent as in the Middle East. This evidence led to many speculations about the actual use of seals and sealings in the Indus Civilization.

According to Maurizio Tosi (1991: 116–117):

«For the archaeologist, clay sealings represent a uniquely direct source of information on such administrative procedures as the control of storage and shipment of merchandise throughout the Middle East in the 3rd and 2nd millennium BC. Literally thousands of them have been found across Southwestern Asia, from Nubia to Anatolia and from Syria to Afghanistan. [...] With a ratio close to 10:1 of seals to sealings, the Indus Civilization is radically different from all other countries in the Middle East that had adopted the use of seals. Since there is no technical reason to explain the scarcity of sealings in all excavations, one has to conclude that seals in the Indus Valley did not serve the same functions as elsewhere»

This hypothesis was further stressed by Gregory L. Possehl (1996: 26):

«Indus seal may not have been used to make huge numbers of impressions, which in turn suggests that they may have been used primarily as a visual identification. The seal itself, not the impression, was most frequently shown. It identified or gave some form of legitimacy to the bearer. [...] The notion that a seal-based administration was needed for the operation of the Harappan political economy comes into doubt from this perspective as well. The usual typology includes many objects in the seal category because of their form, not their function»

However, the handful of clay sealings published in the first excavation reports of Mohenjo-Daro and Harappa already provided the image of a very sophisticated and advanced administrative technology that might not have developed from an occasional use and without firmly established bureaucratic protocols. The first clay sealings found at Mohenjo-Daro included, in fact, one clay tag with multiple impressions of different square and rectangular inscribed seals and another tag stamped twice by the same seals, but inscribed with Indus signs scratched on its back once it was removed from the container that was sealed (Joshi and Parpola 1987: 104–105, M-425, M-426) (Figure 2).

Figure 2. Mohenjo-Daro (Sindh, Pakistan). Clay sealings with multiple impressions of different seals and inscribed on the backside once removed from the container they sealed (from Joshi and Parpola 1987).

Enrica Fiandra (personal communication, 2005), who literally invented the modern method for documenting and interpreting clay sealings and personally studied dozens of thousands of such finds from sites in Italy, North Africa, Egypt, Crete, Anatolia and Iran, admitted that she never saw clay sealings so small, carefully shaped and stamped, and morphologically complex like those from the Indus site of Lothal in Gujarat. So, why do not we have clusters of clay seals from Indus Civilization sites comparable to those found at contemporaneous sites in the Near East? Are we left with the tip of the iceberg only or are there more complex reasons?

Most likely, many of them were not identified during the old excavations or were not preserved due to unfavourable taphonomic and post-depositional processes. It is noteworthy to mention that the largest clusters of clay sealings ever found in the Near East were discovered inside buildings destroyed by major fire events, like at the

Neolithic settlement of Tell Sabi Abyad in northern Syria, in the Minoan palaces of Phaistos and Knossos on Crete, and in the Late Uruk palace of Arslantepe in eastern Anatolia (Akkermans and Duistermaat 1997, 2004; Fiandra 1968, 1975; Ferioli *et al.* 2007; Weingarten 1986). Moreover, Enrica Fiandra (1975: note 57), reported that, once removed from the device they secured, some of the clay sealings found at Phaistos underwent a short intentional heating process between 70 and 100 °C, since geochemical analysis has shown that water content in the clay was much lower than the average but not totally eliminated.

With such premises, the fact that the most ancient clay sealing ever discovered in an Indus site was found discarded in a hearth at Harappa and that the cluster of about seventy clay sealings found at Lothal, the largest so far in the Indus Valley, came from the burnt «warehouse» may not be causal (Kenoyer and Meadow 2008; Frenez and Tosi 2005). The low number of clay sealings found at Indus Civilization sites should be, therefore, evaluated also based on the fact that, according to Ernest Mackay (1938: 276), «evidence for houses having been burnt out is extremely rare (at Mohenjo-Daro) and accidental fires were carefully guarded against». If not intentionally heated or accidentally burnt, small clay sealings were probably too brittle to survive the anthropic and natural sedimentation or even to be recognised and preserved with the excavation methods of the 1930s. According to Ernest Mackay (1943: 149–150), the few clay sealings retrieved at Chanhu-Daro «being imperfectly fired [...] dissolved in the water in which they were being cleaned». Most recently, the sixty clay sealings discovered at Dholavira were not found during the actual excavation activities but recovered from the later sieving (V. N. Prabhakar, personal communication 2014).

In any case, even considering the possible influence of exceptional depositional and post-depositional events, the available numbers, i.e. clusters of several thousand at Bronze Age sites in the Near East versus less than hundred in the Indus Valley, still point to the possible existence of basic differences between the bureaucratic systems and the administrative and storage technologies used in the two regions.

Seal-based administrative procedures

The detailed morphological and functional study of the clay sealings found at the Indus Civilisation sites allows inferring important information about the rooms that were sealed, either structures or moveable containers, and the physical devices and bureaucratic procedures used to administratively secure them. In the Indus Civilization, stamp seals were, in fact, used for the administrative management and record of rooms, containers and goods, but also to produce terracotta tokens to likely provide their users with the same rights and privileges of the original seal owner, to stamp ceramic containers before their firing, and to seal the clay coating of multi-element firing systems used in complex pyrotechnological processes for the

production of particular objects (Halim and Vidale 1984; Frenez and Tosi 2005) (Figure 3). This paper considers the first two types even if some general assumption on the functioning of seals and writing in the Indus Civilization can be extended to all categories.

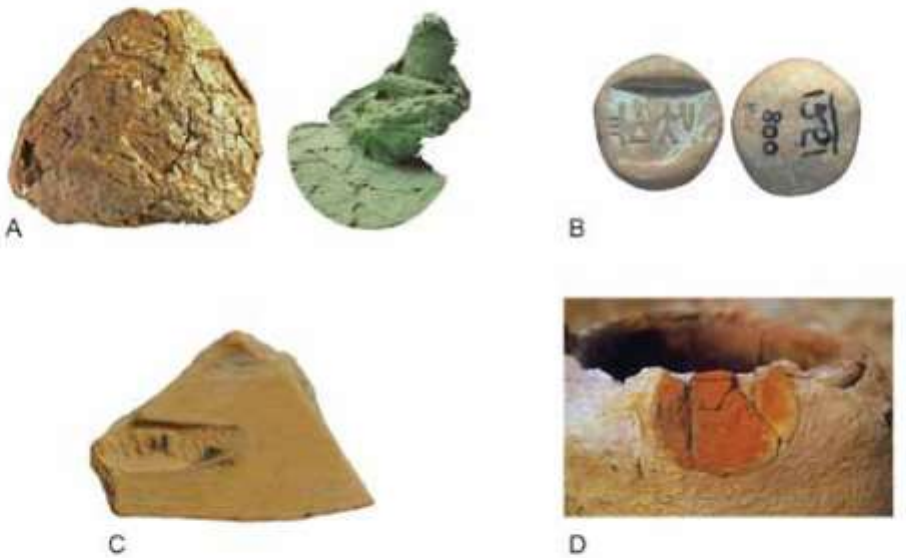


Figure 3. Various types of sealed objects: A) Clay sealing for the administrative control of a door (Bagasra, Gujarat, India); B) Terracotta token with the impression of a standard Indus seal (Dholavira, Gujarat, India); C) Pottery jar stamped with an Indus-inscribed tablet before its writing (Salut ST1, Sultanate of Oman): D) Sealing of the clay coating of a composite jar for the firing of stoneware bangles (Mohenjo-Daro, Sindh, Pakistan) (photographs by D. Frenez and M. Vidale, courtesy ASI, IMTO, IsMEO).

In the Indus Civilization, clay lumps applied on locking devices of rooms and containers were sealed for administrative purposes by impressing one or more times standard square seals with the a main icon below a short inscription in Indus scriptorial signs (Frenez 2018), but also rectangular bar seals with a longer inscription only, seals with geometric designs, and inscribed shaped tablets. While the adoption of the standard square seals at the primary sealing device was to be expected (Figure 4), the use within the same context of a few rare geometric seals is interesting because they were also used to seal doors (Frenez and Tosi 2005: 82 and fig. 3, L-173 and L-175) (Figure 5), which is usually considered be a prerogative of the highest bureaucratic level of control in a hierarchical administrative system (Frangipane *et al.* 2007). The use of miniaturistic inscribed tablets for sealing is instead relevant for the study of both the administrative technology and the writing system of the Indus Civilization (Frenez and Tosi 2005: 77–78, L-209) (Figure 6). According to Asko Parpola, «most of these tablets, both the embossed and the engraved ones, may have functioned as

tokens of votive offerings or of visits to temples» (Joshi and Parpola 1987: xvi, cf. Mackay 1938: 349–351), implying that the inscription was carved in positive to be correctly read directly from the object. Although exceptional, their utilisation to stamp clay lumps for administrative purposes points to the need of considering that the signs on some of them might have been carved specularly to be read correctly only once impressed on clay.

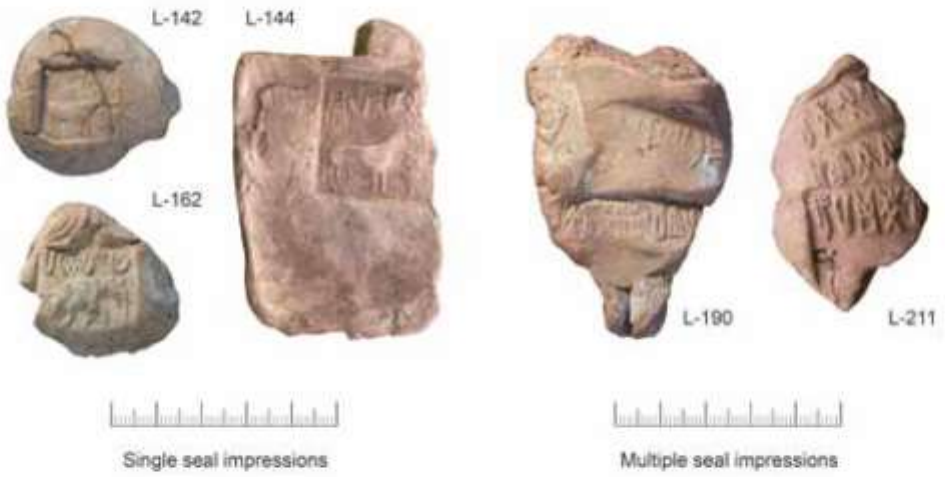


Figure 4. Lothal (Gujarat, India). Clay sealings stamped with standard Indus seals (photographs by D. Frenez, courtesy ASI).

The comprehensive study of the clay sealing found at the Indus Civilization site of Lothal, in Gujarat, proved that one stamp seal could have been used to secure different types of containers, alone or in combination with other seals on the same tag. In fact, about one-third of the clay sealing found at Lothal retain multiple impressions of up to five different seals (see, Figure 4). For the moment, no clear patterns emerged in the use of seals within the Indus administrative system: the same seals were used, in fact, to stamp both single and multiple-impressed clay tags in variable associations with other seals and to secure different containers (Table 1). Perhaps, they indicated the sharing of ownership or, most probably, of storage space or administrative duties on the control of specific containers and stored goods (Frenez and Tosi 2005: 84–85).

Figure 5. Lothal (Gujarat, India). Clay sealings stamped with geometric seals (photographs by D. Frenez, courtesy ASI).

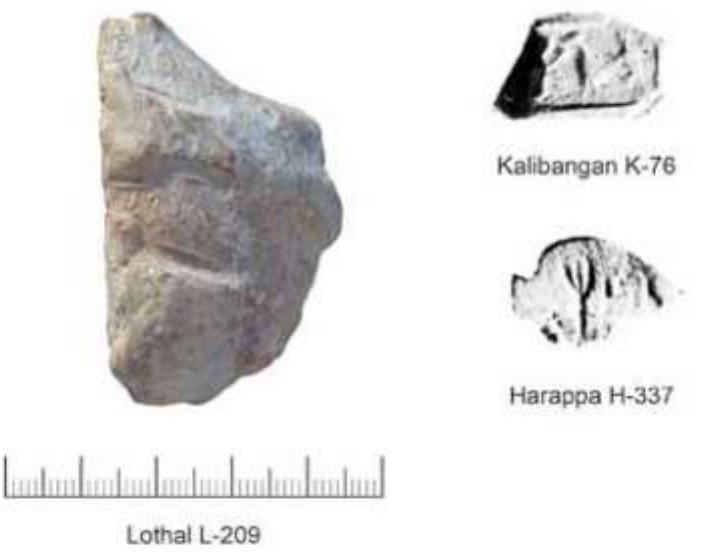


Figure 6. Lothal (Gujarat, India). Clay sealing stamped with an inscribed shaped tablet (photographs by D. Frenez, courtesy ASI, Joshi and Parpola 1987).

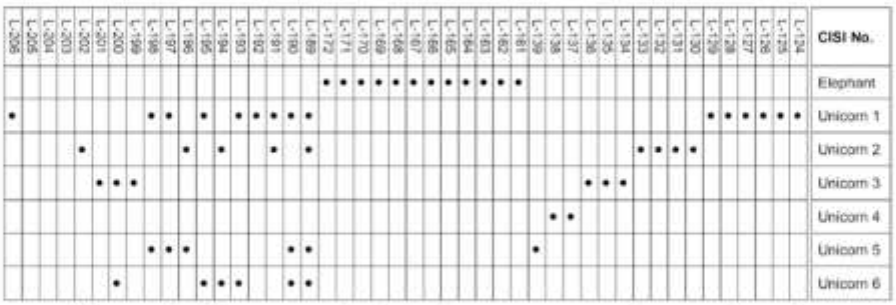


Table 1. Lothal (Gujarat, India). Seals stamping more than one clay sealing.

Interestingly, almost all clay sealings stamped using standard Indus seals had the inscription well readable, while the animal icon was rarely recognisable in its entirety, covered by other impressions, obliterated by fingerprints or simply not impressed (Figure 7). This evidence cannot merely be the result of a fragmentary state of preservation. In fact, this trend is evident also in entire specimens. Moreover, in the case of taphonomic or post-depositional interferences, there should also be a comparable statistical occurrence of fragments with the animal icon only, which are instead almost not present (Figure 8). Apparently, in the administrative system of the Indus Civilization, the inscription on the stamp seals had a central role, while the iconography was not equally important or, in any case, it was subordinate to the inscription and possibly used mainly for direct visual identification.

Storage technology

A central part of in the study of the clay sealings found at Lothal was the reconstruction and understanding of the locking devices and containers that were managed. For this purpose, inert silicone resinswere used to create precise impressions of the back and lateral surfaces of the clay sealings in order to reproduce the sealed surfaces (Frenez 2017).

The functional study of the clay sealings has been often limited by the rather small number of available specimens, which did not allow the creation of a statistically significant typology, by the small size of most clay sealings documented, which retain the impression of only a small portion of the sealed elements, but most of all by the apparent uniqueness and great complexity of the locking devices and containers they sealed. In some cases, it was therefore possible to provide only a morphological description of the clay sealings, speculating about the actual object they sealed (Table 2 and Figure 8).

Figure 7. Lothal (Gujarat, India). Clay sealings with multiple impressions of different seals (photographs by D. Frenez, courtesy ASI, Joshi and Parpola 1987).

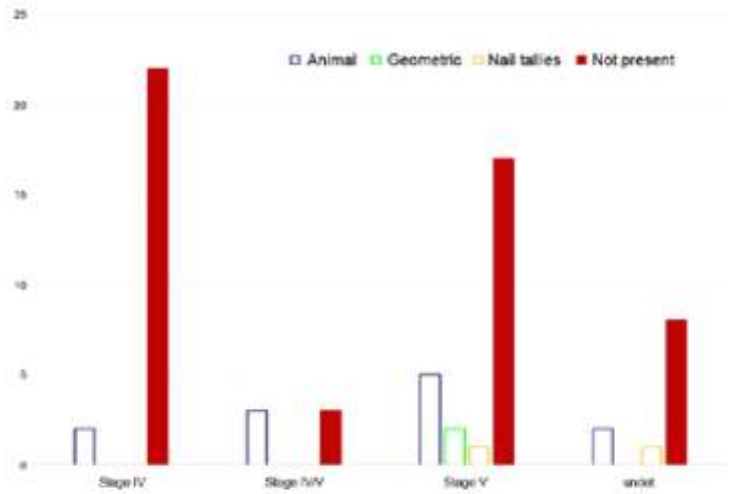


Figure 8. Dholavira (Gujarat, India). Type of iconography stamped on seal-impressed clay tags according to the different occupation stages.

CISI No.	Impressions	Pegs-on-wall	Locker	Structure	Parallel reeds	Wooden box	Pottery jar	Leather sack	Basket	Single rope	Other types	Undiagnostic
L-124	1										●	
L-125	1					●						
L-126	1							●				
L-127	1											●
L-128	1											●
L-129	1						●					
L-130	1			●								
L-131	1											●
L-132	1											●
L-133	1						●					
L-134	1				●							
L-135	1						●					
L-136	1		●									
L-137	1						●					
L-138	1			●								
L-139	1						●					
L-140	1				●							
L-141	1			□								
L-142	1					●						
L-143	1					?						
L-144	1		●									
L-145	1			□								
L-146	1				□							
L-147	1						●					
L-148	1		?									
L-149	1		?									
L-150	2		□									
L-151	1										?	
L-152	1	●										
L-153	1											□
L-154	1	●										
L-155	1	?										
L-156	2											?
L-157	1	●										
L-158	1		●									
L-159	1						●					
L-160	1											●
L-161	1					●						
L-162	1					●						
L-163	1					●						
L-164	1					●						
L-165	1					●						
L-166	1					●						
L-167	1					●						
L-168	1					●						
L-169	1					●						
L-170	1					●						

Table 2 (Part 1): Lothal (Gujarat, India). Containers and structures sealed by seal-stamped clay tags with indication of the discovery context: ● Warehouse; □ Other context; ? Unknown context

CISI No.	Impressions	Pegs-on-wall	Locker	Structure	Parallel reeds	Wooden box	Pottery jar	Leather sack	Basket	Single rope	Other types	Undiagnostic
L-171	1					●						
L-172	1					●						
L-173	1	●										
L-174	1						□					
L-175	1	●										
L-176	1						●					
L-177	1						●					
L-178	1											?
L-179	1	●										
L-180	1				●							
L-181	1						?					
L-182	1											?
L-183	1											?
L-184	1											?
L-185	1											?
L-186	1						●					
L-187	1						?					
L-188	3						?					
L-189	4			●								
L-190	3			●								
L-191	2			●								
L-192	2	●										
L-193	3			●								
L-194	2						●					
L-195	2						●					
L-196	2						●					
L-197	2						●					
L-198	2			●								
L-199	2											●
L-200	2						●					
L-201	2											●
L-202	2											●
L-203	2											●
L-204	2								?			
L-205	2											□
L-206	2	●										
L-207	2			●								
L-208	2									□		
L-209	2		●									
L-210	2		□									
L-211	3					?						
L-212	2						●					
L-213	2		?									
L-214	2						?					
L-215	5							□				
L-216	2											□

Table 2 (Part 2): Lothal (Gujarat, India). Containers and structures sealed by seal-stamped clay tags with indication of the discovery context: ● Warehouse; □ Other context; ? Unknown context

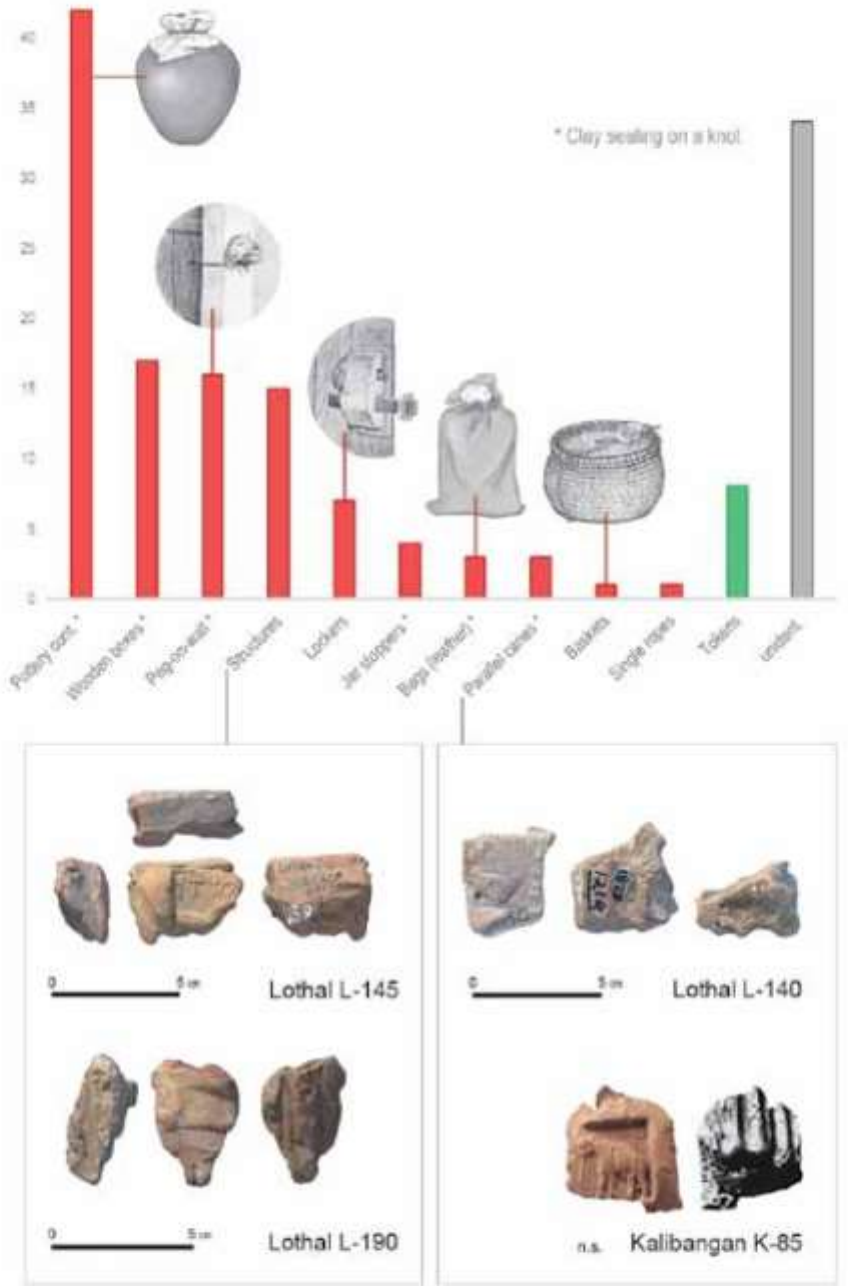


Figure 9. Lothal (Gujarat, India). Containers and structures sealed by seal-stamped clay tags (photographs by D. Frenez, courtesy ASI, Ferioli and Fiandra 1983).

Several elements sealed for administrative purposes in the Indus Civilization can be positively compared with similar locking devices and storage containers reconstructed from clay sealings found at Bronze Age sites in the Middle East (Figure 8, above the graph). Most of them retain, in fact, the impression of strings used to fasten pieces of leather or fabric around the mouth of ceramic containers or tied around wooden pegs fixed in structural frames or walls to close doors of rooms or cabinets. Moreover, different types of lockers, bags and baskets have been identified. Some other types have no parallels instead outside the Indus Valley and it was almost impossible to propose functional interpretations for all of them confidently. At Lothal, clay sealings resulted being often applied on structures with a complex three-dimensional articulation that combined elements made from different materials, possibly including doorframes but also small wooden cages (for examples, see respectively L-145 and L-190 in Figure 8). A few sealings retain on two sides the impression of thin parallel reeds that were possibly part of light structures or a strong packaging (for examples, see L-140 and K-85 in Figure 8). Interestingly, this type of clay sealing was documented also at the Indus site of Kalibangan in Rajasthan (Joshi and Parpola 1987: 316, K-85).

Conclusions

The bureaucratic procedures in use at Indus Civilization sites for the administrative management of goods stored in rooms and movable containers using seal-stamped clay tags seem following the same three-steps protocol reconstructed by archaeologists for the Middle East, where it was developed mainly to manage the accumulation and redistribution of food rations (Frenez and Tosi 2005: 65–66, cf. Ferioli and Fiandra 1989: 566). Clay sealings were, therefore,mainly used also in the Indus Civilization to regulate and record access to specific rooms and containers and to the goods they contained, and not to secure the integrity of shipped packages.

Clay sealings were mainly used for the administrative management of containers, including both rooms and moveable containers, comparable to those reconstructed for the Middle East, but there areal so several storage systems and closing devices unique of the Indus Civilization. About one-third of the clay sealings found at Lothal was stamped with more than one seal to possibly share ownership, storage space or administrative duties.

Considering the much lower occurrence of clay sealings in the Indus Civilization compared to coeval sites in the Middle East, and the use of a rather different storage technology, seal-based administrative procedures were not used at Indus sites for the daily management of food but rather to control the access to items and raw materials of crucial socio-economic and ideological importance within the Indus socio-economic and political sphere.

Acknowledgements

I wish to thank the National Fund for Mohenjodaro, Government of Sindh, for having invited me to present my research in the «International Conference on the Indus Script», with particular reference to Kaleemullah Lashari and Sajid Hussain Khan. Thanks also to the Archaeological Survey of India, Government of India, for the permissions granted to study the clay sealings of Lothal and Dholavira, to the Indian Institute of Technology Gandhinagar for the assistance in documenting the materials from Dholavira (Gujarat), and to the Department of Archaeology and Ancient History of the Maharaja Sayajirao University of Baroda for the materials from Nagwada, Bagasra and Shikarpur (Gujarat). I wish to thank also the Italian Archaeological Expedition in Eastern Anatolia at Arslantepe, in particular Marcella Frangipane, Enrica Fiandra, Alessandra Mezzasalma and Romina Laurito, for having granted me with access to their reference collection of sealings and sealed objects. A special thanks to Jonathan Mark Kenoyer from the University of Wisconsin–Madison, Massimo Vidale, University of Padova, Gianni Marchesi and Maurizio Cattani, University of Bologna, with whom I have to honour to collaborate in several projects and research. Thanks to «Zhermack SpA – Materials for Impressions in Surgery and Laboratory» for having provided me with tools and materials for making impressions of archaeological materials.

Bibliography

Akkermans, P.M.M.G. and K. Duistermaat 1997. Of Storage and Nomads. The Sealings from Late Neolithic Sabi Abyad, Syria. Paléorient 22: 17–44.

Akkermans, P.M.M.G. and K. Duistermaat 2004. More Seals and Sealings from Neolithic Tell Sabi Abyad, Syria. Levant 36: 1–11.

Duistermaat, K. and G. Schneider 1998. Chemical analyses of sealing clays and the use of administrative artefacts at Late Neolithic Tell Sabi Abyad (Syria). Paléorient 24.1: 89–106.

Ferioli, P. and E. Fiandra 1983. Clay sealings from Arslantepe VI A: Administration and bureaucracy. In M. Frangipane and A. Palmieri (eds.), Perspectives on Protourbanization in Eastern Anatolia: Arslantepe (Malatya). An Interim Report on 1975-1983 Campaigns. Rome: La Sapienza – University of Rome, 455–509.

Ferioli, P., E. Fiandra and G.G. Fissore 2000. Research into the Use of Cretulae in Ancient Administrative Systems: Problems regarding Orientation and Methods. In M. Perna (eds.), Administrative Documents in the Aegean and their Near Eastern Counterparts (Naples, 1996) (CIRAAS, 3). Turin: Paravia scriptorium, 353–364.

Fiandra, E. 1975. Ancora a proposito delle cretule di Festòs: Connessione tra i sistemi amministrativi centralizzati e l'uso delle cretule nell'Età del Bronzo. *Bollettino d'Arte* 1-2: 1–25.

Fiandra, E. 1982. L'Archeologia dei sistemi economici. *Le Scienze* 169: 102–112.

Frangipane, M. 2000. The Development of Administration from Collective to Centralized Economies in the Mesopotamian World. In G.M. Feinman and L. Manzanilla (eds), *Cultural Evolution: Contemporary Viewpoints*. Boston, MA: Springer, 215–232.

Frangipane, M. 2016. The development of centralised societies in Greater Mesopotamia and the foundation of economic inequality. In H. Meller (ed.), *Rich and Poor: Competing for resources in prehistoric societies* (Tagungen des Landesmuseums für Vorgeschichte Halle, 14.2). Halle: Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt, 1–22.

Frangipane, M., P. Ferioli, E. Fiandra, R. Laurito and H. Pittman 2007. *Arslantepe Cretulae. An Early Centralised Administrative System Before Writing* (Arslantepe: Scavi e Ricerche ad Arslantepe-Malatya, 5). Rome: La Sapienza – University of Rome.

Frenez, D. 2017. L'impronta del tempo. L'uso di resine siliconiche di derivazione dentistica in Archeologia. *Z-Life Magazine*: 7.

Frenez, D. 2018. Private Person or Public Persona? Use and Significance of Standard Indus Seals as Markers of Formal Socio-Economic Identities. In D. Frenez, G.M. Jamison, R.W. Law, M. Vidale and R.H. Meadow (eds.), *Walking with the Unicorn. Social Organization and Material Culture in Ancient South Asia – Jonathan Mark Kenoyer Felicitation Volume*. Oxford: Archaeopress 166–193.

Frenez, D. and M. Tosi 2005. The Lothal Sealings: Records from an Indus Civilization town at the eastern end of the maritime trade networks across the Arabian Sea. In M. Perna (ed.), *Studi in Onore di Enrica Fiandra. Contributi di Archeologia Egea e Vicinorientale* (Studi Egei e Vicinorientali, 1). Paris: De Boccard, 65–103.

Frenez, D., V.N. Prabhakar and R.S. Bisht 2016. Administrative clay sealing technology from the Indus site of Dholavira (Gujarat, India). Preliminary observations. Paper presented at the European Association for South Asian Archaeology and Art Conference 2016, Cardiff, July 4-8, 2016.

Halim, M.A. and M. Vidale 1984. Kilns, bangles and coated vessels. In M. Jansen and G. Urban (eds.), *Interim Reports, Vol. 1. Reports on field work carried out at Mohenjo-daro, Pakistan 1982-83 by the IsMEO-Aachen University Mission*. Aachen/Rome: Rheinisch-Westfälische Technische Hochschule/Istituto Italiano per il Medio ed Estremo Oriente, 63–97.

Joshi, J.P. and A. Parpola (eds.) 1987. *Corpus of Indus Seals and Inscriptions, Vol. 1. Collections in India* (Annales Academiæ Scientiarum Fennicæ, Series B 239; Memoires of the Archaeological Survey of India, No. 86). Helsinki: Suomalainen Tiedeakatemia.

Mackay, E.J.H. 1938. *Further Excavations at Mohenjo-daro. Being an official account Archaeological Excavations at Mohenjo-daro carried out by the Government of India between the years 1927 and 1931*. New Delhi: Government of India Press.

Mackay, E.J.H. 1943. *Chanhu-daro Excavations 1935-36* (American Oriental Series, Vol. 20). New Haven, CT: American Oriental Society.

Mahadevan, I. 1977. *Texts, Concordance and Tables* (Memoirs of the Archaeological Survey of India, 77). New Delhi: Archaeological Survey of India.

Parpola, A. 1994. *Deciphering the Indus Script*. Cambridge: Cambridge University Press.

Parpola, A. 2007. Seal impressions on the clay tags from Lothal. A re-analysis. In T. Osada (ed.), *Linguistics, archaeology and the human past* (Occasional Papers, 2). Kyoto: Research Institute for Humanity and Nature, 1–12.

Possehl, G.L. 1996. Indus Age. The Writing System. New Delhi: Oxford &IBH Publishing.

Tosi, M. 1991. The Indus Civilization beyond the Indian Subcontinent. In M. Jansen and G. Urban (eds.), Forgotten Cities on the Indus. Early civilization in Pakistan from 8th to the 2nd millennium BC. Mainz: Philipp von Zabern, 111–128.

Weingarten, J. 1986. The Sealing Structures of Minoan Crete. MM II Phaistos to the Destruction of the Palace of Knossos. Oxford Journal of Archaeology 5: 279–298.

Wells, B.K. 2015. The Archaeology and Epigraphy of Indus Writing. Oxford: Archaeopress Archaeology.

Indus Scripts Incised on the Seals Discovered from the Initial Phase of Harappan Period in the Ghaggar Basin: Their Significance for Understanding the Chronology, the Context and the Interpretation of Indus Writing System

Ayumu Konasukawa, Ph.D.

Introduction

The chronology of Indus seal must be taken into consideration for discussing various aspects of Indus script because Indus script is basically incised on the Indus seal.

Based on the results of Harappa excavations, the Indus seals having a right-facing animal discovered from the initial phase of the Harappan Period in the Ghaggar Basin can be understood as the seals corresponding to the seals from Harappa period 3A (2600-2450BCE).

Indus scripts incised on the Indus seals having a right-facing animal, i.e. Indus scripts used in the initial phase of the Harappan Period, are restricted in only 71 signs. There are some seal examples sharing common Indus script(s). Indus seals having a right-facing animal excavated in the Ghaggar basin are characterized by common Indus script(s) such as a diamond-shaped sign, a fish-like sign, a spear-like sign, a dot-shaped sign which is comprised of several dots and a tree-like sign.

In the present paper, various aspects of the Indus script used in the initial phase of the Harappan Period in the Ghaggar basin, including its carving technique, will be appraised. The results of this paper do indicate their significance for the better understanding the chronology, the context and the interpretation of Indus writing system.

Previous research on the Indus script and aim of the present paper

The Indus script has been studied from various viewpoints and approaches since the beginning of archaeological studies on the Indus civilization: mainly attempts to decipher the Indus script (e.g. Fairservis 1992; Farmer *et al.* 2004; Mahadevan 1977; Parpola 1994; Possehl 1996; Rao 1982; Zide and Zvelebil 1976). Furthermore, there are three volumes of *Corpus of Indus Seals and Inscriptions* (hereafter the 'CISI') (Joshi and Parpola 1987; Parpola *et al.* 2010; Shah and Parpola 1991).

However, no studies till date have considered the chronology of Indus script. For this reason, the present study focuses on discussing the Indus scripts incised on the seals discovered from the initial phase of Harappan period in the Ghaggar Basin to lead the better understanding of the chronology, the context and the interpretation of Indus writing system.

Indus scripts discussed in the present study

The chronology of Indus seal must be taken into consideration for discussing various aspects of Indus script, especially the chronology, because Indus script(s) is basically incised on Indus seal.

The chronology of Indus seal based on the results of Harappa excavations

The results of Harappa excavations (e.g. Kenoyer and Meadow 2010) must be taken into consideration for discussing the chronology of the seals from the Early Harappan to the Harappan Periods. A preliminary chronology based on the Harappa excavations is as follows:

Harappa period 2 (2800-2600BCE)
: Seals having geometrical motif(s) mainly without Indus script(s),
Harappa period 3A (the initial phase of Harappan period, 2600-2450BCE)
: Indus seals having a right-facing animal mainly with Indus script(s),
Harappa periods 3B (2450-2200BCE)/3C (2200-1900BCE)
: Indus seals having a left-facing animal mainly with Indus script(s).

According to this tentative Harappa chronology, it is possible to discuss the chronology of the seals which were discovered from the archaeological sites in the Ghaggar Basin, e.g. Kunal (Acharya 2008), Banawali (Joshi and Parpola 1987), Kalibangan (Joshi and Parpola 1987), Farmana (Shinde *et al.* 2011) and Bhirrana (Sant *et al.* 2005). A preliminary chronology of the seals in the Ghaggar Basin is as follows (Figure 1):

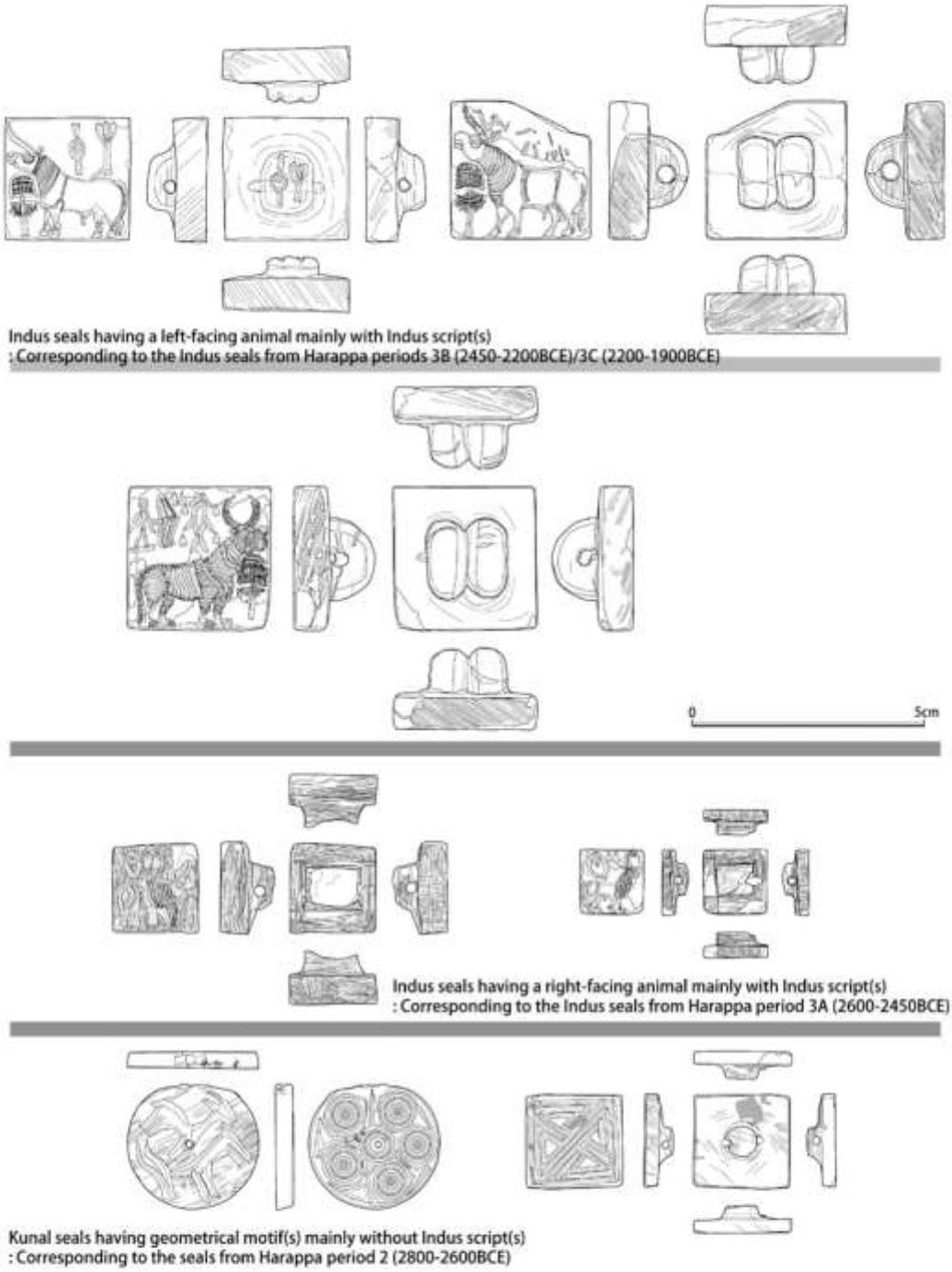


Figure 1: Tentative chronology of the seals from the Early Harappan to the Harappan periods in the Ghaggar Basin

Kunal seals having geometrical motif(s) mainly without Indus script(s)
: Corresponding to the seals from Harappa period 2 (2800-2600BCE),
Indus seals having a right-facing animal mainly with Indus script(s)
: Corresponding to the Indus seals from Harappa period 3A (2600-2450BCE),
Indus seals having a left-facing animal mainly with Indus script(s)
: Corresponding to the Indus seals from Harappa periods 3B (2450-2200BCE)/3C (2200-1900BCE).

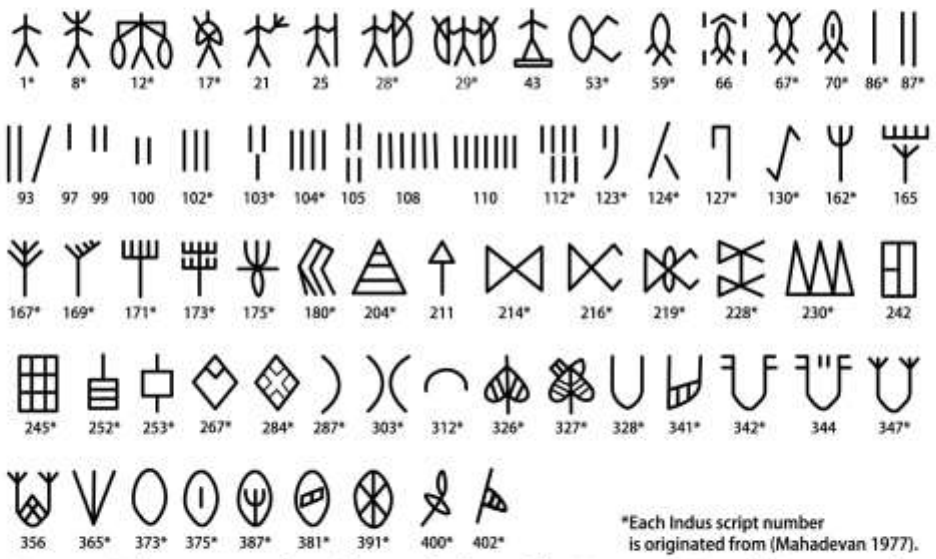


Figure 2: Indus scripts used in the initial phase of the Harappan Period (Corresponding to the Indus seals having a right-facing animal mainly)

The chronology of Indus script based on the seal chronology

Based on this tentative seal chronology, the Indus scripts can be divided into the following two major categories because Indus script(s) is basically incised on Indus seal:

Indus script(s) used in the initial phase of the Harappan Period (Figure 2)
:Corresponding to the Indus seals having a right-facing animal mainly,
Indus script(s) used in the later phases of the Harappan Period
:Corresponding to the Indus seals having a left-facing animal mainly.

Indus scripts used in the initial phase of the Harappan Period

The details of Indus seals having a right-facing animal (e.g. their design, carving technique and distribution pattern) were discussed in the author's previous paper (Konasukawa in press a) (Table 1).

In this paper the Indus scripts incised on this type of Indus seal was intensively discussed.

Indus scripts used on the Indus seals having a right-facing animal are restricted to only 71 signs (Figure 2).

This type of seals share common Indus script(s) with a high percentage. For example, this type of seals excavated from the archaeological sites in the Ghaggar Basin (e.g. Kunal, Banawali, Kalibangan, Farmana and Bhirrana) are characterized by common Indus script(s) such as a diamond-shaped sign, a fish-like sign, a spear-like sign, a dot-shaped sign and a tree-like sign

Those specific Indus scripts are also used on this type of seals discovered from Harappa (H-85 in the CISI), Bala-kot (Blk-5 in the CISI) and Mohenjodaro (M-749 and M-233 in the CISI) (Figure 3). Thus, it can be pointed out that these specific Indus scripts were shared in a broad area extending throughout this society in the initial phase of the Harappan Period. Furthermore, Indus scripts engraved on this type of seals are not expressed in reverse, which is the case with Indus signs on the Indus seals having a left-facing animal.

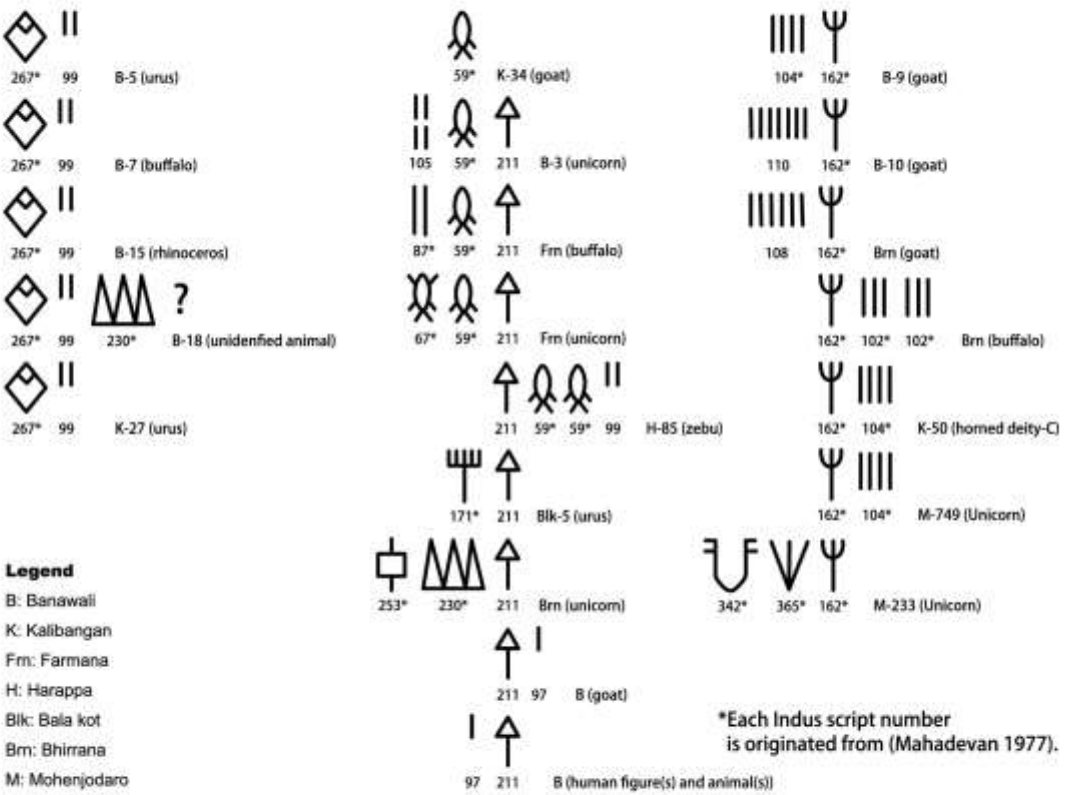


Figure 3: Common Indus scripts shared among the Indus seals having a right-facing animal

Who carved the Indus script(s) in the initial phase of the Harappan Period in Banawali?

It is an important approach to discuss the engraver of Indus script(s) for the better understanding of the context of Indus writing system.

Although the observed samples are few, Scanning Electron Microscopy – SEM analysis demonstrates that the details of carving techniques and tools had been used to carve the Indus scripts depicted on the surface of Indus seals (e.g. Konasukawa 2013, in press b, in press c). In this study the following research method was used to observe the carving techniques of the Indus scripts.

Before SEM observation, silicon resin was poured into the depressions of seals (i.e. carving marks and boring parts, etc.) to make a silicon replica of the seal, which was then observed through SEM. All the surface data including the carving marks etc. was completely transcribed on the surface of the seal's silicon replica. Thus, it was possible to observe the details of carving techniques of the Indus script(s) in a full sense through SEM. It is also important to pay attention to that the carving mark, which is seen as a convex form, originally is a depression. It is a reversed image as the SEM image is made from the silicon replica of the seal. Some depressions in the SEM images are caused by bubbles formed in the silicon replica.

The material comprises of three Indus seals from the initial phase of the Harappan Period in Banawali (Figures 4 to 6). These three seals have a right-facing animal respectively (i.e. Urus, Buffalo and Rhinoceros)and share two common Indus scripts.

Each part of the Indus scripts was first carved roughly and then refined to make that shape. According to the observations of small fine marks, seen at the side and bottom of the Indus scripts (Figures 4 to 6), it is likely that the seal makers carefully repeated the carving behavior, which is based on the back and forth strokes by using a tin-bronze or copper tool with a flat or a pointed head, many times.

These SEM observations demonstrate the similarity of carving technique and tools used in the final forming process, and on the other hand the difference of carving (stroke) order to make the shape of same Indus script. Thus, the results of this part lead to a tentative observation – that three different script carvers were involved to carve these Indus scripts.

Discussions and conclusions

The chronology of Indus script has never been considered till date. But based on the recent archaeological excavations and studies, the chronology of Indus seal must be taken into consideration for discussing various aspects of Indus script. The Indus scripts can be divided into the following two major categories because Indus script is basically incised on Indus seal: Indus scripts used in the initial phase of the Harappan Period (corresponding to the Indus seals having a right-facing animal mainly), Indus scripts used in the later phases of the Harappan Period (corresponding to the Indus seals having a left-facing animal mainly).

The SEM analysis of Indus scripts demonstrates the details of carving technique and tools used in the final forming process and leads to a tentative observation – that some different script carvers were involved to carve the Indus script in the initial phase of the Harappan Period in Banawali.

The present study concludes that some aspects of the Indus writing system in the initial phase of the Harappan Period were passed on to those in the later phases of the Harappan Period and rapidly evolved with an increase in number of the Indus script/ the organization of the Indus script carvers.

Although the data for this analysis is very limited, and there are some examples which should be carefully considered on account of their chronological position, even if it is impossible to decipher, the tentative conclusion reached here do indicate that archaeological approaches also can contribute for the better understanding the chronology, the context and the interpretation of Indus writing system.

The next objectives of this study are: 1, to undertake a synthetic study of Indus seals and Indus scripts for reappraising the results of present study; 2, to accumulate SEM data of Indus seals and Indus scripts for understanding their carving technique/process in detail; 3, to undertake an experimental archaeological study for reconstructing the carving technique/process of Indus seals and Indus scripts in a full sense.

Table 1: Catalogue of the basic data for the Indus seals having a right-facing animal

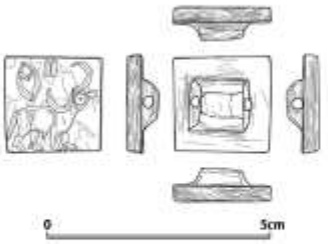
CISI No.	Site	Main motif	Object in front of animal	Direction of main animal's head	Crosswise (mm)
M-223	Mohenjodaro	Unicorn	Script instead of standard	Right	22.3
M-737	Mohenjodaro	Unicorn	Standard	Right	30.5
M-738	Mohenjodaro	Unicorn	Standard	Right	29.5
M-749	Mohenjodaro	Unicorn	Standard	Right	32.5
M-955	Mohenjodaro	Unicorn	?	Right	18.5
M-977	Mohenjodaro	Unicorn	–	Right	21.0
M-1855	Mohenjodaro	Unicorn	–	Right	12.5
H-60	Harappa	Unicorn	Standard	Right	27.8
H-73	Harappa	Unicorn	–	Right	22.0
L-44	Lothal	Unicorn	?	Right	20.0
K-3	Kalibangan	Unicorn	–	Right	37.0
K-6	Kalibangan	Unicorn	Standard	Right	29.8
K-16	Kalibangan	Unicorn	Standard	Right	23.5
K-17	Kalibangan	Unicorn	Standard	Right	23.3
K-18	Kalibangan	Unicorn	Standard	Right	28.3
K-26	Kalibangan	Unicorn	Script instead of standard	Right	29.0
C-17	Chanhudaro	Unicorn	Human figure instead of standard	Right	21.0
B-1	Banawali	Unicorn	Standard	Right	34.0
B-3	Banawali	Unicorn	Script instead of standard	Right	14.8
–	Farmana	Unicorn	Script instead of standard	Right	21.3
–	Bhirrana	Unicorn	–	Right	22.5
K-27	Kalibangan	Urus	–	Right	15.0
B-4	Banawali	Urus	Script instead of standard	Right	15.8
B-5	Banawali	Urus	–	Right	14.3
Blk-5	Bala-kot	Urus	Script instead of standard	Right	21.0
–	Dholavira	Bison (Antelope ?)	–	Right	30.0
H-85	Harappa	Zebu	–	Right	25.3
M-269	Mohenjodaro	Buffalo	–	Right	22.8
M-270	Mohenjodaro	Buffalo	–	Right	22.0
M-1124	Mohenjodaro	Buffaro	Manger	Right	–
B-7	Banawali	Buffalo	–	Right	22.8
–	Farmana	Buffalo	Script instead of manger	Right	20.0
–	Bhirrana	Buffalo	–	Right	21.0
M-271	Mohenjodaro	Goat	–	body to left, head turned back to Right	15.0
M-272	Mohenjodaro	Goat	–	body to Right, head turned back to left	25.3
M-273	Mohenjodaro	Goat	–	Right	21.0

Lengthwise (mm)	Thickness excluding boss (mm)	Thickness including boss (mm)	Inscript number (Mahadevan 1977)	Material	Remarks	Source
21.5	–	–	342, 365, 162	Fired steatite		CISI Vol. 1
30.5	–	–	?, 59, 342, 1	Fired steatite	Left part broken	CISI Vol. 2
29.0	8.5	17.5	?, 342, ?, 341	Fired steatite	Left upper part broken	CISI Vol. 2
32.5	–	–	169, 104	Fired steatite		CISI Vol. 2
18.5	–	–	102, 216, 123	Fired steatite		CISI Vol. 2
21.0	4.0	7.0	342, 387	Fired steatite	Right lower part broken	CISI Vol. 2
13.5	–	–	?, ?	Fired steatite	Only impression	CISI Vol. 3.1
27.5	–	–	102, 287, 342, 242, 391, 100	Fired steatite		CISI Vol. 1
21.5	–	–	70, 12	Fired steatite		CISI Vol. 1
17.0	4.0	–	93 ?	Copper	Very coarse dipicted	CISI Vol. 1
35.0	10.0	–	–	Terracotta ?	Very coarse dipicted	CISI Vol. 1
29.5	3.0	10.0	242, 216, 391, 267, 402, 242, 342, 341	Fired steatite		CISI Vol. 1
23.5	–	–	67, 342, 1, 391, 124	Fired steatite		CISI Vol. 1
23.3	–	–	228, 342	Fired steatite		CISI Vol. 1
28.8	–	–	17, 230, 100, 356, 180	Fired steatite		CISI Vol. 1
29.0	–	–	326, 342	Fired steatite		CISI Vol. 1
20.5	–	–	8, 342, 1	Fired steatite		CISI Vol. 1
34.5	–	–	391, 391, 216, 402, 99, 59, 342, 1	Fired steatite		CISI Vol. 1
14.8	–	–	105, 59, 211	Fired steatite		CISI Vol. 1
21.0	4.3	12.5	67, 59, 211	Fired steatite		Shinde *et al.* 2011
21.5	5.0	9.0	253, 230, 211	Fired steatite		Kumar and Dangi 2006
14.5	–	–	267, 99	Fired steatite		CISI Vol. 1
15.8	–	–	53, 342, 162	Fired steatite		CISI Vol. 1
14.3	2.6	5.8	267, 99	Fired steatite		CISI Vol. 1
20.0	3.5	10.0	171, 211	Fired steatite		CISI Vol. 2
30.0	7.0	–	–	Fired steatite		NHK and NHK Promotions 2000
25.3	–	–	211, 59, 59, 99, 267	Fired steatite	Lower half broken	CISI Vol. 1
22.3	–	–	204, 245, 342	Fired steatite		CISI Vol. 1
23.5	4.0	10.5	–	Fired steatite		CISI Vol. 1
–	–	–	?	Fired steatite	Broken piece	CISI Vol. 2
21.8	3.5	7.2	267, 99	Fired steatite		CISI Vol. 1
20.0	6.0	11.5	87, 59, 211	Fired steatite		Shinde *et al.* 2011
20.0	–	–	162, 102, 102	Fired steatite		*Rao et al.* 2004
14.5	–	–	–	Fired steatite		CISI Vol. 1
24.5	–	–	284, 100	Fired steatite		CISI Vol. 1
19.8	–	–	326	Fired steatite		CISI Vol. 1

to be continued

CISI No.	Site	Main motif	Object in front of animal	Direction of main animal's head	Crosswise (mm)
M-1129	Mohenjodaro	Goat	Script	Right	24.5
K-34	Kalibangan	Goat	Script	Right	8.5
C-23	Chanhudaro	Goat	–	Right	27.0
B-8	Banawali	Goat	–	Right	21.0
B-9	Banawali	Goat	–	Right	22.5
B-10	Banawali	Goat	Script	Right	14.3
B-12	Banawali	Goat	Seven dots	Right	18.5
B-13	Banawali	Goat	–	Right	20.8
–	Banawali	Goat (Antelope?)	–	Right	17.0
–	Bhirrana	Goat	Script	Right	18.0
K-40	Kalibangan	Elephant	–	Right	21.5
K-41	Kalibangan	Tiger	–	Right	34.0
M-1134	Mohenjodaro	Rhinoceros	–	Right	38.0
M-1139	Mohenjodaro	Rhinoceros	–	Right	20.5
M-1911	Mohenjodaro	Rhinoceros	–	Right	18.0
B-15	Banawali	Rhinoceros	–	Right	19.0
B-16	Banawali	Rhinoceros	–	Right	25.5
M-298	Mohenjodaro	Triple-headed animal	–	Right	23.0
M-1170	Mohenjodaro	Triple-headed animal	–	Right	27.0
K-43	Kalibangan	Triple-headed animal	–	Right	25.0
Ai-6	Amri	Triple-headed animal	–	Right	28.0
–	Bhirrana	Triple-headed animal	–	Right	20.0
–	Dholavira	Triple-headed animal	–	Right	20.0
B-17	Banawali	Horned tiger	Standard	Right	30.5
M-1026	Mohenjodaro	broken bovid	–	Right	23.0
M-1130	Mohenjo Daro	Unidentified animal	Standard	–	–
H-1676	Harappa	Unidentified animal	–	Right	–
H-1688	Harappa	broken bovid	–	Right	23.5
B-6	Banawali	Unidentified animal	–	Right	–
B-14	Banawali	Unidentified animal	Script	Right	17.0
B-18	Banawali	Unidentified animal	–	Right	–
Ad-8	Allahdino	Unidentified animal	Standard	Right	35.5
M-312	Mohenjodaro	Human figure(s) and animal(s)	–	Right (Buffalo)	25.0
M-1918	Mohenjodaro	Human figure(s) and animal(s)	Script	Right	31.5
K-49	Kalibangan	Human figure(s) and animal(s)	–	Right	32.8
C-27	Chanhudaro	Human figure(s) and animal(s)	–	body to Right, head turned back to left	27.3
–	Banawali	Human figure(s) and animal(s)	Script	Right (Buffalo)	30.0
–	Dholavira	One human and triple-headed animal	–	Right	18.0
K-50	Kalibangan	Horned deity-C	–	Right	19.0
Ns-9	Nausharo	Horned deity-C	–	Right	23.5

Lengthwise (mm)	Thickness excluding boss (mm)	Thickness including boss (mm)	Inscript number (Mahadevan 1977)	Material	Remarks	Source
23.5	–	–	?, 342, 180, 342, 214	Fired steatite	Coarse dipctited	CISI Vol. 2
8.5	–	–	59	Fired steatite		CISI Vol. 1
26.0	–	–	86, 327, 100, 102, 381, 28, 180, (312, 303, 312), 180, 29, 267	Fired steatite		CISI Vol. 1
20.5	3.5	7.0	124, 342	Fired steatite		CISI Vol. 1
20.5	4.5	8.0	104, 162	Fired steatite		CISI Vol. 1
12.5	3.1	6.9	110, 162	Fired steatite		CISI Vol. 1
18.5	4.0	9.0	167, 112	Fired steatite		CISI Vol. 1
19.0	4.5	–	?	Fired steatite		CISI Vol. 1
17.0	11.0	–	211, 97	Fired steatite		NHK and NHK Promotions 2000
18.0	–	–	108, 162	Fired steatite		Rao *et al.* 2004
22.0	–	–	341, 127, 373, 373, 267, 100, 86, 347	Fired steatite		CISI Vol. 1
34.0	–	–	–	Fired steatite	Upper half broken	CISI Vol. 1
37.5	–	–	391, 252, 381?, 219	Fired steatite		CISI Vol. 2
20.5	5.0	10.0	391, 245, 99, 173, 342	Fired steatite	Lower part broken	CISI Vol. 2
18.0	–	–	391, 99, 228, 162, 242	Fired steatite	Only impression	CISI Vol. 3.1
19.0	6.5	11.8	267, 99	Fired steatite		CISI Vol. 1
25.5	10.0	–	?	Fired steatite	Broken piece	CISI Vol. 1
22.3	–	–	–	Fired steatite		CISI Vol. 1
27.0	4.0	9.0	165	Fired steatite		CISI Vol. 2
24.5	–	–	344, 53, 53, 344, 103, ?, 347, 342	Fired steatite		CISI Vol. 1
29.5	–	–	–	Fired steatite		CISI Vol. 2
20.5	–	–	?, 342	Fired steatite		Rao *et al.* 2004
20.0	10.0	–	167	Fired steatite		NHK and NHK Promotions 2000
29.5	7.9	17.8	43, 180, 99, 66	Fired steatite		CISI Vol. 1
23.0	8.0	16.0	?, ?, 12	Fired steatite	Very coarse dipicted (unfinished?), brolen piece	CISI Vol. 2
–	–	–	?	Fired steatite	Very coarse dipicted, brolen piece	CISI Vol. 2
–	–		?, 21, 130?	Fired steatite	Broken piece	CISI Vol. 3.1
23.5	–	–	328, ?	Fired steatite	Broken piece	CISI Vol. 3.1
–	–	–	?	Fired steatite	Broken piece	CISI Vol. 1
17.0	–	–	?	Fired steatite	Broken piece	CISI Vol. 1
–	6.5	–	267, 99, 230, ?	Fired steatite	Broken piece	CISI Vol. 1
35.0	–	–	342, 127, 204, 267, 1	Fired steatite	Very coarse dipicted	CISI Vol. 2
21.0	–	–	–	Fired steatite		CISI Vol. 1
31.5	–	–	?, 21, 242	Fired steatite	Only impression	CISI Vol. 3.1
32.5	–	–	102, 112, 12	Fired steatite		CISI Vol. 1
27.3	–	–	?	Fired steatite	Upper part broken	CISI Vol. 1
30.0	11.0	–	97, 211	Fired steatite		NHK and NHK Promotions 2000
18.0	10.0	–	–	Fired steatite		NHK and NHK Promotions 2000
19.0	3.5	8.0	162, 104	Fired steatite		CISI Vol. 1
23.0	–	–	375, 204, 175, 180, 400, 99, 342, 25, 99	Fired steatite		CISI Vol. 2



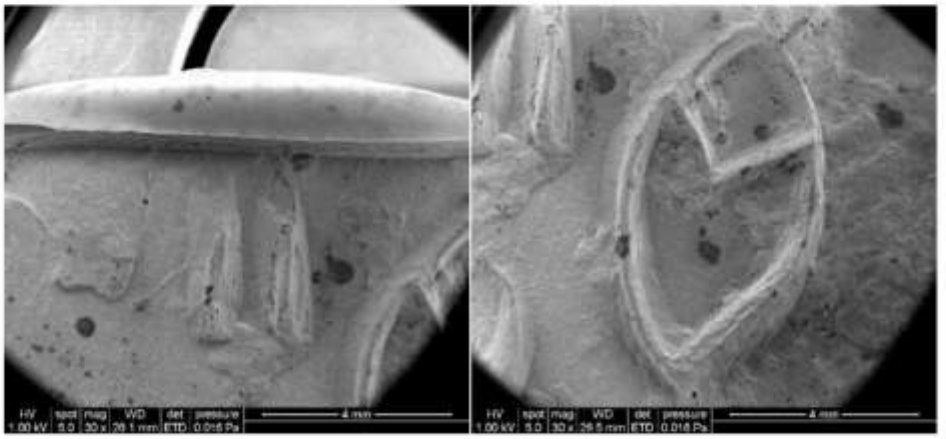


Figure 4: Indus seal from the initial phase of the Harappan Period in Banawali (1)

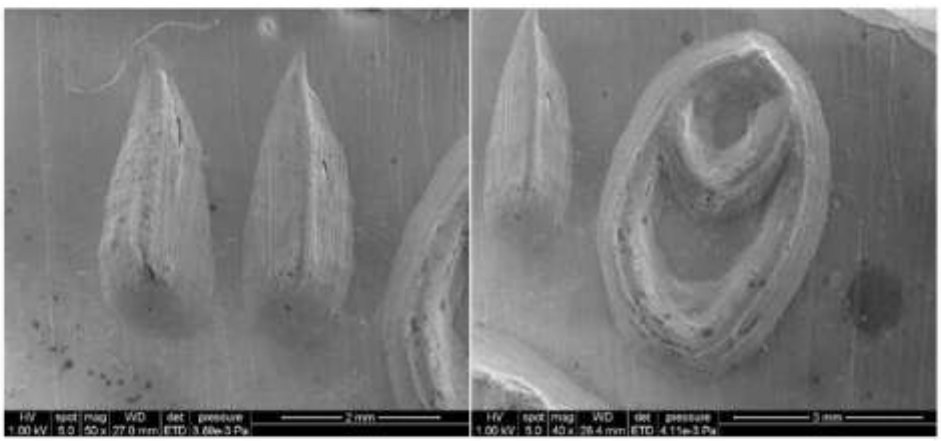


Figure 5: Indus seal from the initial phase of the Harappan Period in Banawali (2)

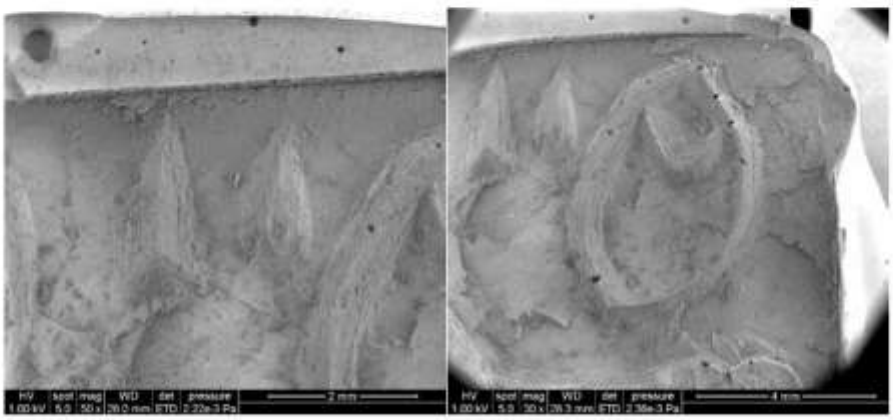


Figure 6: Indus seal from the initial phase of the Harappan Period in Banawali (3)

Acknowledgments

I would like to express my heartfelt thanks to the following body of organization and people who supported my research works in various ways. For the International Conference on Indus Script, at Mohenjodaro, Pakistan (in random order): Dr. Kaleemullah Lashari, Dr. Asma Ibrahim, Dr. Sajid Hussain Khan, Prof. J Mark Kenoyer, The National Fund for Mohenjodaro, Culture, Tourism and Antiquities Department, Government of Sindh. For the present study (in random order): Prof. Vasant. S. Shinde, Dr. R. S. Shastry, Dr. R. Purohit, Prof. Hideo Kondo, Dr. Seiji Nakayama, Deccan College Post-Graduate and Research Institute, Department of Archaeology & Museums, Haryana, Shri Krishna Museum and many people who always helped me during my studies in India, Pakistan and Japan. For the research grants: Grant-in-Aid for Research Activity Start-up of Japan Society for the Promotion of Science (JSPS) (JSPS KAKENHI Grant Number 17H06775), Grant-in-Aid for Early-Career Scientists of JSPS (JSPS KAKENHI Grant Number 19K13402).

