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# Semantic scope of Indus inscriptions comprising taxation, trade and craft licensing, commodity control and access control: archaeological and script-internal evidence

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This article studies the semantic scope of the yet undeciphered Indus script inscriptions, which are mostly found on tiny seals, sealings, and tablets. Building on previous structural analyses, which reveal that Indus script was semasiographic and/or logographic in nature, this study analyses the combinatorial patterns of Indus script signs, and the geographical distribution of the inscriptions, to establish that the inscriptions did not encode any proper noun, such as anthroponyms, toponyms, or names of specific organizations. Analyzing various archaeological contexts of the inscribed objects—e.g., seals found concentrated near city gates (e.g., Harappa), craft workshops (e.g., Chanhu-daro), and public buildings (e.g., Mohenjo-daro), often along with standardized Indus weights that were used for taxation; sealings attached to various storage containers and locking systems of “warehouse” chambers as indicated by their reverse-side impressions (e.g., the sealings of Lothal “warehouse”); inscribed sealing-pendants of Kanmer, conjectured to be passports/gate-passes by archaeologists; and seals with identical inscriptions often found from distant settlements—this study claims that the inscribed stamp-seals were primarily used for enforcing certain rules involving taxation, trade/craft control, commodity control and access control. Considering typological and functional differences between the seals and tablets, and analyzing certain numerical and metrological notations () typically found at the reverse sides of many two-sided tablets whose obverse sides contain seal-like inscriptions, this study argues that such tablets were possibly trade/craft/commodity-specific licenses issued to tax-collectors, traders, and artisans. These reverse-side tablet inscriptions possibly encoded certain standardized license fees for certain fixed license slabs, whereas their obverse-side inscriptions specified the commercial activities licensed to the tablet-bearers. These seals/tablets were possibly issued by certain guilds of merchants/artisans, and/or region-based rulers or governing bodies, who collaborated in the integration phase of IVC, to standardize certain taxation rules and trade/craft regulations across settlements. The seal/tablet iconographies might have been the emblems of the guilds, rulers, and/or governing bodies.

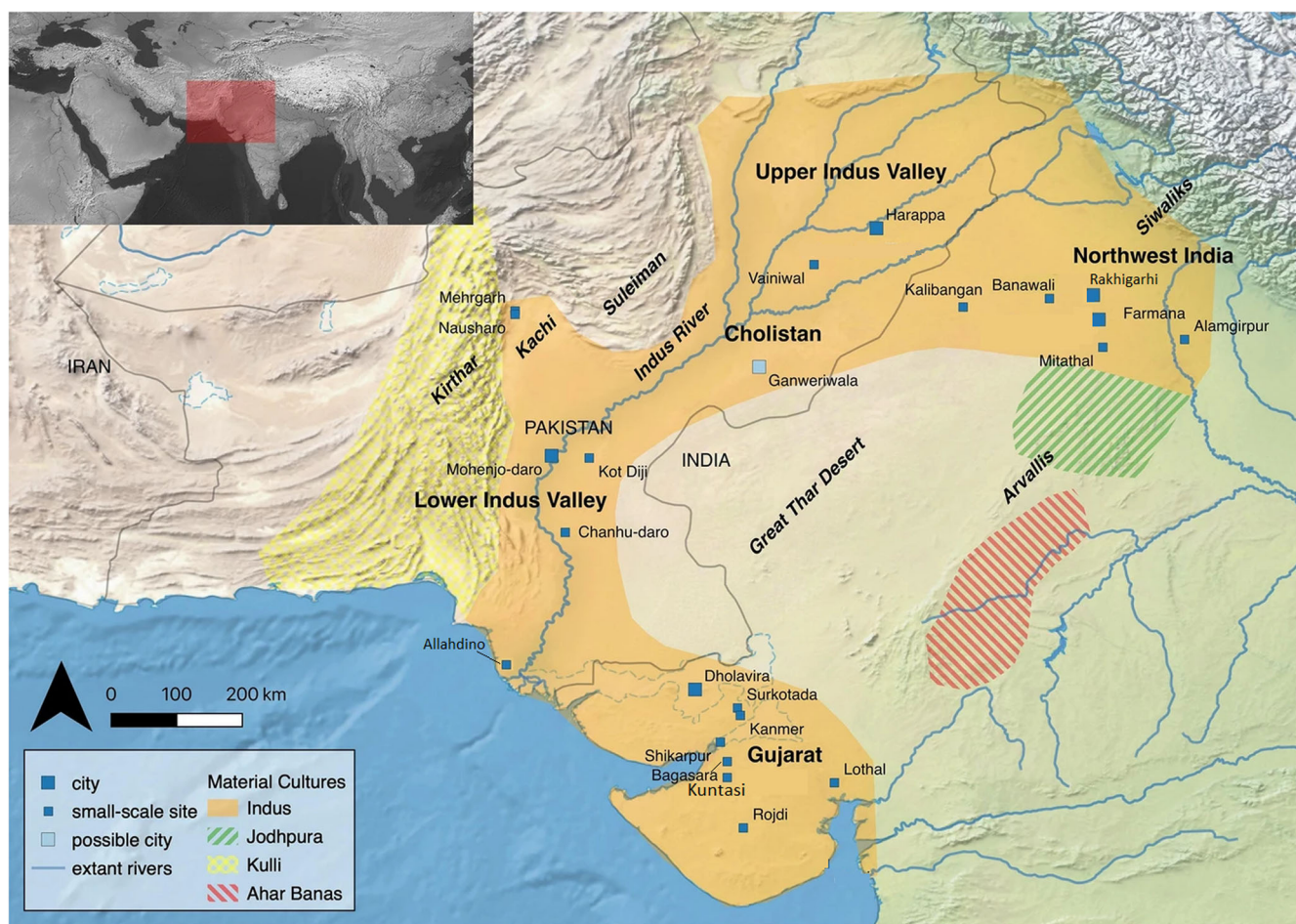
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## Introduction

At its peak (c. 2600–1900 BC), Indus Valley Civilization (IVC) was the most expansive Bronze Age civilization, spanning almost one million square kilometers, covering much of today's Pakistan and northwestern India (Kenoyer, 2010). Figure 1 shows a map of IVC, with certain selected Indus sites mentioned in this article, and certain contemporary neighboring cultures (e.g., the Ahar-Banas culture, the Jodhpura culture, and the Kulli culture) (Green, 2021; McIntosh, 2008). Indus script (ISC), one of the most enigmatic aspects of IVC, is presently embodied in less than 6000 recorded inscribed objects excavated from various Indus sites, comprising seals, sealings (seal-impression carrying tags), tablets (incised and bas-relief), pottery shards, “stoneware” bangles, ivory sticks, etc. (Fig. 2). The Dholavira “signboard” is one of the rare instances where ISC is found in a non-miniature form (Fig. 2g). A few Indus seals were also found from sites of ancient Near East, with whom IVC had trade relationships—e.g., a 3rd millennium BC seal with Indus-inscription  discovered from Kish (Langdon, 1931).

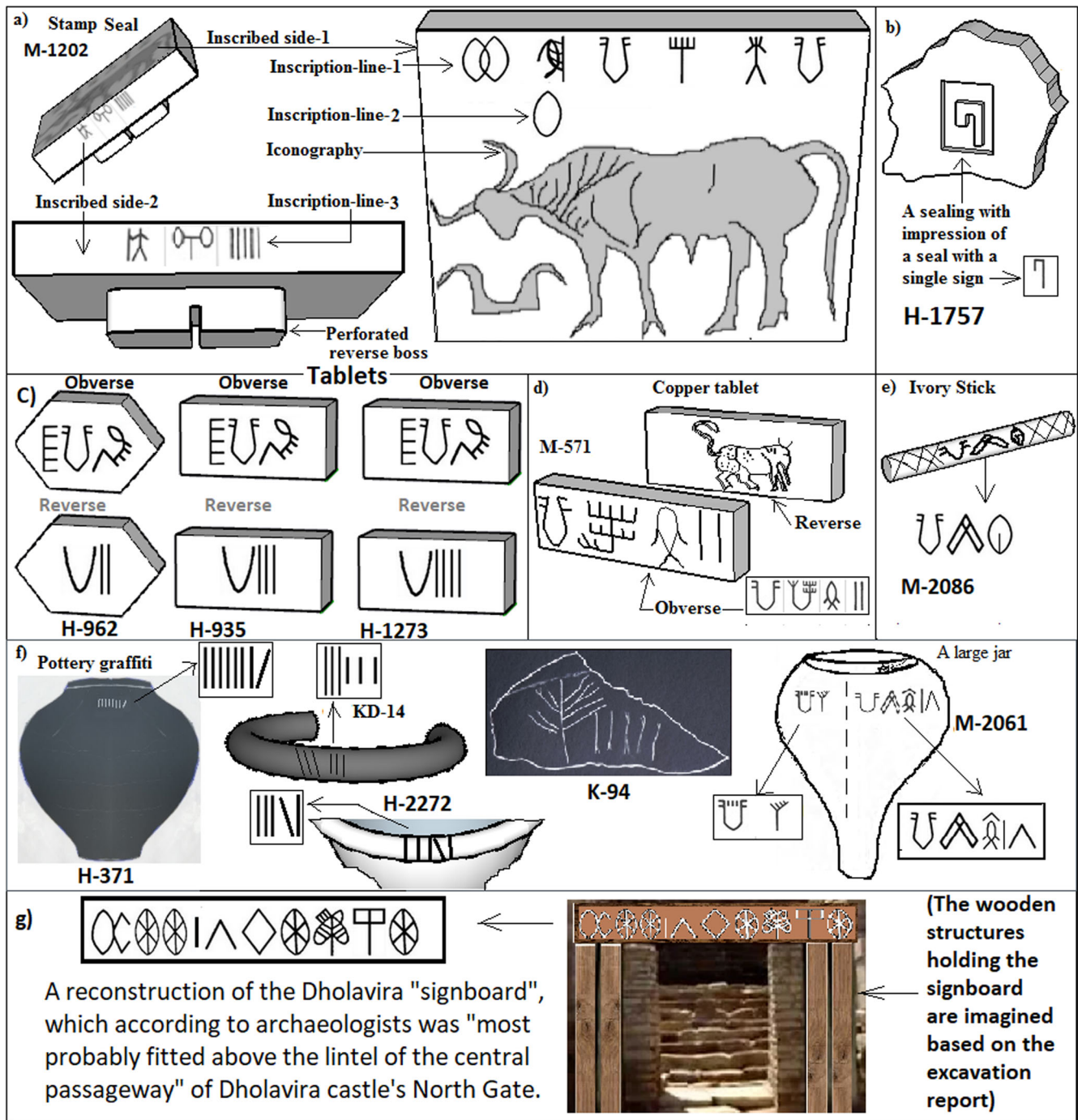
Despite more than 100 years of extensive scholarly research, ISC is not yet decoded. Various issues, including the limited number of inscribed artifacts discovered yet; the briefness of ISC inscriptions (average length around five signs, less than 50 inscription-lines contain ten or more signs); uncertainties about ISC's underlying language(s) or whether ISC at all encoded

linguistic words; uncertainties about ISC's relationship with other Indic scripts of later historical era; poor chronological control maintained in the ISC corpora; and the absence of any bilingual inscribed object like the Rosetta-Stone containing any known script along with ISC, have impeded ISC's decoding (see Supplementary-File-Section-1 for details). Moreover, although several pioneering scholars (Asko Parpola, Iravatham Mahadevan, Bryan K. Wells, to name a few) have significantly contributed towards ISC's research, there are various crippling issues in many of the existing research methodologies, which have led to some hasty and logically incoherent conclusions regarding the sounds and/or meanings of ISC-signs (see Possehl, 2002 p.138, and Supplementary-File-Section-2). This article's author believes that before trying to assign random phonetic values or meanings to a small set of ISC-signs and inscriptions, without caring whether such claims explain similar sign-patterns present in other inscriptions (see Supplementary-File-Section-2), a researcher should narrow down the semantic scopes of ISC-inscriptions, so that future studies can analyze the iconicity and positional-statistical features of individual ISC-signs to infer their semantics within those established semantic scopes. To achieve this objective, this study analyses various script-internal and archaeological evidence, and concludes that IVC's inscribed seals/sealings/tablets were primarily used for encoding certain administrative rules and regulations for (i) controlling the cultivation/manufacturing/trading of certain commodities; (ii) collecting taxes and issuing



**Fig. 1** A map of the Indus civilization along with some of its contemporary neighboring material cultures, showing certain Indus sites selected from the sites mentioned in this article. The map is adapted with permission of Adam Green from Figure-1 of Green (2021), which is covered by the Creative Commons Attribution 4.0 International License.





