Title

Gold  and 'ratti'  signs inscribed on Mohenjo-Daro's gold-assaying needles, fish-sign inscriptions signifying gemstones concentrated near lapidaries: Indus script's taxed commodities

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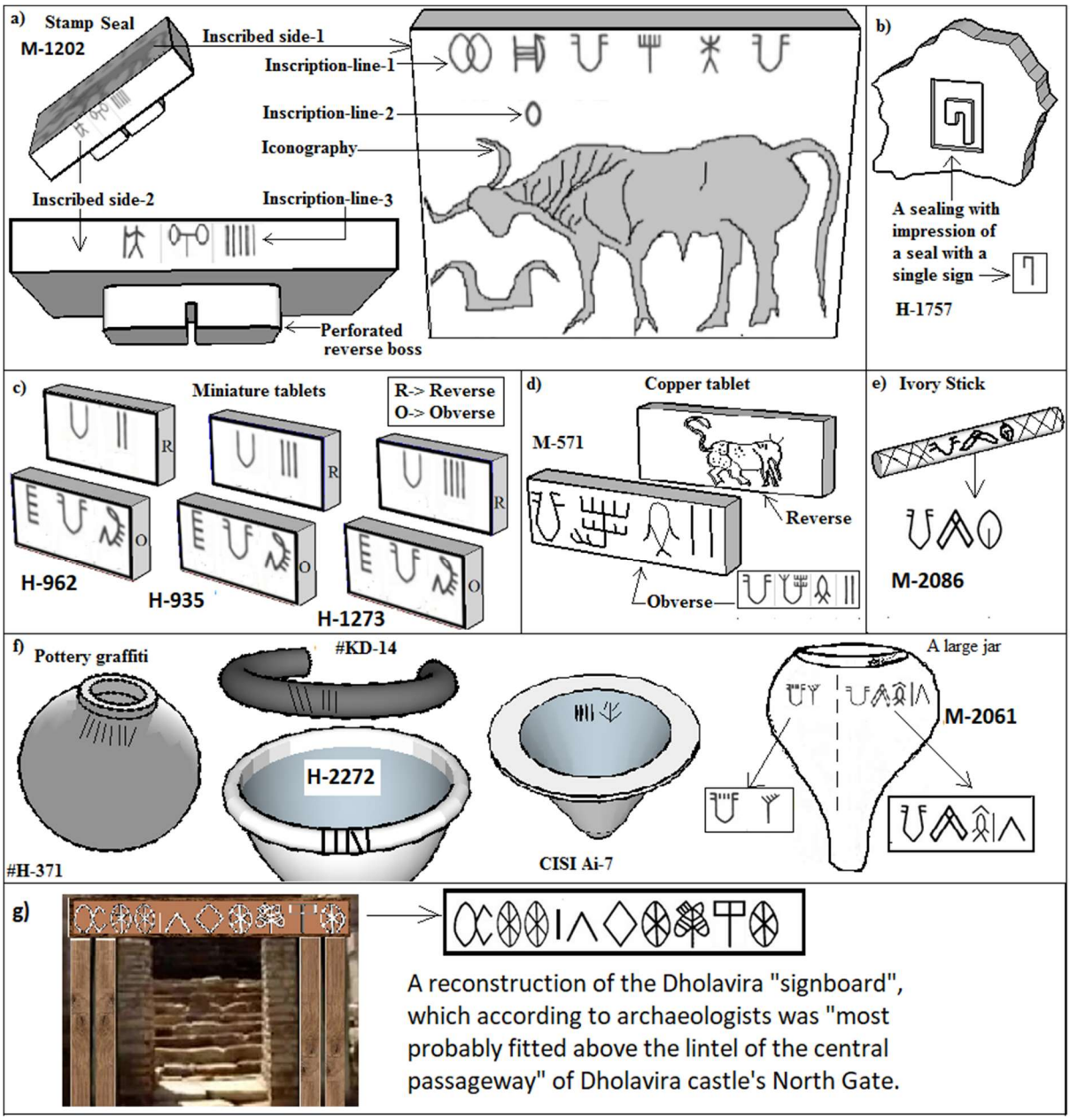
Abstract

This article claims a breakthrough in decoding Indus script. It builds on the author's earlier papers which established Indus script's use in taxation, and trade/craft licensing, and discussed how different segments of the semasiographic Indus inscriptions encoded different information (tax-types, license-categories, commodity-names, tax-paying modes, tax-rates, tax-receiving entities, etc.). This paper claims that certain inscribed needle-shaped gold artefacts found in a jewelry hoard of Mohenjo-daro, and a similar gold-tipped copper stylus found from Kotada-Bhadli, were gold-assaying needles used with touchstones. Such touchstones, sometimes gold-streaked, are found from Mohenjo-daro, Banawali, etc. Revealingly, the way modern gold-testing needles bear the words "gold" and "karat", Mohenjo-Daro's gold-testing needles bear signs  and  . This study claims that the frequent Indus sign  symbolized a blowpipe  inside a crucible  , and metonymically signified gold, precious metals () and gold-smithy (sign  clearly depicted the fire below crucible). Crucible-blowpipe-based words and symbols have signified metal-smithy in ancient Egypt, Mesopotamia, and India. This study also identifies sign  , which symbolized Abrus precatorious seeds, and signified the related 'ratti'/'kākaṇi' based weight-system. 'Ratti'/'kuṉṟi', India's traditional gold-measuring and numismatic unit, was the basis of Indus civilization's weight systems. In certain inscriptions (),  , a modified "ratti"-symbol, occurs as a metrological term related to gold  . In Indus inscriptions, fish-like signs (e.g.,  ,  , ) occur frequently with precious-metal symbols (). Interestingly seals/tablets containing fish-like signs, are mostly found near Indus lapidaries, bead-factories, and jewellers' shops. This article argues that fish-like signs signified gemstones, lapidary activities, related precious commodities, and corresponding weight standards. Since ancestral Dravidian languages were spoken across Indus settlements, Indus scribes possibly applied the ancient Dravidian homonymy, where the polysemic Proto-Dravidian fish-word "mīn", a popular fish-word of India, also signified 'shining', 'bright', and 'gemstone'. Relevantly, the eye-patterned apotropaic gemstone-beads imported from Indus valley were called fish-eye-stones ("NA^4-IGI- ḪA", "NA^4-IGI-KU6") in Mesopotamia.

1. Introduction

Since the first discovery (Cunningham, 1875) of the tiny inscribed seals and tablets found from Indus settlements, Indus script (ISC) has been vehemently researched by both scholars and amateur enthusiasts. ISC is presently embodied in around 5500 inscribed objects, comprising inscribed seals, sealings (seal-impression carrying tags), tablets (incised, bas-relief and copper-made), pottery vessels (see Fig. 1), and incised or painted bangles, excavated from various locations of Indus valley civilization (IVC), which spanned across almost one million square kilometers (c. 2600-1900 BCE) (Kenoyer, 2010). The Dholavira "signboard" is one of the rare occurrences where ISC was found in a non-miniature form (Fig.1g).

Figure-1: Indus inscriptions found in different media



A few Indus seals were also found from places of ancient Near East, with whom IVC had thriving trade relationships. For example, a 3rd millennium BC seal with Indus-inscription  was reported from Kish by Langdon (1931).

Decoding ISC has been delayed for various reasons. Indus-Inscriptions are written very briefly (more than 70% of the distinct inscription-lines contain only 1 to 5 signs). With only around 5400 recorded inscribed objects, ISC also has a very limited corpus. Moreover, the semasiographic/logographic nature of the inscriptions (Ansumali-Mukhopadhyay, 2019) makes it impossible to apply modern natural-language processing algorithms and machine-learning methods, which work well on phonological scripts, but remain quite clue-less when ideograms/logograms have to be decoded. Also, since the present population residing in different IVC locations speak different types of languages (Parpola, 2015, pp. 163–164), it is difficult to determine which specific type of language(s) had influence on ISC. Moreover, it is not easy to prove whether any linguistic word was at all encoded in this script (see Farmer, Sproat, Witzel, 2004). Also, the most ancient Indian scripts, such as Brahmi and Kharoshthi, do not have any proven relationship with ISC, despite such claims made by scholars (e.g., Kak, 1987).

In almost 140 years of research, ISC has received hundreds of theories and decipherment claims, where invaluable insights were often intermixed with unacceptable and logically incoherent conjectures. Thus, it is impossible to provide a comprehensive literature survey of ISC research in a journal-article, which, while maintaining a reasonable length, strives to provide several archaeological, historical, linguistic, and script-internal evidence to substantiate its claims of decoding certain Indus script signs. So, this article will only mention those research articles on ISC which it directly builds on, or which it directly refutes.

Regarding the epigraphical aspects of ISC, this article heavily builds on three previous articles of Ansumali-Mukhopadhyay (2019, 2022a, 2022b).

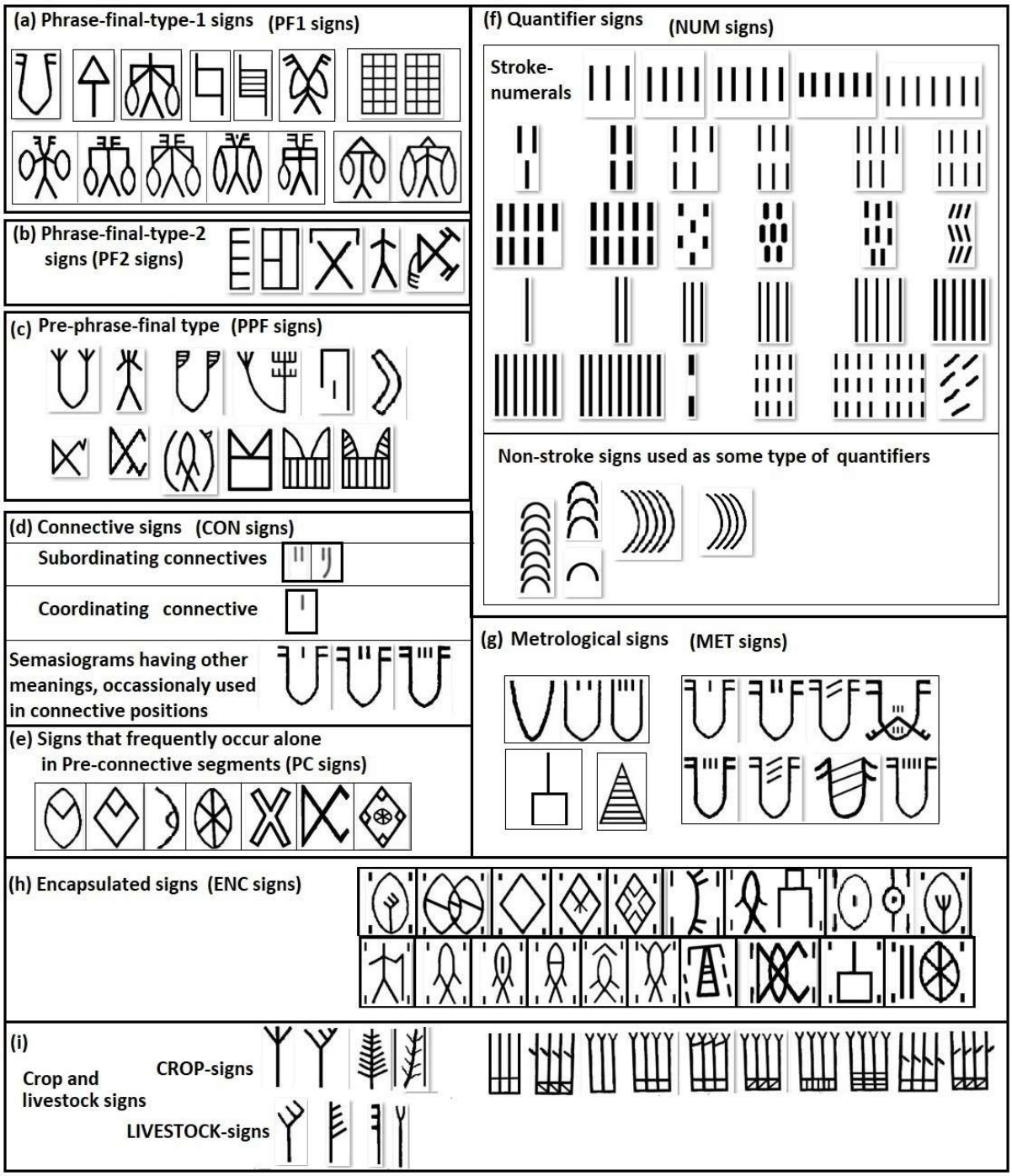
In Ansumali-Mukhopadhyay (2019), a thorough structural analysis of ISC is done. Ansumali-Mukhopadhyay (2019) categorizes several ISC-signs into certain semantic/functional sign-classes, based on their graphical and positional-statistical features (see Fig.2). Ansumali-Mukhopadhyay (2019) also analyzed the "semantic co-occurrence restrictions" demonstrated by certain classes of ISC-signs, which proves (with almost mathematical certainty) the logographic/semasiographic nature of the majority of Indus-inscriptions. Analysing the co-occurrence restriction patterns maintained by functionally homologous ISC-signs, Ansumali-Mukhopadhyay (2019) has proven that the signs of Indus-inscriptions demonstrate semantic co-occurrence restrictions that work in the domains of phrases, sentences and discourse, not phonological co-occurrence restrictions that can function only in the domains of adjacent phonemes and syllables. Its corollary is that the individual ISC-signs mostly functioned as semasiograms and logograms, not as adjacent phonemes that jointly spelt a word. She has also argued that the rigid formulaic positional preferences of Indus signs would allow grievously limited sound combinations, which could not have phonetically encoded words of any natural language.

The semasiographic/logographic nature of ISC does not imply that there was no linguistic influence on ISC-signs. It is quite possible that certain individual signs had

applied linguistic homophony or homonymy to signify their meanings. For example, ISC's fish-signs () were possibly used signify names of a related class of commodities and craft-activities, as the fish-word used in IVC was homonymous with the name of that commodity class (see Section-3.3). But, the way logo-syllabic scripts apply rebus principle by treating multiple adjacent word-symbols only for their phonological sounds to spell words, (for example, a logo-syllabic script designed to write English, might use a honey-bee symbol and a leaf-symbol side-by-side for writing the English word "belief" as /bee-leaf/), ISC almost never did that (Ansumali-Mukhopadhyay, 2019).

Ansumali-Mukhopadhyay's (2022a) article, titled "Guild-based trading, taxation, tax farming, trade and craft licensing, access control: Economic practices of Indus civilization encoded in Indus script", has argued that IVC's inscribed seals, sealings, and tablets, which are often found concentrated near customs houses of fortified city gates, or near different craft-making areas, were mainly used for taxation, licensing, craft and trade control, access control, etc.

Figure-2 Certain functional classes of Indus script signs



The inscribed stamp seals of IVC, which were used to endorse contents of packed merchandise (Rao, 1979 pp.113-114; Frenez & Tosi, 2005 p.71, Parpola, 1994 pp.114), were used as revenue stamps, and stamps for enforcing certain trade regulations and access control. The inscribed tablets were mostly licenses issued to tax-collectors, tax-farmers, traders, and artisans, authorizing them to operate on specific commodities and commercial activities. Ansumali-Mukhopadhyay (2022a, 2022b) also argues that Indus-inscriptions were patterned formulaic messages, whose different segments encoded different information categories, such as taxes and licenses, tax-rates, tax-paying modes, names of the taxed commodities and licensed commercial activities, types of tax-receiving entities, etc.

Below I shall briefly discuss the structural aspects of ISC, and the inferred semantic scopes of different functional classes of ISC-signs. Many of these points are already elaborately discussed by Ansumali-Mukhopadhyay (2019, 2022a, and 2022b). But since understanding these points are imperative for following the arguments made in the present paper, they are briefly included in Sections 1.1 and 1.2. In Section-1.3 the outline of the main claims of the present paper will be discussed. Later sections will then argue these claims in details with due substantiation.

1.1 Structural aspects of Indus-inscriptions

i) Several ISC-signs can be classified into certain functional or semantic classes based on their positional-statistical behaviors and graphemic features (Fig.2, Fig.3).

ii) Indus-inscriptions can be clustered into two broad structural categories
   a) Non-composite inscriptions (Fig.4a)
   b) Composite inscriptions (Fig.4b-c)

iii) The non-composite basic inscriptions are more in number than the composite inscriptions.

iv) The non-composite inscriptions contain phrase-final (PF) signs, pre-phrase-final (PPF) signs, and signs that occur preceding the PF and PPF signs (Fig.4d), in the core-informational segments of Indus-inscriptions.

v) The Phrase-final signs are signs that mostly occur in the terminal positions of Indus phrases. The phrase-final-sign's meaning applies to the whole-inscription, not only to the signs directly preceding or following it.

vi) There are two types of Phrase-Final signs (Fig.2a-b). The Phrase-Final-Type2 or PF2-signs generally follow the Phrase-Final-Type1 or PF1-signs (Fig.3d).

vii) The PPF-signs do not occur in many Indus inscriptions. But whenever they occur, they almost always occur directly before the PF1-signs (Fig.2c, Fig.3b).

viii) There are certain composite Indus-inscriptions. They contain certain connective signs, which sit in between two independently meaningful segments of Indus inscriptions (Fig.2d, Fig.3d, Fig.4b-e).

ix) Two types of connectives are used in Indus-inscriptions: a) subordinating connectives b) coordinating connectives (Fig.2d, Fig.3d)

x) Generally, a small single-stroke, written in the upper-half of an inscription-line () is used as a coordinating connective. The inscriptions occurring on both sides of such connectives are independently meaningful phrases, which generally end with PF-signs, or other terminal signs such as Crop-Livestock signs (Fig.4b).

xi) In case of the subordinating connectives, there is usually clear differences between the pre-connective and post-connective sign-sequences (Fig.2d, Fig.3d). The post-connective sign-sequences are usually messages that occur independently in seals and tablets. They generally contain the terminal Indus signs. The pre-connective parts are mostly dominated by a small group of signs (Fig.2e, Fig.4c). These signs, which occur in pre-connective parts in unexpectedly high frequencies, are classified as pre-connective or PC-signs.

xii) The composite Indus-inscriptions containing sub-ordinating connectives are complex composite inscriptions, whose post-connective parts are independent main clauses and pre-connective parts are dependent subordinating clauses. Many of the non-composite inscriptions that occur independently in seals/tablets, occur in the post-

connective parts of the complex composite inscriptions. The pre-connective parts of such complex-composite inscriptions generally do not include any PF1 or PF2 signs.

xiii) Certain ISC-signs are constituted of different number of strokes arranged in vertical/horizontal stacks. These stroke-signs, which usually occur before specific logograms (Fig.3c,3e), are classified as numerical or NUM-signs (Fig.2f).

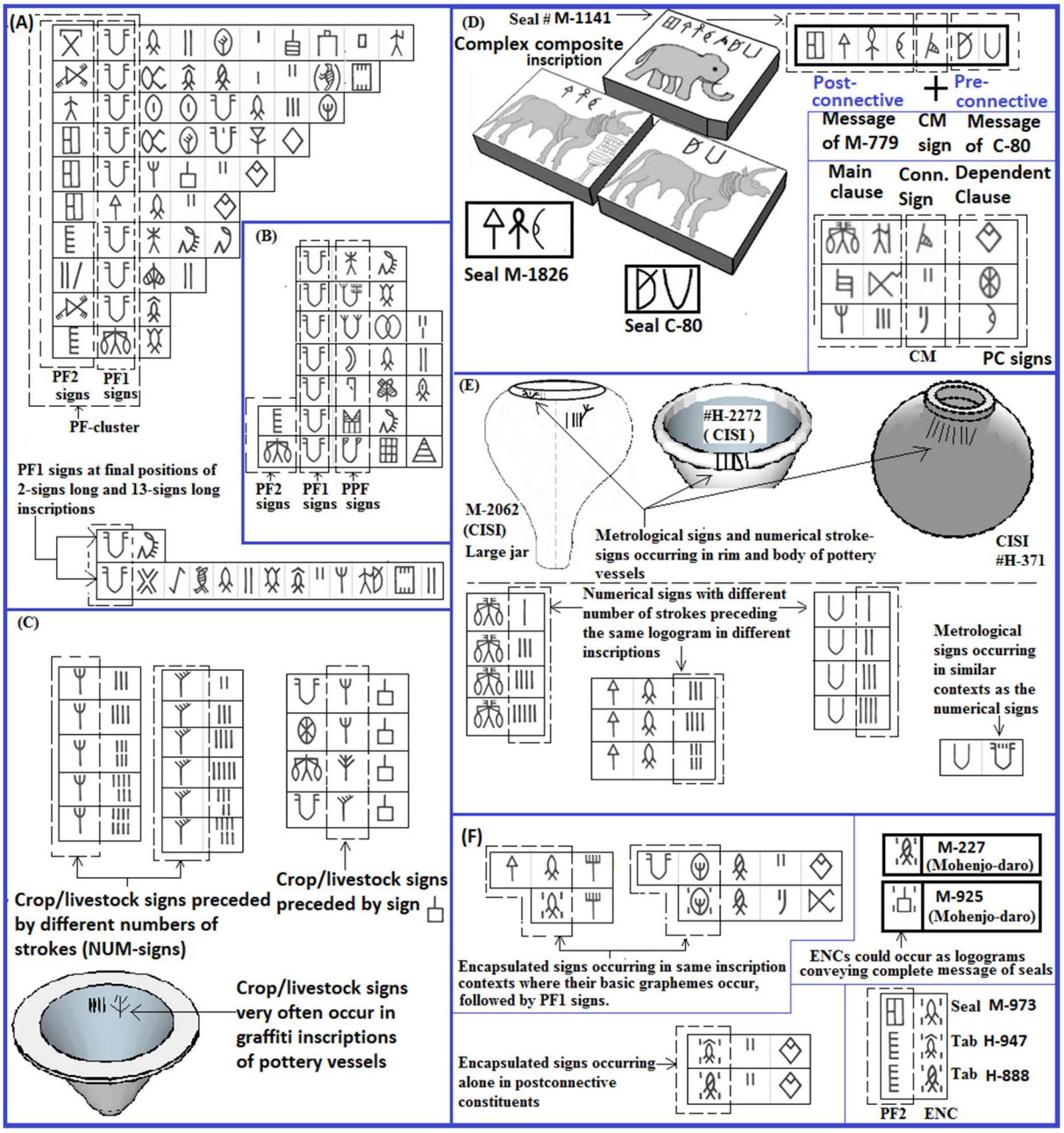
xiv) Certain signs are constituted of jar-like graphemes, but modified with varying strokes, signifying some types of numerical notations (Fig.2g). These signs occur not only on seals or tablets, but also on rims of pottery vessels (Fig.3e). These signs also occur in typical inscriptional contexts of the stroke-numerical signs (see  in Fig.3e). These signs are classified as volumetric metrological signs. The sign  graphemically resembles a conical object, possibly a conical weight that hangs from a load-bearer's shoulder in sign  . Such heavy conical stone weights (some weighing around 11.5 kg), with holes bored in their tops for suspension with a cord or a rod, are found in Mohenjo-daro (Marshall, 1931 Vol2, p.463; Mackay, 1938 p.402). Another sign, sign  , replace NUM-signs in several inscriptional contexts. These signs were possibly associated with certain metrological standards prevalent in IVC, and signified related revenue-based meanings.

xv) Certain phytomorphic signs, and signs that resembled tails of certain livestock animals depicted in Indus seal iconographies (Ansumali-Mukhopadhyay, 2022b), occasionally occur in pre-connective parts, but mostly occur in terminal and medial positions in non-composite inscriptions and post-connective phrases, preceded by certain numerical and metrological signs. These signs are classified as Crop-Livestock signs (Fig.2i, Fig.3c).

xvi) There are certain composite ISC-signs which are made of some basic graphemes enclosed in 4-stroke circum-graphs (Fig.2h). The positional-statistical behaviors of these signs indicate that they combine the functionalities of PF1-signs, PPF-signs, and their basic-graphemes (Fig.3f).

xvii) The core-informational segments occurring in non-composite Indus-inscriptions, and in post-connective phrases of the complex-composite inscriptions, are constituted of informational units that occur separately in other shorter inscriptions (Fig.5). Thus, longer composite and non-composite inscriptions are structurally similar to shorter composite and non-composite inscriptions. Just their core-informational and pre-connective segments contain multiple semantically related informational units.