Bibliography

Acharya, M. 2008. *Kunal Excavations (New Light on the Origin of Harappan Civilization)*. Haryana.

Fairservis, Walter. A. Jr. 1992. *The Harappan Civilization and Its Writing: A Model for the Decipherment of the Indus Script*. New Delhi.

Farmer, Steve, Sproat, Richard and Witzel, Michael. 2004 "The Collapse of the Indus-Script Thesis: The Myth of a Literare Harappan Civilization." *Electronic Journal of Vedic Studies (EJVS)* 11(2): 19-57.

Joshi, Jagat Pati and Parpola, Asko, eds. 1987. *Corpus of Indus Seals and Inscriptions: 1. Collections in India*. Helsinki.

Kenoyer, Jonathan Mark and Meadow, Richard H. 2010. "Inscribed Objects from Harappa Excavations 1986-2007." In *Corupus of Indus Seals and Inscriptions: 3. 1. Supplement to Mohenjo-daro and Harappa* (Vol.3: New material, untraced objects, and collections outside India and Pakistan, Part 1: Mohenjo-daro and Harappa), edited by Parpola, Asko, Pande, B. M., and Koskikallio, Petteri, xliv-lviii. Helsinki.

Konasukawa, Ayumu. 2013. "Diversity of Harappan Civilization: A Case Study of the Ghaggar Basin (with Special Reference to Seals)." PhD diss., Deccan College Post-Graduate & Research Institute (Declared as Deemed-to-be University under Section 3 of the University Grants Commission Act, 1956).

Konasukawa, Ayumu. In press a. "Regional Variations of the Harappan Seals in Light of Their Design and Carving Techniques Observed through SEM and PEAKIT (3D) Analyses." *South Asian Archaeology and Art 2014*, European Association for South Asian Archaeology and Art, Stockholm.

Konasukawa, Ayumu. in press b. "Chronological Change and Continuity of the Seal from the Early Harappan to the Harappan Periods in the Ghaggar Basin: Their Significance for Understanding the Seal Chronology and 'Invention' of Indus Seal." In *Cultural Heritage of South Asia and Beyond: Recent Perspective*, edited by Shinde Vasant, Shrikant Ganvir, and Sayan Bhattacharya, 49-60. New Delhi.

Konasukawa, Ayumu. in press c. "Comparative Analysis on the Seal Carving Techniques of the Early Harappan and the Mature Harappan Periods: A Preliminary Observations through SEM and PEAKIT." In *Pratnamani* (Felicitation Volume of Prof. Vasant Shinde), edited by Prabodh Shirvalkar and Esha Prasad. New Delhi.

Mahadevan, Iravatham. 1977. *The Indus Script: Text, Concordances and Tablets.* Memoirs of the Archaeological Survey of India 77. New Delhi.

Manmohan Kumar and Vivek Dangi. 2007. "A Harappan seal from Bhirrana." *Numismatic Studies* 8: 135-136.

NHK (Nihon Housou Kyoukai-Japan Broadcasting Corporation) and NHK Promotions. 2000. *Exhibitions of the World's Four Great Civilizations: Indus Civilization.* Tokyo.

Parpola, Asko. 1994. *Deciphering the Indus Script.* Cambridge.

Parpola, Asko, Pande, B. M., and Koskikallio, Petteri, eds. 2010. *Corpus of Indus Seals and Inscriptions. 3.1. Supplement to Mohenjo-daro and Harappa* (Vol.3: *New material, untraced objects, and collections outside India and Pakistan.* Part 1: Mohenjo-daro and Harappa). Suomalaisen Tiedeakatemian Toimituksia Annales Academiae Scientarum Fennicae Humaniora (AASF Hum)359. Helsinki.

Possehl, Gregory. L. 1996. *Indus Age: The Writing System.* New Delhi.

Rao, L.S., Sahu, Nandini B., Sahu. Prabash, Shastry, U. A., and Diwan, Samir. 2004. "Understanding Harappan Settlement at Bhirrana (2003-04)." *Puratattva* 34: 20-24.

Rao, Shikaripura Rangantha. 1982. The Decipherment of the Indus Script. Bombay.
Shah, Sayid Ghulam Mustafa, and Parpola, Asko, eds. 1991. *Corpus of Indus Seals and Inscriptions 2: Collections in Pakistan.* Helsinki.

Shinde, Vasant, Osada, Toshiki, and Manmohan Kumar, eds. 2011. *Excavations at Farmana: District Rohtak, Haryana, India, 2006-08.* Kyoto.

Zide, Arlene R. K., and Zvelebil, Kamil V. 1976. *The Soviet Decipherment of the Indus Valley Script: Translation and Critique.* Mouton.

Ancient Writing and Modern Technologies – Structural Analysis of Numerical Indus Inscriptions

Dr. Andreas Fuls

Andreas Fuls, Technische Universität Berlin (Germany)

The Indus culture (2600 to 1700 BCE) developed a writing system that still remains mostly undeciphered. The inscriptions found on several artefacts (i.e. seals, tablets, pots, bangles, tags, and other types of artefacts) show a distinct pattern of Indus signs. An Interactive Concordance of Indus Texts (ICIT) has been developed and is accessible through a web-interface. It contains at present 5318 Indus texts on 4351 artefacts and additional 869 artefacts with iconography. The signs are coded according to an extended sign list with 702 distinct signs (Wells 2015). This interactive-searchable database facilitates the study of specific sets of iconographic elements, signs, and artefacts. Several tools allow for the statistical and spatial analysis of inscribed artefacts and Indus signs. The aim is to make all Indus inscriptions accessible to scholars worldwide and to stimulate further research on Indus writing and Indus culture in general.

A detailed study of sign sequences has become possible through the Multivariate Segmentation method. It enables one to perform structural analysis and the identification of segments of Indus inscriptions with similar meaning. The structural analysis focuses on texts with numerical signs and allows to have a better understanding of the economic content of many Indus inscriptions.

GENERAL FEATURES OF INDUS WRITING

Sign sequences in Indus writing are arranged in a linear order on seals, tablets, pottery, bangles, and other artefacts. Seals are impressed into clay (tags) fulfilling several functions such as door and container sealings. However, inscriptions on perishable material have not survived due to climatic conditions.

TEXT CORPUS

An Interactive Concordance of Indus Texts (ICIT) has been developed (Fuls 2010) containing at present 5318 Indus texts on 4351 artefacts and additional 869 artefacts with iconography. Most data records based on the Interactive Corpus of Indus Texts (ICIT) were collected by Wells (2011) and have been constantly updated as soon as new inscriptions become available. At present (September 2019), the inscriptions come from 57 sites, foremost from Harappa (42.9%) and Mohenjo-daro (40.5%). Middle sized sites with less inscribed artefacts are Dholavira (5.1%), Lothal (3.9%), Kalibangan (2.1%), and Chanhujo-daro (1.5%). The rest are small or Non-Indus sites forming together a total of 156 inscribed artefacts, or 3.6% (Figure 1). The location of 12 inscribed artefacts is unknown.

Not all inscriptions are in good condition. About 1.7% of the 5318 available texts are in fine condition, 21.5% are in good condition, and the condition of about 23.8% texts can be classified as fairly good. However, about 52% of the texts are in poor condition. In case when signs cannot be securely identified they are coded as 000 (eroded), even if parts of the grapheme are visible.

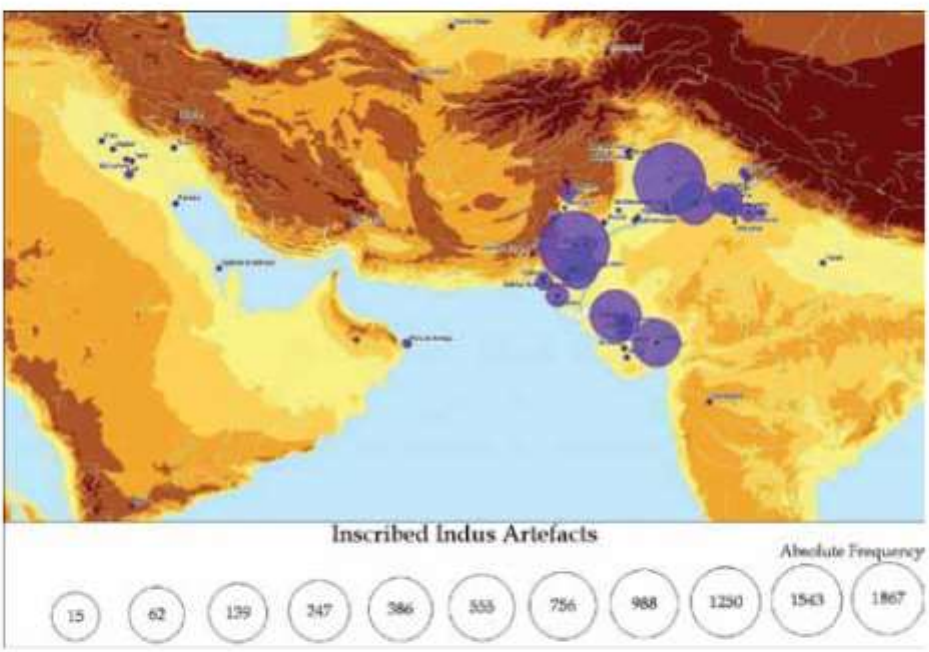


Figure 1: Map of artefacts inscribed with signs of the Indus script. The artefact frequency at each site is indicated by circle size with logarithmic scaling. One Indus text was found as north as in Gonur Depe (Turkmenistan) and 27 others were found in Mesopotamia and the Persian Gulf.

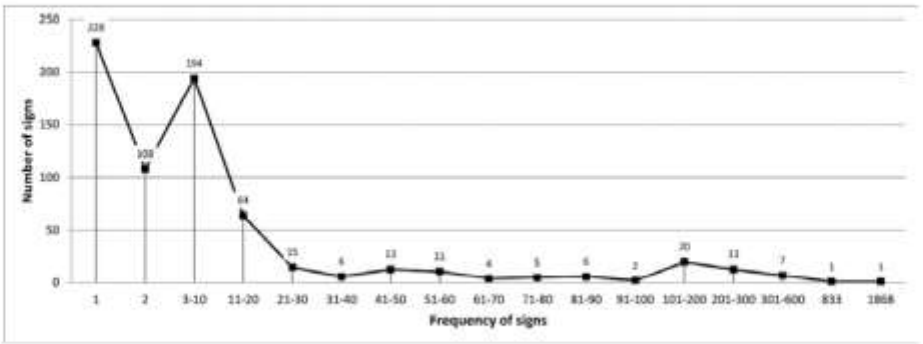


Figure 2: Frequency distribution of Indus signs grouped into 17 classes from frequency 1 to 1868.

SIGN LIST

The sign list by Wells (2011, 2015) has been extended to currently 702 distinct signs after adding new inscriptions from Dholavira, Lothal and other small sites (Appendix A). On the whole, there are 19115 sign occurrences, but 1757 of them are eroded or cannot be identified.

The frequency distribution shows that most signs occur very seldom: 384 of 702 signs occur not more than 3 times in the corpus and 588 signs less than 20 times (Figure 2). Only 42 signs have a frequency greater than 100. Sign 740 is the most frequent one.

The core of Indus signs that occur at least once at Harappa, Mohenjo-daro, Dholavira and Lothal totals 92 distinct signs. They account for about 73% of all sign occurrences in the text corpus.

TYPE OF WRITING AND DEGREE OF PHONETISATION

The comparison of the sign frequency distribution of Indus writing with many known writing systems indicates that it is a logographic-syllabic writing system with about 48% syllables and 52% logograms (Fuls 2019:12-13).

The statistical comparison is provisional for several reasons. The first reason is the size of the text corpus. The total number of 17360 legible signs is too small to provide a complete sign list, since more signs may appear later with the discovery and publication of new inscriptions. Moreover, extending the text corpus increases the number of rare logograms but not the number of frequent syllabic signs. Another problem is the artefact preservation and thus the restricted subject matter that eliminates certain signs not present in the sign list. Apart from these problems,

some signs might be polyvalent or poly functional, i.e. used as a logogram as well as a syllable depending on context. Nevertheless, it is certain that Indus writing uses syllabic as well as logographic signs, even if we cannot tell for sure the exact ratio between both. Therefore, we can only estimate the degree of phonetization that falls in the range between 50% and 80% syllables.

READING DIRECTION

The direction of writing can be detected through overlapping incised signs on pottery, squeezing signs at the end of a text because of restricted space on the artefact surface, and the continuity of writing below the last sign. Besides, the ratio between left to right end sign frequencies shows that Indus writing must be read from right to left (Ashraf and Sinha 2018). These factors indicate that the direction of writing was mostly from right to left. Since we do not assume that the writing was done backwards, the direction of reading was also from right to left (R/L).

Thus, all sign sequences are coded in a way to be read from right to left, whatever the original writing looks like (for all seals the reading direction is determined from the impression in clay, otherwise structural analysis would not be possible). Original reading direction is indicated by the parameter "direction" in the ICIT. Therefore, most times we can find R/L, but also L/R (221 times left to right), T/B (13 times top to bottom), or BUS (8 times boustrophedon).

SEGMENTATION METHODS

Text segmentation is a process that breaks longer sign sequences into smaller units by means of determining morphological boundaries and bounded sign clusters within each text. After the segmentation process is over, the results must be evaluated by comparing the segmentation trees with the results derived from paradigmatic cluster analysis, structural analysis, or positional analysis of signs. The aim is to determine meaningful units (e.g. syntactic elements).

Several methods have been proposed and applied to segmenting Indus texts into smaller units. Most of these methods use statistical behaviour of signs, counting the frequencies of signs and sign pairs.

Parpola (1994) applies Harris' approach to Indus inscriptions. Each text is compared to similar sign sequences and the frequency of sign pairs starting first from the right and then from the left of a text. The method requires a huge amount of similar texts not available for Indus writing. A detailed description of this approach is given by Parpola (1994: 98-99).

Bonta (1996:17) suggests the comparative method and compares similar sign sequences in order to determine morphological boundaries within those sequences. It is similar to Harris' approach, but it does not account for the frequency of sign pairs as in Harris' approach.

Korvink (2007:7) uses the elimination process that is similar to the comparative method. The only difference is that the elimination process is iterative and starts at both sides of the text, namely with the initial and the terminal signs. The elimination process can be summarized in the following way:

determination of Initial Marker
determination of Terminal Marker
determination of groups of signs used together
determination of meaningful single signs
determination of bounded sign clusters
segmentation of texts.

The process of elimination also includes complete solo signs and sign pairs that most probably represent a meaningful unit (morpheme).

This method works only for Patterned texts with typical initial and terminal markers, bounded clusters, and known sign groups such as fish signs and numerical signs. No pattern can be recognized by the process of elimination in a Complex text (defined by Wells (2011) as a text written with an unusual sequence of signs) or text parts with a low frequency of sign sequences.

Sinha *et al.* (2010) developed a segmentation method using z-scores. It is based only on the frequency of sign pairs. This is efficient for bounded cluster but does not account for repetitive sign sequences in Indus texts. The resulting segmentation trees differ from the results of structural analysis (Wells 2015) and are not useful for understanding the pattern of Indus sign sequences.

MULTIVARIATE SEGMENTATION METHOD

Previous methods discussed so far have been based mostly on the frequency of signs and sign sequences. Because there are many short texts that are often segments of longer texts and because signs or sign pairs are often used solo or in initial or terminal positions in short texts, these well-defined segments can be used in order to search for morphological boundaries within longer texts. The following parameter can be used to segment signs sequences:

frequency of each sign in initial position
frequency of each sign in terminal position
frequency of each sign pair in initial position
frequency of each sign pair in terminal position
frequency of bounded sign pairs
frequency of solo sign pairs
ratio between initial and terminal sign frequency indicating either a strong sign pair or a boundary between the sign pair.

The combination of these parameters leads to the Multivariate Segmentation Method, which is described in detail in Fuls (2015, 2019). It uses a model of connectivity with a value representing the strength of connection between each sign pair.

It is also possible to draw a segmentation tree based on the connectivity values, where a high connectivity value corresponds to a high z-score. The tree height depends on the length of the text and the number of directly connected sign pairs. This means that a small tree index shows a well-structured text (Figure 26), while a high tree index shows a less structured text. If a text remains less structured, this is due to the low frequency of signs, sign pairs or unusual sign sequences.

NUMERICAL SIGNS

The role of numerical systems in the process of decipherments is important as can be shown for the decipherment of many ancient writing systems. The first Maya signs identified by Rafinezque (1832) were the numerical signs for one and for five. Bennet analysed the numerals in Linear B, thereby helping to identify lists of quantities (Chadwick 1967). Nissen *et al.* (1993) used a special method to distinguish between different numerical systems in Early Sumerian writing. In all cases, analysing numerical signs was the first step towards a successful decipherment.

The Indus sign list contains different kinds of strokes: short strokes, short stacked strokes, long strokes, and special stroke signs (Figures 3-6). It is often assumed that stroke signs represent numerical values as in other cultures (Parpola 1994, Korvink 2007, Wells 2011).

The most obvious reason to assume that stroke signs represent numbers is the use of strokes in other cultures for counting. Another reason is that sequences of stroke signs most likely represent a complex numerical expression as in numerical systems of other cultures.

Figure 3: Short strokes (SHN) and their frequencies.

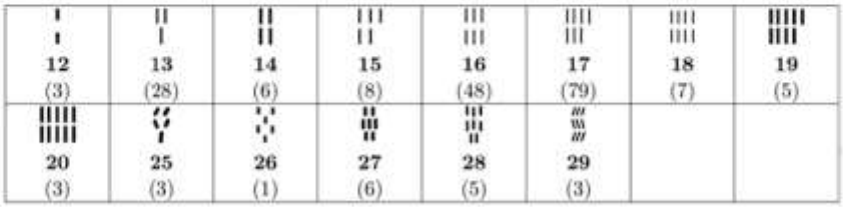


Figure 4: Short stacked strokes (SSN) and their frequencies.

Figure 5: Long strokes (LON) and their frequencies.

There exist several special signs that often co-occur with stroke signs, and, therefore, are used in a numerical context (Wells 2015:73-76). They are also regarded as numerical signs with special values or restricted usage.

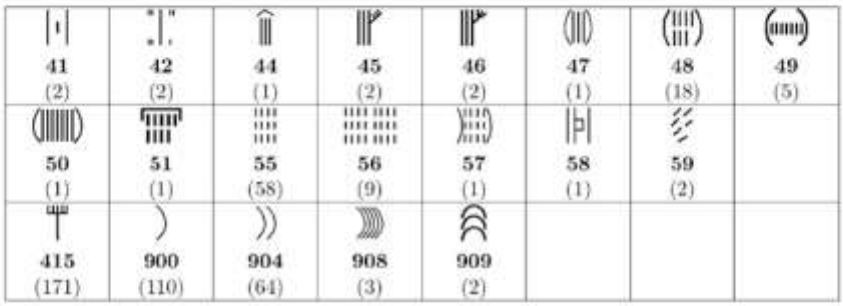


Figure 6: Special strokes and numerical signs (SPN) and their frequencies.

At present, we don't know for sure the base of the Indus number system or if there exist more than one base as is the case in Cuneiform writing. It has been suggested that Indus numerals are based on a decimal system because there are no more than 9 long or short stacked strokes (Wells 2011:135; Das Gupta 2019:7). An octal system with base 8 is favoured by others, since the root for 'eight' in Dravidian *en also means 'to count' and 'number' (McAlpin 1981:40-41; Fairservis 1992:61). This is supported by the maximum of 7 short strokes in Indus writing.

However, the frequencies of numerical signs are not equal but follow roughly a power law known as the Newcomb-Bendford-Law. According to the Newcomb-Bendford-Law the numbers in first position have decreasing frequencies from one to the highest possible number depending on the base. In a decimal system number one occurs about 30.1% in first position, number two 17.6%, number three 12.5%, and so on up to number nine (4.6%). In second and higher positions the frequencies are about the same for all numbers. The relative frequencies in other numerical systems (base 5 to 12) are shown in Figure 7 in comparison with the relative frequencies of long, short and stacked stroke signs and some special numerical signs.

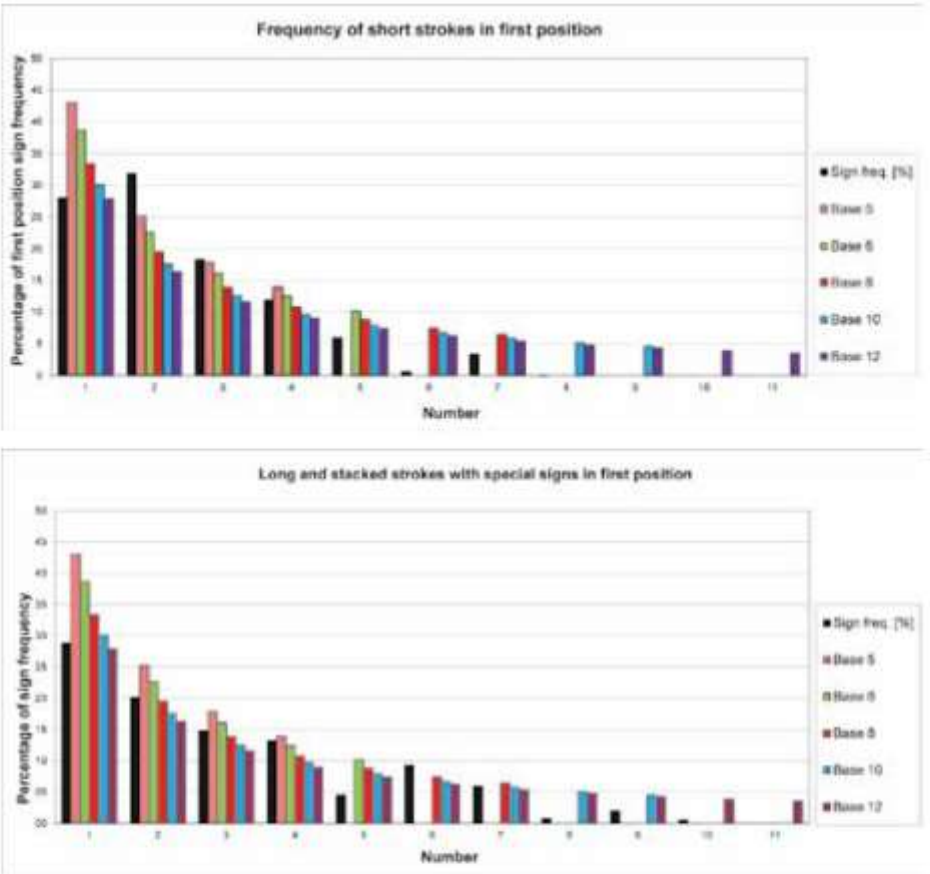


Figure 7: Relative frequencies of long, short and stacked stroke signs and some special numerical signs in comparison with the expected frequencies for numbers in first position according to the Newcomb-Bendford-Law for numerical systems of base 5 to 12.

NON-NUMERICAL SIGN PAIRS

There are frequent number-sign pairs with a high frequency of one numerical sign. The sign pairs 033-705 (101x), 033-706 (43x), and 100-415 (41x) are already recognized by Korvink (2007) and Wells (2011:135) as specific terms. Other sign pairs also have a high pair frequency to one specific numerical sign (Figure 8).

A second indicator of a non-numerical context is the case when a sign is affixed

Sign pair	Frequency	Connectivity	Sign pair	Frequency	Connectivity
 033-705	104	0.876	 033-706	46	0.838
 156-003	36	0.777	 156-031	11	0.516
 Set 30 -003	sum of 26 (only)	0.964	 520-033	55	0.697
 840-013	11	0.814	 861-003	28	0.609
 165-900	10	0.684	 226-032	15	0.727
 585-017	29	0.833	 100-415	41	0.761
 575-017	14	0.600	 220-415	90	0.875
 220-032	68	0.687			

Figure 8: Possible non-numerical frequent sign pairs. The keyword only indicates that the sign is only affixed by that numerical sign.

by only one specific numerical sign. Since we can expect that a countable object or measurements may co-occur with different numbers, the limitation to only one number most likely indicates a non-numerical context.

The high frequency of three strokes not only influences the relative frequencies of all other numerical signs in Figure 7, but also may indicate that in the Indus language the word for three can also be used as a homophone, non-numerical expression or word.

POSITIONAL NOTATIONS

Stroke signs can be combined to a sequence of stroke signs representing positional notation. Not all combinations of stroke signs can be found as shown in Figure 9.

ID	CISI	Type	Left signs	Numerical signs	Right signs	Other side
2393	M-1745	SEAL:S				
229	H-1312	TAB:I				
3613	M-1308	SEAL:R				
1534	H-589	SEAL:S				
177	(Harappa)	POT:T:g				
4233	(Dholavira)	SEAL:S				

Figure 9: Sequences of different types of numerical signs that may represent positional notation of numbers.

The text on seal M-1745 contains a sequence of four numerical signs. However, the first three signs of the text represent an initial cluster with sign pair 031-892 as a bounded cluster and Sign 2 as a grammatical marker of initial cluster. Only two of the stroke signs are used as numbers.

The only example of a combination of two special numerical signs can be found on pottery graffiti (M-2006). There Sign 415 is followed by Sign 900 (Figure 11, ID 2203).

The absolute numerical position of signs is a complicated question, since signs could represent a value in the next higher position because of the absence of a sign for zero (e.g. Sign 32 could be read as 2 or 2.0)[1]. Another question is how to read the combination of stroke signs and special numerical signs. Shall they be read in an additive manner (like Roman numerals) or in a positional manner?

[1] In this paper numbers in positional notation are listed with a dot in between, e.g. (decimal) 120 is written 1.2.0.

Another question is related to the internal reading order of numerical sign sequences. We know from Maya hieroglyphic writing that calendar dates start with the highest unit in positional notation (Bak'tun, K'atun, Tuun, Winal, K'in), but with the lowest unit in a distance number (K'in, Winal, Tuun, K'atun, Bak'tun). A similar flexibility may occur in Indus writing where numbers in different context are used.

SPECIAL NUMERICAL SIGNS

The numerical value of stroke signs is most likely the number of strokes. Stacked strokes are used only in first position, which means that they do not represent any higher numerical position. Other stroke signs represent the value depending on the position and the base of the numerical system.

Sign 415

Sign 415 is often used together with stroke signs (Figure 10) or is used instead of a numerical sign, e.g. the sign pair 220-415 replaces 220-032. It is therefore suggested that Sign 415 is a special numerical sign, at least in some context (Bonta 1996; Wells 2011:123).

The numerical value of Sign 415 is unknown. Its grapheme looks like a generalized hand with five fingers, but in context with 'fish'-signs it is supposed to have a value of 14 (Figures 20, 21, 23).

ID	CISI	Type	Left signs	Numerical signs	Right signs
1996	L-18	SEAL:S			
718	-	POT:T:g			
1250,1692	H-219, H-801	TAB:B			
2689	M-163	SEAL:S			
2902	M-406	SEAL:R			
2087	L-145	TAG			
1075	H-14	SEAL:S			

Figure 10: Examples of the numerical Sign 415.

Sign 900

Sign 900 may well be regarded as a special numerical sign (Figure 11). Its frequent use in combination with stroke signs, Sign 415, as well as the repetition of Sign 900 as Signs 904 and 908 indicates its use as a number. Sign 900 is only prefixed by one to five short strokes. The absence of numbers greater than five may indicate that Sign 900 represents number six. Signs 904, 914 and 908 are repetitions of Sign 900 and most likely represent multiples of the numerical value, i.e. 2x6=12, 4x6=24, and 5x6=30, respectively (Figure 12). Evidences for the numerical value six of Sign 900 will be shown in Figures 16, 18 and 21.

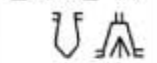
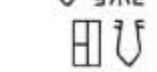
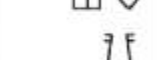
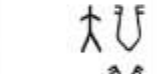
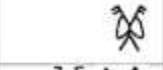
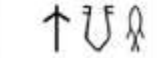
ID	CISI	Type	Left signs	Numerical signs	Right signs
3892	-	SEAL:S			
319	H-1077	SEAL:R			
1459	H-472	SEAL:S			
1119	H-60	SEAL:S			
1810, 3298	H-930, M-893	TAB:I, SEAL:S			
2719	M-194	SEAL:S			
2203	M-2006	POT:T:g			
4302	-	TAB:B			
1884	K-9	SEAL:S			
3742, 3745, 3746	M-1476, M-1479, M-1480	TAB:C, TAB:C, TAB:C			
3000	M-525	TAB:C			
3657	M-1358	SEAL:R			
1020	H-1657	SEAL:S			

Figure 11: Examples of the numerical Sign 900.

ID	CISI	Type	Left signs	Numerical signs	Right signs
1253	H-226	TAB:B			
3798	M-1569	TAB:C			
2826	M-307	SEAL:S			
835	H-2112	TAB:I			
228,229	-, H-1312	TAB:I			
2975	M-494	TAB:B			
170	H-1397	MISC			
2197	M-1685	SEAL:S			
2663	M-136	SEAL:S			

Figure 12: Special numerical Signs 904, 908, and 914.

Sign 70

Sign 70 may also be regarded as a numerical sign. It often appears together with stroke signs in positional notations (Figure 13). Since Sign 70 often follows two long or short strokes (Sign 2 or 32), a non-numerical interpretation as a bounded cluster is possible as well.

ID	CISI	Type	Left signs	Numerical signs(?)	Right signs
3099	M-658	SEAL:S			
1182	H-141	SEAL:R			
3422	M-1045	SEAL:S			
1540	H-597	SEAL:S			
3115	M-677	SEAL:S			
2695	M-170	SEAL:S			
2398	M-1883	SEAL:S			

Figure 13: Sign 70 as a numerical candidate or bounded cluster with two strokes.

SIGN 700 WITH NUMBERS

Numerical signs before or after Sign 700 are limited to Signs 1 to 4, 31 to 34 and 36, 14 and 17. However, their frequency distribution does not agree with the New comb-Bend ford-Law (Figure 14). Sign 700 has a very low frequency in combination with one stroke, but has an unusually high frequency with three and four strokes.

Wells (2018) demonstrates that Sign 700 represents a volumetric system with a unit of 40.4 litre for one long stroke. However, if a long stroke is 10 as will be shown in the next sections, then one volumetric unit equals 4.04 litre (Figure 16).

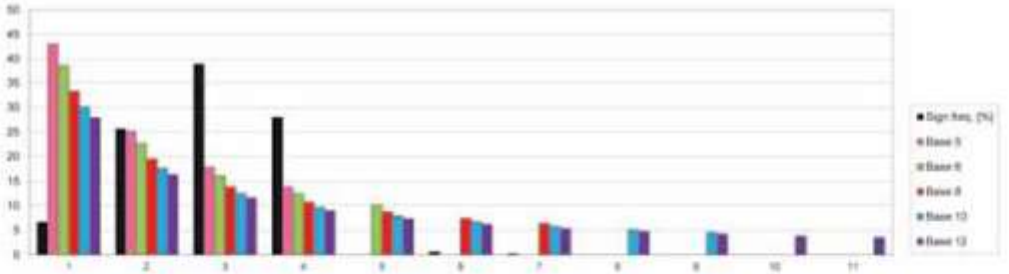


Figure 14: Relative frequency of numbers attached to Sign 700 in comparison with the expected frequency according to the Newcomb-Bendford-Law for bases 5 to 12.

NUMERICAL VALUES OF SIGNS

To determine the numerical values of signs several inscriptions can be used that contain some numerical signs as well as other information about the counted objects. Both parts of information can be compared on the basis of 'equations'. Even if the objects represented by Indus signs remain unknown, the numerical values should fulfil mathematical laws.

Counting bangles in a pot

In 1985 a pot used for firing stoneware bangles was found in Mohenjo-daro. 82 fragments of bangles were discovered inside the pot. About 15 to 20 complete bangles are reconstructed from these fragments (Wells 2015:94-95).
Near the rim of the pot a seal impression is still partly legible. While the beginning of the text is eroded (the first three signs are reconstructed), the rest of the sign sequence can be read (Figure 15).

ID	CISI	Left signs	Numerical signs	Right signs (reconstructed)
3679	M-1383			
			$7 + 1 \times \text{base}_L$	

Figure 15: Inscription on pot with 15 to 20 bangles (M-1383). The value of baseL is either 10 or 12.

Wells (2015:94-95) suggests that the two numerical signs 017-031 represent the original number of stoneware bangles once fired inside the pot. If this is correct, then the number should fall in the range between 15 and 20. The two numerical signs must therefore fulfil the equation

15 <= 7+1 x baseL <=20 (1)

with baseL representing the base of long strokes. The possible solutions for baseL fall between 8 and 13.

Then taking the maximum number of 9 long stokes into account (Sign 039) the base should be 10 or greater. The result is that baseL is either 10 or 12, excluding uneven numbers such as 11 or 13 as the base of long strokes because they would be prime numbers and impractical for a base of a numerical system.

Numerical value of Sign 900

The numerical value of Sign 900 can be derived from inscriptions on 3 two-sided tablets. Each of them lists the count of units of Sign 700 (Side 1) and the count of Sign 840 (Side 2). The first two tablets give the same number on both sides, 20 and 30 (in a decimal system), respectively, expressed by long or short stacked strokes (Figure 16). They do not offer the chance to detect the numerical system and its base.

ID	CISI	Text Side 1	Text Side 2	Count Side 1	Count Side 2
829 TAB:I	H-2211	 $2 \times 10 = 20$	 $2 \times 10 = 20$	20×  (80.8 litre)	20× 
1805 TAB:I	H-925	$3 \times 10 = 30$	 $3 \times 10 = 30$	30×  (121.2 litre)	30× 
3786 TAB:C	M-1540	 $3 \times 10 + 6 = 36$	 $2 \times 10 + 2 \times 8 = 36$	36×  (145.4 litre)	36× 

Figure 16: Numerical relationships between Sign 700 and Sign 840. The bases of long and stacked strokes are identical. Sign 700 represents a unit of 4.04 litre.

However, the third tablet (ID 3786) gives a more complex numerical expression. On Side 1 the count of Sign 700 units is expressed by two numerical signs, Sign 032 (three long strokes) and Sign 900. The numerical signs on Side 2 before and after Sign 840 are two long strokes and two short strokes. Because of the other tablets with identical number on both sides we can expect the same equivalency on this tablet. Therefore, the equation 3 x baseL + v = 2 x baseL + 2 x baseS must be fulfilled, with v being the numerical value of Sign 900 greater than zero. This gives us the equation

v = 2 x baseS - 1 x baseL (2)

Possible solutions for baseL of long strokes, baseS of short strokes, and value v of Sign 900 are listed in Table 1. If short and long strokes use the same base, then the value of Sign 900 equals the base. As indicated by the count of bangles (Figure 15) baseL is 10 or 12, excluding an uneven base for practical reasons.

Solution	Long stroke $base_L$	Short stroke $base_S$	Sign 900 value v
A	10	10	10
B	**10**	**8**	**6**
C	12	8	4
D	12	10	8
E	12	12	12

Table 1: Possible solutions for baseL of long strokes, baseS of short strokes, and Sign 900 value v. If baseL is an even number it is either 10 or 12 because of Formula 1. Only Solution B will meet the requirement in Figure 18 of an equation between three numerical expressions.

The maximum number of short strokes equals seven (Sign 7). We can, therefore, expect that the base of short strokes is 8 or greater. For long strokes the maximum number is nine (Sign 39). This is in agreement with a decimal system (Base 10). Taking these considerations into account, the calculations result into possible solutions of 4, 6, 8, 10, or 12 for the value of Sign 900, but never an uneven number such as 5, if the bases of both stroke systems are divisible by two[2].

[2] From Formula 2 we can derive the equation baseS = (v+baseL)/2. Since baseS must be a whole number, baseS is an even number. Furthermore, v and baseL must be both either even or uneven numbers, so that their sum is divisible by two.

Wells (2011:128) argues that the value of Sign 900 should be five, since Sign 900 plus Sign 2 replace seven stacked strokes (Sign 17) in front of Sign 585 on H-472. The argument is that sign pair 585-017 is a strong cluster with a pair frequency of 29 in 17 distinct texts, for example on M-547, M-1534, and M-1138 (Figure 17).

However, Sign 585 has a frequency of 59 and is not always prefixed by Sign 17. One example can be found on seal M-98 with sign pair 017-900 in front of Sign 585. On M-798 and M-2106 no numerical sign is used in front of Sign 585. And on M-722 and M-1112 no Sign 17 is written but other signs with numerical connotations. Therefore, the usage of sign pair 900-002 in front of Sign 585 is not necessarily a replacement of Sign 17.

ID	CISI	Type	Left signs	Numerical signs	Right signs
3212	M-798	SEAL:S			
2394	M-2106	ROD			
3483	M-1112	SEAL:S			
3146	M-722	SEAL:S			
3019	M-547	TAB:C			
3783	M-1534	TAB:C			
3505	M-1138	SEAL:S			
1459	H-472	SEAL:S			
2625	M-98	SEAL:S			
1064	H-3	SEAL:S			

Figure 17: Combinations of Sign 585 with and without numerical signs.

Because of the rare frequency of six short and long strokes (Signs 6 and 36) Sign 900 would be a good replacement for values of six. This and the base of short and long strokes are supported by another text as shown in Figure 18.

Another argument in favour of value six is the special fish sign 221 which is twice enclosed by Sign 900 (Figure 20). Wells has associated Sign 221 with a weight of 1/3 of the basic fish sign (Sign 220). If Sign 900 has a value of six but represents the fraction 1/6 then enclosing the basic fish sign, the sum of both enclosing signs would be 2 x 1/6 = 1/3 of the weight of the basic fish sign, or about 2.27 grams (Figure 20).

Finally, a value of six for Sign 900 requires a decimal system for long strokes (Table 1) which is in agreement with two long strokes representing the number 2x10=20 (Figures 20, 21, 22, 23).

List of items on a four-sided seal

Some inscriptions consist of several parts of texts with numerical signs and non-numerical signs in between. They can be interpreted as a list of items. From Sumerian inscriptions list of items are well known to list also the sum of all items.
Seal M-331 is a cuboid without boss inscribed on four sides: obverse (Side 1), reverse (Side 2), and two lateral faces (Sides 3 and 4). The texts contain several numerical signs, which can be analysed for the numerical system and its base (Figure 18).

The second line of Side 1 contains five stacked and four short strokes (Sign 14), separated by Sign 492 with unknown meaning. If Sign 14 is in second position of base 8, then it represents the number 4x8=32. Thus, Line 2 contains the numerical value 5+32=37.
Side 2 bears two numerical signs. Reading from right to left Sign 900 is in the second and Sign 1 in the first position. Therefore, they represent number 6x10+1=61 (if Sign 900 is number 6).

On Side 3 there are three short strokes with the possible value of 3x8=24 that again make use of an octal system for short strokes as on Side 1. They might be related to Side 4 listing the counted items. Comparing all numbers of the tablet leads to the equation 6x10+1=3x8+5+4x8=61. Therefore, Side 2 represents the sum of all items listed on the tablet.

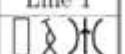
ID	Side 4 (lateral face)	Side 3 (lateral face)	Side 2 (reverse)	Side 1 (obverse)	
				Line 2	Line 1
2849 (M-331)		$3 \times 8 = 24$	 $6 \times 10 + 1 = 61$	 $5 + 4 \times 8 = 37$	
Sum:			$37 + 24 = 61$		

Figure 18: Positional notation on a four-sided seal with bases 8 and 10 of counted items (Side 1 Line 2, Side 3) and the sum of all items (Side 2).

The numerical expressions on the seal indicate that an octal system is used for short strokes, while Sign 900 represents the value 6 and belongs to the decimal system of long strokes. The mixture of different base systems is known from Sumerian writing and explains the different frequencies of stroke signs used as numbers (Figure 7).

'FISH'-SIGNS AND INDUS WEIGHTS

In the inscriptions of Indus writing we can find several different signs that look like a 'fish'. They are nicknamed 'fish'-signs. As shown in Figure 19 'fish'-signs are marked by great difference in the frequencies of occurrence; some are very frequent while others are very rare.

 **220** (466)	**221** (6)	 **222** (16)	 **223** (2)	 **224** (1)	**225** (1)	 **226** (38)	**227** (2)
 **228** (1)	**229** (3)	 **230** (3)	**231** (87)	 **232** (10)	**233** (192)	 **234** (9)	**235** (249)
 **236** (25)	**240** (352)	 **241** (12)	 **242** (5)	 **243** (12)			

Figure 19: 'Fish'-signs with sign numbers and their frequencies.

The so-called 'fish'-signs have been associated with weights by Bonta (1996). His argument based on the homophony of the Dravidian word for 'fish' (min) and ancient weight systems from Southwest Asia called minas. As known from several excavations, the Indus culture also used a weight system ranging from several grams up to kilograms (Marshall 1931, Mackay 1998, Vats 1940).

As shown by Korvink (2007) 'fish'-signs occur in a certain order. This is what we can expect when weights are put onto a scale. One will start with the heaviest weight and add smaller weights until the scale indicates the balance between weights and measured item(s).

Wells (this volume) recognized a cluster of weights in Harappa, Mound F together with inscribed artefacts where the texts contain several 'fish'-signs, in fact more than maybe expected for a random sign distribution. This confirms a relationship between 'fish'-signs and weights.

The question is, which 'fish'-sign represents which weight? The association of certain 'fish'-signs with Indus weights is proposed by Wells (this volume). He based his approach on a set of five 'fish'-signs in comparison with five weights in sequence from the cubic weight system defining the relation between 'fish'-signs and weights. The basic 'fish'-sign is Sign 220 corresponding to a weight of about 6.82 grams (Weight E in the cubic weight system as defined by Marshall (1931:590).

'Fish'-sign	Weight class	Factor of Weight E	Gram
	C	$\frac{2}{6} = \frac{1}{3}$ E	2.27 g
	D	$\frac{1}{2}$ E	3.41 g
	E	1 E	6.82 g
	F	2 E	13.64 g
	G	4 E	27.28 g
	H	8 E	54.56 g
	I	14 E	95.48 g
	J	20 E	136.40 g

Figure 20: 'Fish'-signs and associated weights.

In the following sections his associations will be tested within the Indus writing system in search of what can be called 'equations' between 'fish'-signs and counted items.

SIGN SEQUENCES OF COUNTING AND WEIGHING

There are several inscriptions listing the similar item (Signs 390, 405, and 407). They often follow directly Sign 590. In some texts we can find also one or more 'fish'-signs. In the sections that follow we will analyse these co-occurrences of the numerical count of (unknown) items and 'fish'-signs presumably representing some kind of weighing.

Weighing items of sign pair 407-590

On some inscriptions one can find the sign pair 407-590 preceded by numerical signs as well as 'fish'-signs in the first part of the text. In order to determine the existence of a constant ratio between the number of the item and the weight represented by the 'fish'-signs we will analyse the texts given in Figure 21.

On the rectangular seal M-1310 (ID 3615) the text contains the 'fish'-sign 235 representing a weight of about 54.56 grams. It is followed by the sign pair 407-590 and Sign 740, the later terminates the first part of the text. There are two numerical signs in Part 2, Sign 1 and Sign 4, followed by Sign 407. Thus, Sign 407 appears twice in the text, once with and once without Sign 590. This appears quite unique when we compare the sequence of two short strokes with other numerical inscriptions. If Sign 1 is not a word divider as suggested by Wells (2011:99), then it should be part of

a numerical expression. Since both numerical signs are of the same type, they should be added together to represent the value of 1+4=5. Calculating the ratio between the number of five items of Sign 407 and the weight of 8 E results in 8E/5 = 1.6E, or 10.91 grams for each item.

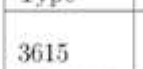
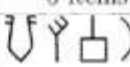
ID (CISI) Type	Count of items	'Fish'-signs (weight)	Initial cluster Ratio
3615			
(M-1310)	4 + 1 = 5	8 E	8E/5 = 1.6 E
SEAL:R	5 items ≙ 8 E (54.56 g)		1 item≙10.91 g
2063			
(L-114)	6 + 6 = 12	20 E	20E/12=1.67 E
SEAL:R	12 items ≙ 20 E (136.4 g)		1 item≙11.37 g
2422			
(M-1954)	10	14 E	14E/10=1.4 E
SEAL:R	10 items ≙ 14 E (95.48 g)		1 item≙9.55 g

Figure 21: Relation between counted items of sign pair 407-590 and 'fish'-signs representing multiples of Weight E (6.82 grams).

In the text of the rectangular seal L-114 (ID 2063) Sign 904 is given in the 3rd part of the text. As was already argued before, Sign 904 represents the doubled value of Sign 900: 6+6=12. Sign 60 functions as an ICTM followed by Sign 803 (with infixed Sign 390). In part 2 the basic fish sign 220 is given with Sign 32, representing 2x10=20 fish units of Weight E (2 fish units would be expressed by Sign 240). If the text contains the equation 20E (about 136.4 grams) equal 12 items, then one item has a weight of 20/12=1.67E (11.37 grams).

The last example is again a rectangular seal from Mohenjo-daro, M-1954 (ID 2422). sign pair 220-415 is used in the medial part of the text. It is a special sign combination associated with a weight of 14E (about 95.48 grams). In the terminal part of the text the sign pair 407-590 is prefixed by one long stroke (Sign 31). Since Sign 31 is a long stroke it belongs to the base 10 system, therefore representing value ten. The calculation of the ratio results in 14E / 10 = 1.4 E for one item, or about 9.55 grams.

Then calculating the ratio between the count of sign pair 407-590 as an unknown item and the weight represented by the 'fish'-signs, we get fractions of 1.6, 1.67, and 1.4 for all three examples. They correspond to a weight of about 10.91 grams, 11.37 grams, and 9.55 grams for one item. It is important to emphasise, that all three inscriptions dealing with sign pair 407-590 give about the same ratio between counting and weighing. This confirms that sign pair 407-590 represents a specific item with a specific weight. The average weight for the unknown item equals 1.56 E (±0.08 E), or about 10.62 grams (±0.55 grams).

Weighing items of sign pair 405-590

Sign pair 405-590 looks graphically similar to sign pair 407-590 but behaves in a different way with respect to the Bounded clusters 033-705 and 033-706. It never co-occurs with the Bounded cluster 033-705 but with the Bounded cluster 033-706. Therefore, we must analyse the two sign pairs separately.

There are several inscriptions with sign pair 405-590 that have no number. However, these inscriptions include different 'fish'-signs representing weights of 3E, 8E and 20E. It is interesting to note that the three weights describe a series with an almost constant factor of 2.67 and 2.5, respectively:
8/3=2.67 and
20/8=2.5.
Therefore, sign pair 405-590 is used in these texts in a general way, not with an explicit count, since the weight may already represent the implicit count of the item.

ID (CISI)	Artefact type	Terminal part	'Fish'-signs	Initial part
1175 (H-134)	SEAL:R		 3E	
3066 (M-605)	TAB:C		 3E	
3111 (M-672)	SEAL:S		 8E	
1402 (H-389)	SEAL:S		 8E	
1235 (H-204)	TAB:B		 8E	
2888 (M-392)	SEAL:R		 20E	

Figure 22: Examples of 'fish'-signs and sign pair 405-590 in the terminal part of the text.

It is interesting to note that the ratio between the specific weights for sign pairs 407-590 and 590 is 10.62 grams/4.12 grams=2.58, a value close to the ratio mentioned above.

Weight of Sign 590

Sign 590 also occurs by itself on one side of a tablet, while some 'fish'-signs can be found on the reverse side on two identical tablets (Figure 23). The texts on the two sides, obverse and reverse, may represent again an 'equation' between the number and the weight of items.

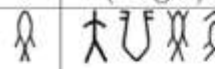
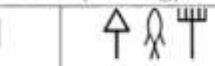
ID (CISI) Type	Side 2: Count of items	Side 1: 'Fish'-signs (weight)	Ratio
902, 904 (H-2020, H-2019) TAB:B	 20 , 'weighing of'?	 4 + 8 = 12 E	12E/20=0.6 E 1 item≙4.09 g
	20 items ≙ 12 E (81.84 g)		
848, 1821 (H-2149, H-941) TAB:I	 20 + 3 = 23	 14 E	14E/23=0.61 E 1 item≙4.15 g
	23 items ≙ 14 E (95.48 g)		

Figure 23: Relation between counted items of Sign 590 and 'fish'-signs representing multiples of Weight E (6.82 grams).

The first example shows two 'fish'-signs on side 1 that express the total weight of 4+8=12E, which is equivalent to about 81.84 grams. On side 2, Sign 32 represents the number 20 in front of Sign 590 (in this context Sign 220 most likely stands for a general term such as 'weighing'). Therefore, 20 items are equivalent to 12E, or 81.84 grams. Thus, one item would weigh about 4.09 grams.

In the second example there is a special combination of 'fish'-sign and a number. It is sign pair 220-415 representing a weight of 14E, or 95.48 grams. The numerical expression on the reverse side (side 2) includes Sign 3 (number 3), Sign 645 of unknown meaning, and Sign 32 (number 20). The sum of the two numerical signs equals 3+20=23. Therefore, the 'equation' of 23 items corresponding to a weight of 14E (95.48 grams) results in about the same weight of one item as in the first example: 4.15 grams.

Since the two derived weights for one item are nearly identical (4.09 and 4.15 grams), we can calculate an average of 4.12 grams (±0.03 grams) per item represented by Sign 590. The agreement of both examples indicates that Sign 645 of unknown meaning is not used as a number in this context.

As can be shown for several other inscriptions there does not exist always a mathematical relationship between 'fish'-signs and other counted or measured items, e.g. on many tablets for Sign 700 + number inscriptions. As known from other cultures, economic relations are influenced by several factors depending on time and/or region, thereby creating sometimes a more flexible relation between counted items and their weight or monetary value.

STRUCTURAL ANALYSIS OF INDUS TEXTS

In the following section we present the syntactic analysis of long patterned texts with numerical expressions or 'fish'-signs.

SYNTACTIC POSITION OF NUMERICAL SIGNS

Numerical signs are mostly used for counting or measuring items. Only in some cases numerical signs might be used in a non-numerical context. To analyse the syntactic position of numerical signs with a known numerical context, we use only clear-cut examples of long patterned texts (Figure 24). As can be seen numerical signs appear in initial, medial or terminal text parts. It follows that the syntax in long patterned texts is very flexible. Nouns represented by numbers, countable or measurable items occur in any part of the text.

ID	CISI	Type	Terminal part	Medial part	Initial part
Numerical signs in the initial text part					
1370	H-351	TAB:I			
2298	M-1758	SEAL:S			
1075	H-14	SEAL:S			
2592	M-64	SEAL:S			
Numerical signs in the medial text part					
1971	(Kish)	SEAL:S			
1174	H-133	SEAL:R			
2229	M-1737	SEAL:S			
Numerical signs in the terminal text part					
939	H-1705	SEAL:R			
1936	K-80	TAG:L			
Numerical signs in more than one text part					
2877	M-381	SEAL:R			
3711	M-1426	TAB:B			
2063	L-114	SEAL:R			

Figure 24: Syntactic position of numerical signs in long patterned texts.

The question remains, especially what concerns the last examples if there always should be a verb. Or is it possible to write complete statements without a verb in the Indus language? As for lists of items, verbs are certainly not necessary there.

SYNTACTIC POSITION OF 'FISH'-SIGNS

Within the Initial cluster that is terminated by Signs 1, 2, or 60 only the basic 'fish'-sign, Sign 220, can be found. In this context, Sign 220 presumably functions not as a specific weight but as a general term related to weighing. Other 'fish'-signs representing the weight of unknown items occur only in medial and terminal text parts (Figure 25). This means that the syntactic position of weighted objects is medial or terminal in Indus writing, in contrast to words with numbers that may also occur in initial position (Figure 24).

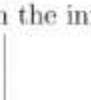
ID	CISI	Type	Terminal part	Medial part	Initial part
'Fish'-signs in the initial text part					
1293	H-268	SEAL:S			
3268	M-856	SEAL:S			
2592	M-64	SEAL:S			
'Fish'-signs in the initial and medial text parts					
2557	M-29	SEAL:S			
2135	L-219	TAG			
2801	M-280	SEAL:S			
'Fish'-signs in the medial text part					
1073	H-12	SEAL:S			
1098	H-39	SEAL:S			
3089	M-644	SEAL:S			
2861	M-365	SEAL:R			
2478	M-1906	SEAL:S			
'Fish'-signs in the terminal text part					
2582	M-54	SEAL:S			
2428	M-1738	SEAL:S			
3096	M-653	SEAL:S			
2389	M-1681	SEAL:S			
92	C-4	SEAL:S			
3598	M-1293	SEAL:R			
3318	M-921	SEAL:S			
27	B-1	SEAL:S			
2783	M-260	SEAL:S			

Figure 25: Syntactic position of 'fish'-signs in patterned texts.

SEGMENTATION OF H-1657 (ID 1020)

Square seal H-1657 was found at Area F, Trench 43 during the Harappa Archaeological Research Project (HARP) listed as H99-4064[3]. The artefact belongs to Period 3C and has 13 signs inscribed on the top part of the surface of the seal. The iconography is that of a Bull:i:W symbol and a SAN cult object as classified by Wells (2011).

The following MVS tree shows the division of the text into five parts:

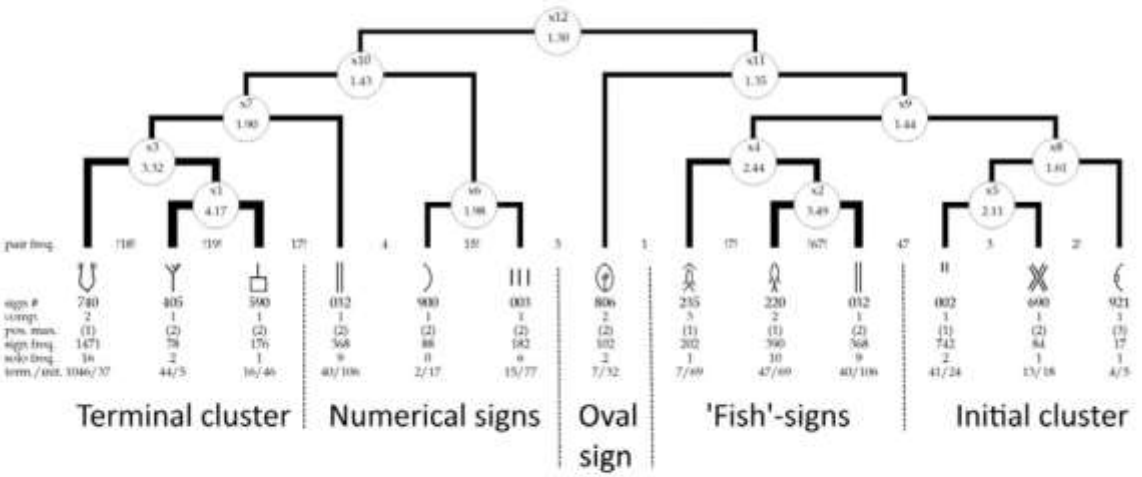


Figure 26: Multivariate segmentation tree of the inscription on seal H-1657 with a low tree index of 0.38 (reading direction is from right to left).

It is a typical Long Patterned text containing an Initial cluster that ends with Sign 2, a sequence of 'fish'-signs, an oval sign, a sequence of numerical signs, and finally a Terminal cluster with Sign 740 at the end.

The segmentation process starts with the analysis of solo signs. Seven distinct signs are solo signs that occur at least once as a complete text in the corpus and are, therefore, potential logograms: Signs 2, 3, 32, 220, 235, 405, and 740. Then searching for solo sign pairs that are part of this text we can find three secure and one presumable solo sign pair (Figure 27). The sign pairs 220-032, 405-590, and 740-405 can be found on other artefacts as complete solo texts. Sign 220 prefixed with Sign 32 is a frequent pair which is known from the analysis of 'fish'-sign sequences by Wells (2011). Sign pair 235-220 on H-2012 might be a complete or incomplete text, since the artefact is a fragment. Nevertheless, the end of the 'fish'-sign sequence after Sign 235 represents, no doubt, a morphological border.

[3] *Harappa Excavations 1999: Richard H. Meadow, Jonathan Mark Kenoyer and Rita P. Wright July 30, 2000, Figure 32.07.*

Shown in Figure 27 is also the Sign triplet 740-405-590 on M-1922, a square seal without any iconography from Mohenjo-daro found in the DK.G (South) area. The triplet proves that all three signs belong together forming one word or phrase.

Text on H-1657													
Signs:	740	405	590	32	900	3	806	235	220	32	2	690	921
Solo signs:	11x	1x	-	46x	-	6x	-	1x	8x	46x	2x	-	-
Solo sign pairs		M-681							ID 151 H-1084				
	ID 57							H-2012?					
Solo sign triplet	M-1922												

Figure 27: Segmentation of the Long Pattern text on H-1657 (ICIT ID 1020). For solo signs their frequency as a solo text is listed.

There exists an interesting text on H-8 (ID 1069) that is similar to the one on H-1657. Both of them are Long Pattern texts starting with the same three signs: 002-690-921. Besides, both contain the Sign triplet 740-405-590. In the text H-8 the frequent sign pair 033-706 is located between both parts. In post-terminal position are Signs 354-001, an appendix that also occurs in text M-1340.

CISI	Post-terminal	Terminal	Numerical	Oval	Fish	Initial
H-1657 Signs:		740-405-590	032-900-003	806	235-220-032	002-690-921
H-8 Signs:	354-001	740-405-590	033-706			002-690-921

Figure 28: Comparison of two similar texts.

On the whole, the segmentation of the Long Patterned text on seal H-1657 shows that the text has an Initial cluster with three signs of unknown meaning, a 'fish'-sign sequence most likely representing information about the weight (20E+8E=28E, or about 193.2 grams), Sign 806 infixed with a sign of Set 28 similar to Sign 405 that occurs near the end of the text, a sequence of numerical signs that may represent the number 3+6+20=29 or 3x8+6+20=50, and finally the Terminal cluster with a focus on Sign 405 in the centre of the triplet.

SUMMARY

Indus inscriptions can mostly be read from right to left. They involve a sign list of about 702 distinct signs, although only less than 100 signs belong to the 'core' of Indus signs of high frequency or widespread usage. It is a logographic-syllabic writing system with roughly 50% of logograms and 50% of syllables.

About 3976 texts with numerical signs and 1237 texts with 'fish'-signs have been found so far. The numerical base of long and short strokes as well as the numerical value of some special signs can be detected through 'equations' found on tablets and seals. The numerical value of Sign 900 is six as verified in Figures 16, 18, and 21. There are several pieces of internal evidence that a decimal and an octal system were in parallel use in Indus writing differentiated only by the length of the strokes. Long strokes are use in a decimal system while short strokes are used in an octal system. The numerical system of stacked strokes is less secure (Figure 16, ID 1805) but most likely also a decimal system. Short or stacked strokes are used in combination with long strokes to represent numbers smaller than ten (Figure 29).

Decimal system (Base 10)		Octal system (Base 8)		Weight system (Base 10)	
	$1 \times 10 = 10$				$\frac{2}{6} = \frac{1}{3}$ E
	$6 + 6 = 12$				1 E
	$7 + 1 \times 10 = 17$		$4 + 1 = 5$		3 E
	$2 \times 10 = 20$				4 E
	$2 \times 10 + 3 = 23$				8 E
	$3 \times 10 = 30$				$4 + 8 = 12$ E
	$3 \times 10 = 30$		$3 \times 8 = 24$		14 E
	$3 \times 10 + 6 = 36$		$4 \times 8 + 5 = 37$		$2 \times 10 = 20$ E
	$1 + 6 \times 10 = 61$				
Mixed system (Bases 10 and 8)					
	$2 \times 10 + 2 \times 8 = 36$				

Figure 29: Signs used in the analysis of the Indus number system and the Indus weight system.

Because of the absence of a sign for zero, it is sometimes difficult to decide whether sequences of numbers should be added or they represent positional notation. At present no rule on this issue can be traced because of the small sample size of 'equations'. However, Sign 645 may indicate that the sum of the numbers should be calculated as demonstrated on two examples (Figures 16 and 23).

At least five 'equations' between 'fish'-signs and counted items confirm the associated weights proposed by Wells (this volume) for several 'fish'-signs. They confirm that Sign 32 in right position of Sign 220 represents number 20; confirming therefore a decimal system of long strokes. The weights represented in the inscriptions are usually very small, falling in the range between 3 and 136 grams. The implication is that small or light items are listed in the inscriptions with a specific weight of about 4.1 grams and 10.6 grams for each item, respectively.
The syntactic analysis shows that stroke signs are used in all positions of Long Patterned texts while 'fish'-signs, except the basic 'fish'-sign 220, occur only in medial and terminal positions. This means that weighted items follow the Initial cluster and that the syntactic position of objects is medial and terminal in the Indus language. It does not necessarily indicate, however, that the initial position represents a predicate, since a list of items usually does not require a verb. This is confirmed by the initial position of numerical expressions in several Long Patterned texts, since subjects can be counted in the same way as objects.

LITERATURE

Ashraf, Md. Izhar; Sinha, Sitabhra: The "handedness" of language: Directional symmetry breaking of sign usage in words. PLOS ONE 13(1) (2018), 1-16.

Bonta, Christopher Steven: Topics in the Study of the Indus Valley Script. Brigham Young University 1996.

Chadwick, John: *The Decipherment of Linear B*. Cambridge University press, Cambridge 1958 (2nd edition 1967).

Nissen, Hans J. ; Peter Damerow, Robert K. Englund: *Archaic Bookkeeping: Early Writing and Techniques of Economic Administration in the Ancient Near East*. University of Chicago Press, 1993.

Das Gupta, Tapan Kumar: *Induskultur: Zahlen, Sprachen, Schrift*. Books on Demand, 2019.

Fairservis, Walter A.: *The Harappan Civilization and its Writing. A Model for the Decipherment of the Indus Script*. New Delhi: Oxford and IBN Publishing Co. Pvt. Ltd. 1992.

Fuls, Andreas: Entwicklung einer geographisch-epigraphischen Datenbank der Indusschrift. In: Sven Weisbrich and Robert Kaden (Ed.), *Entwicklerforum Geoinformationstechnik 2010*, Shaker Verlag, Aachen 2010, pp. 29-45.

Fuls, Andreas: Positional Analysis of Indus Signs. *Voprosi Epigrafiki*, Vol. 7 (1) 2013, pp. 253-275.

Fuls, Andreas: Appendix I: Automated Segmentation of Indus Texts. In: Bryan K. Wells, *The Archaeology and Epigraphy of Indus Writing*. Archaeopress, Oxford 2015, pp. 100-118.