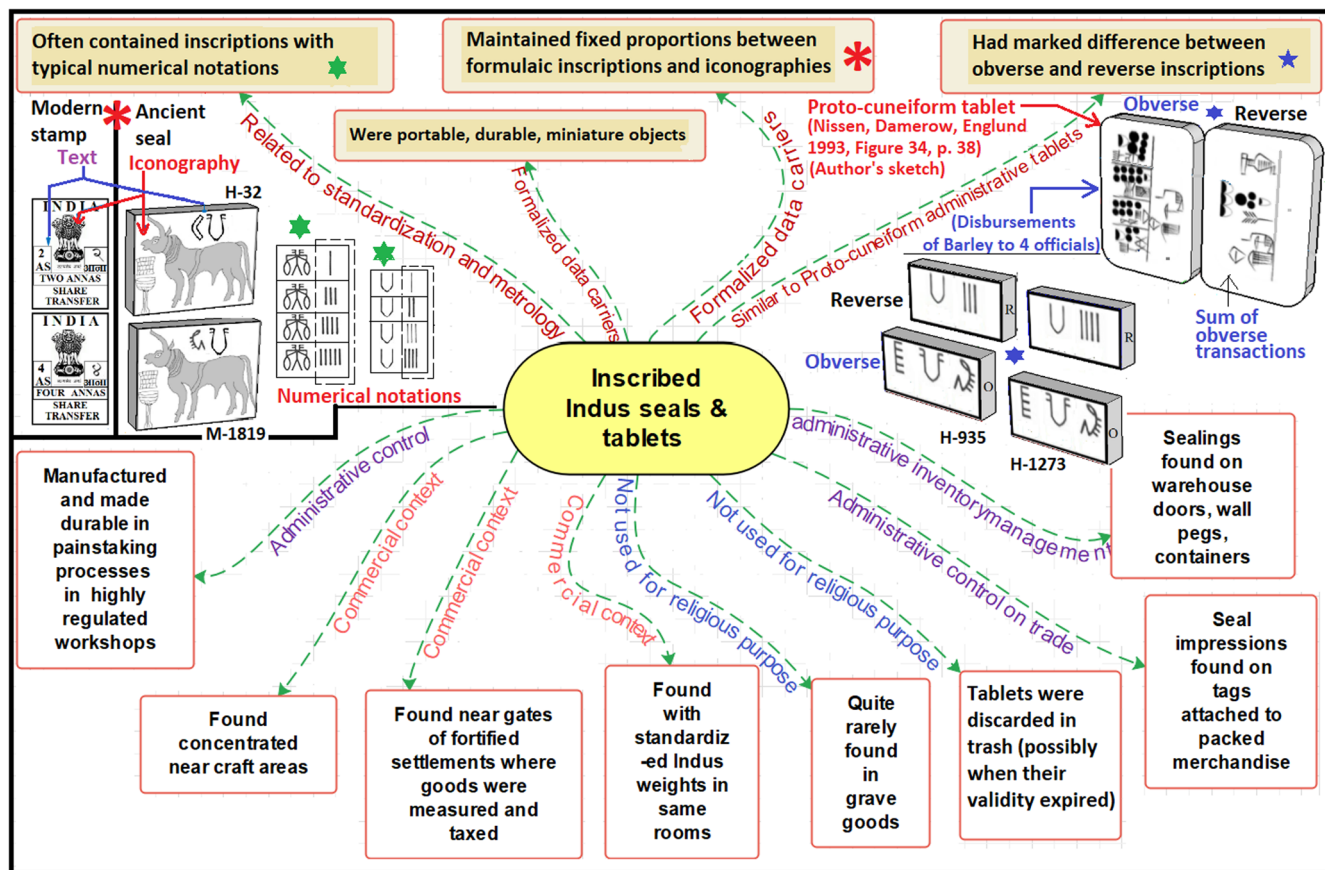
**Fig. 2 Examples of Indus script inscriptions found in different types of objects.** The examples include inscriptions found from seals (a), sealings (b), tablets (c, d), ivory sticks (e), pottery shards and vessels (f), and a “signboard” (g). The images of the artifacts are drawn by the author as representative examples of the original artifacts.

licenses for specific commodities and commercial activities; (iii) exerting access control; etc.


**Materials and methods**

For analyzing the graphemic and combinatorial features of ISC-signs, and visualizing the inscribed artifacts, this study uses three different corpora namely, (i) an interactive online corpus (ICIT) (Wells and Fuls, 2006/2023) (ii) Mahadevan’s digitized corpus (M77) (Mahadevan, 1977); and (iii) Parpola’s photographic corpora of inscribed objects (CISI) (Joshi and Parpola, 1987; Shah

et al. (1991); Parpola et al., 2010; Parpola et al., 2019). Whenever the signs identified in these corpora differ, the actual images of the inscribed objects are consulted from CISI and/or the excavation reports. All Indus artifacts are referred to using their CISI serial-numbers, if not mentioned otherwise. In a few cases, the excavation numbers (prefixed with “ASI#” for artifacts excavated by the Archaeological Survey of India) or ICIT’s serial-number (prefixed with ICIT-) are used. Since most of the ISC-inscriptions were read from right-to-left (Parpola, 1994; Mahadevan, 1986), all the inscriptions (including the left-to-right seal-inscriptions originally rendered in intaglio so that the sealing-impressions were



**Fig. 3 An infographic summary of evidences that Indus seals and tablets were formalized data carriers used in commercial contexts where trade-control, standardization and metrology played important roles.** Texts and images for related topics are marked with same-colored stars. The images of the artifacts are drawn by the author as representative examples of the original artifacts. The Proto-Cuneiform tablet is drawn after Figure-34 of Nissen et al. (1993).

read right-to-left) rendered without the artifact-images in this article’s texts and figures (e.g., ) are rendered in a normalized right-to-left direction, by concatenating the sign-images sourced from ICIT.

This study’s methodology involves programmatically analyzing the ISC corpora and connecting script-internal evidence with archaeological, linguistic, and historical data to understand the inscriptions’ semantic scopes.

**Outline of the article’s structure**

As summarized in Fig. 3, Ansumali Mukhopadhyay (2019) has already established that Indus seals and tablets, from which more than 85% of ISC-inscriptions are found, were “formalized data carriers” (a term used in Nissen et al., 1993, in context of the Proto-Cuneiform administrative tablets), and their inscriptions were most likely used in commercial contexts where standardization and metrology played important roles. This article advances this hypothesis and analyses both script-internal evidence (Section “Semantic scopes of Indus-inscriptions: Script-internal evidence”) and archaeological contexts (Section “Archaeological evidences indicate ISC’s use in taxation, licensing, craft/trade-control, commodity control, and access control”), to argue that the inscribed Indus seals and tablets were used in various administrative processes, such as: (i) tax collection, (ii) trade/craft licensing, (iii) commodity control, (iv) access control, etc. However, to follow these arguments, one should understand ISC’s basic structural features, which are summarized in “Certain

important structural features of Indus-inscriptions”. The contentions of the article are summarized in “Conclusions”. A supplementary file containing further details on certain points is also added.

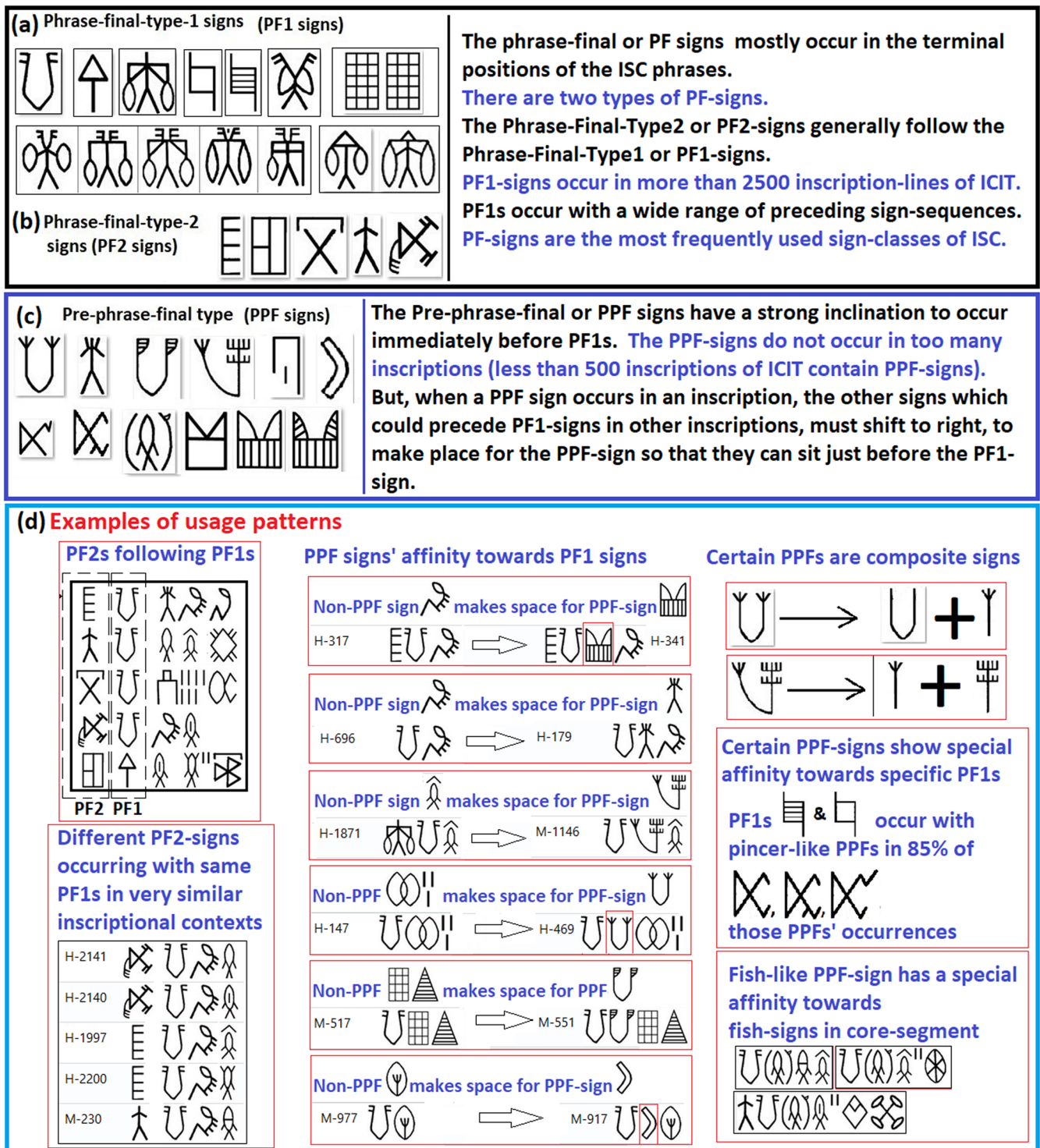
**Certain important structural features of Indus-inscriptions**

Certain important structural features of ISC, most of which are already elaborately discussed by Ansumali Mukhopadhyay (2019), are very briefly summarized below. Indus-inscriptions are logographically/semasiographically written brief formulaic inscriptions (see Supplementary-File-Section-3 for differences between sematograms and logograms), where specific sets of signs generally occur in specific inscriptional segments (terminal, pre-terminal, core-informational, connective, and pre-connective segments). Several ISC signs can be classified into certain functional or semantic classes based on their combinatorial behaviors and graphemic features. Figures 4–12 provide brief infographic descriptions of the ISC sign classes, and selected examples of their occurrences in various inscriptional segments.