Figure-3 Typical inscriptional occurrences of Indus script signs of different functional classes



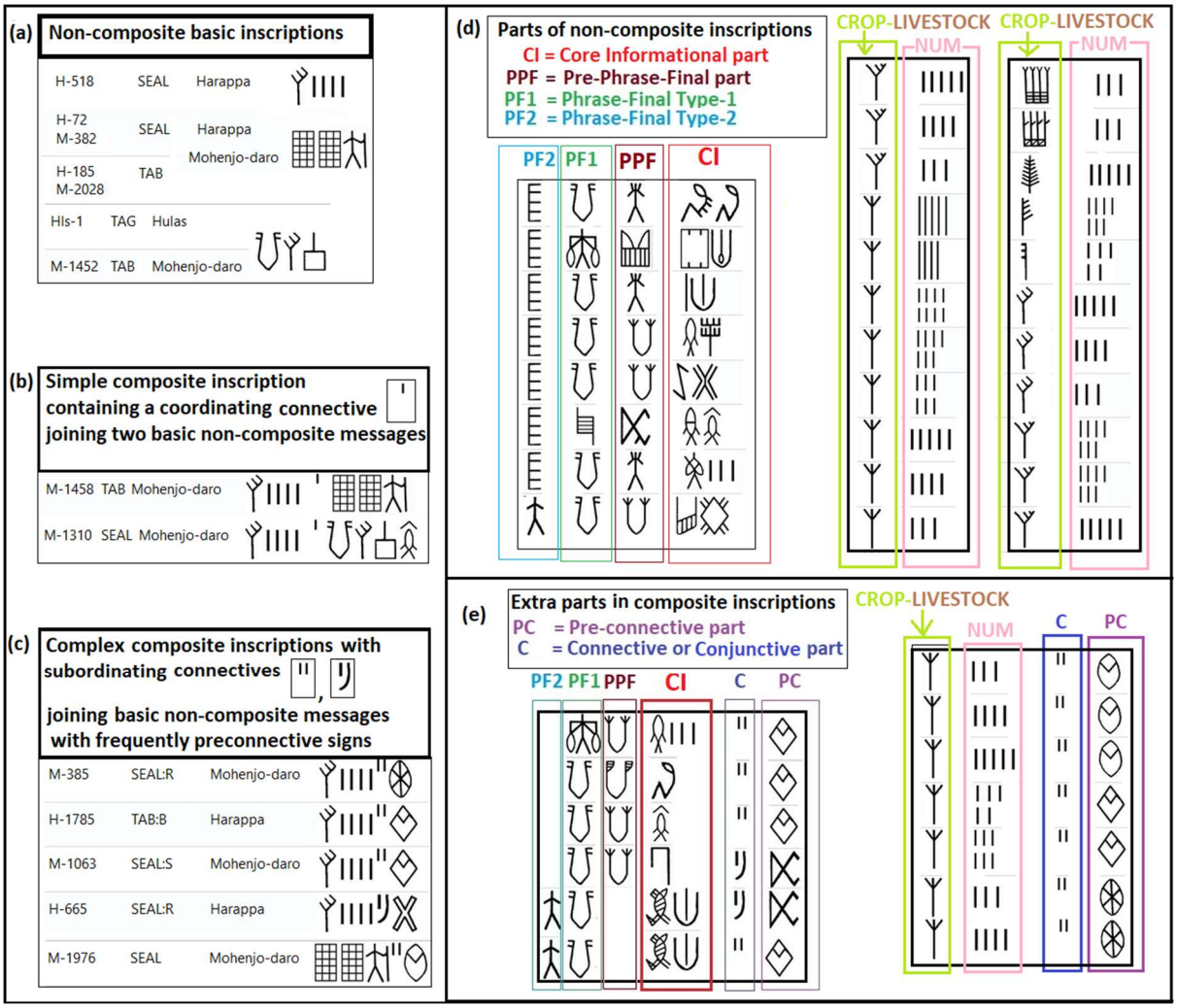
1.2 Inferred semantic scopes of different functional sign-classes and inscriptional segments

As shown in Fig.6:

i) The PF1-signs, some of whose graphemes resemble volumetric and weight-based metrological standards used in IVC, signified broad tax categories.

ii) Signs occurring in the core-informational segments denoted taxed commodities and licensed craft-making activities. Sometimes, commodity specific tax-rates, and craft/trade-specific licensing fees were also mentioned through NUM-signs, which preceded the commodity/craft signs.

Figure-4 Indus inscriptions segmented in different functional parts



iii) PPF-signs, which have close inscriptional relationship with PF1-signs (e.g., PPF and PF1), and sometimes with certain commodity-related semasiograms/logograms (e.g., PPF-sign and commodity-sign), denoted methods of tax-payments, i.e., types of commodities used to pay taxes.

iv) The core-informational parts of Indus-inscriptions were particularly sensitive to their archaeological contexts. Thus, if seals and tablets containing a specific set of ISC-signs in their core-informational parts (e.g., fish-like signs) are repeatedly found concentrated near workshops of particular type of crafts (e.g., lapidaries), then it can be safely inferred that those signs (e.g., fish-like signs) signified commodities and craft-activities related to that specific craft (e.g., gemstone cutting, bead-making, glazing, etc.).

v) The numerical signs, which precede specific semasiograms/logograms (signs signifying taxed commodities, licensed crafts, tax/license types, etc.) in fixed patterns, signified certain commodity-specific and craft-specific tax-rates.

vi) The metrological-signs also denoted certain tax-rates. The jar-like MET-signs possibly signified certain taxes based on their rates.

vii) The numerical and the metrological signs, when occurring in isolated contexts, on pre-firing and post-firing graffiti present on rims and bodies of pottery vessels, denoted the capacities of those vessels, and the quantities of their actual contents.

viii) The frequently pre-connective PC-signs mostly denoted types of tax-receiving and license-issuing entities. In certain cases, graphically related signs occurred in both pre-connective and post-connective segments of complex composite inscriptions (e.g.,  ,  , etc.). In these contexts, the pre-connective phrase possibly encoded both tax-paying purposes and tax-receiving entities.

Figure-5 Juxtaposition of informational units of shorter inscriptions in the core-informational segments of longer inscriptions

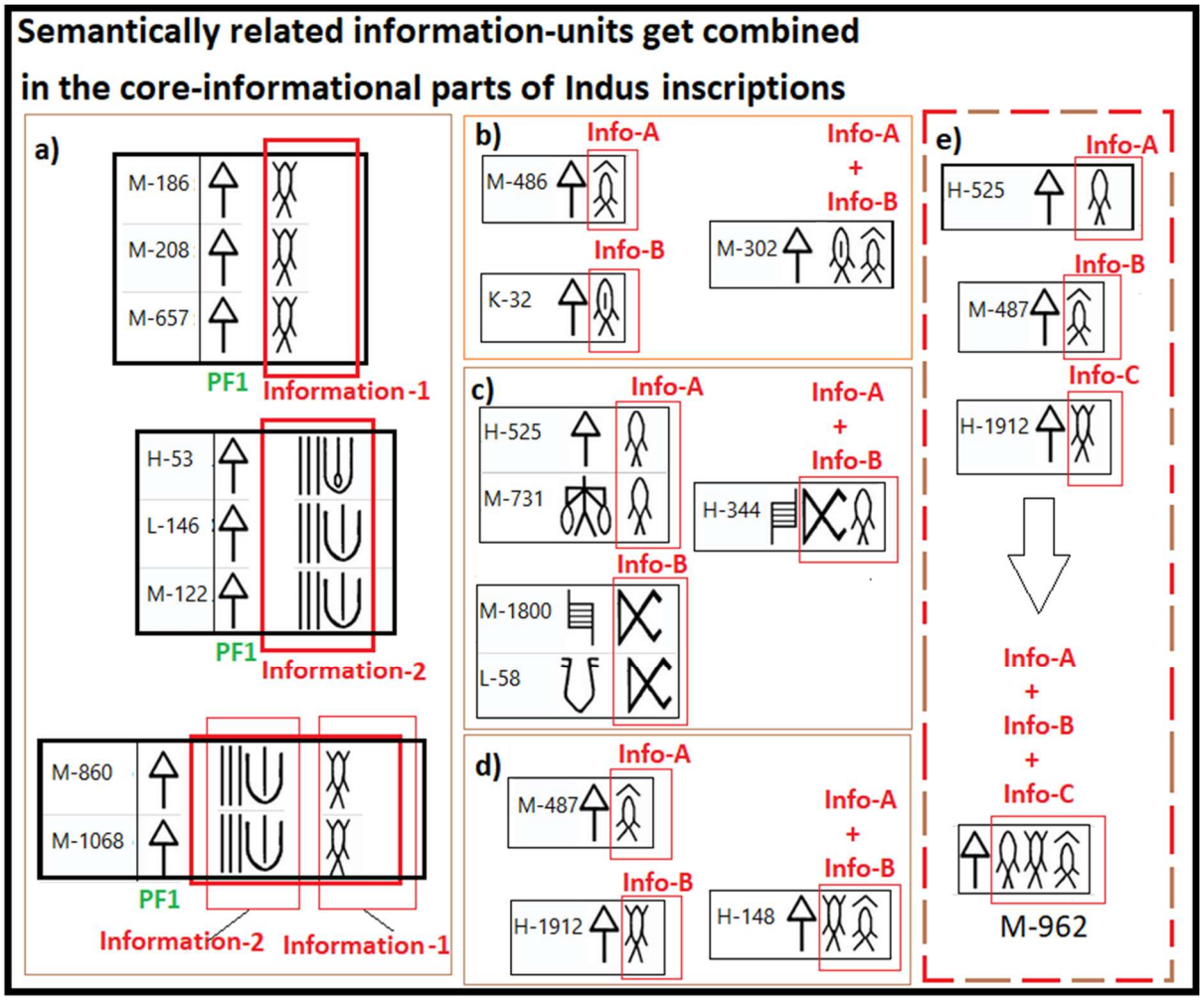
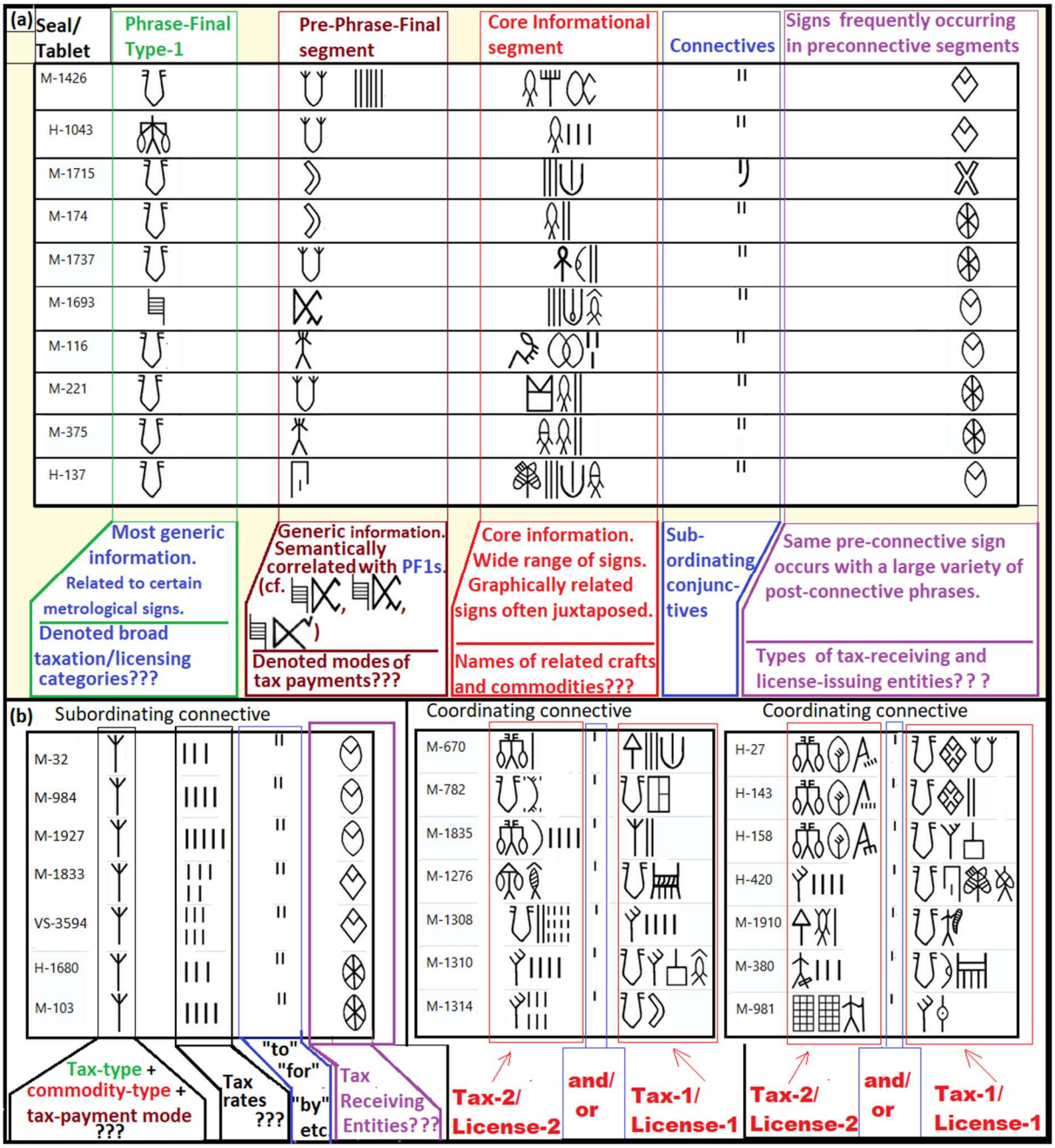


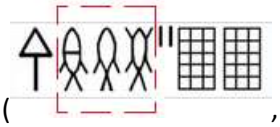
Figure-6 Inferred semantic scopes of different functional segments of Indus inscriptions



ix) In pre-connective phrases (, , , , , etc.) which signified "tax paid for doing so-and-so", "tax paid to so-and-so", "license issued by so-and-so", "license issued for doing so-and-so", etc., the subordinating connectives possibly denoted meanings like "for", "to", "by" etc.

x) The frequently pre-connective signs possibly denoted tax-receiving entities and license-issuing entities, such as oligarchic units governing specific trade-guilds and artisan-guilds, governing-bodies of settlements, rulers of certain regions, etc.

xi) Mutually related commodities and crafts, mentioned separately in shorter inscriptions, often occur adjacently in the core-informational parts of longer Indus-inscriptions. But, since one seal's inscription generally contained information related to one single tax-category, one single tax-paying mode, and one single tax-receiving entity, those segments

of Indus inscriptions generally contained only one member of corresponding functional classes. But, since multiple related taxed commodities and related licensed craft-activities could be part of the single inscription, the core-informational medial segments generally contained multiple signs of similar graphemes ( ,  , ). This explains the co-occurrence restriction, and co-occurrence preference patterns demonstrated by ISC sign-classes, as discussed in Ansumali-Mukhopadhyay, 2019.

xii) In certain inscriptions, the Pre-connective parts also contain multiple signs (), possibly to provide more specific information about the tax-receiving entities. But, frequently pre-connective PC-signs, which denoted the main tax receiving entities, almost never co-occur in the same pre-connective segment of a complex-composite inscription, possibly because, only one such entity is applicable to a tax/license related message of a single inscription. In some rare cases, (not more than 10 inscriptions recorded in ICIT), more than one PC-sign occur adjacently (

). Interestingly, such occurrences occur typically in terminal positions, not pre-connective positions. Inscription  (CISI#M-759) shows such a rare-occurrence of multiple frequently-pre-connective signs in the same pre-connective segment.

1.3 The main findings of the present article

Having discussed the important structural and semantic aspects of ISC, we have our stage set up for discussing the specific claims of this article. This article mainly deals with the core-informational segments of Indus-inscriptions where the commodity-names and licensed craft-names were mentioned. It specifically claims certain novel findings as stated below:

Gold-assaying needles:

This paper claims to have identified the functionality of certain gold needles found in Mohenjo-daro (CISI#M-2128, CISI#M-2129) and a gold-tipped copper needle found at Kotada Vadli (Shirvalkar & Rawat 2012, Plate-22), as gold-assaying needles. The functionalities of these needle-shaped artifacts have baffled the archaeologists till date.

Gold-symbol  :

This paper claims that sign  symbolized a blowpipe inside a crucible  , and metonymically signified gold and gold-smithy. Revealingly, sign  occurs on one of these gold-assaying needles (CISI#M-2128) as the symbol of gold.

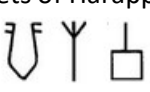
Precious metals  *:*

The crucible-blowpipe sign  very often collocates with a three-long-stroke sign  . In this collocation, the numerical sign  does not precede the semasiogram/logogram. Moreover, no other numerical sign follows sign  in this way. Thus, here sign  does not function as a general quantifier, but forms a fixed-collocation with  . This paper argues that  signifies "three precious metals", possibly gold, silver, and copper/bronze, which were used by jewelers and gold-smiths. Many of IVC's jewelry items, such as bangles, finger-rings, etc., were made of copper and/bronze (Marshall, 1931 Vol.1 p.30, vol.2 p.505, etc.). Moreover, the spacers and terminals of necklaces were often made of copper. Thus, gold, silver, and copper/bronze, the three precious metals used by gold-smiths, could have been referred to as  , to signify precious-metals and gold-smithy.

Ratti-symbol  *:*

This article identifies the graphical referent of sign  as Abrus precatorious seed, known as 'raktikā', 'kṛṣṇala', 'kākaṇi', 'guñjā', 'guri-ginja', 'chirmiti', 'kuṉṟi', 'ratti', etc., in several Indo-Aryan and Dravidian languages of India (Khare, 2008). The standardized weight of Abrus precatorious seeds was used as the basis of the weight system and numismatics of ancient historical India (Arthaśāstra: Shamasastry, 1929 p.141). It was also the basis of IVC's weight-system, embodied in IVC's standardized small cubical weights (Kosambi, 1975 p.174), which were mostly used for measuring precious metals and gemstones. The 'ratti' unit, based on the weights of the Abrus precatorious seeds, are till date widely used to measure gold across India. This paper identifies  (allograph ) as this "ratti"-symbol.

Intriguingly, as recorded in Arthaśāstra, the Indic equivalent of carat/karat was indeed the Abrus precatorius (also known as 'ratti', 'kākaṇi', etc.) seeds. Revealingly, the way the metrological word "karat"/"carat", an universal measurement for indicating proportion of gold in an alloy, and a metrological standard for weighing gold and gemstones, is often inscribed on modern gold-assaying needles, the 'ratti'-sign  is found inscribed on one of IVC's gold-assaying needles (CISI#M-2129).

In many Indus-inscriptions,  and its allograph  occurs in pre-connective positions. The polyvalent use of  and  is discussed in Section-5.4, to explore their meanings in the pre-connective contexts. Here I shall point out that  , a modified grapheme based on the 'ratti'/'kuṉṟi'-sign  , occurs with the gold-sign  in a few revealing inscriptions( , ) found in some tablets of Harappa. Comparing inscription  with inscriptions  ,  , and  , where the CROP-Livestock signs occur preceded by sign  , and

followed by terminal jar-sign  , we find that when the commodity-sign changes from CROP-livestock signs to Gold-sign  , the terminal sign changes from volumetric-metrology related jar-sign  to gold-measuring 'ratti'/'kuṉṟi' related sign  .

Fish-signs, Gemstones and shiny precious commodities:

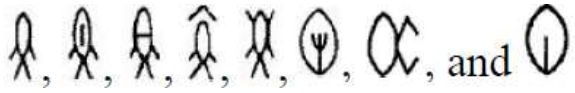
As discussed in Ansumali-Mukhopadhyay(2022a), inscriptions containing fish-signs are often found near jewelry hoards and lapidary workshops in unusually high frequency. This paper claims that ISC's fish-signs ( , etc.) denoted lapidary-related crafts, gemstones, and some other shiny-precious materials. This fish-symbolism for shiny-precious commodities such as gemstones could be associated with the word "mīn", the polysemic Proto-Dravidian root-word for 'fish', which also signifies 'shining', 'bright', and 'gemstone' in various Dravidian languages. This ancient word 'mīn' is presently used in several Dravidian and non-Dravidian languages of India to signify fish. Now, several linguistic and archaeogenetic studies have established that ancestral Dravidian languages were widely spoken in IVC (Parpola, 2015, Ansumali-Mukhopadhyay, 2021). Hence it is quite possible that the Indus scribes chose the widespread 'mīn'-based words to apply homonymic symbolism for signifying gemstones and other shiny precious commodities through the fish-like logograms. Relevantly, the eye-patterned apotropaic gemstone beads (e.g., banded agates and etched carnelian beads) imported from Meluhha or Indus valley were called fish-eye-stones ("NA4-IGI- ḪA", "NA4-IGI-KU6") in Mesopotamia (Donkin, 1998 p. 50; Howard-Carter, 1986).

Co-occurrence of Gold-signs and Gemstone-signs:

Since gold, precious-metals, gemstones, and gemstone beads are related commodities, the gemstone-signifying fish-signs very often occur with the crucible-blowpipe based gold symbol  , in the tax/license related inscriptions of IVC. More than 120 Indus inscriptions found from Allahdino, Chandigarh, Chanhujo-Daro, Dholavira, Harappa, Lothal, and Mohenjo-Daro, contain both fish-signs and crucible-blowpipe sign  .

1.4 Some existing hypotheses related to signs  , etc.

The most frequent fish-like sign  is classified as a syllabic sign by Wells (2015 p.7), an attributive-lexeme by Mahadevan (1986:21), and a metrological unit by Bonta (2010, pp.22-30,57-58). Parpola (1994 pp.179-185,279-283) suggests that  might have represented the Dravidian word "mīn" which meant "fish", "star" and "to shine or glitter". According to Parpola, this "mīn" word was part of certain theophoric astral names used as anthroponyms in IVC. Fairservis (1992, p.11) however conjectured that the fish-like signs were not related to fish at all, but were semantically associated to a "knot or twist in a loom". According to Fairservis (1992 pp.48-58), Dravidian words related to "twist", "loop", etc. (e.g., 'piri'), which homonymously meant "chief", inspired the fish-signs, which allegedly signified different Dravidian chief-words ('pir', 'talpir', 'acci-pir', 'maru-pir', etc.). Rao (1979 pp.183-186,262-264), applied an acrophonic principle for deciphering ISC, by first speculating graphical referents of certain ISC-signs, then speculating certain Sanskrit words (often gleaned from Vedic texts) for those meanings, and finally choosing the initial syllables of those words as sound-values of corresponding ISC-signs. In this process, Rao assigned phonological values 'ś',

'man', etc., to various fish-signs, and claimed to have deciphered several Indus-inscriptions in that process. Among these widely varied research methodologies and conclusions regarding ISC's fish-signs, the author finds Bonta's approach (2010, pp.22-30,57-60) most scientific, as he at least considers certain script-internal, archaeological, and historical evidence for building his conjectures. However, the author does not agree with Bonta's conclusion that  were different denominations of a series of weight-units, mainly because if one applies Bonta's logic, and compares the inscriptional occurrences of fish-signs with many other signs, almost all signs that occur in the core-informational segments, will be interpreted as metrological units, and there will be no place for any other information left. To know more about ISC's fish-sign related interpretations done by various scholars, please see Mahadevan (2011).

Sign  is interpreted as 'mortar-pestle' by many Indus scholars including Fairservis (1992 pp.10,28,33-34,111). Mahadevan (1970, 2011) had identified the graphical referent of  as a 'mortar-pestle', and interpreted sign  to signify 'pounding' or 'grinding' related verbs and their homonyms.

Mahadevan's corpus (1977) does not distinguish between signs  , and  (also see Daggumati & Revesz, 2021). The Finnish team of scholars who worked on ISC, including Parpola, compared signs  and  with Harappan ladles made of conch shells (Parpola, 1994 p.104). Mahadevan (1970 pp.42-49; 2011) had accepted the conch-shell related identification of Finnish team, and used "Dravidian linguistic parallel" and homonymy, to interpret sign  as 'city', 'citadel'. Wells (2015, p.93) also concurred with the city-related interpretation of  .

At this point, rather than explaining why the author does not agree with these existing hypotheses, it is better to discuss how the findings of this article, which are different from all these hypotheses, get corroborated by interlocking evidence gleaned from archaeological, historical, linguistic, and script-internal data.

2.Methods

The methodology of this study mostly involves the following:

2.1 Methodology-A:

Whenever Indus-inscriptions containing specific group of signs (e.g., fish-like signs) in its core-informational segments, repeatedly occur in specific archaeological contexts (e.g., lapidary workshops, bead factories, etc.) in a statistically significant way, then the archaeological contexts of those inscriptions can be correlated with the signs present in the inscriptions' core-informational segments. This study has exhaustively analyzed excavation reports of several Indus sites to analyze the inscriptions' archaeological contexts.

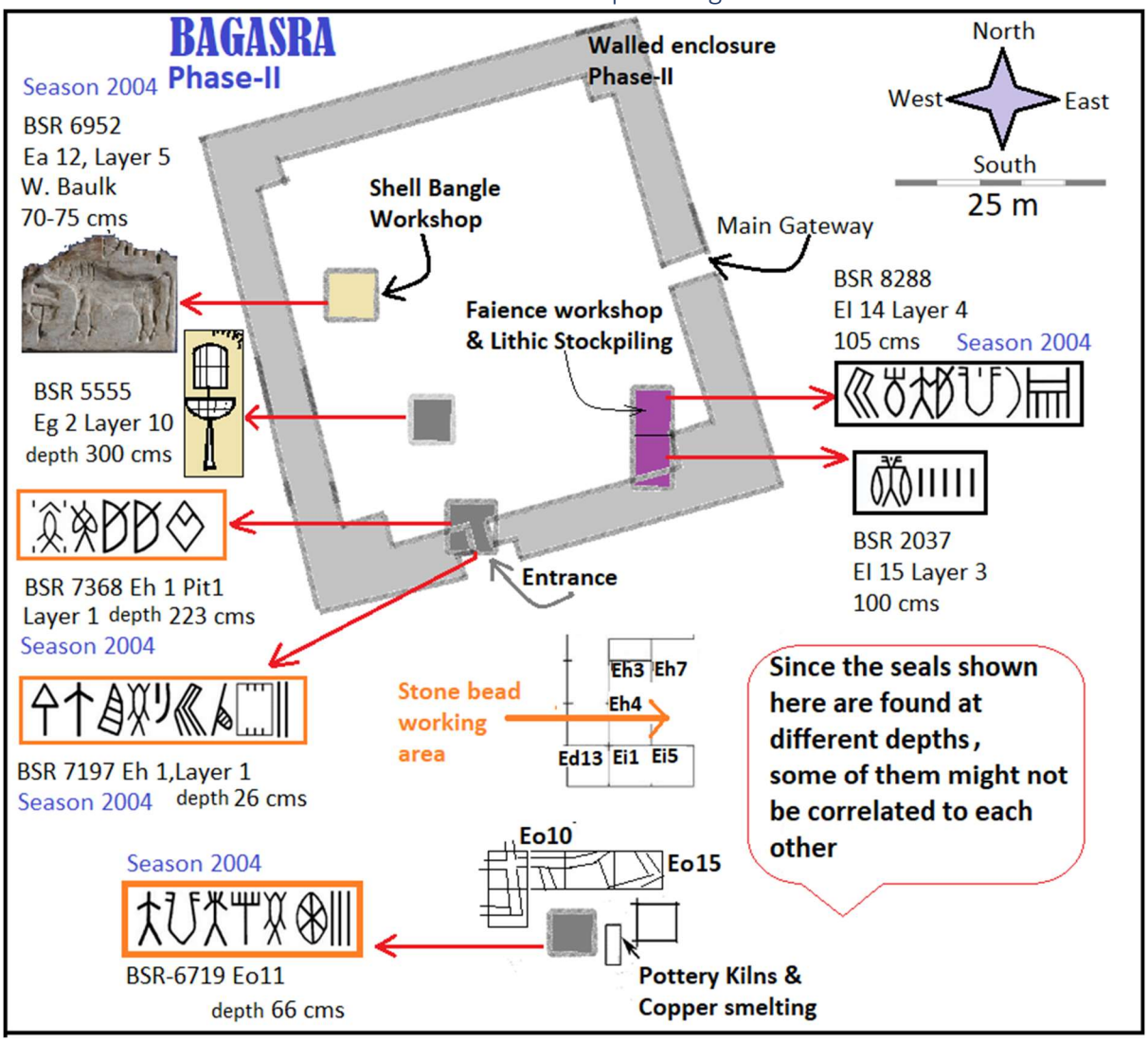
2.2 Methodology-A in details

There are several ways of analyzing Indus-inscriptions based on archaeological contexts:

2.2.1 Context-type-1: Inscriptions found together in workshops and craft areas:

As shown in Fig.7, inscribed Indus seals/tablets are often found near craft-workshops. Fig.7, which is adapted from Fig-2 of Jamison et al., 2017 and Fig.8 of Bhan, 2018, shows provenances of certain inscribed seals excavated from Bagasra, a small but commercially important Indus settlement. Now, if inscribed seals/tablets containing specific ISC-signs occur repeatedly in specific craft areas, then we can argue that those inscriptions are semantically associated with the raw materials and end products of that craft, and related commercial licensing and taxation. For example, as elaborately discussed in Section-3, i) Marshall (1931, pp.194-195) had identified a jeweler's workshop in Mohenjo-daro where an inscribed seal containing only a fish-sign in its core-informational segment was found; ii) Vats (1940 pp.58-60,435) identifies a lapidary workshop in Harappa which yielded several inscribed seals and tablets, a majority of them containing fish-signs; iii) Mackay (1943) had identified lapidaries and bead-factories in Chanhu-daro where inscribed seals containing fish-signs were found in unexpectedly high numbers. The archaeological contexts of these inscriptions, when analyzed, suggest strong correlation of fish-signs with lapidary crafts and jeweler's craft.