Fuls, Andreas: Classifying Undeciphered Writing Systems. *Historical Linguistics*, Vol. 128 (1), 2015, pp. 42-58. DOI: 10.13109/hisp.2015.128.1.42.

Korvink, Michael P.: *The Indus Script. A Positional-Statistical Approach*. Gilund Press, 2007.

Mackay, E. J. H.: *Further Excavations at Mohenjo-daro*. Munshiram Manoharlal Publishers Pvt., Ltd., Delhi 1938.

Marshall, Sir John: *Mohenjo-daro and the Indus Civilization*. London: Arthur Probsthian 1931.

McAlpin, David W.: *Proto-Elamo-Dravidian: The Evidence and its Implications*. Philadelphia: The American Philosophical Society 1981.

Wells, Bryan: *Epigraphic Approaches To Indus Writing*. Oxbow Books, Oakville and Oxford 2011.

Wells, Bryan: *The Archaeology and Epigraphy of Indus Writing*. Archaeopress, Oxford 2015.

Wells, Bryan: The Volumetric System of Harappa. In: Dennys Frenez, Gregg M. Jamison, Randall W. Law, Massimo Vidale and Richard H. Meadow, *Walking with the Unicorn: Social Organization and Material Culture in Ancient South Asia*, Oxford: Archaeopress 2018, pp. 623-627.

APPENDIX A: SIGN LIST WITH 702 SIGNS OF THE ICIT DATABASE.

 1	2	 3	4	 5	 6	 7	 12	 13	 14	 15	 16	 17	 18
19	20	 25	26	27	28	 29	31	32	33	 34	35	36	37
 39	 41	 42	 44	 45	46	 47	48	 49	50	 51	55	56	57
58	59	60	61	62	63	64	65	66	67	68	69	70	71
72	73	74	75	80	81	82	83	84	85	90	91	92	93
94	95	97	98	99	100	101	102	103	104	105	106	107	110
111	112	113	115	116	117	118	119	121	122	123	125	126	127
128	129	130	131	132	133	134	135	136	137	138	139	140	141
142	143	144	145	146	147	148	150	151	152	153	154	155	156
157	158	159	160	161	165	166	167	168	169	170	171	172	173
175	176	177	178	179	180	190	191	192	193	194	195	200	201
202	203	204	205	206	207	208	209	215	216	217	219	220	221
222	223	224	225	226	227	228	229	230	231	232	233	234	235
236	240	241	242	243	244	250	251	252	253	255	256	257	260
261	262	263	264	265	266	267	268	269	270	271	272	275	276
277	278	279	280	281	285	286	287	290	291	292	293	294	295
296	297	298	299	300	301	302	303	304	305	306	307	308	309
310	311	315	316	317	318	319	320	321	322	323	324	325	326


327 328 329 330 335 336 337 338 340 341 342 343 344 345
346 347 348 350 351 352 353 354 360 361 362 363 365 367
368 370 371 372 373 374 375 376 380 381 382 383 384 385
386 387 388 389 390 391 392 393 394 400 401 402 403 404
405 406 407 408 409 410 411 412 413 415 416 417 418 420
421 422 423 424 425 426 427 428 429 430 435 436 440 441
442 443 444 445 450 451 452 453 454 455 456 457 458 460
461 462 465 466 467 468 469 470 471 472 473 474 475 479
480 481 482 483 484 490 491 492 493 494 495 500 501 502
503 504 505 506 510 511 512 513 515 516 517 518 519 520
521 525 526 527 528 530 531 532 533 534 535 540 541 542
543 544 545 546 547 550 551 552 554 555 556 560 561 562
563 564 565 570 571 572 573 575 576 577 578 579 585 586
590 591 592 593 595 596 597 599 600 601 602 603 604 605
610 611 615 616 617 620 621 622 623 625 626 627 628 629
630 631 632 633 634 635 636 637 638 639 640 641 642 645
646 647 678 679 680 681 682 683 684 685 686 687 688 689
690 692 693 694 697 698 699 700 702 703 704 705 706 707


708 709 710 711 712 713 714 715 716 717 718 719 720 721
722 725 727 728 729 731 732 733 734 735 736 740 741 742
743 744 745 746 747 748 749 750 751 752 753 760 761 762
763 764 765 766 767 768 770 772 773 775 776 777 778 780
781 782 783 784 785 786 790 791 792 793 794 795 796 797
798 799 801 803 804 805 806 807 808 809 810 811 812 813
814 815 816 817 818 820 821 822 823 824 825 826 827 828
829 830 831 832 833 834 835 836 837 838 840 841 842 843
844 845 849 850 851 852 853 854 855 856 857 858 859 860
861 862 863 864 865 866 868 869 870 871 872 874 875 876
877 878 879 880 890 891 892 893 894 895 896 897 898 899
900 901 902 903 904 905 906 907 908 909 910 911 912 913
914 918 919 920 921 922 923 924 925 926 927 928 930 931
932 933 940 942 943 944 945 946 947 950 951 952 953 956
957 958

Indus Weights and "Fish" (Set 11) Signs

Dr. Bryan K. Wells,
October 1, 2019. Duncan, B.C.

A. The Indus System of Weights

Introduction

The Indus culture had a system of well-defined weights and measures, which formed the bases of their system of exchange. The most well known element is the Indus system of weights. It is also know that the Indus system was used in Dilmun (modern Bahrain) and there is overlap of the Indus system with many other old world cultures (Table 1). It is evident from this table that the ≈13.5 g weight was in international use.

All Indus			Dilmun			Ebla			Notes
Weight	Freq	Class	Wt	Freq	Dif	Wt	Freq	Dif	
0.87	5	A							
1.7	13	B	1.8	1	0.1	1.4	1	-0.30	
2.28	9	C							
3.5	31	D				**3.6**	**1**	**0.10**	
6.9	45	E				**6.90**	**3**	**0.00**	
13.4	***91***	***F***	***13.7***	***2***	***0.3***	***13.8***	***1***	***0.40***	***Egyptian golden dbn of 13.5g***
27.4	**94**	G	**27**	**1**	**-0.4**	25.4	1	-2.00	
54.8	**23**	H				53.9	1	-0.90	
96.5	1	I				66.5	2	-30.00	
136.02	11	J				145.655	3	9.63	
174.5	**1**	K	**171**	**1**	**-3.5**				7x26.5=185.5
271.33	4	L							
546.7	1	M	670	1	123.3	473	3	-73.70	**Dilmunx13.7**
1317.5	4	N	**1370**	1	52.5	1232	1	-85.50	105.0191606
2701.4	2	V				2232	1	-469.40	199.6919708
5556	1	W							
6903	1	X							
10865	2	Y							

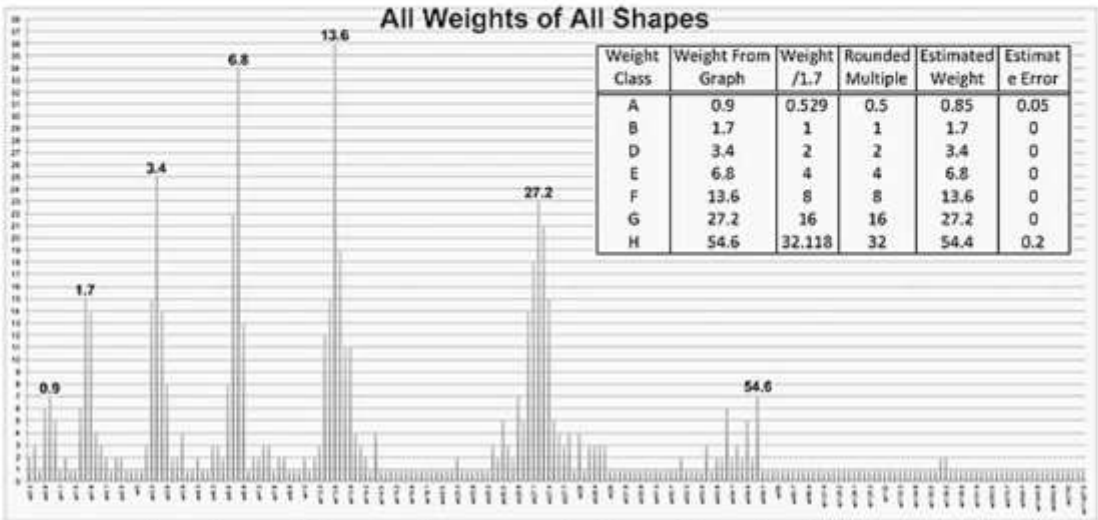
Weight: Wt, Frequency: Freq, Wt - Indus Wt = Diff

Table 1. Comparison of the Indus system of weights to Dilmun, Ebla and Egypt. Yellow = light weights in common; Orange = heavy weights in common; Blue = international standard weights.

The basic Indus system is often said to be binary or doubling (except weight Class C), but the excavated weights are not that simple nor are they as uniform as is commonly stated. Instead, what is found is that weights in the basic Indus system are far less uniform than the literature would suggest. There are regional differences, differences between shapes, and several weights in perfect condition are not in the basic Indus system. These variations are ignored for the sake of simplicity in all published accounts. These differences are likely the results of social behavior. As the reconstruction of ancient social behavior is the ultimate goal of archaeological excavation, it seems ill advised to discard this important information without analysis. One focus of this discussion is the variations between weights.

The Data

To date 744 weights (Figure 1) have been excavated and reported from Indus sites. This total excludes Kalibangan, Dholavira and Farmana, whose material remains are still unpublished. Of the weights listed in the literature, the details describing them vary widely.



Weight Class	Weight From Graph	Weight /1.7	Rounded Multiple	Estimated Weight	Estimat e Error
A	0.9	0.529	0.5	0.85	0.05
B	1.7	1	1	1.7	0
D	3.4	2	2	3.4	0
E	6.8	4	4	6.8	0
F	13.6	8	8	13.6	0
G	27.2	16	16	27.2	0
H	54.6	32.118	32	54.4	0.2

Figure 1. All weights of all shapes and sites. Inserted table matches well with the traditional system as proposed by Marshall (1927).

The most detailed data listings (Mackay 1937) give the accession number, condition, shape, dimensions, material, provenience, weight class, and weight in grams. However, for the majority of weights only the weight and sometimes the shapes are listed (Figure 2).

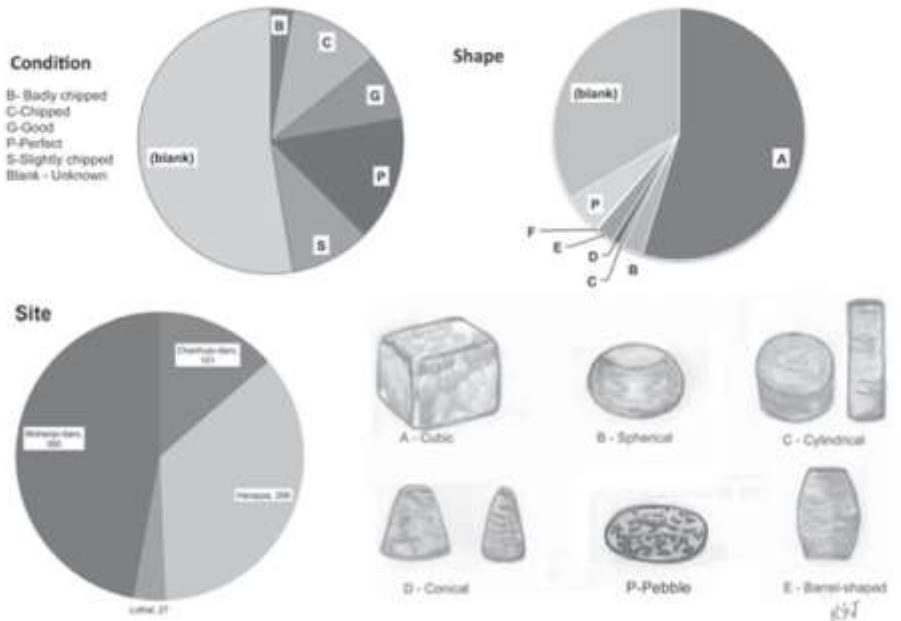


Figure 2. Examples of the various shapes, conditions and sites of origin for the Indus weights (drawing courtesy of R. Johnson 2012).

The incomplete nature of data for weights creates some serious problems in the analysis of Indus Weights. For example, a cubic weight weighing 13.4 grams that has been broken into two pieces (with only one piece surviving) cannot be distinguished from a weight weighing 6.7 grams in perfect condition. Consequently, meaningful research into the Indus system of weights must be based on artifacts whose condition is known.

Of the 744 weights recorded 114 are in perfect condition, 85 are in good condition and 73 are slightly chipped, totaling 272 weights for analysis. To put this into perspective there are 392 weights whose condition is unknown and 105 have significant damage. These heavily damaged weights play no role in the following analysis and neither do the 37 pebble-shaped weights from Chanhujo-daro, as these are not certainly weights.

Weight shape is another issue impacted by the available data (Figure 2). Shape data is more commonly recorded with the shape of 450 weights known and 249 unknown. Of the 450 weights with recorded shapes the vast majority (407) are cubic (Figure 2). Cubic weights whose condition is know and that are in good enough condition to be used in analysis number only 207. This is the largest usable data set in the inventory of Indus weights.

The following analysis begins with the most certain data and uses this as a baseline for analyzing the less certain data. For this reason we need to start with the weights that have the most detailed description of their characteristics: The Mohenjo-daro excavations of Mackay (1937).

Mohenjo-daro

There are 350 weights from Mackay's excavations at Mohenjo-daro. Of these 253 are in good enough conditions to be analyzed, but the shape is known for only 232 weights. The weights excavated from Mohenjo-daro come in many different shapes(but not pebble-shaped which are specific to Chanhujo-daro).

Cubic Weights

Cubic weights are the most common type reported from Mohenjo-daro (n=200). Examining this list of cubic weights in detail it becomes clear that there are at least 9 clusters of weight values (Table 2). These differ from the traditional weight system (Table 4) in several ways. First, the smallest perfect weight weighs 0.55 grams, this value is not found in the traditional system. Weight Classes A and B, and D-G, differ only fractionally from the traditional system. Weight class L can also be verified with only a 0.366% error. Weight classes C, I, J, K and M-Y are not part of the cubic weight system with certainty.

Mean	Min	Max	Rng	% mean	Freq	x6.777	Multiple
0.550					1	0.081	16th
0.873	0.818	0.928	0.11	12.600	4	0.129	8th
1.780	1.684	1.891	0.207	11.626	6	0.263	Quarter
3.449	3.313	3.78	0.467	13.539	19	0.509	Half
6.777	6.305	6.957	0.652	9.621	15	1.000	1
13.706	13.079	14.29	1.211	8.836	30	2.022	2
27.294	26.312	28.02	1.708	6.258	20	4.028	4
54.415	54.297	54.496	0.199	0.366	3	8.030	8
274.938					1	40.572	40

Table 2. Results of Cubic weights analysis from Mohenjo-daro Dk.G (Mackay 1937) using perfect weights.

In addition to the weights in good condition that fit the overall pattern, there are weights in perfect condition that do not fit this pattern (Table 3).

ID #	Condition	Shape	Weight
DK3746	P	A	15.937
DK3542	P	A	16.64
DK5503	P	A	25.354
DK4622	P	A	29.225

Table 3. Aberrant cubic weights from Mohenjo-daro that are in perfect condition.

These objects are enigmatic and point to the complexity of the data related to Indus weights. They may be special purpose weights or weights of a second system.

Spherical Weights

Spherical weights comprise a smaller analytical set with only 9 examples in good enough condition to be used (Table 4). They fit the same system as Cubic weights, but with only 6 classes extant. There is an interesting pattern of multiples in that 1, 2 and 4 x 6.7g form 1 set of small weights, 28 x 6.7g is a middle sized weight and 215 and 400 x 6.7g form a set of heavy weights. Some of these gaps in the sequence could exist because of the small sample size, but the fact that 1438g is very close to 100x13.64 and 2656.045 is ≈100x26.48g is suggestive of a system of fixed product weights. That is, while cubic weights are used to weigh items of any size, spherical weights may have been used to measure things of fixed weights.

Mean	Freq	x6.7	Multiple	Est. Wt.	Error	% Error
7.011	3	1.046	1	6.700	0.311	4.436
13.640	2	2.036	2	13.400	0.240	1.760
26.480	1	3.952	4	26.800	-0.320	-1.208
185.500	1	27.687	28	187.600	-2.100	-1.132
1438.763	2	214.741	215	1440.500	-1.738	-0.121
2656.045	2	396.425	398	**2666.600**	-10.555	-0.397

Table 4. Spherical weights in good condition from Mohenjo-daro.

The question of why the Indus people would go to the trouble of making spherical weights, when cubic weights are so much easier to manufacture remains unanswered. I consider this the best evidence that weights of different shapes were used to weigh different classes ofcommodities. There is a single example of a spherical weight from Harappa, but its condition is unknown (Vats 1940).

Barrel-shaped

Another class of Indus weightsare barrel-shaped. Like spherical weights, weights of this shape are relatively rare (n=5) and so their analysis faces all the same problems as spherical weights (Table 5).

Weight	6.777	Freq	Mult	Est Wt	Error	% Error
28.47	4.201	1	4	27.108	1.362	4.784
33.553	4.951	1	5	33.885	-0.332	-0.989
55.9	8.248	1	8	54.216	1.684	3.013
96.476	14.236	1	14	94.878	1.598	1.656
151.424	22.344	1	22	149.094	2.330	1.539

Table 5. Tabulation of Barrel-shaped weights from Mohenjo-daro.

As can be seen in Table 8, there are only 5 usable Barrel-shaped weights from Mohenjo-daro. Each weight has a unique value. There are no very large or very small Barrel-shaped weighs. We cannot say much about such a small sample. The multiples of 4, 5, 8, 14 and 22 x 6.77g do not seem to form a complete sequence. If they are used to weigh a specific commodity, then this sequence could not be expected to conform to the pattern of other weights.

Summary

What has been shown in this discussion is that the Indus system of weights is far more complex than traditional opinion would lead us to believe. Significant regional differences can be shown (Table 6).

These results demonstrate that weights vary across the Indus valley (i.e. there is no pan-indus system of weights). This is also true of sign use in the Indus script and the distribution of artifact types. Historically, research into the Indus Valley as adhered to the pan-Indus nature of Indus material culture. Here we offer this data as a new starting point for the analysis of Indus weights. Research needs to recognize the variety and difference in the distribution and uses of items of Indus material culture.

Table 6. Indus weights by shape, site and excavator.Mackay and Marshall from Mohenjo-daro; Vats and HARP from Harappa; S.R. Rao from Lothal.

Fish Signs (Set 11)

B. Set 11 "Fish" Signs

Bonta (1995) has suggested that the Set 11 signs (Wells 2006), also known as "Fish" signs, represent the units of some metrological system, perhaps weights (Figure 9). In this study I have tried to differentiate between data sets on the basis of their reliability. In the case of Bonta's identification of Set 11 signs as units in the Indus system of weights, it is based entirely on the distribution of these signs in the Indus inscriptions and cogent reasoning. In Bonta's own words:

The so-called "fish" signs are among the most distinctive signs in the Indus Script inventory. We hypothesize that, based on distributional and graphological evidence,

that the fish signs as a class often denote metrological data, and propose that many of the seal inscriptions, sealings, and other corpus materials denote commercial information such as ownership of assets, weights, commodity amounts, etc. Bonta 2010 IMSc Chennai.

Within the ICIT corpus and sign list Fish-like signs are designated as Set 11. There are 20 signs in Set 11 (Figure 3).

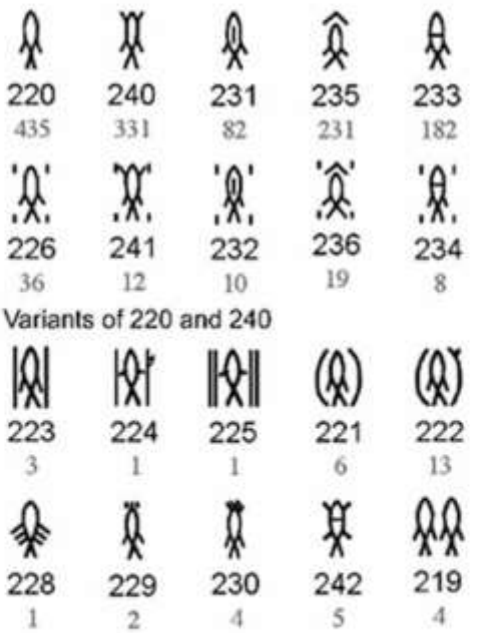


Figure 3. Set 11 "fish" signs with sign numbers and frequency of occurrence.

There are several ways we can evaluate the various signs in Set 11. We can examine their frequency and note that some of these signs are far more common than other varieties. A close examination of the 5 most frequent Set 11 signs result in the following list: 

. Sign 220  is both the most frequent and the simplest in design. This suggests that sign 220 is the most basic of the Set 11 signs and other sign graphs are elaborations of this basic design. The same may be true for the items these sign represent, perhaps weights.

Figure 4 lists 16 Indus texts were sign 220 collocates with various numerals. These sign clusters have been called M-cluster (Bonta 1995). The "M" stands for metrological.

Figure 4. Sign 220 plus number clusters in medial M-contexts

These are not the complete set of sign 220 collocations with numerals, but they are representative. Longer texts are more difficult to analyze. This obstacle can be over come by applying the Multivariate Segmentation Method (Fuls 2015). In Figure 5 the rectangular seal text M-0369 is analyzed using this method.

With regards to Set 11 signs and right adjacent numerals, Table 7 lists their colocations.

Search for sign combination %FSH-num%
Text frequency from any site on any type "%"
21 left sign(s) AND 37 right sign(s)

	right sign												
	3	4	14	16	17	31	32	33	3455	65	415	705
left sign	𓏺	𓏺𓏺	𓏺𓏺	𓏺𓏺	𓏺𓏺	𓏺	𓏺	𓏺	𓏺𓏺	𓏺	𓏺	𓏺
220	20	4	2	14	1	4	66	3	1	10	8	82	1
221	-	-	-	-	-	1	-	-	-	-	-	-	-
226	1	-	-	-	-	-	13	-	-	-	-	4	-
227	-	-	-	-	-	-	-	1	-	-	-	-	-
231	1	-	-	-	-	-	-	-	-	-	-	1	-
232	-	1	-	-	-	-	-	-	-	-	-	-	-
233	1	-	-	-	-	1	-	-	-	-	-	4	-
234	-	-	-	-	-	-	-	-	-	-	-	1	-
235	-	-	-	-	-	1	-	-	-	2	-	-	-
240	-	-	-	-	-	9	1	3	-	-	-	2	-
241	-	-	-	-	-	1	-	-	-	-	-	-	-
243	-	-	-	-	-	2	-	-	-	-	-	-	1

Table 7. Set 11 signs and their collocations with right adjacent numerals with null results eliminated.

The distribution of numeral and Set 11 sign collocations are uneven (Table 7). This data indicates that, whatever these signs are annotating, the system has a fixed set of

values and not all possible combinations are part of the system. This preference of use is emphasized by the fact that the original search matrix (21 Set 11 signs by 37 numeral signs) had 777 cells, of which only 32 cells have frequencies. That is, only 4% of the combinations of Set 11 signs and numerals are used.

To discover the use of M-Clusters we can look to their context in M-0369 (Figure 5) for an example of their context.

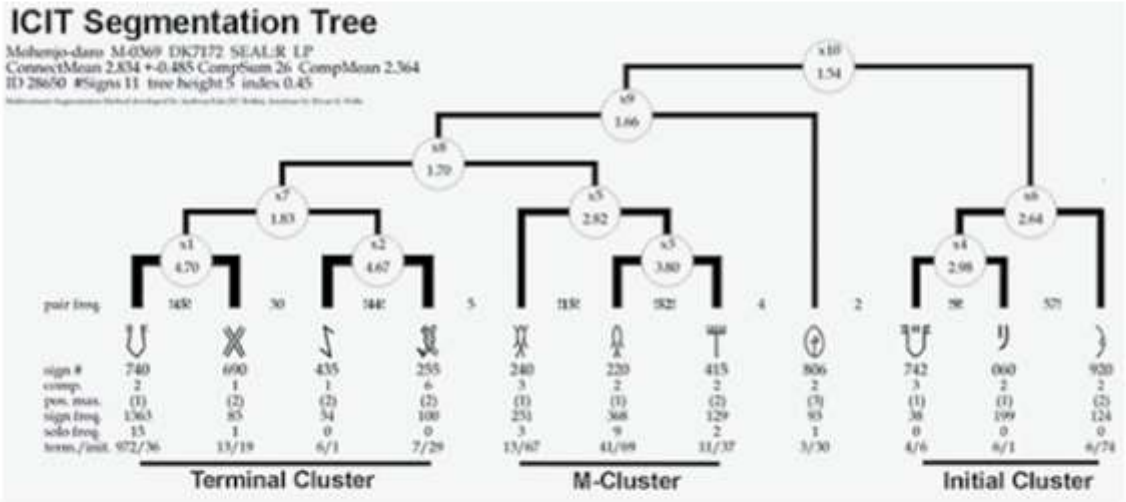


Figure 5. Segmentation tree for M-0369 showing the context of M-cluster in a Long Patterned text (from ICIT).

It can be seen in Figure 5 that this text breaks down into three highly correlated elements: Initial, Metrologic and Terminal sign clusters. An Important feature of this figure is that, within the M-cluster, sign 220 is most highly correlated to sign 415 . This same correlation can be seen with Sign 032 in other similar contexts (Figure 10). The strong relationship between sign 220 and both sign 032 and 415 has lead Bonta (1995) to suggest that these specific pairings with sign 220 are actually one sign: and , representing different units of the Indus system of weights. It is also possible that both 032 and 415 are numerals counting quantities of 220, in which case 032 and 415 are found in numeric contexts elsewhere, but rarely.

For the purposes of the following analysis I will accept Bonta's suggestion that some fish signs in some context are elements of the Indus system of weights, and that and are elements in this system. I will also suggest here the basic "Fish" signs represent the basic (most common) cubic weights. From this starting point we can begin the analysis of "Fish" signs in comparison to the cubic weight system.

C. Basic "Fish" Signs as Weights

How can the Set 11 signs and the Indus weights be equated? The short answer is that they cannot with absolute certainty. All that can be done is to suggest possible associations based on logical deductions and the patterns in weight size. This exercise is not intended to be the last word on the fish = weight equation. Rather it is intended as one possible solution.

The starting point for this research is the assumption that the most common Set 11 signs are likely associated with the most common weights. As was demonstrated in the discussion of these weights, the system is based on the Class E weight of 6.9 gbeing the basic weight (Table 8).

X220	Weight	n	Class	Expected	Error	Formula	%error	Comment
1/8	0.87	5	A	0.8625	-0.01	1/8xE	-0.86	
1/4	1.7	13	B	1.725	0.03	1/4xE	1.47	
1/3	**2.28**	**9**	**C**	**2.3**	**0.02**	**1/3xE**	**0.88**	**Break in sequence**
1/2	3.5	31	D	3.45	-0.05	1/2xE	-1.43	Adjusted for I & J
1	6.9	45	E	6.9	0	E	0.00	**Basic unit**
1.94	13.4	91	F	13.8	0.4	2XE	2.99	High % error
3.97	27.4	94	G	27.6	0.2	4xE	0.73	
7.94	54.8	23	H	55.2	0.4	8xE	0.73	
13.99	**96.5**	**1**	**I**	**96.6**	**0.1**	**14xE**	**0.10**	**Break in sequence**
19.71	136.02	11	J	138	1.98	20xE	1.46	
25.29	174.5	1	K	175	0.5	50xD	0.29	
39.32	271.33	4	L	276	4.67	40xE	1.72	
79.23	546.7	1	M	536	-10.7	40xF	-1.96	
190.94	1317.5	4	N	1370	52.5	50xG	3.98	High % error
391.51	2701.4	2	V	2740	38.6	50xH	1.43	
805.22	5556	1	W	4830	-726	50x14xE	-13.07	High % error
1000.43	6903	1	X	6900	-3	50x20xE	-0.04	
1574.64	10865	2	Y	10860.6	-4.4		-0.04	

Table 8. The reconstructed system of cubic Indus weights using perfect weights published in MacKay 1937.

It can be seen in this table (8) that there are two breaks in the pattern of weights being twice that of the previous weight. The first break is between classes C and D and the second is between classes H and I. This creates a sequence of 5 consecutive weight classes: D, E, F, G and H which are even multiples of D. It is unlikely to be coincidental that there are also 5 basic Set 11 Signs: 233 D, 220 E, 231 F, 240 G, 235 H. We know that Class E is the basic weight and sign 220 is the basic Set 11 sign. Therefore, this seems a good point to begin the equation of "Fish" and weights. If weight E (6.9 g) = , then we can say that there should be a sign graph that matches Class D at 1/2 of Class E. I would suggest on the basis of graph design that sign 233 is the best fit for this weight class. This is because sign 233 has a horizontal line through the basic graph. Further, 233 is most commonly the last "Fish" sign when more than one "Fish" sign is in a text (left most; with 2 exceptions in 16 examples). This fact is important because weights in all cultures are listed from largest to smallest, for example 1 lb., 1 oz., 1 gm. This practice is common because this is the way in which weights are added to the scale when weighting items. If sign 233 is 1/2 sign 220, then which sign is twice sign 220? I would suggest that sign 231 is 220+| and is intended to represent the Class F weights of 13.4 g. In Indus texts with both sign 233 and 231 (n=5), sign 231 always precedes sign 233 (i.e. should be a heavier weight). The rest of the sequence can be established using the text of H-039 (Figure 6).

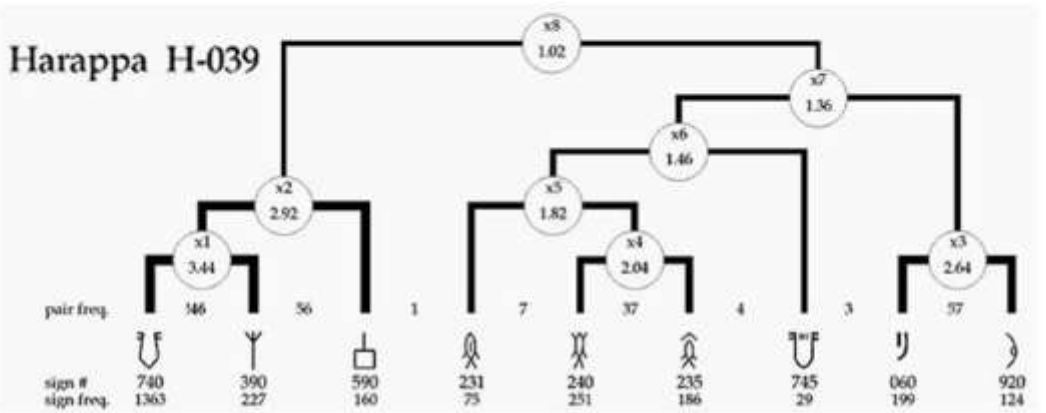


Figure 6. Square Seal from Harappa (H-039) showing the sequence of signs 235, 240 and 231.

The M-cluster of H-039 contains three "Fish" signs: 231 240 235. Using the assumption that the heaviest weight will precede the lighter weights, we can set the order of the five basic "fish" signs as: 233 D, 220 E, 231 F, 240 G, 235 H heaviest to lightest, right to left.

It is Long Patterned texts (Figure 6) that have the clearest contexts of Set 11 signs as M-Clusters. There are 202 complete Long Patterned texts that contain more than one Set 11 sign. Their collocations left or right of each other are summarized in Table 9.

left sign	right sign 220	231	233	235	240
220	15	1	1	16	16
231	2			6	7
233	11	2		20	16
235	8		4		6
240	21		3	45	

Table 9. Pairing of the basic Set 11 signs in compete long Patterned texts.

The most important feature of this table is that it shows that, while there is a preferential order to the 5 basic Set 11 signs, there is no definitive order evident from all the examples.

The next question is what are the values of  and  ? Following the five basic weights (D-H) are 2 possible candidates: Class I that is 14xE and Class J that is 20xE. Based solely on the signs associated with 220, I would suggest that represents Class I (14xE), and that represents Class J (20xE).

Having established the Set 11 signs that represent weight classes D-J, we can turn our attention to weight classes K-N, V, W and X. One possibility is that enclosed varieties of the basic system of sign/weight matches are of the next higher order of Indus weights. This results in the following additional matches:

One interesting feature is that these new pairs (i.e. the caged varieties) are approximations of 40 or 50 times the "uncaged" variety. In addition, W = 50xEx14 and X = 50xEx20 fit the pattern of their lower order equivalent.

This leaves only weight Classes A-C to identify for their glyphic counterparts. I can see no data that would allow their identification. I can only point out that A = 1/8th E and B = 1/4 E, while C = 1/3 E, and that the sign graph candidates:  consist of two similar sign graphs (223 and 225) and one that is quite different (221). This is only my best guess and not to be considered as the only possible placement of these Set 11 signs and Cubic weights (Table10). The order of 223 and 225 are not certain.

X220	Weight	n	Class	Expected	Error	Formula	%error	Comment
1/8	0.87	5	A	0.8625	-0.01	1/8xE	-0.86	
1/4	1.7	12	B	1.725	0.03	1/4xE	1.47	
1/3	**2.28**	**9**	**C**	**2.3**	**0.02**	**1/3xE**	**0.88**	**Break in sequence**
1/2	3.5	31	D	3.45	-0.05	1/2xE	-1.43	Adjusted for I & J
1	6.9	45	E	6.9	0	E	0.00	**Basic unit**
1.94	13.4	91	F	13.8	0.4	2xE	2.99	High % error
3.97	27.4	94	G	27.6	0.2	4xE	0.73	
7.94	54.8	23	H	55.2	0.4	8xE	0.73	
13.99	**96.5**	**1**	**I**	**96.6**	**0.1**	**14xE**	**0.10**	**Break in sequence**
19.71	136.02	11	J	138	1.98	20xE	1.46	
25.29	174.5	1	K	175	0.5	50xD	0.29	
39.32	271.33	4	L	276	4.67	40xE	1.72	
79.23	546.7	1	M	536	-10.7	40xF	-1.96	
190.54	1317.5	4	N	1380	62.5	50xG	3.98	High % error
391.51	2701.4	2	V	2740	38.6	50xH	1.43	
805.22	5556	1	W	4600	-726	50x14xE	-13.07	High % error
1000.43	6903	1	X	6900	-3	50x2DxE	-0.04	
1574.64	10863	2	Y	10860.6	-4.4		-0.04	

Sign #	Graph	Frequency
225		1
223		3
221		6
233		182
220		289
231		82
240		331
235		231
220/415		81
220/032		65
234		9
226		36
232		10
241		12
236		19
226/415		4
226/032		14
?		

Table 10. The Cubic weights and their possible Set 11 sign equivalents.

The equation of specific weights with specific Set 11 signs is speculative. It is one possible solution. Other solution may also be viable. Further, not all Set 11 signs are found in M-Clusters, as the follwing section demonstrates.

Exceptions to the M-cluster use of Sign 220

It is clear from data presented elsewhere (Wells 2015) that Initial Clusters (IC) can vary widely in length (from two signs to six signs). Further, not all signs are used in initial clusters. It has been shown (Wells 2011) that signs with a frequency of <6 (singletons and low frequency signs) are most often initial signs, most often on square seals, and most of these are from Mohenjo-daro. This results in a good deal of variety in initial cluster sign inventories between sites. What is important here is that there is also a good deal of overlap between sites.

Regardless of complications, Initial Clusters seem to be limited to three forms: 1) the Initial Cluster Terminal Marker (ICTM) + 1 sign (solo) form, 2) the sign cluster + solo IC sign + ICTM form and 3) the sign cluster + ICTM form. Initial clusters using this last form are very frequently limited in the signs that can occur right adjacent to the ICTM. These signs (constants in Figure 13) also pair very frequently with a limited number of signs right adjacent to the constant (semi-variables). In most cases there is an initial sign right adjacent to the semi-variable. These look to me like syllabic spellings of their functional equivalents in one sign ICs. Of the 18 occurrences of 220+ICTM, 7 also use Fish sign left of the ICTM. It is interesting that none of these medial clusters use sign 220 and only sign 220 is used in Initial Clusters.

Figure 7. Initial clusters with constant signs right adjacent to sign 002.

The most vexing problem is: "What is the subject matter of ICs?" If we use the proto-Dravidian syntactic model they would be names/titles. But I am unaware of any structure of proto-Dravidian (p-D) that could account for the tripartite affixing of ICTMs. Patterning of case markers, clitics or postpositions in p-D do not seem to match the reconstruction of p-D morphology, but I would be happy to be corrected on this point by a Linguist.

One possibility is that the constants are the names of professions (Figure 7and 8). For example, if sign 220 is the most basic weight, its use in an IC may indicate the person who does the weighing. This interpretation would lend force to Proto-Dravidian as the root language of the script, as names and titles would be initial in the p-D syntax. In any case, sign 220 has a non M-cluster context that seems to confirm that some signs, including sign 220 in recognizable Initial Clusters suggest that these signs have at least two distinct functions (Figure 14).

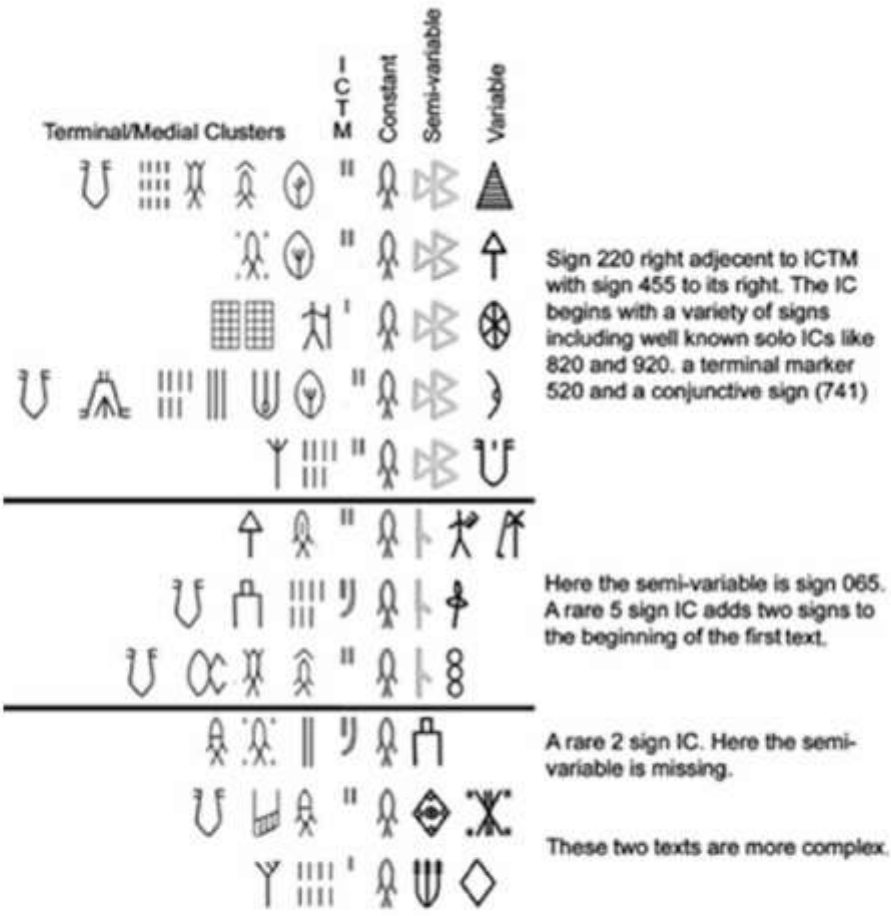


Figure 8. Initial Clusters with sign 220 right adjacent to ICTMs that employ Semi-variable.

D. Seals, Weights and the Cycle of Production

Seal and weights are found in various concentrations at the Indus site of Mohenjo-daro. In the Dk.G Area (Figure9). In the northern section (Block 9) two small kilns are located against a wall in an open courtyard, 16 seals and no weights are found in close proximity. All the weights in this block (4) are found in one small room (35).

Figure 9. Distributions of seals, weights and tablets at Dk.G (South) Blocks 7, 9 and 10 during the Late I-III periods. Map after Mackay (1937).

A large kiln dominates the open area in front of Block 7 (29). Most weights and seals are found in this Block (7) are found in Room 88 and 89, and few are located near the kiln. A second cluster of weights can be found in Block 7, Rooms 15 and 9. A second, but much smaller kiln (28) is located against the east wall of Block 10. Inside Block 10 (26) is a well room with bathing platform and access to both kilns.

This map seems to show two independent work areas. One area (Block 9) employs a system where seals are found in association with two small kilns, and weights are used in adjacent rooms. The second area (Block 7) employs a system where both seals and weights are concentrated in adjacent rooms. These differences suggest two groups using pyrotechnic technology in different ways. Likely they were producing different products.

These examples demonstrate that not all seals are used in the same way, but they do seem to be an important part of the cycle of production.

Mound F - Trench I, Weight and Seal Cluster

The early excavations of Harappa (Vats 1940) have been widely criticized for poor quality excavation and reporting. For this reason it has been largely ignored by modern scholarship. While the reporting by Vats is spotty at its best and nonexistent at its worst, there is still important information buried in this site report. One photo in particular is relevant to the discussion of the relationship between seals and weights (Figure 10).

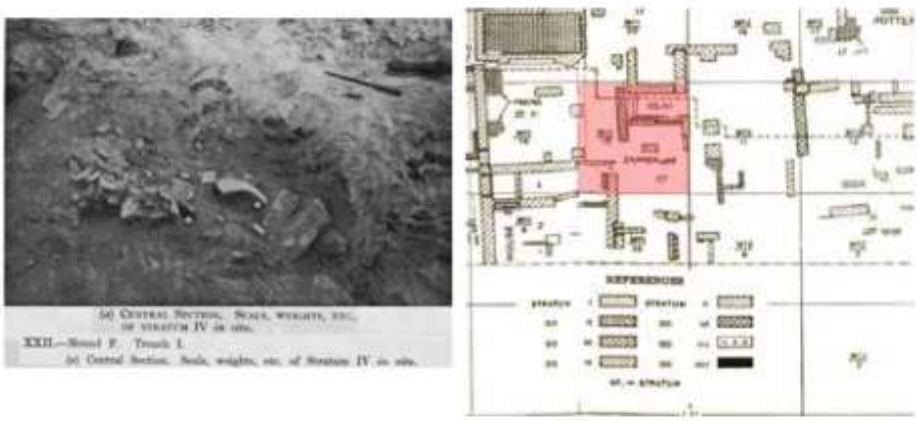


Figure 10. Left: Seals and weights found together in situ Trench I, Mound F, Harappa (Vats 1940: Plate XXII); Right: Map from Plate XIX (Vats 1940) showing find spot of 6 seals and 9 weights in square M11/15.

Found in the center of Trench I, Mound F in square M11/15 at depth 5 ft. 9 inches there is a cluster of 9 cubic weights and 6 seals. While the text says this material is in Stratum III, the photo says Stratum IV. Using the ICIT database it was possible to Identify the seals as follows: H-009, H-012, H-411, H-026, H-135, H-097 (Figure 11).

The 9 cubic weights are less well documented. All 9 are of chert, but only one (No. 120) has a detailed description. No. 120 is a Type A (cubic) weight, made of grey stone and weighs 25.35g. The other cubic weights have a size between 0.5 inches3 and 1 x 0.95 x 0.6 in. Fuls (pers. comm. 2016) calculates the lower and upper limit of these weights as follows:

1) 0.5 x 0.5 x 0.5 = 0.125 cubic inches, with a weight of at least 3.6 g -- Class E.

2) 1.0 x 0.95 x 0.6 = 0.57 cubic inches, with a weight about 27.2 g -- Class G.

This is the minimum and maximum, therefore, we can suggest that the other intermediate sized weights are likely, especially Class F, weighing about 13.8 grams. Fuls estimates the weight of these objects using the relationship between size and weight for chert weights listed by Mackay (1937). In addition to the seals and weights, 4 conch shells, a dozen terracotta beads, some pottery bangles and vases were also found. Because of Vats' reporting, or lack of reporting, leaves us with many unanswered questions regarding all of the artifacts in this cluster.

There is more Information available for the seals found in this location (Figure 18). This figure presents all available information related to the 6 seals in question. Using the equivalents established in Table 10, the fish signs in these texts can be used to calculate the weights expressed by these texts.

Figure 11. Texts from ICIT and weight equivalents based on fish sign identifications in Table 14 and the weight Class combinations of weights found with the seals.

What is interesting about the texts in this cluster is that 5 of 6 bear Set 11 signs. Given the proportions of Set 11 texts at Harappa we would expect only one of these texts to bear Set 11 signs (Table 11).

	Harappa	Mohenjo-daro	Lothal
Observed Set 11 Texts	439	581	56
All Texts in ICIT	2452	1814	196
Percentage Set 11	17.90	32.03	28.57
Expected Set 11	1.08	1.9	1.7

Table 11. Set 11 texts frequency and proportions for Harappa, Mohenjo-daro and Lothal with expected frequency of Set 11 signs give a cluster of 6 texts.

This unexpectedly high proportion supports the conclusion that there is a link between Set 11 signs and weights. While details are lacking, the Set 11 signs in the texts measure amounts that can be weighed using the cubic weight found with them. If the system in Table 10 is applied to these texts the resulting amounts give us some idea of the scale of the Harappa economy (Figure 19). The smallest amount weighs 13.4 g and the largest 89.1 g. We can be sure that at this scale the items of exchange must have a relatively valuable.

E. What Do Things Weigh?

There are several Indus seals with complex M-clusters. If the arguments presented above are accepted, the M-clusters should give us an estimate of the weights of items being traded within the Indus network of exchange. The 5 examples given in Figure 12 were chosen because they are complex and are part of longer Indus inscriptions.

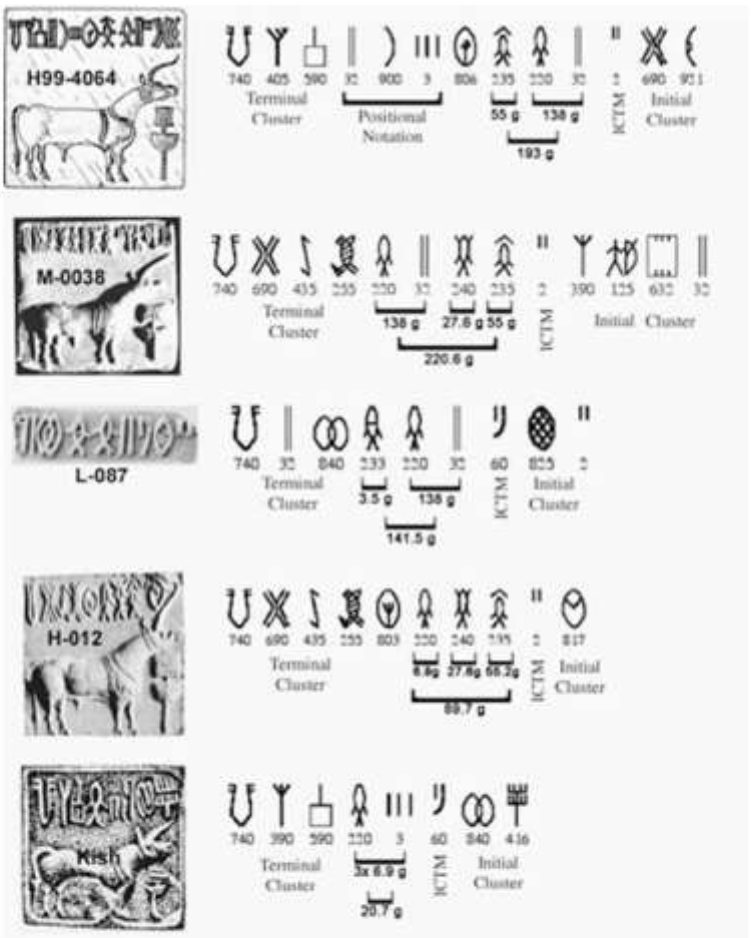


Figure 12. M-clusters and the weight of items annotated by them using complete texts with 8+ signs.

There are several interesting features of these texts. To begin with H99-4064 has a M-cluster is standard order that annotates 193 g. Because numerals precede nouns in the majority of cases, this text might be measuring 196 g of  . The identity of sign 806 is unknown. Another feature of this text is that signs 003, 900 and 032 are numerals representing positional notation. We know that the sign sequence 740-405-590 does not collocate with numerals. This fact suggests that the positional natation is referring to the M-cluster or that  may be the number of items that weigh 196 grams (beads?).

M-0038 list the Set 11 signs in the M-cluster in the reverse order that they are usually given. It lists 55+27.6+138 g = 220.6 g. This indicates that the order of the Set 11 signs in M-clusters, while listed in order of magnitude, the normal order of largest to smallest is not fixed in every case. The M-cluster measures 220.6 grams.

L-087 is a rectangular seal with a three sign M-cluster. It measures 138+3.5 g = 141.5 g and is ordered in the usual way with the largest weight first.

The same is true of the sequencing of the M-cluster on H-012 with 55.2+27.6+6.9 g = 89.7 g.

So far the examples have been from Harappa, Mohenjo-daro and Lothal. These are all well-known sites in the Indus valley. The final example is from Kish in Mesopotamia. This is not an Indus site and there is only one Indus inscription from it. The M-cluster, and in fact the entire inscription, is a typical Indus text. The M-cluster 003+220 occurs 20 times in all and can be found at Harappa, Mohenjo-daro and Kalibangan. The M-cluster consists of 3 x 6.9 = 20.7 g.

It is clear from these examples that M-cluster are common on seals, but there are also hundreds of examples from tablets. M-clusters are not limited to a specific site or artifact type. That is, M-clusters are common components of Indus texts and indicate a strong interest in metrology in Indus texts.

F. Summay

F. Summay

The point of this paper is that there are systematic similarities between the distributions of weights and the basic "fish" signs. Further, the distributions of both sets matches in a way that adds force to the argument that they are related in meaning. Bonta's original argument was first epigraphic based on contexts in inscriptions, second on linguistic arguments connecting fish = weight=min = minas(minas is both 'fishes' and a well-known system of weights known in antiquity from the Persian gulf Mesopotamia,

the Eastern Mediterranean as far west as Greece. Archaeological evidence support the fish as weights connection, showing special spatial relationships between inscriptions with fish signs and weights. Finally, all lines of data converge on the relationship of fish signs and weights as being closely related. The most logical pairing of fish sighs and weights is given in Table 10. The resulting weights of items mentioned in texts are relatively small weights, in keeping with Indus trading practises.

References Cited

Bonta, Steve

1995 The Indus Valley Script: A New Interpretation. Master's Thesis submitted to Brigham Young University.

Joseph, Tony

2017 How genetics is settling the Aryan migration debate. *The Hindu* (JUNE 16).

Joshi, Jagat Pati and Asko Parpola

1987 *Corpus of Indus Seals and Inscriptions*. Vol. 1, Suomalainen Tiedeakatemia, Helsinki.

Mackay, E. J. H.

1938 *Further Excavations at Mohenjo-daro*. Munshiram
Manoharlal Publishers Pvt. Ltd., Delhi.

Mahadevan, Iravatham

1977 The Indus Script, Texts Concordance and Tables. Archaeological Survey of India, New Delhi.

Marshall, Sir John

1931 Mohenjo-daro and the Indus Civilization. Arthur Probsthian, London.

Parpola, Asko

1994 *Deciphering the Indus Script*. Cambridge University Press, Cambridge.

Parpola, Asko, B. M. Pande, and Petteri Koskikallio

2010 *Corpus of Indus Seals and Inscriptions*. Vol. 3.1, Suomalainen Tiedeakatemia, Annales Academiae Scientiarum Fennicae, Humaniora 359.

Rao, S. R.

1979 and 1985 Lothal: A Harappan Port Town (1955–1962) (Memoirs of the Archaeological Survey of India) ASIN: B0006E4EACSarja, Series B, NIDE.

Shah, Sayid Ghulam Mustafa and Asko Parpola

1991 *Corpus of Indus Seals and Inscriptions*. Vol. 2, Soumalainen Tiedeakatemia, Helsinki.

Vats, Madho Sarup

1940 *Excavations at Harappa*. Munshiram Manoharlal Publishers Pvt. Ltd., Delhi.

Wells, Bryan K.

1998 *An Introduction To Indus Writing*. Early Site Research Foundation, Independence.

2007 *Epigraphic Approaches to Indus Writing*. PhD Dissertation, Harvard University, Cambridge, MA.

2012 *Epigraphic Approaches To Indus Writing*. ASPR Monograph Series, Cambridge, MA. Oxbow Press.

2015 The Archaeology and Epigraphy of Indus Writing. Archaeopress, Cambridge.

2018 The Volumetric System of Harappa, In: Jonathan Mark Kenoyer Felicitation Volume, Dennys Frenez, Gregg M. Jamison, Randall W. Law, Massimo Vidale and Richard H. Meadow (Eds).

Multifaceted studies of Indus seals: style, technology, and inscriptions

Gregg Jamison

Introduction

Since their discovery heralded the announcement of a new ancient civilization nearly a century ago, Indus seals and their inscriptions have captivated scholars and the general public alike. As symbols of wealth and power, used by ruling elites to legitimize and reinforce the social order (Kenoyer 2000), they are some of the best evidence we have of Indus administrative behavior and control. Seals are also end products of extremely complex, multi-faceted technological processes, the control of which was also likely an important strategy of elite power and control (Kenoyer 2000). Despite the significance of both of these roles, Indus seals are perhaps best known as the primary medium of the undeciphered writing system, the earliest in South Asia and among the first widely used during the third Millennium BCE. Numerous studies of the script often engraved on Indus seals have been influential in our understanding of the Indus, having utilized many approaches and having produced many interpretations concerning its linguistic affiliation, function, and use. Collectively, this body of research represents one of the most significant long-term areas of study in the Indus.

Yet in spite of the considerable scholarly attention given the study of the Indus script, especially linguistic and functional aspects of it, few studies have examined and compared the technologies and techniques used to create inscriptions, including those present on seals. This paper presents an introductory attempt to do so by investigating the techniques and carving styles used to engrave Indus seal inscriptions. Building on my earlier research (Jamison 2013, 2017, 2018) focusing on stylistic variation in seal iconography, the study aims to identify patterns in morphometric properties of inscribed characters and full inscriptions on a sample of Indus seals. This includes groups of seals identified in previous research as demonstrating high levels of stylistic coherence, thought to represent the products of different artisans and workshops. The current study is a pilot study to determine if similar patterns

can be identified in carving styles and metric proportions of the inscriptions on these seals, which can further strengthen the inference that they represent the products of distinct workshops and artisans.

Using complementary methods of formal analyses, it has been possible to uncover evidence of morphometric coherence in the inscriptions among a sample of seals already known to demonstrate stylistic and proportional parallels in iconography. For the most part, these patterns apply to individual inscribed characters that are duplicated on multiple seals. However, there are a few examples of similar sequences of more than one inscribed character present on multiple seals, and a single, exceptional example of a pair of seals with nearly identical iconographic carving styles and a high degree of uniformity between their inscriptions. The study has also identified marked variation in the inscriptions on seals that are otherwise alike, especially in the carving styles and proportions of animal iconography. Variability in the morphometric properties of inscriptions can be explained by multiple factors and is compatible with earlier studies of seal iconography focusing on similar phenomena.

Overall, the results of this study provide new insights into the technologies and practices involved in creating Indus seal inscriptions. The results of this preliminary study complement analyses of patterned variation in seal iconography, which resulted in the identification of stylistically distinct seal groups thought to represent different artisans and workshops. Taken together, the discovery of seals from multiple sites that demonstrate morphometric coherence in iconography and inscriptions suggests that production was undertaken by multiple artisans and workshops, within and among different settlements and throughout the Indus as a whole. These interpretations can be further evaluated in future research, using similar methods on a larger sample of seals. Such studies are valuable methods for investigating the complex and important relationship among seals, writing, and integration in one of the world's earliest and most unique urban societies.

Background: Seals in the Indus Civilization

Most inscribed seals belong to the Harappa Phase of the Integration Era (2600-1900 BCE), the chronological period associated with the apex of the Indus Civilization (Kenoyer and Meadow 2010). It was during the Integration Era that the Indus reached its greatest geographical extent, with diverse forms of material culture recovered at dozens of sites of varying sizes, found in incredibly diverse environmental and ecological regions. Detailed syntheses of the current state of Indus culture history can be found elsewhere (see Kenoyer 2014 for an excellent summary), it will suffice here to mention that seals in varying quantities, types, and styles have been found

at multiple sites dating to the Integration Era. Unfortunately, many of them were excavated and published prior to the use of careful stratigraphic controls, making detailed diachronic analyses difficult in many cases, and impossible in others.

Thanks to long-term excavations at Harappa, it has been possible to further sub-divide the Harappa Phase into sub-periods that document the growth and development of the site, along with changes in some craft traditions, including seals and other inscribed materials (Table 1). Using this framework, it has been possible to correlate some patterned variation in seal and inscription carving styles and techniques with change over time (Kenoyer 2006, 2009; Kenoyer and Meadow 2010). In instances where seals and other inscribed materials have been recovered from unknown and or unreliable stratigraphic contexts, the Harappa seal chronology is a useful comparative tool that can be used to estimate which sub-period of the Harappa Phase a seal may have been carved in. It has also been invaluable to contextualize and interpret the incredible variation present in the full corpus of Indus seals and related inscribed materials.

Period	Dates	Animal Motif Carving Style	Inscription Carving Style	Inscription Orientation
3A	2600-2450 BC	Angular	Curved	Linear
3B	2450-2200 BC	Angular	Curved	Irregular
3C	2200-1900 BC	Natural	Bold, Rigid	Linear

Table 1. Indus Seal Chronology from Harappa (Kenoyer 2006, 2009; Kenoyer and Meadow 2010).

Indus seals are diverse. They come in a variety of shapes and sizes, were fashioned from different raw materials, using distinct technologies and production systems. The iconography is also variable, as are the uses of writing and inscriptions. There are seals with iconography and inscriptions, seals with only inscriptions, and others with only iconography. This diversity can be understood through multiple perspectives, including typology, morphology, and function to name a few. Numerous types of Indus seals and related inscribed materials have been described and documented, from the original excavations up to the present (Bisht 2015; Kenoyer 1998; Kenoyer and Meadow 2010; Lal *et al.* 2015; Marshall 1931; Mackay 1938, 1943; Possehl 1996; Rao 1985; Vats 1940). These typological classification systems have been influenced by clear, easily identifiable variability in morphology, and to a lesser extent, raw materials and production methods. It is also clear that seals and Indus writing served different functions, another source of variation that has only recently

been investigated in any systematic way (Kenoyer 2006). There are multiple sources to consult for a detailed discussion of these and other matters related to variability of Indus seals and history of their study (Jamison 2017; Kenoyer 1998; Possehl 1996).

The most common type of Indus seal, and one that frequently depicts inscriptions and iconography, are referred to as intaglio stamp seals (Kenoyer 2009). They are called thus because the iconography and inscriptions are always carved in negative, so that they create a positive impression when stamped against a soft material. This is what distinguishes intaglio stamp seals from related forms of Indus inscribed materials, including molded tablets, sealings, and seal impressions, which always depict iconography and inscriptions in relief. Current research suggests at least some of the inscribed materials in relief were likely made by intaglio stamp seals and incised tablets, which are also carved in negative from soft stone and can be used to make positive impressions (Frenez and Tosi 2005; Kenoyer 2006, 2009; Parpola 2007). Indus intaglio stamp seals are usually square or rectangular in shape, less than 5cm in any dimension, and fashioned from fired steatite or similar soft stones. Exceptions to this exist, belying variability even within a single class or type of seal that is widely distributed and recognized as being diagnostic of the Indus Civilization.

Since there is variation within the category of intaglio stamp seals, further distinctions and classification is useful. At many Indus sites, the most common intaglio stamp seals are square in shape, and usually depict an engraved obverse face that contains an animal icon and short inscription. Most intaglio square stamp seals of this character also have a carved knob, often called a boss, that is perforated on the rear face of the seal. Much research has focused on the production of intaglio square stamp seals, which were undoubtedly complex and required the use of non-local raw materials, highly skilled carving, and sophisticated pyrotechnologies necessary to transform soft steatite into objects that were durable, beautiful, and transmitters of culturally significant information (Green 2015; Jamison 2012, 2013; Kenoyer 1998, 2009; Konasukawa 2013; Law 2011; Mackay 1938, 1943; Rao 1985).

A wide variety of animal, geometric, anthropomorphic, and composite motifs are present on intaglio square stamp seals, with some variation correlated with diachronic patterning (Ameri 2013, 2018; Jamison 2018). Of these, the most common is the unicorn, the well-known single-horned bovid depicted in profile. There has been much discussion about the nature and origin of the Indus unicorn and its origin (Kenoyer 2013; Parpola 2011), but the term is still appropriate because of its widespread use. Regardless of its source and inspiration, the motif was clearly important to the Indus people, as it is depicted frequently on seals and also appears in other mediums, including painted ceramics and terracotta figurines (Kenoyer

2013). Because intaglio square stamp seals are the most common type at many sites, they provide a more robust data source for comparative analyses and have been the primary focus of earlier and current studies.

Approximately thirty years ago, the first detailed, comparative research on variability in Indus seal carving styles was published (Franke-Vogt 1991, 1992; Rissman 1989). Using a combination of attribute analyses, distribution patterns, and statistical methods, these studies identified patterns in the ways that unicorn seals were engraved and adorned. More recent studies (Ameri 2013; Green 2016; Jamison 2018; Kenoyer 2009; Konasukawa 2013; Uesugi 2011) have further explored variation in Indus seal carving styles and techniques and attempted to link them with diachronic distribution patterns, technologies and production methods, and the people who made the seals. My dissertation research (Jamison 2017) focused on a sample of published intaglio square stamp seals engraved with the unicorn motif. Using methods of formal analyses, it was possible to identify groups of seals that demonstrated clear evidence of stylistic and metric coherence in the carving styles and techniques of the unicorn motif. These were inferred to represent the products of different artisans and workshops, and the distribution patterns of identified groups were complex and variable, suggesting a decentralized form of seal production and use throughout the Indus as a whole, even if production was controlled and regulated on a local scale (Jamison 2017). This research builds on my dissertation and provides a way to test some of its interpretations by studying inscriptions on some of the seals already identified, using complementary methods.

Methodology

The methods used in this research have been presented elsewhere (Jamison 2013, 2017) and consist of formal attribute and metric analyses of inscriptions on a sample of twelve published intaglio square stamp seals from five Indus sites (Figure 1; Table 2). They follow and build on the methodology used in earlier studies to investigate patterned variation in Indus seal iconography. In this study, analyses included identifying and recording different carving styles of discrete elements of characters that make up inscriptions, then describing the characteristics and style of each character in an inscription. When possible, this included examining the profile of and counting the number of cutting strokes used to engrave the characters. These studies were supplemented by measurements of maximum length, width, and the ratio between them; including compositional elements of each character, individual characters, and full inscriptions (Figure 2).

This line of inquiry has been supplemented by a pilot study of morphometric properties of duplicate characters on multiple seals, using a computer software program called ImageJ. The program is an open source image processing program used for scientific morphometric analyses. It records two-dimensional X and Y coordinates for selected landmarks on high-resolution images and can be used on multiple images of different samples. By using standardized landmarks and images of known sizes and dimensions, it is possible to examine and compare variability among multiple samples. These can be easily studied using various methods of statistical analyses and provide a useful tool to examine variability and coherence in size and shape. The program has been used in this study to test variation in the morphology of shared characters of the script that are inscribed on multiple seals. A strength of this application is that it facilitates quantitative analyses of angles and orientations, of segments and full characters, that are not possible using standard methods of measurement, and this is the first systematic attempt to use it to study Indus seals.

The primary data source for this study are high-resolution images of Indus intaglio square stamp seals published in all three volumes of the *Corpus of Indus Seals and Inscriptions* (Joshi and Parpola 1987; Parpola *et al.* 2010; Shah and Parpola 1991). These represent the best data to conduct analyses using published images, as they are comprehensive, containing seals from many Indus sites; are of high quality and sufficient size for analysis, and contain valuable contextual information. It is hoped to be able to use some of this contextual information to identify seals housed in various institutions in Pakistan, India, and beyond that can be analyzed directly in the future. In the meantime, the published images from the *CISI* volumes is an excellent source of data for this type of analysis.