**Semantic scopes of Indus-inscriptions: script-internal evidence**

**Diverse functionalities of ancient inscribed seals and tablets, and their applicability in Indus context.** Establishing the exact semantic scopes of undeciphered inscriptions engraved on ancient seals/tablets is not an easy task. This is because, as listed in Table 1 and Table 2, since antiquity, in different civilizations,



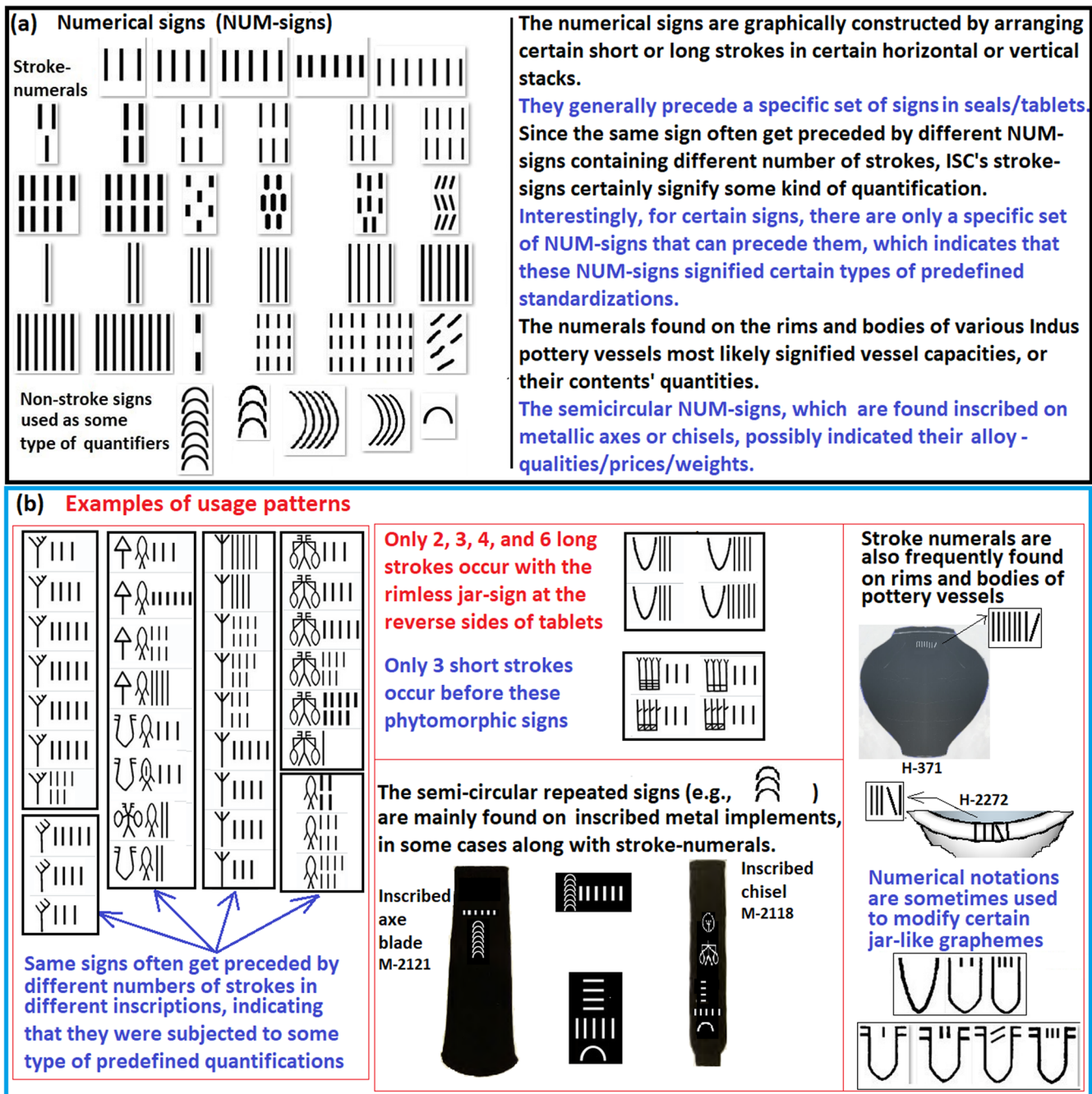


**Fig. 4** Infographic descriptions of the Phrase-final and Pre-phrase-final sign-classes of the Indus script. Certain important features of Phrase-final (a, b) and Pre-phrase-Final (c) signs are shown along with certain examples of their usage patterns (d).




seals and tablets have been used in many different ways, and their inscriptions have encoded widely varying types of information.





**Indus-inscriptions did not encode names of individual seal-owners.** Since the inscribed seals of ancient Near East were often used for identifying the owners or endorsers of stamped commodity packages, or for recording the participants and witnesses of transactions in stamped contractual or juridical documents,

their inscriptions often encoded anthroponyms (Ameri, 2018). In fact, anthroponyms and toponyms have played crucial roles in the decipherment of Egyptian Hieroglyphs, Persian Cuneiform, and Greek Linear B script. This possibly influenced certain researchers of ISC, who argue that Indus seal-inscriptions might have also encoded anthroponyms. However, such anthroponym-based claims (e.g., Mackay, 1938 p.336; Parpola, 1994; Kenoyer, 2020) can be easily disproved by analyzing various script-internal

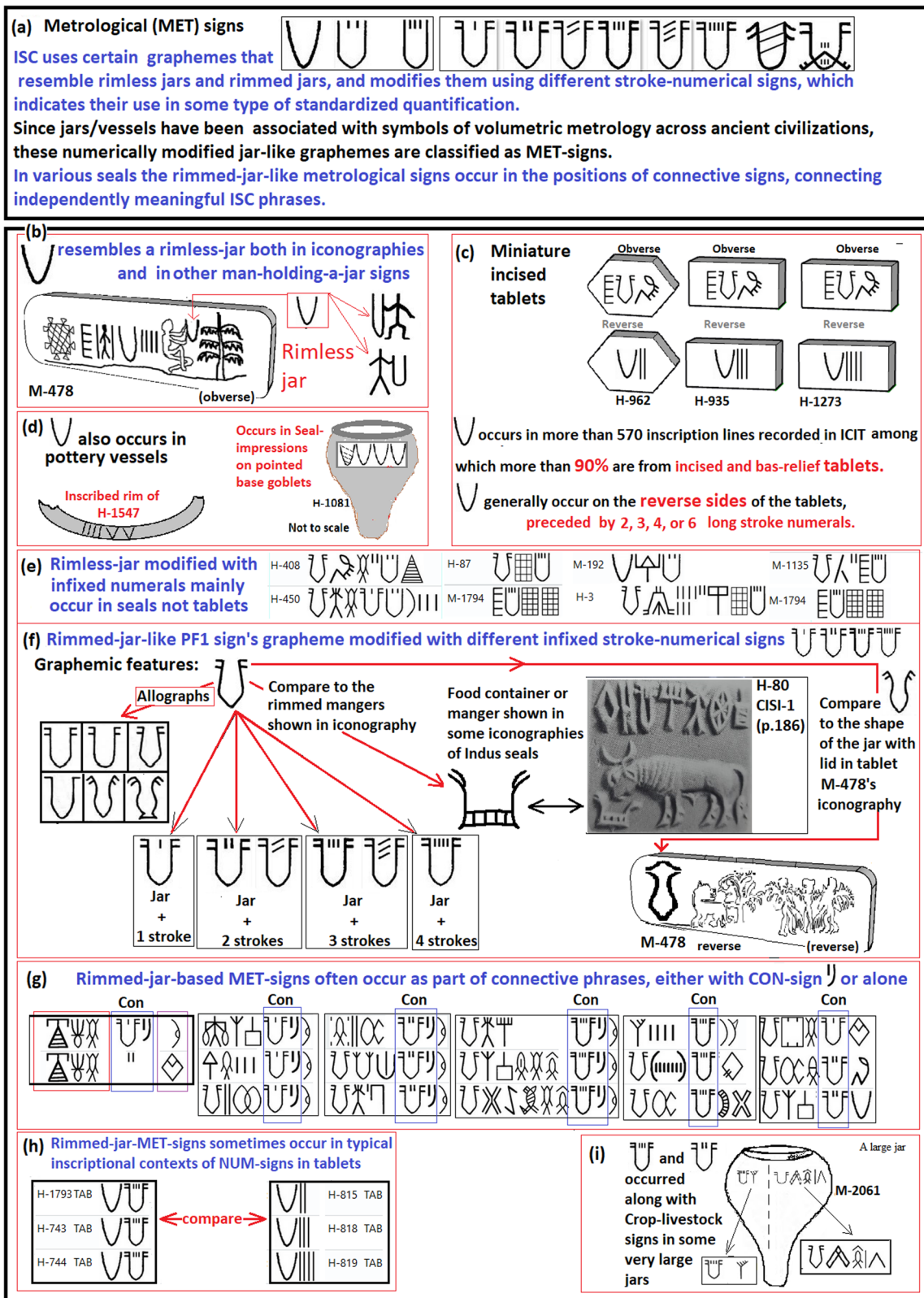


**Fig. 5 Infographic descriptions of the Numerical sign-class of the Indus script.** Panel a shows certain important features of the Numerical signs, and panel b shows certain examples of their usage patterns. The images of the artifacts are drawn by the author as representative examples of the original artifacts.

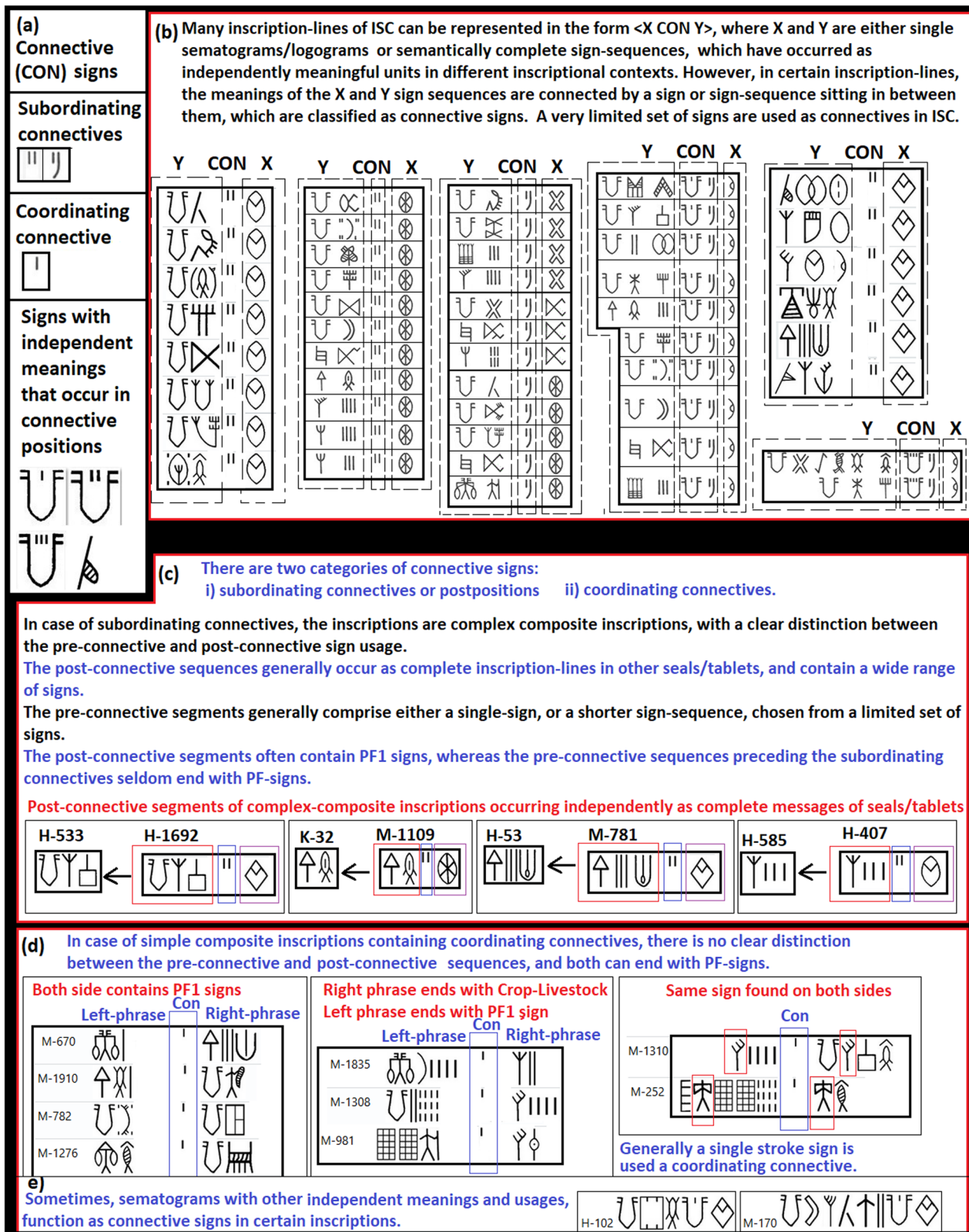
evidence. For example, both Heras (1953) and Parpola (1994) have famously claimed that some of ISC's <stroke-sign fish-sign> constructs encoded anthroponyms. As discussed in Supplementary-File-Section-2, Parpola (1994) has read the ISC sign-sequences , , and , as “3 + fish”, “6 + fish”, and “7 + fish” respectively, and has inferred that they encoded the ancient Dravidian words ‘mu(m)-min’, ‘(\*c)aru-min’, and ‘eļu-min’, which were certain theophoric astral names of the Indus seal-owners. According to Parpola (1994), these fish-signs were inspired by a Proto-Dravidian homonymy, where the word “min” signified both “fish” and “star”. However, Parpola’s

anthroponym-based conjecture does not explain many other similar sign-sequences present in Indus-inscriptions, where signs like , , , and  get preceded by different numbers of strokes in different inscriptional contexts (see Fig. 5b, Sections “Specifics of individual commercial transactions were not recorded”, “Numerical expressions in Indus seal-inscriptions possibly recorded craft/commodity-specific tax-rates and/or license-slabs” and “Reverse-side numerical expressions in Indus incised and mould-made tablets possibly recorded license-fees and license-slabs”). Did all such sequences encode names of Harappan seal-owners? Did most of such alleged anthroponyms of IVC mysteriously contain certain numerical elements? Moreover, the seal-