Figure-7 Inscribed seals found near various craft-workshops of Bagasra



2.2.2 Context-type-2: Inscriptions found together in khans, residential places and bureaucratic centers:

Unlike the easily contextualizable inscriptions repeatedly found in archaeological contexts of specific craft-making areas, inscriptions found together in residential houses, khans, and administrative centers for licensing or tax-collection, cannot be always related to specific crafts or commodities. (For the clarity of non-specialist readers, khans were ancient inns that functioned as trading centers and hostels, with accommodation for people, their beasts, and storage spaces for merchandise. Unlike caravansaries situated in city outskirts, khans were smaller public buildings situated inside city walls). This is because, in khans, different traders dealing with wide range of commodities will stay in adjacent rooms carrying their seals/tablets with them, while their main merchandise might be stored away in separate places. Similarly, in administrative buildings used for tax-collection and trade/craft licensing, officers designated to handle different crafts and commodities, might sit near each other. Hence, while the seals/tablets found in the same room might belong to the same trader, artisan, or officer, and thus might be correlated to some extent, we cannot contextualize them with sufficient surety. Relevantly, in Mohenjo-daro, many houses are identified as public buildings, residential houses, khans, and ordinary inns (Mackay, 1938 pp.11,18,20,33-36,93,105,116,119,120,164). For such buildings, it was often "well-nigh impossible to determine the use of a building with any certainty from the antiquities found in it" (Mackay, 1938 p.41). Thus, the seals/tablets obtained from such houses of Mohenjo-daro, whose functionality could not be identified from its material remains (Mackay, 1938 p.41), are given less importance in this study's contextualization process than the seals found together with jeweler's weights in a bead-factory identified in Chanhujo-daro (Mackay, 1943). However, when a jeweler's shop of Mohenjo-daro yielded a single seal, or a bead-workshop of Harappa yielded several related inscriptions (details later), those instances are considered invaluable for contextualization (Vats 1940, Marshall 1931).

2.2.3 Context-type-3: Inscriptions found along with specific traded commodities:

As an extension to Context-Type-2, if seals/tablets carrying certain inscriptions are repeatedly found along with specific commodities even in a residential house or inn, then they should be semantically correlated with those commodities, crafts, and related permits or licenses.

2.2.4 Context-type-4: Correlation between inscriptions and standardized weights:

The standardized weights found across several Indus settlements can be categorized into certain large, medium, and small weight ranges. Interestingly, excluding a few large conical and barrel shaped weights, a large fraction of the Harappan weights found till date weigh less than 50 grams (Ruikar et al., 2015). Now, other than certain extremely precious spices, perfumes, and medicines, only gemstones and precious metals have been traditionally weighed with such precision. Archaeological evidence strongly indicates that most of the tiny weights (generally cuboidal and made of chert), were used in lapidary and jewelry related metrology (Mackay, 1943 p.243; Lal et al., 2020 pp.1004-1020).

Thus, the contextualization process of Indus-inscriptions should compare the finding spots of such small weights with the finding spots of seals/tablets to check whether inscriptions containing specific signs had correlation with goldsmith's/jeweler's weights. Any such statistically significant correlation will indicate that those inscriptions were used by people who dealt with precious metals, gemstones, etc., and their core-informational segments can be correlated with such crafts.

Alternatively, if seals containing a wide range of inscriptions are found to cooccur with such weights, then that should indicate that traders, tax-collectors and license-issuing officials dwelling in cities carried such weights irrespective of the commodities they traded or controlled, as they needed

to transact in terms of gold/silver ingots of standardized weights using them as medium of exchange, and needed corresponding weights to verify their transacted values. However, such gold/silver bullions of standardized weights are generally not reported from Indus sites.

Such contextualization of seal-inscriptions needs detailed provenances of weights, jewelry items, and inscribed seals/tablets. Only a few available excavation reports, which contain sufficient details of such three-fold data, can be used for Contextualization-type-4.

2.2.5 Context-type-5: Inscriptions found on implements

Certain Indus signs are found mostly on specific type of implements. For example, the semi-circular numerical signs () are till now found only on metal implements, sometimes adjacent to stroke-numerals (). They possibly signified quantifiers related to the weight and/or price of such implements.

2.2.6 Handling space-time locus-depth correlation

While analyzing Context-types 1 to 4, a significant challenge is how to correlate objects that are found together in the same location, i.e., the same grid-square getting excavated, or in the same room of a house, but at different depths. In different excavation reports, different techniques of mentioning the provenances of objects are used. For example, in Dholavira, Bisht (2015) have used a Grid-Square-Quadrant (GSQ) system, where each square-kilometer area was divided into 100*100 m grids, each grid comprised 10*10 m squares, and each square comprised 5*5 m quadrants. The artifacts found in the same GSQ locations, and at similar depths, might be correlated, by considering the stratigraphical interpretations given in the excavation report. However, while excavating the northern and southern portions of the G-section of Mohenjo-Daro's DK area, Mackay (1938) had purposefully avoided the grid-system for better contextualization, and tried to analyze the stratigraphy of artefacts mostly based on their occurrences inside same rooms of same houses or in loci near to certain houses. "The levels of every building and of every well were [therefore] taken, especial attention being paid to door-sills and pavements as being for purposes of stratification the most important parts of a building" (Mackay, 1938 p.xii). However, "if a jar or a seal lies either below or at some distance above a pavement or door-sill, it is difficult to decide to what period it belongs" (Mackay, 1938 p.xii). This limitation was generally addressed by adopting the rule "that all objects found in or near the foundations of a building be assigned to the period of that building rather than to the previous phase, unless they actually rested on the remains of a pavement of earlier date; for it is more than probable that they were dropped or left behind when the foundations were being made". However, such assumptions were not always applicable. For example, certain forms of pottery that were of Late date were occasionally found in the Intermediate levels. While the particular types of jars were "easily assignable to their proper period", the seals that happened to be dropped into holes could not be "so readily dated" (Mackay, 1938 p.xiii). Only the association of the seals with the dumped potsherds helped Mackay to infer their age. Mackay (1938) had identified three periods of occupation (Late-uppermost level, Intermediate, Early) at DK-G area, which were each divided into 3 to 4 phases and sub-phases. There were generally 3 ft. difference between the levels of the successive strata from the Late II down to the Intermediate II Phase, whereas a greater distance separated the Intermediate II and III Phases, possibly owing to a great flood. As explained in Vidale (2000), in Indus settlements, artefacts found on surface were often "displaced by rain and by complex cycles of surface decay caused mainly by saline weathering and rain wash-out […], so that the study of each single "activity area" required careful geo-archaeological monitoring. Thus, while contextualizing artefacts,

one needs to carefully study whether the actual deposition contexts were primary or secondary; whether the artefacts being analysed were dislocated by building, rebuilding, moving soil from one place to another, earth quake, flood, etc. Moreover, cities like Mohenjo-Daro were not flat parking lots that grew up in perfectly horizontal layers. Even contemporary buildings might have been laid at different levels.

Keeping all these in mind, this article contextualizes artefacts that were only found in the same room of the same house of Harappa and Mohenjo-daro, at exactly same depth or within depth-variation of less than one feet. This article does not try to correlate objects found scattered in broad areas, or on streets. Even at the same room of a house, a seal and a weight could be kept in different shelves. In Vidale, 2000 p.124, an archaeological context of a workshop in Nausharo (excavated by S. Mery) is discussed, where unbaked pottery, that was stored in suspended shelves, crashed on floor and piled up on one another. Thus, when the objects stored in same or different containers, at same or different shelves of a same room crash on floor, they might land at slightly different depths. Moreover, even when they land at same depths initially, due to post-depositional events, their loci and depths might change. Similarly, artefacts originally kept at different loci, might also end up together.

However, depending on the archaeological context, at least in some instances, the objects found at slightly different depths in same enclosed rooms might be safely correlated. This is supported by multiple instances where more than one cubical weight were found together in the same room at same depth in Indus settlements such as Harappa, Mohenjo-Daro, and Dholavira (see Section-3.2.2). For example, a conical jasper weight (0.814 gram, @GSQ-55x51x1-layer-2-depth20cm), a cuboid agate weight (6.75 gram @GSQ-55x51x1-layer-2-depth5cm), and an amorphous shell weight (1.873 gram @GSQ-55x51x1-layer-2-depth20cm), were found at same and similar depths at same locus and layer. Similarly, the discovery of 5 shell weights (0.952 gram @GSQ-58x53x3-layer-8-depth195cm, 1.033 gram @GSQ-58x53x3-layer-8-depth195cm, 0.756 gram @GSQ-58x53x3-layer-8-depth205cm, 0.718 gram @GSQ-58x53x3-layer-8-depth210cm, 0.872 gram @GSQ-58x53x3-layer-8-depth215cm) at the same GSQ location and same layer, at depths 195, 205, 210, and 215 cm, strongly indicate that they were correlated.

2.3 Methodology-B:

Archaeological evidence has already narrowed down the semantic scope of Indus-inscriptions. Keeping that in mind, the positional statistical features of functionally homologous ISC-signs can be analyzed to explore the semantic scopes of ISC's sign-classes and to guess what kind of meanings were conveyed in which parts of the brief formulaic inscriptions. However, Ansumali-Mukhopadhyay's earlier papers (2019, 2022a, 2022b) have already dealt with these evidences in a detailed way. As discussed in the introduction section, the present paper builds on their findings (Fig.2 to Fig.6).

2.4 Methodology-B in details:

This article mainly focuses on the context-sensitive core-informational segments of Indus-inscriptions. Specifically, it deals with inscriptions containing the fish-like signs (), the crucible-blowpipe sign  (allograph), and the 'ratti'/'kunṛi' sign (allograph ). It analyzes script-internal evidence to prove that the fish-signs and the crucible-blowpipe sign are semantically strongly correlated.

2.5 Methodology-C:

Indus-inscriptions should be analyzed to explore which signs frequently co-occur in the core-informational segments of same inscription-lines, in same sides of seals/tablets but in different inscription-lines (Fig.1a), and in different sides of the same inscribed objects (Fig.1c). Signs co-occurring in such contexts are semantically related to each other, though in different ways (Section-2.6). In certain cases, semantically related semasiograms/logograms do not only co-occur in inscriptions, but share similar graphemic features.

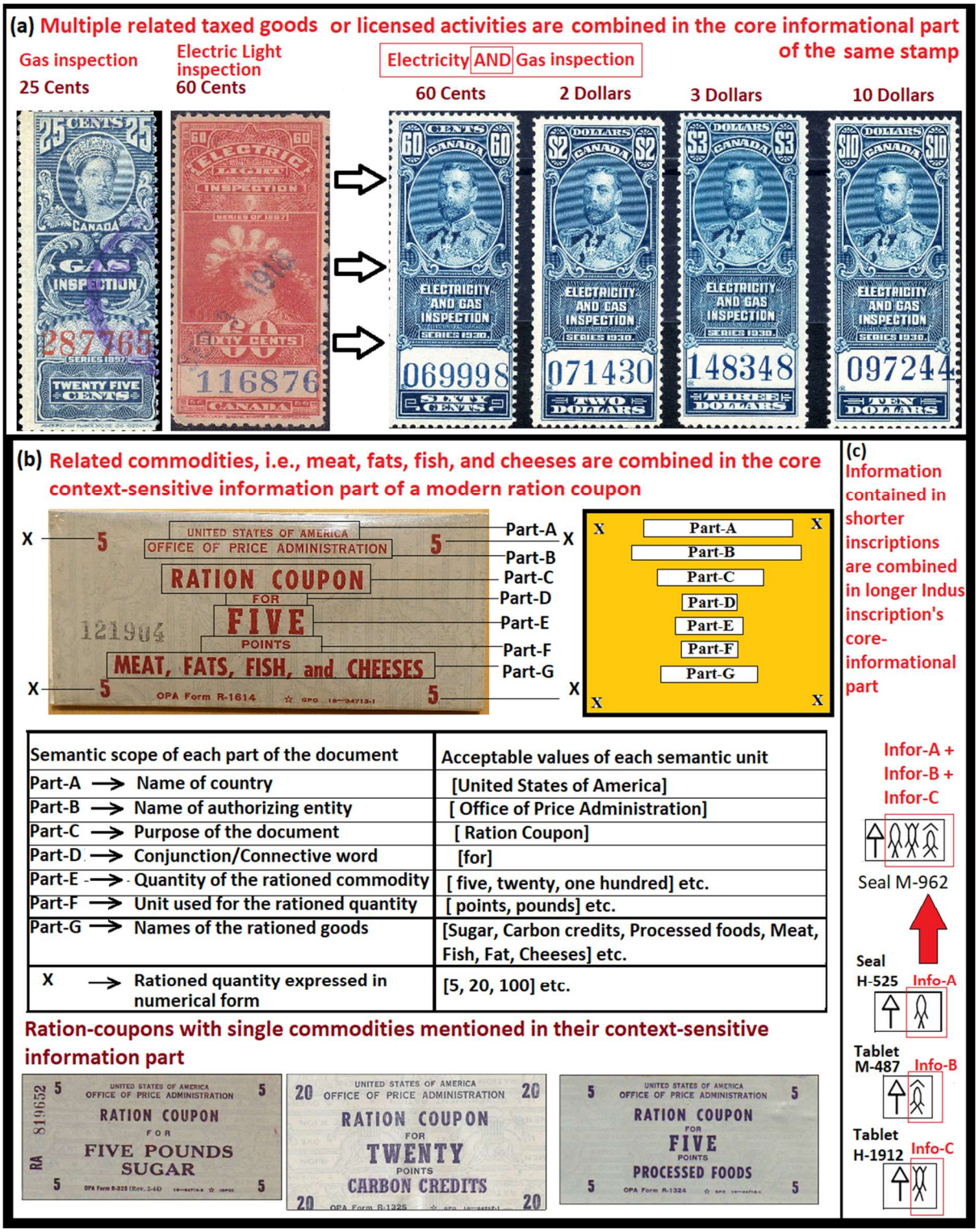
2.6 Methodology-C in details:

We can identify semantically related ISC-signs in following ways:

2.6.1 Cooccurrence in Core-informational segments:

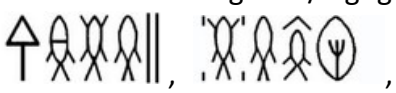
As discussed in Ansumali-Mukhopadhyay (2022a), formalized data-carriers of modern times, such as modern tax-stamps or ration-coupons, often combine related commodities or craft-names in same documents (see Fig.8). Fig.8b shows how the food-related rationed commodities. e.g., 'Meat', 'Fats', 'Fish', and 'Cheeses', which were obtainable from same shops, were mentioned together in the Context-Sensitive Part-G of some USA ration-coupons, whereas the fuel-related "Carbon Credits" was never clubbed with them. Fig.8a shows how related taxed commodities, and commercial activities, which occur separately in certain tax-stamps, get combined in others. Similarly, ISC-signs, which frequently cooccur in core-informational segments, but can also occur independently in shorter inscriptions (Fig.5, Fig.8c), should be categorized as signs belonging to related semantic scopes. Considering the semantic scopes of the core-informational segments, such signs were possibly names of mutually related commodities and crafts, which were taxed and licensed in similar ways.

Figure-8 Related commodities and crafts occurring in same tax-stamps and ration-coupons of modern era



2.6.2 Graphemic and combinatorial similarity:

In logographic/semasiographic scripts, logograms/semasiograms, which are constituted of similar basic graphemes, are supposed to be semantically related. This hypothesis gets strong corroboration when graphically related semasiograms/logograms of ISC show similar

combinatorial patterns. For example, fish-like semasiograms/logograms very frequently occur together in the core-informational parts (in more than 200 inscribed objects), and show special affinity to the same set of signs ( ,  , etc.). Similarly, semasiograms/logograms constituted by modifying the pincer-like grapheme  ( ,  ,  , etc.), when occurring in PPF position, mostly cooccur with PF1-sign  (). The fish-sign  make frequent collocations with signs  and  (e.g.,  ,), and so does its encapsulated counterpart  (e.g.,  ,). The CROP-LIVESTOCK signs  , and also show strong affinity to same set of signs (e.g., stroke-numerals,  , ). Interestingly, both  , and  have ligatures  , and  , which share similar inscriptional contexts (e.g.,  , ). Also, two to three fish-like semasiograms/logograms often co-occur side-by-side in inscription (e.g.,  , ,  , ). Thus, ISC-signs made of similar basic graphemes are undeniably semantically correlated. So, understanding the semantic scope of one such sign, should help us to infer the semantic scope of its close graphemic neighbours.

2.6.3 Individual messages clubbed in the same inscription:

Generally the inscription of one Indus seal/tablet contains one semantically complete phrase, terminated with a single PF1-sign/ENC-sign/Crop-Livestock-sign. However, in some cases, more than one such messages are inscribed side-by-side or in separate lines, often terminating with different PF1 signs (Fig.9a). Such inscriptions help us to understand the applicability of different Indus inscriptions in related semantic scopes.

2.6.4 Different seal-inscriptions on the same sealing:

A very important source of understanding the mutual applicability of multiple Indus-inscriptions in related commercial scopes, comes from the occurrences of multiple seal-impressions found on the same clay tags, which were attached to merchandise packages, warehouse-door-knobs, warehouse-pegs-on-wall, etc. (Frenez & Tosi, 2005; Parpola, 2007). Since the seal-impressions inform us about the actual usage of seal-inscriptions, if different seal-inscriptions containing specific signs get applied to the same commodity-package or a related set of commodity-packages stored in the same room of a warehouse, then we can explore the semantic relationship between such semasiograms/logograms (Fig.9b). Unfortunately, owing to the perishable nature of clay-seals, we find a very limited set of such inscriptions. Only a few tags that were accidentally (Mackay, 1938 p.353) or deliberately (Rao, 1985 p.305) burnt, remained for analysis.

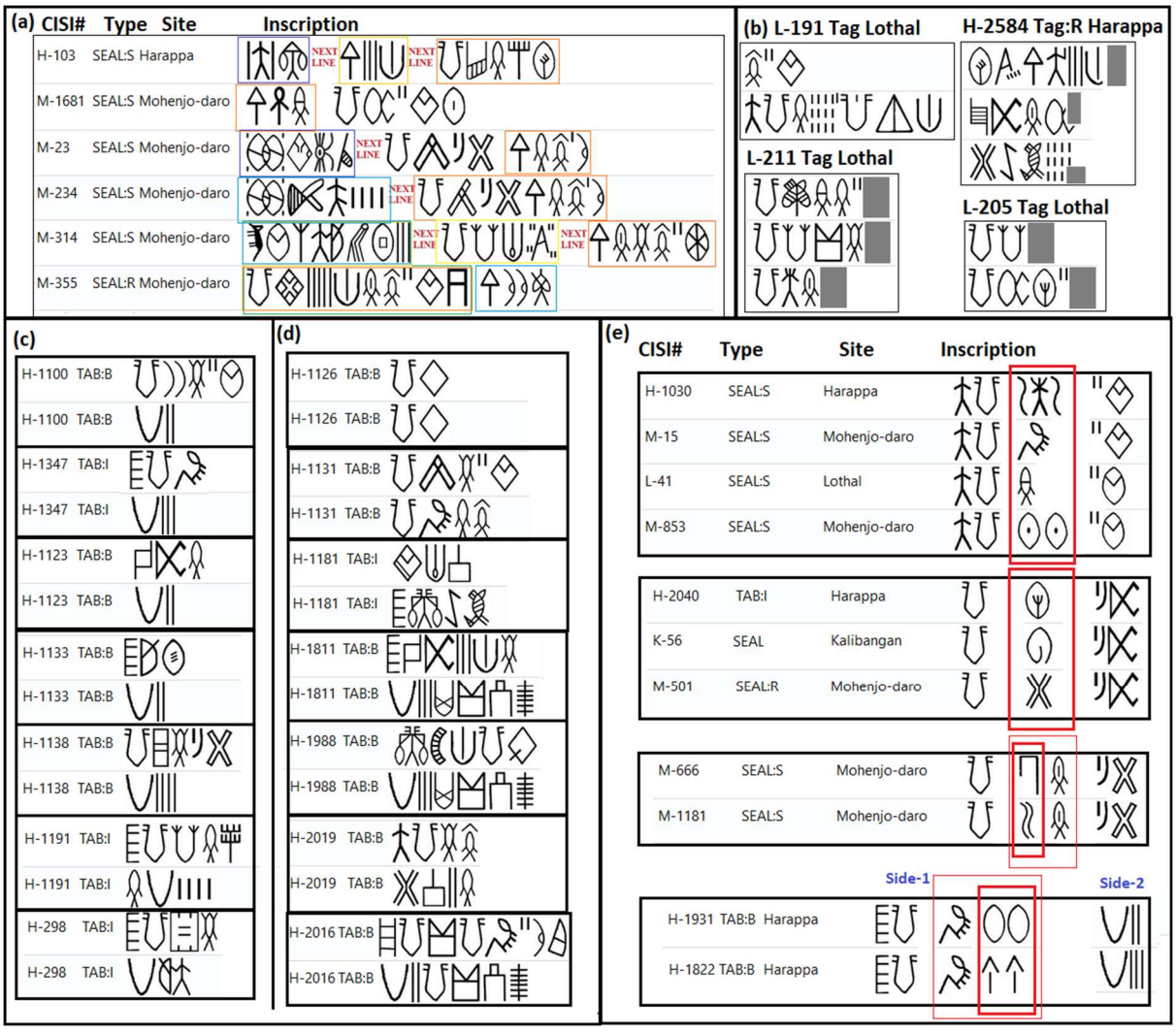
2.6.5 Inscriptions on different sides of multi-sided tablets:

Indus tablets (cuboid or prism shaped) often contain multiple inscribed sides. In some cases, the obverse and reverse inscriptions found in such tablets show pronounced difference in syntax and sign usage. For example, the inscriptions that occur alone in Indus seals, often occur in the obverse

parts of Indus tablets, accompanied by typical reverse-side inscriptions where stroke-numerals  , and  precede rim-less-jar-sign  (examples in Fig.9c).

Figure-9 Semantic relationship between Indus signs deductible from different co-occurrence patterns

a) Inscription lines cooccurring in different lines of seals; b) Different seal-impressions on single sealings; c-d) Multiple inscribed sides of tablets; e) Different Indus signs occurring in identical inscriptional contexts



Ansumali-Mukhopadhyay (2022a) has claimed that Indus tablets were certain types of licenses issued to tax-collectors, traders, and artisans. The information about the commodities and crafts associated with the licenses were written in the obverse sides. The reverse side inscriptions where stroke-numerals , and precede rim-less-jar-sign , signified certain standardized slabs of license-fees, which implicitly signified certain license categories (Ansumali-Mukhopadhyay, 2022a). Thus, here the ISC-signs occurring in the obverse and reverse inscriptions had an indirect relationship. However, inscriptions of containing similar signs and syntaxes also occur in different sides of some tablets. For example, as shown in Fig.9d, fish-signs occur in both sides of tablets H-1131 and H-2019.

Sign  occurs in both sides of tablet H-2016. Different sides of such tablets possibly contained information of multiple related licenses, which could be issued to the same person (Ansumali-Mukhopadhyay, 2022a).

2.6.6 Identical inscriptional contexts shared by different signs:

Certain Indus signs share identical inscriptional contexts with each other (Fig. 9e). Such patterns help us to confirm that the type of meanings conveyed by such signs belong to the same category, whereas those meaning need not be contextually related. For example, the phrases "Sugar" and "Carbon credits", occurring in the context-sensitive Part-G, shared same inscriptional contexts in USA ration-coupons (Fig.8), as they were both rationed commodities. But, unlike "Meat, Fats, Fish, and Cheeses", they were not contextually related, as one is a food-item, another is a fuel. Similarly, the signs highlighted with dark-red-lines in Fig.9e, belong to similar functional categories, whereas their meanings and their archaeological contexts might be similar or different.