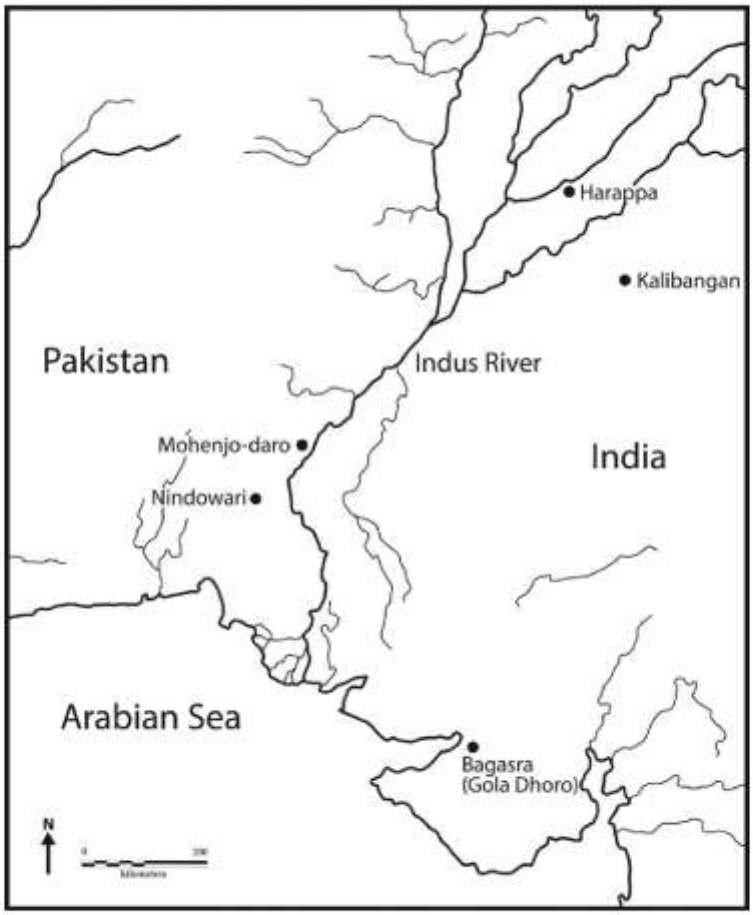


Figure 1. Map of Sites with Seals Discussed in the Text.

Stylistic Group	**Seals Count**	***CISI*/Excavation Numbers**
Harappa #1	3	H5, H6, H7
Mohenjo-Daro Tiger	2	M289, M116
Mohenjo-Daro - Bagasra	2	M104, BSR 6719
Mohenjo-Daro #11	2	M747, M892
Mohenjo-Daro - Kalibangan - Nindowari	3	M68, K2, ND1
Sum	**12**	

Table 2. Seals from Stylistic Groups Analyzed in the Study.

Selecting a sample of seals for this pilot study was straightforward and simple. Only seals from previously identified stylistic seal groups (Jamison 2017) were chosen, for several reasons. First, they have already demonstrated to be sufficiently preserved and of high enough image quality and resolution to conduct formal analyses using the methods outlined above. Second, choosing seals that have stylistic coherence in iconography provides a simple and effective way to test if there is a correlation between iconography and inscriptions in terms of stylistic and metric coherence among multiple seals. Finally, using seal groups already identified and analyzing their inscriptions is a way to further test the inferences that they represent the products of different artisans and workshops. Though there is much work yet to be done, preliminary results are encouraging and complement earlier work focusing on patterned variation in Indus seal iconography.

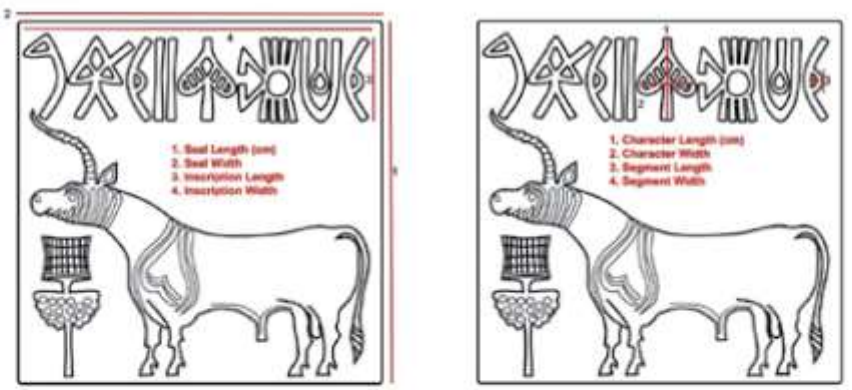


Figure 2. Measurements of Inscriptions and Inscribed Characters in the Study.

Results

Preliminary analysis on stylistic seal groups that contain seals that have shared inscribed characters has revealed evidence of morphometric coherence and variation. Some correlate with similar levels of stylistic coherence in iconography, others do not. In the following paragraphs I present a few examples of both patterns, which are present on seals in stylistic groups from single and multiple sites. Some of the latter have multi-regional distribution patterns that demonstrate links among different sites and regions. It is important to reiterate that the results and inferences derived from them are preliminary and represent a pilot study. The sample on which analysis has been completed is not large, in terms of total numbers of seals studied and the stylistic groups they are from. Further studies on more seals and stylistic groups is necessary to strengthen or refute preliminary findings.

Nonetheless, the combination of various methods of formal analyses of Indus seal iconography and inscriptions provide powerful tools to investigate how production was organized, varied, and to develop explanatory models that can be tested against archaeological data. This discussion is organized in two sections. The first focuses on groups that contain shared characters in their inscriptions that demonstrate high levels of morphometric coherence. Following this, brief examples of inscribed characters that are more variable are presented. Taken together, the results of the current study complement those of my earlier research on patterned variation in iconography and provide further support for the interpretation that it is possible to identify seals made by the same artisans and workshops using methods of formal analyses, which can be further tested by analyzing the seals.

Stylistic Seal Groups with Morphometric Coherence in Inscriptions

One of the best examples of seals that demonstrate strong coherence in the morphology and proportions of their shared inscribed characters comes from Harappa. Three seals, classified as Harappa Group #1 in earlier studies, depict finely engraved unicorns and standards that are stylistically very alike (Figure 3). In fact, the group is noteworthy for its high level of stylistic coherence (Jamison 2017), with clear parallels in the carving styles and proportions of most elements of the unicorns and standards. This level of standardization in the execution of the unicorn, specifically all of the decorative elements used to adorn it, is rare in the corpus of published unicorn seals. Further, the details on the unicorns' face, head, and body, as well as both aspects of the standard, are complex and finely engraved. By any measure, these are very well-carved seals, produced by experienced crafts people with considerable skill, and the fact that the iconography is so similar on all three suggests that the same artisans made them.

Figure 3. Harappa Seal Group #1 (Joshi and Parpola 1987).

This group was included in the current study because two of the seals contain the same inscribed characters, which are good representations of the finely engraved, linear sequences that characterize the inscriptions on all of the seals in the group. Analysis of the duplicate characters reveals evidence of strong similarities in morphology and proportions. These characters are fairly common in the corpus of Indus inscriptions, and based on their morphology and multiple segments, would have required a fair degree of skill to replicate to scale. Analysis was undertaken by recording the maximum length and width of each character, as well as the small, finely engraved circular segment at its midpoint, then calculating the ratios of length/width between them (Figure 4). Though the maximum dimensions of length and width for the characters vary, based on the overall dimensions of the seals and their full inscriptions, the ratio of length/width is nearly identical (Table 3).

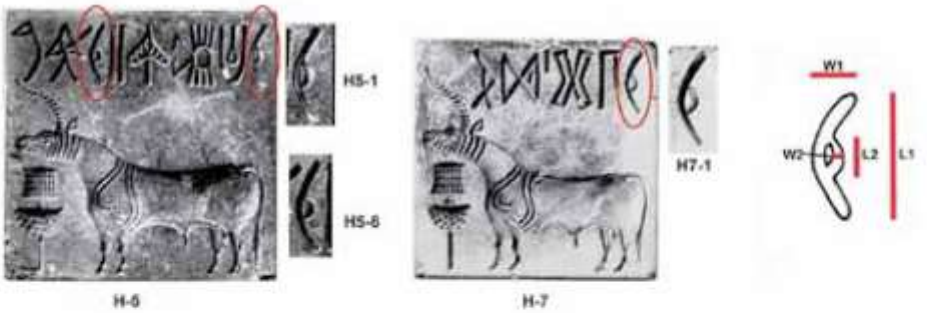


Figure 4. Shared Characters on Seals from Harappa Group #1 with Measurements (Joshi and Parpola 1987).

Measurement (cm)	H5-1	H5-6	H7-1
Length 1	1.25	1.26	1.3
Width 1	0.4	0.4	0.42
Length/Width 1	3.12:1	3.15:1	3.1:1
Length 2	0.4	0.41	0.39
Width 2	0.2	0.2	0.2
Length/Width 2	2:01	2.05:1	1.95:1

Table 3. Measurements of Length and Width and Ratios for Shared Characters on Seals from Harappa Group #1.

Further evidence of the coherence among the inscribed characters is present in morphometric analyses using the ImageJ program. Using images of each shared character, scaled to the same standardized dimensions, a total of six landmarks

on each were analyzed. The X and Y coordinates of each chosen landmark on the three characters were recorded and plotted to facilitate comparative analyses. They represent the spatial relationships among the different carving strokes, segments and angles that make up each character. Overall, the data are very similar, particularly the relationships among the values recorded for each landmark. Minor variation in absolute values needs to be further explored, and the sample size is not robust, but the data, most easily shown graphically, show that all three characters are alike in their morphometric properties as well (Figure 5).

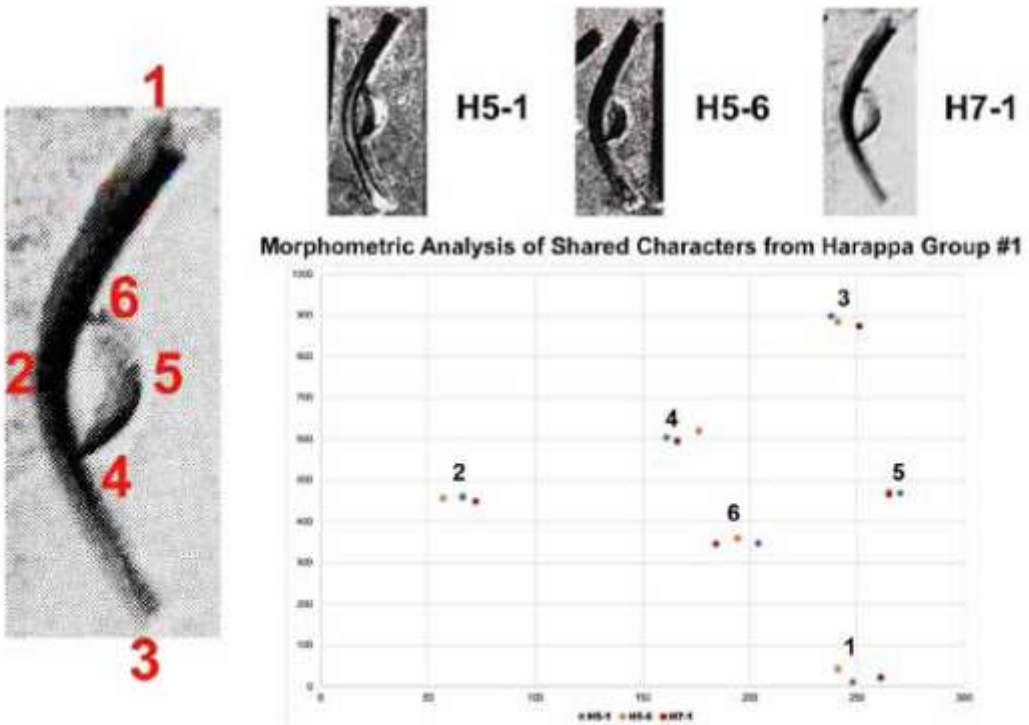


Figure 5. Morphometric Analysis of Shared Characters from Harappa Group #1 (after Joshi and Parpola 1987).

Taken together, the results of this analysis provide further evidence of strong similarities among the seals in this group. Not only are they stylistically alike, but their inscriptions, which are comparable in proportions and orientation, contain duplicate characters that are nearly identical in their morphometric properties. These levels of coherence strongly suggest that the same artisans crafted the seals, including their iconography and inscriptions. It is not possible to determine whether one or multiple individuals where involved in production and based on the results of earlier work (Jamison 2013, 2017) it is unlikely that different crafts people could have produced seals that are so alike in their carving styles and morphometric properties. Moreover, it appears that the artisans who made them were highly skilled. This inference is

based not only on stylistic and metric coherence in the iconography and inscriptions, but also the finely carved details and regularly spaced, linear inscriptions. Similar phenomenon can be seen with at least two other examples from other stylistic groups.

Another stylistic seal group that demonstrates high levels of coherence among their inscriptions is comprised of a pair of seals from Mohenjo-Daro. The seals both depict tigers, and recent research (Jamison and Ameri, in preparation) has uncovered clear evidence of stylistic coherence among them. Visible similarities in the carving styles of most elements of the animals' bodies are present, including small, finely engraved details on the faces, bodies, and claws (Figure 6). The number, placement, and orientation of the incised lines that decorate the animals' bodies and distinguish them as tigers are nearly identical. Both seals also contain undecorated troughs with similar tool marks and orientations. To date, they represent the only stylistic group identified that depicts tigers, and simple visual inspection confirms that the ways in which the iconography was carved and decorated is quite similar. Analyses of their inscriptions reveals similar patterning worth further discussion here.

The reason this group was included in the current study is because of their inscriptions. Though not duplicates, they do contain four of five shared characters. The characters occur in the same sequence on both seals, and the overall dimensions and orientations are comparable, with only minor variation. Both inscriptions are regularly spaced and linear, deeply engraved, with clear, well carved characters (Figure 6). This is fairly uncommon in the corpus of published Indus seals. There are not many examples of duplicate inscriptions on multiple seals, or many with similar sequences. Further, this is the only stylistic group identified in my earlier studies that contains multiple shared characters, and it appears on seals with an animal motif that is also not common. Including this group in the current investigation was a good way to examine inscriptions in a more thorough manner and explore iconographic coherence among seals with motifs other than unicorns.

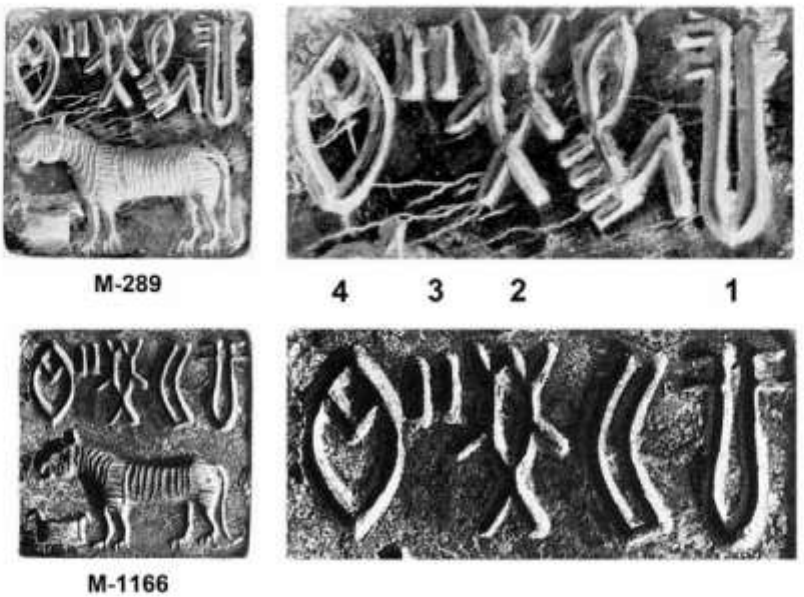


Figure 6. Tiger Seal Group from Mohenjo-Daro with Multiple Shared Characters (after Joshi and Parpola 1987; Shah and Parpola 1991).

Analyses of measurements of length, width, and especially ratios among the shared characters has revealed clear evidence of coherence among them (Table 4). The ratios of length/width among three of the four shared characters are nearly identical, even though two of them contain multiple segments that require multiple carving strokes. Minor variance in the fourth is at least partially influenced by its placement at the beginning (or end) of the sequence. Considering that these characters are small, often contain multiple segments, and were carved by hand, some variation can be expected among multiple seals, even those made by the same artisans (Jamison 2017). In light of this, the coherence among them is even more impressive. Morphometric analyses (in progress) using ImageJ software should provide further insights into the similarities and differences among all four shared characters on both seals.

Seal	C1 L (cm)	C1W (cm)	C1 L/W	C2L (cm)	C2W (cm)	C2 L/W
M289	1.1	0.55	2:01	0.97	0.58	1.67:1
M1166	1.02	0.52	1.96:1	0.92	0.55	1.67:1
Seal	**C3 L (cm)**	**C3 W (cm)**	**C3 L/W**	**C4 L (cm)**	**C4 W (cm)**	**C4 L/W**
M289	0.38	0.27	1.41:1	0.93	0.49	1.9:1
M1166	0.33	0.24	1.38:1	0.91	0.47	1.94:1

Table 4. Measurements of Length, Width, and Ratios of Shared Characters in the Mohenjo-Daro Tiger Seals Group.

This pair of tiger seals from Mohenjo-Daro is among the best examples of stylistic and metric coherence identified to date. Similarities among the carving styles and proportions of the animal motifs, one of the most unique and significant in Indus seal iconography (Jamison and Ameri, in preparation) represent one of only a few that do not depict the unicorn that has been identified. Morphometric coherence among multiple duplicate inscribed characters that appear in the same sequence on the two seals is also uncommon and important. As with the first group from Harappa discussed above, this pair of tiger seals from Mohenjo-Daro also provides support for the interpretation that in some instances the same artisans carved iconography and inscriptions, and that it is possible to identify their products through formal analyses. A final example highlights further evidence in support of these inferences.

The last stylistic seal group that demonstrates coherence in inscriptions is a pair of unicorn seals, one each from the sites of Mohenjo-Daro and Bagasra (Figure 7). The group was identified in earlier studies (Jamison 2017) and is defined on the basis of eight shared attribute styles of the unicorn and standard. Of these, several elements, including the eyes, unadorned necks, and snouts, are distinct and their combinations are without clear parallels in other stylistic groups identified to date. Minor variations in other elements demonstrate less coherence that the two examples discussed above, a pattern compatible with earlier research on patterned variability in unicorn seal carving styles (Franke-Vogt 1991, 1992; Green 2016; Jamison 2017; Kenoyer 2009; Rissman 1989). Some of this can be explained by minor, likely unintentional differences in carving strokes, and in the case of the ears, the placement of the inscriptions above them. Nonetheless, the appearances of the unicorns are much more alike than different, and the multi-site distribution pattern is one of many identified that represents stylistic seal links among different sites and regions.

This group was included in the current study based on lower level of stylistic coherence (compared to the two examples discussed above), its multi-regional distribution pattern, and the presence of a single duplicate inscribed character present on both seals (Figure 7). It should be mentioned that there are actually likely two shared characters in the inscriptions, but one is damaged on both seals, due to its position at the end (or beginning) of the sequence. In any case, the shared character that is present on both seals is located in the same position in the inscriptions, is one of the most common in the corpus (Mahadevan 1977; Parpola 1994; Wells 2015), and is engraved tightly within linear inscriptions that appear to have been made using similar tools and carving strokes. The analysis of the inscriptions, specifically the shared character, provides a means to evaluate whether reduced levels of stylistic coherence in animal iconography correlate with less coherence in inscribed characters.

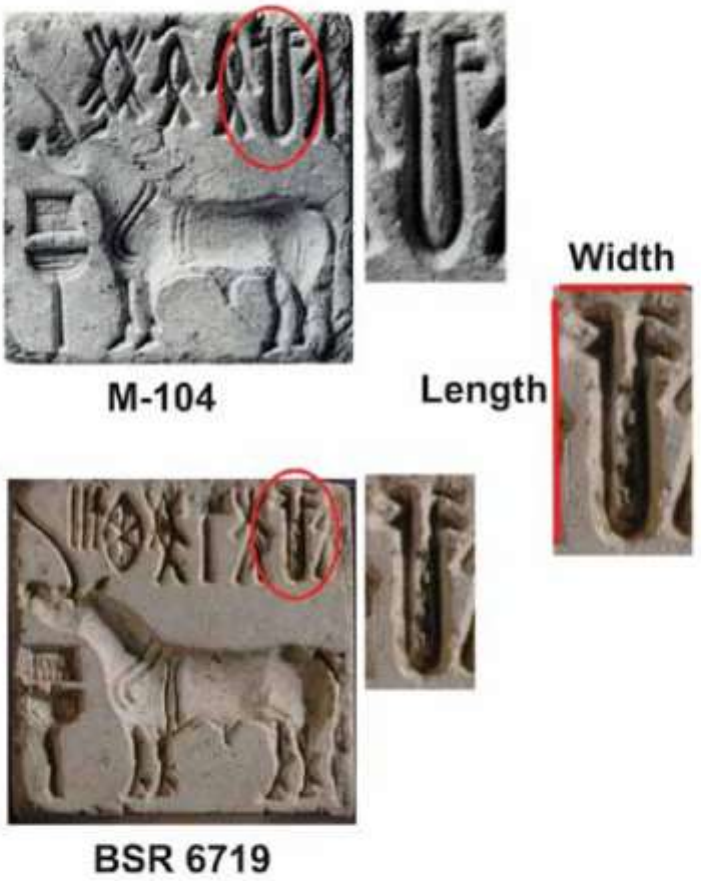


Figure 7. Mohenjo-Daro – Bagasra Seal Group with Shared Characters and Measurements (after Parpola and Joshi 1987: Bagasra Seal Image Courtesy of MSU Archives).

To be sure, one example is not statistically significant, but in this case, the proportions of length/width of the shared character are actually very similar (Table 5). The length/width ratios are for the full characters, not their segments, and reflect similarities in the overall proportions. Morphologically they are also comparable, though the morphometric values using the ImageJ program are more diverse that those presented above for the group from Harappa. This is most clear in the two sets of parallel carving strokes that emanate from the top of the U-shaped main segment of the signs, and at its base, where the character on the seal from Mohenjo-Daro is wider and with a different angle.

Seal	Shared Character Length (cm)	Shared Character Width (cm)	L/W Ratio
M104	1.01	0.49	2.04:1
BSR 6719	0.75	0.37	2.02:1

Table 5. Measurements of Length, Width, and Ratios of the Shared Character in the Mohenjo-Daro – Bagasra Seal Group.

These differences do not inherently indicate that the characters or full inscriptions were carved by different artisans. Overall, they are minor and may simply reflect minor variation in the carving strokes used to create them, concerns with the amount of space available to engrave them, or a lack of concern about crafting them to identical proportions and morphology. The unicorns and standard on this pair of seals demonstrate slightly more variation than the other two groups discussed above, perhaps the fact that they have a shared inscribed character that is very similar proportionately but more diverse morphologically is not surprising. Further, there are other groups with greater and lesser stylistic coherence that demonstrate more variation in inscribed characters than this or the previous two examples already discussed.

Stylistic Seal Groups with Morphometric Variation in Inscriptions

Thus far two stylistic groups have been analyzed that contain shared characters in their inscriptions, both of which demonstrate more morphometric variation than the examples described above. The first of these is a pair of unicorn seals from Mohenjo-Daro (Figure 8). Both are fragmentary but maintain enough iconography and inscriptions to facilitate formal analyses. The group was originally identified during earlier research (Jamison 2017) and classified as Mohenjo-Daro Group #11, defined on the basis of shared carving styles of all unicorn elements that are intact, including unique methods of carving the halters, pizzles, legs, and hooves. Both seals also depict engraved testicles between their rear legs, which previous research by Kenoyer (2009) has determined in not common among Indus unicorn seals. More broadly, the seals are engraved with angular carving styles that stand in contrast to the smooth, rounded engraved surfaces of many unicorn seals. Current research (Jamison 2017; Kenoyer and Meadow 2010) suggests that this may be associated with changes in carving styles over time, with bold, angular carving styles, such as seen on this pair, being associated with the first half of the Integration Era (2600-1900 BCE). This group was chosen for analysis in the current study based on the presence of two shared inscribed characters.

Figure 8. Mohenjo-Daro Seal Group #11 (Shah and Parpola 1991).

Both inscriptions are distinctive in that their orientations are not linear and contain characters in two registers. In appearance the inscriptions are more variable than many others in identified stylistic groups, another reason this pair was chosen for analysis. The measurements of length, width, and the ratios between them are more variable (Table 6), and there are clear differences in their morphology and orientations as well. Cut marks and carving strokes visible at the ends of the engraved surfaces are also distinct. Morphometric analysis has also verified that the shared characters are much more diverse, with recorded X and Y coordinates for each of the ninelandmarks analyzed using the ImageJ program being much more variable than those discussed above (Figure 9). Taken together, these shared characters represent easily identifiable variation that contradicts the higher levels of stylistic coherence in the animal motifs.

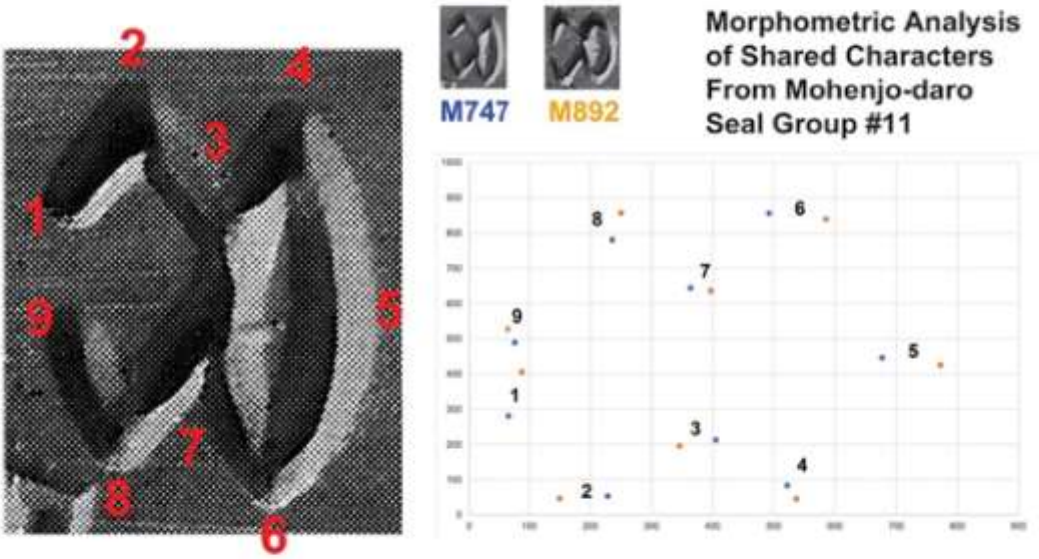


Figure 9. Morphometric Analysis of Shared Characters from Mohenjo-Daro Seal Group #11 (after Shah and Parpola 1991).

Seal	Shared Character Length (cm)	Shared Character Width (cm)	L/W Ratio
M747	0.86	0.66	1.3:1
M892	0.52	0.44	1.2:1

Table 6. Measurements of Length, Width, and Ratios of the Shared Character in Mohenjo-Daro Seal Group #11.

It is not possible to confidently explain this pattern of increased variation in the inscriptions at present, though multiple potential sources can be identified. In this case, the variance is at least in part explained by the location of the shared characters within the larger sequence of the inscriptions on each seal, but even when this is taken into account, they are still distinct in their morphology and style. It is possible that the animals and inscriptions were carved by different artisans who worked on different production tasks within the same workshop. Alternatively, the inscriptions could have been engraved by the same artisans using different tools. Earlier studies (Jamison 2012; Kenoyer 2004, 2005) have demonstrated that different tools create distinct engraved surfaces, and that tools can become dull quickly even when carving soft stones such as steatite that were used to make the majority of Indus seals. Another possible explanation is that the variance is simply a reflection of the difficulties associated with replicating to scale small, often complex signs on multiple seals, and that doing so was not an important strategy of Indus seal production. Evaluation of these explanations is difficult based on archaeological evidence alone; however, it is possible to examine the tools used to engrave iconography and inscriptions by studying the seals themselves.

Another example of a stylistic group with greater variation in inscriptions is a trio of unicorn seals, one of the most significant identified in my earlier studies (Jamison 2017). It is comprised of four seals, of which three, one each from the sites of Mohenjo-Daro, Kalibangan, and Nindowari (Figure 10), contain shared inscribed characters.

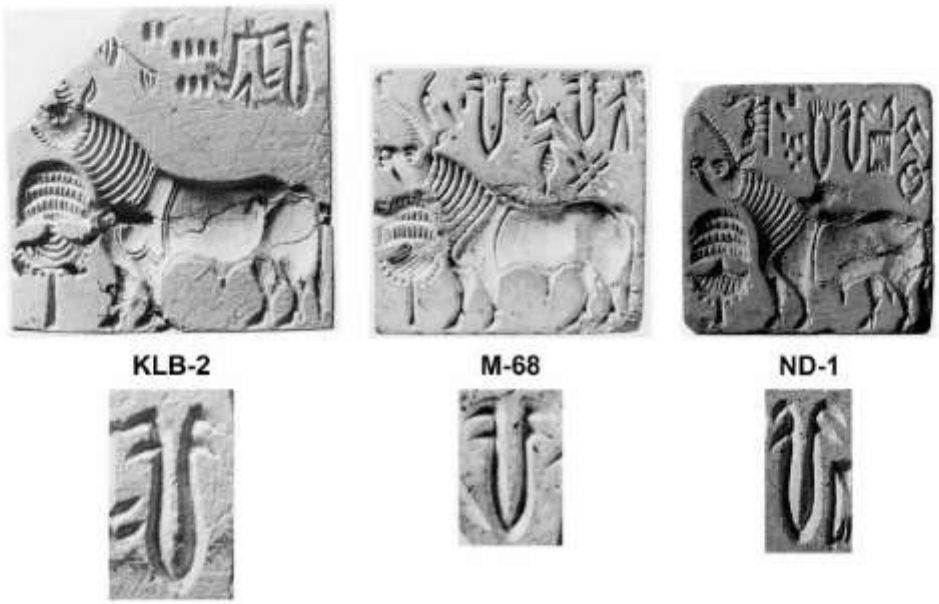


Figure 10. Seals with Shared Characters from the Mohenjo-Daro – Kalibangan – Nindowari Group (Joshi and Parpola 1987: Shah and Parpola 1991).

In addition to its complex distribution pattern (three sites from different regions, unique among stylistic groups), the seals also depict unique carving styles and combinations of multiple elements of the unicorn and standard not seen in other groups. These include distinct styles of heads, eyes, necks, and standards, and they also contain engraved testicles between the rear legs. This group was included in the current study for all of these reasons.

The inscriptions on the three seals are diverse, varying in the number of characters, registers they are engraved in, overall dimensions, and the proportions of signs that comprise them. Each contains a single shared character, which is among the most common in the Indus writing system (Mahadevan 1977; Parpola 1994; Wells 2015). Like the inscriptions more broadly, the shared characters on the three seals are variable. They appear in different positions in the sequences of signs, are different in dimensions of length, width, and their proportions, and are also distinct in morphology (Table 7). Visible differences in tool marks and the characteristics of their engraved surfaces (especially depth) can also be seen.

Seal	Shared Character Length (cm)	Shared Character Width (cm)	L/W Ratio
KLB2	1.15	0.66	1.74:1
M68	0.87	0.54	1.61:1
ND1	0.89	0.46	1.93:1

Table 7. Measurements of Length, Width, and Ratios of the Shared Character in the Mohenjo-Daro– Kalibangan – Nindowari Seal Group.

Simply put, the inscriptions are much more variable than the unicorns and standards in this seal group. Possible explanations for this are the same as those discussed above and require further testing, though this group is comprised of seals from multiple sites and regions, so the possibility that different artisans were involved in production may be greater. On the other hand, the seals are still stylistically and proportionately coherent, and previous research (Jamison 2017) suggests that this represents a workshop or artisan carving style. Based on visual comparison of the shared characters present on all three seals, their respective positions in the sequences are likely a major source of the variation observed. Regardless of the explanation of why they are diverse, these shared characters provide further support for the interpretation that not all identified stylistic seal groups have similar levels of coherence and standardization in iconography and inscriptions.

Discussion

Preliminary results of this pilot study examining shared inscribed characters among seals in previously identified stylistic groups are compatible with earlier research on variability in the carving styles of animal iconography. There are groups that contain strong similarities in the carving styles of animal motifs and inscribed characters, evidenced by formal analyses of morphology and metric properties. These include seals with unicorn and tiger iconography, from single and multiple sites, most of which appear to have been made by skilled artisans. Multiple levels of stylistic coherence present on these seals suggest the same artisans made them, including engraving animal iconography and inscriptions, and provide insights into how production was organized and varied. The results support earlier interpretations that seals were produced by multiple artisans and workshops within and among different settlements (Jamison 2017), and the identification of morphometric coherence among shared inscribed characters suggests that in at least some cases, the same artisans were engraving iconography and inscriptions.

On the other hand, there are examples of groups of stylistically similar seals with greater variation in morphometric properties of their inscriptions, specifically shared characters that appear on multiple seals. Hypotheses for this diversity has been discussed above and includes multiple factors including different artisans carving iconography and inscriptions, different tools, difficulties in replicating inscriptions to scale on multiple seals, or that doing so was not an important strategy in Indus seal production. These require further testing, preferably on the seals themselves. What is important to reiterate here is that there are varying levels of morphometric coherence in inscriptions, even among seals that are stylistically similar in terms of animal iconography. Further, there is no direct correlation between iconographic and inscription morphometric coherence. A few of the groups discussed in this research do demonstrate high levels of coherence among iconography and inscriptions, others do not. Overall, the data underscore the complex patterns of coherence and variation that are present in Indus seals and support the use of methods of formal analyses for investigation them.

A multi-faceted research program that combines formal analyses of iconography and inscriptions, including attribute analyses, measurements of and ratios of length and width, and computer-aided morphometric analyses are powerful tools for examining the nature and scale of patterned variation in Indus seal production. Ethnoarchaeological studies focusing on replicating Indus seals (Jamison 2013, 2017) indicate that at least some variation in seal production can be explained by idiosyncratic carving styles among different artisans. Seal carving by hand is analogous to handwriting; everyone does it differently, even when doing the same thing. The methods used in this study have been used to test these interpretive models of how and why seals are diverse and variable in their carving styles and proportions. Though the sample analyzed here is not large, preliminary results support my earlier studies and can be used in future research to strengthen or refute these provisional interpretations.

The methods used in this study are easily replicable, can be used on images, and can be applied to the study of other forms of Indus inscribed materials. They also generate quantitative data sets that can be used in comparative analyses to evaluate variation and standardization within and among previously identified stylistic seal groups. Considering that there are very few stratigraphically excavated seal workshops or other production signatures known from archaeological contexts, comparative studies of seals represent the best way to understood how production was organized and varied, within and among different settlements. This methodology is a novel, innovative way to do so, and though the preliminary findings discussed here are a good first step, there is still much work to be done.

The first major goal in future investigations is of course to create and study a larger sample for analysis. More seals need to be examined, including those from previously identified stylistic groups not included in the current study. The scope of investigation

can also be expanded beyond shared duplicate characters on multiple seals, as they are generally few in number and are only present on two or three seals; to include full inscriptions. Morphometric analyses on full inscriptions can provide further evidence of patterns that may relate to carving styles and techniques used by individual artisans that build upon the few examples discussed here. Morphometric analyses can also be applied to animal iconography to create a more robust, quantifiable comparative data set helpful in identifying signatures in the carving styles of different artisans and workshops that have not previously been explored.

The utility of studying seals as opposed to images of them has been alluded to throughout this research as well. The use of high-quality images is advantageous in some respects, particularly in being able to measure small, finely engraved elements, conduct computer-aided morphometric analysis, and conduct comparative studies on multiple seals. The ability to study seals, however, provides additional information not often present in images of them, including investigations of tool marks, raw materials, and other signatures of production. These data can supplement the methods applied in this and my earlier research to identify additional patterning associated with different artisans and workshops, including multiple aspects directly correlated with technological aspects of production. Another crucial future research direction is a more critical analysis of archaeological context and chronology, using original records from excavations, and when these are insufficient or incomplete, the comparative seal chronology from the HARP project discussed earlier. These investigations are necessary to identify additional patterns associated with workshop and artisan styles, if possible, and to correlate variability in carving styles and techniques with changes over time and space. All of this research will greatly aid in the continued investigation of the organization of Indus seal production and help further evaluate and refine the preliminary results discussed here.

Conclusions

Seals and inscriptions are diagnostic components of the Indus Civilization (2600-1900 BCE), the focus of many studies over the past century. Collectively, this body of work has contributed significantly to our understanding of the Indus, yet many questions remain unanswered, in part because the script has yet to be deciphered. This research has examined Indus seals in a novel way, by focusing on variation in carving styles and morphometric properties. Using complementary methods of formal analyses developed and employed in earlier research, this study has examined and compared inscriptions among seals in previously identified stylistic groups with shared styles of animal iconography. By examining animal iconography and inscriptions, it has been possible to identify patterns of coherence among both, present on multiple seals, that strongly suggest that the same artisans produced them. The identification of groups of seals likely made by the same artisans provides crucial insights into how production was organized and varied.

Preliminary results also demonstrate varying levels of coherence among identified stylistic groups in terms of iconography and inscriptions. Some examples demonstrate strong coherence between both, others have greater variation among animal iconography, and a few have less coherence among their inscriptions. Taken together, the results underscore the complex nature and scale of variation in Indus seal production strategies and techniques. The results of this pilot study complement earlier research on variation in Indus seal iconography and provide clear directions for future research. Such studies are necessary to learn more about the important roles of seals and writing in the Indus Civilization, and its relationship to larger issues of sociopolitical organization and control. Until the script is deciphered, detailed comparative studies of seals provide crucial windows into the organizational dynamics of South Asia's earliest urban civilization.

Acknowledgments

I am indebted to the organizers of this conference for allowing me to participate and share the results of this research. My sincere thanks also go to Dr. Asko Parpola of the University of Helsinki, and Drs. K. K. Bhan, P. Ajithprasad, and K. K. Krishnan of the Department of Archaeology and Ancient History. M.S. University of Baroda, for providing me with high-quality images used in this research. Dr. Michael J. Pauers of the University of Wisconsin-Milwaukee at Waukesha has shared his valuable time and expertise of the ImageJ software program with me, I am grateful to him as well. Finally, I wish to acknowledge my mentor, Professor J. Mark Kenoyer of the University of Wisconsin-Madison for his ongoing support for my research.

Bibliography

Ameri, M.

2013 "Regional variation in the Harappan world: the evidence from the seals." In *Connections and Complexity: New Approaches to the Archaeology of South and Central Asia*, edited by S. Abraham, P. Gullapali, T. Raczek & U. Z. Rizvi, pp. 355-375. Left Coast Press, Walnut Creek, CA.

2018 "Letting the Pictures Speak: An Image-Based Approach to the Mythological and Narrative Imagery of the Harappan World." In *Seals and Sealings in the Ancient World: Case Studies from the Near East, Egypt, the Aegean and South Asia*, edited by M. Ameri, S. K. Costello, G. Jamison, and S. J. Scott, pp. 144-166. Cambridge University Press, Cambridge.

Bisht, R. S.

2015 *Excavations at Dholavira (1989-90 to 2005-05)*. Archaeological Survey of India, New Delhi.

Franke-Vogt, U.

1991 *Die Glyptik aus Mohenjo-Daro. Uniformität und Variabilität in der Induskultur: Untersuchungen zur Typologie, Ikonographie und räumlichen Verteilung.* I: *Text und Tabellen*. II: *Appendices und Tafeln*. (Baghdader Forschungen, 13.) Verlag Philipp von Zabern, Mainz, Germany.

1992 "Inscribed Objects from Mohenjo-Daro: Some Remarks on Stylistic Variability and Distribution Patterns." In *South Asian Archaeology 1992*, edited by In C. Jarrige, pp. 103-112. Prehistory Press, Madison, WI.

Frenez, D., and M. Tosi

2005 "The Lothal Sealings: Records from an Indus Civilization Town at the Eastern End of the Maritime Trade Circuits across the Arabian Sea." In *Studi In Onore di Enrica Fiandra*, edited by M. Perna, pp. 65-103. Institute for Aegean Prehistory, Naples.

Green, A. S.

2015 *Stamp Seals in the Political Economy of South Asia's Earliest Cities*. PhD Thesis, New York University.

2018 "Operational Sequences and Stamp Seals: a Preliminary Report on an Experimental And Microtopographic Framework for Identifying Groups of Seal Carvers in the Indus Civilization." In *Seals and Sealings in the Ancient World: Case Studies from the Near East, Egypt, the Aegean and South Asia*, edited by M. Ameri, S. K. Costello, G. Jamison, and S. J. Scott, pp. 187-203. Cambridge University Press, Cambridge.

Jamison, G. M.
2012 "Experimental Studies of Harappan Steatite Carving and Firing Techniques." *Pakistan Heritage* (4): 1-18.

Jamison, G. M.
2013 "Experimental and Ethnoarchaeological Approaches to Indus Seal Production: Modeling Variation in Manufacturing Techniques." *Heritage: Journal of Multidisciplinary Studies in Archaeology* 1:222-243.

2017 *The Organization of Indus Unicorn Seal Production: A Diachronic Comparative Study of Style, Skill, and Sociopolitical Organization.* PhD Thesis, University of Wisconsin.

2018 "The Organization of Indus Unicorn Seal Production. A Multi-faceted Investigation of Technology, Skill, and Style." In *Walking with the Unicorn: Social Organization and Material Culture in Ancient South Asia*, edited by D. Frenez, G. Jamison, R. W. Law, M. Vidale, R. H. Meadow. pp. 272-291. Archaeopress, London.

Joshi, J. P., and A. Parpola
1987 *Corpus of Indus Seals and Inscriptions, 1. Collections in India.* Annales Academiae Scientiarum Fennicae B 239, Memoirs of the Archaeological Survey of India No. 86, Suomalainen Tiedeakatemia, Helsinki.

Kenoyer, J. M.
1998 *Ancient Cities of the Indus Valley Civilization*. Oxford University Press and American Institute of Pakistan Studies, Karachi.

2000 "Wealth and Socio-Economic Hierarchies of the Indus Valley Civilization." In *Order, Legitimacy, and Wealth in Early States*, edited by J. Richards and M. Van Buren, pp. 90-112. Cambridge University Press, Cambridge.

2005 "Steatite and Faience Manufacturing at Harappa: New Evidence from Mound E Excavations 2000-2001." *Museum Journal* (National Museum of Pakistan) Vol. III-IV: 43-56.

2006 "The Origin, Context and Function of the Indus Script: Recent Insights from Harappa." In *Ethnogenesis of South and Central Asia, Proceedings of the Pre-Symposium of RIHN and the 7th ESCA Harvard-Kyoto Roundtable, 6-8 June 2005*, edited by T. Osada and N. Hase, pp. 9-27. RIHN, Kyoto.

2009 "Indus Seals: An overview of Iconography and Style." *Ancient Sindh* 9:7-30.

2013 "Iconography of the Indus Unicorn: Origins and Legacy." *In Connections and Complexity: New Approaches to the Archaeology of South and Central Asia*, edited by S. Abraham, P. Gullapali, T. Raczek and U. Z. Rizvi, pp. 107-125. Left Coast Press, Walnut Creek, CA.

2014 "The Indus Civilization." In *The Cambridge Prehistory*, edited by Colin Renfrew and Paul Bahn, pp. 407-432. Cambridge University Press, Cambridge.

Kenoyer, J. M., and R. H. Meadow
2010 "Inscribed objects from Harappa Excavations: 1986-2007." In *Corpus of Indus Seals and Inscriptions, Vol. 3. New Material, untraced objects, and collections outside India and Pakistan, Part 1: Mohenjo-daro and Harappa*, edited by A. Parpola, B.M. Pande, P. Koskikallio, pp. xliv-lvii. Suomalaisen Tiedeakatemian Toimituksia Annales Academiae Scientiarum Fennicae, Humaniora 359 and Memoirs of the Archaeological Survey of India, No. 96. Suomalainen Tiedeakatemia, Helsinki.

Konasukawa, A.
2013 *Diversity of Harappan Civilization: A Case Study of the Ghaggar Basin (with Special Reference to Seals)*. PhD Thesis, Deccan College, Pune, India.

Lal, B. B., J. P. Joshi, A. K. Sharma, M. Bala, and K. S. Ramachandran
2015 *Excavations at Kalibangan, the Harappans (1960-69). Memoirs of the Archaeological Survey of India 110.* Archaeological Survey of India, New Delhi.

Law, R. W.
2011 *Inter-Regional Interaction and Urbanism in the Ancient Indus Valley: A Geologic Provenience Study of Harappa's Rock and Mineral Assemblage*. Indus Project, Research Institute for Humanity and Nature, Kyoto.

Mackay, E. J. H.
1938 *Further Excavations at Mohenjodaro.* Government of India Press, New Delhi.

1943 *Chanhu-daro Excavations 1935-36.* American Oriental Society, New Haven, CT.

Mahadevan, I.
1977 *The Indus script: text, concordance and tables.* Memoirs of the Archaeological Survey of India No. 77, Archaeological Survey of India, New Delhi.

Marshall, J. R. (ed.)
1931 *Mohenjo-daro and the Indus Civilization.* Probsthain, London.

Parpola, A.
1994 *Deciphering the Indus Script.* Cambridge University Press, Cambridge.

2007 "Seal Impressions on the Clay Tags from Lothal: A Re-Analysis." *Linguistics, Archaeology and the Human Past, Occasional Paper 2*, edited by T. Osada, pp. 1-12. Indus Project, Research Institute for Humanity and Nature, Kyoto.

2011 "The Harappan unicorn in Eurasian and South Asian perspectives." In *Linguistics, archaeology and the human past: Occasional paper 12*, edited by T. Osada and H. Endo, pp. 125-188. Indus Project, Research Institute for Humanity and Nature, Kyoto.

Parpola, A., B. M Pande, and P. Koskikallio
2010 *Corpus of Indus Seals and Inscriptions, Vol. 3. New Material, untraced objects, and collections outside India and Pakistan, Part 1: Mohenjo-daro and Harappa*. Suomalaisen Tiedeakatemian Toimituksia Annales Academiae Scientiarum Fennicae, Humaniora 359 and Memoirs of the Archaeological Survey of India, No. 96. Suomalainen Tiedeakatemia, Helsinki.

Possehl, G. L.
1996 *Indus Age: The Writing System*. Oxford and IBH Publishing, New Delhi.

Rao, S. R.
1985 *Lothal: A Harappan Port Town (1955-62),* 2 Vols. Memoirs of the Archaeological Survey of India 78. Archaeological Survey of India, New Delhi.

Rissman, P. C.
1989 "The Organization of Seal Production in the Harappan Civilization." In *Old Problems and New Perspectives in the Archaeology of South Asia*, edited by J. M. Kenoyer, pp. 159-170. Wisconsin Archaeological Reports, Vol. 2. University of Wisconsin-Madison.

Uesugi, A.
2011 "Development of the Inter-Regional Interaction System in the Indus Valley and Beyond: A Hypothetical View Towards the Formation of the Urban Society." In *Cultural Relations between the Indus and the Iranian Plateau During the Third Millennium BCE*, edited by T. Osada and M. Witzel, pp. 359-380. Cambridge: Department of Sanskrit and Indian Studies, Harvard University, Boston.

Vats, M. S.
1940 *Excavations at Harappa.* Government of India Press, Delhi.

Wells, B.
2015 *The Archaeology and Epigraphy of Indus Writing.* Archaeopress, London.

Survival of Harappan Crocodile Cult in Present-Day Gujarat and Sindh

Asko Parpola

Preliminary note

Dr Kaleemullah Lashari, Chairman of the Management Board for Antiquities and Physical Heritage, Government of Sindh, kindly invited me to read a paper at the conference on the Indus script held by the National Fund for Mohenjo-daro on January 9-11, 2020, at Mohenjo-daro. "The organizers feel happy to undertake the costs of the international and local travel along with the hospitality in Pakistan.

In case you are constrained to attend the conference, despite the great desire of the people of Sindh, who want to see you, we would certainly like to have your paper for the conference", wrote Dr Lashari.

I visited Mohenjo-daro for the first time in January 1971, and have been there several times after that, last during the second international Mohenjo-daro conference in 1992. I would have liked to return to Mohenjo-daro now and to participate in the Indus script conference in person, and I am really sorry that my present health condition unfortunately does not allow this. Yet I am grateful for the opportunity to present a paper at the conference *in absentia* [1].

---

[1] In an international workshop on "The Harappans in Gujarat" held at Bhuj, Kutch, Gujarat, in January 28-31 2010, I read a paper entitled "Crocodile in the Indus Civilization and later South Asian tradition". That paper was shortly afterwards enlarged into a more comprehensive account of 58 printed pages, published in 2011 in Japan and reprinted in 2012 in India. For the Proceedings of the Bhuj conference I submitted selections from that wider paper most relevant to the conference theme "Harappans in Gujarat". This shorter paper covers the most significant result of my crocodile studies, namely finding concrete evidence for the survival of Harappan religion through four thousand years to the present day, which testifies to the tenacity of ancient religion in South Asia. Eight years have passed, and the Proceedings of the Bhuj conference have not appeared. I therefore decided to enlarge this unpublished gist of my Bhuj paper by adding a reference to the similar continuation of the Harappan crocodile cult until very recently even in Sindh, and to present this paper at the Indus script conference in January 2020 at Mohenjo-daro.

The tribal crocodile cult of southern Gujarat

In his 1902 *Census report of the Baroda State,* Jamshedji Ardeshir Dalal, noted that

In Baroda the crocodile god, Magar Deo, is worshipped once a year to protect men and animals from the attacks of these monsters, and also as a preventive against illness. The deity is represented by a piece of wood in the form of the animal, supported on two posts [2].

Some of the wild tribes in Baroda, to avert injury to men and animals as well as sickness, worship Magardeo in the form of a piece of wood shaped like a crocodile and supported on two posts [3].

In 1969, Dr Eberhard Fischer of the University of Heidelberg and Shri Haku Shah of the Tribal Research and Training Institute at the Gujarat Vidyapeeth documented in fair detail this crocodile cult of southern Gujarat. They were not aware of Dalal's reference to it, believing that they had discovered a previously wholly unknown cult. Fischer and Shah made three field trips by jeep and visited more than fifty villages of the Choudhri, Gamit and Vasava tribes in the tribal areas of the Surat District, documenting their sanctuaries, ways of making the wooden statues of the crocodile gods and interviewing their oracle priests (*bhagat*) and other informants on their significance and cult. The results were published in 1971 in a jointly authored booklet entitled *Mogra Dev: Tribal crocodile gods*. In what follows, I summarize their most important findings.

There is both communal and individual worship of the crocodile gods. Among the principal reasons for communal worship is getting cows and milk, and also offspring and good crops.

In Devalpada village, people told:

The cows from this village were not giving milk and they were not having calves. After installing this crocodile, we got milk and calves.

In Amba village:

This crocodile has been installed because the people did not get sons. The tiger was eating their cattle and the crops were spoiled. The (crocodile) god proved good and true. All twelve months they worship the crocodile.

[2]Dalal 1902: I, 157 as quoted in Crooke 1912: 9a.
[3]Dalal 1902: I, 157 as quoted in Crooke 1926:377

In Jamkhadi:

Four buffaloes have come to my house. They have been sent by *bela mogra* ['cool crocodile']. (The god) cool crocodile comes walking and gives. Human beings drink milk. -- Man's life is like mogra's life. That is why we offer milk to the crocodile as well[4].

Individuals usually install crocodile icons to get children.

In Singhpur village, people told:

This man had no sons. When he was old (about 70 years ago), in his dream the crocodile-god said: 'Put me', and the man got the crocodile made and installed.

In Sakerda village:

One woman was getting no son. She took a vow that she would install a crocodile and worship it after having born a son. That was before 45 years. She got a son and installed this crocodile. -- Manyo Bhondo had no sons. When he had got his first son, he installed the crocodile. That son is still alive[5].

The crocodile god helps in sorcery and illness as well.

In Bhatvada village people told:

If a ghost or a witch has entered someone's body, he will worship. When such a person has become all right again, he will relieve himself of the vow taken when ill[6].

The mode of worship was explained as follows in the villages near Mandvi.

All Chodhris install such (undecorated one-headed) crocodiles, usually once a year. The time is usually *maha amas* [new moon] in February. The village carpenter makes all the crocodiles. The wood is not worshipped before the crocodile is installed. Where the crocodile image is erected, one goat is killed and wine is offered. The

---

[4]Fischer and Shah 1971: 39-41.
[5]Fischer and Shah 1971: 39.
[6]Fischer and Shah 1971: 41.
[7]Fischer and Shah 1971: 38.

priests and others drink wine as well. Besides wine, milk is among the major offerings to the crocodile[7].

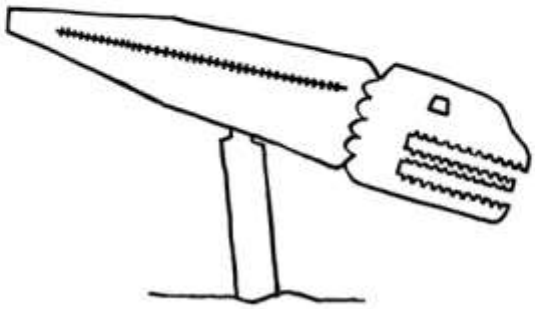


Fig. 1. A wooden tailed crocodile image set on a pole. After Fischer & Shah 1971: 14.

The researchers wanted to have a crocodile image for the museum. A *bhagat* hesitatingly agreed to the carving of a crocodile, after he had been promised the working material (including a wood block of teak tree ritually felled for the purpose), the articles necessary for the installation ceremony, and a fee for his work. The carved crocodile had to be formally installed, even if it went to a museum later on. This was considered essential by the *bhagat*.

In the evening, the ground under a tree near a broken well was cleared and made even, and the crocodile was placed on its supporting post. Then it was taken down and sprinkled all over with water, and finally fixed to the post. The *bhagat* muttered in Gujarati to the crocodile a formula ending in the words "Goddess Crocodile, we offer you worship". Then he sprinkled grain on the crocodile and deposited another handful of grain in the central shallow depression of its body. A coconut was offered, then broken on a stone, and its two parts placed near the post. A cock was placed in front of the post and then killed with a sickle by a helper. Vermilion and oil were mixed in a bowl and smeared on the crocodile and the post with coconut fibres. Women from the neighbouring houses then gathered around the crocodile and sung a song of a marriage procession for it, mentioning the new owner as the bridegroom who has come to fetch *Hela Mogra* to his village. Then rice was once more offered to the crocodile, wine was poured on the ground in front of it, and the *bhagat* uttered:

If children are asked, give children; if money is asked, give money; if grain is asked, give grain; if service is asked give service; give everything asked for. We offer you worship, gift of chicken, gift of coconut, gift of rice, offering of wine is given.

The cock was plucked, cut into pieces and roasted. The liver and the heart were offered to the crocodile with some drops of wine, while the participants had a small feast with the chicken and the left-over wine[8].

Fig. 2. Wooden crocodile icons set on poles in Devlimadi sanctuary. After Fischer & Shah 1971: pl. 2. Photo Eberhard Fischer.

The majority of the wooden crocodiles were found in groups in the sanctuaries of Dudhmogra (Mandvi Taluk), Devlimadi (Songadh Taluk) and Devmogra (Zagbara Taluk). Often there were just one or two crocodiles in sanctuaries, not in the immediate vicinity of the village but at some quiet spot near places of worship of other gods or ancestors. They were always near the fields, rarely near a creek or water pond, and usually under a group of trees or under a roof, on wooden posts: there should be shelter over the crocodile to keep it cool[9]. Most of the images were old and not much cared-for, but to a few of them cocks, grain, food or money had been offered recently. This reflects the gradual discontinuation of the cult[10].

---

[8]Fischer and Shah 1971: 18-32.
[9]Fischer and Shah 1971: 13, 17.
[10]Fischer and Shah 1971: 17.

The icons have two basic forms. The Chodris of the Mandvi Taluk erect a relatively realistic crocodile with one head, a body (octagonal in section) and a tail. The body, which is octagonal in section, is usually ornamented only with grooves imitating reptile scales. The crocodile revolves on its post: it is thought to be alive, to see with its eyes, to be able to turn around. The mouth of the crocodile should point towards the sunrise; if it points to the north or the sunset, something bad is to happen. There are also stories that it has bit hands that have been put into its mouth[11].

The Gamits and Vasavas also make wooden crocodile figures mounted on poles, but these usually have one body and a crocodile head at both ends. The body, which is square in section, is ornamented with relief or chiselled motifs[12]. The ornamental motifs are usually the sun and crescent moon, followed by two horse riders separated by a standing figure. Other aquatic animals form the next common scene, while less frequent motifs include birds and cattle.
Gamit informants in Ghoda village near Songadh commented the two-headed images as follows:

Mogra is a couple by itself: one side is male, one side is female[13].

From this it appears that this image type has replaced an older pattern of two crocodile images. The fact that quite often two crocodiles are standing together was explained in Karoli:

There must be two. As we are men and women, we have to install two[14].

One is reminded of what Francis Buchanan Hamilton in the beginning of the 19th century reported from Purneah in Bengal:

[a water tank was] dedicated to a saint, and inhabited by a pair of crocodiles which are identified with the saint and his wife[15].

In some places, however, the crocodile can be accompanied with a pole instead of a second crocodile... Chhania Holia explains it [like this]: 'This *khambh*, pole, was installed together with *mogra*, crocodile. It is called *mogra nu jodu*, crocodile's partner

---

[11]Fischer and Shah 1971: 13-14, 17.
[12]Fischer and Shah 1971: 15.
[13]Fischer and Shah 1971: 38.
[14]Fischer & Shah 1971: 37.
[15]Buchanan Hamilton quoted in Crooke 1906: 112.
[16]Fischer & Shah 1971: 38.

(pair). *Khambh* is husband, *mogra* is wife. It was like this in the old sanctuary as well... It is the same with human beings in the house: it needs a couple[16].'

The pole is of the same height as the crocodile, square in section, chamfered and ends on top in spherical form[17].

The installation ceremony ends in *sindur* being applied on the crocodile and the post, in women singing a wedding song of the crocodile goddess & feasting[18].

Many legends connected with the history of the crocodile cult and its origin are reported by Fisher and Shah. Some of them are reflected in the rider images carved on the two-headed crocodile images. On this basis, the researchers came to the following conclusion:

The tracing of tribal cultures of Gujarat to prehistoric findings, seems to us out of place and in a future analysis we shall show, that elements from these tribal cultures tend more to be degenerated forms of much later traditions rather than stagnated primitive cultures[19].

A unique painted potsherd excavated at Amri in Sindh, attesting to the Harappan background of the Gujarati crocodile cult

Fischer and Shah are thus clearly opposed to the opinion of Sir John Marshall who, after quoting some beliefs and practices connected with the crocodiles in South Asia in historical times, came to the following conclusion:

The foregoing facts respecting the present-day worship of these animals afford, of course, no proof that they were similarly worshipped five thousand years ago. In a country, however, which is as conservative as India, particularly in regard to its religious cults, these facts are not without real significance; and when we find, as we do, that most of the elements which make up this prehistoric religion [of the Indus Civilization] — so far as we can at present analyse them — are perpetuated in later Hinduism, we are justified in inferring that much of the zoolatry which characterizes Hinduism and which is demonstrably non-Aryan, is also derived from the prehistoric age[20].

---

[17]Fischer & Shah 1971: 16. AP: The pole as described here resembles the shape of the linga statues.
[18]Fischer & Shah 1971: 30-31.
[19]Fischer & Shah 1971: 7-8.
[20]Marshall 1931: I, 73.

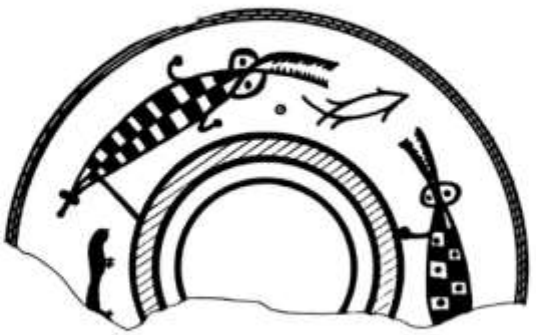


Fig. 3. A unique Mature Harappan painted pot fragment excavated at Amri, lower Sindh, Period III, representing a fish and two crocodile icons set on poles. After Casal 1964: II, fig. 75 no. 323.

Marshall of course did not know of the study of Fischer and Shah published 40 years later. But nor did Fischer and Shah know of the evidence excavated at Amri in the lower Indus Valley by Jean-Marie Casal, which was published in 1964.

The incompletely preserved Mature Harappan painted pot found by Casal at Amri depicts a fish, a small dot-in-circle and an indistinct (animal?) figure, and in addition two long-snouted crocodiles that have a pole-like extension projecting in a 90 degrees' angle from their lower body to a painted border that can be interpreted as the ground[21].

When I included the picture of this potsherd in my book *Deciphering the Indus script* published in 1994[22], I wondered about the meaning of these projecting extensions, and looked for an explanation in Casal's excavation report, but in vain, for he does not discuss the motif in any detail.

Later, when studying Fischer and Shah's document of the Gujarati crocodile cult, this puzzling potsherd came to my mind. The Gujarati crocodile images installed horizontally upon upright poles fixed to the ground perfectly clarify this unique Harappan painted scene. The potsherd also shows two crocodile icons, which agrees with the Gujarati custom of often installing two crocodile icons to represent them as man and wife. Without this single potsherd from Amri, we would not be able to project the present-day Gujarati crocodile cult back to Harappan times. Gujarat belonged to the Harappan realm, being closely connected with Sindh, and tribals living in its remote jungle villages are the most likely people to have preserved stagnated prehistoric cults. In my opinion, we have here a fairly clear proof that Harappan religion could in such circumstances survive even 4000 years after the collapse of the Indus Civilization. This means that South Asian religious practices

[21]Casal 1964 II: fig. 75 no. 323.
[22]Parpola 1994: 180 fig. 10.1 e.

attested much earlier, in Vedic texts (c. 1200-400 BCE) and other Sanskrit literature, can very well be of Harappan heritage.

Other evidence of Harappan crocodile cult

The Amri potsherd is unique in showing that the Harappans made crocodile icons set on poles, such as are still being made by the Gujarati tribals 4000 years later. That singular potsherd, however, is by no means the only evidence for a Harappan crocodile cult.

Fig. 4. "Gharial with fish in its mouth" in an Indus seal (M-410) from Mohenjo-daro.

The crocodile is depicted four times as the main heraldic animal on Indus seals; all of these come from Mohenjo-daro[23]. One of these seals is rectangular and has no script; it illustrates a gharial that has a fish in its mouth. The fish is drawn in the same way as the 'fish' signs of the Indus script.x The gharial mainly eats fish, and this scene repeatedly attested in Harappan glyptics proves that the similar-shaped sign of the Indus script depicts 'fish'. It does not follow, however, that in the Indus script this sign always means 'fish'. The Indus script used the so called *rebus* principle for phonetization as did the other very early writing systems[24]. In the Proto-Dravidian language, on which the Indus script is based, the usual word for 'fish' was **mīn,* and this word was pronounced like the word for 'star', **mīn*[25]. While common people among the Harappans probably saw only 'fish' and 'crocodile' in this scene, as in their folk religion, for the Harappan priestly elite both of these animals had also an astral meaning[26].

---

[23] These seals have been illustrated in the CISI vols. 1 and 2 under the following code numbers: M-292, M-293, M-410 and M-1223.

[24] Parpola 1994: 29-34; 2015: 267.

[25] Parpola 1994: 179-190.

[26] For the astral meanings, see Parpola 2015: chapters 16 and 21

Although the crocodile is relatively rarely depicted in the Indus seals, it appears very often on the small moulded and incised "sacrificial tablets" excavated at Mohenjo-daro and in larger numbers at Harappa[27]. The interpretation of these tablets as "sacrificial" is based especially on the tablet M-478 and its duplicates.

Fig. 5. Tablet M-478 from Mohenjo-daro recording the offering of four vessels to a sacred tree. After CISI 1: 115.

Here (on the right) a kneeling worshipper is depicted extending what looks like a vessel in profile towards a tree, which is likely to be sacred. The accompanying inscription (to the left of this scene) shows a similar-looking vessel, preceded[28] by a sign which consists of four strokes and probably expresses the numeral 'four'. The majority of the 'sacrificial tablets' are bifacial, and their reverse side usually shows nothing but the 'vessel' sign preceded or not by a sign consisting of one to four strokes, thus expressing the meaning 'one, two, three or four (sacrificial) vessels (containg offerings)'. I see a confirmation to this interpretation in the tablet H-764, where the reverse consists of nothing but UUU, i.e. three 'vessel' signs, meaning 'three vessels'. On the reverse of the tablet H-247, instead of a plain 'vessel' sign, we have a more complex sign, which consists of 'a kneeling person holding the vessel sign', and in the manner of the plain 'vessel' sign, this complex sign is preceded by two strokes standing for 'two'[29].

Fig. 6. Reverse sides of tablets H-302 and H-1192. After Parpola 1994: 194 fig. 10.21.

[27]For all tablets excavated at Mohenjo-daro and Harappa see CISI 1: 108-121, 207-233; 2: 187-198, 316-344; 3.1: 102-111, 153-174, 252-296.

[28]The normal direction of writing in the Indus script is from right to left.