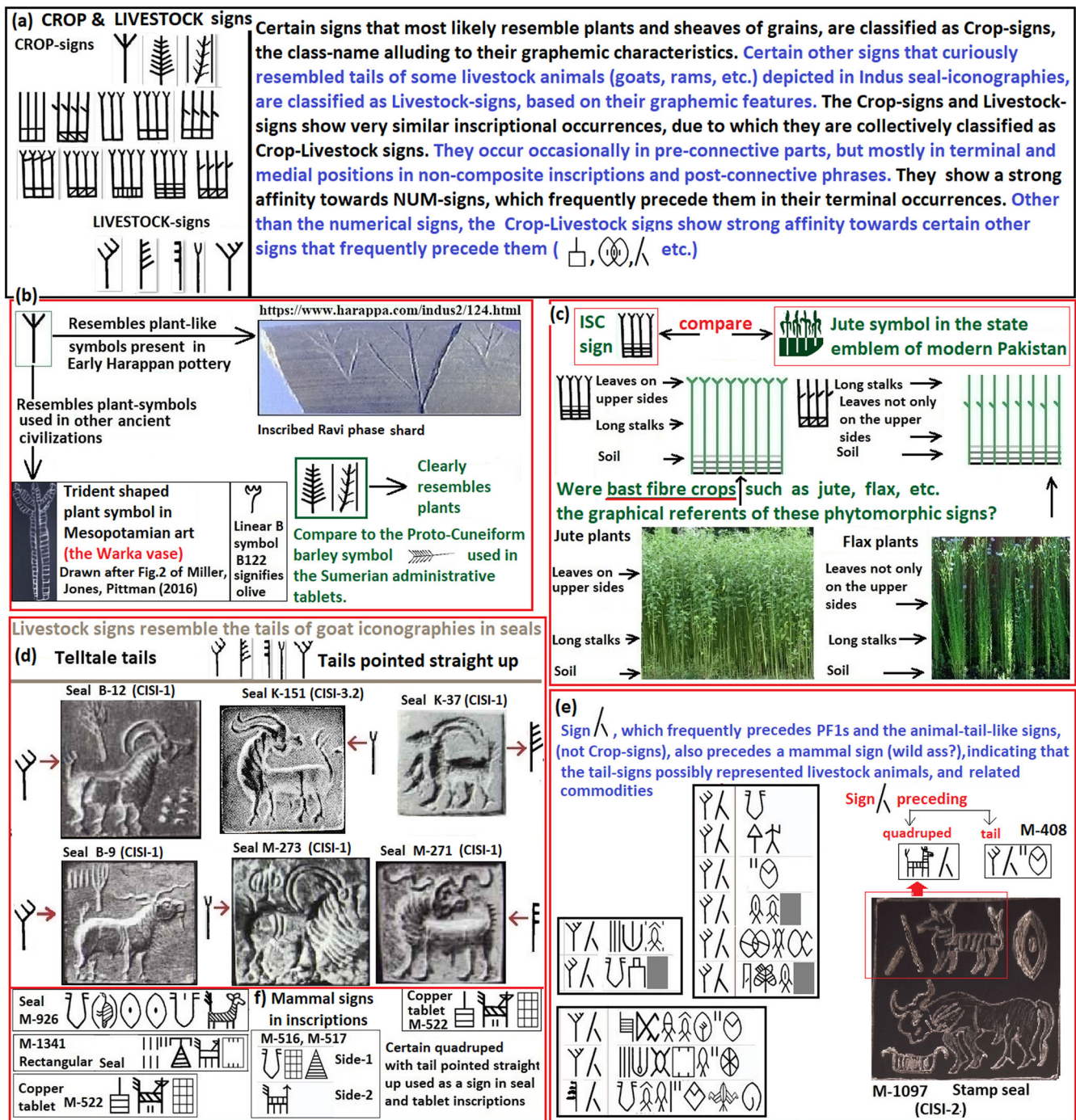
**Fig. 6** Infographic descriptions of the Metrological sign-class of the Indus script. Panel **a** shows certain important features of the Metrological signs, and panels **b-i** show certain examples of their usage patterns. The original image of seal H-80 from CISI vol.1 is used with the permission of the Archaeological Survey of India. The images of all other artifacts are drawn by the author as representative examples of the original artifacts.



**Fig. 7 Infographic descriptions of the Connective sign-classes of the Indus script.** Panel a shows different categories of the connective signs. Panel b shows the formulaic structures of certain composite Indus script inscriptions containing connective signs. Panels c and d describe the complex composite and simple composite inscriptions containing subordinating and coordinating connectives respectively. Panel e shows certain jar-like signs used as connective signs.







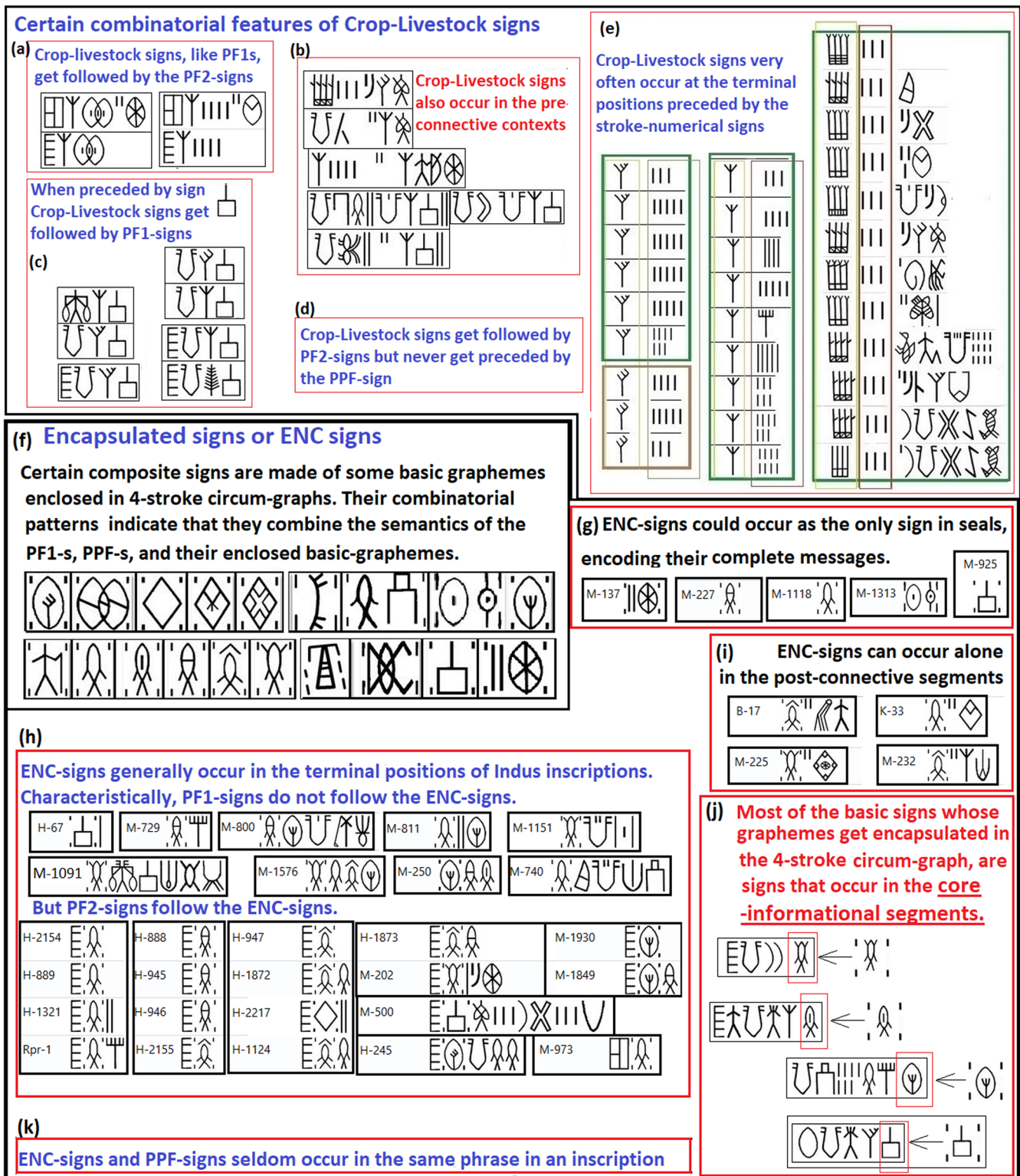
**Fig. 9 Infographic descriptions of the Crop-Livestock sign class of the Indus script.** Panel a shows certain important features of the Crop-Livestock signs. Panels b-c show the graphemic similarities of certain Crop-signs with different types of plants. Panel d shows the graphemic similarities of certain Livestock-signs with the tails of certain quadrupeds shown in seal-iconographies. Panel e shows certain important usage patterns of the Livestock-signs. The trident plant symbol shown in b, is drawn by the author after the symbol in Fig. 2 of Miller et al. (2016). An original image of a pottery shard from the Harappa.com website with permission from Harappa.com is also shown in b. Original images of certain seals from CISI volumes 1 and 3.2 are shown in d, with the permission of the Archaeological Survey of India. All other images of artifacts are drawn by the author as representative examples of the original artifacts.

by using complex symbols. Even if one argues that ISC was supposed to be understood by only a selected set of people involved in administration, it would have been impracticably difficult to continually train the people deputed in distant settlements (see “Identical seal/tablet-inscriptions found across distant settlements”), to encode and decode new proper nouns by using complex symbols. Thus, unlike many of the phonetically

written Mesopotamian and Egyptian seals, the semasiographic inscriptions of Indus seals/tablets were not designed for encoding individual seal-owner’s names and were not used to authenticate individual ownership or individual endorsement of stamped merchandise.

Another interesting evidence that anthroponyms were not encoded by seal-inscriptions, comes from the fact that as analyzed



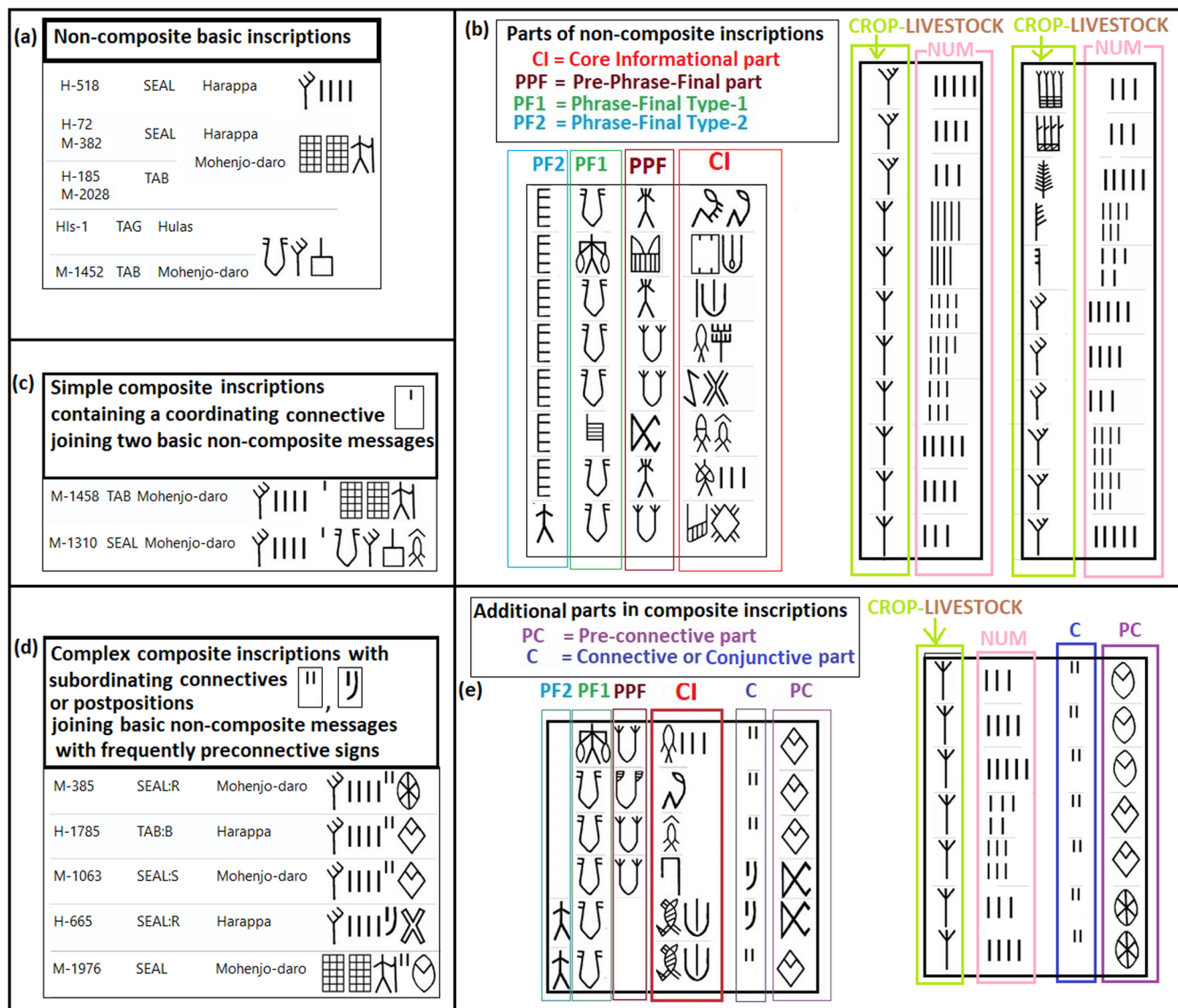


**Fig. 10** Infographic descriptions of the Crop-Livestock and Encapsulated sign classes of the Indus script. Panels a-e show certain usage patterns of the Crop-Livestock signs. Panels f-k show certain important features and usage patterns of the Encapsulated signs.