2.7 Methodology-D:

Iconicity of certain ISC-signs can be analyzed to check whether the apparent graphical referents of a sign, and its inferred semantic scope (inferred by analysing their positional-statistical features and archaeological contexts) match with each other. If such associations are found, the researcher should then check whether the inferred symbolism associated with the sign's iconicity have been used in ancient India. One should also check whether similar symbolism was used in scripts of other ancient civilizations which were contemporary with IVC, and had similar technological advancement as IVC.

2.8 Methodology-D in details:

A representative example of application of Methodology-D is this study's claim that sign  (allographs  , ) symbolized a blowpipe  inside a crucible  , and metonymically signified gold and gold-smithy. Now, crucible-blowpipes are traditionally associated with the meanings of smelting, precious metals, gold-smithy and metal-smithy. For example, in Egyptian hieroglyphic writing, symbols of "an artisan using a blowpipe and a crucible" ( ,  , ) are used as determinatives in words 'nubi', 'nub-t', and 'neb', which signified 'smelter', 'foundryman', 'goldsmith', "metal working" etc. (Budge, 1920 p. 354, 366). In Mesopotamia, Akkadian smith-word 'nappâḫu', and Sumerian smith-word 'simug' have used similar blowpipe and crucible symbolisms (Forbes, 1950). In India, smithy-words related to blowing air and blowpipes are found across Indo-Aryan (e.g., 'nāḍindhama', 'dhmāyaka', 'nālindhama') and Dravidian languages (e.g., 'kommukāḍu', 'kommūḍeḍivāḍu', 'ūdu', 'nāḍindhamuḍu'). Thus, for the sign  , its iconicity completely matches with its inferred meaning (inferred based on archaeological, and script-internal evidence, as discussed in Section-6).

2.9 Methodology-E:

This study analyzes linguistic words used in ancient India, as well as linguistic words used in other civilizations contemporary to IVC, which signified the inferred meanings of ISC-signs, and used

the symbolisms related to the signs' graphemes in their coinages. This provides corroborating evidence for the conjectures made based on archaeological contexts of Indus-inscriptions and script-internal positional-statistical and graphemic features of ISC-signs. Methodology-E is different from Methodology-D, as it includes a script's application of homonymy.

2.10 Methodology-E in details:

When a group of people, for some reason, associates meaning-1 to meaning-2 through certain symbolism, then the linguistic words that signify meaning-2, can indirectly signify meaning-1. This kind of symbolism, often metonymical in nature, may reflect in a semasiographic/logographic script, where a symbol that resembles an object related to meaning-2, will be used to signify meaning-1. For example, since the White House has been the residence of every U.S. president since 1800, the term "White House" is used as a metonym for the serving U.S. president and his advisers. Thus, a logographic script can show a "white house" icon to signify the U.S.A. president, or the U.S.A. government. Sometimes such symbolisms are local to a certain place (e.g., "White House"). Sometimes, there is a universal symbolism used for a meaning, which germinates similar coinages in various mutually unrelated languages. For example, as discussed in Section-2.8, crucible-blowpipe related words have been used to signify goldsmiths in languages of ancient Egypt, Mesopotamia, and India.

While this study analyses historical evidence for discovering any such symbolism used in ISC-signs, it also adds the necessary disclaimer that whenever linguistic words related to meanings of ISC's signs are discussed, this study neither tries to assign any specific sound-value to those signs, nor the author suggests that all the ISC-signs were closely associated to the words of any specific language family. Since linguistic words often encode ancient symbolisms related to a meaning, and a particular coinage of one language often gets used as a calque in another, this study uses such linguistic references to show how ancient coinage of certain Indic and foreign words closely relate to the proposed symbolisms of an Indus sign, and corroborates related conjectures. However, if the symbolism related to a specific sign seems to be closely related to a particular language's homonymic words that are not found in any other languages, then one can suspect that some ancestral form of that language had influence on that particular sign of ISC (e.g., the suspected Dravidian 'mīn'-based homonymy applied in ISC's fish-signs, discussed in Section-3.3).

2.11 Methodology-F:

Identifying functionalities of certain inscribed artefacts whose functionality has baffled archaeologists till date, and correlating the inscriptions found on them with their functionalities.

2.12 Methodology-F in details:

This study claims to have identified certain gold needles, and a gold-tipped copper needle found from Mohenjo-daro and Kotada Vadli, as gold-assaying needles, which were used along with touchstones. The identification is done based on the shape, material, and archaeological contexts of the artefacts. Now, sign  , which is identified as IVC's gold-symbol, was inscribed on one of the assaying-needles. The sign  , whose icon closely resembles an Abrus precatorious seed was inscribed on another. The traditional 'ratti' unit used by Indian goldsmiths since ancient times, which is based on weights of Abrus precatorious seeds, is comparable to 'carat', an international weight unit for measuring gemstones, and a measurement of purity for gold, which is traditionally associated to carob seeds (Turnbull et al., 2006). The modern assaying-needles often bears the "carat" word, or its abbreviation 'k', accompanied by numerals 18, 22, etc., which signify the numerators of 24-based

fractions. Thus, occurrence of  accompanied by stroke-numerals in an assaying needle of IVC, gives our identifications of  and  , a very strong corroboration.

2.13 Materials

The materials used in this study include Indus script corpora created by three different scholars. The corpus compiled by Wells and maintained by Fuls (referred to as ICIT), Mahadevan's digitized corpus (1977), and Parpola's photographic corpora of inscribed objects (CISI), are used in this study to analyze the graphemic and combinatorial features of ISC signs and for visualizing the inscribed artefacts (Wells and Fuls, 2006; Mahadevan, 1977; Joshi and Parpola, 1987; Shah and Parpola, 1991; Parpola et al., 2010; Parpola et al., 2019). All inscribed artefacts are referred to using their CISI serial-numbers, if not mentioned otherwise. When CISI-numbers are absent, the excavation numbers of those artefacts, prefixed with ASI# (Archaeological Survey of India), are used. All the Indus inscriptions are rendered in a right-to-left normalized direction, when not mentioned otherwise.

Other than ISC corpora, various archaeological excavation reports, ancient texts, and books on history and linguistics, have been used in this study.

3 Decoding fish-like ISC signs

Fish-like signs (Fig.10a) are one of the most prominent group of signs used in Indus-inscriptions, as they occur in around 1250 inscription-lines among around 5500 inscription-lines recorded in ICIT (see Fig.10b-c). The usage of the crocodile-fish symbolism found in certain artefacts (e.g. seal CISI#M410, Fig.10b), and the fish-shaped incised-tablets containing fish-sign inscriptions (CISI#H-329, Fig.10b) confirm that the fish-like semasiograms/logograms used some kind of fish symbolism to convey their meanings. Below I shall use archaeological, ethnolinguistic and historical evidence to substantiate my claim that the fish-signs have strong semantic association with gemstones, lapidary craft, related taxations and trade permits.

3.1 Archaeological evidence of the correlation between fish-signs, gemstones and bead-making

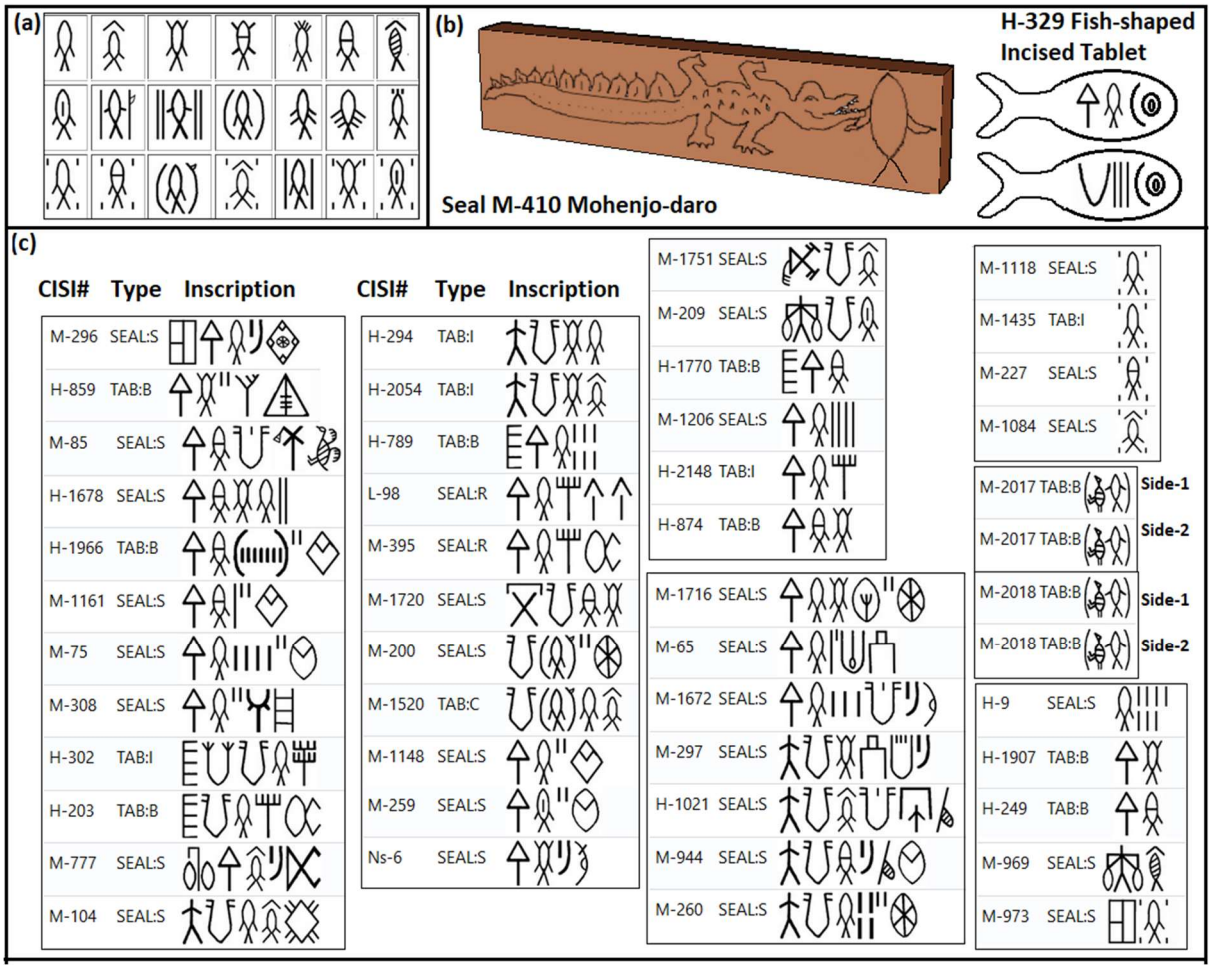
3.1.1 Evidence from Mohenjo-daro (Methodology-A, Context-type-1):

Marshall (1931, Vol-1 pp.194-195) describes a small 8-by-7 feet room found in Mohenjo-daro, part of House-VIII in HR Area, which "yielded the most important find of the season". The artefacts found in this room were (i) silver and copper vases (ii) a copper axe and chisel (iii) various gold and silver ear-ornaments (iv) bangles, (v) diadems, (vi) fillets, (vii) pins, (viii) unfinished ornaments, (ix) "a large collection of beads of gold, silver, faience, semi-precious stones, mounted in some cases in gold caps at both ends", (x) pendants made of different materials, (xi) perforated spacers, (xii) hemispherical ornament terminals. This room was undoubtedly part of a jeweller's shop as: (a) It is simply not possible that so many items linked to jewellery had accidentally landed over this 8-by-7 feet small enclosure from different stratigraphic layers; (b) Since a chart scraper, several unfinished ornaments, and parts of ornaments (spacers, terminals, etc.) are found in this room, it must have been a place of making and selling jewellery, not a personal treasury of a wealthy person.

Interestingly, this jeweller's shop has yielded a single seal, CISI#M-294, containing the inscription  , and an interesting iconography with two animals, a syncretic bovine-animal with a trunk and an elephant (Fig.11a). Though this seal is clipped on right side (see CISI-1, p.71), analysing the

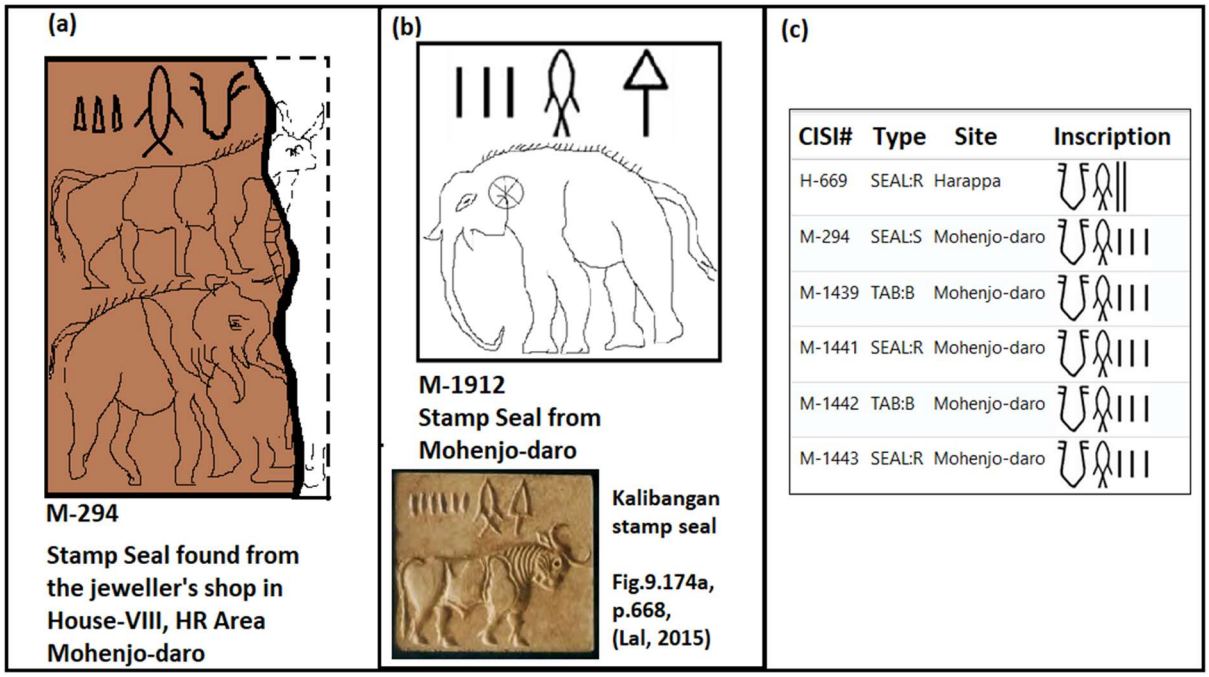
position of its text and the accompanying iconography, the existence of the phrase-ending PF1-sign , the space remaining after , and the spacing pattern in similar inscribed seals/tablets (Fig.11b-c), we can be sure that this inscription-line was the undamaged complete message of this seal, which is not affected by clipping (Fig.11a). Moreover, similar patterns of <Stroke-sign Fish-sign PF1> are found in several Indus seals and tablets (Fig.11b-c). Now, since Indus seals were mostly used as tax-stamps and commercial permits (Ansumali-Mukhopadhyay, 2022a), when we get a seal in an undoubtable archaeological context of a jeweller's shop, we should semantically link its inscription's context-sensitive-part, i.e., , with commodities related to jeweller's craft and associated taxation and trade-license.

Figure-10 Fish-like semasiograms/logograms and their usages in Indus inscriptions



So, ignoring the numerical sign , which possibly signifies some commodity-specific tax-rate or licensing-fee (Ansumali-Mukhopadhyay, 2022a), the remaining fish-sign of the context-sensitive core-informational part of the inscription, should be associated with the archaeological context of this seal, i.e., the context of a jeweller's shop.

Figure-11 Representative Drawings of Seals M-294 (a), M-1912 (b), and some related inscriptions (c)



3.1.2 Evidence from Harappa (Methodology-A, Context-type-1):

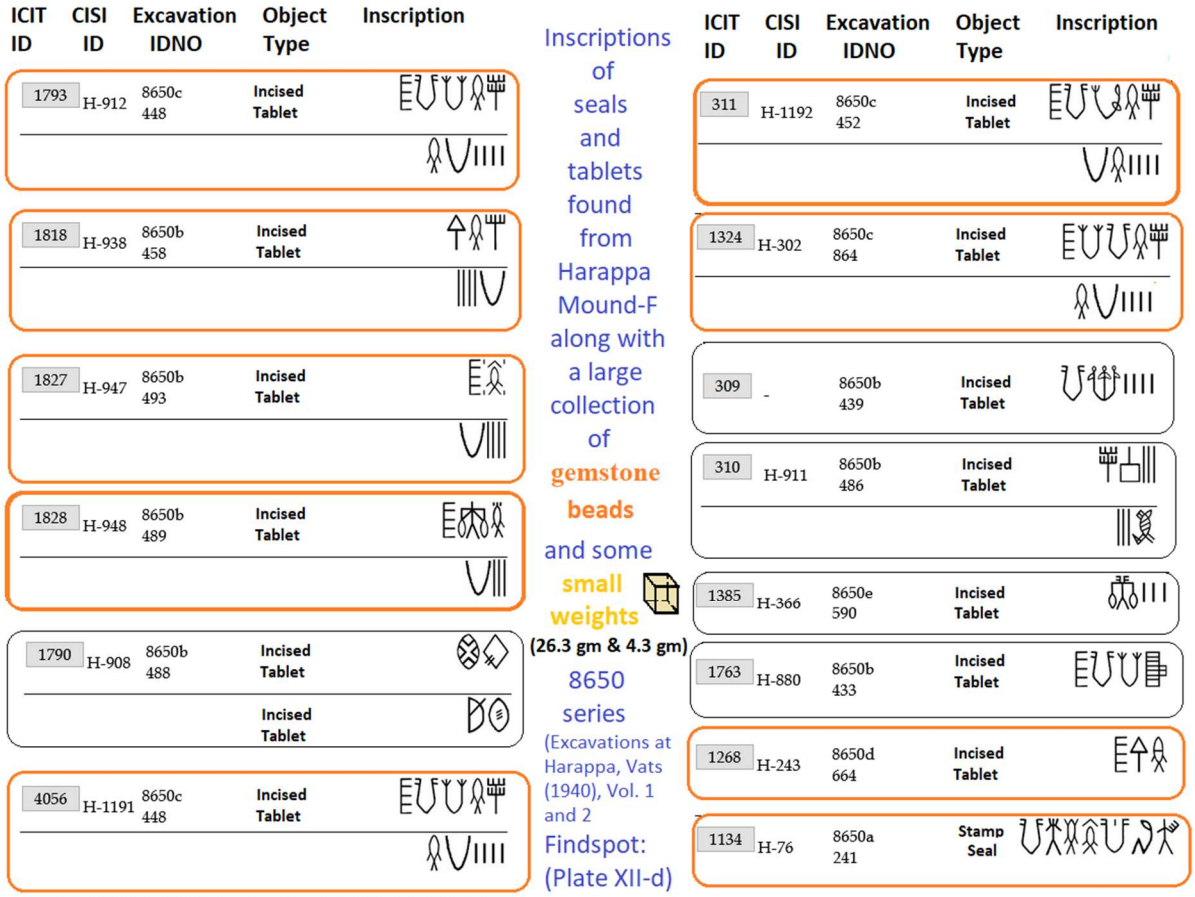
In Harappa, Vats (1940 pp. 58-60, 435) reports the finding of "a number of instructive antiquities, including a representative collection of jewellery" (Series No. 8650), which comprised i) numerous objects of stone, faience, gold, and copper; ii) two small cubical weights (26.3 and 4.3 grams); iii) shells; iv) a large collection of beads (of various shapes and sizes, made of gold, carnelian, steatite, faience, shells, etc.); and iv) several seals and incised tablets. All these artefacts were discovered in squares H-12/21 and I-12/1 of Mound-F Stratum-IV where "a well and fourteen Workmen's Quarters of peculiar design" were also found. Here, the presence of a large collection of gemstone beads, small weights, and workmen's quarters indicate that this place was an important lapidary workshop. Now, among the 14 tablets and seals found from this location, 8 tablets and 1 seal contain fish-signs (see Fig.12), indicating a strong correlation between fish-signs and lapidary and jewellery workshops.

3.1.3 Evidence from Chanhu-daro (Methodology-A, Context-type-1):

Chanhu-daro, located around 130 kilometres south of Mohenjo-daro, in Sindh of Pakistan, was a significant commercial settlement of IVC. This settlement was inhabited in different phases, some of which cannot be analyzed for contextualization due to destruction and dislocation of artifacts owing to flood. However, the material remains of the Harappa-II occupation of Chanhu-daro (middle of third millennium BC), could be satisfactorily contextualized. At this period Chanhu-daro was a thriving centre of various commercial activities, among which "[b]ead-making was an important source of revenue" (Mackay, 1943 p.52). "Large numbers of unfinished beads, together with the stone drills used for boring them" were discovered in Chanhu-daro (Mackay, 1943 p.52). "Supplies of the raw materials for bead-making were also unearthed; in several cases nodules of agate showed signs of having been treated with heat. There were also lumps of amethyst, crystal, and carnelian" (Mackay, 1943 p.52).

Relevantly, Mackay (1943 pp.46-47) has identified a small room, Room#174 (7 feet 7 inches by 3 feet 2 inches), in a house in Square-9/D of the second Harappan Occupation, which functioned as a small lapidary workshop. This room has yielded many unfinished beads at the level +6.8 feet and a seal (ASI#2297, PI- LI, 29; CISI#C10) at a slightly lower level. This seal contains an inscription  depicting two fish-signs, indicating the correlation between fish-signs and gemstones.

Figure-12 Contextualized diagrams of inscriptions of seals and tablets found from a lapidary workshop of Harappa. Objects with fish-sign inscriptions are marked with orange borders



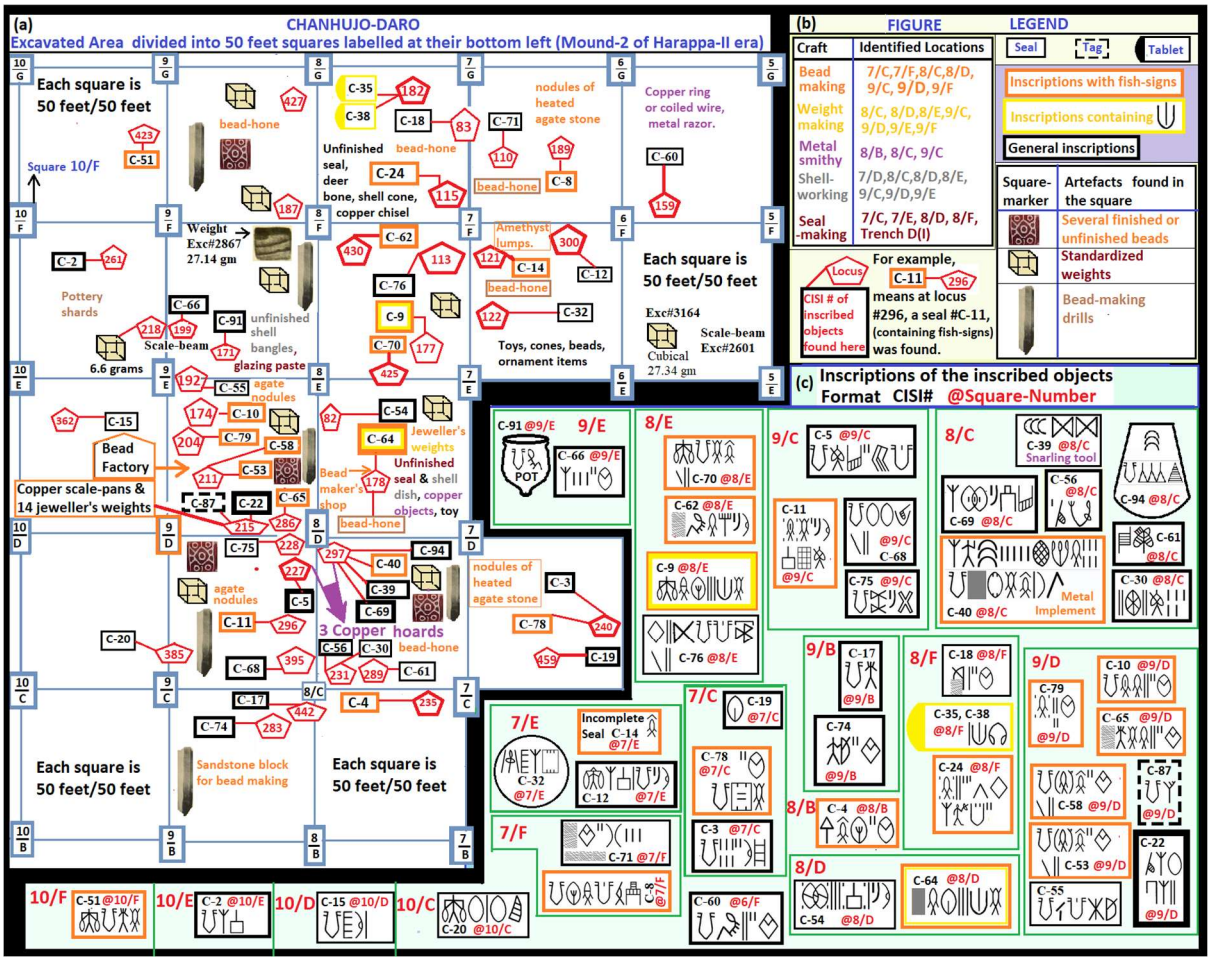
Since Mackay (1943) has admirably identified which excavated areas were possibly related to which craft (bead-making, shell-working, metal-smithy, etc.), Chanhu-daro provides many more instances that support the fish-sign-gemstone hypothesis. The Plate-IV in Mackay's (1943) excavation report contains a detailed contour map of Chanhudaro's Mound-II of Harappa-II occupation, where the excavated area is divided into 50-feet squares labelled with row and column numbers. Using this map, the detailed provenance of artefacts provided in the excavation-report, and Mackay's analysis of the commercial activities performed in specific locations, I have provided a contextualized diagram of certain inscribed seals and tablets in Fig.13.