[29]Parpola 1994: 109, figs. 7.9-12.

That the 'sacrificial vessel' probably contained fish as offerings is made likely by the reverse sides of the tablets H-302 (and H-1191) and H-1192, which can be interpreted to mean 'four pots fish' and 'four fish-pots' [30].

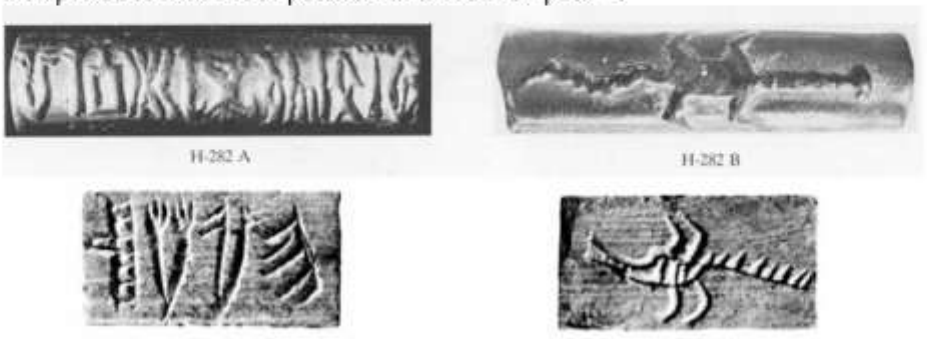


Fig. 7. Realistic crocodile images on tablets H-282 and H-287 from Harappa. After CISI 1: 223.

The gharial is depicted as a realistic image on one side of many of the bi- or multisided tablets found at Mohenjo-daro and Harappa, for instance on the moulded tablet H-282 and the incised tablet H-287.

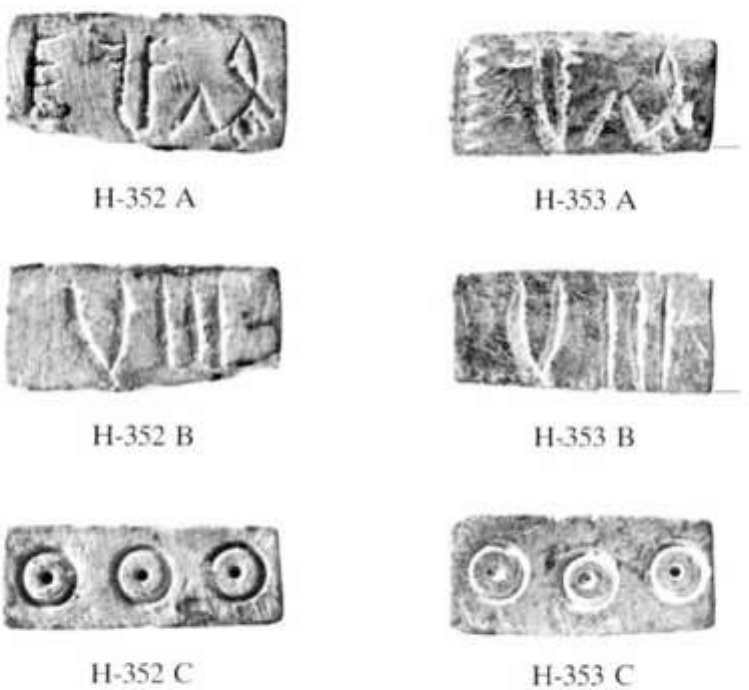


Fig. 8. The threesided tablets H-352 and H-353 from Harappa. After CISI 1: 230.

[30]Parpola 1994: 194, fig. 10.21.

But the gharial appears to be expressed in the "sacrificial tablets" also through an Indus script sign, which occurs in their inscriptions, this being in fact the first sign of one of their most frequent texts (for example H-933 to H-935).

H-742 A

Fig. 9. Obverse side of the tablet H-742 from Harappa. After CISI 2: 322.

In the tablet H-742, the sign, which I have proposed[31] to denote 'crocodile', occurs next to a similar but simpler sign[32]. On the basis of two more realistic variants[33], the simpler sign depicts an enraged cobra that stands upright with expanded hood, and probably has the meaning 'snake'. The four short strokes attached to the 'crocodile' sign express this meaning by depicting it as a 'reptile with four legs'.

This evidence suggests that the Harappans were offering potfuls of fish to crocodiles, presumably not only to their wooden icons, but also to live crocodiles, as in later Hinduism:

The Hindu temples are usually constructed on the banks of various rivers and tanks where these reptiles are found. Therefore, devotees have been offering food to these sacred animals which were tamed by the priests[34].

There is evidence to suggest that the main motif of the Harappan offerings to their crocodile god was the wish to obtain offspring[35]. The worshippers would have received an appropriate tablet from the priests in charge either as a receipt for their offering, or as an amulet, or the tablet may have had both functions.

---

[31]Parpola 2011: 48.

[32]These two signs are nos. 87 and 86 in my sign list of the Indus script in Parpola 1994, fig. 5.1.

[33]One of these realistic variants of the 'snake' sign is in the seal impression M-1379, the other is an unpublished seal from Banawali, where the iconographic motif is the 'three-headed beast'; this latter object came to my knowledge only in 2016.

[34]Crooke 1906: 112.

[35]This evidence is presented in Parpola 2011. One reason for worshipping the gharial in order to obtain offspring is probably the male gharial's long snout, which has a phallic meaning; its protuberance continues to be a coveted aphrodisiac.

Magar talāo near Karachi

William Crooke has observed that

Tame crocodiles are protected and fed in many places, as in the famous Magar Talâo, or 'Crocodile Tank', near Karáchi[36].

At Magar Talāo, 'crocodile tank', near Karachi, in connection with the cult of Pīr Mango, who caused a stream to trickle out of the rock, tame crocodiles are kept and fed by pilgrims[37].

According to the local legend, Mango Pir was formerly, some 700 years ago, a Hindu dacoit, notorious for looting caravans. Impressed by the teachings of Baba Farid, he converted to Islam. Pleased with Mango's devotion, Farid titled him Pir. He became a saint respected by both Hindus and Muslims. The crocodiles were gifted to Mango Pir either by Baba Farid, or by the Sindhi saint Lal Shahbaz Qalandar: originally they were lice of the saint, but converted into crocodiles when put into the pond[38].

From this legend we can conclude that the habit of feeding crocodiles in a pool attached to a shrine of a saint goes back to pre-Muslim Hindu traditions of lower Sindh. The name of the saint connected with the cult, Mango, appears to be related to the Sindhi words *mangar-macho* and *manguro*, which have been recorded to mean 'whale' and 'a kind of sea fish', respectively; the original meaning 'crocodile' is preserved in Baluchi *māngar*, which is considered to be a loanword from Sindhi. These are all nasalized variants of the Sanskrit word *makara* 'crocodile' and its later cognates like Hindi *magar-mach* 'crocodile', which is also part of the local name of this crocodile pool, *Magar talāo*[39].

The Harappans worshipped the fish-eating long-snouted gharial, the only crocodile species illustrated in the seals and tablets of the Indus Civilization. After the extinction of this now highly endangered crocodile species (which still lives in the Ganges and its tributaries), its cult in lower Sindh was apparently transferred to the saltwater crocodile, whose typical habitats are tidal estuaries and lower reaches of larger rivers.

---

[36]Crooke 1906: 112.
[37]Crooke 1926: 377. Here Crooke refers to R. F. Burton, *Sind revisited*, London, 1877, i. 92ff.; and E. Balfour, *The cyclopaedia of India and of eastern and southern Asia*, Madras 1858, i. 838f.
[38]Baloch 2004: 12.
[39]Cf. Turner 1966: 554 no. 9692.

References

Baloch, Waseem, 2004. Manghopir, Karachi, Pakistan, and crocodiles. *Crocodile Specialist Group Newsletter* 23 (3): 12-13.

Casal, Jean-Marie 1964. *Fouilles d'Amri,* I-II. (Publications de la Commission des Fouilles Archéologiques: Fouilles du Pakistan.) Paris: C. Klincksieck.

CISI = *Corpus of Indus Seals and Inscrptions*. Helsinki: Suomalainen Tiedeakatemia.
1. *Collections in India.* Edited by Jagat Pati Joshi and Asko Parpola. 1987.

2. *Collections in Pakistan.* Edited by Sayid Ghulam Mustafa Shah and Asko Parpola. 1991.

3. *New material, untraced objects, and collections outside India and Pakistan.* Part 1. *Mohenjo-daro and Harappa.* Edited by Asko Parpola, B. M. Pande and Petteri Koskikallio. 2010.

Crooke, William 1906. *Things Indian, being discursive notes on various subjects connected with India.* London: John Murray.

Crooke, William 1912. Dravidians (North India). In: James Hastings (ed.), *Encyclopaedia of Religion and Ethics,* Vol. 5. Edinburgh: T. & T. Clark. Pp. 1-21.

Crooke, William 1926. *Religion and folklore of northern India*. Prepared for the press by R. E. Enthoven. London: Oxford University Press.

Dalal, Jamshedji Ardeshir 1902. *Census of India 1901, Report.* Vol. 18: Baroda, Part I. Bombay: Government Central Press. (Cited from Crooke 1912 and Crooke 1926.)

Fischer, Eberhard, and Haku Shah 1971. *Mogra Dev, tribal crocodile gods: Wooden crocodile images of Chodhri, Gamit and Vasava tribes, South Gujarat (India).* (Art for tribal rituals in South Gujarat, 1.) Ahmedabad: Gujarat Vidyapith.

Marshall, John 1931. Religion. In: John Marshall (ed.), *Mohenjo-daro and the Indus Civilization,* I. London: Arthur Probsthain. Pp. 48-78.

Parpola, Asko 1994. *Deciphering the Indus script.* Cambridge: Cambridge University Press.

Parpola, Asko, 2011. Crocodile in the Indus Civilization and later South Asian traditions. Pp. 1-58 in: Toshiki Osada & Hitoshi Endo (eds.), *Linguistics, Archaeology and the Human Part: Occasional Paper 12.* Kyoto: Indus Project, Research Institute for Humanity and Nature. Reprinted, pp. 1-58 in: Toshiki Osada & Hitoshi Endo (eds.), *Current Studies on the Indus Civilization,* Vol. 9. New Delhi: Manohar, 2012.

Parpola, Asko, 2015. *The Roots of Hinduism: The Early Aryans and the Indus Civilization*. New York: Oxford University Press.

Turner, R. L. 1966. *A comparative dictionary of the Indo-Aryan languages.* London: Oxford University Press.

Indus Script and Indus Culture

M N Vahia
School of Mathematical Sciences, NMIMS, Mumbai

Rajesh P. N. Rao
Paul G. Allen School of Computer Science and Engineering, University of Washington, Seattle,Washington, United States of America

Nisha Yadav
Tata Institute of Fundamental Research, Mumbai

1. Introduction

We take a broader view of the purpose of writing and attempt to interpret the contents in a non-linguistic model to guide any ideas on what may be the content of writing in the Indus Script. We analyse the general characteristics of writing and then compare it with the insights provided by syntactic studies of the Indus script to get insights into the nature of Indus writing.

2. The need for writing

Why does a civilisation write? It can be:

1) to aid short and long term memory
2) to convey information to others who are beyond easy reach.

The characteristics of both these writing objectives are significantly different with different requirements, design, medium and output. Objective (1)implies a local requirement which in extreme cases, such as pottery marking, can be highly individualistic. But even for local memory aid, the symbols must have locally agreed meaning. These are therefore sensitive to local culture. Objective (2) requires agreement on the content and grammar of writing over long distances as well as a very high level of standardisation of writing including mutually agreed signs and their

meaning as well as commonly agreed grammar. It also has to be independent of local variations in language and dialect.

3. Nature of writing

The next question is: how will a culture design or invent a script. This depends on local visualisation and the contents one wishes to express. The script can be:

1) Pictographic
2) Logographic
3) Logo syllabic
4) Alphabetic

The number of signs and the design of signs is significantly different in each case. The level of sophistication in choosing the symbol system that represents information also depends on the intellectual growth of a civilisation.

Civilisations evolve and incorporate influences of other cultures. Over a period of hundreds of years, one does not expect either the language, trade or cultural practices to remain static.

4. Characteristics of the Indus Script

There are multiple dilemma associated with the Indus script. These include:

1) Cryptic nature of the writing given the lack of knowledge of the underlying language(s), the brevity of the surviving texts, and lack of a ' Rosetta stone'.

2) Its sudden appearance in fully formed format.

3) Its uniformity across a large area of almost 1.5 million square km and beyond.

4) Its appearance in a highly sophisticated cultural background.

5) Apparently little changes in writing style or grammar except towards the end of the culture (as inferred by the crudeness of the written objects).

6) Varying landscape over which the culture spread.

7) Trading activity that is spread over several thousand kilometres and well into the present day West Asia.

The physical spread of cultural evolution of the civilisation have been discussed elsewhere which we know is complex and time evolving. Yet, except for the evidence of the sudden appearance of the fully formed script around 2600 BC, very little is known about the script.

The fact that the script is highly homogenised in terms of its grammar and sign use over more than a million square kmsuggests that there must have been a centralised system of educating the writers and readers and a centralised administration – something that is also obvious from other aspects of standardisation such as weights. Other authors have discussed various possibilities about what the writing may be. These include suggestions that the writing may be tokens of payment to possibly a numeric symbolism of entities in the accompanying drawing. Attempts have also been made to fit specific linguistic models such as proto-Dravidian, proto-Sanskrit, or Sumerian. Researchers have even tried to start by assigning meanings to a small number of signs through association with other scripts such as Brahmi, with little success.

It is also a general rule of information content that the more cryptic the writing, the greater is the need for a prearranged agreed-upon coding system, unless only simple information is being transmitted. All indications of the complexity of Indus writing and the failure of obvious post facto models of writing (Yadav, Rao and Vahia, 2012) indicate a coding technique that is fundamentally different from other forms of writing.

Major features of the script itself are discussed elsewhere. Here we attempt to create a network of ideas on the relative importance of a script and speculate on the nature of the script's use by the Indus people.
There exists archaeological evidence for the script's use for the following possible applications:

- Tags for securing goods/storage rooms in trade: Examples include clay tags with seal impressions found in Lothal and other locations.

- Identification mechanism for guilds/manufacturers/workshops/ individuals: It has been suggested that seal bearers may have used their seal(s) to identify themselves as members of a guild (e.g., via the 'totem' animal such as the 'unicorn' on the seal). Additionally, seal impressions on pottery could serve as branding for a potter or workshop.

- Tokens as primitive coinage for exchange of goods and administration of labour: Some of the seal impressions on clay tokens may have been used as "I owe you" receipts to facilitate payment to labourers, porters etc. in exchange for their labour (Rao, 2018).

- Religious purposes such as amulets for protection: Seals depicting rituals, mythical scenes, tree worship and revered personages likely served a religious function, for example, acting as protective amulets if worn by a person. Seal impressions on clay tokens may also have acted as receipts for donations to religious institutions.

5. Results from structural studies

A large number of studies (Yadav *et al.* 2008a, b; Rao *et al.* 2009a,b; Yadav *et al.* 2010; Rao *et al.* 2010; Yadav and Vahia 2011a, b; Yadav *et al.* 2012, Yadav 2013; Yadav *et al.* 2017) have provided us with significant insights into the nature of the Indus Script. Some of the salient features are:

1) The use of the script is highly uniform across the entire culture

2) The writing appears over a short period of time in a highly evolved manner (Kenoyer, 2006)

3) There exists a small sense of similar signs in proximate regions

4) The grammar of writing is highly standardised across the region with the proximity rule defined across the civilisation (Rao *et al.* 2009a)

5) The writing is highly ordered, with flexibility similar to linguistic writing (Rao *et al.* 2009b, rao *et al.* 2010

6) While the average number of signs per written sting is 5, the statistical data shows that there is preference in written strings for pairs of signs, triplets and 4 sign sequences which appear far more frequently than random chance (Yadav *et al.* 2008a)

7) Machine learning can predict missing signs with more than 75% accuracy suggesting that the rules are not writer dependent but are defined in absolute terms. (Yadav *et al.* 2010)

8) Many signs seem to be a combination of other signs and the environment of appearance of combined signs is significantly different from the original signs. (Yadav and Vahia, 2011)

9) Unsupervised pattern search algorithms suggest that the writing seems to be divisible into 9 distinct groups of writing. (Yadav *et al.* 2017)

10) Most signs require significant number of strokes suggesting that the design of signs was not evolutionary but formalised in their meaning. (Yadav and Vahia, 2011)

11) Generic models that suggest that Indus Script may be a random scribble, or purely numeric or writing in one of the later scripts do not agree with the statistical patterns of sign usage (Yadav *et al.* 2012)

Most Indus writing is formal, appearing not on pottery or randomly shaped objects but on objects (mainly seals) of square geometry whose sides are on the scale of 2 to 5 cm, suggesting a specificity which adds significantly to the knowledge. Many of these objects also have exquisite geometry (Vahia and Yadav 2010; Sinha *et al.* 2011). This suggests that the writing was a highly coordinated activity with centralised teaching centres which trained the writers to provide standardised exchange of information. While trade would be one obvious purpose, the possibility that the purpose was the creation of literary works, in view of the cryptic nature of the writing, is small. However, given the fact that the flexibility in writing is similar to that of linguistic writing, the written information cannot possibly be simple trade or name tag information. The division of the writing into nine distinct groups also suggests that the writing served more than one purpose and any model of interpretation would have to assume that a variety of information was precisely coded in this writing. Some variations across the medium on which writing was written also suggests some evolution of writing (Yadav 2013). Some authors have also associated the writing with the icons drawn on the objects but since a large number of objects do not have an accompanying pictorial motif (Joshi and Parpola 1987; Shah and Parpola 1991), the relation between the motifs and the written material is unclear.

We therefore conclude that the Indus script had multiple uses and was used to convey fairly sophisticated ideas or information cryptically across vast regions through specialised writers. The script was used for expressing heterogeneous information but using a highly standardised grammar across both space and time.

References

Joshi, J. P. and Parpola,A. 1987 *Corpus of Indus Seals and Inscriptions*, 1. *Collections in India.* Helsinki: Suomalainen Tiedeakatemia, also Memoirs of the Archaeological Survey of India No. 86.

Kenoyer, J. M. 2006"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.

Rao, R. P. N., Yadav, N., Vahia, M. N., Joglekar, H.,Adhikari, R. and Mahadevan, I. 2009a A Markov Model of the Indus Script.Proceedings of the National Academy of Sciences, vol. 106, pp. 13685-13690.

Rao, R. P. N., Yadav, N., Vahia, M. N., Joglekar, H., Adhikari, R. and Mahadevan, I. 2009b. Entropic Evidence for Linguistic Structure in the Indus Script. Science. vol. 324, p. 1165.

Rao, R. P. N., Yadav, N., Vahia, M. N., Joglekar, H., Adhikari, R. and Mahadevan, I. 2010. Entropy, the Indus Script and Language: A Reply to R. Sproat.Computational Linguistics, vol. 36, pp. 795-805.

Rao, R.P. N. The Indus Script and Economics. A Role for Indus Seals and Tablets in Rationing and Administration of Labor. 2018. In Walking with the Unicorn: Social Organization and Material Culture in Ancient South Asia. (Jonathan Mark Kenoyer Felicitation Volume) D. Frenez, G. M. Jamison, R. W. Law, M. Vidale & R. H. Meadow (Eds.),pp. 518-525, Archaeopress, Oxford, UK.

Shah, S. G. M. and Parpola, A. 1991 *Corpus of Indus Seals and Inscriptions*, 2. *Collections in Pakistan.* Helsinki: Suomalainen Tiedeakatemia, also Memoirs of the Archaeology and Museums.

Sinha, S., Yadav, N. and Vahia, M. N. 2011. In Square Circle: Geometric Knowledge of the Indus Civilization, in Math Unlimited: Essays in Mathematics, R. Sujatha, H. N. Ramaswamy, and C. S. Yogananda, Eds., Enfield: Science Publishers, pp. 451-462.

Vahia, M. N. and Yadav, N. 2010. Harappan Geometry and Symmetry: A Study of Geometrical Patterns on Indus Objects. Indian Journal of History of Science, vol. 45, pp. 343-368.

Yadav, N., Vahia, M. N., Mahadevan, I. and Joglekar, H. 2008a. A Statistical Approach for Pattern Search in Indus Writing. International Journal of Dravidian Linguistics. vol. XXXVII, pp. 39-52.

Yadav, N., Vahia, M. N., Mahadevan, I. and Joglekar, H. 2008b. Segmentation of Indus Texts. International Journal of Dravidian Linguistics. vol. XXXVII, pp. 53-72.
Yadav, N., Joglekar, H., Rao, R. P. N, Vahia, M. N., Adhikari, R. and Mahadevan, I. 2010. Statistical Analysis of the Indus Script Using n-grams. PLoS ONE. vol. 5.

Yadav, N. and Vahia, M. N. 2011a. Indus Script: A Study of its Sign Design. Scripta, vol. 3, pp. 133-172.

Yadav, N. and Vahia, M. N. 2011b. Classification of Patterns on Indus Objects. International Journal of Dravidian Linguistics. vol. 40, pp. 89-114.

Yadav, N., Rao, R. P. N. and Vahia, M. N. 2012. Indus Script. Current Science, vol. 103, no. 11, pp. 1265-1266.

Yadav, N. 2013. Sensitivity of Indus Script to Site and Type of Object. Scripta, vol. 5, pp. 67-103.

Yadav, N., Salgaonkar, A. and Vahia, M. N. 2017. *Clustering* Indus Texts using K-means. International Journal of Computer Applications 162 (1):16-21.

An Informal Comment On The Decipherment Of The Indus Script

Massimo Vidale

Department of Cultural Heritage: Archaeology,
History of Art, of Music and Cinema
University of Padova (Italy)

I am not a linguist, nor an expert on ancient writing systems. In 2007, I reacted (possibly, even over-reacted) to Steve Farmer and other scholars who abundantly advertised on the web the idea that the Indus system was not a true writing code, and - with a totally improper and somehow denigrating statement - that the Harappan civilization was "illiterate" (Farmer *et al.* 2004; Vidale 2007). It was easy to answer that the greatest part of the early Bronze age world in Eurasia, in the 3rd and 2nd millennia BC, was completely illiterate - of course, even the celebrated Mesopotamia - simply because writing was a technology invented by minority elite circles for a variety of different functions, but anyhow restricted to the seats and needs of the upper ruling classes.

My viewpoint was purely archaeological: besides Farmer's obviously preconceived radicalbias, the idea that a highly codified system as that of the iconography of the Indus steatite stamp seals, dominated by unicorns, was linked to a symbolic array of signs loosely signifying a vast array of mysterious religious or clan references, simply made no sense.

In contrast, the Occam's razor actually suggested (and still does) that the Indus system was a standardized information technology whose signs conveyed meanings in forms of phonemes and/or ideograms/logograms, like was happening at the same time in Egypt, Mesopotamia, on the Iranian Plateau and would have happened one thousand years later in Shang China. The very conservative evolutionist background of this hypothetical assumption is somehow tempered by the recognition that the invention of writing (provocatively linked by C. Levi Strauss, 1976: 391-393, to

the need of enslaving people) had originally taken place under completely different functional frameworks: writing the names of kings for ritual reasons in early Egypt; accounting of centralized storage agencies in Mesopotamia; accounting of small-scale rural transactions by unknown agencies and institutions, only for a few centuries, across the Iranian Plateau (Proto-Elamite tablets); specialized royal divination at the courts of Shang China. Diverging functions, against loose formal similarities or synchronicity, introduce in this perspective elements of the bush-likeor branching evolutionary models that today dominate neo-Darwinian studies. And, paradoxically enough for Farmer and his co-authors, the quite partial and fragmentary data at our disposal suggest that Indus writing might have developed in contexts of heterarchic seats of power under the influence of craft and trade-oriented groups (Vidale 2020) - therefore, in an early urban environment which, from this viewpoint, might have been *less illiterate* than those witnessing the same developments in other Eurasian civilizations!

This said, I confess that I can contribute little to the crucial issue of this meeting in Mohenjo-Daro, the archaeological site that I love most. Although I deeply respect the work so far carried out along decades of harsh efforts by some colleagues - I think in first place of the monumental research and unvaluable documentation by AskoParpola and his teams (among others, Parpola 2009 and the first three CISI volumes) - I cannot hide my skepticism. I just believe that Indus texts are too short;that they probably are too specialized in their unknown functions and structure; that they express one or more languages that at present we are totally unable to identify; and, as you all know, we have no bi-lingual keys of access. And, above all, that they do not include independently known lists of royal or divinities names.

In fact, the recent and - let me say - epochal decipherment of the first phonemic sequences of the Linear Elamite of late 3rd millennium BC Iran system by Francois Desset[1] (2012, 2018a, 2018b) was based on the identification in a parallel set of long and partially bi-graphic and bilingual inscriptions of the names of kings (such as Puzur-Inshushinak, Shilhaha and Ebarat) and gods (Napirisha), following exactly the same path followed by the decipherers of Egyptian hieroglyphs and Achemenid cuneiform. Yuri Knozorov'sbreakage of Mayan glyphs system (1955), although aided by computerized statistics, depended on the arbitrary intuition that the language of Mayan inscriptions was the same still spoken by the local Lacandon peoples, and on the marginal aid provided by Diego de Landa'sfictionary "maya alphabet". No even remotely similar condition, at present, can be recognized in the current studies of the Indus scripts. Not for nothing Knozorov's attempts at the Indus system with the same approach were a notorious failure (1965).

[1] CNRS team Archéorient, Lyon, France;UMR 5133.

If I would be asked to deviate from this negative but, I am afraid, realistic attitude, and express some possible hints for tackling in future with this issue, I would point to your attention the following (not new and certainly minimalistic) considerations:

1. it is a fact that the Indus inscriptions on seals do not include the expression "the son, the daughter of" otherwise we would have easily recognized the repetition of the corresponding signs on many seals inscriptions. Consequently, the inscription might have included personal names (??) but not patronimics. This might imply that Harappans conceived their individuality in different social terms;

2. the inscriptions on the majority of the Indus-related seals found in western locations (the Persian Gulf, Mesopotamia, the Iranian Plateau and southern Central Asia) bear as a prominent animal icon the gaur (*Bos gaurus*) which, in contrast, is much less common in the motherland(Vidale 2004, 2005). I therefore hypothesized that the gaur, a half-domesticated, half wild powerful bovid living outside permanent settlements,could have been selected as a symbol of the Harappan trading families resident in the west;

3. the inscriptions of the round "Gulf seals" used in the 21st century BC and other western ones, on the basis of statistical combinations among signs, are recognized by AskoParpola as encoding one or more languages different from that (or those) presumably spoken in the Indus valley;

4. the same inscriptions of the round "Gulf seals" and other western seals show a quite anomalous frequency of the "man" or if you prefer "matchstick man" anthropomorphic sign and its commutations, which is relatively rarer in the writing inventories of the Indus core settlements. Discoveries made in the last decades in the Dilmuniteand Maganitecultural areas have emphasized a substantial Amorrean component in the personal names which emerged in the Bronze age settlements and burials (Glassner 2003; Laursen 2008; Marchesi and Laursen 2016). Therefore, given the greater frequency of patronimic constructions in the personal names of semitic languages-speaking communities of the Near East, I wonder if the unknown language of the Persian Gulf seals was Amorrean or another related semitic language. In such case, the "man" signs could stand for the expression "the sonof", or, when the signs is repeated, "the son of the son of", etc., a construction missing from the normal Harappan short texts.

The possible conclusion could be that the "man" sign could have been read in the Gulf inscriptions as maru, the Amorrean word for son, or as another equivalent semitic term, regardless of the original meaning or phonetic value of the same sign in the Indus valley.

I propose all this as a purely conjectural speculation, accepting the possibility to be completely off the track. In other past articles (Vidale 2004, 2005, already quoted), I discussed some aspects of this matter in very simplistic terms (as I am doing now, given also the hurry with which I am now writing) and for this I have been harshly criticized by Steffen TerpLaursen and Piotr Steinkeller (2017). The comments were nasty, but absolutely right; to my partial excuse, I had based myself on some published paperwork. However, the imagination of the time, like this one, was entirely mine, and, again, it is fully open to a most welcome, mandatory criticism.

Bibliography

Desset F. (2012). *Premièresécrituresiraniennes : lessystèmes proto-élamite et élamitelinéaire*, Series Minor n° 76, Dipartimento di Studi Asiatici, Università degli Studi di Napoli "L'Orientale", Napoli.

Desset F. (2018a) Linear Elamite. In J. Alvarez-Mon, G.-P. Basello and Y. Wicks (eds.), *The Elamite World*. Routledge World Series, Taylor and Francis, Abington, 397-415.

Desset F. (2018b) Nine Linear Elamite texts inscribed on silver 'gunagi' vessels (X, Y, Z, F', H', I', J', K' and L') : new data on the Linear Elamite writing and the history of the Sukkalmah dynasty.Iran 46,105-143.

Farmer S., Sproat R.and Witzel M. (2004) The Collapse of the Indus-Script Thesis: The Myth of a Literate Harappan Civilization. *Electronic Journal of Vedic Studies* 11, 2, 19-57.

Glassner J.-J. (2003) Dilmun et Magan. Le Peuplement, L'OrganisationPolitique, la QuestiondesAmorrites e la Place de l'Écriture. Point de Vue de l'Assyriologue. In S. Cleuziou S., M. Tosi and Y. Zarins (eds.)*Essays on the Late Prehistory of the Arabian Peninsula*. IstitutoItaliano per l'Africa e l'Oriente, Rome, 337–381.

Laursen S. T. (2010) The westward transmission of Indus Valleysealing technology: origin and development ofthe 'Gulf Type' seal and other administrativetechnologies in Early Dilmun, c.2100–2000 BC. *Arabian Archaeology and Epigraphy* 21, 96–134.

Laursen S. T. (2008)Early Dilmun and its rulers: new evidence of theburial mounds of the elite and the developmentof social complexity, c. 2200–1750 BC. *Arabian Archaeology and Epigraphy* 19, 155–166.

Laursen S. and Steinkeller P. (2017) Babylonia, the Gulf Region, and the Indus. *Archaeological and Textual Evidence for Contact in the Third and Early Second Millennium B.C.*Eisenbrauns, Winona Lake, Indiana.

Levi-Strauss C. (1976). *Triste Tropiques*. Penguin, Harmondsworth.

Knozorov Y. (V. 1955) (ed.) *A brief summary of the studies of the ancient Maya hieroglyphic writing in the Soviet Union*. Reports of the Soviet Delegations at the 10th International Congress of Historical Science in Rome (English translation). AkademiyaNaukSSSR, Moscow.

Knorozov Y. V. (ed.) (1965) *Predvaritel'noesoobshchenieobissledovaniiprotoindiyskikh textov*. Moscow.

Marchesi G. and Laursen S. T. (2016) *Kings of Dilmun identified by name and announced in a press conference held by BACA*. Accessed on Dicember 2019 at the site http://culture.gov.bh/en/mediacenter/news_center/2016/November2016/Name,13962,en.html

Parpola A. (2009) *Deciphering the Indus Script*. Cambridge University Press, Cambridge.

Vidale M. (2004) Growing in a ForeignWorld. For a History of the 'MeluhhaVillages' in Mesopotamia in the 3rdMillennium BC. In A. Panainoand A.Piras (eds.), *Melammu*
Symposia 4: Proceedings of the Fourth Annual Symposium of the Assyrian and Babylonian Intellectual Heritage Project. Università di Bologna and Istituto Italiano per l'Africa e l'Oriente (IsIAO), Milano, 261–280.

Vidale M. (2005) The Short-Horned Bull on the Indus Seals: A Symbol of the Families in the Western Trade? In U. Franke-Vogt and H.-J. Weisshaar (eds.) *South Asian Archaeology 2003*, Aachen, 147-158.

Vidale M. (2007) The Collapse Melts Down. A Reply to Farmer, Sproat&Witzel. *East and West* 57, 1-4, 333-366.

Vidale M. (2020) Heterarchic Powers in the Indus Cities? *Journal of Asian Civilizations*, in press.

Computational Studies of the Indus Script

Nisha Yadav
Tata Institute of Fundamental Research, Mumbai

Indus script has defied decipherment. There have been several attempts to decode the Indus writing in the past, but there is no agreement on its contents. The lack of precise knowledge of its structure makes it difficult to evaluate any claim of decipherment objectively. In our research, using various computational techniques, we tried to fill this lacuna by analyzing the structure of the Indus texts in detail. Our study focuses on identifying patterns in the Indus writing and exploring its underlying logic without making any assumptions about its content. The present article summarizes our work on the structure of Indus script.

Keywords: Ancient scripts, undeciphered scripts Harappan civilization, Indus seals, Indus script, Harappan script, sign design, sign compounding, computational linguistics, machine learning, data mining

1. INTRODUCTION

One of the most intriguing and enigmatic aspects of the Indus Valley civilization is its undeciphered script (Wright 2010, Agrawal 2007; Possehl 2002; Kenoyer 1998). About 5000 samples of Indus script inscriptions have been found so far on objects such as seals, sealings, miniature tablets, copper tablets, bronze implements and ivory sticks at various sites of the Bronze Age civilization. An Indus seal from Harappa and a subset of Indus signs from the sign list of Mahadevan (1977) are shown in Fig. 1.

Fig.1. A large unicorn seal from Harappa on the left (Copyright Harappa Archaeological Research Project/J.M. Kenoyer, Courtesy Dept. of Archaeology and Museums, Govt. of Pakistan) and a subset of Indus signs from the sign list of Mahadevan (1977) on the right.

In addition to the Indus script, the inscribed objects often contain images of animals, mythical figures, composite or multi-headed animals, scenes, and other types of geometric and abstract motifs (Joshi and Parpola 1987; Shah and Parpola 1991; Parpola, Pande, and Koskikallio 2010). The most common animal motif depicted on the Indus seals is the Unicorn. Classification and analysis of distinct patterns on the Indus seals and inscribed material was performed in Yadav and Vahia 2011a. A detailed analysis of the geometric and symmetric designs was reported in Vahia and Yadav (2010) and Sinha *et al.* (2011).

2. OUR APPROACH

Despite numerous claims of decipherment in the past, the problem of Indus script lies unresolved (see Possehl 1996 for a review). Major obstacles to decipherment include extreme brevity of Indus texts, absence of multilingual texts and lack of knowledge of the language(s) of the civilization. In the book *Indus Age: The Writing System*, Gregory L. Possehl examined several claims of decipherment and summed up the problem of Indus script as follows:

"There is very little agreement among these scholars concerning the nature of the Harappan Civilization, its writing system and its history. The language affiliation has been taken to be Dravidian, Indo-Aryan, Sumerian, Egyptian, even Malayo-Polynesian.... Method, when method can be determined, ranges from the use of the *rebus* principle to concern with graffiti, to comparative analysis with distant scripts, and to the arcane world of Tantric symbols. This has yielded a hodgepodge of readings." Possehl (1996: 162-163)

The need for an independent test forevaluating the claims of decipherment was emphasized by Possehl (1996) as follows:

"The question as to how one might go about testing the legitimacy of a claim for decipherment remains a significant one. The appearance of an exemplar with a substantial bilingual inscription, one in Indus script, the other in a writing system that could be read (at the moment, not Proto-Elamite), would settle this. Failing that, the tests have to fall back on how well the proposed decipherment and statistical data available on the script fit, sign counts, positional patterns, and sign associations such as pairings. In the absence of a good bilingual text, the test is ultimately going to have to rely on meaningful and consistent patterns, and unfortunately, concepts that unfortunately elude precise definition." Possehl (1996: 167)

Our work on the Indus script is an attempt in this direction, and it aims to define a broad syntactic framework of the Indus script. We make no assumptions about the nature, content or purpose of the Indus script. To understand the structure of Indus script, we used statistical and computational techniques from the fields of data mining, machine learning and information theory. Questions related to the significance of sequencing of signs in Indus texts and segmentation of Indus texts were addressed in Yadav *et al.* 2008a and Yadav *et al.* 2008b respectively. A probabilistic model of the Indus texts was developed in Yadav *et al.* 2010. The model was used to restore damaged and illegible Indus texts. The 'flexibility' in the usage of signs in the Indus script was compared to other linguistic and non-linguistic systems in Rao *et al.* (2009). Various aspects related to the design of Indus signs were dealt in Yadav and Vahia 2011b and a contextual analysis of the Indus script was performed in Yadav 2013. Yadav 2017 identified nine distinct clusters of Indus texts using the technique of unsupervised machine learning. The results of our studies so far can be used to evaluate distinct claims of decipherment (see for example, Yadav *et al.* 2012).

In the following sections, we summarise our studies of the structure of the Indus script, its contextual analysis and the design of Indus signs. We used a digitized version of the concordance of the Indus writing created by Iravatham Mahadevan in 1977 (Mahadevan 1977, henceforth referred to as M77). The sign list of M77 consists of 417 signs indexed from 1 to 417.

3. STUDIES OF THE STRUCTURE OF INDUS SCRIPT

3.1 Sign Frequency Distribution and Beginner-Ender Asymmetry

The sign frequency distribution of the Indus script follows the *Zipf-Mandelbrot* law,

an empirical law generally followed by various ordered systems (Yadav *et al.* 2010). This suggested that a small number of signs account for the bulk of Indus writing and a large number of signs occur rarely in the Indus texts. The pattern of occurrence of the Indus signs at the beginner and ender positions in the Indus texts was studied using the cumulative frequency distribution plots of text beginners, text enders and all signs (Fig. 2).

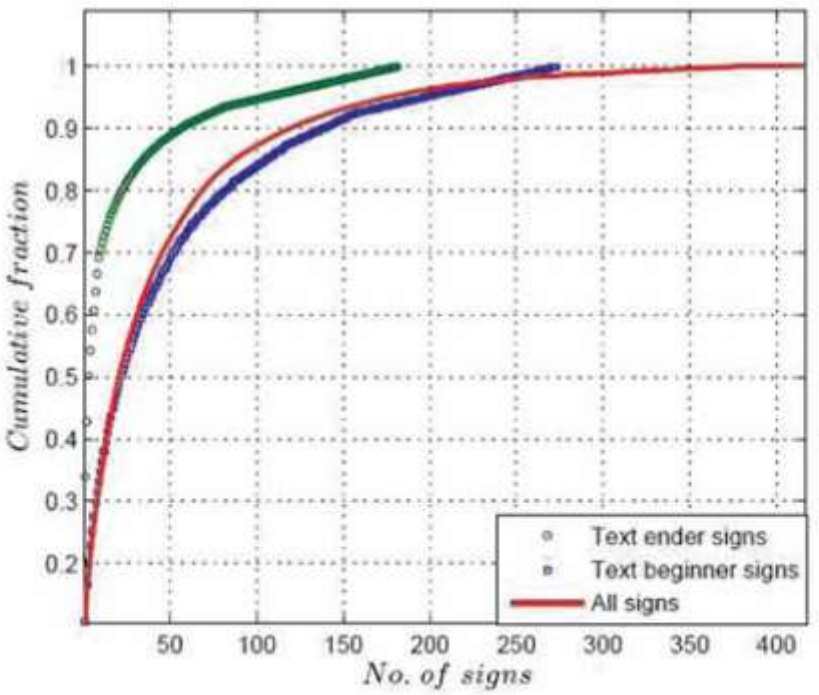


Fig. 2. Cumulative frequency plot for all signs, text-beginners and text-enders (Yadav et al. 2010): While 23 signs account for about 80% of all text enders, around 82 signs account for about 80% of all text beginners. As the direction of the Indus script is from right to left, the signs occurring at the rightmost extreme in the seal impressions are the text beginners and the signs occurring at the leftmost extreme are the text enders.

In the use of the signs at the beginner and end positions in the Indus texts, there is an asymmetry. While a small number of signs can end the Indus texts, relatively large number of signs can begin the Indus texts. This suggested the presence of syntax in the Indus writing.

3.2 Significance of Sequencing in Indus Texts

The sign sequencing in the Indus texts was compared with randomly sequenced texts (Yadav *et al.* 2008a). It was found that sign sequences of 2, 3 and 4 signs (sign pairs, sign triplets and sign quadruplets) occurred much more frequently in the Indus script dataset than is expected by chance. The study confirmed the presence of correlations between signs in the Indus texts. The frequent sign sequences were found to have preferred positions in the Indus texts (Yadav *et al.* 2008a). For instance, 86 % of the total occurrences of the most frequent sign pair (267, 99) are at the beginning of the Indus texts and 97 % of the total occurrences of the sign pair (342, 176) are at the end of the Indus texts (Table 1).

Sign Pair	Frequency	Solo (%)	Initial (%)	Medial (%)	Final (%)
	168	0.60	85.71	11.90	1.79
	75	0.00	10.67	89.33	0.00
	59	0.00	0.00	3.39	96.61
	58	1.72	0.00	25.86	72.41
	56	0.00	91.07	8.93	0.00

Table 1: Positional distribution of frequent sign pairs (Yadav et al. 2008a).

3.3 Segmentation of Indus Texts

To explore the possibility of segmenting the longer Indus texts into smaller units, a segmentation scheme was developed with different segmentation approaches such as: comparing nearly identical texts, using frequent sign sequences, comparing adjacent sign pair frequencies and using text beginners or text enders (Yadav *et al.* 2008b). The length of an Indus text ranges from 1 to 14 signs in a single line. About 88% of all Indus texts of length greater than 5 or more signs could be segmented into smaller units of 2, 3 or 4 signs (Table 2).

Text No.	Text Segments						
4254	2371	2015	1226				
							
	P53	T148	P116	PM9	389		
2537	8001		1093			4305	
							
	P41	PM14	67	PM9	389	344	PB1

Table 2. Examples of segmented Indus texts (Yadav et al. 2008b). The four-digit numbers are the text identification numbers from M77. The alphanumeric sequences below the segments are the markers used for identification of these segments.

3.4 Statistical Model of the Indus Script: Restoration of Illegible Indus Texts

Advances in computational linguistics and machine learning have contributed to the study of statistical properties of sequences (Jurafsky and Martin 2008; Manning and Schütze 1999). A probabilistic model of the Indus script was developed by computing the probabilities of Indus signs following each other (Yadav *et al.* 2010). The model enabled restoration of illegible Indus texts, comparison of Indus texts from distinct sites of discovery (or objects) and generation of artificial Indus texts conforming to the structural patterns followed in the Indus writing. The model could predict signs in the damaged or illegible Indus texts with about 75% accuracy (Table 3).

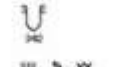
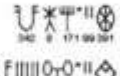
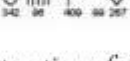
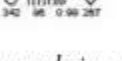
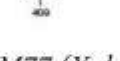
Text No.	Text	Incomplete Text	Most Probable Restoration	Most Likely choices for Restored Sign
8302				
5317				
1193				
1407				
2179				

Table 3: Restoration of doubtfully read signs in the Indus texts of M77 (Yadav et al. 2010). The signs with asterisk sign at the top right are the doubtfully read signs restored using the probabilistic model.

3.5 Comparison of 'Flexibility' in Sign Usage

The 'flexibility' of using signs given a preceding sign in the Indus text (quantified using *conditional entropy,* an information theoretic measure) was compared with the 'flexibility' in the sequences from linguistic and non-linguistic domains such as English, Sanskrit, Old Tamil, Sumerian, DNA, Protein, and Fortran (Rao *et al.* 2009). The 'flexibility' in the use of signs in the Indus script was found to be close to the linguistic systems.

3.6 Clustering Indus Texts

The non-contiguous associations between the signs in the Indus texts were explored using *clustering,* an unsupervised machine learning technique (Jain and Dubes, 1988).Nine clusters of Indus texts were extracted such that the texts in each of these clusters were more similar amongst themselves than to texts belonging to other clusters (Yadav *et al.* 2017). The nine clusters were found to have their signature set of signs and sign sequences (Table 4). The study suggested that the Indus writing had clusters of texts corresponding to distinct styles or contents. The text clusters were not found to have any significant correlation to the sites of discovery or object types.

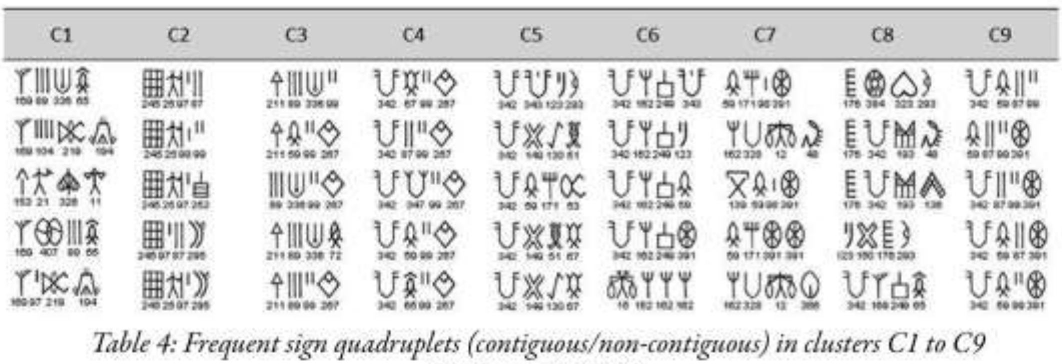


Table 4: Frequent sign quadruplets (contiguous/non-contiguous) in clusters C1 to C9 (Yadav et al. 2017).

4. CONTEXTUAL STUDIES OF THE INDUS SCRIPT

The Indus script appears on distinct types of objects found at various sites of the Indus Valley civilisation. Variation in the usage of signs on distinct types of objects and sites was studied in Yadav 2013.

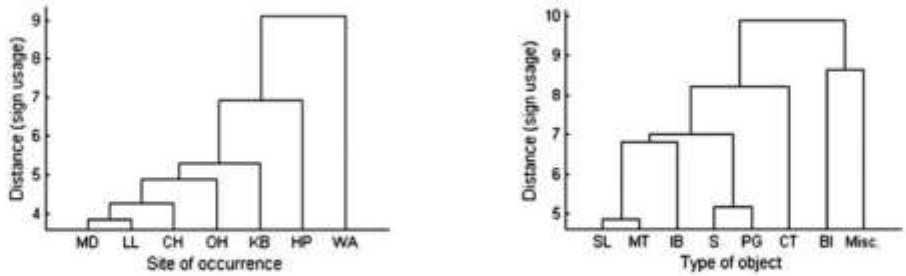


Fig. 3. On the left, similarity between sites based on the usage of signs at different sites (MD: Mohenjodaro, HP: Harappa, LL: Lothal, CH: Chanhudaro, KB: Kalibangan, OH: Other Harappan sites, WA: West Asian sites). On the right, similarity between different types of objects based on the usage of signs on inscribed material (S: Seal, SL: Sealing, CT: Copper Tablets, MT: Miniature Tablets, PG: Pottery Graffiti, BI: Bronze Implements, IB: Ivory or bone rods).

Mohenjodaro and Lothal were found to share a high level of similarity. The usage of Indus signs at Harappa and West Asian sites was found to be quite distinct from other sites. Seals were found to share a high level of similarity with pottery graffiti while sealings were found to be similar to miniature tablets (Fig. 3). The most frequent 67 signs account for about 80% of all sign occurrences in M77. For most sites and object types, these signs account for nearly similar percentage of sign occurrences. However, the relative contribution of each of these 67 signs fluctuates across various sites and types of objects. Studying these fluctuations in the use of signs at various sites and on different types of objects is important. The results highlight the need to understand the level of non-uniformity against conditions in the Indus script where uniformity appears to be the norm.

Mohenjodaro has largest percentage of inscribed objects in the form of seals, while Harappa has comparable percentage of seals, sealings and miniature tablets. Sealings (being seal impressions) are generally assumed to have been created using seals and therefore a seal must have existed for each sealing. However, while it was known that not many seals corresponding to the sealings were found, the statistical study showed that, in terms of the use of signs, seals and sealings are quite different. This implies that in the collection of objects that have survived and discovered from different sites, the seals used to make the sealings are not present.

The study suggested that while the Indus writing contains a common thread of rules and grammatical structures, the use of signs across sites and object types provides individualistic clues to their content. Additional studies on the use of certain motifs on the inscribed objects, evolution in sign designs (Kenoyer 2006) and stratigraphic studies of the inscribed objects can add further clarity to this problem.

5. DESIGN OF INDUS SIGNS

Indus signs vary in the level of complexity of their design. The designs of the Indus signs were studied and three categories of the design elements were identified: Basic signs, Provisional basic signs and Modifiers (Yadav and Vahia, 2011b). Provisional basic signs and modifiers do not have an independent occurrence in the sign list. They only occur in the designs of certain Indus signs, compounded with other design elements.

Indus signs were classified into two broad categories based on the complexity of their design: Basic signs and Composite signs (Fig.4). Composite signs were further classified into: Compound signs (composite of basic signs) and Modified signs (signs modified by modifier).

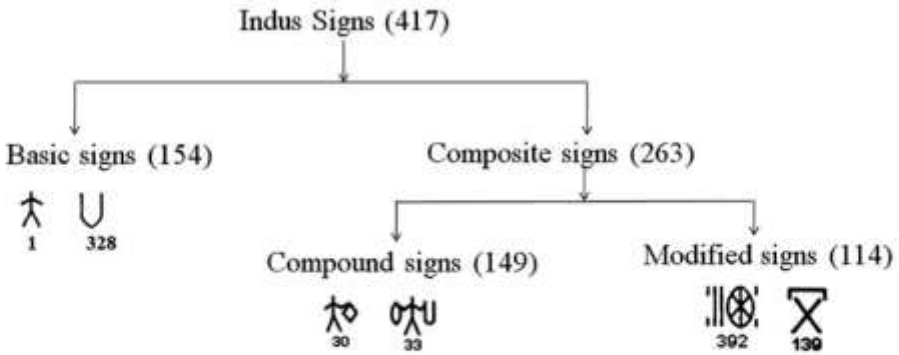


Fig.4. Classification of the Indus signs based on their design (Yadav and Vahia, 2011b).

The pattern of occurrence of the compound signs and the corresponding sequences of their constituent basic signs was analysed and it was found that the compound signs are not a compact version of the sequences of their constituent basic signs.

Indus signs have a special emphasis on symmetry in their design with an underlying effort to retain the overall aesthetic sense. About 60% of the signs conform to either vertical or horizontal symmetry. The designs of Indus signs also seem to employ techniques such as sign compounding, conflation of signs etc. that were used in other ancient writing systems to optimize the usage of a limited number of signs (Bottéro, 2004; Coe, 1992). A lot of thought, planning and utility issues have been taken into consideration while designing the Indus signs. There is logic and creativity in the structure of Indus signs.

The Indus civilization was spread over an area of about a million square kilometers and yet, the sign list over the entire civilization was identical. This indicates that the signs, their meaning and their usage were agreed upon by people spread over a large area. This arrangement worked satisfactorily for about 700 years. Hence, the

understanding of the Indus signs and their meaning must have been robust, yet versatile and easy to use.

6. DISCUSSION AND CONCLUSIONS

Human communication has remarkable degree of complexity and a variety of forms have been used to code it. Writing is an epitome of the intellectual creation of a civilization. It involves comprehension as well as abstraction of signs that signify specific aspects of human communication. When a civilization leaves behind some written records, they are not only valuable for understanding the dynamics of the civic society, but also for understanding the fundamental processes of thinking that defined the civilization.

In general, the sequence of signs in a text can be random, have a fixed order or may have varied levels of flexibility. Writing provides a significant window into the intellectual perspective of a civilization. Ancient cultures used their writing system for numerous purposes. Writing equipped ancient people to keep inventories, record observations, track time, express ideas, store and communicate knowledge and information, facilitate short or long distance communication, securely transmit information through a network, record dynastic information, express superiority, impose authority and perform several other functions. Nevertheless, as writing arose from a civilization's need for a particular type of coding, it often became obsolete with that civilization's decline.

Ancient script decipherment is often aided by the discovery of a multilingual text in which the same document is written in an undeciphered script as well as a recognized script (Pope, 1999, Baines 2004). Egyptian Hieroglyphs were deciphered with the aid of Rosetta stone and the Behistun inscription helped decode Mesopotamian Cuneiform texts. Continuing linguistic traditions also provide important clues for deciphering ancient scripts and sometimes interlocking phonetic values are used as evidence of decipherment. Many ancient scripts have been deciphered by later generations with great efforts, but some scripts such as the Indus script have resisted decipherment because of large-scale discontinuity and the ambiguity associated with their context and use. In such cases, it is crucial to identify an approach that can reveal the syntax of the undeciphered script.

Recent progress in data mining, computational and statistical linguistics provides a wide range of tools for exploring a script. Different methods designed to search and recognize patterns can greatly reduce the amount of human effort needed to extract patterns in the data. We identified techniques from the domains of data mining, machine learning, statistics and information theory that can be applied to an undeciphered script to understand its structure. Our study establishes the strengths and limitations of these computational methods to analyze the structure of an undeciphered script.

We used a series of computational methods and statistical tests on the Indus script dataset. Our studies suggest that there is an underlying logic in Indus writing. Indus script's sign frequency distribution follows *Zipf-Mandelbrot* law, an empirical law that is followed by different ordered systems. In the pattern of use of text beginners and text enders in the Indus texts, there is an asymmetry. A few signs occur as enders of Indus texts while a relatively large number of signs occur as beginners of Indus texts. Indus sign sequences (of 2, 3 and 4 signs) occur at a much higher frequencies than expected by chance and have a preferred location in the Indus texts.

The signs in the Indus texts have some significant characteristics, such as (i) the most frequent sign in the Indus writing is a text ender (sign number 342), (ii) the second most frequent sign (sign number 99) usually follows beginner signs of text, and (iii) the third most frequent sign is a beginner of text (sign number 267). Structural analysis shows that there are three main constituent units in the Indus texts: beginner units, middle units, and ender units. There may be one or more signs in each of these units. While a large number of signs are allowed to start the Indus texts, the beginner unit typically has no more than 2 signs, and the ender unit can have as many as 3 signs indicating that additional information was reinforced to complete the text. The middle unit has maximum flexibility in its use of signs and it appears to carry a wide range of information as inferred by the number of signs that appear in this unit. In the longer Indus texts, it is possible to identify pairs of Indus signs that occur together but usually have no association with each other. Using this insight, the entire corpus of the Indus script was revisited and we found that the longer Indus texts can be segmented into smaller units.

A probabilistic model of the Indus script can restore signs with about 75% accuracy in the illegible Indus texts. The model can also be used to generate artificial Indus texts in accordance with the patterns of the sign usage in the Indus script. The Indus script was versatile enough to allow writing of distinctly coded information, as can be seen from the Indus texts found at West Asian sites with different sign usage patterns. Comparison of the flexibility of sign use shows that the use of signs in Indus writing is as flexible as natural linguistic systems and more flexible than artificial linguistic systems (computer languages). Nevertheless, the use of signs in Indus writing is less versatile compared to the structures that express abstractions (music) or the way biological data (DNA or Protein) is encoded. Nine robust clusters of Indus texts, each with a characteristic collection of signs and sign groups, were extracted by unsupervised *clustering* of Indus texts. While Indus script can be found on a variety of materials, seals are the most frequently inscribed artifacts followed by sealings. The original seals of most sealings (seal impressions) were not found for reasons that are not clear. Likewise, sealings are also rare for the seals that have been found.

The Indus signs can be divided into two major categories based on their design: Basic signs and Composite signs. Composite signs can be further divided into: Compound signs and Modified signs. Statistical analysis shows that the compound signs are not a 'short-hand' or space saving device.

Any proposed interpretation of the Indus script should be able to explain these characteristics. A successful decipherment of Indus writing will provide us with a unique window to understand this intricate and ingenious creation of Harappan people.

REFERENCES

Agrawal, D. P. 2007. The Indus Civilization: An Interdisciplinary Perspective. New Delhi: Aryan Books International.

Baines, J. 2004. The Earliest Egyptian Writing: Development, Context, Purpose, in *The First Writing: Script Invention as History and Process,* S. D. Houston, Ed., Cambridge: Cambridge University Press, pp. 150-189.

Bottéro, F. 2004. Writing on Shell and Bone in Shang China, in *The First Writing: Script Invention as History and Process,* S. D. Houston, Ed., Cambridge: Cambridge University Press, pp. 250-261.

Coe, M. D. 1992. Breaking the Maya Code. New York: Thames and Hudson.

Jain, A. K. and Dubes, R. C. 1988. Algorithms for Clustering Data. Upper Saddle River, NJ, USA: Prentice-Hall, Inc.

Joshi, J. P. and Parpola, A. 1987. Corpus of Indus Seals and Inscriptions, 1. Collections in India. Helsinki: Suomalainen Tiedeakatemia, also Memoirs of the Archaeological Survey of India No. 86.

Jurafsky, D. and Martin, J. H. 2008. Speech and Language Processing: An Introduction to Speech Recognition, Computational Linguistics and Natural Language Processing, 2nd ed. New Jersey: Pearson Prentice Hall.

Kenoyer, J. M. 1998. Ancient Cities of the Indus Valley Civilization. Oxford: Oxford University Press.

Kenoyer, J. M. 2006. 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.

Mahadevan, I. 1977. The Indus Script: Texts, Concordance and Tables. New Delhi: Archaeological Survey of India.

Manning, C. and Schütze, H. 1999. Foundations of Statistical Natural Language Processing. Cambridge: MIT Press.

Parpola, A., Pande, B. M., and Koskikallio, P. 2010. Corpus of Indus Seals and Inscriptions, Volume 3: New Material, Untraced Objects, and Collections Outside India and Pakistan, Suomalainen Tiedeakatemia, Helsinki.

Pope, M. 1999. The Story of Decipherment: From Egyptian Hieroglyphs to Maya Script. London: Thames and Hudson.

Possehl, G. L. 1996. Indus Age: The Writing System. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.

Possehl, G. L. 2002. The Indus Civilization: A Contemporary Perspective. New Delhi: Vistaar Publications.

Rao, R. P. N., Yadav, N., Vahia, M. N., Joglekar, H., Adhikari, R. and Mahadevan, I. 2009. Entropic Evidence for Linguistic Structure in the Indus Script. Science. vol. 324, p. 1165.

Shah, S. G. M. and Parpola, A. 1991. Corpus of Indus Seals and Inscriptions, 2. Collections in Pakistan. Helsinki: Suomalainen Tiedeakatemia, also Memoirs of the Archaeology and Museums.

Sinha, S., Yadav, N. and Vahia, M. N. 2011. In Square Circle: Geometric Knowledge of the Indus Civilization, in Math Unlimited: Essays in Mathematics, R. Sujatha, H. N. Ramaswamy, and C. S. Yogananda, Eds., Enfield: Science Publishers, pp. 451-462.

Vahia, M. N. and Yadav, N. 2010. Harappan Geometry and Symmetry: A Study of Geometrical Patterns on Indus Objects. Indian Journal of History of Science, vol. 45, pp. 343-368.

Wright, R. P. 2010. The Ancient Indus – Urbanism, Economy and Society. New York: Cambridge University Press.

Yadav, N., Vahia, M. N., Mahadevan, I. and Joglekar, H. 2008a. A Statistical Approach for Pattern Search in Indus Writing. International Journal of Dravidian Linguistics. vol. XXXVII, pp. 39-52.

Yadav, N., Vahia, M. N., Mahadevan, I. and Joglekar, H. 2008b. Segmentation of Indus Texts. International Journal of Dravidian Linguistics. vol. XXXVII, pp. 53-72.

Yadav, N., Joglekar, H., Rao, R. P. N, Vahia, M. N., Adhikari, R. and Mahadevan, I. 2010. Statistical Analysis of the Indus Script Using *n*-grams. PLoS ONE. vol. 5.

Yadav, N. and Vahia, M. N. 2011a. Classification of Patterns on Indus Objects. International Journal of Dravidian Linguistics. vol. 40, pp. 89-114.

Yadav, N. and Vahia, M. N. 2011b. Indus Script: A Study of its Sign Design. Scripta, vol. 3, pp. 133-172.

Yadav, N., Rao, R. P. N. and Vahia, M. N. 2012. Indus Script. Current Science, vol. 103, no. 11, pp. 1265-1266.

Yadav, N. 2013. Sensitivity of Indus Script to Site and Type of Object. Scripta, vol. 5, pp. 67-103.

Yadav, N., Salgaonkar, A. and Vahia, M. N. 2017. Clustering Indus Texts using *K*-means. International Journal of Computer Applications 162 (1):16-21.

Lakhan-Jo-Daro Seals, Sealing, And Inscribed Objects

Prof. Dr. Qasid H.Mallah
Department of Archaeology
Shah Abdul Latif University Khairpur
mallah64@hotmail.com

Introduction

Lakhan-jo-Daro is situated near modern Sukkur city of Sindh Pakistan on northwestern scattered hilly outcrops adjoining the Indus plain. The settlement of Lakhan-Jo-Daro consists of three major areas: (a) Central mound (b) Western Mound and (c) Eastern Mound and covers around 300 hectares in total area (Figure 1). The total area of the site needs further verification through additional survey and excavation, but if it is confirmed then this site is as large as or larger than Mohenjo-Daro, which has been estimated at around 250 hectares (Kenoyer 1998; Kenoyer 2015). The prime location, environment, size and cultural assemblage; all have increased the importance of settlement in the settlement hierarchy of Indus Civilization.

The western mound of Lakhan-jo-Daro is located at 27,43,38.7N degrees and 68,50,25.3E degrees of the world map and has divers geography at local and general level. The proper location of this part is on the hillocks at the northern end of Rohri hill's sequence. The hills at this position are scattered having smaller valleys in between the Indus Plains around them. The residents might have built their houses covering both flat areas on the tops of the hills as well as on the slopes and in the depressions between the plateaus. This type of construction is very clearly seen at Kot Diji site, which is located next to the high hill and occupies the entire space including the slopes and top of the small hill.

The Indus plains extend from all other directions providing vast plains that were suitable for herding domestic animals, hunting wild animals, and cultivation of domestic crops. Along the Indus River there would have been oxbow lakes, flood

channels, and sandy bars that would have been suitable for fishing and seasonal cultivation of fast growing plants like vegetables, melons, and millets. At the site of Lakhan-Jo-Daro there is both direct and indirect evidence for the exploitation of a wide range of fish and mammals. Direct evidence is seen in the Zooarchaeological remains of animal bones and fish bones. Indirect evidence is seen in the presence of animal figurines, seals, painting on the potsherds. These different sources of evidence show that cattle, water buffalo, goat, sheep, deer and pig (Rajput Shafiq 2016)all belong to the habitat and ecology as explained here. The terracotta duck figurine, fish bones and painting of duck on the pottery suggest swamps and lakes. The deer also like this type environment.

In the broader geographical setup there were two rivers, Indus in west and Hakra on the east and numerous flood channels from both rivers surround the region (Flam 1993, fig 14.3, 271). The riverine forest and shrubs of plain region like 'Kandi' *Prosopis cineraria*, 'Babur' *acacia*, 'Lao' *tamarix* and 'Talhi' *Dalbergia sissoo* were commonly found (Wright 2010,32). Rohri hills being prime source of the flint, banded chert and limestone were available locally. The banded chert has been valued commodity as cubical weights were mainly prepared from this stone. The Rohri chert was used in all of the settlements of Indus valley. Stronger summer monsoon have been agreed upon during the Integration phase (Kenoyer 1998,30). Rainwater rivulets from the Rohri hills may have created the lakes and forest pockets where small game, seasonal birds and fodder for animals were available. The lakes within and around the hills are still favoring the people nowadays. Till date investigation suggests that Lakhan-jo-Daro had a diverse subsistence base and that it was situated in an optimal location for controlling the movement of raw material resources from multiple directions. It was the combination of all of these factors that allowed the Lakhan-jo-Daro settlement to thrive.The future research will show how this site continued to be occupied throughout the Indus Tradition and into the Early Historical period and even to the modern day.