from the seals found from Harappa, and other major Indus sites, the number of signs used in seals generally increased with time. For example, as documented by Kenoyer (2020 Table 2), the seal-inscriptions generally contained 1–2 signs during 2800–2600 BC, 1–3 signs during 2600–2450 BC, but longer inscriptions in 2450–2200 BC and 2200–1900 BC. Is it possible that the anthroponyms could be encoded with lesser number of signs in

the earlier stages of IVC, but needed many more signs in the later stages? Now, someone might argue that in the later-era seals, multiple anthroponyms were encoded making their inscriptions longer. But, since generally the terminal and initial signs of those longer inscriptions often contain the same signs as the shorter inscriptions, and only the core-informational portions of the inscriptions increase in length (see Fig. 11d), it can be easily





**Fig. 12 Different structural categories of the Indus script inscriptions.** Examples of the formulaic structures of the non-composite (a), simple composite (c), and complex composite (d) Indus script inscriptions, and their different inscripational segments (b, e).

proved that if shorter inscriptions such as 𑀩𑀺𑀫𑀺 𑀩𑀺𑀫𑀺 or 𑀩𑀺𑀫𑀺 𑀩𑀺𑀫𑀺 phonologically (e.g., logo-syllabically) encoded certain names, then very similar longer inscriptions, where only one more medial sign is added (e.g., 𑀩𑀺𑀫𑀺 𑀩𑀺𑀫𑀺 and 𑀩𑀺𑀫𑀺 𑀩𑀺𑀫𑀺) cannot logically encode anthroponyms. Ansumali Mukhopadhyay (2019) has already shown the semantic compositionality of Indus-inscriptions, where members of specific functional sign-classes predictably occur in specific inscripational segments (Fig. 12). Thus, the structural realities of ISC, and its obvious semasiographic/logographic nature (see the semantic co-occurrence restrictions depicted by many of ISC's sign-classes, as discussed in Ansumali Mukhopadhyay (2019)) help us to confidently preclude Functionality-1 of encoding anthroponyms.

It should also be noted that, in modern administrative systems, the stamp-seals used by a government, a bank, or a corporate

organization, often contain only the name of the organization, and the seals' purpose, not the names of individual employees using those seals to endorse specific transactions. Similar examples also existed in ancient civilizations. For example, in Seleucid Babylonia, inscriptions of many seals encoded only different tax/tithe types (salt-tax, slave-tax, port-dues, etc.) and the identities of their issuing administrative departments (McDowell, 1935), not individual anthroponyms, as encoding anthroponyms was not necessary in certain administrative contexts.

The semasiographic/logographic mercantile script of IVC possibly devised an inclusive intuitive system where widespread contemporary symbolisms were used to encode a limited set of vocabulary of a commercial sublanguage and where new symbols of associated/extended meanings were generatively created from existing sematograms/logograms, using certain repeatable easy-to-remember rules of modifying the existing graphemes (see Fig. 13).

**Organizational Identities were possibly encoded by iconographies not inscriptions.** Unlike many ancient Near-Eastern



**Table 1 Some of the common and expected functionalities of the inscriptions and iconographies of seals stamped on commercial documents or merchandise packages.**

Name	Description	Examples
Functionality-1: Encoding relevant anthroponyms Functionality-2: Encoding relevant toponyms	Authenticating stamped merchandise-packages and documents by encoding the anthroponyms of their individual owners or endorsers. Encoding certain toponymic information related to the stamped merchandise (e.g., origins and/or destinations of the merchandise) or stamped documents (e.g., the place where the document was registered).	The royal-name scarabs and private-name scarabs used in the Old-Kingdom and Middle-Kingdom era of Egypt (Wegner, 2018 pp.239-242; Ben-Tor, 2018 pp.293-298). Many of the ancient "Yehud stamp-impressions" found on jars, bearing the toponym "Yehud" (Lipschits & Vanderhooft, 2011). Seals of Seleucid Babylonia, bearing city-names as part of their legends (McDowell, 1935).
Functionality-3: Encoding organization names	Mentioning names and/or emblems of the seal-issuing entities (e.g., rulers, royal departments, settlement-authorities, guilds, etc.) through texts and/or iconographies.	The institutional seals of ancient Egypt often encoded names of various institutions and departments, such as "Treasury of Abydos", "storehouse", "the treasury of the fortress overthrowing the 'Bow-people' [i.e.: Nubians]", etc. (Wegner, 2018 p.249; Smith, 2018 p.303).
Functionality-4: Mentioning rules and regulations	Encoding certain predefined taxation, licensing, and trade/craft-control related commercial rules, for ensuring their observance by stamped merchandise or documents.	In Seleucid Babylonia, seals mentioning different tax-types, such as salt-tax, slave-tax, port-dues, etc., were used, whose impressions on various bullae endorsed satisfaction of the taxation-rules applicable to specific transactions (McDowell, 1935). Similarly, in modern era USA, stamp-seals often contain texts like "Tax paid stamp for colored oleomargarine," "State tax paid," etc.
Functionality-5: Specifying types of contents of the sealed packages	Encoding the types and contents of the stamped merchandise or documents, either directly, or indirectly.	Certain ancient Mesopotamian seals used specific iconographies and proto-cuneiform signs for encoding specific commodity-types (Ameri, 2018 pp.36-53). Certain sealings found among the remains of wooden boxes and hundreds of bronze points at an arsenal at the Mycenaean Knossos, were inscribed with the appropriate logogram of a spear-point (Linear B *254), most likely to identify the contents for delivery (Ameri, 2018 p. 351). As recorded in <i>Kautilya's Arthashastra</i> (2.21.01-2.21.06), in ancient India of c. 300 BC (or earlier), the seal-impressions on incoming merchandise-packages of merchants were examined by tax-collectors at toll-houses erected near city-gateways, for checking whether the commodity-type mentioned in the seal-mark matched the actual commodity of the merchandise-package, to ensure that the merchandise were properly measured and taxed (Shamasastri, 1929 p.121). This clearly shows that in ancient India, specific kinds of tax-collection seals were used for specific commodity types, and those seals' impressions encoded commodity-type related information.
Functionality-6: Ensuring integrities of the sealed packages	Indicating the integrity of the content of a stamped package or document. Importantly, just the presence of a recognizable, undamaged seal-impression of the right authority on a closure system of a merchandise package or a document, can ensure their integrity, irrespective of the types of designs, iconographies, or texts used on the seal.	In ancient Mesopotamia, "textual sources give detailed information for the use of seals to protect packed merchandise against pilfering. On the arrival of the goods at their destination, the seals were broken open and the contents weighed and checked, in the presence of witnesses" (Parpola, 2018 p. 141). Similarly, phrases like "Do not purchase if seal is broken" are often used on sealed packages of various modern merchandise.

cylindrical seals, which were made of a wide range of raw-materials, and engraved with a diverse range of motifs, chosen according to individual seal owners' preferences and amuletic requirements (Frenez, 2018 pp.180-182), Indus seals/tablets were not made according to the predilections of individuals. They were most likely issued by certain guilds of artisans/merchants, and/or certain rulers or governing bodies of Indus settlements, who controlled different aspects of IVC's commerce, and collaborated in the Integration Phase of IVC, to enforce certain standardized commercial regulations for facilitating IVC's complex trade networks. These conjectures are based on the following facts:

(i) Indus seals and tablets were largely made from a specific set of materials, such as "almost exclusively specific varieties of

pure and compact steatite," faience, terracotta, copper, etc. (Frenez, 2018 p.180; Miller and Kenoyer, 2018 p.392), which indicates that such seals were issued in a controlled standardized manner.

- (ii) Analyzing the material remains of a bead and tablet production workshop (c. 2450-2200 BC) excavated from Harappa's Mound-E, Kenoyer (2005) stated that "it is evident from the restricted area of the workshop, that faience and steatite tablet production was a highly regulated craft".
- (iii) Most of the seals/tablets demonstrated significant glyptic homogeneity by using certain standardized sets of iconographies and maintaining standardized patterns of sign-usages, even across distant settlements.

**Table 2 Some of the common and expected functionalities of the inscriptions and iconographies used on tablets.**

Name	Description	Examples
Functionality-7: Recording bookkeeping related information	Tablets with incised inscriptions were often used for recording transactional details and bookkeeping-related information of day-to-day commercial transactions for accounting purposes.	Proto-cuneiform administrative tablets of Mesopotamia (Nissen et al., 1993). Mycenaean tablets with Linear B inscriptions, used in palace administration (Ventris & Chadwick, 1956/1973).
Functionality-8: Recording trade, craft, and commodity control-related information or regulations	Tablets containing seal-impressions, which are used in commercial contexts, often encode standardized commercial regulations, and trade/craft specific information	Seal imageries on certain seal-impressed tablets and documents of the Uruk Period of Mesopotamia, encoded “complex messages that referred to the subject or object being controlled (textile production, food distribution) as well as the identity of the controlling authority” (Pittman, 2018 p.18).
Functionality-9: Encoding official titles, privileges, permits, restrictions, and responsibilities	Seals and tablets worn and carried by individuals often functioned as visual identifiers, indicating the official designations, responsibilities, privileges, or commercial permits assigned to their bearers.	Various official titles and/or designations, such as “tax-collector” (Földi, 2021), “vizier”, “royal-treasurer”, “storeroom-manager”, “door-keeper”, “foreman”, “military officer”, (Wegner, 2018 pp.239, 351) etc., are found in the official and/or institutional seals/tablets used in ancient Egypt, Mesopotamia, and Greece, in different time periods.
Functionality-10: Working primarily as protective amulets	Certain tablets were primarily used as protective or magical amulets, and/or votive artifacts. Such tablets are usually found in religious and funerary contexts	Some royal-name and private-name scarabs of ancient Egypt, were primarily used as amulets (Ben-Tor, 2018 p.293; Smith, 2018 p.303).

As discussed in the following sections, by carefully analyzing the structural and distributional features of Indus inscriptions, one can rule out five of the aforementioned functionalities (Functionalities 1, 2, 3, 7, and 10), and focus on the remaining possible usages (Functionalities 4, 5, 6, 8, and 9).

Now, the identities of the issuing institutions must have been an important piece of information to be encoded in Indus stamp-seals, so that the authorities controlling IVC’s commerce at city-gates (as in Harappa), craft-areas (as in Chanhu-daro), and controlled markets inside fortified settlements (as in Dholavira), could understand and verify which particular authority had endorsed a stamped merchandise. But, the mechanism of registering the seal-issuing organization’s identity was possibly not of encoding the organization’s name through inscriptions. Indus settlements, which were distributed across more than one million square-kilometer, surely had distinct regional cultures (Kenoyer, 2010), languages, and dialects (Parpola, 2015 pp. 163–164; Ansumali Mukhopadhyay, 2021). So, the name of a guild that originated in the western coast of India (e.g., Lothal in modern Gujarat), might have been a noun coined in a language/dialect, which was quite different from the languages/dialects spoken in the north-western parts of the sub-continent (e.g., Mohenjo-daro in modern Pakistan). Therefore, guild-names, and/or settlement-based or territory-based rulers’ names, being proper nouns of different languages/dialects, could not possibly be encoded using ISC’s semasiographic/logographic signs. This is possibly one of the reasons why Indus seals used a standardized set of iconographies. The seal-iconographies, most of which were animal-centric (bull, goat, “unicorn”, tiger, elephant, scorpion, etc.), most possibly functioned as different seal-issuing organizations’ emblems. Interestingly, various Indian tribes, clans, and septs have often been named after animals since antiquity. For example, Vedic texts record various animal-based ethnonyms, such as “Mahāvṛṣa” (big bull), “Aja” (goat), “Matsya” (fish), etc. (Macdonell and Keith, 1912 a, b). Similarly, several South-Indian tribal sub-clans have been using animal-centric names such as “Bhāg” (tiger), “Puli” (tiger), Nāg (snake), Mēkala (goat), Cēli (goat), Āne (elephant), Jinka (gazelle), Adu (sheep), Thelu (scorpion), etc. (Thurston, 1909). Besides, many of the punch-marked coins of early-historic India, also used similar zoomorphic iconographies (“tiger”, “elephant”, “bull”, “peacock”, etc.), as insignias of their issuing clans and dynasties (Kosambi, 1996/1956). For example, certain punch-marked

coins issued by the Mauryan dynasty, contained the iconography of a “peacock on arches”, arguably signifying the Mauryan clan-name “Moriya,” which meant “of the peacock” (Kosambi, 1996/1956).