As observed by Mackay (1943), metal-smiths, lapidary-workers, and shell-cutters often worked in the same houses. For example, in Square-9/D, inside Room-215, copper-tools, copper and bronze knives, a copper pin, a flake drill, a faience gamesman, a queer shell object, some carnelian nodules, and various unfinished beads that were meant to be glazed, were found in the same level (+10.4 feet). Moreover, 14 small weights and scale-pans of copper were also discovered and an

additional weight was found in a nearby furnace-room. Two large shells were also present here, indicating that "shell working was also practised in this workshop" (Mackay, 1943, p.43).

Now, most importantly, Mackay has identified this building (comprising locations 215, 286, and 287) as a "bead factory with furnace". Interestingly, Seal CISI#C-65 (ASI#CH-2428) was found here, on the floor of passage 286, and it contained a fish-sign inscription  , corroborating the Fish-sign-Gemstone-Bead correlation.

Figure-13 Some contextualized inscriptions found from Mound-II, Second Harappan Occupation at Chanhujo-daro.



Square-9/D is specifically identified as bead-maker's area, that yielded not only unfinished beads, but various rare bead-making tools, and a system of flues possibly used for glazing beads (Mackay, 1943 pp.41-44,187). Now, we can see in Fig.13 that out of the 9 inscribed seals found from 9/D, six seals have fish-signs in them. Among the Squares of Mound-II, Square-9D, containing the bead-factory, has yielded the maximum number of inscriptions containing fish-signs, which cannot be mere coincidence, and strongly corroborates our fish-sign-gemstone-bead hypothesis. Interestingly, almost each of the Squares which Mackay has associated with lapidary workshops (7/C, 7/F, 8/C, 8/D, 9/C, 9/D, 9F), have yielded at least one fish-sign containing seals, and many of them (e.g. 8/C, 8/D, 9/C, 9/D, etc.) have yielded small cubic weights. In Mackay's (1943, p.52) words, "Closely associated with bead-making was the manufacture of stone weights, many of which are so highly finished that we suspect that they were used for testing purposes". Interestingly, a small room from where a door-

way opened to a courtyard in locus-297 of Square-8C (Square-8c was a area used for bead-making, seal-making and metal-smithy), was possibly "occupied by the man in charge of what appears to have been a factory for beads and seals" (Mackay 1943, p.44). According to Vidale (2000, p.121), the buildings of Chanhu-daro, "might have been warehouses of rich merchants, more than workshops and actual residences of craftspeople, while the working areas, as suggested by Mackay, might have been sheltered outside the buildings, under provisional roofings. Some important activities such as storage, hoarding and perhaps accounting, and some critical manufacturing steps, for example the firing of good quality, valuable carnelian nodules could be carried on in the buildings (the kiln in room 215-286), under direct control of merchants and craft supervisors". Now, as shown in Fig.13, 3 inscribed artefacts are found from locus-297, and one of them contained 2 fish-signs. Thus the abovementioned co-existence of lapidary workshops, cubic weights and fish-sign inscriptions found near the supervisor's room of the workshop strongly supports our hypothesis that fish-sign-inscriptions are generally found in lapidary contexts, and were associated with related trade-control and craft-control activities.

Moreover, in the seal inscriptions found in 8/D and 8/E, both the crucible-blow-pipe signs related to gold-smithy (see Section-5), and the fish-signs related to gemstones co-occur (see inscriptions marked by both yellow and orange borders in Fig.13). Thus, as expected, the relationship between gemstones, bead-making and gold-smithy got reflected in these seal/tablet inscriptions, which were used as trade-permits and tax-stamps.

3.1.4 Corroborating data from Bagasra

In the Phase-II urban occupation in Gola Dhoro (Bagasra) of Gujrat, this site was a thriving commercial centre involved in i) shell working ii) gemstone bead making iii) procurement and initial processing of gemstones (stockpiles of almost 170 kilograms of jasper, significant amount of white-banded-black-agate, etc. are found) which were shipped to other Indus settlements for local bead-making, etc (Bhan, 2018). Now, since the seals found from Bagasra "were recovered at varying depths, from 3 meters to 26 centimeters below datum, a range of nearly 2.75 meters", it is not easy to directly associate all of them with specific craft-production areas, as some of them could be to some extent dislocated "through alluvial and or erosional activities" (Jamison et al., 2017). However, archaeologists claim strong association between these seals and Bagasra's craft-production activities (Jamison et al., 2017). Since this fortified settlement is strongly correlated with trading and redistribution of gemstones, the existence of 3 seals with fish-sign inscriptions, among the 5 undamaged seals found from this area (see Fig.7), significantly corroborates our fish-sign-gemstone related hypotheses.

3.1.5 Data from Indus sites with less detailed excavation reports

Excavation reports written without sufficient details often rob us off opportunities of correlating Indus-inscriptions with their specific contexts. For example, In the draft report of the Rakhigarhi excavations of seasons 1997-98 and 1999-2000 (the final report is not available yet, even after 20 years from excavation), Nath (2014 p.116-118) records two sealings found from the floor of a bead factory, in the context of hundreds of carnelian beads found in various stages of manufacture, rejected cores and flakes, a bead polisher, a bead-drill, and a bead-kiln situated near the building. But Nath (2014) mentions nothing about the sealings other than their elephant iconography, depriving us of a contextualization opportunity. Similarly, a fragmented seal (ASI#6304) with the fish-sign inscription  was found from Rakhigarhi's bead-rich RGR-2 area (among the 11421 beads found from Rakhigarhi, more than 8000 beads come from

areas RGR-2 and RGR-4). But Nath (2014) provided no detailed locational information for the RGR-2 beads or seals. Interestingly, inscriptions similar to  are found from other Indus settlements with more contextual data, which seem correlated to lapidary related contexts. For example, in Chanhujo-daro,  (Seal CISI#C-67, ASI#CH-4960) was found in Square-13/J of Mound-I, where lapidary related small agate weights (e.g., 27.36 gm, ASI#3822; ASI#3882), rare round-sectioned chisels for making depression in beads (see Bisht, 2015 p.446; Kenoyer, 1991 p.53), copper axe, shell inlays, shell ladles, antler of a hog deer (deer antlers are still used as raw material for beads), etc., are found (Mackay, 1943). Similarly, another Chanhujo-daro seal  (CISI#C-4, ASI#CH-2390) is found from the upper part of square 8/B (see Section-4), very near to Square 8/C, where lapidary work and metal-smithy were in vogue and certain lapidary related weights were discovered (Mackay, 1943). Interestingly, round-sectioned bead-drills are quite rare, and the only two found from Chanhujo-daro are discovered from squares 13/J and 8/B, precisely the locations of  and  . In Harappa, seal-inscription  (ASI#10835a) is found at 3 ft. depth in Mound-F's Stratum-II, Square P-9/5 (400 square-feet area), along with various faience and steatite beads (Vats, 1940 pp.9,124,130 & Plate XXVI). Hence, circumstantial evidence indicates that if Rakhigarhi excavation reports were made available with sufficient details, we could have found more evidence that correlates fish-signs with lapidary activities.

Similarly, in the brief articles on Banawali, Bisht (1984, p.96; 1982, p.117) has mentioned a seal (CISI#B-17, ASI#BNL-9201) containing a syncretic horned-tiger iconography, and the inscription  , which was found from the "paved sitting room" of a "prominent" merchant's house. This house also yielded "a rich harvest of seals, weights, beads, including those of gold, lapis and etched cornelian, besides the deluxe pottery of the age". Now, since this seal-inscription contains a fish-sign, it corroborates this study's proposed correlation of fish-signs with gemstone-beads and lapidary weights. But, unfortunately, Bisht's articles provide no details about the other seals recovered from this house and its neighborhood. Thus, the other fish-sign inscriptions ( ,  ,  , ) found from Banawali, that are recorded in CISI, remain mostly context-less.

ICIT has recorded around 24 inscriptions from Kalibangan that contained fish-signs. But the huge two volume excavation reports of Kalibangan (Lal et al., 2015; Lal et al., 2020), which were published almost after 50 years of the excavations, contain almost no details regarding the exact find-spots of inscribed objects, beads, weights, and other artifacts, making any contextualization almost impossible.

There are many such instances of insufficient details given about inscribed artifacts in IVC's excavation reports that affect Indus-script research.

3.2 Inscribed artifacts containing fish-signs share archaeological context with jeweller's weights (Methodology-A, Context-type4)

The tiny weights used by jewellers and goldsmiths are often found near lapidary workshops, or near lapidary stockpiles. For example, "a series of very small weights in the form of gold discs", whose weights were multiples of the standard weight of Abrus precatorius seeds (traditionally used as goldsmith's weights), were "carefully preserved in a pot" found in a "building close to the bead factory at Lothal" (Rao, 1985 p.693) (the Lothal "bead factory" was probably not a workshop, but a house of a merchant dealing with gemstone beads, as observed by Vidale and Kenoyer (Vidale, 2000 p.115)). In Mohenjo-daro, a jeweller's hoard buried in a copper canister in DK area, block 15, house VI, which included beads, broken silver, bracelets, etc., also contained a jeweller's weight weighing around 6.4 grams, along with certain stone objects suspected to be touchstones (Mackay, 1938 p.404). Many more such instances are recorded in IVC's excavation reports.

3.2.1 Fish-sign inscriptions and jeweller's/goldsmith's weights found in craft-making areas

As expected, fish-sign inscriptions are correlated with findspots of small-range jeweller's weights. As shown in Fig.13, in Chanhujo-daro, inscriptions containing fish-signs were strongly correlated with the findspots of tiny weights (e.g., squares 9/D, 9/C, 8/D, 8/E). At, Square-9/D, in the bead-factory, 14 tiny jeweller's weights are found, whereas Square 9/D yielded the maximum number of fish-sign inscriptions.

As discussed in Section-3.1.2, two small cubical weights weighing 26.3 and 4.3 grams were found along with a large collection of beads, a lot of jewellery related items, and many seals and incised tablets containing fish-sign inscriptions (Fig.12). These artefacts were discovered in squares H-12/21 and I-12/1 of Mound-F Stratum-IV where "a well and fourteen Workmen's Quarters of peculiar design" were also found.

3.2.2 Fish-sign inscriptions and jeweller's or goldsmith's weights found in residential areas, khans, etc.

As discussed in Section-2.2.2 and Section-2.2.3, seals or tablets found together in residential buildings and khans have to be contextualized differently. At

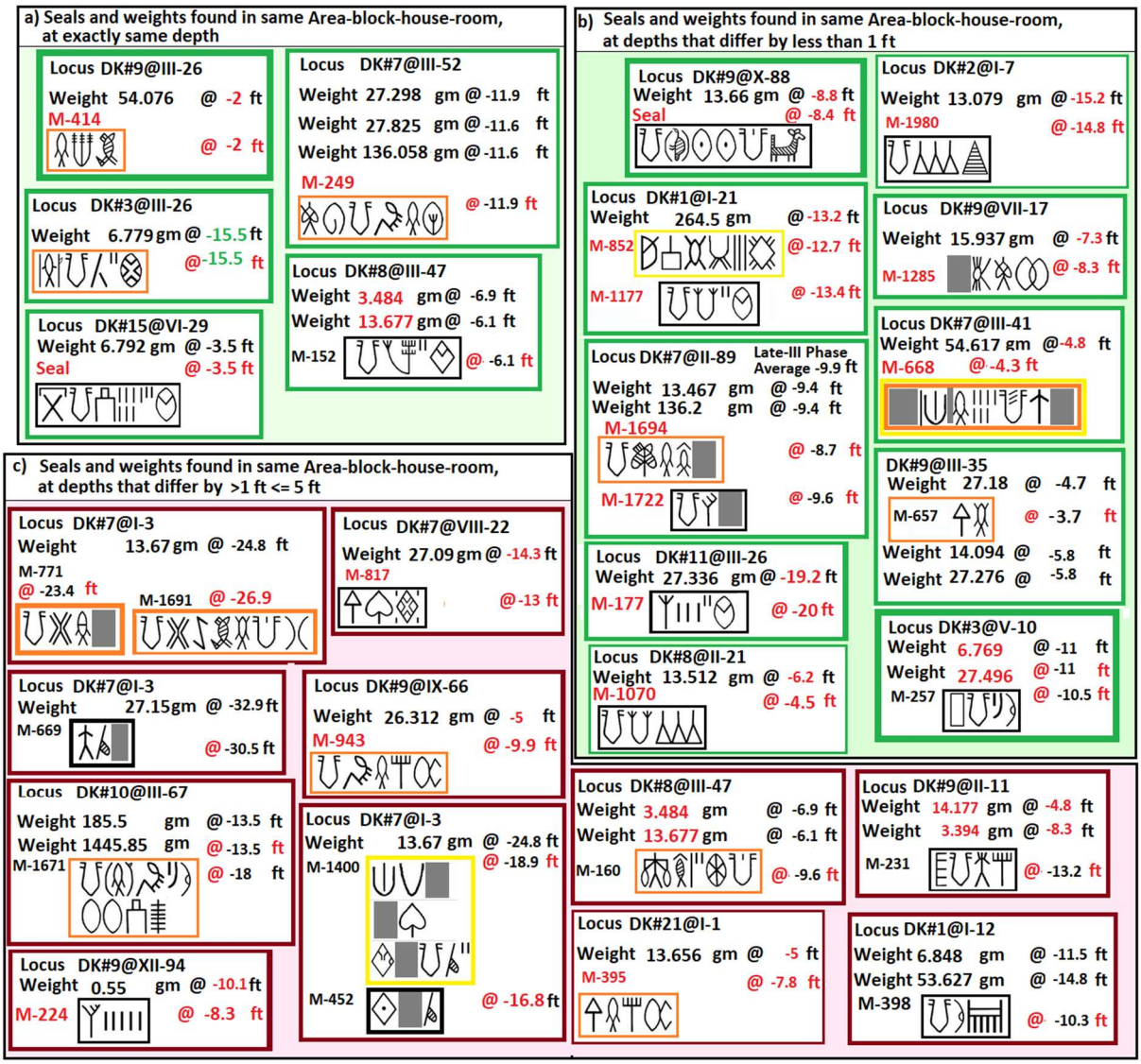
In Harappa, other than a few public houses, and workmen's quarters near workshops, most of the buildings excavated by Vats (1940, p.14) are "dwelling-houses". Most of the time, the seals/tablets found in such houses will have no specific craft/trade related contexts, as the dwellers of these residential houses might have kept their trade-related belongings somewhere else (Vidale, 2000 has relevantly observed that at "Mohenjo-Daro, we have positive evidence that at least some craft industries were performed outside the boundaries of the possible ceremonial-residential areas of the Citadel and the Lower Town"). But, when seals/tablets are found together with specific commodities in such a building, we can apply Context-type-4. For example, at Harappa, in SquareP-10/15 of Harappa's Mound-F, tablet H-747 (ASI#11516) containing inscription  , is found with cubical chert weight of 6.9 gram, at depth of 4 feet 8 inches below-surface (Vats, 1940 p.133-135). More importantly, in Square M11/15, at depth of around 5 feet to 5 feet 9 inches below surface, 5 complete seals containing fish-sign inscriptions ( ,  ,  ,


) and a fragmentary seal with a crucible-blowpipe sign (

CISI#H-97), were found together, along with 9 cubical jeweller's weights (size ranging between 0.5 in. cube and 1 X '95 x '6 inches), 4 conch shells, a dozen terracotta beads, some pottery bangles and vases, shell beads, etc. (Vats, 1940 pp.85,416). These seals most likely belonged to a trader dealing with gemstones, jewellery and shiny-precious commodities, whose licenses were expressed through fish-signs and gold-sign (Section-6).

In case of public buildings, different rooms of the same building can be occupied by traders and officials handling different types of trades and crafts. This applies to several public and residential buildings of Mohenjo-daro. Thus, here we can apply context-type-2 and context-type-4, to check if specific types of inscriptions are generally found together with characteristic artifacts, such as goldsmith's weights.

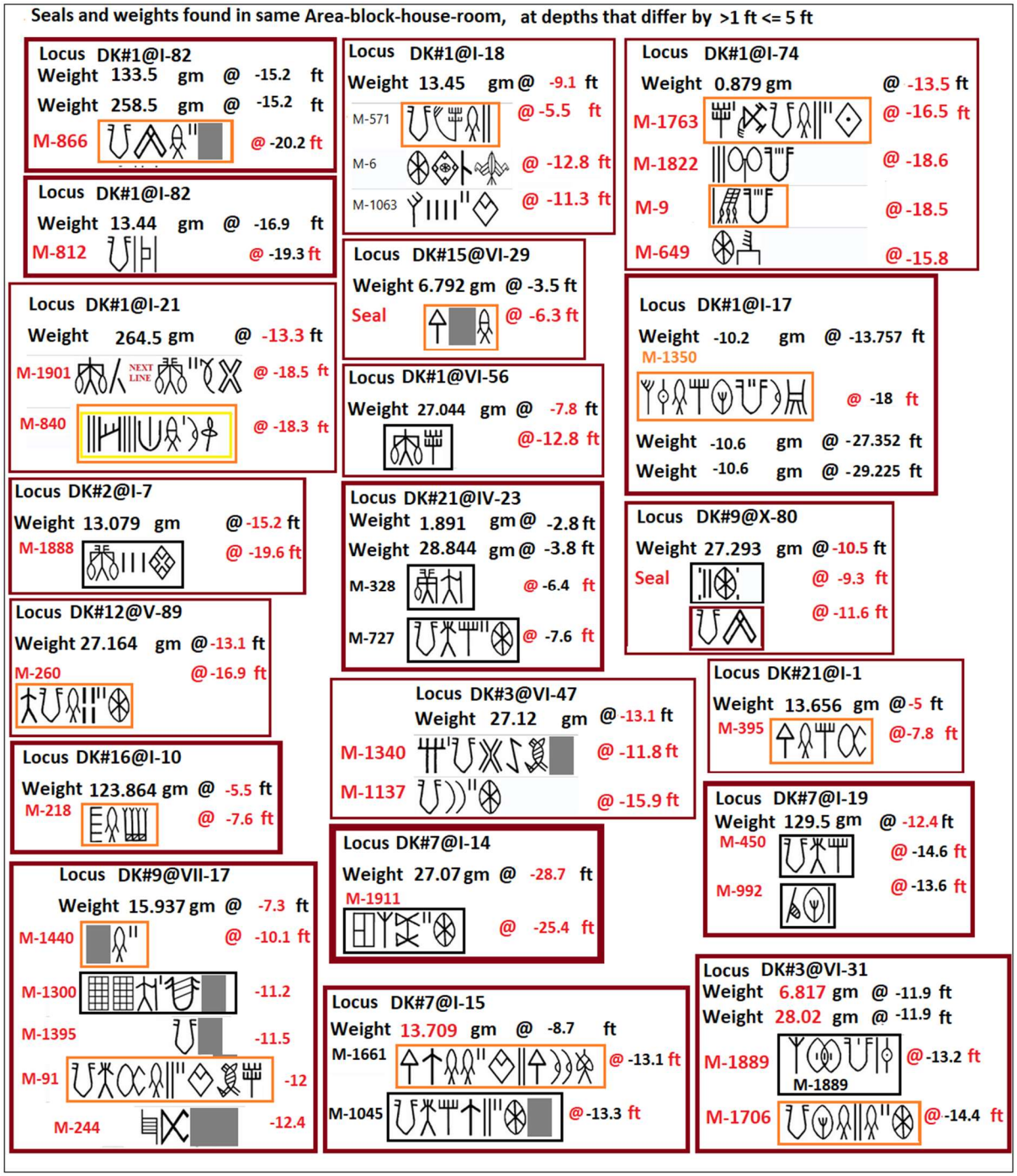
Figure-14 Inscribed seals/tablets and small standardized jeweller's weights discovered from Mohenjo-daro at same room of same house, same or different depths (List-1)



Using the detailed provenance of 220 weights documented in Mackay (1938, pp.400), this study finds that 76 of them do not have a block-house-room level provenance detail. For the 144

weights having specific room-level granular provenance, around 75 weight share the same locus with one or more inscribed seals and tablets. But, if we match the depths of the seals/tablets and the weights found in the same loci, only 15 such rooms are found where the seals and weights were found either at exact depth, or within 1 feet depth difference. In Fig.14, Fig.15, and Fig.16, inscribed seals/tablets found at same house-rooms as weights, but at different depths, are categorized by the difference of depths. Among the 5 seals found along with weights at exactly same depths of the same house-rooms, 3 seals contain fish-signs. With increasing difference of depth, the surety of correlation might decrease considerably. However, among seals/tablets and weights found with 1 feet, 2 feet, and 5 feet differences, quite a few of them contain inscriptions with fish-signs or crucible-blowpipe signs (Fig.14, Fig.15, Fig.16).

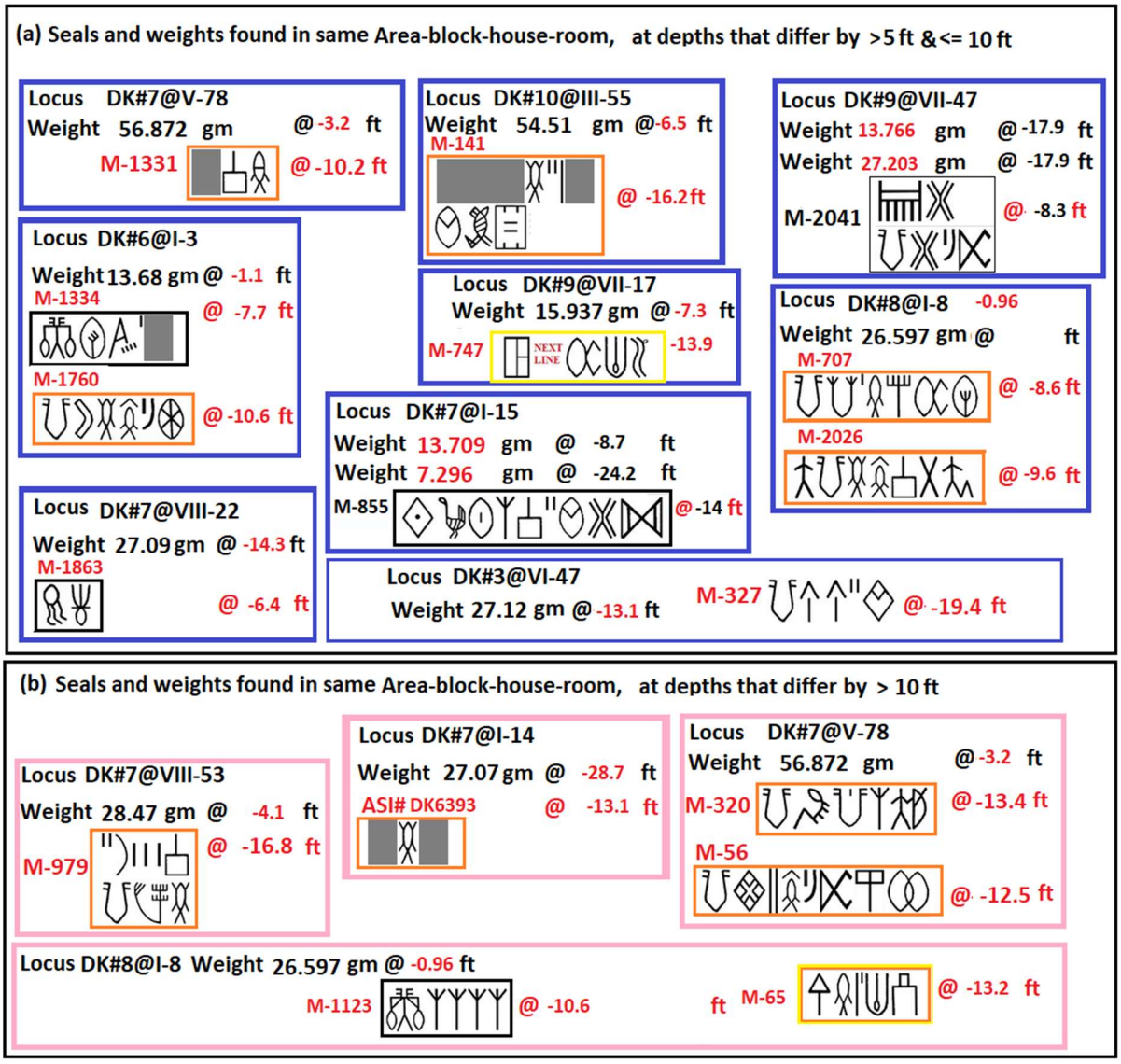
Figure-15 Inscribed seals/tablets and small standardized jeweller's weights discovered from Mohenjo-daro at same room of same house but different depths (List-2)



However, blindly correlating inscriptions with small-range weights found in residential areas and khans is potentially risky, as such cooccurrences might not always prove that the commodities or crafts mentioned in those inscriptions were commodities that had to be weighed with goldsmith's weights. It is true that fish-sign inscriptions found in residential contexts do cooccur with small-range weights. But, after throughly checking the findspots of weights reported at excavation reports, this study has found that small range weights are also found with inscribed seals/tablets that do not

contain fish-signs. It seems that wealthy merchants, and trade-controlling/tax-collecting officials, who lived in large Indus cities, used to keep certain small range weights with them, irrespective of the commodities they traded, or the crafts/trades they controlled. The best explanation of this archaeological observation is that such merchants and officials often accepted payments in form of precious metal bullions or ingots of standardized weights. Thus, they possibly carried their own weights to verify those payments or carry out related transactions.

Figure-16 Inscribed seals/tablets and small standardized jeweller's weights discovered from Mohenjo-daro at same room of same house but different depths (List-3)



3.3 Dravidian Mīn and Sumerian NA_4-IGI-ME-LUḪ-ḪA, "NA4-IGI-ḪA", "NA4-IGI-KU6": Linguistic, cultural and historical contexts of using Fish-signs to signify gemstones and bead related meanings

The linguistic and cultural basis of gemstone's fish-related iconicity can be understood by exploring the ancient linguistic and historical records of both India and Near-East. To unravel the fish-symbolism related to the gemstones and beads in Indus culture, this study engages with two kinds of possibilities:

A) Homonymic usage of the Proto-Dravidian word “mīn” that meant both ‘fish’ and ‘gemstone’, could have led to the use of fish-based Indus logograms to signify gemstone related meanings (explained in Section-3.3.1).