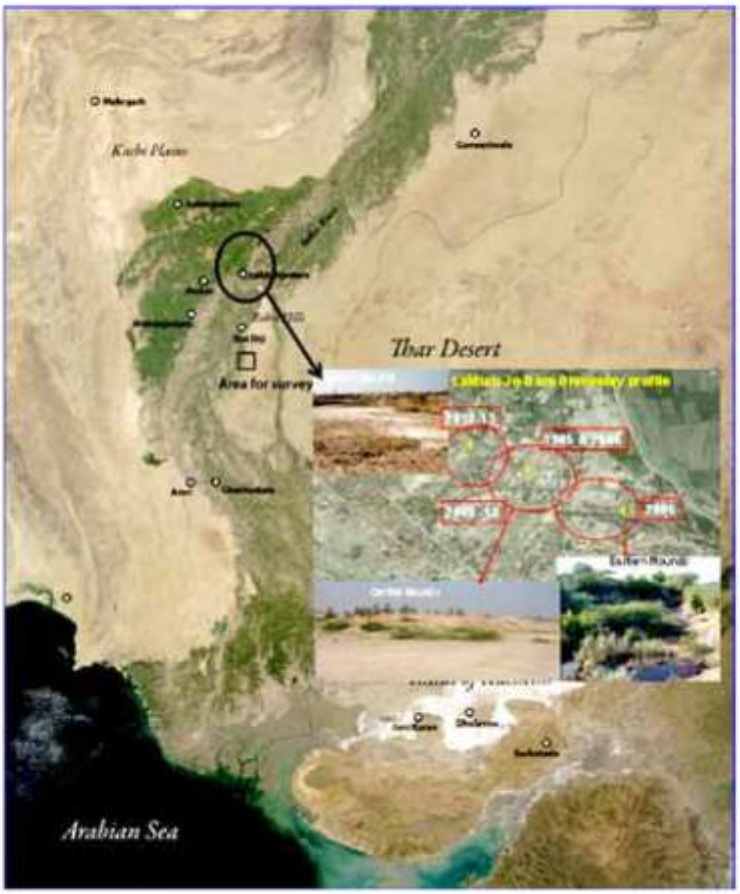


Figure1: locational map of the Lakhan-Jo-Daro site

Inscribed Items discovered from Lakhan-jo-Daro

Indus urban phase of 2600 BCE to 1900BCE was an era in which people lived into municipal environment where all utilities thrived through perfect marketing system in which seals, sealing and awarding the identities and value(s) to the items was involved through some kind of writing system prevailed at that time. The administrative authorities, entrepreneurs and technocrats had their own seals and symbols to run the business.

From Lakhan-jo-Daro at least three things like (a) seals, (b) sealing and (c) inscription on individual objects have been discovered. The seals are made from steatite and faience and copied on the terracotta. Few items also hold very similar character observed in seals. Such symbols suggest the identity of technocrat(s) for their production(s).

Steatite

The mineral *talc* (hydrous magnesium silicate) commonly known asSteatiteis found (Figure 2) in every major region surrounding the Indus Valley (Law 2011). Steatite stone is definite raw material used for seal manufacturing. It has two categories (i) tan colored and (ii) black color steatite (Figure 3) and both types of steatite stone were used in the industry of Lakhan-Jo-Daro industries.

Figure 2: (a) tan color steatite and (b) black color steatite collected from Lakhan-Jo-Daro site excavation

Figure 3: Raw nodules of black setatite found from Lakhan-Jo-Daro site excavation

Lakhan-Jo-Daro Seals

A good number of seals have been discoveredfrom Lakhan-Jo-Daro Site. The repertoire consists of four complete /slightly damaged steatite seals, three broken pieces, one unfinished seal was discovered. Two faience one in white color and other in yellow color; two "T" shape terracotta tablets and five terracotta sealings were recorded.

During the previous excavation of 2008 and surface survey of the western mounds following two seals were found (Figure 4). Among which seal of white steatite (a) contains geometrical design of unidentified creature and this type of seal is not found from any of the Indus site or beyond the Indus region. Another steatite seal is having only two signs along with unicorn animal (Figure 4).

Figure 4.(a) steatite seal with geometrical design and (b) unicorn seal with two Indus script symbol

STEATITE SEAL 1:
Unicorn seal, square with boss that has a single groove

Figure5: Different views of the Steatite seal.

Measurements: square 2.7 cm, thickness 8mm. the boss is semi circular with 1.5x1.3cm dia with 2mm perforation dia.

The seal is complete with slight chipping on some edges and the back. The Unicorn is facing to the left with a ritual offering stand beneath the head. Two lines for a collar are incised at the neck with tiny cross hatching on each line. The halter is made with a double line that does not meet in the middle. The pizzle (penis) is carved at the belly. The tail has a bushy pointed tip. There are seven Indus script signs above the body, starting from just above the ear to the end of the rump.

The steatite is tan colored with white hardened surface that is highly polished, but many working marks are still visible, especially on the back. The boss is perforated.

Steatite Seal 2 :Unicorn seal, square with boss that has a single groove

Figure 6 : The front view and boss of the Steatite seal.

Measurements:Square 2.7 cm, thickness 8mm. the boss is semi circular with 1.1cm dia with 3mm perforation dia.The seal is broken with most of the ritual offering stand missing and the lower part of the unicorn legs missing. The Unicorn is facing to the left with a ritual offering stand beneath the head. Two lines for a collar are incised at the neck with perpendicular hatching between the two lines. The halter is made with a double line that meets in the middle. The pizzle (penis) is carved at the belly. The tail has a bushy pointed tip. There are five Indus script signs above the body, starting from behind the ear to the end of the rump.

The steatite is tan colored with white hardened surface that is highly polished, but many working marks are still visible, especially on the back. The boss is perforated.

Glazed Faience Button Seal

Figure 7: Glazed faience Button Seal.

Measurements: square 1.4x 0.4cm; semicircular Boss 8x7mm dia. This is a square seal with stepped cross motif on the front and a single groove boss on the back. The surface is covered with a blue green glaze that fills the depressions of the cross motif. A similar type of seal is found From Mohenjo-Daro M-1255A(Shah and Parpola 1991, 158).

Faience Button Seal

Figure 8: Faience Button seal.

Measurements: Rectangular 1.7x1.2 Cm boss flat 8x7mmRectangular button seal with eight section grid sign or motif on the front. The hole perforation from the back of the boss has pierced through the body to the front of the button seal. Yellow faience with no trace of glaze remains. The boss on the back is rounded and covers the entire back. This style of boss is associated with Period 3C at Harappa, dating to around 2200-1900 BC.

Broken Seal Fragments

Fragment 1

Long rectangular seal with convex back. Right lower corner of the seal is preserved, the rest is missing. Fired steatite,with white fired surface. Deeply incised Indus script signs. Three signs are preserved including the last sign (furthest to the right on the seal), which is the most common Indus sign "U" shape (Mahadevan sign 342)(Mahadevan 1977).

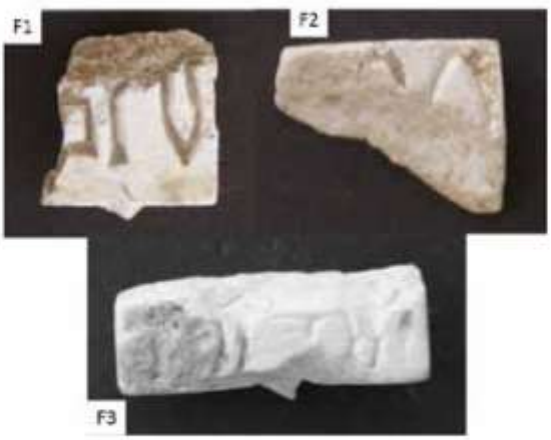


Figure 9: three steatite seal fragments.

Fragment 2

Steatite seal, square type, only one corner of the seal is preserved and only two partial signs are preserved. White fired steatite, badly eroded and weathered.

Fragment 3

Steatite seal, square type, with complete body length and thickness measuring as 2.4x1.9 with 1.2 cm boss dia. The upper part is completely broken or damaged and lower part is partially broken. The body, legs and pizzle of unicorn along with ritual stand are present.

STEATITE SEALS 2017 project

Three steatite seals were discovered from trench "B" while removing the rubble/waste dump. All the seals are rough and needed some more finishing work. An unfinished complete seal block was made from black steatite and was ready for making any motif and script characters.

This type of unfinished seal was also found during the 2009/10 excavation from central mound. The second seal contained water buffalo fight/ hunting motif also incomplete. The third seal is small having all features like bas in broken condition and something carved on the flat side, which is hard to understand at this stage. This seal is also in rough condition required finishing work. These seals when added with other seals found from Lakhan-jo-Daro make a total of seventeen in number, which suggests that the Lakhan-jo-Daro was one of the primary urban centers of Indus valley civilization.

SEAL 1: WATER BUFFALO HUNTING/ TAMING MOTIF

The steatite seal having all characteristics of Indus seals such as motif, platform and drilled bas. The platform and boss are in square shape measuring as platform 22.39 x 6.24/7.11 mm; base 10.41mm.

The seal is left half-finished as the platform and sides are polished, however, the back side has the saw marking incredibly visible. The bas is rubbed / polished along the upper edges and remaining sides of boss and backside platform carry saw markings. Additionally; the perforation of hole is imperfect as it seems started drilling at the center of bas on one side but is skewed towards the side. The central perforation is not maintained through which indicate the low technical competence of the manufacturer. The scene motif carries active action of the water buffalo having with sharp and robust horn and human either with the target of hunting/killing or empowering to tame the animal. The water buffalo is carved with posture having slightly lowering and turning the head to make the position of the sharp horns towards human from knees to shoulder. While the legs are slightly bended and tail is also little bit uplifted at emerging point or near to the hips. This posture definitely suggest that buffalo was furiously attacking/ defending the human. On the other hand, human is depicted holding long weapon/ shaft in the left hand that has reached up to the hip part of the animal and either a small weapon / shaft in right hand or and uplifted to hold the sharp end of the horn. Meanwhile, the left leg of human is uplifted and foot is kept on the lowered horned. It is noticed that the head of human is turned left where two rounded ball or bubble are made. What this posture signifies needs further research.

Figure 10 : Steatite seal with water buffalo –human motif

The terracotta molded tablet found from Harappa with almost similar motif has been described as "*theman spearing the water buffalo*" (Kenoyer and Meadow 1997,12; Meadow and Kenoyer 2000,72).

Figure 11: Water buffalo motif found from Harappa (left) (Kenoyer 1998), seal from Lakhan-jo Daro (right).

The present motif is carved simply but delivers and holds an important message. Water buffalo is explained as a demon that apparently looks ugly in the physique having with power and toughness in which horn multiply as a dangerous weapon. This weapon must be large, look strong and furious. The ancient Indus and Mesopotamian societies believed in large horns as symbol of power and wear them as a headdress or crown (Parpola 1994; Potts 1997,187; Kenoyer 1998; Kenoyer 2010). In the numerous Indus seals, the anthropomorphic figure regardless of gender (male and/ or female) having with robust horn(s) are publicized. The depiction of the horned costume may have been "*the powerful hunters or shamans, or even some form of water buffalo or cattle deity*" (Kenoyer 1998).This ugly postured robustness seems converted into identity of the socio-religious aspect and might have carried strong hold into the ancient Indus and Mesopotamian societies. In the Indus societyseal of the so-called "Proto-Shiva" from Mohenjo-Darowith multiple faces and having beasts around him is given title of "Lord of beasts" (Possehl 2007,441). In the seal a water buffalo is

shown – the horn on the water buffalo and "Proto-Shiva" (the Master) in typology looks almost similar, hence, those horns make figure more robust in posture. The hunting of beast, mastering the beast and finally taking of some physical attribute(s) suggest socio-religious tradition exercised by Indus people. Lakhan-jo-Daro, one of the Indus cities thriving during 2600-1900 BCE was also practicing similar socio-religious tradition as confirmed through the discovery of present seal of water buffalo and anthropomorphic figure in action suggesting that a powerful and daring being is facing/ killing /empowering the beast.

Perusing the history of the water buffalo (*Bubalus bubalis*) begins when it was first domesticated at the Mehrgarh during seventh millennium aceramic Neolithic period (Meadow 1981,164). After its first appearance as a domesticated animal; the popularity is observed during Kot Dijian period (2800-2600 BCE) when the face with elaborated horn were painted in black color on a pot found from Kot Diji site. This motif became popular as horn-deity motif and was found from several settlements of Gomal Plain Burzahom in Kashmirand Padri in Gujarat India (Possehl 2007, 448, Fig. 9.13).

Later on, during urban period (2600-1900 BCE) of Indus civilization; the water buffalo was prominently depicted on the seals and the horn was symbolized and utilized for socio-religious identity. Theological continuation is seen in the later period as Mahabharata epic mention the " war –god Killing the Buffalo Demon" and in Ramayana killing of buffalo is alsomentioned (Possehl 2007). The continuations of motif however suggest that the water buffalo belief / rituals had indigenously developed which are still continued in the contemporary Hindu communities of South Asia.

SEAL 2: INDISTINGUISHABLE MOTIF

This is small square shape seal with little variations in measurement in length and width and measures as 14.96x15.67mm; the bas area measure as 5.71mm is in broken condition and has the visible impression of drilling of a hole (Figure 12).The seal manufacturer had tried maximum to create any motif but seems to have failed. Looking at the scratched area and tentatively given outline in square shape where some type of the image or motif was scratched but again left incomplete.In the Indus Seal repertoire has several symbols either in the oval or round shape outlines. Those outlines are given further additions of the characteristics.The symbol or the character made in the center of present seal carries some sort of similarity with the 'upper part of trishul /trident' .

Figure 12: steatite seal with un-deciphered motif.

SEAL 3: HALF-FINISHED SEAL

This seal is made of black steatite and carries complete profile such as flat platform and rectangular bas on the back without having perforation. The platform and sides are polished which suggests that the item was ready for further process like creating a motif and adding of the writing(s) if necessary. The seal is measuring as 18.93 x 17.48 mm and boss is measuring as 9.28x 6.69mm in rectangular in shape without drill hole (Figure13).

Figure 13: unfinished seal made from black steatite stone.

This is second incomplete seal found from Lakhan-jo-Daro which indicate the hierarchy of settlement where seal were made and given to the concern quarter(s).

Unfinished Square Steatite Seal

Measurements: Body with boss 11.01mm 1.1cm

Without boss 5.23 mm 0.6 cm

LW2.1xBB 1.1xWB0.5 cm

Tan colored unfired steatite (Figure 14). The unfinished seal has a square plan (measurement 2.1cm x 2.1 cm). The thickness of the seal is 0.5cm and the total thickness including the boss is 1.1 cm. The front of the seal is flat with some irregular scratch marks but there does not seem to be any clear outline of script or animal motif prepared on the surface. The edges of the seal are slightly rounded and the edge line is also slightly convex. The unfinished boss on the back has a single groove in the middle and has been perforated (dia 1.2 cm on one side and 1.2 cm on the other side perforation hole dia is 2mm). The overall surface of the seal is covered with irregular scratch marks from scraping with a stone or copper tool. The surfaces have not been smoothed as is the case of finished seals.

Figure 14: Tan colored unfinished steatite seal.

TERRACOTTA TABLET WITH PROJECTING ROUNDED EDGE

Measurements:

Length 5.2, width1.1, thickness 0.8cm. The length of projected area is 1.5 cm. The object is in Reddish-yellow fine terracotta with time white inclusions. Molded tablet with square section and molded narrative motive on two sides. Edges are worn and rounded.

Obverse:

Animals are lined up on the panel facing to the right. Starting from the left to the projecting rounded end of the tablet has a rhinoceros facing a column like object that has a spreading base and a spreading top. Next is a pipal leaf motif that has projecting portions on the top like is seen in some Indus script signs. The next animal to the left is a unicorn facing a ritual offering stand. The final is swastika motif in a square frame.

Reverse:

The figure sequence on the tablet is as first figure on the left is a goat or Ibex with upraised tail, and head facing to the left. The back arching horns are clearly visible. Next is a pipal leaf sign with two projecting additions on the top followed by the U shaped Indus script sign. The next image is a unicorn facing a ritual offering stand. Next is a goat like figure with a short upraised tail and the head is looking back over the shoulder to the left. The upper portion of the head and horns is badly worn, but this type of image is known from seals. The last motif on the left in the projecting rounded end is a Gharial figure with the head oriented to the top of the tablet.

Figure 15: Terracotta tablet with projecting rounded edge in "T" shape.

Terracotta molded tablet Column Motif (Figure 16)

Figure 16: Terracotta tablet with "T" shape.

Measurements: The total length of object is 4.5cm. The width of base is1.1 cm and 0.8mm just below the "T" shape projection. The thickness at base is 1.00 cm and below "T" shape part is 0.9 mm. The measurement of "T" shape part is length 1.7cm. Width and thickness is 1.0 cm. The object itself is in Reddish-yellow fine terracotta with lime white inclusions. Molded tablet with square section and molded narrative motive on two sides. Edges are not worn.

Obverse: The overall plan of the tablet is "T" shaped but the form has been warped while drying and is slightly bent to the right. The base of the column is trapezoidal with a swastika motif in relief. The column is slightly more narrow than the base and has convex curved ridges like is seen on a date palm tree. The top of the column has two convex rings, similar to the ringstones found at Mohenjo-Daro, Harappa, and Dholavira. The uppermost portion is "T" shaped with drooping edges. In the center is a common Indus script sign showing a figure carrying two containers and a "U" shaped head/headdress.

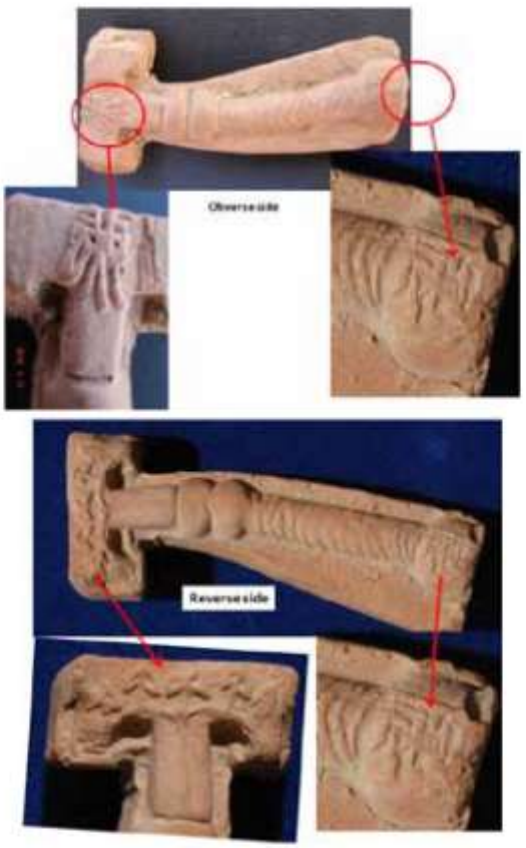


Figure 17

Reverse: The reverse side has an identical base with a swastika motif. The column surface has the convex ridges and two ringstone like objects at the top. The uppermost part of the column has a pipal tree with five upward projecting leaves.

Terracotta Sealings

A total of five terracotta sealings have been discovered among them four are round and one is rectangular in shape (Figure 18). The similarities of signs on all sealings indicate the use of one identical seal impression from a unicorn seal with two Indus signs above the body of the unicorn. The back of the sealing is smooth and this suggests that they were used as tokens or "passports" for trade and not attached to a bundle of goods. The sealing is made of fine reddish-yellow terracotta and well fired.

Two circular sealings are made with the same seal, possibly a unicorn seal, at the tip of the unicorn horn is barely visible beneath the first sign on the right (read from right to left).

The rectangular sealing is made with a unicorn seal having the same sign sequence as the two circular sealings, but the size and style of the script carving indicate that this seal was a separate mold. The tip of the unicorn horn is seen beneath the first sign on the right. The measurement of object is as length 3.2cm – width 1.7 com and thickness 0.9cm.

Figure18: 1)Terracotta rectangular sealing with trace of unicorn horn; 2, 3)Terracotta sealing having with unicorn and Indus script symbols; 4, 5 0Terracotta sealing having Indus script symbols.

Indus Script Character

A white stuff in plaque/ tablet in broken condition has triangular type of something may be a character form Indus script as perceived on potsherd found from the surface of mound 'D' of Lakhan-jo-Daro during current visit of 2017 project. Sometimes these are deliberate writing for specific purpose as seen on several large jars found in urban settlements of Indus Valley. The script character is found depicted / written on other items as well.

Figure 19: triangular symbol on a plaque

INSCRIBED POTSHERDS

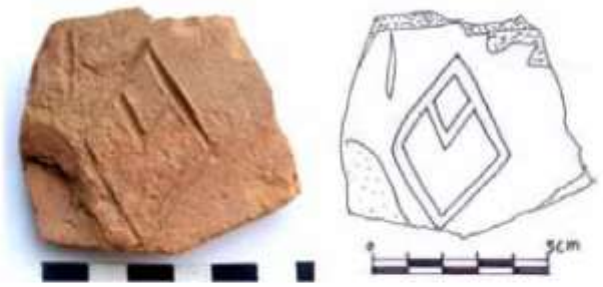


Figure 20: Indus Script character on the potsherd.

LJD2k10:Tr. 31(1) 27 (Fig:21)

Body sherd thick in texture, plain,and the exterior contains smoothing lines. The high magnification at 200x image of clay composition on exterior surface shows mica and other minerals. The potsherd has two pre firing symbols (a) fish and (b) single line that is broken. The face of fish symbol is also damaged.

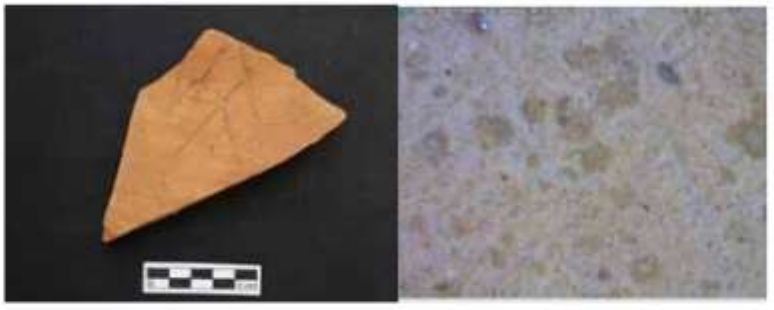


Figure 21: Pottery with Indus script symbol and high magnification image of the surface.

LJD2k10: Tr.19(1) 28(Figure 22)

Body sherd medium in texture and recycled as disc sherd having red slip on exterior. This contains post firing lines on one side from exterior. The high magnification image at 205x from the interior surface shows clay composition that has mica and the other minerals.

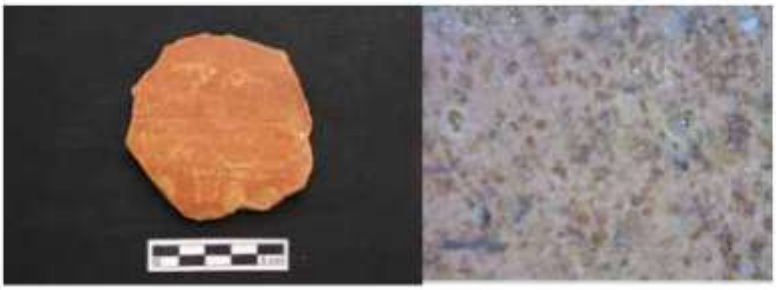


Figure 22: Pottery with graffiti symbol and high magnification image of the surface.

LJD2k10: Tr.19(1)56 (Fig:23)

Base with body sherd, it is broken, plain and contains scraping impression on exterior surface near the base. The high magnification image at 50x near the cut mark line show clay composition that includes several minerals. The interior has mica visible and may have treated with clay slurry.Nodetaching marks are seen on the base surface. The base contains three pre-firing cut mark line two as pair and one at some distance.

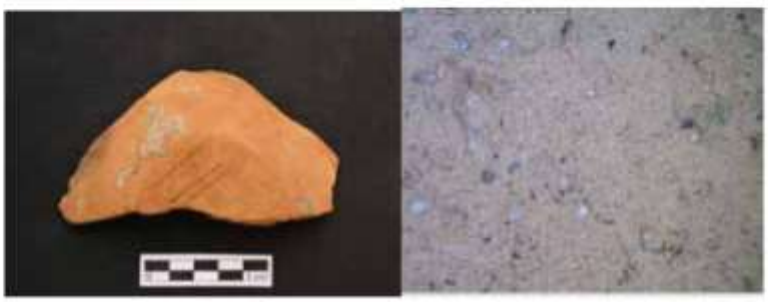


Figure 23: Pottery with graffiti symbol and high magnification image of the surface.

LJD2k10:Tr.12 (1) 10(Figure 24)

Thick body sherd of a chuck base mold used to make large jars. The exterior is plain and smooth may have treated with clay slurry and has concentric groves on interior surface. The high magnification image of interior surface at 205x shows clay composition which consist ofmica and other minerals. The sherd contains two panels of the pre-firing cut marks; the lower panel consists of four cut marks; three of them are clearly visible. The upper panel is damaged and only lower portion of two cut marks are visible.

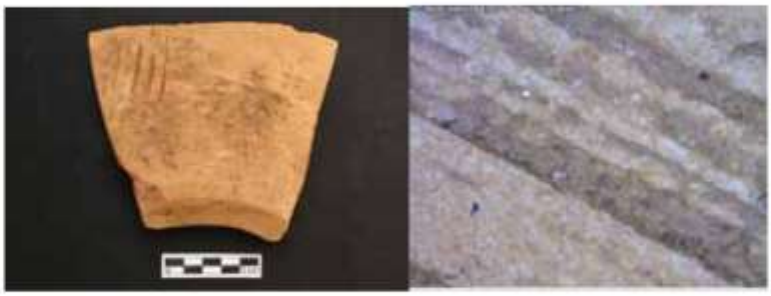


Figure 24: Pottery mold with potter's marks and high magnification image of the surface.

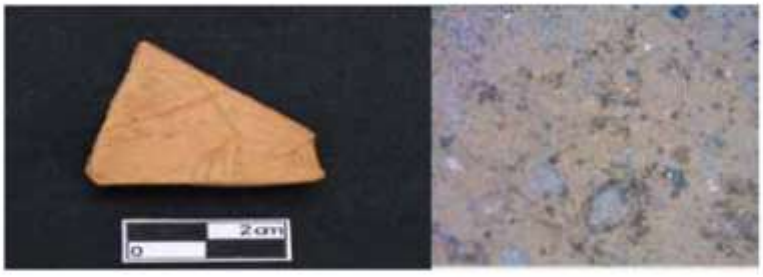
LJD2k10:Tr.17(1)8 (Figure 25)

Rim sherd of a large jar, thick in body texture and containstraces of the red slip and black band on exterior. The interiorside is plain and contains several voids in body surface. The high magnification image of interior surface at 205x shows presence of the mica as whitish material and other minerals. The rim had two panels of the post firing lines each panel has three such lines which makes six lines in total.

Figure 25: Pottery with graffiti symbol and high magnification image of the surface.

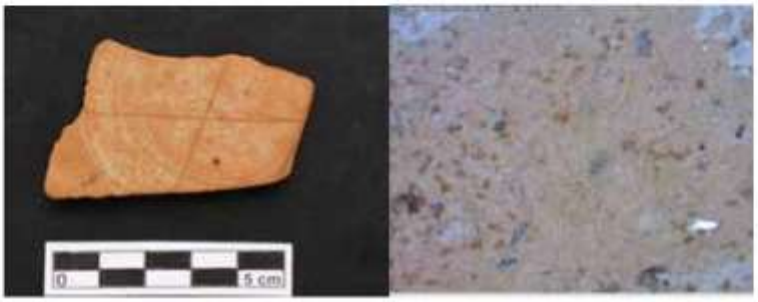
LJD2k10:Tr.18(s)52 (Figure 26)

Small body sherd with medium body texture, plain in decoration having some pre-firing damaged graffiti marks. The high magnification image at 205x shows the presence of several different minerals including the mica.



LJD2k10:Tr.16(2)22 (Figure 27)

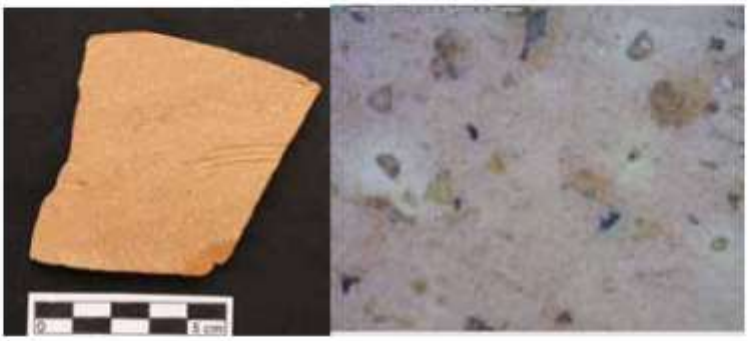
Base sherd, plain in decoration. The thread cut marks on the base surface on exterior. The interior is also plain and smooth. The high magnification image at 2.5x reveals the presence of mica and other minerals in the clay composition. The exterior body contains post – firing 'x' mark.



LJD2k10:Tr.23(1)19 (Figure 28)

Small thin textured sherd plain in decoration and exterior was treated differently and had slightly cream color and the interior surface is plain and red. The high magnification image from exterior surface shows presence of some minerals and the black spot of burnt organic material.

The sherd contains three pre-firing incised lines among which the central is slightly longer than other two on sides.

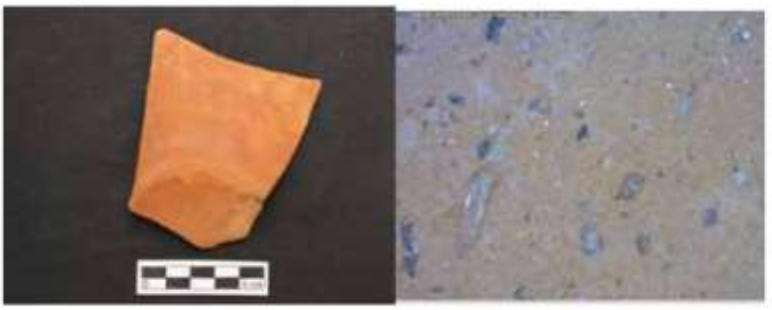


LJD2k10:Tr.26(s)04 (Figure 29)

Rim sherd with body plain in decoration and has one post-firing symbol. The high magnification image at 205x shows the presence of mica and other minerals.

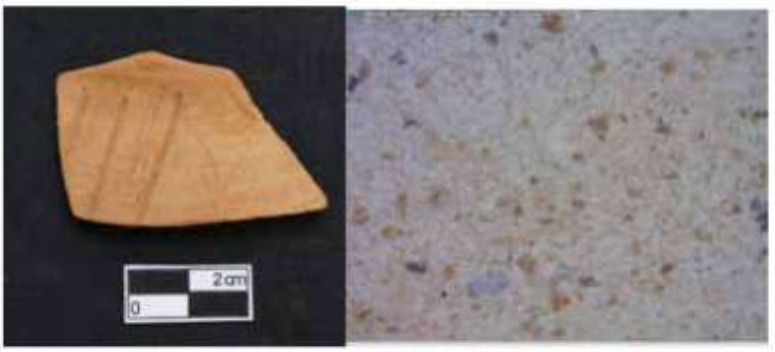
LJD2k10:Tr.16(2) 24 (Figure 30)

Base with body sherd, medium in texture, red slip on exterior and interior is plain. The post –firing 'x' mark on exterior surface is present. The high magnification image reveals presence of burnt organic material, mica and minerals.



LJD2k10:Tr.16(1)21 (Figure 31)

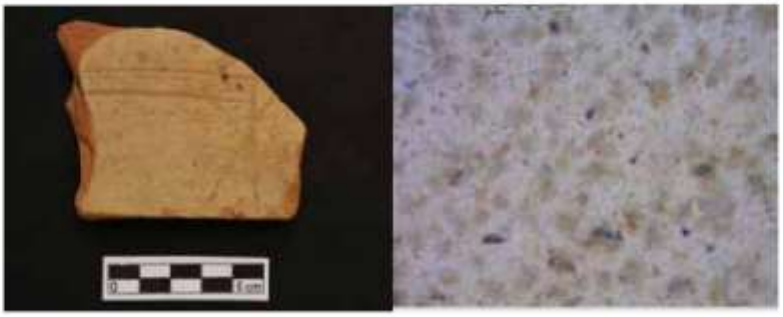
Small body sherd, thin in body texture, plain in decoration contain three post firing incised lines on exterior surface below the broken neck. The high magnification image at 195x reveals presence of mica, burnt organic material and minerals.



LJD2k10:Tr.16(1)62 (Figure 32)

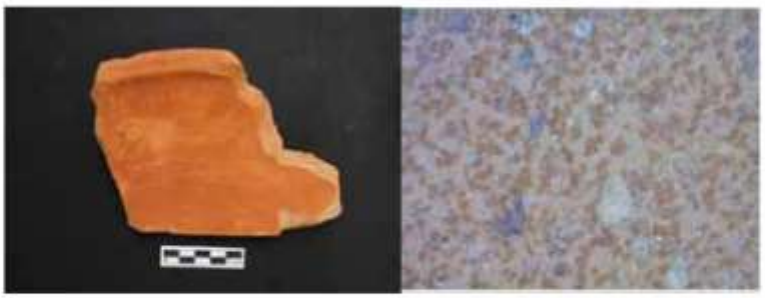
Body sherd, medium in texture, some grooved lines and cream color slip on exterior. Interior is dull red and has finger pressing grooves. The sherd contains pre-firing symbol made through incised lines. The high magnification image at 200x from exterior surface of the sherd shows the presence of different types of minerals

in the clay.



LJD2k10:Tr.34(1)07 (Figure 33)

Part of plate of dish-on-stand, medium in body texture, red slip applied on the both surfaces. The rim contains eight post-firing incised lines. The high magnification image at 200x shows the presence of mica and other minerals.



LJD2k10:Tr.17(1) 124 (Figure 34)

Broken bowl type lid, the exterior smooth and interior rough. The base is pointed having thread cut lines which are very thing suggesting the use of a thin thread. The base contains post-firing 'x' mark. The high magnification image at 205x from exterior surface reveals the presence of limestone chunks and other minerals. Nevertheless, the limestone was also present on the interior surface as well.

LJD2k10:Tr.17(1) 10 (Figure 35)

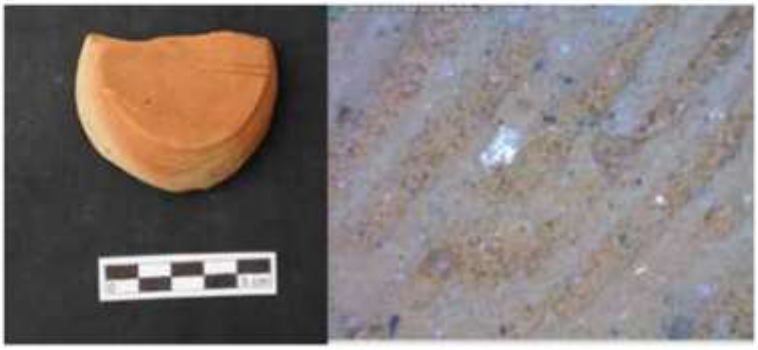
Rim sherd with body, medium in body wall thickness, plain in decoration and contains three deep pre-firing incised lines the fourth one is partially broken. The high magnification image at 200x from exterior surface shows the presence of mica and other mineral in clay.

LJD2K10:Tr16(1)97 (Figure 36)

Base sherd with body, the base wall measures as 1.1cm and contains the pre-firing 'x' mark on the exterior base surface. The detaching impressions are clearly cut through which means that this object was given this graffiti mark after detaching the object from potter's wheel. The high magnification image at 52x shows the presence of mica, limestone and other minerals on the interior surface.

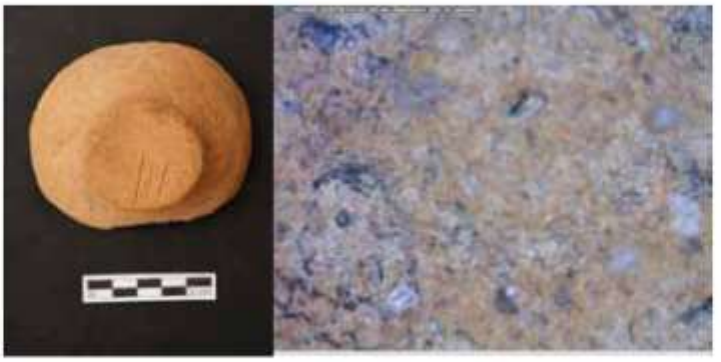
LJD2k10: ----- (Figure 37)

Base sherd with body, plain with thread cut mark showing detaching pattern which has detaching cut at the side and the thread concentric lines are intentionally given two deep pre-firing incised lines. The interior of base has finger pressing impressions of the concentric lines resulted from thumb pressing are also visible. The high resolution image at 205x the deep lines of thread cut and inclusions like mica, black color spots and the other minerals.



LJD2k10:---- (Figure 38)

The base of a small jar with body, plain with rough interior and exterior surfaces. The finger pressing impressions and mica inclusion on both surfaces are visible. The pre-firing three incised lines are given on the base. The high resolution image at 200x shows the inclusion of various types including mica.



Bibliography

Flam, L. 1993. Fluvial Geomorphology of the Lower Indus Basin (Sindh, Pakistan) and the Indus Civilization. In *Himalayas to the Sea: Geology, Geomorphology and the Quaternary*, editet ld by J. F. J. Shroder, pp. 265-287. London, Routledge Press.

Kenoyer, J. M. 1998. *Ancient Cities of the Indus Valley Civilization*. Karachi, Oxford University Press.

Kenoyer, J. M. 2010. Master of Beasts or Beastly Masters in the Iconography of the Indus Civilization. In *Master of Animals in Old World Iconography*, edited by D. Counts and B. Arnold, pp. 37-58. Budapest, Archaeolingua.

Kenoyer, J. M. 2015. The Archaeological Heritage of Pakistan: From the Palaeolithic to the Indus Civilization. In *History of Pakistan*, edited by R. Long, pp. 1-90. Karachi, Oxford University Press.

Kenoyer, J. M. and R. H. Meadow 1997. New Inscribed Objects From Harappa. *Lahore Museum Bulletin* IX(1 (1996)): 1-20.

Law, R. W. 2011. *Inter-Regional Interaction and Urbanism in the Ancient Indus Valley: A Geologic Provenience Study of Harappa's Rock and Mineral Assemblage, Occasional Paper 11*. Kyoto, Research Institute for Humanity and Nature.

Mahadevan, I. 1977. *The Indus Script: Texts, Concordance and Tables*. New Delhi, Archaeological Survey of India.

Meadow, R. H. 1981. Early Animal Domestication in South Asia: A First Report of the Faunal Remains from Mehrgarh, Pakistan. In *South Asian Archaeology 1979*, edited by H. Härtel, pp. 143-180. Berlin, Dietrich Reimer.

Meadow, R. H. and J. M. Kenoyer 2000. The "tiny steatite seals" (incised steatite tablets) of Harappa: some observations their context and dating. In *South Asian Archaeology 1997*, edited by M. Taddei and G. De Marco, pp. 321-340. Rome/Naples, Istituto Italiano per l'Africa e l'Oriente/Istituto Universitario Orientale.

Parpola, A. 1994. *Deciphering the Indus Script*. Cambridge, Cambridge University Press.

Possehl, G. L. 2007. The Indus Civilization. In *Penquin Handbook on Ancient Religion*, edited by J. R. Hinnells, pp. 418-489. New York, Penguin Books.

Potts, D. T. 1997. *Mesopotamian Civilization: The Material Foundations*. Cornell U. Press, Cornell.

Rajput Shafiq, T. 2016. *Multidisciplinary approach to comprehend the animal use during Urban Phase of Indus Civilization: A view from Lakhan-jo-Daro and Thar Desert*. M. Phil Thesis Shah Abdul Latif University Khairpur. .

Shah, S. G. M. and A. Parpola 1991. *Corpus of Indus Seals and Inscriptions. 2. Collections in Pakistan*. Helsinki, Suomalainen Tiedeakatemia.

Wright, R. P. 2010. *The Ancient Indus: Urbanism, Economy, and Society*. Cambridge, Cambridge University Press.

Study of The Indus Valley Scripts Through Socio-Economic Approaches

Dr. P.K. Choudhary
Associate Professor,
University Dept. of Sociology,
Ranchi University, Ranchi,
Jharkhand, India.

Hypothesis:

1 There are strong relation between culture and language.
2 Socio-economic factors having impact on scripts.
3 Assessment of Religious and Spiritual Knowledge of existing society would be input to understand the scripts.

METHODOLOGY:

Socio-economic aspects are very important and are closely related with the surrounding of the society. On the other hand we can say that social conditioning has deep impact over language and literature. For example, upload, download, online, offline, softcopy, hardcopy, and selfie are the languages of modern society.

What type of social condition and situation had been prevailing would be evaluated through text which shall throw light on decipherance of Indus scripts.

Introduction:-

The Indus Valley Civilization was the most ancient Civilization of the world. It was overall technologically advanced and it's still a mystery for how the people were so rational and had a very well civilized society. This Civilization was spread over Karachi Baluchistan, Chandigarh, Punjab, Haryana, Rajasthan, Uttar Pradesh and Gujarat.

The city of Indus was cosmopolitan and population composition was included Mediterranean's, Proto- Australoid, Alpines and Mongoloids. That is why those were advancing wide range of religious practices the and historians have different views over the same.

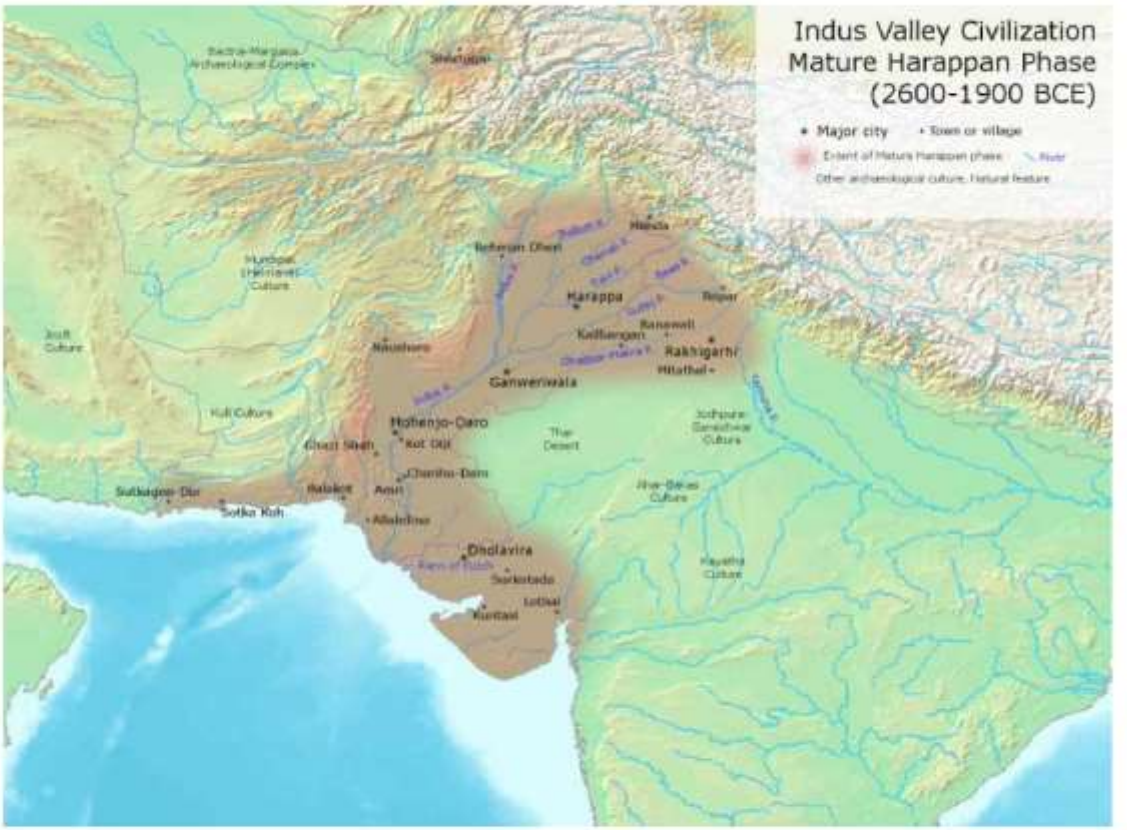
The language and literature of any Civilization deserve to convey the Socio-economic and cultural situations of the existing society. Albert and Thomas cable said "It understates matters to say that political, economic and social forces influence over the language. These forces shape the language in every aspect" on the other hand it is to be said that after analyzing the socio-economic condition of the civilization that would be light on decipherance of scripts.

Methodology:-

In this study the data collection and facts analysis would be applied by individual approach method, which were applied by the various social scientist in 20th century for historical interpretation Age cyclic approach in which to connect the relationship between different ages. Toyanbee, Spenglar were supported through this very approach to analyse the historical facts.

The discourse method is useful and important in present day in social sciences for analyzing the facts through evaluation of the text. While evaluating the social conditions of prevailing society objectivity should be maintained.

Area of Indus Valley civilization:-



The Mohenjodaro and Harappa Civilizations are also known as Indus Valley Civilization. The Director- General of Archaeology of India, Sri John Marshall was the first eminent scholar and with his colleagues who discovered the new civilization between the year 1921 to 1927 which is known as Mohenjodaro and Harappa Civilization and later on another Director General of Archeology of India Dr. Mortimele wheeler highlighted Indus Valley Civilization. Harappa covers the areas of rupar at the foot of simla hills at Alamgirpur in Meerut District, Kolibangan in Rajasthan Lothal and Surkotada In Gujrat.

Rai Bahadur Dayaram Sahni discovered the site of Harappa in the Montgomery District of Punjab and Mohenjodaro and R.D. Banerjee and K.N. Dikshit in the larkana District of Sind which is about 300 miles north of Karachi.

Later on, next work was done in the village of Nal in Kaat- state Baluchistan, M.S. Vats executed his work on Harappan sites during the period from 1921 to 1934

The villages of Jomal-Kirio and Chanhudaro area were found and Jhukar and Khaugar site of Sindh were also discovered.

The department of Archeology of the Government of India undertook excavation work at Rupar in the Amala District, work was also conducted at Rangpur, Swekotada and Lothal in Gujrat. In the year between 1961 to 1969, B.B. Lal and B.K. Thapar carried out Excavation work to Kalibangan in Rajasthan.

Important excavations works were being carried out later were Sutbagendor (300 miles west of Karachi and near the coast of Arabian sea): Satka Koha and Balakota in Baluchistan, Gumla in Gomal valley in north-west; Chandu Daro, Judejodaro, Kotdiji, Ali Murad and Amir in Sind, Rupar, Sanghaol and Chandigarh besides Harappa in Pubjab; Banvali and Mithal in Haryana, Kudwala Thar in Bahawalpur, Kalibangan in Rajasthan, Alamgirpur in Uttar Pradesh and Rangpur, Lothal, Surkotda, Rajade etc in Gujarat.

The latest discovery of Bhirdhana in December 2014, is known as oldest city of Indus Civilization. The fourteen hundred centre of Indus Valley have been known so far, but out of which only three percent excavation work have been undertaken.

Period of Indus Valley Civilization:

It is believed that Indus Valley Civilization existed about 5000 to 7000 years back. Sir John Marshall started that this civilization existed nearly around 3000 B.C. During Excavation Iron was found at none of the sites hence this civilization is accepted as that of the chalcolithic age or copper age. Therefore it is believed that the Indus Valley Civilization might have started beyond 3500 B.C. and developed till 2800 B.C. On the basis of universal reliable Radio Carbon C14 dating system, the Indus Valley period was 2350 to 1750 year back and it has come under prehistoric period. This is the most ancient civilization of the world.
Infra-structure of Indus valley civilization:-

People of this civilization were aware of the construction of houses, mud bricks and kiln-burnt bricks were used for construction of houses, drains system, bathing room, kitchen, Dockyard and courtyard around the houses were also found. Small house which consisting of four to six rooms and big house which might have up to 30 rooms existed for water they had personal and public well.

The staircase denotes about the first and second floor of the house. The wooden ladder was used and ladder had high narrow steps. Individual house drains which were connected to street-drains opened into river outside the city. The drain system was very advanced used for disposal of waste water and consisted of covered street drains which were made of Kiln-burnt brick and main hole were also provided at required distances for cleaning of the drains.

The roofs, doors and windows of the majority houses were made up of wood. In the house there were no provisions of windows; light and air come mainly through doorways. In some cases, latticed windows of pottery have been found. In the few houses latrines were build up in between the bathroom and street wall. Bathroom and latrines in may cases found in ground floor and first floor.

Generally, people used to cook in the courtyard and some times in side rooms but in a big building kitchen were found with fuel and cooking utensils.

Pottery pipes were used for waste water drainage and these pottery pipes were fitted both vertically and horizontally directions. It is stated that sanitary engineering was very much developed.

The scholar stated that there were granaries; assembly hall and big bath area have been found. The big bath was used for secular purposes or in religious ceremonies.

The town planning system was also developed. The houses were raised on state line and it was protected with a wall for protection of enemy and safety purpose. In few houses, there was room for watchman. Lamp-posts like street lights in each row were used and no encroachment was allowed on main public highway by any type of private construction. The fortification system was on practice in Indus Civilization.

Economic Life:

On the basis of discovered item, scholars assume that Indus valley people had developed a prosperous civilization. The people were well acquainted with agriculture, pottery, weaving, art, painting, sculpture, melting, transporting goods and so on. The land was productive due to river side and facilities of irrigation were available. People generally produced wheat, barley, rice, cotton and a wide variety of fruits vegetables on a large scale. They domesticated animals like cow, bulls, buffaloes, sheep, pig, dog, humped-bull, donkey, parrot, cat, peacock, fowl etc. Elephants, camels and horses were also known to them but horse was imported by the Aryans. Buffalo, monkey, bear, tiger, lion, rhinoceros, hare, crocodile and gharial were also known to them which they used to hunt.

They also had the knowledge of weaving a large number of spindles and spinning wheels were discovered from the sites which were used to weave cotton and wool.

Art of melting gold, silver, bronze, copper, tin, lead etc was in practice, Making of pottery was another important skill known to them and also very mush developed as a large number of pots, Artistic paintings for decoration etc. was found which seemed to fetch them a better outcome. Many sculptures were found in the form of clay stone and other metals.

People of the civilization had trade relation with other part of India and also with the western countries like Mesopotamia, Egypt, Crete and summer, both by sea and land.

Due to several industries, large scale food production, trade and businesses, Indus civilization was prosperous. Historians say that even the workmen of the civilization could afford the luxury of two room brick build houses.

Probably they imported copper from south India and Afghanistan, Lead-ore from Rajasthan, South India, Afghanistan and Persia, turquoise from knorassan in north eastern Persia, and marble from Rajasthan. They were having frequent trade with Sumeria and Mesopotamia by sea.

Terracotta in form of human head, animal, female figure, toys were found in that civilization. People were artist in making clay. Stone and metal sculpture. Generally they used to make human and animal figures. They worshipped the clay sculpture of mother Goddess, probably the culture of worship of a large number of female Goddess came from Indus civilization in the modern society. The people of the civilization had an expertise in stone sculptures; a bearded man stone sculpture found during the excavation is probably a priest.

They were familiar with the art of making statuettes through sandstone. The statuette of dancing and muscular youth discovered from the sites depicts the advancement of Indian sculptures in pre-historic period. They also excellent in the art of metal sculptures, the very popular bronze female figure of dancing girl and many animal images of bronze are some of the examples of those arts.

Seals of Indus Civilization:

With an artistic point of view, Harappan artist were very much efficient in making seals. B. Rowland writes "they are amongst the world's greatest expressions of an artist's ability to embody the essentials of a given form in artistic shape." A.K. Coomaraswamy said "The representation of these various animals, especially that of the bull and the elephant, is masterly in the extreme, that of the limestone sculptures is aesthetically decadent rather than primitive"

They were master in quality of cutting the seals. Some seals bear scripts only and some bear human or semi-human forms. More than one thousand seals have been found on the sites.

A number of seals found in tree-script figuring which reveals the act of hypnotizing the tiger-demon. A number of seals also showed bull-men and the super-

human being traits. It denotes that female were not dominant in Indus religion. On the basis of recovered items, Sir John Marshall came to the conclusion that Saivism was the oldest religion of that area.

These people worshipped nature in its various forms. It is significant from the findings that there were no mosques or temples but people used to pray at the corners of the rooms therefore religion was a private affair. However Dr. Mortimer Wheeler and Dr. Piggott analyze that the people where ruled by the priest king.
Administrative system in Harappan Civilization:

On the basis of facts, it is to be said that the state was ruled over by the priest kings and the ruler was autocratic. Harappa was governed by two capital cities, northern and southern kingdoms, which were 350 miles away and communication between the capital cities was through navigation. According to historians the twin capital cities were laid out to a common ground and it was too much organized, centralized and had full control over the production, distribution and taxation. Mortimer Wheeler said "The wealth and discipline of the city-state were vested in the chief deity. The bureaucratic machinery was capable of organizing and distributing the surplus wealth. The people were having little political liberty.
Social Life:

As far as the social life of Indus Civilization is concerned, the social life of Indus Civilization people, there is no evidence of division on the basis of caste and Varna. However people of different classes used to leave together without any practice of untouchability. It has been said that there were four classes, the upper first class probably consisted of priests, astrologers and physicians etc, the second class consisted of warriors, the third class consisted of the traders, artisans and artists and the fourth one consisted of manual workers, such as peasants, fisherman weavers, domestic servants etc. The division was based on economic profession, it means the society was more open and people were having opportunity to get social mobility. As per Archeologist analysis, the people of Indus Civilization were having both food habits that is some were vegetarian and some were non-vegetarian people, used to cook beef, mutton, poultry, fishes etc and vegetarian people took fruits, vegetables and grain etc. The Archeologists came to know about the non-vegetarian food culture of the civilization by the half burnt bones of animals found during excavation.

No actual clothing's has been discovered at any place however, it is assumed that both male and females used to bear the same dress. As per observation of statuettes a shawl which was worn over the left shoulder and under the light arm, was the upper garment, and the lower garment resembled modern dhoti. Women however used one fan-shaped small piece of cloth too as head dress. Both woolen and cotton garments were used by the Indus people and probably they knew sewing by the needless which is prominent from the buttons found during excavation.

Both men and women of the civilization used to have long hairs and for long hairs they used hair-pins of gold, silver and copper. The combs were used basically for keeping hair in proper manner. Man shaved their moustaches and kept short beards.

The ornaments of different metals like gold, silver, copper, stone and other precious stones stated that ornaments were very much popular during that period. Both men and women used to bear necklaces, armlets, fillets and finger-rings were used by the males. Women in particular used head bands, bangles, bracelets, ear-rings, girdles and anklets. Nose ornaments were not in practice.

Probably gold, silver, ivory, faience or other precious stone ornaments were used by rich people and; shell, bone, copper and terracotta ornaments were used by poor people.

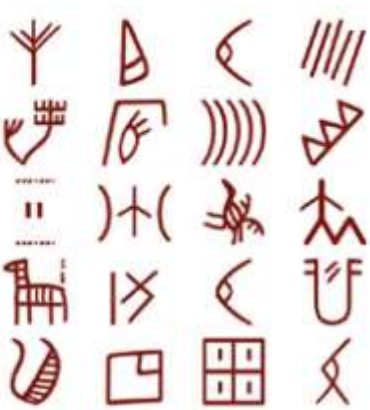
Harappan people used various household articles which were made of pottery, stone, wood, ivory and metals like copper and bronze. The modern names of articles used at that time are dishes, basins, goblets, Jars, Pans, needles, axes, saws, knives, fish-books, chairs, stools, tables, cots, candlesticks etc.

As far as entertainment of Harappan's people is concerned, balls, dice-playing, fishing, hunting animals and bird-fighting's were source of entertainment. The seal of Harappa shows that men used to hunt wild goats and large antelopes with bows and arrows. Dancing and singing of folk songs were also a source of entertainment. It is said that children toys were made of terracotta such as rattles, whistles, birds, coats, statuettes, of man and women. They also used to build toys with marvel limbs and children used to make clay modeling.

It appears that the funeral system consisted of the custom to dispose off the dead bodies by the method of cremation. During excavation a number of urns containing human bones and ashes, vessels of burnet and other offerings, such as certain household article for the use of another life have also been found. But in depth analysis reveals that the people of civilization used to bury the dead bodies of their people.

Languages and script of Indus:

Various scholars have tried their best since a long time to understand the language and script of Indus Valley Civilization but they could not come to any definite conclusion. On the light of the findings of some scholars, it is to be said that the Buruhi language was used by the people of Indus Valley which is still spoken in the part of the region, which belongs to Dravidian family. The Dravidian words come from western languages, specially from Greek and latin which they must have learnt when they went for exports of goods, some words are similar to Tamil for example the Tamil, Arisi" (Rice) is the Greek "Oryze". The Tamil "Togei" is Greek "toas" (peacock). It is believed that Dravidian people had migrated from western region and settled in this region and established different cultures in India.



As far as scripts of Indus Valley are concerned, it is still a mystery for scholars who are involved in the study of this script. There are differences in the views or approaches of origin and development of the script. There are few scholars who are of the belief that the civilization was pre-Aryan and languages and scripts were Dravidian. Sir John Marshall and Father Heras believe that the Indus script can be read from left to right and it can be translated into Tamil language. This belief is not very much appropriate as we do not have any idea bout the Tamil language of fourth millenniums B.C.

Some are of the view that Indus script came from Egypt and Mesopotamia. G.R. Hunter said that sings of script are similar to ancient Egypt. Up to some extent the signs of Indus script are similar to Egypt and Mesopotamia for example the signs of tree, fish, bird etc. But it is believed that it is a mere co-incidence that few signs are common and might be possible that the ancestry was common. The nature of pictography in the script of Indus Valley is very typical and need to understand without anthropological evidences and racial classification of in habitants of Nile, Euphrates and Indus Valley.

Another historian David Drininger supported above facts and said that the scripts were derived from outside and the originator or of the script might be common ancestor.

On the basis of above facts and beliefs it is included that the origin and understanding of the script is still unknown. And more research and efforts needs to be carried out for the script to be deciphered by the scholars working in this area. According to Sir Mortimer Wheeler inscriptions of Indus Valley are mostly short. There are so many conjectures and assumptions made by various authors. For example Meriggi said that the Indus Valley inscriptions consist of ideographs and every single symbol is an ideogram. According to Hunter and Langdon, the Indus script is a prototype of the Brahui script. According to the German scholar Hrozny, the Indus script and the Hittite script are similar and one can be read as the other.

A large number of complicated symbols have been derived in that script. This writings belong to quasi-pictographic family, there are more than 600 letters and 60 of which are basic and the rest are their variants.

The scholars have different opinion regarding the findings for the deciphering of the Indus script. Some say that it is to be read from right to left but other have the opposite opinion.

Some scholars have suggested that Indus script is a prototype of Brahmi script and Brahmi script can be read from left to right. Therefore till date we have not been able to understand the script and still have no direction and idea for deciphering the script.

Origin and growth of language and literature:

According to scholars of literature there are different idea of the origin and growth of language and literature.

Mahendra Pal Sharma said that "in every era there are parallel public languages which must be imbibed in language and literature public or indigenous language contributing new dimensions in contemporary literature." According to Dewendra Prasad Singh after various research and several discussion we come on to the point that Indus script is the oldest-script of the would and Brahmi, Debnagarik is a bio-product of the Indus script.

Albert and Thomas cable states that "the diversity of cultures that find expression in it. It understates matters to say that political, economic and social forces influence a language. These forces shape the language in every aspect." Otto Jespersen said that "The relations between the ideas being expressed by means of endings more intimately fused with the chief element of the word"

Conclusion:

On the basis of observation of various studies related to Harappa Civilization. It could be said that Indus scripts are still unknown. It is primitive language of simple pictograms, more than five hundred distinct symbols have been identified, which is similar to ancient language of Sumerian, from Mesopotamia and old Tamil script logo-syllobic, proto Dravidian. Few people have suggested that the script is a bit similar to the Chinese language but it does not seem to be similar with Bhutan, Tibat, Brahmi, Devanagari and Bengali script. The observer said uniformly that Indus script is written from right to left. A number of scholars have tried their level best but could not decipherer the script.

According to the findings of historians it could be said that there is some similarity between the religion and culture of other civilization. The most common sign of swastika and worship of nature was found, which could be seen even to day in different society.

In Gujrat state of India the Rangolis drown by Gujrati women in front of their houses, during auspicious occasions is totally similar to that civilization. Some historians said that symbol of Harappa Civilization is very common to several tribal society in India. The technique of intersecting circles is found in Harappa pottery. This type of mechanism was used on the top of the Boddhi throne at Bodh-Gaya, Bihar, India. Apart from this a lot of other symbols such as the hollow cross, the tree on a raised platform, the fish, the peacock, the antelope, the papal (fig) leaf etc, are common in current culture. Still today we could assess the importance in contemporary culture of India. For example Darbhanga District of Bihar state of India the king palace the symbol of fish every where in the fort, another example is of (fig) papal tree which is still regarded sacred and worshipped in several parts of India.

On the basis of the statement of Archeologist the people of Indus Valley Civilization were worshiper of nature and their script were written in manner from right to left. The Pre-Dravidian tribal family who had been living in surrounding of Sindhu-Ghati area, which is known as Bheil, Meana and Gond tribes, still today follow the common religion and culture of Indus Civilization. For example they worship the nature and believe in animal totem. They bury the dead body of their people along with some foods which is similar to the custom of Indus Civilization.

The scholar's have already wasted too much time, energy and resources to decipherer the language in the light of Proto-Dravidian languages group like, Tamil, Telugu, Kannada and Malayalam which is thousands of miles away, but did not succeed.

Therefore, Indus script should be tried decipherer in the light of Pre-Dravidian language group. It is believed that Pre-Dravidian language originated from Daierbir of Gond tribal language. Gonad tribes used to worship nature and believeing on animal totem and taboo.

On the other hand at the hypothesis level, the method of Dr. Brain Weiss, psychiatrist, who lives and practices in Miami Florida, U.S.A. would be applied for knowing the script of Indus valley. According to this method, any patient who are suffering from severe health problems and traditional therapy fails to cure the health problem, then Dr. Weiss will applied his method, which is known as regression and Hypnosis, which means therapy through recalling the past life, the continuation of life after death and the influence of past life which seems to hold the key of health problems. So under this process same method would be applied for recalling the past life and the person who is able to go back in the age of Indus period could throw some light on the Indus script.

REFERENCES

1. Albert C. Baugh and Thomas Cable: 2002, 'A History of the English Language', Prentice Hall Inc,

2. Banerjee , R.D. 1959 ' A Junior History of India', Blackie & Son.

3. Coomaraswamy, A.K.: 2013, ' Introduction of Indian Art', Literary Licensing, LLC

4. Derrida, Jacques.: 1997 ' Deconstruction In A Nutshell', Fordham University Press, New York.

5. Dikshit, K.N.: 1939, ' Pre- History Civilization of the Indus Valley'.

6. Dutt, Ramesh Chunder: 1972 ' A History of Civilization in Ancient India' (Vol-I-B.C.2000 to 320) Vishal Publication, Delhi

7. Heras, F: 1953 ' Studies In Proto- Indo- Mediterranean Culture,' Indian Historical Research Institute, Bombay.

8. Hrozmy, Bedrich: 1933 ' Deciphering of the Hittite language, orientalni Vstav, Prague.

9. Hunter, G, R: 1934, 'The Script of Harappa and Mohenjodaro And it Connection with other scripts', Landon.

10. Internet links Assessed from 1-10-2019 to 1-12-2019

11. Lal, B, B: 1964, ' Indian Archaeology since Independence, Delhi

12. Mackay, B, J, H: 2001 ' the Indus Civilization' Sang - e- Meel, Publication.

13. Marshall, Sir, John: 1931 ' Mohenjo - Daro and the Indus Civilization' Vols - 3, London.

14. Ojha, Shri Krishna: 1983 ' History of Ancient Indian Thought', Research Publication in Social Sciences, New Delhi

15. Otta, Jespersen: 1988 ' Growth Structure of the English Language', Oxford University, Press, Delhi.

16. Pandey, Danpati: 1993, ' Ancient Mesopotamia, Motilal Varansi Das, Delhi.

17. Paikkar, K.M.: 1945, ' A Survey of India History', George Allen and Unwin, London.

18. Parpola, Asko: 1994 ' *Deciphering The Indus Script*', Cambridge University, Press Newyork.

19. Parpola, Asko and Others: 1969-70, 'Decipherment of The Proto-Dravidian Inscriptions of The Indus Civilization,' Scandinawian Institute of Asian Studies, Special Publication Nos- 01 to 03, Copen hagen.

20. Piggott,s: 1961, ' The Dawn of Civilization,' Thames and Hudson, London.

21. Pusalkar, A. D., 1980 ' the History and Culture of The Indian People' - Vol-2 Bharatiya Vidya Bhavan, Delhi.

22. Ritti, Shrinivas and Gopal. B.R. (ed): 1971, 'Studies In Indian History And Culture,' K.E. Board's Printing Press, Dharwar.

23. Rao, Ranganatha, Shikaripur: 1973 'Lothal And The Indus Civilization' Asia Publishing House.

24. Rawland, Benjamin: 1953, ' The Art and Architecture of India', Penguin Books.

25. Sahni Dayaram, Rai Bahadur: 1991 " Archaeological Remains And Excavations At Sambhar During Samvat year 1993.

26. Sharma Mahendra Pal: 2003, ' Hindi Language: Stage of Development,' Sanjay Publication, Delhi.

27. Singh, Devendra Prasad: 2012 ' Language Literature and History' Nirmal Publication, Delhi.

28. Spengler, Oswald: 1961" The Decline of the West,' the Free Press of Glencoe.

29. Toyanbee, A.J.: 1948 " Civilization an Trial And The World And the West', Oxford University Press.

30. Upaydhya, Basudeo: 1974 ' Gupta Abhilekha,' Hindi Granth Aakadamy, Patna.

31. Vats, M.S.: 1940 ' Excavation of Harappa, Vols - 2

32. Weiss, Dr. Brain : 1998 ' Through Time into Healing', Piatkus Publication. Co. U.K.

33. Wheeler, Sir Mortiner: 1953 ' the Indus Civilization' (Supplement to the Cambridge History of Indian, Vol-1) Cambridge University Press New York.