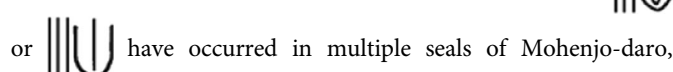
The “unicorn,” the most popular Indus iconography, till now found in more than 60% of recorded Indus seals, is discovered from varied stratigraphic layers across several Indus settlements. It might have been the traditional emblem of a group of merchant/artisan guilds which operated across numerous IVC settlements over multiple generations (see Kenoyer, 1998 pp.87–88; Frenez, 2018 p.176).

Importantly, mutually contemporary Indus seals containing similar iconographies often contained a wide range of inscriptions. For example, the unicorn-iconography seals found at House-I of Mohenjo-daro’s HR-A area (Jansen, 1985), contained inscriptions

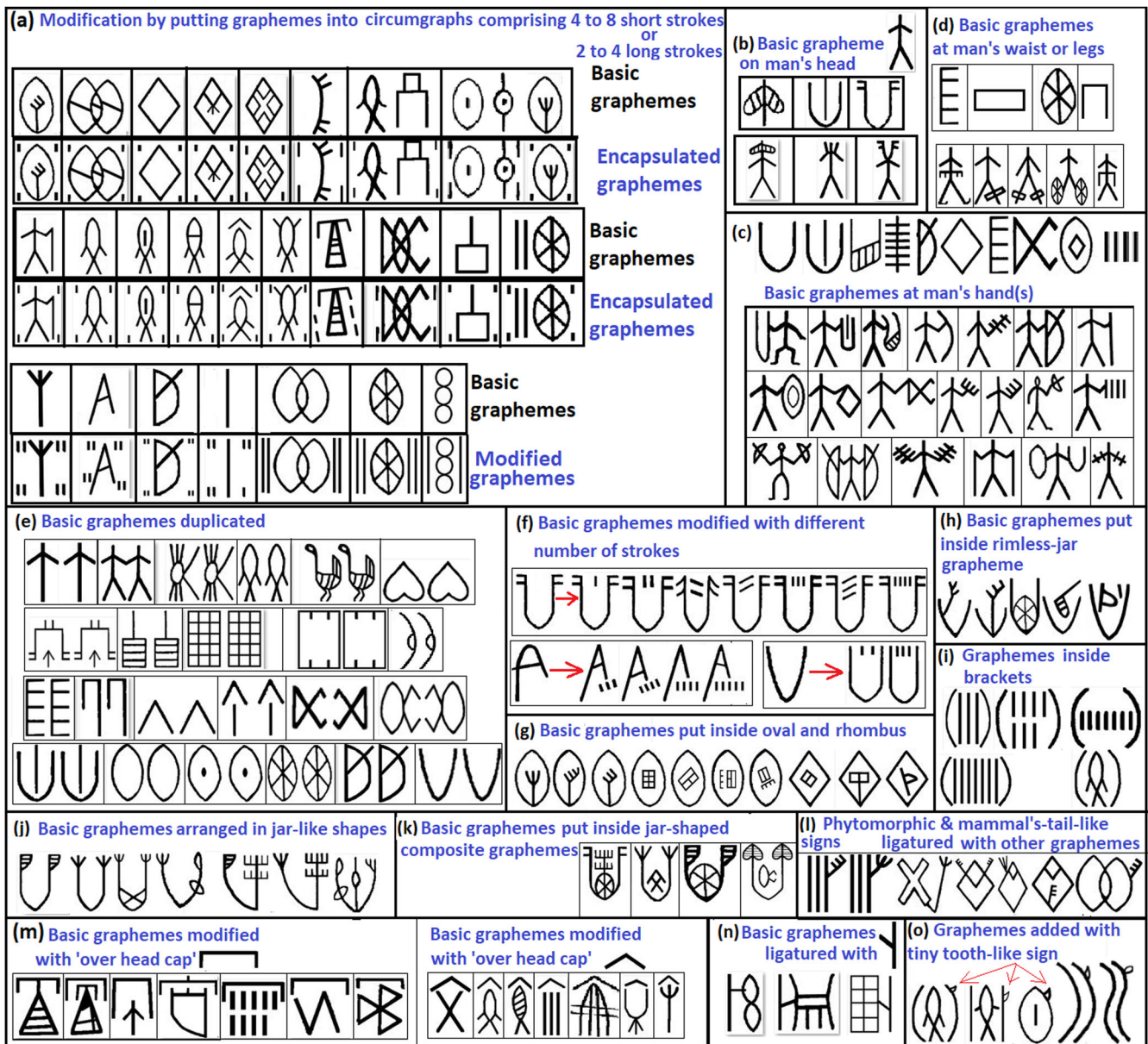


such inscriptions encoded information associated with different crafts, commodities, and related regulations, (see Sections “Numerical expressions in Indus seal-inscriptions possibly recorded craft/commodity-specific tax-rates and/or license-slabs” and “Reverse-side numerical expressions in Indus incised and mould-made table-possibly recorded license-fees and license-slabs”), then the entities identified by the “unicorn” must have controlled a wide range of trades and crafts (see similar conjectures in Kenoyer, 1998).

On the other hand, sometimes seals found from the same settlement contain different iconographies but similar inscriptions. For example, inscriptions containing the collocation



or have occurred in multiple seals of Mohenjo-daro,

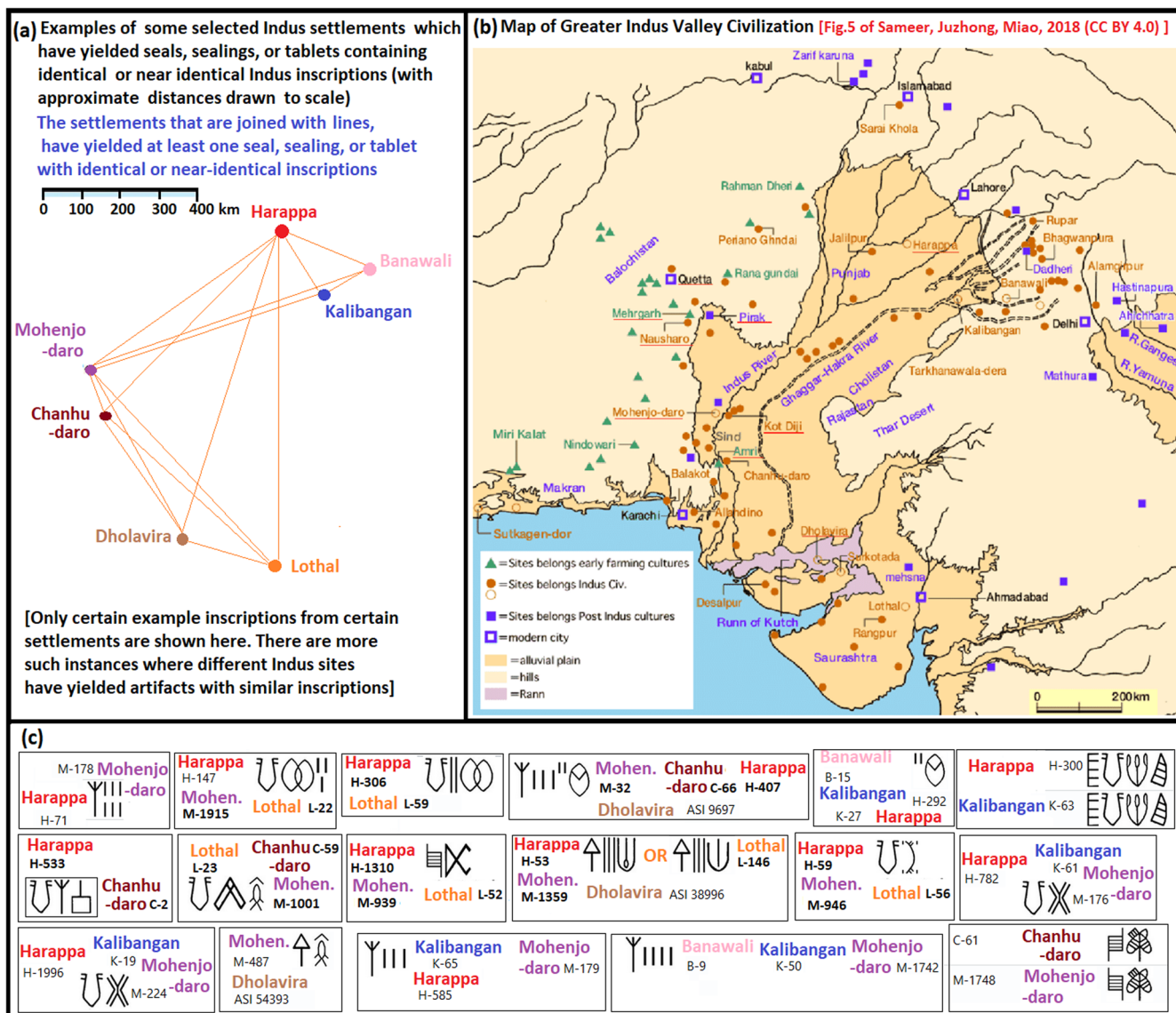


**Fig. 13** Examples of certain generative mechanisms used to form the graphemes of new Indus script signs by modifying the graphemes of the existing basic signs. Types of such modifications include putting basic signs inside circumgraphs (a), joining basic signs with different body-parts of anthropomorphs (b-d), duplication of signs (e), adding numerical notations (f), putting basic signs inside different types of shapes (g-k), joining multiple basic signs and other graphemes (l, n, o), and adding overhead caps to basic signs (m).

containing different iconographies, depicting “unicorn” (M-753, M-1693, M-781), “bison” (M-1079, M-1890), “rhinoceros” (M-276), “elephant” (M-1155), and a three-headed composite animal (M-1169). Some of these different-iconographies-similar-inscription seals were found in similar depths from the same area-section-portion (Mackay, 1938), indicating that they were possibly contemporary to each other (e.g., M-753, M-1693, M-1155 found between -17 to -17.7 feet at DK-G-South; and M-1890 and M-781 found between -9 and -9.6 feet at DK-G-North). This pattern possibly indicates that certain officials/artisans/merchants, who controlled/practiced similar crafts/trades, but belonged to different guilds/rulers/governing-bodies, and used their organization/ruler specific seals, coexisted in the commercially thriving cities like Mohenjo-daro. Certain Lothal tags (L-189, L-190, L-194, etc.) carry multiple seals’ impressions (Parpola, 2007) with different iconographies (e.g., “unicorn” and

rhinoceros). This possibly indicates that different guilds/rulers/governing-bodies identified by different emblems, endorsed the same merchandise packages with different stamps, endorsing the observance of their respective trade/craft regulations. Interestingly, even in Allahdino, seal#Ad-3 (U)U with ‘unicorn’ iconography, and seal#Ad-6 (A)U with “rhinoceros” iconography, cooccur in the context of Building-III (Fairservis, 1976 pp.7-10), indicating cooperation between the authorities using the “unicorn” and rhinoceros-based emblems. Since peaceful co-existence of the representatives of multiple settlement-based rulers in a single city/city-state is less likely than collaborative co-existence of different guilds operating in same geographical regions, such seals possibly indicate that at least some of these iconographies represented certain merchant/artisan