B) IVC’s eye-patterned gemstone beads were coveted in ancient Near East, and were revealingly recorded as “eye-beads” and “fish-eye beads” in Mesopotamian lexicons and trade documents. Thus, the apotropaic aspects of fish and fish-eye, as believed in several ancient cultures, could have led to the fish-based names of the apotropaic gemstone beads and the same symbolism might have been reflected in Indus script (elaborated in Section-3.3.2).

The above-mentioned possible reasons behind the fish-based symbolisms used for gemstones in Indus script need not be mutually exclusive. They might have been mutually complimentary.

3.3.1 The Dravidian homonymy-based aspect of fish related symbolism for gemstones:

A significant portion of Indus valley population most possibly had spoken some ancestral-Dravidian languages (Ansumali-Mukhopadhyay, 2021; Parpola, 1994). Therefore, some of the most popular trade-related words for certain IVC commodities could have had a Proto-Dravidian etymology. According to Ansumali-Mukhopadhyay (2021), a Proto-Dravidian elephant-word ‘pīlu’ was used by IVC traders to signify ivory (this word had travelled from IVC to ancient Near East through ivory trade, and remained preserved as elephant-words ‘pīri’, ‘pīru’, etc. and ivory-word ‘pīrus’ in Akkadian and Old-Persian languages). Similarly, this study conjectures that another Proto-Dravidian fish-word “*mīn”, and its homonymic usage could have inspired IVC’s scribes to choose fish-like logograms for signifying gemstones and similar shiny-precious commodities. Interestingly, the Proto-Dravidian root-verb “*mīn”, and other verbs derive from it (‘miṉṉu’, ‘miṉuṅku’, ‘minnuka’, ‘minugu’, ‘minugu’, etc.) means “to emit lightning”, “to shine, “to glitter”, etc., in several Dravidian languages (e.g., Tamil, Telugu, Malayalam, Kannada, Kodagu, Tulu, Kota, Toda) (Burrow and Emeneau, 1984). This is why, things that shine and glitter, such as stars, fireflies, glow-worms, lightning, etc., are also signified with words derived from the “*min” root. For example, “minni” (Malayalam) and “*minna*” (Telugu) means “gem” and ‘jewel’, whereas “miṉukku” (Tamil), ‘minnuka’, ‘minukkuka’ (Malayalam), mean “to polish, brighten, varnish, make glitter”, (Starostin, 2006-2013; Burrow and Emeneau, 1984). Similarly, ‘miṉṉal’ (Tamil, Malayalam), ‘minnu’ (Malayalam), ‘miñcu’ (Kannada), etc., mean lightning, which are etymologically related to the same verb which means to flash or glitter (Tamil Lexicon). Also, ‘mīṉ’, ‘mīn’, ‘mīnkō’, etc. mean ‘star’ across Dravidian languages. In Sinhalese, an Indo-Aryan language with Dravidian influence, "mina" meant ‘fish’, “zodiac Pisces”, and “a sort of gem” (Clough, 1892).

Now, the most important aspect of gemstones is that they glitter. But that intangible abstract quality is difficult to express through a logogram/semasiogram. Thus, it is quite possible that the people of IVC used this homonymic word “*min”, that signified both “fish” and “gemstones”, for encoding certain gemstone and lapidary related meanings through fish-like semasiograms/logograms. The word “*min” is still one of the most popular words used for fish across several Indo-Aryan and Dravidian languages across India. Interestingly, if one translates the English sentence “The gem is glittering like fish and firefly” to Tamil, through Google-Translation (https://www.google.com/search?q=English+to+Tamil), the Tamil sentence reads: “Māṇikkam mīṉ maṟṟum miṉmiṉip pūcci pōl miṉṉukiṟatu”. Here “mīṉ” means fish, “miṉmiṉip pūcci” means firefly, and “miṉṉukiṟatu” means “is glittering”. This sentence shows how “miṉ” is one of the most widely used root-words to signify any object that glitters or shines, even today. Thus, being a semasiographic/logographic script used by a population with considerable number of ancestral Dravidian language speakers, ISC possibly chose “miṉ” (fish) based symbols to signify gemstones and other similar precious shiny commodities through homonymy.

3.3.2 The apotropaic aspect of gemstone's fish-eye symbolism:

Gemstone beads imported from IVC were highly prized commodities in Persian Gulf and West Asia. Thus beads were among the most specialized craft items and trade commodities of IVC, having a crucial place in IVC's economy. Relevant in this context is Vidale's (2004:271) remark:

> "Just to give an impression of the possible cost of an Indus necklace or belt made of long barrel-cylinder carnelian beads, on the basis of experimental replications we calculated that the production of one of these ornaments roughly amounts to 480 days of work by a highly skilled artisan … No wonder that such precious beads were actively sought for and monopolized by the Sumerian elites".

Analysing IVC's industry-scale bead-production systems, Kenoyer (2013) too comments:

> "The use of shell beads with concentric circular patterns that could be interpreted as eyes begins around 7000 BC at sites such as Mehrgarh. Later, during the Regionalization Era or Early Harappan Period, new forms of eye designs were created using natural stones and also carved steatite beads and button seals. The use of eye motifs became more widespread during the urban period and continued to become more elaborate during the late Harappan and Early Historic periods."

Several texts of ancient Mesopotamia, including the Mesopotamian lexicon "ḪAR-ra=ḫubullu", have documented "fish-eyes" ("IGI-KU_6" and "IGI-ḪA"), "Eye-stones" of Meluhha ("NA_4-IGI-ME-LUḪ-ḪA"), and "fish-eye-stones" ("NA_4-IGI-ḪA", "NA_4-IGI-KU_6") among the treasured import items of Mesopotamia (Donkin, 1998; Howard-Carter, 1986:305-310). Donkin (1998:50) refers to a scholarly consensus that the "fish-eye", "fish-eye-stones" and "eye-stones" in old Mesopotamian texts refer to the etched carnelian beads and pebbles of banded agates, which were "cut to resemble closely a black/brown pupil and white cornea" (see Fig.17b-d), and were imported from northwest India.

As documented by archaeologist Howard-Carter (1986:305-306), certain pedagogical texts taken from tablets of Sultantepe give irrefutable explanation of the etymology of "fish-eye-beads". The texts instruct that the "name of a stone which looks like a fish-eye is fish-eye stone" (see Fig.17a-b), "name of the stone which looks like a snake's eye is snake-eye stone", etc. Carter also clarifies that though eye-stones got their first textual references in the Akkadian version of the "Descent of Ishtar", their first archaeological appearance was in the Indus valley trade-port location in Lothal. The eye-patterns on such gemstones, when not natural, were manmade, and were achieved by a special process called "etching", which involved painting eye-like patterns on the beads using alkaline solutions. Analysing the "dramatic increase in methods to create eye designs during the Integration Era" of IVC, Kenoyer (2013) states that, this phenomenon "cannot be explained simply as a growth in technical expertise", and hypothesizes that IVC's "fish-eye" beads possibly had an ethno-historical significance of "protective amulets" (Fig.17b).

Even in modern days, eye beads or eye-shaped amulets, used as talismans against the so-called "evil-eye", are prevalent in Turkey, India, and many other places (see https://www.nytimes.com/2017/02/22/nyregion/zigana-gift-shop-evil-eye.html; https://www.bbc.com/culture/article/20180216-the-strange-power-of-the-evil-eye). Such beads are presently famous as "Dṛṣṭi" ('Dṛṣṭi' means eye-sight or glance in Sanskrit) and "Nazar" ("Nazar" means eye-sight in Arabic) amulets (See Fig.17a). Interestingly, the Tibetan dZi/gZi beads, which are mostly etched agate beads, are particularly prized depending on the number and type of eye-patterns etched on them (Ebbinghouse and Winsten, 1988; Reinhardt et al. 2020). Similar etched beads are also found in various places of Southeast Asia, and scholars (Glover and Bellina, 2001 pp.192,210; Beck, 1933 p.39) believe that since etching these beads had a specialized method which few people can emulate

even today, these beads that were often found in burials, were technically and culturally continuations of the apotropaic eye-patterned etched beads produced in India, whose origin was in IVC.

The significance of fish as an apotropaic amulet against evil-eye possibly stems from the fact that since in many cultures "evil-eye" is supposed to cause "drying, desiccation, withering, and dehydration", "fish are thought to be immune from evil-eye as they are always wet" (Pitts-Taylor, 2008: 111). Even today, fish-designs are part of various protective amulets (see Fig.17a-c).

Another relevant symbolism prevalent among Semitic people of ancient Persia is the comparison of fish-eye to the God's watchful eye, as both never shut, and hence symbolize divine protection (Frankel and Teutsch, 1992). Even in Christianity, the term "ichthys" (symbol ), which means "fish", is considered a very powerful apotropaic (Elliott, 2017), and it occurs in various amulets. Finally, an intriguing Indic traditional symbolism that directly associates ‘fish’ with ‘eye’ is recorded in the Buddhist Aştamangala signs, where symbol of two golden fish or "gser nya", represent Buddha's eyes, "with which he gazes at the world with compassion" (Reis & Hibbeln, 2006; Namgyal, 2016 p.37). Moreover, graphically, the concentric eye patterns found in natural gemstones such as agate or onyx, closely resemble fish eye (see Fig.17). The abovementioned facts satisfactorily explain why fish are very often portrayed in evil-eye talismans in independent cultures.

Interestingly, in ancient Mesopotamian medicine, the "fish-eye stone", "papparmīnu-stone", lapis lazuli and carnelian were mentioned as part of a set of thirteen stones that were used as talismans against waning hair (Scurlock, 2014). The "pappardilû" and "papparmīnu" stones were also prescribed to be used as stone charms against ghost-induced pain (Scurlock, 2014). Now, pappardilû and papparmīnu were banded agate stones with one and two white bands respectively (Parpola S, 2007), and as mentioned before, etched carnelian beads and banded agates imported from IVC were known as "fish-eye stones" and "eye-stones" (Donkin, 1998) in ancient Mesopotamia. Moreover, an inscribed Kassite eye-stone amulet bead found from the early iron grave from Daba of Oman is inscribed with Goddess Gula’s name (Frenez et al., 2021), who was a Mesopotamian healing deity and patroness of doctors. Thus it is evident that such eye-patterned gemstones (see Fig.17b-c), which were mostly imported from IVC (Howard-Carter, 1986 pp.305-306), were indeed used as talismans against evil forces at Near East, and the names of such stones arguably had ethnolinguistic connection with the apotropaic “fish-eye” symbolism. So, along with the linguistic aspects discussed in Section-3.3.1, there could also be an apotropaic-related cultural basis of using fish-logograms to denote "fish-eye-beads" or "eye-beads” of IVC.

Figure-17 Eye, Fish-Eye, and Fish symbolism in ancient and modern evil eye amulets. A) Modern Nazar and Hamsa amulets B,D) A few examples of IVC's beads, some with eye patterns. C) Modern era agate amulets

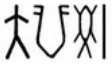
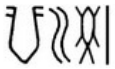
3.4 Possible Meaning Variations of different Fish-signs:

There are various fish-signs that are constituted by making small modifications on the basic fish grapheme  used in Indus inscriptions (Fig.10a). Among the fish signs, sign  , which occurs in more than 450 inscribed objects recorded in ICIT, is the most frequent one. Other frequent signs are:  (around 350 ICIT occurrences),  (around 250 occurrences),  (around 190 occurrences), and  (around 90 occurrences). Often, more than one fish-signs occur adjacently in the same inscription (e.g.  of Seal H-1678).

Now, though archaeological evidence indicates that these fish-signs had meanings related to bead-making, gemstones, jewellery and lapidary craft, how their individual meanings differed from each other is not clear yet. One possibility is that, since the IVC people made beads from various type of materials, such as very precious-stones (e.g., lapis lazuli, carnelian, banded agate), other precious stones (turquoise, jasper, quartz, green felspar, onyx, haematite, limestone, serpentine, breccia) precious metals (gold, silver, copper, bronze), and less costly materials (e.g., shell, steatite, faience, clay, vitreous paste, etc.), some of these fish-signs could have signified different categories of bead-

making materials. This is because, the price of these raw materials would widely vary. For example, in ancient times, lapis-lazuli would generally be much costlier than onyx. Thus, the taxation on such gemstones would vary, and the trade-permits possibly had to mention the licensed categories of gemstones and related bead-making materials through different fish-signs.

Alternatively, some of the fish-signs could also have signified licensing of different type of lapidary activities such as cutting, glazing, etching etc.

Interestingly, among the fish-signs, the most frequent sign  , very often get preceded by numerical stroke signs. Sign  is preceded by different stroke-numeral signs in around 131 inscriptions recorded in ICIT:  (68 inscriptions),  (6 inscriptions),  (20 inscriptions),  (15 inscriptions),  (2 inscriptions),  (2 inscriptions),  (1 inscription),  (4 inscriptions),   (1 inscription),  (12 inscriptions),  (1 inscription). But fish-signs other than  , very rarely get preceded by Stroke-numerical signs, and there are only around 15 such inscriptions recorded in ICIT— e.g.  (CISI#H-25),  (CISI#M-1266),  (CISI#H-440),  (CISI#M-951),  (CISI#M-1910),  (CISI#M-1982). Thus, possibly, sign  signified the most general meanings associated to gemstones, lapidary-work, and related medium of exchange and metrological/revenue standard, while its preceding numerals denoted associated licensing-fees and tax-rates. The other fish-signs possibly signified more specific meanings related to gemstones, lapidary activities, and other shiny-precious materials.

4. Identifying gold-assaying needles

People of IVC were very advanced in gold-smithy and jewellery making. That they used gold-assaying technique using touchstones, is archaeologically proven. In the world, one of the earliest archaeological evidence of touchstones came from Banawali, an IVC settlement of north India, whereas one of the earliest known written references to a touchstone is found in Kautilya's Arthaśāstra (Venable, 2011 pp.264-265; Shamasastry, 1929 pp.91,96). Upinder Singh (2008, pp.152-153) has documented a big jeweller's house found at Banawali, which yielded "a large number of beads of gold, lapis lazuli, and carnelian, tiny weights, and a 'touchstone' showing steaks of gold". Rao (1985, pp.557,579 plate:CCLII-A,CCLXII) mentions a "touchstone of black schist" found at Lothal, which "must have been used by goldsmiths". Touchstones are also reported from DK and HR areas of Mohenjo-daro (Mackay, 1938 pp.404,527; Jansen & Urban, 1985 pp.15,36,79,138).

Before this study, as per the author's knowledge, no one has identified IVC's gold-assaying needles that were used with these touchstones.

4.1 Golden Needles from Mohenjo-daro

In Mohenjo-daro's excavation report, Marshall (1931, vol.2 pp.520-522) had reported a jewellery-hoard, found inside in a large copper bowl covered by a shallow copper dish. Dikshit excavated it from the north-western corner of Room 1, of House I, in Trench E of the DK-Area. This hoard contained a very fine necklace made of carnelian beads and bronze-made spacers and terminals; two ear studs made of gold; several bead-caps made of gold of different purity; an irregularly shaped bead of turquoise matrix fitted with caps and clips made of pure gold and electrum;

and 3 curious "needle-shaped" objects made of gold whose functionality was not clear to the archaeologists (Fig.18). Regarding the needle-shaped objects, Marshall (1931 Vol.3, p.521) has given the following description:

"Three very curious objects found with the studs and the necklace appear to be netting needles of gold. […]

The largest of these needles (E 2044a) is 2.5 inches long. The handle is hollow and cylindrical and tapers slightly, being 0 2 inch in diameter at the needle end. The needle point is 0.5 inch long and has a roughly shaped oval eye at its base.

The medium sized needle (E 2044b) is 2.5 inches long and of the same pattern; but the cap that closed the end of the handle is now missing. The point which has an oval eye at its base is 0.3 inch long.

The third needle (E 2044c) is only 1.7 inches long, with the point 0.3 inch in length. Its handle, which is otherwise similar to those of the other two needles, is badly dented.

The exact use of these three objects is open to question, for they could have been used for either sewing or netting. The handles seem to have been drawn, as there is no sign of a soldered line, but the caps at either end were soldered on with an alloy that is very little lighter in colour than the gold itself. The two smaller needles have evidently been held between the teeth on more than one occasion."

Marshall (1931), possibly missed to notice the inscriptions incised on these tiny objects (Fig.18), which are fortunately noted and documented by Parpola in CISI-3.1 (Fig.19a-c).

Now, before arguing that these golden needle-shaped objects were gold-assaying needles, let us move on to Kotada Bhadli's needle-shaped gold-tipped copper-rod, which gives irrefutable evidence of its assaying function.

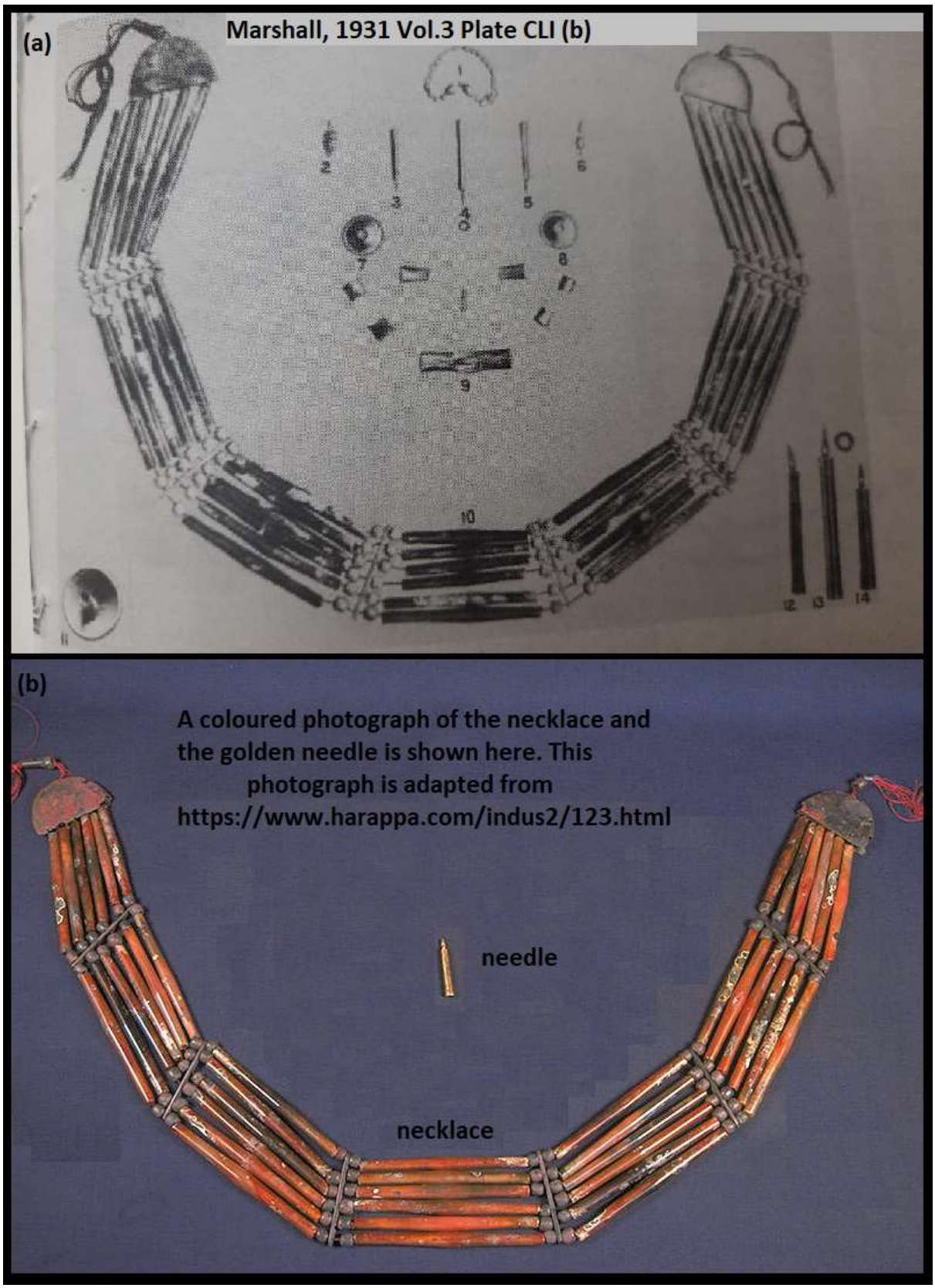
4.2 The gold-tipped copper-rod of Kotada Bhadli

A copper-rod with a gold-tip (Fig.19c), which closely resembles the gold-needles of Mohenjo-daro (Fig.19a-c), is found from Kotada Bhadli, a Late Mature Harappan (2300-2100 BCE) settlement (Shirvalkar, Rawat 2012). As documented by Ruikar (2017), this 54.44 mm long gold-tipped copper "stylus" was recovered from the Open-Area between the fortification and the structural complex of the site.

4.3 Identification of Kotada Bhadli's gold assaying needles

The archaeologists, who found the gold-tipped copper rod of Kotada Bhadli, have remarked that "the use of this copper rod is still a question mark" (Shirvalkar, Rawat 2012 p.199). The author of this study feels that even a cursory glance at the modern gold-assaying needle should solve the puzzle. As shown in Fig.19d, in modern assaying needles, the bodies of the needles are generally made of copper/bronze to reduce cost. Only the tips of the needles, which are soldered to the copper/bronze bodies, are made of gold/silver of a known purity, as only the tip is used on the touchstones for testing gold.

Figure-18 Needle-shaped objects of gold found with necklaces, ear-studs, bead-caps in jewellery hoard



Similarly, in the Kotada Bhadli copper-rod, the "gold tip is in the form of foiling on the copper rod" (Shirvalkar, Rawat 2012 p.199). Thus, gold was not used here as a luxury item to make an expensive stylus/needle. A stylus shaped copper-rod equipped with a golden tip, is focussed towards the functionality of the tip only, which is gold-assaying. The shape, size, and material of this rod unequivocally proves its functionality as gold-testing needle.

Though the archaeological context of the assaying-needle of Kotada Bhadli, found from the Open-Area, is not provided in detail, from Table-5.1, and Table-5.3 given at Ruikar (2017), we know that 3 weights were also found from the Open-Area. We also know that out of the 12 weights found from Kotada Bhadli (weighing 5.14, 7.985, 9.176, 9.470, 15.565, 20.569, 30.876, 31.282, 36.559, 48.053, 66.907, and 160.109 grams), 10 weights were in less than 50-gram range (Ruikar, Shirvalkar and Rawat, 2015 Table-1 p.728). Thus, at least one weight found from Open-Area, must have been of less than 50-gram weight. These light and precise weights were most likely used by jewellers (Kotada Bhadli excavations have yielded precious stone beads of agate, carnelian, jasper, etc.) and goldsmiths. The assaying-needle was possibly dropped by a gold-smith when he was leaving the area.

Regarding gold-testing touch-stones, even though Kotada Bhadli excavation has not reported any yet, like other Indus settlements, such stones must have been used here. A cuboid black chert weight (Excavation#505), which was highly polished but worn at edges from continuous use, weighed only 9.176 gram. Archaeologists might want to get the cuboidal weight (#505) made of black chert tested to check if it was also used as a touchstone.

4.4 Identification of Mohenjo-daro's gold assaying needles

Now that Kotada Bhadli's gold-assaying needle (Fig.19b) is identified, let us compare Mohenjo-daro's "curious" golden needles (Fig.19a-b), whose size and shape closely resemble Kotada Bhadli's prehistorical gold-assaying needle (Fig,16c), and modern gold-assaying needles (Fig.19d).

The archaeological context of Mohenjo-daro's needle strongly indicate their use in gold-assaying, for reasons explained below.

i) There were 3 such needles, found inside a copper-jar, whose lead was so tightly attached that the archaeologists had to cut it open (Marshall 1931, vol.2 pp.520-522). Thus the copper-jar's contents were surely not scattered or lost. Hence, since several golden-bead-caps without beads, and an unfinished turquoise ornament, were found inside the jar, this hoard, which also included an expensive carnelian necklace and golden ear-studs, surely belonged to a working goldsmith or jeweller, not an elite lady.