34. ..... : 1959, ' Early India and Pakistan.

The Indus Script - through the lens of Dilmun Archaeology

Steffen Terp Laursen
Moesgaard Museum, Denmark

The westward spread of Indus script and related technology - Context and conditions

I wish to use this contribution to provide an informed update on recent advances in the investigation of the Dilmun Culture (Kuwait, Saudi Arabian and Bahrain) and beyond. The survey is aimed specifically at the context of, and processes behind, the short-lived adaptation of the Indus script in Dilmun. Brief reference is made to the introduction and use of the Indus weight system and weights as well as the profound (and more enduring) Indus Valley inspiration that appear in Gulf and earlier Dilmun

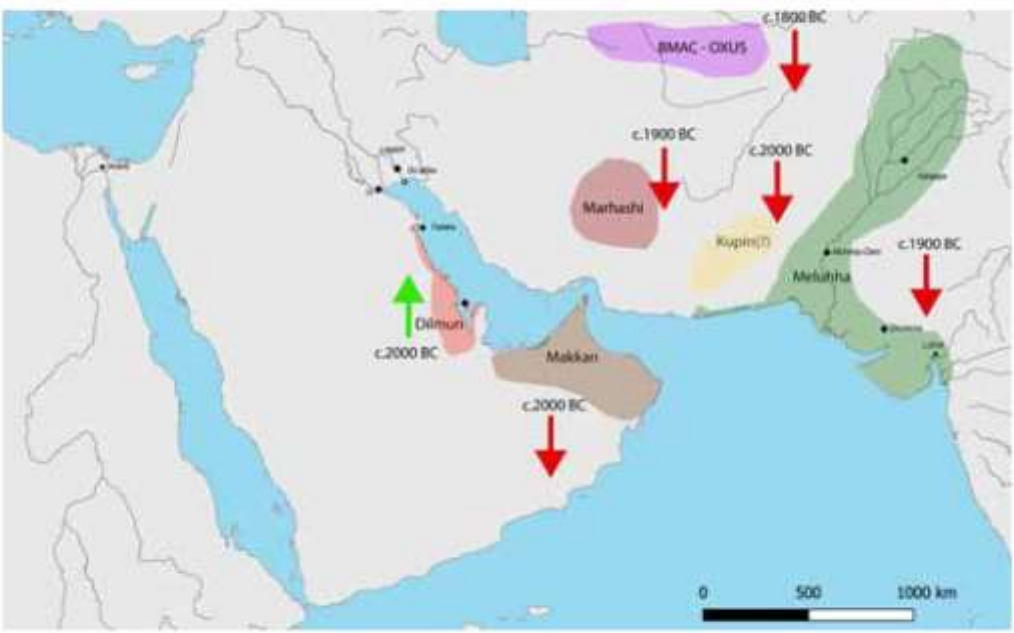


Fig. 1: The controversial "Eclipse" of the East.

type stamp seals. The primary geographical focus is on the region of Dilmun spanning from the island of Bahrain in the south-east, along the Saudi Arabian littoral to Failaka island (Kuwait) in the north-west. Attention is chiefly paid to the 2100-1700 BC period when the influence of Indus related technology was most pronounced in the Dilmun Culture.

In order to improve our understanding of the global context for the westward transmission of Indus technology one also needs to consider more overall geographical developments. First, I wish to briefly direct attention to the major, and admittedly controversial (Fig.1) "Eclipse of the East" horizon of widespread societal disintegration in Middle Asia.

The "Eclipse of the East" is roughly concomitant with the c. 2004 BC collapse of the Ur III state and the arrival of Amorites in Egypt (see below) and included the disintegration of Makkan (Umm an-Nar Culture/Oman), c. 2000 BC (Laursen 2009, Gregorica 2014), Kupin (Kuilli/Kuli Culture?), c. 2000 BC, Marhaši (Jeroft/Bampur/Kerman Civilization), c. 1900 BC (Steinkeller 1982; 2006, Lawler 2003, Madjidzadeh 2003; 2008, Pittman 2008), the Oxus Civilization (BMAC), c. 1800 BC and the Indus Civilization, c. 1900 BC (Wheeler 1968: 131, Dales 1977, Kenoyer 1998, Wright 2010: 29-32).

Societal fragmentation characterizes the developments in Middle Asian complex societies during the first centuries of the 2nd millennium BC and represent a complex and multi causal phenomenon. More than a collapse *sensu stricto* the effected societies witnessed a development towards less urban organization and less integrated and "mature" culture expressions. I conjecture that the observed volatility was the result a chain of a push-and-domino effects involving both ecological and climatic change and possibly a disruptive level of human migration. The relevance of brining the controversial "Eclipse of the East" into the discussion of the Indus Script is that the transformative developments around and after c. 2000 BC probably both conditioned the transmission of Indus technology to the west and the rise of Dilmun's trade economy.

Secondly, I call attention here to the recent adjustment of the role played by the City of Ur in the Gulf trade which up till now was assumed to have been very substantial - if not entirely dominant. A revision of the textural evidence has demonstrated that for the entire duration of the Indus Civilization, Babylonia's paramount point of embarkation to the sea was in fact the port town of Gu'abba / E-Ninmar situated at an unknow location on the seacoast of the Lagash province (Laursen and Steinkeller 2017: 71-78 with references). This new insight may have widespread implications for the topic of Indus relations with the lands to the west.

Considered of equal importance to the question of what conditioned the spread of Indus technology is the role played by the so-called "Amorite phenomenon" during which "West"-Semitic speakers sweep across Egypt (Burke 2019), Mesopotamia (Buccellati 1966) and the Gulf Region (Zarins 1986, Højlund 1989, Glassner). Notably, both the general political fragmentation, the transmission of Indus

technology and the disintegration of the Indus Civilization roughly coincide with Amorites speakers making their presence known across the Old-World stage.

The Amorite expansion and "homelands"

Research into the Amorites have narrowly focused on the early 2nd mill. BC conquests of the Mesopotamian city states by so-called West-Semitic speaking tribal nations (Buccellati 1966). Much has been written about their role in the fall of the Ur III state, but this appear to be highly exaggerated. To that effect De Boar has recently pointed out that the after the fall of Ur c. 2004 BC one does not see the emergence of any Amorite city state in Babylonia until decades later when the first "Amorite" kingdoms appeared in Larsa and Uruk, c. 1950 BC (De Boar 2018).

It is, however, becoming increasingly clear that simultaneous with these event the geographical extent of the "Amorite phenomenon" developed on a much more wide-ranging scale than hitherto assumed (Laursen and Steinkeller 2017: 60-63).

I shall argue here that Amorites contrary to common belief, in the early 2nd millennium operated across an east-west going water and land corridor that spanned more than 5000 km from Nubia (Sudan) in the south-west to Gujarat (India) in the east. The "Amorite" label should be understood as vastly diverse tribal and urban communities loosely tied together by shared traits of culture, ideology and language. Accordingly, the evidence should probably not in any way be taken to reflect one well-defined Amorite people or Civilization that functioned with any major degree of inter-polity coordination or overall political leadership.

Amorites in Egypt and Nubia

The extreme south-western expansion of Amorite groups materialized in the form of multiple waves of Amorite speakers (Canaanite west-Semites) that settled and eventually conquered ancient Egypt around 1800 BC (Burke 2019, Ryholt 1997).

During the Middle Kingdom the Egyptian state had endured a remarkable string of political stability functioning for more than 170 years as a unified kingdom. This changed around 1803 BC when a new and Semite speaking Amorite dynasty rose to power in upper Egypt. Amorites had already arrived to the delta centuries earlier (Burke 2019) but them assuming power over the north inaugurated the Second Intermediate Period (c. 1805-1540 BC) when Egypt became politically fragmented and economically weakened (Ryholt 1997).

Historically, the developments in Egypt and their timing are of great relevance to understanding the political evolutions of many other lands during the Amorite horizon. The process by which Amorites entered Egypt is furthermore instructive because it can serve as a guide to understand and reconstruct similar development else ware where the evidence is less clear or differ from the equally well-documented Amorite conquest of the Mesopotamian city states.

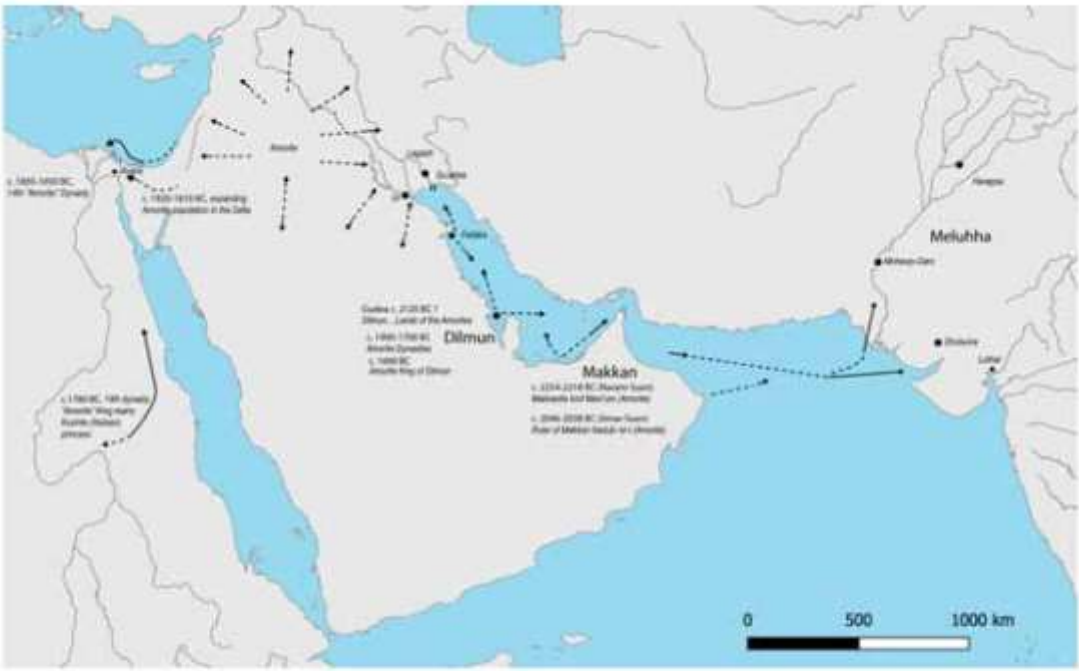


Fig. 2: The Amorite east-west expansion from Nubia to Gujarat. Details of the complex developments in greater Mesopotamia are omitted.

According to Ryholt (1997) the events can be reconstructed as following: West Semites, presumably from the area around Canaan, had gradually migrated into the Nile delta. By c. 1803 BC this Semitic speaking population brought an end to the 12th dynasty (-1803 BC) and gave rise to the new 14th dynasty (1805-1649 BC) of Canaanite (Amorite) origin. These Amorites established rule over the delta in a from that point in time, politically and ethnically divided Egypt. The events leading to the fall of the 12th dynasty remain unclear but indirect evidence suggest endemic political turmoil and disruption of relations towards the lands north of Egypt.

King Amenemhet III (c. 1860-1814 BC) left no heir to the 12th dynasty and this resulted in disputes over the line of royal succession and possibly even civil war thereby opening the political stage to contenders. Already during the reign of the succeeding King Amenemhet IV (c. 1815-1806 BC) expeditions to Sinai ceased for 30 years (from c. 1806-1776 BC) and after his reign relations with Byblos were also cut off. The loss of the delta to the Amorite (Semite) kings of the 14th dynasty left the indigenous Egyptian 13th dynasty (1803-1649 BC) - a *de facto* continuation of the 12th dynasty - severely weakened. The loss led to deteriorating economic conditions attested during Amenemhet IV (c. 1815-1806 BC) and female King Nofrusobk (c. 1806-1802 BC). It was during the reign of Nofrusobk (c. 1806-1802) that local Amorites (Semites) openly asserted their independence in the delta by proclaiming a king of their own and this was the process by which the 14th dynasty rose to power. In the parts of Nubia controlled by the Egyptians the military outposts were gradually deserted eventually leading to an almost complete abandonment of the Egypt's

occupation of the south. During the 13th dynasty the mercantile and economic conditions at times improved but by the end of King Aya's reign (c. 1701-1677 BC) an administrative collapse seems to have ensued with a succession of 24 swiftly changing kings on average reigning less than a year.

The 14th (Amorite) dynasty's first five kings Yakbim, Ya'ammu, Qareh, 'Ammu and Sheshi (c. 1805-1705 BC) ruled over a small state but significant for the scenario in the Gulf region, the Amorite dynasty soon established an extensive trade network with both the Levant, the 13th dynasty Egyptian State and Nubia. In testimony of the overall vastness of these Amorite's political and commercial network King Sheshi even married a Kushite (Nubian) princess named Tati. King Shershi's part Nubian son and heir King Neshsy (Lit. "The Nubian") (1705-) died after only one year of reign and not long after trade with the Levant ceased suddenly. An Amorite king named Ya'qub-Har (c. 1675-) maintained relations with Canaan and 13th Dynasty Egypt and Nubia but henceforth the dynasty was characterized by a succession of ephemeral kings. Ultimately, a collapse began to unfold in the 14th dynasty state conterminously with that of the 13th dynasty and much evidence suggest the reason was widespread famine and resultant plagues. Eventually, c. 1649 BC both the Egyptian 13th and Amorite 14th dynasties were overcome by so-called Hyksos invaders – another Amorite group also of Canaanite origin (Ryholt 1997: 293-301, Burke 2019). The developments which followed in the wake of the Hyksos fall outside the chronological scope of this paper.

Amorites in Dilmun and Makkan

Far removed from ancient Egypt and Nubia, the eastern most extreme of the Amorites has since long been detected in the Arabian Gulf Region (see Fig. 2). Here in the ancient lands of Dilmun and Makkan (Oman Peninsula) our understanding of the role played by Amorite language, people and identity has substantially improved in recent years. This improvement has informed us on both the character, politics, geography and chronology of the Amorite phenomenon in the Gulf Region and consequently has added new details about the context into which stamps seal with Indus scripts were transmitted, re-created and used.

It still remains unclear if the Amorite presence in the Gulf Region was the result of an influx of Amorite "West"- Semitic speakers or if the Amorite language was in fact "native" to these lands. Regardless, when attempting to understand the transmission of Indus script and other technologies the involvement of Amorites in Dilmun should not be ignored.

The presence in the Bronze Age of the Amorite people in the east Arabian countries of Saudi Arabia and Bahrain has long been invoked in explanations of observed cultural developments. Zarins has argued to link a Neolithic technological complex covering western Saudi Arabia and parts of Jordan, Syria and the Sinai Peninsula with an early "Home land" of the Amorites (MAR.TU) (1986: 233-250, fig. 68). J.-J. Glassner has in a number of studies addressed the question of the Amorites presence in both Dilmun and Makkan from the point of view of the philological evidence and provided

a basic understanding of in particular, the overwhelming Amorite onomasticon attested from the region (Glassner 1996: 240; 2000; 2002). F. Højlund developed a framework explaining the c. 2050 BC rise of an Early Dilmun state organization on Bahrain as the result of Amorite involvement (1989: 45-59). Højlund's hypothesis was recently confirmed when the Amorite names of two Dilmunite kings (Marchesi 2017) were discovered on inscribed soft stone vessels from a royal tomb dating c. 1700 BC (Laursen 2017: 220-246). More about the new evidence from Bahrain will follow below.

However, several strands of evidence suggest an Amorite presence of much greater antiquity in both Dilmun and Makkan. That Amorites were already present in Dilmun almost 500 years before the newly attested Amorite kings from the royal cemetery and possibly even were synonymous with the "native" Dilmunite population is suggested by a recently translated royal inscription of Gudea of Lagash (c. 2144–2124 BC). In this inscription Dilmun is tellingly referred to as "the land of the Amorites"(. . . i⟨-na⟩ša-du-ú Dilmun[k]i ma-at A-mu-ri-im)(Wilcke 2011: 40 no. 22 iv 3–4). Notably, this demonstrates that Dilmun already before 2120 BC was considered an Amorite territory (Laursen and Steinkeller 2017: 56, n.54).

The philological evidence relating to ancient Makkan is exceedingly limited but should not be omitted in this connection because it too speaks to the presence of Amorites on the Oman Peninsula during the Bronze Age. We thus know of a Makkanite "lord" with the Amorite name Manium from an inscription of Akkadian King Naram-Suen (c. 2254-2218 BC). Later, a man titled the ruler of Makkan (ensi$_2$ Ma$_2$-gan) is similarly identified by the Amorite name Nadub-el-I during the reign of Ur III King Amar-Suen (c. 2046-2038 BC), (Laursen and Steinkeller 2017: 36, with references).

The above-mentioned discovery at the Royal Mounds of A'alī in Bahrain, which is the dynastic burial ground for the early second millennium BC kings of Dilmun (Laursen 2017), has provided the strongest evidence yet connecting Dilmun's political elites to the Amorite identity. In one of the very last tombs built by the royal dynasty entombed at A'ali, the dead king had been interred with at least three inscribed soft stone vessels (Laursen 2017: 377-396) that carried his name and title (Marchesi 2017). The entombed king's name was Yaglī-'el and in one of the inscriptions it is furthermore specified that Yaglī-'el was the son of a certain Ri'mum. The names clearly identify the two kings as Amorites (Marchesi 2017). Both kings are afforded the royal title "the servant of Inzak of Akarum" (Marchesi 2017: 429), where Inzak is the relatively well-known tutelary god of Dilmun and Akarum probably represent a local name for Bahrain (Laursen 2017: 390) or, in my opinion less likely, Failaka island (Glassner 1984: 47-48, Marchesi 2017: 430-433).

The tomb of King Yaglī-'el is dated to 1738 BC-1658 BC or 1783 BC-1627 BC Calibrated age (modelled) at 68.2% and 95.4% confidence interval(s), respectively on the basis of extensive radio carbon dating and Bayesian modeling. A neighboring royal tomb believed to have held his father King Ri'mum is dated to 1750 BC-1674 BC or 1796 BC-1645 BC Calibrated age (modelled) at 68.2% and 95.4% confidence interval(s), respectively (Laursen and Olsen 2017: 374-375, fig. 509).

The newly obtained philological understanding of the royal title "the servant of Inzak of Akarum" has allowed Marchesi to identify the name of a third Dilmunite king mentioned on an inscribed bi-facial stamp seal of Lapis Lazuli found on Failaka island (Kjærum 1983: no. 366). The inscription of the seal identified the seal owner as a female (princess) named Panipa who is the daughter of a (King) Sumu-lêl the servant of Inzak of Akarum (Marchesi 2011: 428-431). The seal itself can stylistically be dated to around 1650-1550 BC (Højlund and Abu-Laban, Laursen 2018). What is of most importance here is the fact that the names of the Dilmunite royalties identified all four of them as Amorite (Marchesi 2017). This mean that the rulers of Dilmun were still using Amorite names 500 years after Gudea first called Dilmun "... the lands of the Amorites". The new evidence demonstrates that the ruling class of Dilmun, and probably the Dilmunite population in general, consisted of Amorite speakers (Marchesi 2017: 425-446, Laursen 2017: 377-396).

In light of this new evidence from the Royal Mounds it all of a sudden makes perfect sense why Amorite King Shamshi-Adad I (1809-1776 BC) towards the end of his reign is known to have gifted an anonymous King of Dilmun, living approximately 1600 km from Shamshi-Adad's capital Shubat Enlil (Tell Leilan), with a jar of precious oil (Charpin 1984: 120, no. 61, Eidem & Højlund: 1993).

The excavations at the Royal Cemetery undertaken by the present author has made it possible to establish, for the approximately fourteen Royal Mounds of A'ali, a sequence spanning from c. 1900-1700 BC. Even if there are no direct connections to the events in ancient Egypt the dating of Dilmun's Amorite dynasty is conspicuously similar to Egypt's 14th (Amorite) dynasty's first five kings Yakbim, Ya`ammu, Qareh, `Ammu and Sheshi (c. 1805-1705 BC) (see above).

Indus Script in Dilmun

This subject has been dealt with at some lengths in previous publications (Papola 1994; Vidale 2005, Laursen 2010a). Here the earlier conclusions will be briefly summarized and the evidence will be slightly updated. Within the territory of Dilmun stamp seals of Gulf Type with inscriptions in the Indus Script have been discovered in 9 cases of which 7 are from Bahrain and 2 are from Failaka island, Kuwait. (Fig. 3)

This is contrasted by 11 Gulf Type seals with Indus inscriptions from Babylonia and 3 from Iran. From sites in the Indus region come five circular stamp seals, closely reminiscent of the Gulf Type but more local in style (Laursen 2010a). Finally, a Gulf Type stamp seal proper with Indus script has been found at Dholavira (R. S Bisht 2015: 298). The proportions of these seal have previously allowed me to establish a robust classification into four morphological classes (groups 1-4, see G-no. in fig. 4) that are fairly closely associated with each seals region of discovery (Laursen 2010a).

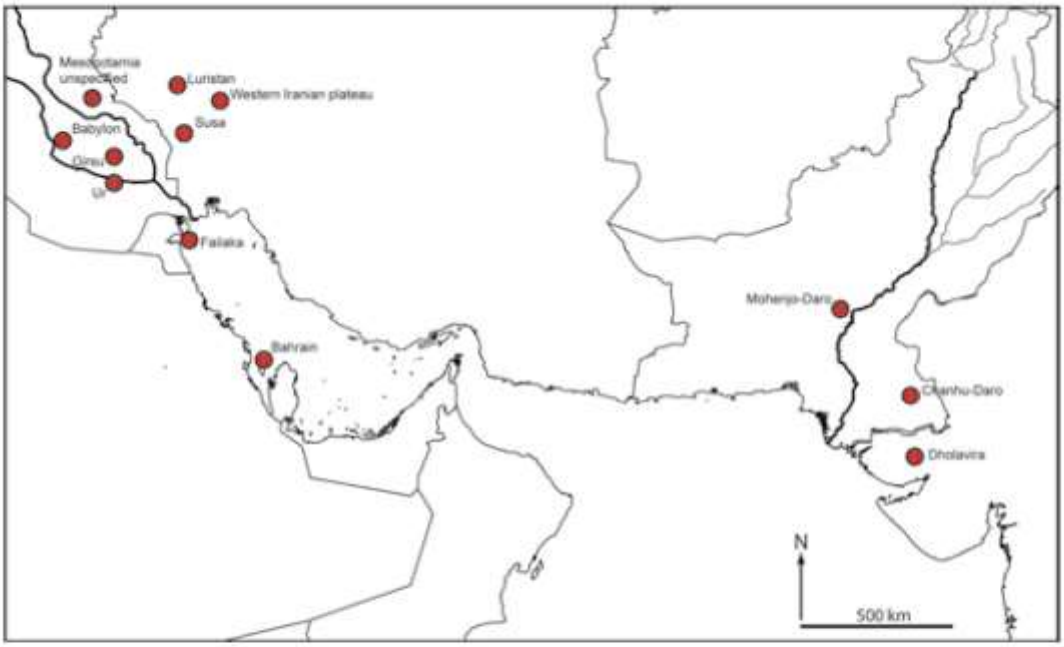


Fig. 3: Geographical distribution of Gulf Type seals with inscriptions (After Laursen 2010: Fig. 15). With addition of seal from Dholavira (After Bisth 2015: 298, no. 176/50395).

The inscriptions and glyptic art represent other informative aspects of this exclusive corpus of artefacts (Fig. 4). Almost all the inscribed Gulf Type seals have a heraldic animal in the lower half, and, in every case, this is of the short-horned bull type. Vidale has already stressed the significance of this notably fact to the understanding of the general identity of the users of these circular seals (Vidale 2005). Stylistically, the examples from Bahrain and Failaka appear to be locally made while the Babylonian and Iranian examples are slightly different. Four circular seals found in the Indus appear to be local Indus products inspired by the new circular variant Gulf Type seals (Fig. 4) The four Indus seal differ from the Gulf series among others in raw materials, style, shape and the fact that three exhibit a unicorn or a unicorn-related animal. Stylistically, six of the seals found in modern Iraq and one from Pakistan appear very close to their square Indus inspiration both in terms of carving of the bulls and scripts signs (Fig. 4). As there is ample reason to suspect them to be the chronologically earliest these seals are here hypothetically label "1. Generation". The seals of the "1. Generation"are in every case found outside of Dilmun and must have been the first to circulate in the networks of trade around or slightly after 2000 BC. Judging from the soft stone raw materials alone the seals appear to have been produced outside the Indus. However, there appear a single "1. Generation" seal from Mohenjo-Daro (Fig. 4 no. 2) which by implication must be considered a product "foreign" to that city. Interestingly, the"1. Generation" seals did for some unknow reason, not inter archeological contexts in Bahrain. The first seals to enter the archaeological record in Dilmun are here classified as "2. Generation" (Fig. 4). These are notably more "provincial" in the style and quality of execution than the former seals. Both the bulls and the inscriptions are clearly not carved by someone skilled in the craft and art

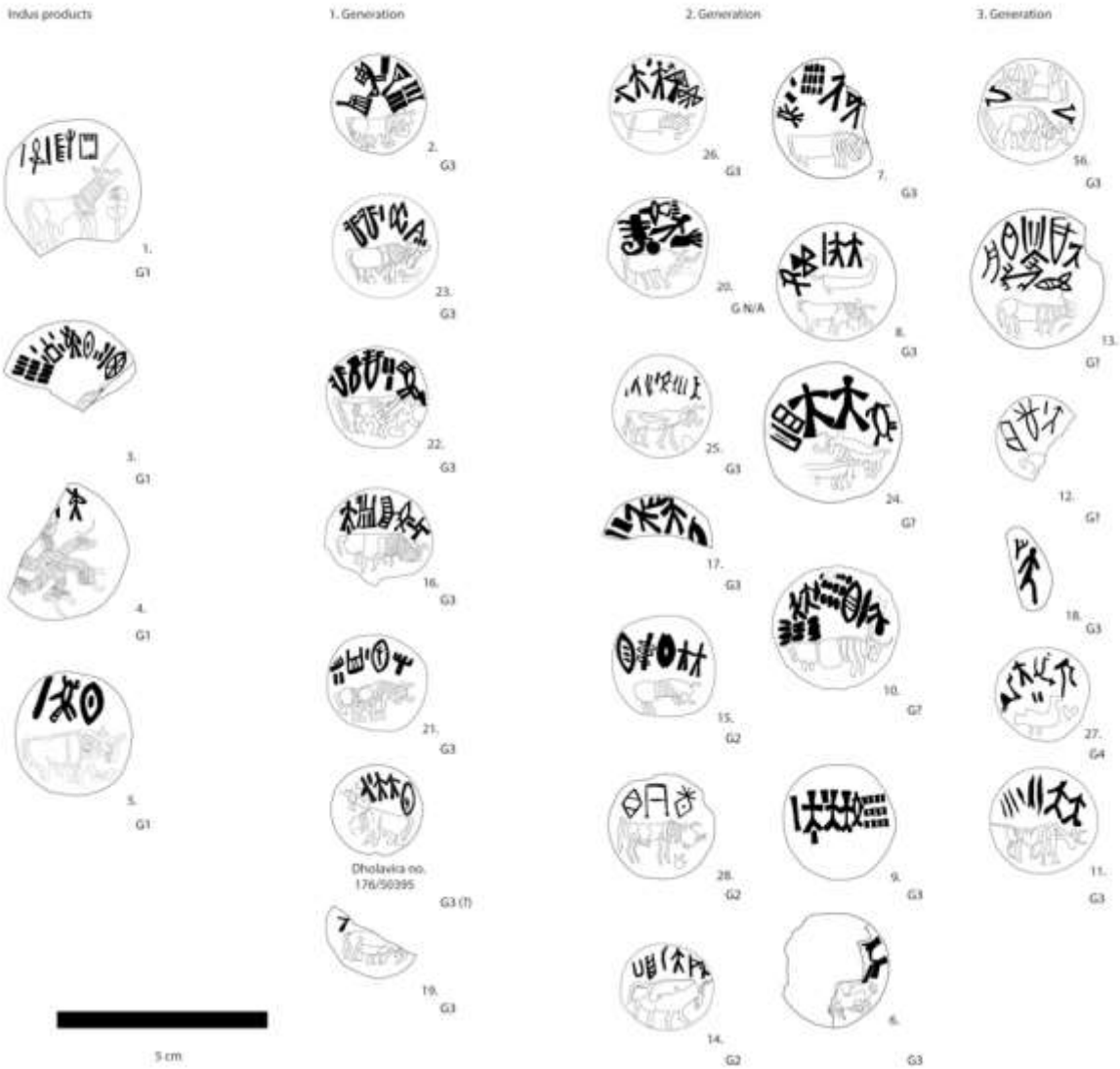


Fig.4:1-2:Gulf Type seals with inscriptions (After Laursen 2010: Fig. 8 and 9 and numbering after Tab. 1). With addition of seal from Dholavira (After Bisth 2015: 298, no. 176/50395). G# indicated associated morphological group (after Laursen 2010: fig. 4).

of the Indus workshops proper. As an important datum it has been demonstrated in another study how the "2 . Generation" appear in Bahrain at exactly at the same time as the compact burial mound cemeteries begin to form and replace scattered mounds fields (Laursen 2010b). The final appearances of the Indus script are on seals of the "3. Generation" (Fig. 4). These appear the furthest removed in time from the 1. Generation seals and their square Indus source of inspiration. One of these seals exhibits apparent pseudo Indus script (Fig. 4 no. 11). Another is of the proto-

Dilmun type with four dots-in circles and three groves on the reverse boss (Fig. 4 no. 13) dating to c. 2000-1950 BC (Laursen 2018: fig.207) and must thus have been carved towards the very end of the Indus scripts active use or after its retirement. This suggests that the script in whatever language it was used to communicate had more or less gone out of use by 1900 BC.

Parpola has analyzed the sequences of the inscriptions on the Gulf Type seals that were available to him at the time as well as Indus inscription found on other artefact types in the Gulf. His conclusion was that the Gulf sequences generally do not match those attested from areas of the Indus Valley Civilization with the exception of two found in Iran and one from Babylonia (Parpola 1994). Parpola importantly noted that twin signs and variant hereof appear uncharacteristically frequently in the Gulf Indus script sequences (1994: 309). Vidale further argued that the seal inscriptions communicated names and that the twin signs possibly represented the patronymic component as logograms in one or more ancient Semitic languages (Vidale 2004: 265, 2005: 156-157). Subsequently, two more Gulf seals with Indus Inscription were published from Bahrain (Laursen 2010a: 98, fig. 1) which gave further support to the idea of a special relation between the use of the script in the Gulf and Twins Signs. In one of the new cases (above Fig. 4 no.11) one is clearly dealing with a pseudo-script but the Twins sign was still remembered in the pseudo-sequence "prefix" position (Laursen 2010a: 118, 98, fig.1b). Notably, the new "1. Generation" Gulf Type seal with Indus script (Fig. 4 no.176/50395) published from Dholavira has only provided added support for many of the above conclusions. The new seal too features a short-horned bull but more astonishingly it's inscription also contains a Twins sign (Fig. 5).

In my opinion the new evidence for Amorites in the Gulf region calls for a reappraisal of Vidale's hypothesis of "one or more ancient Semitic languages" used in the Gulf sequences. The question that now needs to be asked is: "Was the Indus script used to "write" personal names in Amorite dialect on the Gulf Type seals?"

The possible connection to Gulf Amorites and the local Amorite dialects is possible, but also exceedingly hard to prove. Prior to the new-found Amorite names of the kings of Dilmun I have discussed this topic at length and this consequently need not be repeated here (Laursen 2010a). However, the strengthened Amorite connection to Makkan makes it relevant to readdress the situation on the Oman Peninsula. Makkan society did not develop in the same urbanized way as Dilmun and the sealing practices and script do not appear to have been widely used. There are in fact a number of artefacts from Makkan which suggests that an equivalent to the Twin Sign frequently was used as a pictogram in contexts where it may well signify "family relations" (Fig. 6:1-4). The evidence includes: a Bronze Age seal amulet from Kalba site K4, with a distinctly Twin Sign inspired pictogram (Fig. 6:1), a pseudo stamp seal from Ra's al-Jinz with a more crudely looking likely Twin Sign inspired pictogram (Fig. 6:2), a stone relief including a likely Twin Sign inspired pictogram (here unmistakably a man and woman) carved over the entrance of the Hili Grand Tomb (OA 1059). The Hili grand tomb is one of the most elaborate collective tombs ever discovered in

Fig. 5: Indus script sequences from Gulf Type seals (after Laursen 2010: fig. 11). Sequence from Dholavira seal is drawn after Bisth 2015: 298, no. 176/50395.

Fig. 6: Iconography invoking the "Twins sign" or related symbolism. 1. Kalba site K4, (1:1) after Cleuziou 2003: fig.6/2; 2. Ra's al-Jinz, (1:1) after Cleuziou 2003: fig. 6/1; 3. Hili Grand tomb Refief, Abu Dhabi (not to scale); 4. Mohenjo-Daro, (1:1) after Shah & Parpola 1991: 179, M-1370.

Makkan and the fact that this symbol appear over the entrance to a collective tomb, which is the most manifest celebration of the family collective, hardly contradicts the interpretation of a family-union symbolism behind the Twins signs.

Indus Weight in Dilmun and the "Dilmun norm"

Weights imported from the Indus world were used in Dilmun from Qala'at al-Bahrain period IIa (c. 2050/2000-1900 BC) (Højlund 1994: 395-397) and have been found in small numbers in Bahrain and Failaka island, Kuwait. An important datum in the discussion of the Indus weight unit in Dilmun is provided by the Ur tablet (UET V 796). This text famously recalls a transaction of copper from Dilmun involving long-distance trader Ea-nāsir and the mass of which is given both in the Babylonian weight unit and the so-called Tilmun-norm (Bibby 1970, with references). Based on this text the Tilmun-norm was shown by Bibby to be equivalent to the Indus weight system and stone weights discovered in Bahrain (Bibby 1970). It has subsequently been shown how the Old World's units of weights could be cross-referenced by mean of simple arithmetic (Mederos & Lamberg-Karlovsky 2001). Importantly, the tablet is contemporary with King Rim-Sin c. 1822-1763 BC (Leemans 1960: 50pp) which document that the Indus unit as a minimum was in use in Dilmun at that time.

Judging from the archaeological evidence from Bahrain and Failaka it seems that in Dilmun the Indus type weights were supplemented with, but not completely replaced by, the Babylonian spindle and duck-shaped weights and Babylonian unit sometimes towards the end Early Dilmun per. II c. 1750-1700 BC.

Conclusion

Dilmun's strong economic relations with Babylonia could have been forged when its ethnic Amorite dynasty call for "tribal solidarity" among the many Amorites chiefly houses that from c. 1950 BC onwards took control of the Mesopotamian city states.

By all appearances, the Amorite kings of Dilmun (Laursen 2017), or more likely from a chronological point of view the Amorite tribal lords (Laursen 2008) that preceded them, played an instrumental role in facilitating the transmission of Indus knowhow to Dilmun as well as organizing the Meluhhan trade with as distant ports as Dholavira in Gujarat and Mohenjo Daro in Sindh.

The Indus unit of weight (Tilmun-norm) was in use until at least c. 1800 BC (Rim-Sin) and the last "Indus" inscriptions in Dilmun probably date to around 2000-1950 BC. When Dilmun first possessed cuneiform scribes with skills in Old Babylonian cuneiform is difficult to tell. An inscription on a ceramic sherd found in a Royal tomb (Mound P) dating to ca. 1900-1800 BC (Laursen 2017: 194: fig.314 a) was meant to provide the volume of the vessel. Notably it is written both upside-down and in mirrored (Marchesi 2017: 427: No. 5), suggesting generally poor scribal skills at the royal palace of Dilmun at that time.

This draft conclusion will be expanded after the conference and workshop!

Appendix 1

Nanaza and Samar only known Indus/Meluhhan personal names

Of particular interest to the context of this proceeding of the Indus script are the probable Meluhhan personal name of two royal slaves that worked as "bezoar shepherds" at the royal animal park at Ur. The relevant text has recently been dealt in Laursen and Steinkeller (2017: 83-84) but is mentioned again here because it uniquely provides us with the proper names of two people from the Indus Valley Civilization. The tablet in which the Meluhhan slaves Nanaza and Samar are mentioned come from Urusagrig and is dated to Šu-Suen year name 6 (2037-2029 BC). It reads:
1 sila3 i3-giš Na-na-za 1 sila3 Sa6-ma-ar ½ sila3 A-li-a-hi dam-a-ni i3-ba lu2 Me-luh-haki-me a-ru-a lugal sipad adara 4-me'
"1 liter of sesame oil (for) Nanaza, 1 liter (of sesame oil for) Samar, (and) ½ liter (of sesame oil for) Ali-ahi, his wife; the oil allotment of the Meluhhans, royal donated slaves, the shepherds of bezoars" (Nisaba 15 371:1–7). (Laursen and Steinkeller 2017: 83).
The following comments on the text are cited from Laursen and Steinkeller 2017: "*There is no reason to doubt that the first of these two individuals, whose names are distinctly foreign, did come from Meluhha (or some neighboring region). Importantly, these two personal names are the only evidence available that may pertain to the language of Meluhha. Although there is no way of telling how Nanaza and Samar had ended up in Babylonia, the fact that they were royal slaves suggests that they had been acquired by the crown somewhere in the Gulf, probably as part of the Ur III commercial activity in that region. Interestingly, the name of Samar's wife is Akkadian, indicating that she was a Babylonian native. Another remarkable fact about these individuals is that they took care of bezoars. Since the designation "bezoar shepherd" is completely unique, one cannot but suspect that Nanaza and Samar had been "recruited" owing to their familiarity with these exotic animals, which undoubtedly formed part of a royal animal park.*" (2017: 83-43)

Bibliography

Bibby, G. 1970. "...according to the standard of Dilmun" Kuml 1970: 349-353.

Bisht, R.S. 2015. *Excavations at Dholavira (1989-90 to 2004-2005)*. Accessed online on Dec. 16, 2019 at: https://www.scribd.com/document/262316120/Excavations-at-Dholavifra-1989-2005-RS-Bisht-2015

Boer, R.j de "Beginnings of Old Babylonian Babylon: Sumu-Abum and Sumu-La-El" *Journal of Cuneiform Studies*, 2018: 53-86.
Buccellati, G. 1966. The Amorites of the Ur III period, Pubblicazioni del Seminario di Semitistica.
Ricerche:1. (Istituto Orientale di Napoli).

Burke, A. 2019. "Amorites in the Eastern Nile Delta: The Identity of Asiatics at Avaris during the Early Middle Kingdom." P. 67-94 in Bietak, M. &Prell, S (eds.) *The Enigma of the Hyksos Volume I – ASOR Conference Boston 2017 – ICAANE Conference Munich 2018 – Collected Papers*. Wiesbaden: Harrassowitz Verlag.

Charpin, D. 1984. Documents du bureau de l'huile à l'époque assyrienne. *Mari Annales de RecherchesInterdisciplinaires* 3 :83-126.

Cleuziou, S. 2003. "Early Bronze Age Trade in the Gulf and the Arabian Sea: The Society behind the Boats." P. 133-150 inPott, D.T. et al (eds.) Archaeology of the United Arab Emirates. U.A.E.: Trident Press.

Dales, G. 1977. Shifting Trade Patterns between the Iranian Plateau and the Indus Valley in the
Third Millennium B.C. Pages 67-78 in J. Deshayes (ed.) Le Plateau iranien et L'Asie Central des origins á la conquête islamique. Paris, CNRS.

Eidem, J. & Højlund, F. 1993. "Trade or Diplomacy? Assyria and Dilmun in the Eighteenth Century BC" *World Archaeology* 24/3: 441-448.

Glassner, J.J. 1984. "Inscriptions cuneiforms de Failaka" p. 31-50 in J.-F. Salles (ed.) Failaka, fouilles francaises 1983, Travaux de al Maison de l'Orient 9. Lyon: Maison de l'Orient.

- 1996. "Dilmun, Magan and Meluhha: some Observations on Language, Toponymy, Anthroponymy and Theonymy". P. 235-248 in: *The Indian Ocean in Antiquity*, J. Reade (ed.) London: Kegan Pal International with the British Museum.

- 2000. "L'onomastique "Amorrite" Dans La PéninsulaArabique" in *Landscapes – Territories, Frontiers and Horizons in the Ancient Near East* (eds.) Milano, L. et al. Sargon: Padova.

- 2002. "Dilmun et Magan: Lepeuplement, l'organisation politique,la question des Amorrites et la place del'e´criture. Point de vue de l'assyriologue". P 337–381 in Cleuziou, S., Tosi, M. & Zarins, J. (eds), *Essays on the Late Prehistory of the Arabian Peninsula*(Rome, IstitutoItaliano per l'Africa el'Oriente).

Gregoricka, L.A. 2014. "Human response ot Climate Change during the Umm an-Nar /Wadi Suq Transition in the United Arab Emirates." *International Journal of Osteoarchaeology* 26(2): 211-220. doi: 10.1002/oa.2409.

Hugill, P.J. and D.B. Dickson (eds.) 1988. The Transfer and Transformation of Ideas and Material Culture.
College Station: Texas A & M University Press.

Højlund, F. 1989. The Formation of the Dilmun State and The Amorite Tribes. PSAS 19:45-59

Højlund, F. & Andersen, H. H., 1994.*Qalasat al-Bahrain — The Northern City Wall and the Islamic Fortress*. Højbjerg: Jutland ArchaeologicalSociety.

Kenoyer, J. 1998. Ancient Cities of the Indus Valley Civilization. Karachi, Oxford University Press.

Kjærum, P. 1983. *Failaka/Dilmun, the Second Millennium Settlement, vol. 1/1: The Stamp and Cylinder Seals*, Jutland Archaeological Society Publications 17 Aarhus: Jutland Archaeological Society.

Laursen, S. 2017. *The Royal Mounds of A'ali in Bahrain – The Emergence of Kingship in Early Dilmun*. Publications vol. 100. Aarhus: Jutland Archaeological Society in cooperation with Moesgaard Museum and Bahrain Authority for Culture and Antiquities.

Laursen, S.T. 2018. "Chapter Twelve - Seals and Sealing Technology in the Dilmun Culture: The Post-Harappan Life of the Indus Valley Sealing Tradition" Part II - South Asia and the Gulf Region, Chapter 12, p. 204-226 in Ameri, M. et al. (eds.) *Seals and Sealing in the Ancient WorldCase Studies from the Near East, Egypt, the Aegean, and South Asia*. Cambridge: Cambridge University Press.

- 2016. "Symbols of Dilmun's royal house – a primitive system of communication adopted from the late Indus world?" *Arabian Archaeology and Epigraphy* 27: 2-18

- 2010a. "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". *Arabian Archaeology and Epigraphy*. 21:2: 96-134.

- 2010b "The Emergence of Mound Cemeteries in Early Dilmun: New Evidence of a Proto-Cemetery and its Genesis, c. 2050–2000 BC." p. 115-39 in L. Weeks (ed.), *Death and Burial in Arabia and Beyond: Multidisciplinary Perspectives*, Society for Arabian Studies Monographs 10. BAR International Series 2107. Oxford: Archaeopress.

- 2009. "The decline of Magan and the rise of Dilmun: Umm an-Nar ceramics in the burial mounds of Bahrain, c. 2250-2000 BC". *Arabian Archaeology and Epigraphy*.20:134-155.

- 2008. "Early Dilmun and its rulers' new evidence of the burial mounds of the elite and the development of social complexity, c. 2200-1750 BC." *Arabian Archaeology and Epigraphy*. 19:155-166.

Laursen, S. & Olsen, J. 2017. "Radiocarbon chronology based on Bayesian modelling" p. 371-375 in Laursen, S. (ed.) *The Royal Mounds of A'ali in Bahrain – The Emergence of Kingship in Early Dilmun*. Publications vol. 100. Aarhus: Jutland Archaeological Society in cooperation with Moesgaard Museum and Bahrain Authority for Culture and Antiquities.

Laursen, S & Steinkeller, P. 2017. *Babylonia, the Gulf Region, and the Indus – Archaeological and Textural Evidence for Contact in the Third and Early Second Millennium B.C.* Mesopotamian Civilizations Series vol. 21, Winona Lake, Indiana: Eisenbrauns.

Lawler, A. 2003. "Jiroft Discovery Stuns Archaeologists" Science 2003 vol. 302: 973-74.

Leemans, W.F. 1960. *Foreign Trade in the Old Babylonian Period — as revealed by the texts from Southern Mesopotamia*. Leiden: Brill.

Madjidzadeh, Y. 2008. Excavations at Konar Sandal in the Region of Jiroft in the Halil Basin: First Preliminary report (2002-2008), Iran – journal of the British Institute of Persian Studies vol. XLVI: 69-103 - 2003. Jiroft: The Earliest Oriental Civilization, Teheran.

Marchesi, G. 2017. "Appendix 5. Inscription from the Royal Mounds of A'ali (Bahrain) and Related Texts" p. 425-437 in

Mederos, A. &Lamberg-Karlovsky, C.C. 2001. "Converting currencies in the old World – simple arithmetic underpinned trading throughout the Near East during the Bronze Age". *Nature* 411, 437 (24 May 2001).

Oppenheim, A. L. 1954."The seafaring merchants of Ur", *Journal of the American Oriental Society* 74:6-17.

Parpola, A. 1994. "Harappan Inscriptions" p. 304-315 in Højlund, F. & H.H. Andersen Qala'at al-Bahrain – The Northern City Wall and the Islamic Fortress. Aarhus: Jutland Archaeological Publications.

Pittman, H. 2008. IX Glyptic Art, pages 95-101 in Madjidzadeh, Y., Excavations at Konar Sandal in the Region of Jiroft in the Halil Basin: First Preliminary report (2002-2008), Iran – journal of the British Institute of Persian Studies vol. XLVI.

Roaf, M. 1982 Weights on the Dilmun Standard. Iraq 44: 137-141.

Shah, S.G.M. & Parpola, A. 1991. *Corpus of Indus Script Seals and Inscriptions, 2 Collections in Pakistan*. AASF B 240 and Memoires of the Department of Archaeology and Museums, 5. Helsinki: Government of Pakistan.

Steinkeller, P. 1982. The question of Marhasi: A Contribution to the Historical Geography of Iran in the Third Millennium B.C. ZeitschriftfürAssyriologie 72: 237-65.

- 2006. New Light on Marhasi and its contact with Makkan and Babylonia. Journal of Magan Studies 1: 1-17.

Vidale, M. Vidale, M. 2004. Growing in a ForeignWorld. For a History of the 'MeluhhaVillages' in Mesopotamia in the 3rd Millennium BC. p. 261 -280 inPanaino, A. &Piras, A. (eds.), MelammuSymposia 4: Proceedings of the FourthAnnual Symposium of the Assyrian andBabylonian Intellectual Heritage Project.www.aakkl.helsinki.fi/melammu/bibliography/bibllib.php (accessed on25/06/2010).

- 2005. "The Short-Horned Bull on the Indus Seals: A Symbol of the Families in the Western Trade?" p. 147-158 in Franke-Vogt, U. &Weisshaar, H. (eds.), *Proceedings of the Seventeenth International Conference of European Association of South Asian Archaeologists* (7-11 July 2003, Bonn), Achen: Linden Soft.

Wheeler, M. 1968. The Indus Civilization. Supplement volume to the Cambridge History of India. Cambridge University press, Cambridge.

Wilcke, C. 2011. "Eine WeihinschriftGudeas von LagašmitaltbabylonischenÜbers etzung." P. 29-47 in A.R. George (ed.), Cuneiform Royal Inscriptions and Related Texts in the Schøyen Collection. Cornell University Studies in Assyriology and Sumerology 17. Bethesda, MD:CDL.

Zarins, J. 1986 MAR-TU and the land of Dilmun. Pages 233-250 in Al-Khalifa, H and Rice, M. (eds.), Bahrain through the ages - the Archaeology. KPI, New York.

The Indus Script: Origins, Use and Disappearance

Jonathan Mark Kenoyer

Kenoyer, J. M. 2020 (In Press) The Indus Script: Origins, Use and Disappearance. In *Dialogue of Civilisation: Comparing Multiple Centers*. Edited by Hui Zhao, Shanghai Guji Press, Shanghai.

The Indus Script: Origins, Use and Disappearance
by Jonathan Mark Kenoyer

Abstract

The Indus script was used in the cities and towns of the Indus Civilization during the Integration Era, between 2600-1900 BCE. The evidence for the origins of the Indus script is found during the earlier Regionalization Era in the form of post firing graffiti as well as painted on pottery. An Early Indus Script can be identified between 2800-2600 BCE. The Indus Script was used on seals as well as a wide range of artifacts, such as weapons, ornaments, trade pottery and ritual objects. The contexts of script and changes in the writing over time indicate that the Indus script was versatile and that it was probably used to communicate complex ideas as well as multiple languages. The disappearance of the Indus script can be associated with the transformation and decline of Indus urban centers.

Introduction

The oldest known writing system of South Asia is commonly referred to as the Indus script because of its association with the early urban centers of the Indus Civilization, dating between 2600-1900 BCE (Kenoyer, 2014, Kenoyer, 2014 (in Chinese)). When the Indus cities were first excavated in the 1920s and 30s, the main focus in the study of Indus writing was on short texts found on carved steatite seals and molded tablets made of faience and terracotta. However, many other types of objects with writing were also discovered, but due to their fragmentary nature, they received much less attention. For example, writing was on pottery, personal ornaments, copper tools

and ingots, as well as on a wide variety of other objects (Parpola, 1994a). After almost 100 years of research, scholars have still not been able to decipher this writing system because there are no bi-lingual tablets that allow it to be linked to a known language system. Nevertheless, the continued excavations by scholars in Pakistan, India and other adjacent regions has resulted in a large body of archaeological and epigraphic data that make it possible to discuss the origins of the writing system around 3300 BCE (Joshi and Parpola, 1987, Shah and Parpola, 1991, Parpola et al., 2010). It is also possible to define how the writing was used in urban, rural and trading settlements of the Indus Civilization. In addition, comparisons of script on seals and pottery in different chronological periods of the Indus cities provides evidence for changes in the writing system over 700 years (Kenoyer, 2006b, Kenoyer and Meadow, 2010). The lack of long texts suggests that the once it was developed and widely used, the Indus script was not used in the same way that writing was used in other early civilizations. The evidence presented below will show that writing played an important role in the development and functioning of certain aspects of Indus society, economics and religion. Writing was not however, an indispensible part of Indus culture. During the Late Harappan Phase, from 1900-1300 BCE, many aspects of Indus urbanism, technology and ideology continued even though writing and seals were no longer used by the elites.

Table 1. Chronology of the Indus Tradition (Kenoyer, 2015:Tables 2, 3, 4, 5, 6)

Early Food Producing Era (Neolithic)	ca. 7000 to 5500 BCE
Mehrgarh, Period IIa - Ceramic	*6000-5500 BCE*
Mehrgarh, Period 1, Aceramic	*7000-6000 BCE*
Regionalization Era (Chalcolithic/Bronze Age)	
Early Harappan Phase	ca. 5500 to 2600 BCE
Harappa: Period 2, Kot Diji Phase	*2800-2600 BCE*
Harappa: Period 1,A &B, Ravi Phase	*>3700-2800 BCE*
= Mehrgarh, Period IV to V	*3500-3000 BCE*
Mehrgarh, Period III	*4400--3500 BCE*
Mehrgarh, Period IIb	*5500-4400 BCE*
Integration Era (Indus Civilization) (Bronze Age)	
Harappan Phase	2600 to 1900 BCE
Harappa: Period 3C, Final	*2200-1900 BCE*
=Nausharo, Period IV	*2100-2000 BCE*

Harappa: Period 3B, Middle	*2450-2200 BCE*
=Nausharo, Period III	
Harappa: Period 3A, Initial	*2600-2450 BCE*
=Nausharo, Period II	

Localization Era (Bronze Age)

Late Harappan Phase	ca. 1900 to 1300 BCE
Harappa: Periods 4 and 5	*1900- 1700 BCE*
= Mehrgarh Period VIII	*2000-1700 BCE*
Jhukar, Rangpur, Cemetery H Phases	

Context and Chronology of Indus Writing

The geographic context for the emergence of writing in South Asia is the broad alluvial plains of two major river systems, the Indus and the Saraswati-Ghaggar-Hakra Rivers (Kenoyer, 1998, Possehl, 2002, Gupta, 1999). The Indus River and its tributaries form a vast region that encompasses modern Pakistan and parts of northwestern India. The Saraswati-Ghaggar-Hakra River is now dry, but flowed on the east and parallel to the Indus River. This second river had its source in the Himalayas and may have emptied into the Greater Rann of Kutch (Figure 1). Trade networks connecting these two parallel river systems allowed agro-pastoral and fishing communities to interact across the vast region, exchanging ideas and technologies as well as ideologies.

Most earlier studies of the Indus script focused only on the period when the fully developed script was in use, from around 2600-1900 BCE (Mahadevan, 1977, Parpola, 1994a, Wells, 2011, Rao, 1982). The Indus script must be studied in the context of long-term cultural tradition development, rather than simply during the urban phase of the Indus civilization. A "tradition" refers to "persistent configurations of basic technologies and cultural systems within the context of temporal and geographical continuity" (Shaffer, 1992:442, Kenoyer, 2015, Kenoyer, 1998) (Table 1). The foundations of Indus writing can be traced to graphic symbols and painted designs associated with the Early Food Producing Era (Neolithic) at sites such as Mehrgarh (Jarrige et al., 1995, Jarrige and Quivron, 2013). While many of the early graphic symbols are quite simple and may not directly link to later writing systems, some of the signs continued to be used in later periods and eventually became part of the later Indus script. During the subsequent Regionalization Era (Chalcolithic/ Bronze Age) there is more widespread use of graphic symbols and various types of graffiti on pottery and clay objects such as figurines and terracotta cakes. The use of multiple symbols together in varied sequences suggests that they were used to encode language or ideology. During this time period there is evidence for the emergence of an Early Indus Script (Kenoyer and Meadow, 2008) that has been defined at the site of Harappa. It is also possible that there are regional variations in the Early Indus Script, for example in the upper Ghaggar-Hakra River Valley sites such as Kalibangan, Kunal, and Bhirrana (Lal, 1992, Lal et al., 2003, Khatri and Acharya, 2005, Rao et

al., 2005). Other regional forms of Early Indus writing may have been developing in Baluchistan (Dales, 1979:256, Quivron, 1997, Jarrige et al., 2011) and the Gomal and Bannu Plains of Khyber Pakhtunkhwa (Dani, 1970-71, Durrani, 1988, Durrani et al., 1991, Durrani et al., 1995), as well as in Gujarat (Ajithprasad, 2002). As more sites are excavated in each of these regions, the samples size of inscribed objects will increase and eventually it may be possible to trace the development of specific aspects of writing to one or more regions.

The development of what is thought to be a single widespread form of Indus Script is seen during the Integration Era (Bronze Age) from around 2600-1900 BCE, with the rise of major urban centers that had relatively similar economic, political and ideological systems (Parpola, 1994a). It is still not confirmed if this is in fact a single unified writing system, though that is what most scholars assume. Based on the stratigraphic excavations of inscribed objects from the site of Harappa it is clear that the Indus Script changed over time, and that some new signs and new ways of using the script were introduced in the later part of this period (Kenoyer and Meadow, 2010). Given the chronological variation seen at Harappa, it is possible that there are regional variations of the Indus Script and that some areas may have used writing in unique ways. We do have evidence that the Indus script was used to write a different language based on seals found in Bahrain and other regions of the Persian/Arabian Gulf, Iran and Mesopotamia (Brunswig et al., 1983, Parpola, 1994b, Laursen, 2010:115-119). The Indus Script was used for around 700 years and gradually disappears during the Localization Era (1900-1300 BCE), when trade networks were disrupted and the integrated urban centers become isolated and eventually reorganized along different cultural and economic patterns.

Table 2: Chronology of Indus Script and Seal types from Harappa and other major Indus Sites (modified from (Kenoyer, 2006b)

Harappa - Period 1- 3700-2800 BCE
Seals:
Button seal with geometric design, no clear evidence for script

Positive script
Inscribed pottery – post-firing graffiti, one to three signs, pre-firing potter's marks

Period 2 – 2800-2600 BCE
Seals: inverse script
Square steatite seal – animal motif facing left, irregular carving, irregular script placement
Steatite button seal – symbol, no script
Sealing – square seal with script, plant motif and ladder motif

Positive script
Inscribed pottery – post-firing graffiti, pre-firing script?, one to three signs

Period 3A – 2600-2450 BCE
Seals: inverse script
Square steatite seal – angular carving of animal predominantly facing right, linear script placement, curved script above animal motif, one script sometimes below animal head, seal boss is square
Positive script
Inscribed pottery – post-firing graffiti, pre-firing script

Period 3B – 2450 -2200 BCE
Seals: inverse script
Square steatite seal – animal motif predominantly facing left, linear but irregular script above animal motif, seal boss is circular, domed with single or double groove
Square steatite seal – only with script, linear regular script size
Steatite button seal – symbol, no script

Positive script
Incised steatite tablets - regular and irregular script, motifs and symbols
Molded faience tablet – script, motifs and symbols
Molded terracotta tablet – seal impression with animal motif and script

Inscribed pottery – post-firing graffiti, pre-firing script

Period 3C – 2200-1900 BCE

Seals – inverse script
Square steatite, copper and silver seals – animal motif facing left, bold, rigid, regular script, seal boss is circular, domed with single, double or triple groove
Long rectangular steatite seal – no animal motif, bold, rigid, regular script
Terracotta seal – regular script
Faience button seal – symbols, no script

Positive script
Trade and Accounting devices
Incised steatite tablets - script, motifs and symbols
Incised terracotta tablets/ shaped sherds – incised irregular script

Molded copper tablets – regular script, raised in positive
Molded faience tablet – narrative scenes, script, motifs and symbols

Molded terracotta tablet – narrative scenes, seal impression with animal motif and script
Molded terracotta token – circular with script on one or both sides, low fired
Terracotta flat sealing – molded script from various types of seals
Inscribed terracotta conical sealing – irregular script

Pottery
Pointed base goblets – impressed with script seal
Inscribed pottery – large and small, generally irregular post-firing graffiti, large and small refined and regular pre-firing script
Inscribed stone vessel – bold regular script

Architecture
Inscribed ringstone – regular script

Tools / weapons
Inscribed copper tools / weapons – bold, rigid, regular script
Inscribed bone point – irregular script

Ornaments
Inscribed gold jewelry – miniature irregular script
Inscribed stoneware bangles – miniature irregular script
Inscribed shell bangle – irregular script
Inscribed terracotta bangle
Molded terracotta bead – irregular script
Molded faience bead (or perforated tablet) – regular script

Domestic, ritual and other
Inscribed bone and ivory dice – irregular script
Inscribed terracotta conical object / gaming piece – irregular script
Inscribed terracotta top, wheel, figurine
Inscribed terracotta triangular cake
Inscribed pebble – irregular script

Early Graphic Symbols on clay and pottery

The earliest evidence for settled agriculture in this region dates to between 7000-6000 BCE at the site of Mehrgarh, Balochistan (Jarrige et al., 2005). In Period I at Mehrgarh there is no evidence for the use of pottery, and basketry was the main form of container that has been preserved. However, traces of painted linear and dotted decorations using red ochre, brown, black and white pigments have been found on

clay plastered walls of the early houses (Jarrige and Quivron, 2013:28-30). Abstract designs have also been found carved on a bone pendant (Jarrige and Quivron, 2013:Fig. 352), as well as on a wide range of animal and human figurines made from stone and clay. During Period IIa (6000-5500 BCE), low-fired pottery and also terracotta figurines of humans and animals were produced. Some of the pottery was decorated with a plum red slip, and red designs were also painted on some of the figurines. A terracotta bead with incised designs was found from Period IIB (5500-4400 BCE) and the excavators suggest that it may have been used like a cylinder seal to create a design that may indicate vegetation (Jarrige et al., 1995:319). By Period III (4400-3500 BCE) a wide range of hand formed and some wheel thrown pottery vessels were being produced at the site and there is evidence for pre-firing potter's marks on some of the pottery (Quivron, 1980:276). After around 3500 BCE during Periods IV-VII the incidence of potter's marks increases significantly but the excavators do not feel that any of these early forms of graphic art can be directly related to the later Indus script (Quivron, 1980:279). However, many of the simple signs found at Mehrgarh do in fact appear at many other early sites within the Indus region and some of the signs that are found as post-firing graffiti were used in both the Early Indus Script and the later Indus Script (Kenoyer, 2006b).

Potter's Marks and Graffiti

One of the major problems in the study of the origins of Indus writing has been a conflation of terms and the lack of precise documentation of graphic symbols on pottery and other types of objects. The extensive surveys and trial excavations carried out by Walter Fairservis in Balochistan recovered large amounts of pottery with evidence for graphic symbols (Fairservis, 1961, Fairservis, 1959, Fairservis, 1956). Unfortunately it is not clear if the symbols were inscribed on the pottery prior to firing or after firing. This is also the situation with graphic symbols reported from sites such as Rangpur (Rao, 1963), Lothal (Rao, 1985, Rao, 1979), Kunal (Khatri and Acharya, 2005), Rakhigarhi (Nath, 2015) and Kalibangan (Lal et al., 2003, Lal et al., 2015, Joshi, 2007, Lal, 2015). Graphic symbols incised on pottery prior to firing usually consists of one to six strokes, carved as an "X" or "V", or some geometric shape, incised on bottom of the base, or just above the base on the exterior of the vessel (Figure 2: 5 to 11). These pre-firing marks are usually identified as "potter's marks", indicating the person who made the pot or perhaps the person who would eventually receive the pot. Many different pots may have been fired in a communal kiln and this would allow individuals to differentiate their handiwork from that of other potters who were making similar shapes and designs of vessels. In contrast, post-firing marks or "graffiti" are signs that are carved onto a vessel after it was fired and could indicate the person who acquired the vessel or perhaps the contents of the vessel. Post-firing "graffiti" are usually incised on the vessel rim or upper body and can also be simple signs (Figure 2: 1to 4). At the site of Harappa, during Ravi Phase (3700-2800 BCE) and the Kot Diji Phase (2800-2600 BCE) some graffiti included one complex sign that was similar to signs found in the later Indus script

(Figure 2:4). Sometimes two or more distinct signs were arranged in a sequence that was identical to sequences found in the later Indus script (Figure 3). These examples suggest that some of the early graffiti was probably being used as a form of writing and that the later Indus script evolved out of the early graffiti being used on pottery during the Regionalization Era (Kenoyer, 2006b:14-16). Due to the limited area of total excavations, the sample size of Early Indus script from Harappa is quite small, but the discovery of similar signs at other sites in the northern Indus and Ghaggar-Hakra River Valleys suggests that the process of script development was taking place over a broad region.

The use of potter's marks continues from the Regionalization Era through the Integration Era and may reflect a separate though possibly overlapping form of personal identification. Some potter's marks may actually represent words or names, but there is no way to decipher them. Post firing graffiti also continues through from the Regionalization Era to the Integration Era.

In some cases, the post-firing graffiti may simple reflect notations or non-semantic symbols, but others may reflect words or ideological concepts. During the Integration Era, when the Indus Script is well established there are longer sequences of signs that are clearly examples of the use of Indus script on pottery. Large storage jars that were used for shipping goods within the Indus region as well as for external trade often were inscribed with one or more examples of Indus script (Figure 4). After the goods were removed from the large storage jars many of them reused as sump pits for waste water or as latrines. On one such complete jar found at Harappa, there were multiple examples of pre-firing potter's marks and script, as well as post firing graffiti (Kenoyer, 2006b). On the base of the vessel were three pre-firing incised potter's marks and on the upper body were two script signs similar to ones seen on some large copper tools. These were all made prior to firing and presumably by the potter or workshop master. A large post-firing graffiti was made across the upper body and a sequence of single strokes was incised on the rim. It is possible that the writing on the body of the vessel was used to indicate the contents or the person to whom the goods were being sent. The strokes on the rim could possibly represent measures of goods or commodities put into or taken out of the vessel. Sometimes the writing on the exterior of a vessel was re-inscribed by overlapping signs, done at different times. Unfortunately due to the fact that many vessels were broken after they were used for shipping, there are relatively few complete inscriptions found on pottery.

It should be noted that unlike Mediterranean and Egyptian cultures, the Indus people did not write on pottery sherds as "scrap paper." From the recent excavations at Harappa there are only two examples of shaped sherds with writing that was executed on the sherd itself (Figure 5). Although it is difficult to determine why Harappans did not write on broken sherds, this pattern may relate to concepts of purity that are still an important part of ritual traditions of purity and pollution in South Asia. In most regions of India or Pakistan, terracotta vessels are considered to be polluted and

impure after they have been eaten out of (Miller, 2007:96), and are usually discarded and broken after use. Pottery fragments lying in the street or in a dump are considered extremely polluting today and perhaps the Harappans also had a similar belief system.