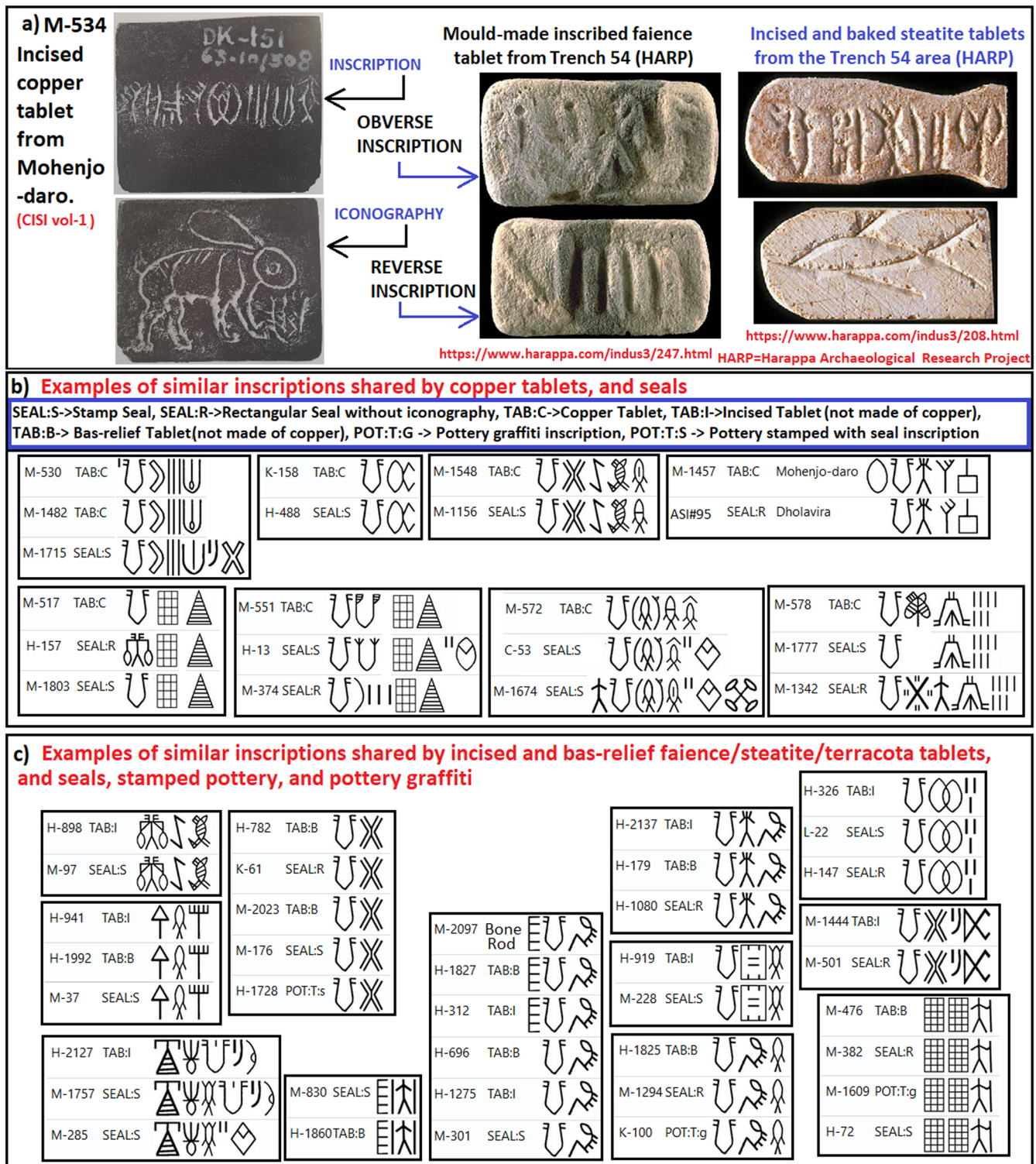


**Fig. 14 Identical Indus script inscriptions found from distant Indus settlements.** Panel a shows a graph diagram depicting approximate distances between certain example settlements that have yielded identical Indus inscriptions. Panel b contains a map showing these settlements along with many other Indus settlements spread across the Greater Indus Valley. Panel c shows examples of inscriptions that are found from artifacts discovered from multiple settlements. The map shown in b uses the map from Fig. 5 of Sameer et. al. (2018), which is covered by the Creative Commons Attribution 4.0 International License.

guilds, not settlement-based rulers. Possibly the seal-iconographies that are found more frequently from stratigraphically related contexts of a region, represented the guilds which had more socio-economic and/or political influence in that region at the corresponding period.

The minute iconographic variations in the decoration of the main animal motifs, and use of various additional inanimate iconographic motifs such as feeding-troughs (e.g., seal H-80), 'cult'-objects (e.g., seal M-122), and occasionally certain ISC-signs (e.g., seal K-37), etc., kept in front of the animal motifs, could have signified different series of such issued seals, or certain departments/subdivisions of a large guild or a regional governing-body. Alternatively, the inanimate motifs could have symbolized the roles of the organizations in the commercial transactions endorsed by the seals. Since animals such as tigers and rhinoceros, which are not usually domesticable, are also shown with feeding-troughs (M-288, M-1138, M-1166), just like buffaloes (M-268), the feeding-troughs (Fig. 6f) must have had some symbolic significance. Conjecturally, "paying tax to an organization"

might be compared to "feeding the organization." For example, even in modern era, paying tax is often compared to "feeding the government" (see Tanous, Cox (2011), p.103). Thus, it is possible that in Indus seal-iconographies, the "feeding trough" signified that the entity identified by the animal facing the trough was a "tax-receiving" entity in this context. As discussed in a recent insightful iconographic cataloging of Indus seals/tablets (Bhaskar, 2022), certain animals, like the zebu (M-263), almost never face the feeding-trough, which might be indicative of the role of the entity signified by zebu in IVC's socio-economic hierarchy. It should also be noted that the same guild might have collected taxes from its members in certain contexts, and might have paid taxes to a settlement-ruler, or other guilds more influential in certain regions, thus having a dual role in the system. This possibly is the reason why the elephant sometimes faces the "feeding troughs" (possibly as a tax-receiving entity), and sometimes stands free (possibly as a tax-paying entity). The use of certain rare iconographies (e.g., M-1186, or ASI#8099 at Dholavira) possibly indicates the existence of certain regional authorities/organizations



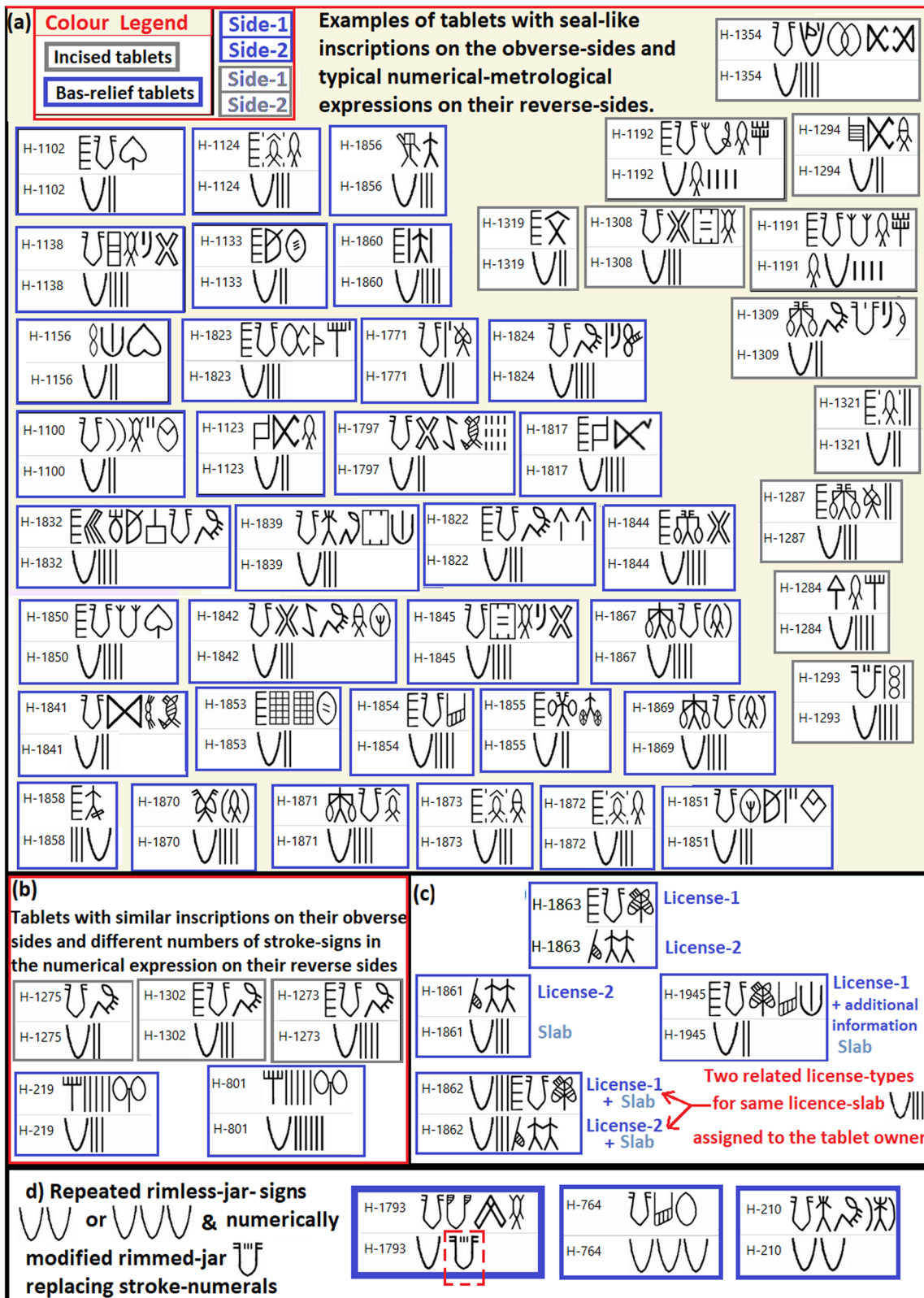
**Fig. 15 Similarities between the inscriptions of Indus seals and tablets.** Panel a shows examples of different types of Indus tablets. Panel b shows examples of certain seals and copper tablets containing identical or similar inscriptions. Panel c shows examples of some identical or similar inscriptions occurring on certain seals, pottery shards and vessels, bone-rods, and faience/steatite/terracotta tablets. Original images of inscribed tablets from CISI vol.1 and the Harappa.com website are used in a, with the permission of the Archaeological Survey of India and Harappa.com.

without pan-IVC reach, who expressed their distinctive cultural/religious practices through their emblems. Certain narrative religious scenes present in certain iconographies (e.g., M-1186), could have been used in certain special “festive issues” of seals/tablets, used for issuing special licenses, or collecting special taxes/tithes. Relevantly, regarding certain composite animals depicted in Indus seals, Frenze

and Vidale (2012, p.120) have insightfully proposed that assembling parts of different creatures in the iconography of a single seal possibly indicates “the inclusion of different actors or authorities in a single social super-body”.

As observed by Vidale (2005), most of the Indus-related seals found from the Near East have gaur/bison iconographies,



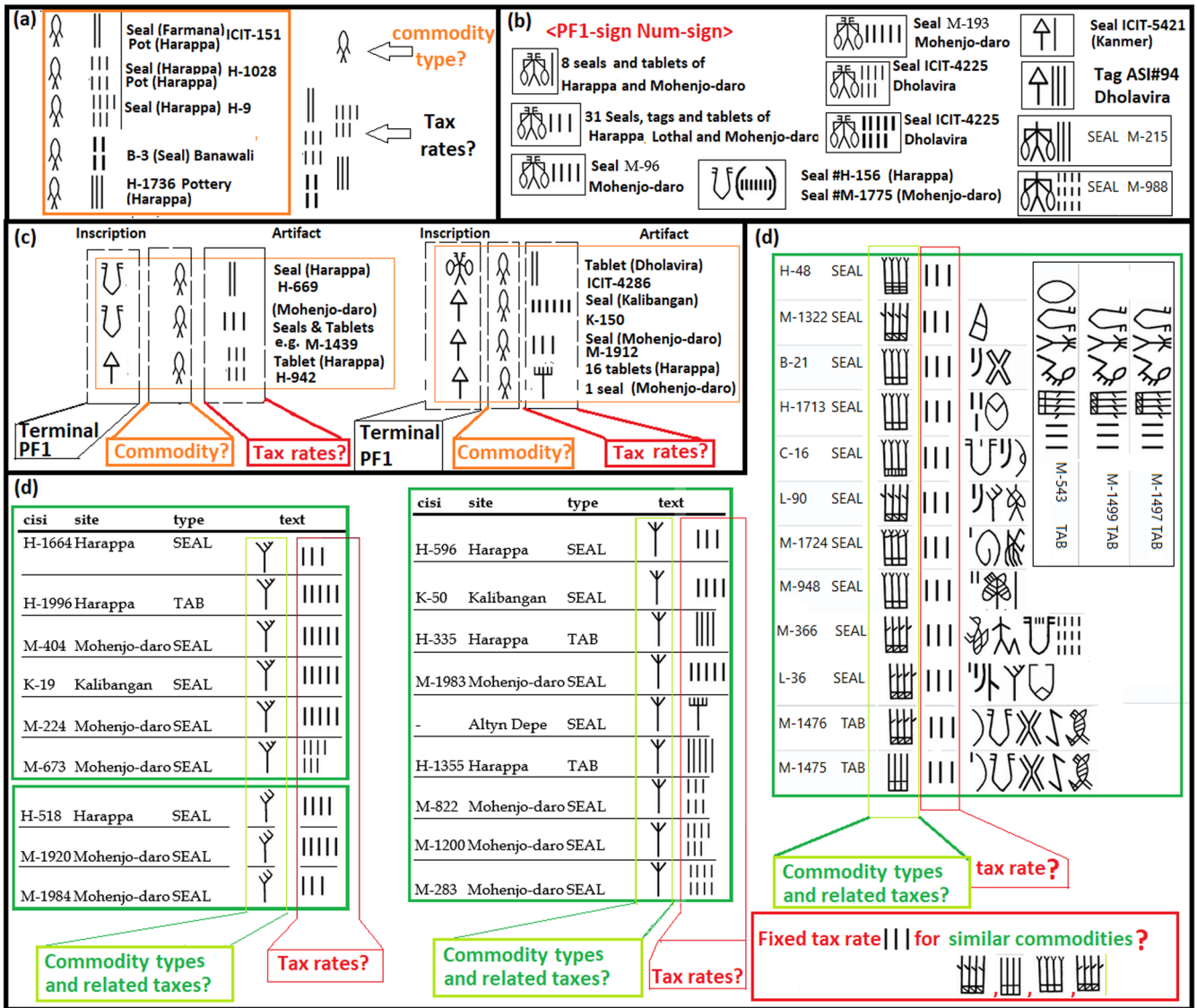


**Fig. 16** Certain examples of incised and mold-made faience/steatite/terracotta tablets with two inscribed sides. Each of the panels (a-d) shows different patterns of the obverse and reverse side tablet inscriptions with necessary explanations.