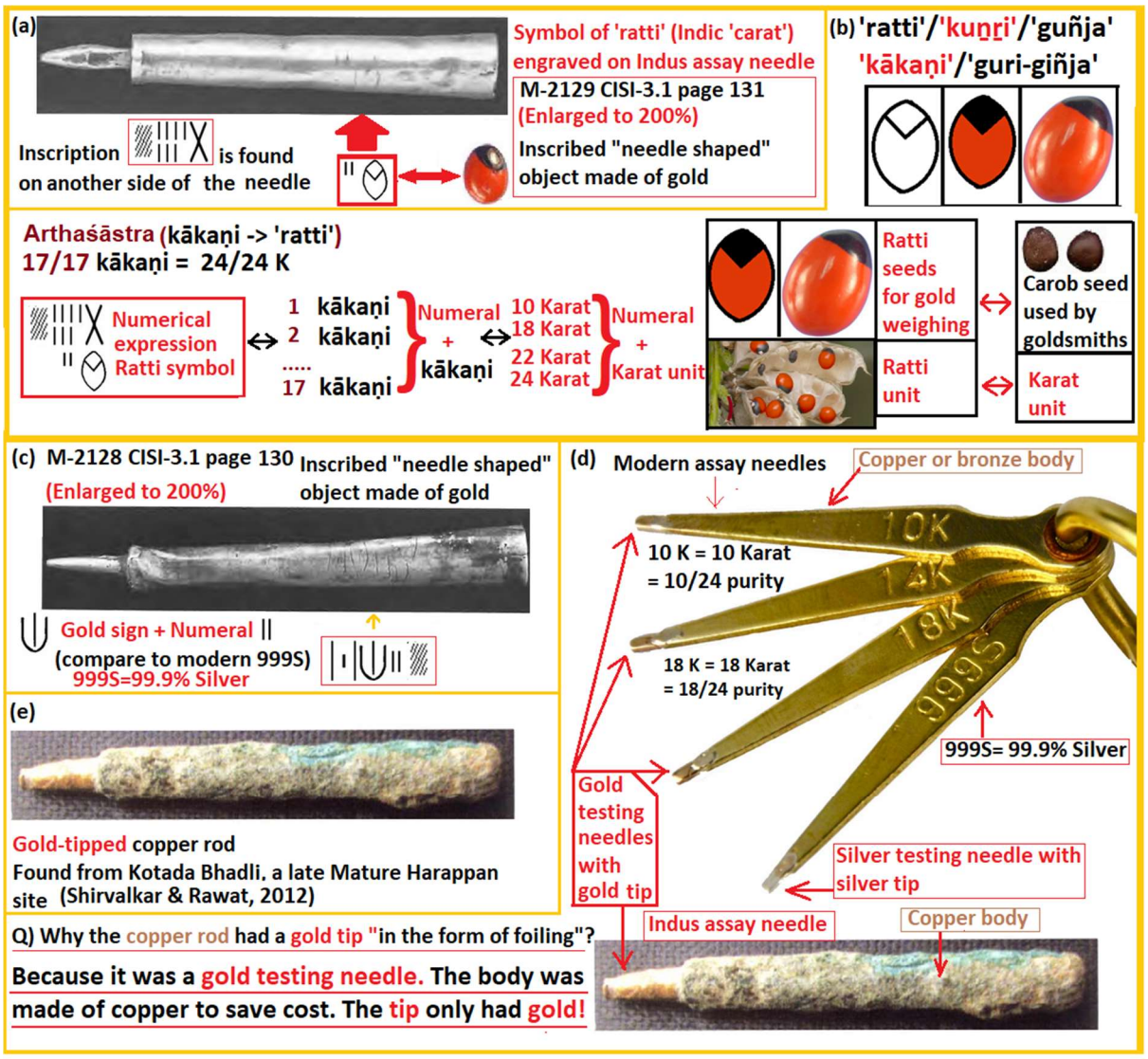
ii) Regarding the golden bead-caps, Marshall (1931 p.521) has also observed that the "gold of which the caps are made varies greatly in colour, ranging from almost coppery-red to pale yellow". So, the goldsmith must have procured the gold from different sources, and must have had to test their purity using multiple gold-testing needles.

iii) Now, as observed by Marshall (1931 p.521), the smaller golden needles "have evidently been held between the teeth on more than one occasion". So, it is evident that the goldsmith used the needles for his own work. If he intended to sell the gold-needles as luxury items, he would not have held them between his teeth. Possibly, when his hands were occupied, he held the assaying-needles between his teeth while working.

iv) Unlike the gold-tipped-copper-bodied assaying needle of Kotada Bhadli, the whole body of these hollow assaying needles were made of gold. Even in modern India, small-scale jewellers often use different samples of gold pieces for assaying, rather than separately buying copper-needles with gold/silver tips.

As discussed in Sections 5.1-5.2, and Section-6.3, the inscriptions on these needles provide further evidence about their gold-assaying functionality.

Figure-19 Comparing Mohenjo-daro's gold-needle with Kotada Bhadli's gold-tipped copper rod and modern gold/silver testing assaying-needles



5 India's traditional 'Karat' symbol (‘ratti’/‘kuṇṛi’/‘kākaṇi’/ ‘gurigiñja’), and gold-symbol , engraved on IVC's assaying-needles

Two of the gold-assaying needles of Mohenjo-daro contained some inscriptions incised on them (Fig.19a-b). The way the incisions were made, where the signs did not look like the carefully engraved signs of Indus seals, indicate that the inscriptions had a functional meaning for the goldsmith.

Now, what kind of functional messages do we expect to be written on a precious metal assaying needle? As shown in Fig.19d, in such modern needles, either the purity index of the gold or silver gets indicated through the gold-measuring unit Karat (abbreviated as ‘K’), with an accompanying number which indicates the numerator of a 24-denominator fraction (24/24 Karat means 100% purity), or the name of metal (e.g., silver abbreviated as ‘S’) gets written along with a number (e.g.

999 signifying 99.9% purity) that indicates the fractional value of the metal's purity. This is why, the modern assay-needles are inscribed with 10K, 14K, 18K, 22K, 999S, etc.

Revealingly, as recorded in Arthaśāstra, the Indic equivalent of carat/karat was indeed the Abrus precatorius seeds (kākaṇi). Quoting Shamasastry's (1929 p.90) translation,

"When the streak of pure gold (made on touchstone) is of the colour of turmeric, it is termed suvarṇa [pure gold]. When from one to sixteen *kākaṇis* of gold in a suvarṇa (of sixteen māshakas) are replaced by from one to sixteen *kākaṇis* of copper, so that the copper is inseparably alloyed with the whole mass of the remaining quantity of the gold, the sixteen varieties (carats) of the standard of the purity of gold (shoḍaśavarṇakāh) will be obtained".

Thus, Arthaśāstra irrefutably proves that since '*kākaṇi*' seed or 'ratti'-seed based weights were used in ancient India for measuring gold, silver, and precious gemstones, '*kākaṇi*' was also used to measure standards of pure gold. So, 24/24 Karat was equivalent to 17/17 '*kākaṇi*' in ancient India.

Therefore, in Indus assaying needles, we shall expect either a 'ratti'/'*kākaṇi*' symbol, or a symbol of gold/silver, accompanied by numeral expressions. Interestingly, that is what has happened exactly, in case of Mohenjo-daro's assay-needles.

5.1 The 'Ratti' symbol on M-2129

Fig.19a shows how sign  , engraved on needle M-2129, closely resembles the Abrus precatorious seed. Since the inscription also contains numerical symbols (), the expression is directly comparable to the expressions 10 K (Karat), 14 K, 22 K, etc., found on modern gold-testing needles. The expression  (along with some accompanying less legible sign), possibly signified one of the numerical values from 1/17 to 17/17 '*kākaṇi*'. Possibly, if we can test the purity of the gold of this assay-needle, we can guess the numerical value of  , and based on that we can guess what is the numerical value of X in the expression, or whether it signified the meaning 'fraction' or 'part', i.e. "<so-and-so> Part of pure 17/17  (*kākaṇi)".*

5.2 The 'Gold' symbol on M-2128

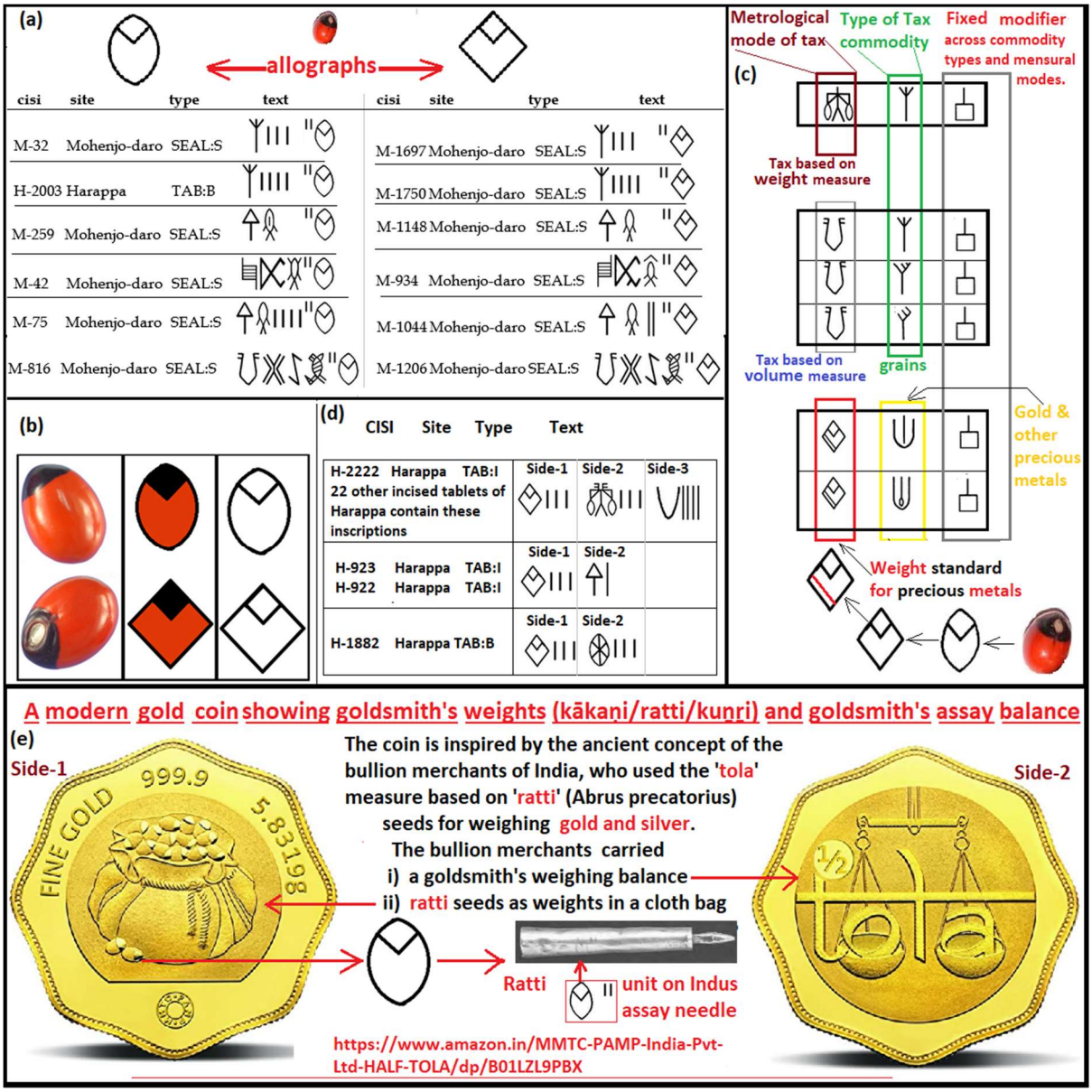
Fig.19b shows how sign  (allograph of ), is engraved on needle M-2129, accompanied by numerical sign  , and 2 more signs. The identification of symbol  as gold-symbol, is elaborately discussed in Section-5. This inscription of  and  is functionally comparable to the expressions "999 S" (99.9% pure silver) found on modern needles.

5.3 Modified 'ratti' symbol occurring in Indus inscriptions as gold related metrological symbol and tax-type

Another revealing evidence of sign  being associated to the 'ratti'-unit of gold measurement, comes from inscriptions shown in Fig.20c. As discussed in Ansumali-Mukhopadhyay,

2019, and Ansumali-Mukhopadhyay, 2022b, the Crop-Livestock signs () often get preceded by numerical tax-rates, and occur in terminal positions of inscriptions (see Fig.3c, Fig.6b) without the help of any PF1-sign. But when preceded by sign  , the Crop-Livestock signs always get followed by a PF1-sign (Fig.3c). So, when sign  precedes a commodity-signifying semasiogram/logogram, a PF1-sign which is related to metrology and signifies a broad tax/license type (Ansumali-Mukhopadhyay, 2022b), follows the commodity-sign. Now, comparing the inscription  with inscriptions  ,  , and  , we find that when the commodity-sign changes from Crop-Livestock signs () to Gold-sign  , the terminal sign changes from volumetric jar-sign  to  , which is the modified grapheme of the gold-measuring 'ratti' symbol  (Fig.20c). Thus, not only a gold-assaying needle, but also IVC's tablet-inscriptions, prove the association of symbol  (allograph  , related sign ) with goldsmith's weight system. Since tablets were used mainly for tax-collection licenses, and trade/craft licenses (Ansumali-Mukhopadhyay, 2022a), sign  , which is till now found only on tablets, possibly signified a gold-related license.

Figure-20 Usages of 'ratti'-seed-based signs in Indus inscriptions



5.4 'Ratti' symbol metonymically signified a tax-collecting entity in the pre-connective contexts

Till now this study has discussed sign only in the context of a gold-assaying needle, and certain tablet-inscriptions possibly containing information about gold-related licenses ( ). But the most frequent use of sign has been in the pre-connective positions of the complex-composite Indus-inscriptions (Fig.20a). Judging from similarity in graphical features and inscriptional usages (Fig.20a), signs and are confirmed allographs (Mahadevan, 1977; Daggumati & Revesz, 2021). Ansumali-Mukhopadhyay (2019), has classified sign ( ) as a PC-sign, i.e., a frequently pre-connective sign (Fig.2e). Now, Ansumali-Mukhopadhyay (2022a) claims that the PC-signs mostly signified certain tax-collecting entities. To understand how a gold-measuring weight standard could signify a tax-collecting entity, we need to understand the role of the 'ratti'-standard in Indian metrology, economy, and numismatics. The four following sub-sections discusses this in details.

5.4.1 Archaeological evidence of Mohenjo-daro's 'ratti'-based weight system and the system's continuity till modern era

As described in Kauṭilya's Arthaśāstra (composed in Mauryan era, around 400 BC.), the seeds of Abrus precatorius, also known as 'raktikā', 'kṛṣṇala' or 'guñjā' seeds, were used as the basis of the weight system prevalent in ancient India. According to Kosambi (1975:174), 95% of the 1059 punch-marked coins found in Taxila hoard, minted under Magadhan influence, "fall into the same range of variation in weight as do the accurately cut and very well-preserved 'D' class stone weights found in the Indus city excavations. The standard accords very well with the 32-raktika weight of the traditional karsapana". Thus, the ratti-based weight system of Mauryan period could be traced back to the IVC era.

Intriguingly, in Taittiria Saṃhitā, Kāṭhaka Saṃhitā and other Vedic texts (c. 1200 B.C. to 1000 B.C.) kṛṣṇala seeds are mentioned as units of gold measurement (Kosambi, 1975:121; Macdonell and Keith, 1912a:185; Bhandarkar, 1921:60). As explained by Bhandarkar, in Taittirīya-Brahmaṇa, the passage "kṛṣṇalam kṛṣṇalam vājasṛdbhyah prayacchati", which means "he gives a kṛṣṇala to each racer", shows beyond doubt the use of the name of "kṛṣṇala" seed as a particular gold coin (Bhandarkar, 1921:60). The fact that even after the official adoption of metric system in 1956 in India, "ratti" (the measure based on raktikā seeds) is used to weigh gold and other gem stones in many urban and rural locations till date, proves how certain metrological standards prevalent in IVC have defied change for almost four millennia.

5.4.2 Influence of 'ratti' in India's numismatics and related weights

Intriguingly, many of the coinage standards used in ancient northern and southern India in various time periods, were not only based on the weight of "guñjā" seeds, but were also named based on various names of these seeds. The Vedic use of "kṛṣṇala" as the name of a particular gold coin (Bhandarkar, 1921:60) is already discussed. Similarly, the "kākaṇa" or "kākiṇī" coins, which were very popular in ancient India, were also based on names of "Abrus precatorius", as the plant and its seeds were called "kāka", "kākiṇī", "kākanantī" and "kākaṇantikā" (Monier-Williams, 1872). Just like "raktikā" or "ratti", the terms "kākiṇī", "kākaṇika" and "kāka" were also widely used as weight standards in ancient India for thousands of years, especially related to the coinage standards or money (Bhandarkar, 1921; Monier-Williams, 1872). Interestingly, in Dravidian languages, some common words used for Abrus Precatorious are 'gurigiñja', 'guru-guñji', 'guru-guñje', 'guru-gañji', etc. (Brown, 1903; Burrow and Emeneau, 1984), which are evidently etymologically related to the word "guñja" present in Sanskrit. It is difficult to say whether the words "guñja"/"giñja"" had ancient Proto-Dravidian or Old Indo-Aryan etymology. However, since in Dravidian languages 'ginja', 'giṃza' or 'ginza' means seed or grain in general (Brown, 1903; Burrow and Emeneau, 1984), a more ancient non-Indo-Aryan etymology might have been more plausible in this case, which possibly got a reduced meaning in Sanskrit. Interestingly the "cinna" coins (Telugu "sinna") which were Canteroy 'fanams', a coin-system popular in South-India, especially in Mysore, were based on the standard weight of guri-giñja seeds (Sircar, 1966 p.74). In Dravidian language Tamil Abrus precatorious seeds are called "kuṉṟi" (Tamil lexicon, 1924-36). The Tamil words "mañjāḍi" and "kalañju", signified certain weights, which were based on "kuṉṟi-

mani", and were used to weigh gold (Sircar, 1966). In fact, another Tamil word used for guri-ginja is gunḍu-mani, whereas ‘gunḍu’ in Telugu means "a weight (stone) for scales" (Brown, 1903). Similarly, kalañju was also a Tamil name of a gold coin of 32 ratti or guñja weight. Fig.20e shows a modern Indian gold coin, whose iconography is inspired by the ‘ratti’-based weight system used by the goldsmiths and bullion-merchants of ancient India.

5.4.3 Script-internal evidence of ratti-based signs getting used as tax/license related to precious metals

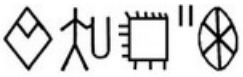
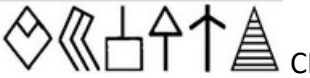
As discussed in Section-5.3, script-internal combinatorial and graphemic evidences suggest that sign  signified some metrological standards and taxes/licenses associated with precious metals. Now, since "guñjā" seeds were the basis of IVC’s weight system, and were the main weight standard traditionally used by Indian goldsmiths for millennia, use of the guñjā-seed based sign in the context of precious-metal-based taxation and metrology, should not surprise us at all.

That the sign  was related to metrological modes is also proven by the inscriptions listed in Fig.20d. Here, 23 identical tablets found from Harappa, which have 3 inscribed sides each, contains metrological terminal signs  and  , signifying tax/license types (see Ansumali-Mukhopadhyay, 2022a) preceded by only numerical signs, in two of their sides. In the third-side, sign  preceded by  occur, evidently as another metrological sign related to tax/license types. Another revealing inscription comes from tablets H-922 and H-923 of Harappa. Here, the assay-balance related arrow-sign  used for precious metal and precious stone’s taxation (Ansumali-Mukhopadhyay, 2022b), and the guñjā-sign  comes in two sides of these tablets. The arrow-sign  is preceded by a single-stroke and the guñjā-sign is preceded by  , evidently expressing some tax/license related equivalencies related to two prevalent metrological modes used for precious metals and gemstones.

5.4.4  based terms for some tax-collecting entity or revenue-centre, comparable to Sanskrit ‘droṇamukha’ and Tamil ‘koḷ-vari’

As discussed in Ansumali-Mukhopadhyay (2022b), in ancient urban civilizations, where the abstract concept of money was either completely absent, or was not fully implemented, the revenues were collected through different type of commodities, with commodity-specific metrological standards. Thus, jars and baskets of standardized capacities, which embodied certain volumetric standards, were used for collecting certain taxes which were collected in the form of food-grains. The names of such taxes, tax-collectors, and tax-collection centres, were often derived from the names of those volumetric-standards. For

example, in Mesopotamia, the metrological word "sūtu" or "šūtu", which primarily meant "a vessel", "a measuring vessel of a standard capacity and its volume", "a measure of area based on the quantity of grain necessary for seeding", also meant "(a tax), rent for a field or orchard paid in kind" (Reiner, 1984). Moreover, the word "šutummu" signifies "a storehouse", while the word "šatammu", which is "clearly connected to the storehouse", represented certain revenue collecting personnel in Babylonian and Assyrian contexts (Johns, 1999). The Mesopotamian words "šutummu" and "šatammu" are arguably connected to "šutu", and their relationship is quite amazingly comparable to the relationship between Indian words "droṇa", "Droṇamāpaka" and "Droṇamukha". In ancient India, ‘droṇa’ was a volumetric unit; the word ‘droṇa’ meant a “wooden vessel”; different denominations of the ‘droṇa’ standard were used for revenue (āyamāna) and trading (vyāvahārikā); certain tax-collectors were called droṇamāpaka’ (‘who measures using droṇa’); and certain revenue-centres were named ‘droṇamukha’ (Arthaśāstra: Shamasastry, 1929 p.141; Kurudhamma Jātaka: Prasad, 1987:40-41). Similarly, in a tax-assessor’s journal of the late Middle Kingdom of ancient Egypt, certain surveyors of the field were called "rope-bearer" and "rope stretcher" (Katary, 2013 p.742), which is a direct parallel to the Indian tax-collector term "rajjugāhaka-Amācca", that signified an official who measured fields with "rajju" (rope) and "daṇḍa" (pole/rod), to assess the tax on its harvest (Jātaka: Prasad, 1987). So, the tax-terms were closely related to the metrological modes of tax measurements in the ancient world.

Now, as discussed above, "guñjā"/‘ratii’ seeds have played a crucially important role in the weight and coinage systems of ancient India. Since the ‘guñjā’ seeds were the basis of most of the IVC’s weight systems, it seems logical that the symbol of "guñjā" seeds can be a symbol of weight-standard (cf. ‘droṇa’), and can be used as a metonym for some tax-collection entity. That  or  sometimes occurred in terminal positions like metrology and tax-type related PF1-signs ( CISI#Nd-1,  CISI#Ns-53,  CISI#Ns-57,  CISI#M-1095,  in 29 tablets of Harappa), already proves their polyvalent use as tax/license types. Thus, the way in ancient India a revenue-collection-centre was named "droṇamukha", based on the volumetric measure ‘droṇa’, a revenue-collection-entity was most likely named with some Indus terminology that signified the weight-standard related to ‘ratti’/‘gurigiñja’ seeds. Relevantly, in Tamil, the word ‘koḷ’ means “horsegram”, and “a small measure of weight used in ancient times” (Tamil Lexicon). Now, another Dravidian word for ‘horsegram’ is ‘kāṇam’, whereas ‘kāṇam’ also signified ‘an ancient weight’ and ‘gold’ (. Thus, the fact that the word ‘koḷ’ for ‘hosegram’, an important grain seed used in south India, is synonymous with an ancient weight, is not a coincidence. Now, “kōl-niṟai-kūli” meant “a tax on articles measured by weight”, and “koḷ-vari” meant “a tax in kind” (Sircar, 1966 p.415), corroborating our hypotheses that a seed used as weight-unit can metonymically represent taxes and tax-collection entities. Interestingly, as recorded by Sircar (1966 pp.138,143), ‘kākiṇi’, and ‘kāka’, alternative names of ‘ratti’-seeds, also signified a “small land measure”, which was possibly 1/16 of a ‘doṇ’ or ‘droṇavapa’ (amount of land required to sow one drone of seeds) measure

of land. Thus, the way 'droṇi' meant treasury, 'droṇamāpaka' and 'droṇāgraka' meant revenue collectors, ''droṇamukha' meant a revenue centre, and 'koḷ-vari' meant 'a tax in kind', the 'kākiṇi'-seed related signs  and  could have denoted some revenue-centre or tax-collection entity, to which certain taxes were paid to obtain certain commercial-licenses. These tax-centres not necessarily collected taxes only by weight. Just like 'droṇamukha' 'koḷ-vari', the  -based names of a revenue collection entity was most likely a general terminology.

6. Decoding the Blowpipe-In-Crucible sign  (allographs )

A crucial decoding made in this study involves sign  and its allographs ( , etc.), which visually symbolize a stick or rod put inside a vessel. This graphical referent of this sign is generally interpreted by Indus scholars as a "mortar-pestle" (e.g., Mahadevan, 2011; Fairservis, 1992 pp.10,28,33-34,111). However, this study confidently claims that sign  graphically symbolized a blowpipe () put inside a crucible (), and metonymically signified precious-metals, gold-smithy, etc. This identification is based on the following:

i) Visual similarity of signs  with crucible and blowpipe.

ii) Existence of graphically related signs  , and  , where a fire-like symbol  is drawn below the  graphemes of  and  , strongly indicates the vessels' association with fire (Fig.21a), and supports the 'crucible-blowpipe' hypothesis. Since  and  symbols are modified with fire-symbol applied below the crucible in signs  , and  , they were possibly "melting crucibles" used by goldsmiths, as ancient smelting crucibles had to be usually heated from inside to generate high temperature (Thornton and Rehren, 2009; Davey 1985). Relevantly, most of the crucibles excavated inside fortified Indus settlements were "melting crucibles", not "smelting crucibles" (Kenoyer and Miller, 1999).

iii) The crucible-blowpipe sign  occurs on the gold-testing needle CISI#M-2128 (Sections 4-5) found in a jewellery-hoard of Mohenjo-daro.

iv) In ancient civilizations including IVC, crucible-blowpipes were essential tools for metal-smithy.

v) Ancient Sumerian pictographs and Egyptian hieroglyphs have used crucible-blowpipes to symbolize precious metals and gold-smithy.

vi) Various ancient Indic words for metal-smiths directly translate to "blowpipe-blower", demonstrating related linguistic symbolism. Similar linguistic symbolism is evinced in Mesopotamian 'smith'-words as well.

vii) Signs  , and gemstone-related fish-signs co-occur in the context-sensitive core-informational segments of various Indus-inscriptions, which indicates that they signified related commodities (precious metals and precious stones) and crafts (lapidary and gold-smithy).

viii) Signs  and gemstone-related fish-signs share archaeological contexts with lapidary and jewellery related craft-centres.