The practice of writing on pottery with Indus script ends around 1900 BCE. However there are some rare examples of graffiti that does not appear to be Indus script on Late Harappan pottery at the site of Harappa and graffiti on pottery is occasionally reported from other Late Harappan sites in the regions of Gujarat and Haryana. Whatever these signs may have represented, they do not appear to reflect a Late Harappan writing system, and well-dated sites with Late Harappan graffiti are not well documented. One example of graffiti on pottery has been reported from the site of Loebanr in the upland valley of Swat, Pakistan, which is actually outside of the known expanse of the Late Harappan cultural tradition (Shah and Parpola, 1991: Loebanr III). The general consensus is that writing on pottery was not common during the Late Harappan period and that the role of writing as a whole was discontinued. The reasons for this will be discussed in more detail below, but it is also linked to the disappearance of Indus styles seals, cubical chert weights used for trade and taxation, as well as many other ideological symbols and diagnostic aspects of the Harappa culture {Mughal, 1990 #2898, Possehl, 1997, Kenoyer, 2005, Ratnagar, 2000).

Early Harappan Seals with Graphic Symbols and Script

Even though pottery is by far the most common medium for graphic symbols such as potter's marks and graffiti, the use of symbols and writing on seals has gained the most attention. Various objects that have been called seals were used in the Indus region, including stamp seals, button seals and beads with incised designs that could have been used as stamp or cylinder seals. Button seals were made from various types of raw of materials, including copper, faience, ceramic, bone/ivory and soft stone and there is considerable variation in seal shapes and sizes.

The earliest evidence for carving abstract designs on a bone pendant comes from Period 1 (7000-6000 BCE) at the site of Mehrgarh (Jarrige and Quivron, 2013:Fig. 352), although it is not thought that this pendant was used as a seal. In Period IIB (5500-4400 BCE) at the same site a terracotta bead had a zigzag design that could have been used as a form of cylinder seal (Jarrige et al., 1995:319). During the Regionalization Era, almost all sites in the Indus region show the use of decorated circular, square or rectangular shaped ornaments with perforations that are commonly referred to as "button seals." The discovery of a sealing made by impressing one of these seals into wet clay found from the Early Harappan site of Lewan Dheri (Shah and Parpola, 1991L Lwn-1) confirms that some were actually used as seals to close containers or store rooms. Some of the button seals have one or two perforations through the body of the seal (Figure 6:1, 3), while others have a perforated knob or boss on the back (Figure 6: 2, 4, 5). The most dominant form of seal during the Regionalization Era is

the square shaped stamp seal with a perforated cylindrical knob on the back (Figure 6:5). Most of these seals were made from soft steatite that was carved and then fired to turn it white. This type of steatite can be found from any major Dolomitic steatite source area, but during the Indus crafts people seem to have preferred the whitest firing varieties that come from the region of Hazara in Northern Pakistan {Law, 2011 #10263:260-261). Systematic studies of the Early Harappan seals have not been carried out, but it is not unlikely that this was also the source of the Early Harappan steatite used in seals at sites such as Rehman Dheri and Harappa. Before firing, the seals were coated with a glaze made of silica with a copper based colorant so that when fired they would have a blue-green silica glaze.

Experimental replications of this glaze have been prepared using crushed rock quartz, copper oxide and using a plant ash flux called *sajji khar* (Urdu) that is generally made by burning the desert plant *Haloxylon recurvum* {Tite, 2006 #11025}. The experimental firing was done at around 940°C to 960°C and this resulted in both whitening the steatite and creating a blue green glaze. This type of glaze does not adhere well to steatite and though some traces do remain in the deep grooves, most seals do not have any remaining glaze on the surface. Most button seals only have geometric designs, but these designs themselves may have had some specific iconic meaning and some of the geometric shapes eventually were incorporated in to Early Indus or Indus script. Some of the button seals also have animal motifs, often pairs of antelopes, wild sheep or goat, or even scorpions. A bone seal or possibly a pendant from Rehman Dheri is decorated on both faces and combines antelope and scorpions with possible forms of Early Indus script (Durrani, 1988) (Figure 7).

At the site of Harappa, there is evidence for the production of new forms of seals during the final period of the Kot Diji Phase (2800-2600 BCE). One broken seal has an elephant carved roughly on the lower part of the square facing to the left, and it is possible that script was carved above it, but this part of the seal is missing (Figure 6:6). When impressed into clay the elephant would have faced to the right, which is the direction most animal motifs on the later Harappan seals face. A second type of seal is represented by a terracotta sealing. This sealing was made using a square seal that had two script symbols along with a geometric ladder shaped motif (Figure 6:7). These two types of seals suggest a period of experimentation in seal design that eventually led to the form of seal that became common during the first part of the Harappa Phase, Integration Era, circa 2600-2450 BCE (Period 3A at Harappa).

Harappan Seals with Script

The Harappan Period is divided into three phases based on the excavations at Harappa and other sites (see Table 1 and 2) and square steatite seals were usually carved with an animal motif in the lower register and a line of script above the back and head of the animal (Figure 8). During Harappa 3A (2600-2450 BCE) the animal motif was carved with deep, bold angular lines and on the one broken seal from Harappa

that comes from a well dated strata, only one script sign was preserved above the rump (Figure 8:1). At the other sites, such as Farmana (Shinde et al., 2008), Bhirrana (Kumar and Dangi, 2007, Uesugi et al., 2016) and Watuwal (Farzand Masih Personal Communication 2011) the seals are not from well dated contexts, but stylistically are identical to the one from Harappa, and there are up to three signs carved above the animal and in some cases a sign or ritual stand was placed below the head (Shinde et al., 2008-2009). The earliest example of a unicorn motif is seen on a seal from the site of Farmana (Shinde et al., 2008-2009). Other animal motifs common on the Period 3A seals include the water buffalo, antelope with front or back arching horns, as well as Markhor goat with spreading horns and sheep with back arching horns. The perforated boss on the back of the seals is generally square with a flat or slightly convex surface. However, some seals have a circular rounded boss with a central groove and this eventually becomes the dominant form of boss in Period 3A, 3B and 3C. The precise dating of seals with specific types of boss designs is not possible, but will hopefully be sorted out when the sample size is increased during future well-dated stratigraphic excavations.

The orientation of the animal on the seals is an important indicator of cultural style and ideology. The orientation of the animal motifs is not highly standardized during the Kot Dijian and initial Harappan Period 3A. When impressed into clay the right facing animals on the Period 3A seals would be facing to the left in the seal impression. This is opposite to the direction of the elephant seal found at Harappa in the Kot Diji levels (see above). The change in direction appears to indicate a period of fluctuation in seal design during the initial Harappa Phase 3A. Other sites with seals that stylistically correspond to the seal from Harappa 3A and have animals facing to the right include Mohenjo-daro (Shah and Parpola, 1991: M-977, M-1170, Joshi and Parpola, 1987: M-223, M-269, M-270, M-272, M-273, M-298), Balakot (Shah and Parpola, 1991: Blk-5), Kalibangan (Joshi and Parpola, 1987: K-34, K-41, K-43) and Banawali (Bisht, 1982, Bisht, 1987). Although the seals from these sites have been broadly dated to the Harappa Period 3 (2600-1900 BCE), the stylistic elements and the direction that the animals are facing suggest that they belong to the earliest period 3A (2600-2450 BCE). There are some examples of the animals facing to the left at both Banawali (Konosukawa, 2013:6) and at Kalibangan (Joshi and Parpola, 1987: K-35, K-37, K-39), indicating that there may have been specific cultural or ideological choices relating to the direction the animal was facing. Konosukawa's research (Konosukawa, 2013) indicates that there are a larger number of right facing animal motifs on seals in the Ghaggar-Hakra region, but this pattern needs to be checked at more sites with seals from well-dated and stratigraphically secure contexts.

Carved steatite button seals continued to be produced during the Harappa Period, and were used along with the stamp seals to impress sealings. Some of these had blue-green glaze but others were only fired white. The geometric designs are generally different from those of the Early Harappan button seals, and consist primarily of

circle and dot motifs, stepped cross, endless knot or swastika motifs. In addition to steatite, many button seals were made from glazed faience. During the Harappa phase button seals were generally not made from terra-cotta, copper/bronze or bone/ivory, which were common earlier.

During Harappa Period 3B (2450-2200 BCE) the predominant orientation of the animal is facing left (Figure 8:2, 3), and the impressions of the seals would have the animal facing to the right. This is the opposite of the pattern that appears to have been dominant during Period 3A. The boss shape also changed and instead of a square boss, the boss was made with a circular domed shape with a single groove in the middle. Some seals had a double groove and rarely there was a triple groove. The perforation oriented horizontally matching the alignment of the animal motif and script. The script was carved on the upper register above the rump and back of the animal motif. If the inscription were long, it would extend to the area above the head of the animal, where the script signs were slightly smaller in order to fit into the reduced space above the animal's head and horns (Figure 8:2, 3). In some rare examples there is evidence of script on the edges of the seal and occasionally even on the boss. The first well-dated example of the use of script on a seal without any accompanying animal motif is seen at Harappa during Period 3B (Figure 8:4)(Parpola et al., 2010: H-1692). The seal with script only is slightly rectangular with a grooved boss as is common with other seals that have animal motifs. There are other examples of seals with only script from the site of Mohenjo-daro (Joshi and Parpola, 1987: M-313, M-316, M-315) and Lothal (Joshi and Parpola, 1987: L-56, L-58, L-59), but the stratigraphic position of the seals and their dating is not certain.

During Harappa Period 3C (2200-1900 BCE) the trend of left facing animal motifs on seals continues along with the use of a circular domed boss with single, double or in rare cases a triple groove. The writing above the animal becomes more standardized and is usually arranged in a straight line that stretches along the entire width of the upper register of the seal (Figure 8:6). All of the script symbols were carved with lines that are approximately the same width with angular edges and script shapes that are generally the same height and relative width. This type of script carving is also seen on a new type of long rectangular seal that has no animal motif and has no separate perforated boss on the back (Figure 8:5). The body of the long rectangular seals were thicker in the middle and had a convex back with the perforation made in the middle of the seal.

Late Harappan Button Seals

During the Late Harappan Period (Period 4 and 5 at Harappa, 1900-1300 BCE) the use of script disappears but seals with geometric designs continued to be used (Figure 9). At sites such as Chanhudaro (Mackay, 1943), Mohenjo-daro (Marshall, 1925-26, Mackay, 1938), Harappa (Vats, 1940, Kenoyer and Meadow, 2010), and other non-Indus sites such as Gilund and Ahar (Shinde and Possehl, 2005, Ameri, 2016) button

seals continued to be made and used. Many of these seals were made in clay, but some were made from carved and fired steatite. The continuation in seal production and used indicates that many of the craftspeople and traders continued to function in the Indus and adjacent regions, but the elites who used script were no longer in power.

Nature of the Indus Script

Current discussions of the nature of the Indus script are based primarily on the study of seals from the major sites such as Mohenjo-daro, Harappa, Kalibangan and Lothal. This approach however is inherently flawed since the seals from these excavations range in date between 2600-1900 BCE, a 700 year period of time. The recent excavations at Harappa indicate that the Indus writing actually begins much earlier than 2600 BCE and that it also appears to evolve during the 700 years of the Harappan period. In the past, most scholars assumed that there were between 400 and 450 discrete symbols from the Harappan period (Parpola, 1994a), but it is possible that there are considerably less during each of the sub periods. It is also possible that there are regional variations of symbols used in different parts of the very large geographical region encompassed by the Indus civilization.

It is generally agreed that the signs found on seals and pottery represent a logosyllabic (morphemic) system, where a single sign can mean a word, a syllable or a sound (Parpola, 1994a). However, it is also clear that many signs are pictographic in form, depicting tools, animals, plants or even people holding different types of objects. Such signs could be read in different ways by people who might speak different languages and still be understood. Other signs, such as the stepped cross, circle or swastika, could be ideograms that again could be read in different languages without compromising the meaning of the sign. Due to the fact that the Indus writing disappeared around 1900 BCE and was never recorded along with any other known writing system, it is not possible to decipher any of the signs or determine the affiliation of the language or languages spoken in the Indus region. Based on the study of place names and the names of rivers and geographical regions of the Indus, it is most likely that several major language families were present during the period of the Indus cities. The major language families defined by linguists include Dravidian, Mundari (Austro-Asiatic), Indo-Aryan, Sino-Tibetan and language "X" of the Neolithic Period (Fairservis and Southworth, 1989, Southworth, 2005). The ancestral forms of these languages may have been spoken in different parts of the greater Indus Valley region and if the Indus script was used to write names of people or deities, it is not unlikely that some if not all of these languages are represented in the inscriptions found on seals and pottery. Although we cannot read the Indus seal texts, the translation of Akkadian inscriptions found on Indus style seals found in Mesopotamia suggest that some of the seals included names of individuals and their affiliations with specific deities, but the names themselves are not Sumerian or Akkadian and therefore may represent some form of Indus name (Frenez et al., In Press). As noted above, we also have evidence that the Indus script was used on circular Gulf seals in very different patterns, which may indicate a non-Indus language (Brunswig et al., 1983, Parpola, 1994b, Laursen, 2010:115-119).

The Indus script was primarily written from right to left, but there are some examples of writing that is executed from left to right, and in rare instances the direction alternates on each line, in a pattern called "boustrophedon" or "turning like an ox" when it plows a field (Parpola, 1994a). The most convincing evidence for the direction of the writing is seen in the sequence of strokes on pottery and clay objects, where it is possible to see overlapping lines proceeding from right to left.

Inscribed Indus Seals and their Use

Unlike Mesopotamia, where seals were used by many different levels of the society (Michalowski, 1990, Bertman, 2003), the Indus seals appear to have been used by a relative limited segment of the society. Based on the fact that seals were used to seal containers for trade and storerooms, we can assume that seal owners would have included individuals who had power over considerable material wealth, such as merchants, landowners and political administrators (Parpola, 2005, Vidale, 2005, Kenoyer, 2009, Jamison, 2016). Since some seals also include ritual scenes and narrative scenes we can also suggest that some seals may have been used by ritual specialists (Kenoyer, 2010). Seals that were discarded were often broken intentionally to keep others from using them, and old seals were often buried in the house floors to keep them from being used by others (Kenoyer, 1996). Based on the excavations at Mohenjo-daro (Marshall, 1931, Mackay, 1938, Franke-Vogt, 1991), Harappa (Vats, 1940, Dales and Kenoyer, 1991) and Dholavira (Bisht, 2015), it is clear that seals were scattered in many parts of the site through post-depositional processes of erosion and moving of fill from one area of the site to the other. However, higher concentrations of seals were found in areas near to the gateways and in some specific houses that may have been locations for workshops or storerooms (Kenoyer, 1993, Dales and Kenoyer, 1990).

Seals that have a combination of writing and pictographic motifs were important for trade, where not everyone would be able to read the text. A literate trader would be able to recognize the name or office of the seal owner, but a laborer or apprentice could recognize the animal motif on a seal and still make sure that the commodities reached the correct storeroom or shipping vehicle.

The most common motif associated with Indus script on stamp seals is the unicorn, a mythical animal with one horn arching forward from the back of the head. The animal had the body of an antelope or deer and the tail of an ox, with various decorative elements such as collars and often a form of coverlet that was hung over the forward quarters. Other animal motifs included the humped and non-humped bull, the elephant, various sheep, goat and antelopes as well as the rhino, the tiger and fantastic animals with three heads or combinations of many different animal motifs. Each of these animals may have reflected a specific hereditary community or different classes of administrative officials. Numerous studies have been undertaken to try and figure out what these animals mean, but without a better understanding of the writing, all of these identifications are still largely speculative. The largest variety of seal motifs is

found at only the largest sites, such as Mohenjo-daro, Harappa and Dholavira. This suggests that the largest urban centers included a diverse group of people who used seals and script, while smaller sites my have had less diverse groups of elites. Seals with the unicorn motif however are found at almost all Indus settlements. The unicorn seals may have been used by middle to low level merchants or officials who were responsible to reinforce the economic, political and ideological aspects of the Indus ruling elite. The unicorn symbol clearly represented one of the most widespread communities and when they no longer had power, the symbol was no longer used. This total obliteration suggests that the unicorn symbol was not something that most people wanted to remember. Other animal figures did continue to be used in painted pottery and terracotta figurines, but the unicorn motif disappears totally from the artistic repertoire of the Late Harappan and subsequent cultural traditions in South Asia. However, the concept of the unicorn did continue in Iran and Mesopotamia, and also spread to the steppes of Central Asia and Tibet, and eventually to China (Kenoyer, 2013).

Indus Script on other Objects

In addition to the use of script on pottery and seals, the Indus elites used writing on a wide variety of other objects that were listed above (Table 2). Among these the use of writing on small, incised steatite tablets (Figure 10:1, 2), or molded faience (Figure 10:3, 4) and terracotta tablets is extremely important. These tablets were not used as seals but were rather a form of token that encoded some words and in some cases what appear to be numbers or calendrical notations (Figure 11:1). Such tokens could have been used for basic economic accounting and trade, or possibly for some form of ritual accounting. Some tablets were flat rectangular with writing on two sides, while others had three or four sides that were used for inscriptions. Some tablets were in other geometric or animal shapes, suggesting that they had specific functions associated with these motifs. Carved ivory and bone rods or plaques were also occasionally inscribed. Another form of tablet are seals or molded faience (Figure 11:3, 5) or terracotta tablets (Figure 11:1, 2, 4) that depict rituals or narrative scenes. Such objects may have been made for special events or used to commemorate annual rituals.

Writing has also been found on large stone rings that were used to construct columns or other architectural structures. The writing on such objects would have been covered up during construction so they may be notations about the maker or the construction that they were associated with though the signs may have had some ritual significance as well. Inscriptions also are found on tools, weapons, ornaments and various domestic items.

Without the decipherment of the Indus writing system is it impossible to determine the meaning of seals or their links to specific individuals or political authority. However the presence of seal users in settlements throughout the Indus region and even in surrounding territories can be interpreted as representing the administrative

power of the elites and traders, some of whom probably represent rulers (Kenoyer, 2000). The association of seals and writing with trade can be confirmed through the use of seals to stamp clay sealings that were used on bundles of goods or locks on storerooms. Furthermore, the association of the script with various mythical animals, as well as narrative scenes on seals and other inscribed objects also suggests that writing was associated with rituals and possibly was even sacred (Parpola, 1994a, Kenoyer, 2001). The visual impact of a seal worn openly, or the impression of a seal on a clay sealing would have served to reinforce both the economic and social aspects of Indus society as well as the ideology that supported the society as a whole. The specific ritual symbolism of each animal or geometric design would also have served to legitimize the text on the seals and reinforce the overall impact of writing.

The actual contexts where these objects were used and eventually discarded is also important to consider. As is common in most archaeological sites, Indus inscribed objects such as seals, tablets, inscribed tools and jewelry have been found scattered throughout the debris of the ancient city and in the debris used to fill up empty areas. Most inscribed objects are broken and appear to have been discarded after they were no longer of use. In fact, many seals that have been recovered appear to have been intentionally broken and discarded with the trash. Unbroken and used seals have been found buried intentionally in house floors, often near a hearth or in a household pit. Some complete seals have been found in drains or on the streets, but these could represent seals that were accidently lost or ones that were redeposited on the street when fill inside a house was removed for reconstruction or simply eroded. Occasionally there have been discoveries of small caches of inscribed tablets that may have been in a container or bag, hidden in a room or buried in a floor. One of the largest inscriptions of the Indus appears to have been part of a wooden signboard that was placed in a room near a major gateway at the site of Dholavira (Bisht, 2015).

The absence of specific types of script is also important to note, since many other contemporaneous cultures were using script to write long texts and in mortuary context. Most Indus script examples are relatively short and so far there are no examples of Indus writing on perishable materials such as cloth, birch bark, or wood. Consequently there are no libraries with large accumulations of texts in any of the Indus settlements excavated so far. Finally, it is important to note that no Indus burials contain seals or inscribed objects (Kenoyer, 2006b).

Disappearance of Indus Script

The last point that needs to be addressed is why did the Indus writing system disappear? The study of the disappearance of writing systems is not well developed, but some scholars have begun to address this issue in other regions of the world (Baines, 2008, Baines et al., 2008, Houston et al., 2003). In Egypt and Mesopotamia, the dominant writing system gradually disappeared and was replaced by other writing systems with a period of coexistence when both the older and the newer writing systems were being used. In Egypt, the final extinction of hieroglyphics, which were still being used in

ritual contacts in temples, coincided with the introduction of Christianity to Egypt in 359 CE (Houston et al., 2003:444). In Mesopotamia, later versions of cuneiform continued to be used by the Achaemenid rulers and was used in ritual contexts of the Zoroastrian religion in Iran up until the introduction of Islam in the 7th century CE (Boyce, 1979).

In the context of the Indus Civilization, the Late Harappan Period has no evidence for the use of script from 1900-1300 BCE or in some regions even as late as 1000 BCE (Mughal, 1990, Shinde, 1991, Magee, 2004, Kenoyer, 2005, Deshpande and Shinde, 2005, Bhan, 1989, Possehl, 1997). It is during this time period that the Indus script disappeared along with many other aspects of Indus ideology and political organization. These other objects included seals, the unicorn symbol, the use of standardized cubical weights, and the diagnostic decorated pottery, as well as many exquisite technologies used to produce ornaments such as stoneware and shell bangles, terracotta figurines and other ritual objects for the elites (Kenoyer, 2005 #8027}. Although there are many different opinions about the nature of the process, this is the time period when Vedic communities were emerging as the dominant cultural tradition in northern South Asia, gradually expanding throughout Indus region and eventually into the Ganga-Yamuna River Valley and even into Peninsular India. These communities spoke various Indo-Aryan languages and dialects, and used the sacred language of Sanskrit for composing ritual hymns that have been preserved orally, but were never written down until much later in time (Thapar, 2000, Bryant, 2001, Erdosy, 1995, Ghurye, 1979, Witzel, 2001).

The fact that the Vedic tradition did not use a writing system and specifically proscribed the use of writing may help explain why there was no other writing system in existence when the Indus script was no longer used. The lack of a writing system during the Late Harappan period however does not mean that the Indus culture disappeared totally. Many aspects of Indus subsistence and material culture technology as well as some aspect of their ideology did continue into later time periods (Kenoyer, 2006a). Excavations of sites that provide an overlap between the Late Harappan and subsequent time periods are needed to help better understand these continuities as well as the changes that were occurring. At present however, there is no evidence that the Indus script is linked to the Brahmi script, which is the next major writing system that emerged in South Asia, during the middle of the 1st millennium BCE. The Brahmi writing system was first documented as graffiti on pottery dating between 450-350 BCE in Sri Lanka (Coningham and Young, 2015) and was later used for the major and minor rock edicts of the Mauryan ruler Ashoka between 269-232 BCE (Coningham and Young, 2015, Dhammika, 1997).

Conclusion

As more excavations unearth new examples of Indus writing, it is possible that eventually some form of bi-lingual tablet will be discovered to help decipher this unknown writing system. However, until that time we can still continue to unravel the complex uses and contexts in which Indus elites used their writing system. The origins of the Indus writing system can be traced to multiple regions throughout the greater Indus valley during the period prior to the rise of major cities. This suggests that the writing system may have been quite diverse in its early stages and also may have been used to write more than one language. Although some scholars have suggested that the Indus script does not encode a language (Farmer et al., 2004), most scholars feel that the evidence presented above clearly demonstrates that it evolved over time and was used in diverse ways that are similar to what is seen in other early civilizations (Parpola, 2008, Vidale, 2007, Kenoyer and Meadow, 2010). As noted above, the development of Indus writing can be divided into the Early Indus script of the Kot Diji phase, and the fully developed Indus script of the Harappa phase. During the Harappa Phase there is also at least three phases of development associated with writing on seals and some indication of the evolution of the script itself (Kenoyer and Meadow, 2010). The recent and ongoing research at sites such as Harappa, Dholavira, Rakhigarhi, Farmana and many other smaller settlements has revealed new types of inscribed objects and more precise chronologies are available for the contextual and spatial analysis of the use of writing. At present, many younger scholars are joining the effort to understand the Indus script by reexamining the seals and inscribed objects from earlier excavations in order to begin sorting these out chronologically. These new approaches will undoubtedly provide new perspectives on the writing system, how it was used by the Indus people and how it changed over time.

Acknowledgements

I would first like to thank the Dialogue of Civilizations Conference and the organizers who invited me to participate in the conference. Also special thanks to Beijing University for hosting the conference and to all the people who have worked so hard to produce this edited volume. I would especially like to thank the Department of Archaeology and Museums, Government of Pakistan, for letting me study materials at Harappa and other museums in Pakistan. Special thanks to all the colleagues who have participated in the research at Harappa and have helped to collect and analyze data. I also want to specially thank the Archaeological Survey of India and all my colleagues in India who have been generous with their materials and shared their ideas with me. My ongoing research at Harappa and the Indus Valley Civilization has been supported by numerous organizations: the National Science Foundation, the National Endowment for the Humanities, the National Geographic Society, the Smithsonian Institution, the American School of Prehistoric Research (Peabody Museum of Archaeology and Ethnology, Harvard University), the University of Wisconsin, www.HARAPPA.com and private donors.

Figures

Figure 1. Map of the Indus Civilization

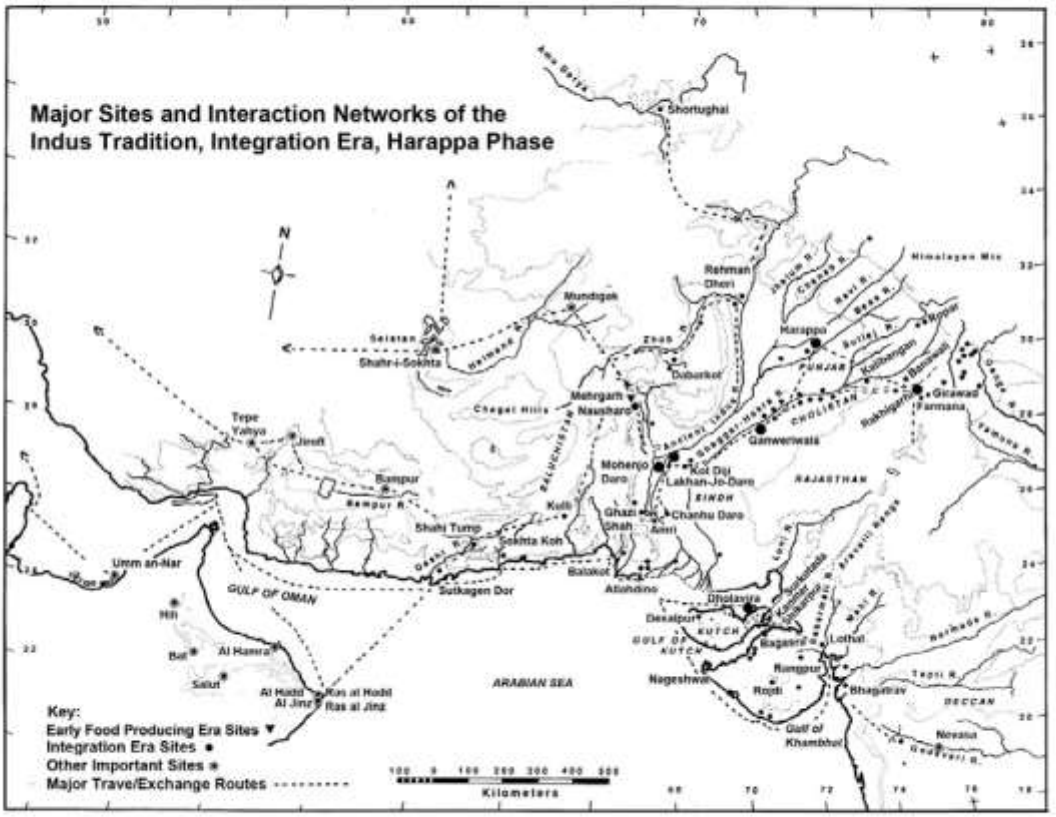


Figure 2. Harappa, Ravi Phase potter's marks and graffiti

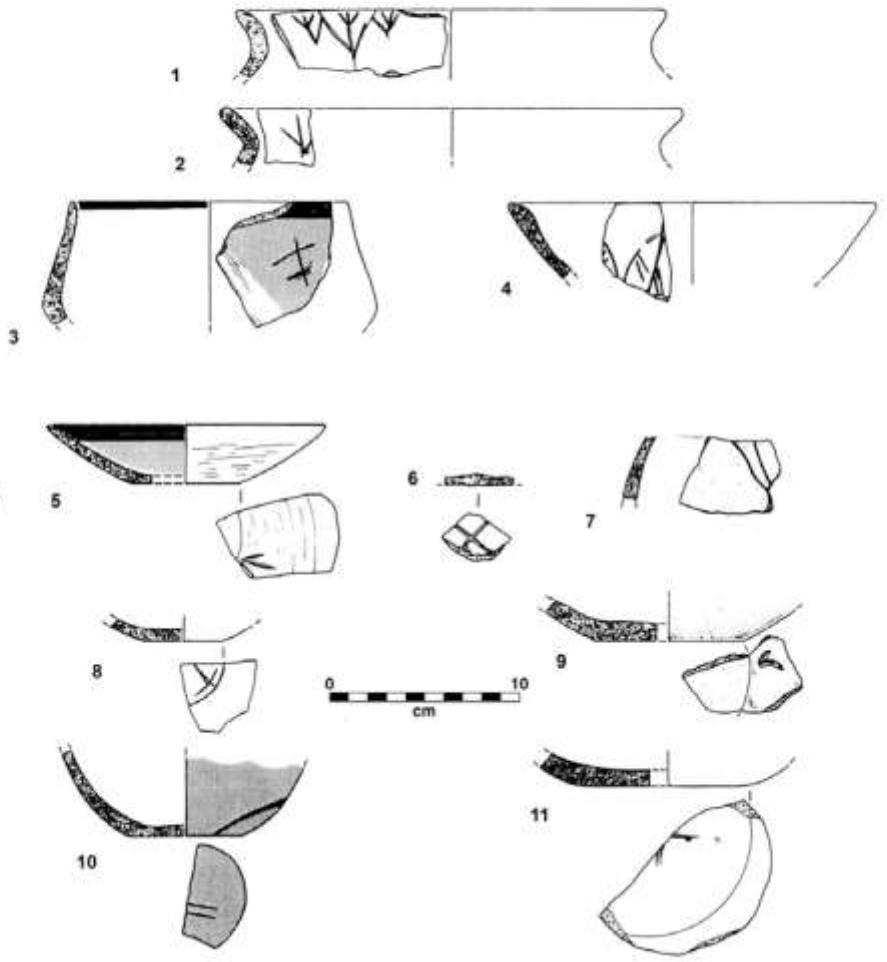


Figure 3. Harappa, Ravi and Kot Diji Script Development

Figure 4. Harappa, Period 3, Inscribed Storage Vessels.

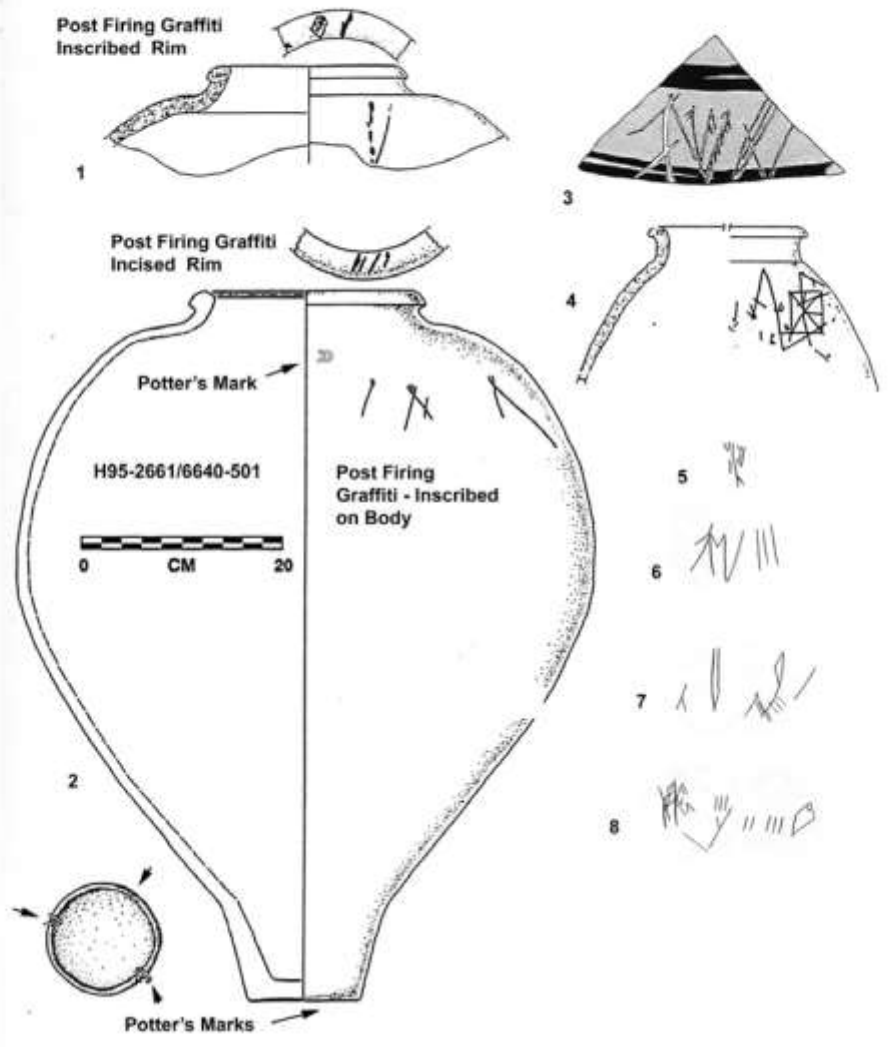


Figure 5. Harappa, Inscribed Sherds

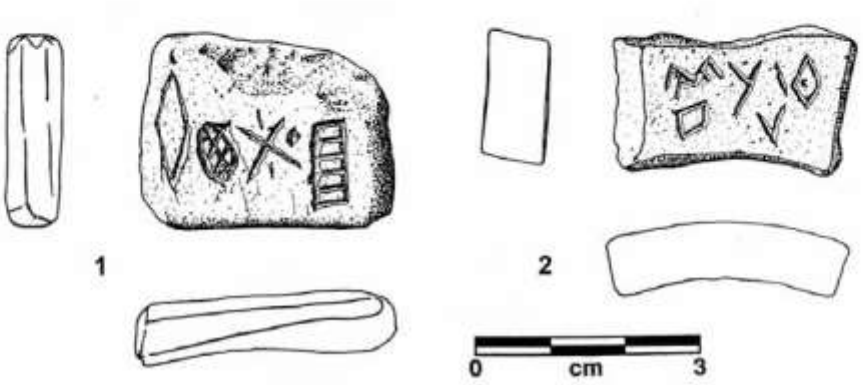


Figure 6. Harappa, Ravi and Kot Diji seals and sealing

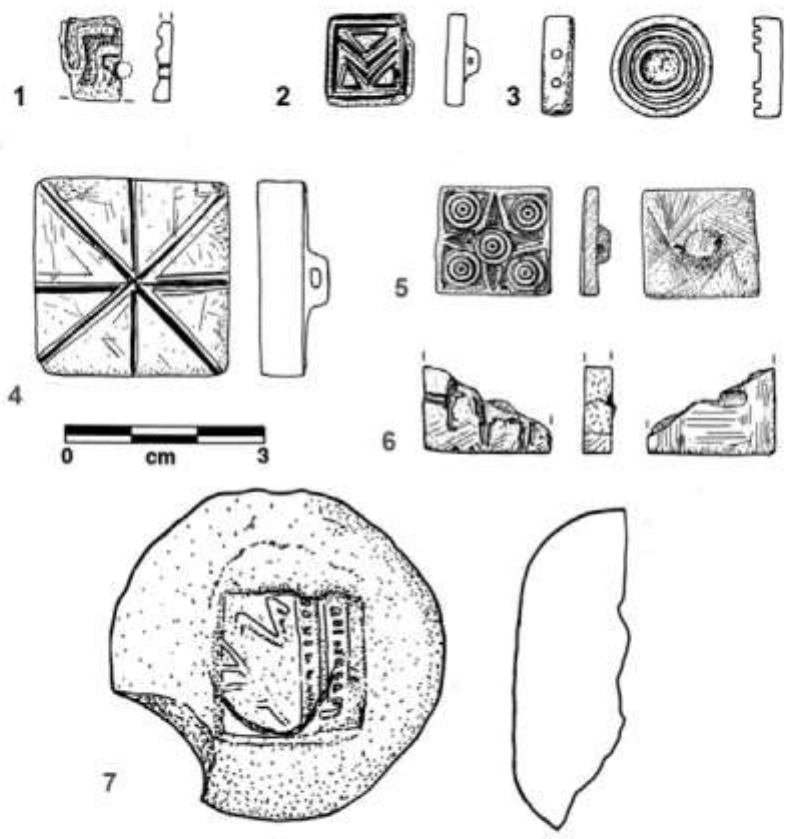


Figure 7. Rehman Dheri, Ivory Pendant/Seal with script

Figure 8. Harappa, Period 3 Seals

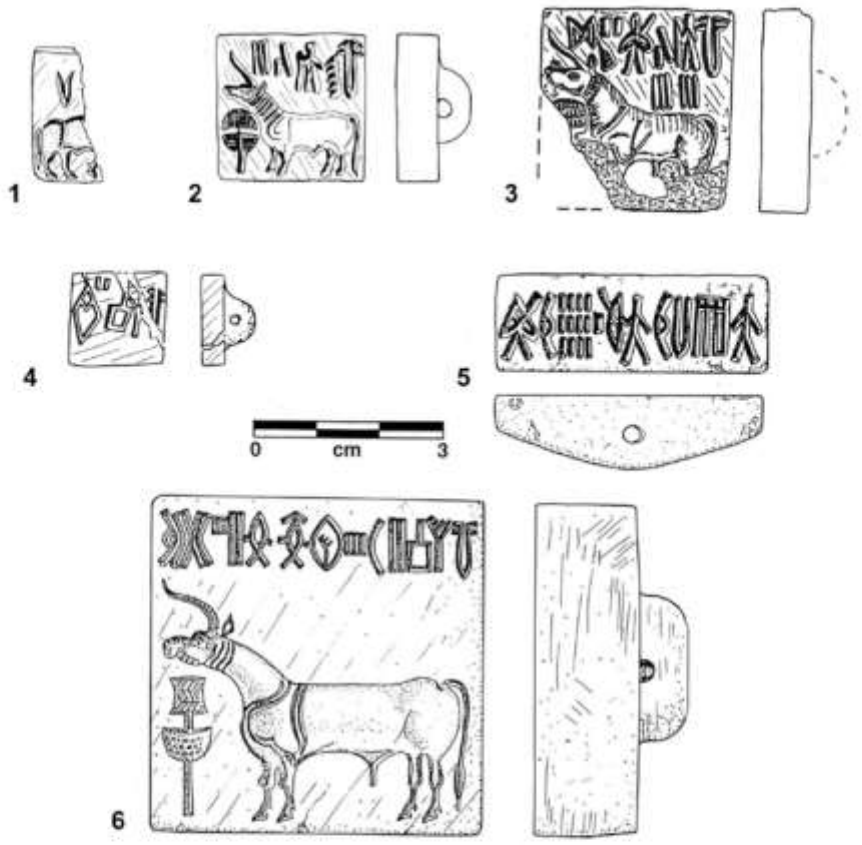


Figure 9. Harappa, Period 4/5 Button seal

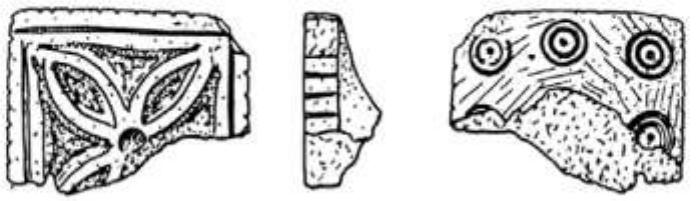
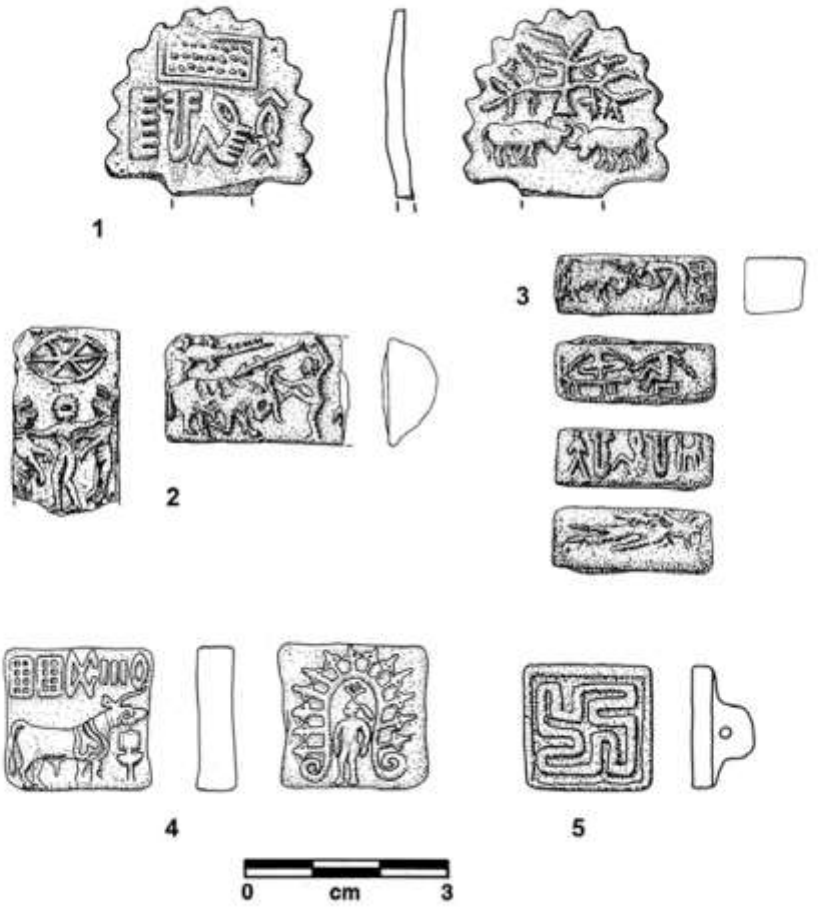


Figure 10. Harappa, Incised and Molded Tablets

Figure 11. Harappa, Molded Tablets with Ritual and Narrative Scenes



Bibliography

AJITHPRASAD, P. 2002. The Pre-Harappan Cultures of Gujarat. *In:* SETTAR, S. & KORISETTAR, R. (eds.) *Indian Archaeology in Retrospect, Volume 2 (Protohistory: Archaeology of the Harappan Civilization).* New Delhi: Indian Council of Historical Research.

AMERI, M. 2016. Changing Patterns of Indo-Iranian Interaction in the Third and Second Millennia BCE as Seen from the Ahar-Banas Culture. *In:* WIDORN, V., FRANKE, U. & LATSCHENBERGER, P. (eds.) *South Asian Archaeology and Art: Contextualizing Material Culture in South and Central Asia in Pre-Modern Times.* Turnhout, Belgium: Brepols Publisher.

BAINES, J. 2008. Writing and its Multiple Disappearances. *In:* BAINES, J., BENNET, J. & HOUSTON, S. (eds.) *The Disappearance of Writing Systems: Perspectives on Literacy and Communication.* London: Equinox Pub.

BAINES, J., BENNET, J. & HOUSTON, S. (eds.) 2008. *The Disappearance of Writing Systems: Perspectives on Literacy and Communication,* London: Equinox Pub.

BERTMAN, S. 2003. *Handbook to Life in Ancient Mesopotamia,* New York, Facts on File, Inc.

BHAN, K. K. 1989. Late Harappan Settlements of Western India, with Specific Reference to Gujarat. *In:* KENOYER, J. M. (ed.) *Old Problems and New Perspectives in the Archaeology of South Asia.* Madison, WI: Wisconsin Archaeological Reports.

BISHT, R. S. 1982. Excavations at Banawali, 1974-77. *In:* POSSEHL, G. L. (ed.) *Harappan Civilization: A Contemporary Perspective.* New Delhi: Oxford and IBH Pub. Co.

BISHT, R. S. 1987. Further Excavations at Banawali: 1983-84. *In:* PANDE, B. M. & CHATTOPADHYAYA, B. D. (eds.) *Archaeology and History.* Delhi: Agam Kala Prakashan.

BISHT, R. S. 2015. *Excavations at Dholavira (1989-90 to 2004-2005),* New Delhi, Archaeological Survey of India.

BOYCE, M. 1979. *Zoroastrians: Their Religious Beliefs and Practices,* London, Routledge.

BRUNSWIG, R. H., PARPOLA, A. & POTTS, D. T. 1983. New Indus Type and Related Seals from the Near East. *In:* POTTS, D. T. (ed.) *Dilmun: New Studies in the Archaeology and Early History of Bahrain.* Berlin: Dietrich Reimer Verlag.

BRYANT, E. F. 2001. *The Quest for the Origins of Vedic Culture: The Indo-Aryan Debate,* New York, Oxford University Press.

CONINGHAM, R. & YOUNG, R. 2015. *The Archaeology of South Asia: From the Indus to Ashoka, c. 6500 BCE-200CE,* New York, Cambridge University Press.

DALES, G. F. 1979. The Balakot Project: Summary of Four Years of Excavations in Pakistan. *Man and Environment,* 3, 45-53.

DALES, G. F. & KENOYER, J. M. 1990. Preliminary Report on the Fifth Season at Harappa, Pakistan, January 1 - March 31, 1990.: U. C. Berkeley and U. W. Madison.

DALES, G. F. & KENOYER, J. M. 1991. Summaries of Five Seasons of Research at Harappa (District Sahiwal, Punjab, Pakistan) 1986-1990. *In:* MEADOW, R. H. (ed.) *Harappa Excavations 1986-1990.* Madison: Prehistory Press.

DANI, A. H. 1970-71. Excavations in the Gomal Valley. *Ancient Pakistan,* 5, 1-177.

DESHPANDE, S. S. & SHINDE, V. 2005. Gujarat betwen 2000 and 1400 BCE. *The Society for South Asian Studies,* 21, 121-135.

DHAMMIKA, S. 1997. An English Rendering of the Edicts of Asoka. *In:* CHOWDHURY, H. B. (ed.) *Asoka 2300: Jagajjyoti: Asoka Commemoration Volume 1997 A.D./2541 B. E.* Calcutta: The Bengal Buddhist Association.

DURRANI, F. A. 1988. Excavations in the Gomal Valley: Rehman Dheri Excavation Report No. 1. *Ancient Pakistan,* 6, 1-232.

DURRANI, F. A., ALI, I. & ERDOSY, G. 1991. Further Excavations at Rehmandheri, 1991. *Ancient Pakistan,* 7, 61-151.

DURRANI, F. A., ALI, I. & ERDOSY, G. 1995. Seals and Inscribed Sherds of Rehman Dheri. *Ancient Pakistan,* 10, 198-233.

ERDOSY, G. 1995. The prelude to urbanization: ethnicity and the rise of Late Vedic chiefdoms. *In:* ALLCHIN, F. R. (ed.) *The Archaeology of Early Historic South Asia.* Cambridge: Cambridge University Press.

FAIRSERVIS, W. A. 1956. Excavations in the Quetta Valley, West Pakistan. *Anthropological Papers of the American Museum of Natural History,* 45 (part 2).

FAIRSERVIS, W. A. 1959. Archaeological Surveys in the Zhob and Loralai Districts, West Pakistan. *Anthropological Papers of the American Museum of Natural History,* 47 (part 2).

FAIRSERVIS, W. A. 1961. Archaeological Studies in the Seistan Basin of Southwestern Afghanistan and Eastern Iran in the Zhob and Loralai Districts, West Pakistan. *Anthropological Papers of the American Museum of Natural History,* 48 (part 1), 1-128.

FAIRSERVIS, W. A. J. & SOUTHWORTH, F. C. 1989. Linguistic Archaeology and the Indus Valley Culture. *In:* KENOYER, J. M. (ed.) *Old Problems and New Perspectives in the Archaeology of South Asia.* Madison, WI: Wisconsin Archaeological Reports.

FARMER, S., SPROAT, R. & WITSEL, M. W. 2004. The Collapse of the Indus-Script Thesis: The Myth of a Literate Harappan Civilization. *Electronic Journal of Vedic Studies,* 11, 19-57.

FRANKE-VOGT, U. 1991. *Die Glyptik Aus Mohenjo-Daro: Text,* Mainz am Rhein, Verlagg Philipp von Zabern.

FRENEZ, D., MARCHSI, G. & VIDALE, M. In Press. Hybrid Identities: Seals with Indus traits and cuneiform inscriptions. *Zeitschrift für Assyriologie und Vorderasiatische Archäologie.*

GHURYE, G. S. 1979. *Vedic India,* Bombay, Popular Prakashan.

GUPTA, S. P. 1999. The Indus-Sarasvati Civilization: Beginnings and Development. *In:* PANDE, G. C. (ed.) *The Dawn of Indian Civilization (up to c. 600 BC).* Delhi: Munshiram Manoharlal Publishers Pvt. Ltd.

HOUSTON, S., BAINES, J. & COOPER, J. 2003. Last Writing: Script Obsolesence in Egypt, Mesopotamia, and Mesoamerica. *Society for Comparative Study of Society and History,* 10, 430-479.

JAMISON, G. M. 2016. Seal Production in the Indus Civilization: a Comparative Analysis of Regional Carving Traditions. *In:* WIDORN, V., FRANKE, U. & LATSCHENBERGER, P. (eds.) *South Asian Archaeology and Art: Contextualizing Material Culture in South and Central Asia in Pre-Modern Times.* Turnhout, Belgium: Brepols Publisher.

JARRIGE, C., JARRIGE, J.-F., MEADOW, R. H. & QUIVRON, G. (eds.) 1995. *Mehrgarh Field Reports 1975 to 1985 - From the Neolithic to the Indus Civilization,* Karachi: Dept. of Culture and Tourism, Govt. of Sindh and the French Foreign Ministry.

JARRIGE, J.-F. & QUIVRON, G. 2013. *Mehrgarh. Neolithic Period: Seasons 1997-2000,* Paris, De Boccard.

JARRIGE, J.-F., QUIVRON, G. & JARRIGE, C. 2011. *Nindowari, Pakistan: The Kulli Culture: Its origins and its relations with the Indus Civilization,* Paris, CNRS- Musée Guimet.

JARRIGE, J. F., JARRIGE, C. & QUIVRON, G. 2005. Mehrgarh Neolithic: the Updated Sequence. *In:* JARRIGE, C. & LEFÈVRE, V. (eds.) *South Asian Archaeology 2001.* Paris: CNRS.

JOSHI, J. P. 2007. *Excavations at Kalibangan, The Harappans, Vol. II, Part 1.,* New Delhi, Archaeological Survey of India.

JOSHI, J. P. & PARPOLA, A. 1987. *Corpus of Indus Seals and Inscriptions. 1 . Collections in India,* Helsinki, Suomalainen Tiedeakatemia.

KENOYER, J. M. 1993. Excavations on Mound E, Harappa: A systematic approach to the study of Indus urbanism. *In:* GAIL, A. J. & MEVISSEN, G. J. R. (eds.) *South Asian Archaeology, 1991.* Stuttgart: F. S. Verlag.

KENOYER, J. M. Urban Development and Craft Production at Harappa, 3300-1700 B. C. American Anthropological Association, 1996 San Francisco.

KENOYER, J. M. 1998. *Ancient Cities of the Indus Valley Civilization,* Karachi, Oxford University Press.

KENOYER, J. M. 2000. Wealth and Socio-Economic Hierarchies of the Indus Valley Civilization. *In:* RICHARDS, J. & VAN BUREN, M. (eds.) *Order, Legitimacy and Wealth in Early States.* Cambridge: Cambridge University Press.

KENOYER, J. M. 2001. Early Developments of Art, Symbol and Technology in the Indus Valley Tradition. *Indo Koko Kenkyu: Indian Archaeological Studies,* 22, 1-18.

KENOYER, J. M. 2005. Culture Change during the Late Harappan Period at Harappa: New Insights on Vedic Aryan Issues. *In:* BRYANT, E. F. & PATTON, L. L. (eds.) *The Aryan Invasion: Evidence, Politics, History.*

London: Routledge.
KENOYER, J. M. 2006a. Cultures and Societies of the Indus Tradition. *In:* THAPAR, R. (ed.) *Historical Roots in the Making of 'the Aryan'.* New Delhi: National Book Trust.
KENOYER, J. M. 2006b. The Origin, Context and Function of the Indus Script: Recent Insights from Harappa. *In:* OSADA, T. & HASE, N. (eds.) *Proceedings of the Pre-symposium and the 7th ESCA Harvard-Kyoto Roundtable.* Kyoto: Research Institute for Humanity and Nature, RIHN.
KENOYER, J. M. 2009. Indus Seals: An overview of Iconography and Style *Ancient Sindh,* 9 (2006-2007), 7-30.
KENOYER, J. M. 2010. Master of Beasts or Beastly Masters in the Iconography of the Indus Civilization. *In:* COUNTS, D. & ARNOLD, B. (eds.) *Master of Animals in Old World Iconography.* Budapest: Archaeolingua.
KENOYER, J. M. 2013. Iconography of the Indus Unicorn: Origins and Legacy. *In:* ABRAHAM, S., GULLAPALLI, P., RACZEK, T. & RIZVI, U. (eds.) *Connections and Complexity: New Approaches to the Archaeology of South Asia.* Walnut Creek: Left Coast Press.
KENOYER, J. M. 2014. The Indus Civilization. *In:* RENFREW, C. & BAHN, C. (eds.) *The Cambridge Prehistory.* Cambridge: Cambridge University Press.
KENOYER, J. M. 2014 (in Chinese). Uncovering the keys to the Lost Indus Cities (Reprint). *Scientific American,* (Special Issue on Archaeology), 9-17.
KENOYER, J. M. 2015. The Archaeological Heritage of Pakistan: From the Palaeolithic to the Indus Civilization. *In:* LONG, R. (ed.) *History of Pakistan.* Karachi: Oxford University Press.
KENOYER, J. M. & MEADOW, R. H. 2008. The Early Indus Script at Harappa: Origins and Development. *In:* OLIJDAM, E. & SPOOR, R. H. (eds.) *Intercultural Relations between South and Southwest Asia. Studies in Commemoration of E. C. L. During-Caspers (1934-1996).* Oxford: BAR International Series 1826.
KENOYER, J. M. & MEADOW, R. H. 2010. Inscribed objects from Harappa Excavations: 1986-2007 *In:* PARPOLA, A., PANDE, B. M. & KOSKIKALLIO, P. (eds.) *Corpus of Indus Seals and Inscriptions, Vol. 3. New Material, untraced objects, and collections outside India and Pakistan, Annales Academiae Scientiarum Gennicae.* Helsinki: Suomalainen Tiedeakatemia.
KHATRI, J. S. & ACHARYA, M. 2005. Kunal Excavations: New Light on the Origin of the Harappan Civilization. *In:* AGRAWAL, A. (ed.) *In Search of Vedic Harappan Relationship.* New Delhi: Aryan Books International.
KONOSUKAWA, A. 2013. *Diversity of Harappan Civilization: A Case Study of the Ghaggar Basin (with Special Reference to Seals).* Ph D, Deccan College Post-Graduate & Research Institute.
KUMAR, M. & DANGI, V. 2007. A Harappan Seal from Bhirrana. *Numismatic Studies,* 8, 135-136.
LAL, B. B. 1992. Antecedents of the Signs used in the Indus Script: A Discussion. *In:* POSSEHL, G. L. (ed.) *South Asian Archaeology Studies.* New Delhi: Oxford & IBH Pub. Co.

LAL, B. B. 2015. The Inscribed Material. *In:* LAL, B. B., JOSHI, J. P., BALA, M., SHARMA, A. K. & RAMACHANDRAN, K. S. (eds.) *Excavations at Kalibangan: The Harappans (1960-69) Part - 1.* New Delhi: The Director General Archaeological Survey of India.

LAL, B. B., JOSHI, J. P., BALA, M., SHARMA, A. K. & RAMACHANDRAN, K. S. 2015. *Excavations at Kalibangan: The Harappans (1960-69) Part - 1,* New Delhi, The Director General Archaeological Survey of India.

LAL, B. B., THAPAR, B. K., JOSHI, J. P. & BALA, M. 2003. *Excavations at Kalibangan: the Early Harappans (1960-1969) (Memoirs of the ASI, No. 98),* New Delhi, Archaeological Survey of India.

LAURSEN, S. T. 2010. The westward transmission of Indus Valley sealing technology: origin and development of the "Gulf Type' sea; and other administrative technologies in Early Dilmun, c. 2100-2000 BC. *Arabian Archaeology and Epigraphy,* 21, 96-134.

MACKAY, E. J. H. 1938. *Further Excavations at Mohenjodaro: Being an official account of Archaeological Excavations at Mohenjo-daro carried out by the Government of India between the years 1927 and 1931,* New Delhi, Government of India.

MACKAY, E. J. H. 1943. *Chanhu-Daro Excavations 1935-36,* New Haven, CN, American Oriental Society.

MAGEE, P. 2004. Mind the Gap: The Chronology of Painted Grey Ware and the Prelude to Early Historic Urbanism in Northern South Asia. *South Asian Studies,* 20, 37-44.

MAHADEVAN, I. 1977. *The Indus Script: Texts, Concordance and Tables,* New Delhi, Archaeological Survey of India.

MARSHALL, J. 1925-26. Excavations at Mohenjo-daro. *Annual Report of the Archaeological Survey of India*, 72-93.

MARSHALL, J. H. 1931. *Mohenjo-daro and the Indus Civilization: Being an official account of Archaeological Excavations at Mohenjo-daro carried out by the Government of India between the years 1922 and 1927,* London, A. Probsthain.

MICHALOWSKI, P. 1990. Early Mesopotamian Communicative Systems: Art, Literature, and Writing. *In:* GUNTER, A. C. (ed.) *Investigating Artistic Environments in the Ancient Near East.* Washington, D.C.: Smithsonian Institution.

MILLER, D. 2007. Structures and strategies: an aspect of teh relationship between social hierarchy adn cultural change. *In:* HODDER, I. (ed.) *Symbolic and Structural Archaeology.* Cambridge: Cambridge University Press.

MUGHAL, M. R. 1990. The Decline Of The Indus Civilization And The Late Harappan Period In The Indus Valley. *Lahore Museum Bulletin,* 3, 1-17.

NATH, A. 2015. *Excavations at Rakhigarhi (1997-98 to 1999-2000),* New Delhi, Archaeological Survey of India.

PARPOLA, A. 1994a. *Deciphering the Indus Script,* Cambridge, Cambridge University Press.

PARPOLA, A. 1994b. Harappan inscriptions. *In:* HØJLUND, F. & ANDERSEN,

H. (eds.) *Qala'at al-Bahrain*
— vol.1. The Northern City Wall and the Islamic Fortress. Aarhus: JASP.
PARPOLA, A. 2005. Administrative Contact and Acculturation between Harappans and Bactrians: Evidence of Sealings and Seals. *In:* JARRIGE, C. & LEFÈVRE, V. (eds.) *South Asian Archaeology 2001.* Paris: CNRS.
PARPOLA, A. 2008. Is the Indus Script indeed not a writing system? *In:* VARALAARU.COM (ed.) *Airavati: Felicitation volume in honour of Iravatham Mahadevan.* Chennai: Varalaaru.com.
PARPOLA, A., PANDE, B. M. & KOSKIKALLIO, P. (eds.) 2010. *Corpus of Indus Seals and Inscriptions, Vol. 3. New Material, untraced objects, and collections outside India and Pakistan,* Helsinki: Suomalainen Tiedeakatemia.
POSSEHL, G. L. 1997. The Transformation of the Indus Civilization. *Journal of World Prehistory,* 11, 425-472.
POSSEHL, G. L. 2002. *The Indus Civilization: A Contemporary Perspective,* Walnut Creek, AltaMira Press.
QUIVRON, G. 1980. Les marques incisées sur les poteries de Mehrgarh au Baluchistan, du milieu du IVe millénaire à la moitié du IIIe millénaire. *Paléorient,* 6, 269-280.
QUIVRON, G. 1997. Incised and Painted Marks on the Pottery of Mehrgarh and Nausharo-Baluchistan. *In:* ALLCHIN, B. & ALLCHIN, R. (eds.) *South Asian Archaeology 1995.* New Delhi: Oxford & IBH.
RAO, L. S., SAHU, N. B., SAHU, P., DIWAN, S. & SAHASTRY, U. A. 2005. New Light on the excavation of Harappan Settlement at Bhirrana. *Puratattva,* 35, 60-68.
RAO, S. R. 1963. Excavations at Rangpur and Other Explorations in Gujarat. *Ancient India,* no. 18-19, 5-207.
RAO, S. R. 1979. *Lothal: A Harappan Port Town (1955-62), Vol.1,* New Delhi, Archaeological Survey of India.
RAO, S. R. 1982. *The Decipherment of the Indus Script,* Bombay, Asia Publishing.
RAO, S. R. 1985. *Lothal: A Harappan Port Town (1955-62), Vol. 2,* New Delhi, Archaeological Survey of India.
RATNAGAR, S. 2000. *The End of the Great Harappan Tradition,* New Delhi, Manohar.
SHAFFER, J. G. 1992. The Indus Valley, Baluchistan and Helmand Traditions: Neolithic Through Bronze Age. *In:* EHRICH, R. (ed.) *Chronologies in Old World Archaeology (3rd Edition).* 3rd ed. Chicago: University of Chicago Press.
SHAH, S. G. M. & PARPOLA, A. 1991. *Corpus of Indus Seals and Inscriptions. 2. Collections in Pakistan,* Helsinki, Suomalainen Tiedeakatemia.
SHINDE, V. 1991. The Late Harappan Culture in Maharashtra, India: A Study of Settlement and Subsistence Patterns. *South Asian Studies,* 7, 91-96.
SHINDE, V., OSADA, T., SHARMA, M. M., UESUGI, A., UNO, T., MAEMOKU,

H., SHIRVALKAR, P., DESHPANDE, S. S., KULKARNI, A., SARKAR, A., REDDY, A., RAO, V. & DANGI, V. 2008. Exploration of the Ghaggar Basin and excavations at Girawad, Farmana (Rohtak District) and Mitathal (Bhiwani District), Haryana, India. *In:* OSADA, T. & UESUGI, A. (eds.) *Linguistics, Archaeology and the Human Past, Occasional Paper 3.* Kyoto: RIHN.

SHINDE, V., OSADA, T., UESUGI, A. & KUMAR, M. 2008-2009. Harappan Seals and Sealing from Farmana, Ghaggar Basin, India. *Ancient Sindh,* 10, 27-36.

SHINDE, V. S. & POSSEHL, G. L. 2005. A report on the Excavations at Gilund, 1999-2001. *In:* JARRIGE, C. & LEFÈVRE, V. (eds.) *South Asian Archaeology 2001.* Paris: CNRS.

SOUTHWORTH, F. C. 2005. *Linguistic Archaeology of South Asia,* London, RoutledgeCurzon.

THAPAR, R. 2000. The Rgveda: Encapsulating Social Change. *In:* PANIKKAR, K. N. & AL, E. (eds.) *The Making of History.* Delhi: Tulika.

UESUGI, A., JAMISON, G., DANGI, V. & NAKAYAMA, S. 2016. A study on the stylistic and technological aspects of Indus seals with a focus on an example from Bhirrana. *Journal of Multidisciplinary Studies in Archaeology,* 4, 1-17.

VATS, M. S. 1940. *Excavations at Harappa: Being an Account of Archaeological Excavations at Harappa Carried Out Between the Years of 1920-21 and 1933-34,* Delhi, Government of India Press.

VIDALE, M. 2005. The Short-Horned Bull on the Indus Seals: A Symbol of the Families in the Western Trade? *In:* FRANKE-VOGT, U. & WEISSHAAR, H. (eds.) *South Asian Archaeology 2003.* Aachen: Linden Soft.

VIDALE, M. 2007. The Collapse Melts Down: A Reply to Farmer, Sproat, and Witzel. *East and West,* 57, 333-366.

WELLS, B. 2011. *Epigraphic Approaches to Indus Writing,* London, Oxbow Books.

WITZEL, M. 2001. Westward Ho! The incredible wanderlust of the Rgvedic tribes exposed by S. Talageri. A Review of: Shrikant G. Talageri, The Rigveda. A historical analysis. *Electronic Journal of Vedic Studies,* 7.