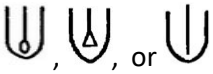
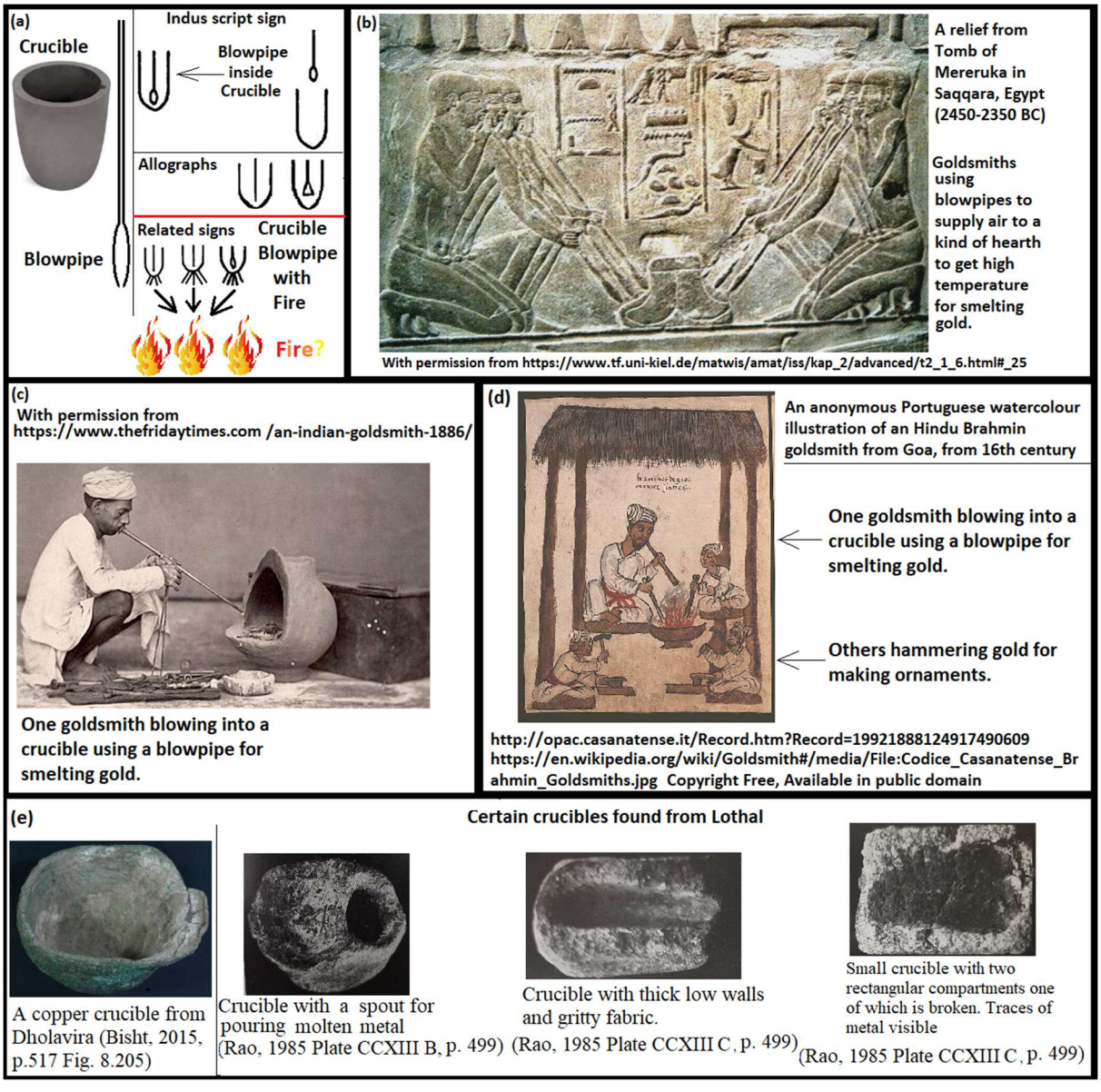
ix) Inscribed seals/tablets containing signs  and gemstone-related fish-signs, share archaeological contexts with goldsmith's weights.

Figure-21 Crucible-blowpipe signs and their symbolic association with gold-smithy



6.1 Use of crucibles and blowpipes in IVC's metal-smithy

"Crucibles played a central role in the development of metallurgy as containers for the high temperatures and specific atmospheric conditions necessary to drive the smelting or melting processes, as collectors for the liquid metal, and often as providers of the silicates necessary for the production of slag […] At the same time, early crucibles had to allow for certain manipulations, such as providing a controlled air flow from above using blowpipes or tuyeres, or lifting and tilting the crucible for casting" (Thornton and Rehren, 2009 p.2701).

Several crucibles, with traces of copper and bronze, are found from various Indus settlements (Fig.21e) — e.g., Mehrgarh (Kenoyer and Miller, 1999), Harappa (Vats, 1940 pp.150,471), Mohenjo-daro (Marshall, 1931 p.212; Mackay, 1938 pp.178), Rakhigarhi (Nath, 2014 pp.76,305), Kanmer (Kharakwal, Rawal and Osada, 2012 pp.93,141,528,530), Goladhoro (Patel and Ajithprasad, 2015), Lothal (Rao, 1979 pp.58,81,85,91,95,100,122), Dholavira (Bisht, 2015 pp.517,525,610,815-827), Kotada Bhadli (Shirvalkar, Rawat 2012 Pl.22), etc. In Lothal, Rao (1979; 1985) has reported quite a few coppersmith's shops where terracotta crucibles accompanied with muffles, moulds, copper artifacts, pot-furnaces, anvils, etc., were discovered. According to Kenoyer and Miller (1999), many of the crucibles found inside fortified Indus cities were possibly not used for smelting copper ore. They were possibly "melting crucibles", used for remelting and refining already smelted metal ingots procured by the city metalsmiths. Interestingly two small copper crucibles were found in KLB-2 region of Kalibangan, which according to Lal et al. (2020 pp.790,800) were possibly used by Indus goldsmiths. While further archaeological research is needed to discover the source of the already refined metal ingots procured by the city metal-smiths, and to differentiate between smelting and melting crucibles used in IVC (same goes for the crucibles found in Mesopotamia, as discussed by Moorey, 1994 p.243), there is no denying that crucibles were prevalent across Indus settlements.

Unlike crucibles, blowpipes are scantily found in archaeological remains across the world, as they were traditionally made of perishable materials (reed, wood, bamboo, clay, etc.), that "will rarely leave recognizable archaeological traces" (Moorey, 1994 p.268-269; Perea and Armbruster, 2011). Regarding archaeological evidence of blowpipe's use in IVC, Marshall (1931, p.198, plate:CLXIV) has mentioned two pieces of metal-smith blowpipes made of copper, found in room-105 of house XII of Mohenjo-daro's HR-area, along with other copper artifacts. Interestingly, a few gold beads, several copper buttons, necklace spacers and terminals were found in a nearby room (room-107), indicating that these locations were occupied by some gold-smith/copper-smith. Thus, the abovementioned blowpipes could be mouth blowpipes used by a goldsmith. Similar bronze blowpipes were found in a 4th century BC goldsmith's toolkit discovered from an Iberian grave (Perea and Armbruster, 2011). However, as pointed out by Kenoyer and Miller (1999), Marshall did not give much explanation regarding those blowpipes' identification. Except the above reference, blowpipes are generally not mentioned in IVC's excavation reports. However, since melting crucibles are found in abundance in IVC settlements, blowpipes must have been used as indispensable tools by Indus goldsmiths.

6.2 Traditional relationship between crucibles, blow-pipes and metal-smithy, as reflected in ancient scripts and languages of Egypt, Mesopotamia, and India

Metal-workers, especially gold-smiths, have been traditionally depicted along with blowpipes and crucibles, across the world (Fig.21B-D), as these tools have been essential for attaining the right temperature while doing brazing, annealing, soldering, or sintering work (Konstantinidi-Syvridi and Goumas, 2020 pp.58-59; Forbes, 1950). Even today, goldsmiths use blowpipes to manoeuvre the temperature of the flame while making fine ornaments. This inseparable relationship between crucibles, blowpipes, and metal-smithy was reflected in the smithy related words, logograms and semasiograms used in some of the most ancient scripts and languages of the world (Fig.22).

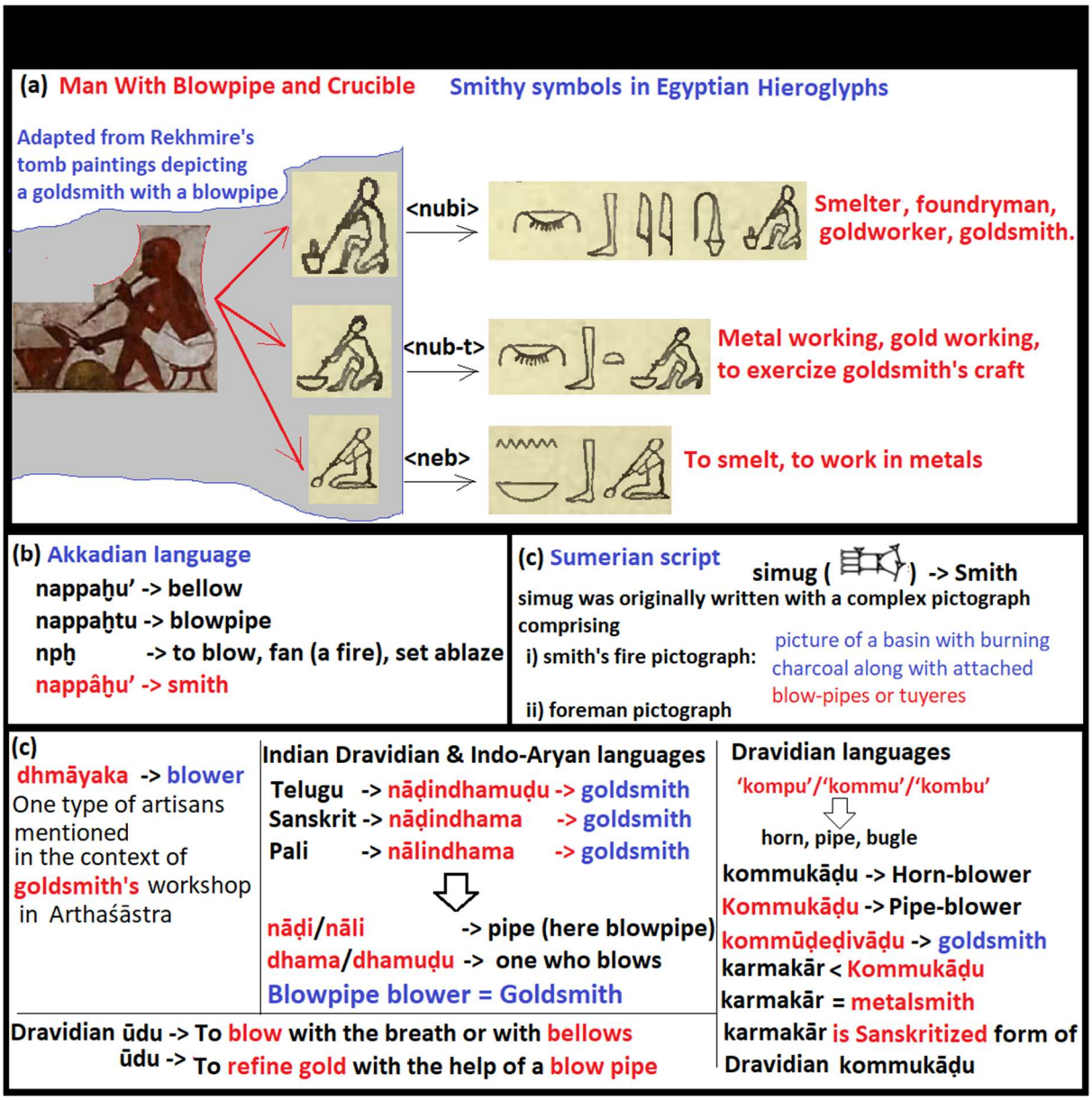
As shown in Fig.22a, certain Egyptian words that signified goldsmiths, used an interesting set of signs ( , ) as determinatives (Budge, 1920 pp.354,366), which depicted a man blowing inside a crucible with a blowpipe. These anthropomorphs and their tools closely resemble the goldsmith's picture (Fig.22) shown in the tomb of Rekhmire (Davey and Edwards, 2007).

Such crucible-blowpipe based smithy symbolisms were reflected not only in ancient scripts, but also in linguistic symbolisms used in ancient smithy words. For example, 'simug' (), a Sumerian term for smith, was originally (in c. fourth millennium BC) written with a complex pictograph, comprising a pictograph for "smith's fire" and a sign for 'foreman' (Falkenstein 1936: no. 325; Moorey, 1994 p.243; Forbes, 1950 p.94). The smith's fire "pictograms very clearly show the picture of a basin with burning charcoal" along with attached "blow-pipes or tuyeres" (Forbes, 1950 p.94; Moorey, 1994 p.243). Similarly, the Akkadian terms for blowpipe and bellow are 'nappaḫu' and 'nappaḫtu' respectively, which derive from the root-word npḫ meaning "to blow, fan (a fire), set ablaze". Now, in Akkadian, 'nappâḫu' means smith (literally means "one who blows the [smith's] fire"), and "nappâḫ ḫurâṣi" means goldsmith, showing direct etymological connection to words for blowpipe and bellow (Forbes, 1950 pp.94,95,118-120).

Similar linguistic symbolisms regarding metal-smithy and crucible-blowpipes are evinced across various Indian languages. In Kannada, Tamil, Telugu and some other Dravidian languages, the word 'ūdu' that means "to blow", also means "to purify and refine metal with the blow-pipe" (Kittel, 1894). In Dravidian languages 'kompu' , 'kommu', 'kombu', etc. means "horn", 'tusk', 'twig' etc. (Tamil Lexicon; Brown, 1903). Possibly since primitive pipes, tubes, and bugles were made of animal horns and plant twigs, 'kompu'/'kommu'/'kombu' also means 'pipe', 'bugle', 'tube', etc. (Tamil Lexicon; Brown, 1903), the same way horn means both animal's horn, and an instrument for making loud noise in English. Thus "kommukāḍu" means a horn-blower (Brown, 1903), or pipe-blower. Interestingly, "kommūḍeḍivāḍu" (Telugu) means a goldsmith (Brown, 1903). According to historian Niharranjan Roy, the word "karmakāra", that means 'blacksmith' in Sanskrit, is a Sanskritized form of certain Dravidian smith-words (Mitra, 1953 p.329). I propose that "karmakāra" is related to Dravidian

'kommukāḍu', i.e. "bellow blower". Also, the words for goldsmith in Sanskrit and Pali are 'nāḍindhama' and 'nālindhama' respectively (Tin, 1920 pp.119). Here 'nāḍi'/'nāli' means pipe, tube, and blowpipe, and 'dhama' means "one who blows". Similarly, in Telugu, "nāḍindhamuḍu" means blowpipe-blower or goldsmith (Brown, 1903).

Figure-22 Crucibles and blowpipes used to signify gold-smithy in Egyptian, Mesopotamian and Indian scripts and languages



Even in Arthaśāstra (c. 400 BC), the word "dhmāyaka" meaning "blower" is mentioned in the context of goldsmiths' shops and related artisans (Shamasastry, 1929, p. 91). So, symbols of crucibles and blowpipes would have been perfect candidates to express gold, silver, and gold-smithy related meanings in the semasiographic/logographic Indus inscriptions.

6.3 Gold symbol engraved on gold-assaying-needle

As discussed in Section5.2, and shown in Fig.19b, sign  is engraved on a golden needle M-2128, accompanied by numerical sign , and 2 more signs (sign  , and possibly sign ). Now, on modern silver-assaying needles, an expression "999 S", meaning "99.9% pure silver", is found, where the numeral 999 is accompanied by 'S', an abbreviation for silver. This inscription of  and , where the gold-sign is accompanied by a numeral, is functionally comparable to the modern expression "999 S". Since another gold-assaying needle found in the same jewellery-hoard is engraved with the ratti-seed symbol  , and an accompanying numerical expression (), which is directly comparable to the expressions 10 K (Karat), 14 K, 22 K, etc., found on modern gold-testing needles, the presence of  on M-2128 provides almost irrefutable evidence that  signified gold, not "mortar pestle".

6.4 Sign  (Gold-sign and numeral ) signified three precious metals

The crucible-blowpipe sign  very often collocates with a three long-stroke numeral. Here, the numerical sign  does not precede the semasiogram/logogram. Thus, here the sign  does not function as a general quantifier, but forms a fixed-collocation with  . For example, in different seal/tablet inscriptions (), different numerals (signifying tax-rates), precede the Crop-Livestock sign  which possibly signified some fiber-crop (Ansumali-Mukhopadhyay, 2022b), and a popular medium of exchange. But, in case of  , any numeral other than  rarely collocates with  . This study argues that  signifies a phrase like "three precious metals". Relevantly, a similar ancient Indian term, 'sapta-lōham' or "seven metals", signified "the five metals, viz., gold, silver, copper, iron, lead and the two alloys**,** bell-metal, and pinchbeck" (Tamil Lexicon). Thus,  most likely signified the "three precious metals" of IVC, i.e., gold, silver, and possibly copper/bronze.

6.5 Inscriptional co-occurrence of crucible-blowpipe sign for gold  () and fish-signs for gemstones

Section-3 has already argued that ISC's fish-signs signified gemstones, jewellery and lapidary crafts, and possibly other shiny precious commodities and related crafts, which were taxed and licensed in IVC. Now, as discussed in Section-2.6.1, Section-2.6.3, and Section-2.6.4, semantically related signs, such as signs signifying related commodities and crafts, should cooccur in tax/license related inscriptions in various ways. So, since gold-smithy is closely related to lapidary and jeweller's craft, and precious metals are closely related to precious stones as commodities, they should

frequently co-occur in Indus-inscriptions. This is what actually happens with  (gold),  (precious-metal) and the fish-signs (gemstones, jewellery, lapidary, etc.). They co-occur with each other in the core-informational segments of inscriptions (Fig.23a), in different-inscription lines of same seal-inscriptions (Fig.23c), in different sides of a tablet (Fig.23b), and in different seal-inscriptions found on the same sealing/tag (Fig.23c).

Figure-23 Cooccurrences of fish-signs and  in several Indus-inscriptions

7. Conclusion

This article makes some ambitious claims, which might prove to be capable of largely freeing Indus script from its sorry state of un-decipherment even after almost one hundred and forty years of scholarly research. Since ISC did not encode words in a phonological way (Ansumali-Mukhopadhyay, 2019), it will never be possible to decipher/decode all the symbols of this semasiographic/logographic script with mathematical certainty. But, if one understands the semantic scopes of most of the Indus inscriptions (Ansumali-Mukhopadhyay, 2022a; Ansumali-Mukhopadhyay, 2022b) and their general mechanisms of meaning conveyance (Ansumali-Mukhopadhyay, 2019), and if one decodes certain ISC signs with interlocking archaeological, scrip-internal, linguistic, and historical evidence, then one should be able say that ISC is decoded to a good extent. This article claims the same.

Let us consider a hypothetical situation, where certain extra-terrestrial intelligent beings come to earth, shortly after the human civilization here gets destroyed in some natural calamity. They try to understand the symbols and languages used on earth by examining instances of non-perishable materials that survive. Among other things, they find electric switchboards in several excavated houses and understands the functionality of the switchboard by examining the vestiges of its electrical wiring, etc. (Fig. 24a). Then they find the symbol of an electric bulb and a fan on the switchboard. By considering the graphemic features of the bulb and fan symbols, and the contexts of the switchboards, they might infer that the symbols signified tools that generated artificial light and caused artificial circulation of air. This inference will get validated by excavating more instances of actual electric bulbs and fans in the context of switchboards, and by noticing the resemblances of the symbols with those actual objects. Later, if the extra-terrestrial intelligent beings find some surviving books on electricity, written in braille, they might get their inferences reconfirmed through the symbols in its circuit diagrams.

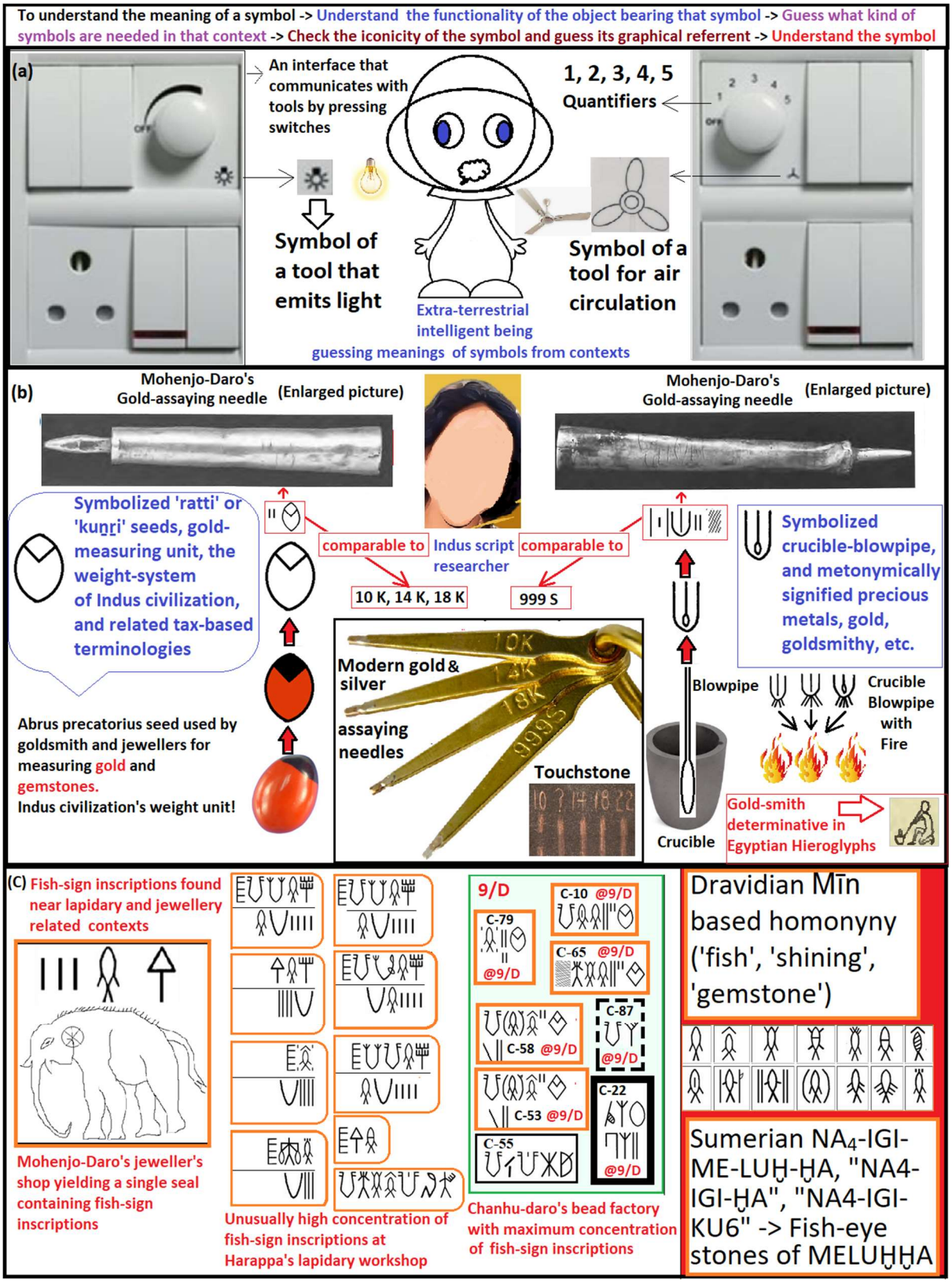
Now, the inferences made in this study get validated in similar ways (Fig.24b), by analysing the crucible-blowpipe and Abrus precatorius seed signs on the gold-assaying needles of IVC, by studying their iconicity and related ancient symbolisms, and by matching their related occurrences in Indus inscriptions found on several seals and tablets. The interlocking evidence found from archaeological, script-internal, linguistic, and historical facts, regarding the fish-signs, the crucible-blowpipe signs, and the Abrus precatorius related signs, prove that the hypotheses made in this study are acceptable explanations about certain aspects of ISC's semantics, not mere speculations.

The novel methodology used in this study, that identifies different functional segments of Indus inscriptions, and successfully correlates the core-informational segments of certain inscriptions with their archaeological contexts, will facilitate future efforts of decoding some other Indus script signs.

This study also indicates the type of language(s) spoken in IVC in an interesting way. An observant reader would have noticed that each time this study refers to the nature of ISC, it uses the expression "semasiogram/logogram" and "semasiographic/logographic". The

reason for this is that, a semasiograms generally signifies a meaning by graphically representing an object which is directly or indirectly associated with that meaning. Thus, semasiograms cannot directly indicate any linguistic influence. For example, the association of crucible-blowpipe to gold-smithy has made Egyptian, Mesopotamian, and Indic languages and scripts to use crucible-blowpipe symbolism to signify gold-smithy. Thus, no linguistic affiliation of ISC can be deduced from decoding its gold-symbol, or Abrus precatorius symbol.

Figure-24 How symbols and their contexts can in general help to decode unknown semasiographic/logographic systems



But, logograms, unlike semasiograms, can be immensely helpful to guess the type of language that influenced their graphemes. This is because, logograms often apply homonymy, where the name of object-1, which is homonymous to the name of object-2, gets used to signify a concept semantically related to object-2, even if object-1 and object-2 are semantically unrelated. Here, in case of ISC, the script-internal evidence of co-occurrences of fish-signs with gold/gold-smithy related signs in inscriptions, and the archaeological evidence of unusual concentration of fish-signs near lapidary related contexts strongly indicate that fish-signs were related to gemstones and lapidary activities (Fig.24C). But gemstones are not linguistically related to fish-signs in all languages. Among Indic languages, only across Dravidian languages, the most common fish-word 'min' (also a Proto-Dravidian word) is homonymous and etymologically related to words for 'gemstone', 'polishing', 'shining', 'emitting light', etc. Even though the Mesopotamian references to IVC's beads as "fish-eye beads" provide an alternative reasoning of the fish-gemstone symbolism, according to the author, the pervasive use of fish-signs in Indus script was most likely inspired by a popular linguistic symbolism, not only the apotropaic properties of the "fish-eye stones". Thus, the Dravidian fish-gemstone homonymy provides a compelling explanation for ISC's fish-symbolism. Moreover, several linguistic, ethnohistorical and genetic evidence strongly indicate the use of Ancestral Dravidian language(s) in IVC (e.g., Parpola, 2015; Ansumali-Mukhopadhyay, 2021; Pagani et al., 2017; Narasimhan et al., 2019; Krishnamurti, 2003, p.501). Since in other language groups (Indo-Aryan, Austro-Asiatic, Trans-Himalayan) prevalent in India, there is no such linguistic connection between the words for "light emitting", 'glittering', 'shining', 'gemstone', and 'fish', ISC's fish-logograms and their connection to gemstones and lapidary craft indicates use of a Proto-Dravidian homonymy, and supports the theory of the existence of Ancestral Dravidian language(s) in IVC.

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