indicating that the trading clans involved in IVC’s westerly trades mostly used bison-based emblems. Interestingly, as shown in Supplementary Fig. 1, and Supplementary Fig. 2 of Supplementary-File-Section-1, at “Stratum-IV” of Harappa’s Trench-IV of

Mound-F, where a bison-seal was found along with multiple unicorn-seals, a large collection of beads including precious-stone beads, and a few round-shaped seals and tablets with Indus-inscriptions were also found. Since Indus seals were traditionally





**Fig. 17** Examples of certain numerical notations used in the Indus script inscriptions. The examples include different stroke-signs preceding a fish-like sign (a, c), PF1-signs (b), and Crop-Livestock signs (d).

square/rectangular, considering the “affinity of the round seals with the Gulf” (Parpola, 2018 p.129), and the fact that gemstone beads were important export commodities for IVC’s westerly trade, this study suggests that in the 8650-series of artifacts, the co-occurrence of a bison-seal with the round-shaped “Gulf-type” Indus seals, and the precious stone beads, might indicate that these artifacts were linked to IVC’s westerly trade. Interestingly, bison iconographies are also found in a few unusual discoid bas-relief tablets found in Mohenjo-daro (e.g., SIDE-1 SIDE-2 of M-2014). A tiny silver finger-ring engraved with an Indus-style bison, possibly made by a silversmith in Iraq with silver originated in Turkey, is recently excavated (around November 2022) by Kimberly Williams from a 5000-year-old tomb unearthed in Oman’s northern Al Batinah Governorate (Archaeological Institute of America, 2022), which further corroborates the use of bison-iconography in IVC’s westerly trade.

The above discussion indicates that even if Functionality-2 of encoding specific organizational identities was not applicable to

Indus-inscriptions, it might have been applicable to the seal/tablet iconographies. Here, it is important to clarify that although ISC-inscriptions did not encode proper names of specific organizations/entities, they could have semasiographically/logographically encoded general types of organizations (e.g., royal tax-collection department, port-control authority, etc.) through members of specific sign-classes.

In this context, it should also be mentioned that according to Frenez (2018, p.186), the seal-iconographies indicated roles/ranks of the seal-owners who were Indus bureaucrats (“socio-economic figures”) operating in the framework of a structured social-economic organization (“central authority”) active across the entire Greater Indus Valley. However, the present author finds it less plausible that a single central authority controlled the commerce across the vast expanse of IVC (see Ahmed, 2014 Section-I; Vidale, 2018). The expansion of the Harappan culture in different Indus settlements happened gradually, and at different time periods (Gangal et al., 2010). Thus, it is more likely that different entities participating in IVC’s commerce emerged in different localities at different era, who eventually created certain powerful organizations which used different



**Fig. 18** Different types of information encoded in different parts of modern stamps and licenses. Panels **a** and **c** show the information content of different parts of certain revenue-stamps and a trade-license. Panel **b** shows how the related information contents provided in a specific segment of certain tax-stamps can be combined into corresponding segment of another tax-stamp. The USA stamp images shown in **a** are from Wikimedia Commons. These images are in the public domain because they are works prepared by some officers or employees of the United States Government as part of their official duties under the terms of Title 17, Chapter 1, Section 105 of the US Code. The stamp images of Canada shown in **b** are from Wikimedia Commons. These images are in the public domain as they were all created more than 90 years before current year, i.e., 2023. A schematic diagram of a license, drawn by the author after the image of a license available at <https://digital.hagley.org/2270421> is shown in **c**.



Close relationship between tax stamps and licenses:

Phrases like "Several penalties are imposed for neglect or refusal to place and keep this Stamp conspicuously in your establishment or place of business" or "Keep this stamp posted" indicate that these tax-stamps were also used as licenses (with specific durations and expiry dates).

Depending on license type or license slabs, i.e., wholesale or retail, licenses for the same commodity (oleomargarine) had different license fees (\$480 vs. \$48) [License rates for oleomargarine in years 1948-1950 were similar, so the variation in license/tax fee is due to license type, not license year]

Image source: <https://wellcomecollection.org/works/atqrnggc/images?id=uhjib2e5> (Public domain mark)  
[https://commons.wikimedia.org/wiki/File:United\\_States\\_Internal\\_Revenue\\_stamp\\_for\\_special\\_tax\\_Wellcome\\_L0064705.jpg](https://commons.wikimedia.org/wiki/File:United_States_Internal_Revenue_stamp_for_special_tax_Wellcome_L0064705.jpg)

Schematic diagram (by author) of the stamp available at <https://digital.hagley.org/2270276>. Specific licensee related information are replaced by generic texts in <>.

Schematic diagram (by author) of the stamp available at <https://digital.hagley.org/2270267>. Specific licensee related information are replaced by generic texts in <>.

**Fig. 19** Examples of certain modern special tax stamps or licenses issued in the USA, to show close relationships of licenses with tax stamps, and similar types of information encoded in corresponding segments of related licenses. This figure uses a public domain image from <https://wellcomecollection.org/works/atqrnggc/images?id=uhjib2e5> and Wikimedia Commons covered under the Creative Commons Attribution 4.0 International license. It uses two other stamp images drawn by the author after the images available at <https://digital.hagley.org/2270276> and <https://digital.hagley.org/2270267>.

iconographies as their emblems. For example, an inscribed stamp-seal excavated from Kanmer of Kutch contains a rare “wild ass” iconography, whereas one of the three inscribed “passport”-like clay-tokens of Kanmer, also contains a “wild ass” sign handwritten on its reverse. This possibly indicates that certain local guild or settlement-based ruler/ruling-body started operating in Indus Kutch at a point of time, who used “wild ass,” a characteristic animal of that region (Parpola and Juha, 2011 p.71), as their emblem. However, since the guilds/rulers/governing-bodies identified by the seal-iconographies were part of the “public persona” of the individuals assigned with the seals, the main point of Frenez’s article (2018) is not contradicted by the present article’s conjectures. Rather, the clear dominance of certain seal-iconographies over others (Konasukawa and Koiso, 2018), buttresses Frenez’s argument that for a long time, IVC’s socio-economic structures remained “in an evident condition of highly unbalanced oligopoly” (Frenez, 2018 p.187).

**Toponyms were not encoded by Indus-inscriptions.** Being logographic/semasiographic in nature, Indus-inscriptions certainly could not encode toponyms by phonetically spelling them.

However, even a logographic script might encode toponyms by using certain reserved logograms. But, in that scenario, since IVC had many commercially important settlements, it would have needed several toponymic logograms, whose inscriptional occurrences should have evinced discernible geographical sensitivities. However, the inscriptional distribution of the frequent ISC-signs does not show any such geographical correlation. Seals and tablets containing identical Indus-inscriptions are often found from distant settlements (Fig. 14). Now, one may argue that the way certain ideograms in Egyptian Hieroglyphs encoded toponyms of large Egyptian regions (e.g., “Upper Egypt”, “Lower Egypt”, etc.), ISC could have used a small number of logograms for representing larger regions comprising a group of Indus settlements. While this is theoretically possible, till now inscriptions from no Indus region have shown exclusive use of a specific ISC-sign in a statistically significant way.


Regarding the ISC-sign  $\parallel\parallel$ , which is till now found only in Chanhu-daro seals, Parpola (1975) has speculated that it represented Chanhu-daro’s ancient toponym. Now, sign  $\parallel\parallel$  usually occurs in the phrase-final-type-2 (PF2) positions (Fig. 4; Ansumali Mukhopadhyay (2019)). But other PF2-signs do not








**Specifics of individual commercial transactions were not recorded.** Sections “Indus-inscriptions did not encode names of individual seal-owners”, “Organisational Identities were possibly encoded by iconographies not inscriptions”, “Toponyms were not encoded by Indus-inscriptions”, and “Seal-iconographies used as issuers’ emblems might have indirectly indicated toponyms or topographical jurisdictions”, establish that ISC-inscriptions did not encode proper nouns, such as proper names of individual seal-owners, seal-issuing organizations, or settlements. Then, what kinds of commercially relevant information did they encode? Since numerical notations frequently occur in Indus-inscriptions, one should explore whether Indus numerals were used for recording the quantities of commodities exchanged in commercial transactions (Functionality-7). However, as explained below, script-internal, and typological evidence confirms that unlike the Proto-Cuneiform administrative tablets (Nissen et al., 1993), or the tablets used in Mycenaean palace administration (Ventris and Chadwick, 1956/1996), Indus tablets could not have recorded the quantities of commodities exchanged in individual commercial transactions.


Unlike incised-tablets, the stamp-seals and mold-made-tablets cannot encode the random quantities exchanged in specific commercial transactions, as they must be engraved with predefined information/rules that are expected to be repeatedly applied in their domains of usage. Even though incised-tablets can theoretically record day-to-day accounting details, after analyzing ISC-corpora, it becomes clear that most of the incised tablets, bas-relief tablets, and copper-tablets, contained obverse-side inscriptions that were very similar to the seal-inscriptions


(see Figs. 15, 16). For example, inscriptions like ,


, etc., occurred on both seals and tablets, showing that Indus tablets shared closely related semantic scopes with seals, and encoded only predefined rules/information. Moreover, from the way only a limited set of stroke-numerals occur preceding a selected set of ISC-signs (Fig. 17), these could not have signified the wide range of possible quantities involved in market transactions. In most cases, only a single numerical-sign comprising strokes in the range of one to twelve, occurs preceding a sematogram/logogram (Fig. 17d). Moreover, the set


of signs , which share related phytomorphic graphemes, are almost invariably preceded by a single NUM-sign containing three short-strokes  (Fig. 17d).

So, if these sematograms/logograms signified certain related commodities exchanged in specific barter activities, and their preceding numerals quantified their contents, then the logical corollary is that in every transaction that type of commodity had to be exchanged only in a fixed quantity, expressible through a single numerical-sign, which is a highly unlikely eventuality. Theoretically, seal-impressions can encode quantities of commodities in only those contexts where the commodities are exchanged only through containers of standardized capacities, which are stamped by those seals. But the contexts of Indus sealing-inscriptions prove that the same inscription could be applied to containers of different shapes and sizes. For example, as discussed in the Section “Sealings attached to commodity-packages and storage-structures”, the inscription

 has occurred in sealings attached to different types of merchandise-packages found in the Lothal “warehouse”, which include pottery vessels of different sizes, wooden boxes, leather sacks, etc. Moreover,

 was also found on wooden-structures, which were possibly storage furniture and peg-on-wall type systems used for locking the warehouse chambers. So, evidently,

the numerical expression  present in

 did not express the quantity of some commodity packed inside a package/container of a fixed standardized capacity. Similarly, other such seal-inscriptions used for stamping Indus merchandise-packages, and related tablet-inscriptions, also did not encode actual quantities of commodities. This eliminates Functionality-7 of recording transaction-specific bookkeeping information. The sealing-inscriptions stamped on merchandise packages most possibly encoded commodity-specific rules and regulations, that had to be abided by those packages (Functionalities 4 and 5).

**Numerical expressions in Indus seal inscriptions possibly recorded craft/commodity-specific tax rates and/or license slabs.** As discussed in Sections “Sealings attached to commodity-packages and storage-structures”, and “Generalizability of the semantic scopes of sealing inscriptions”, quite a few Indus-inscriptions are found on sealings attached to merchandise-packages, and those inscriptions are structurally similar to a large number of Indus-inscriptions found on various Indus seals. Thus, many of the Indus seal-inscriptions must have been used for encoding important information related to commodity packages. Now, commodity packages are generally stamped with only a few types of information: (i) names of the individuals or organizations who were the manufacturers, owners, or intended recipients of the merchandise; (ii) names of the individuals or organizations who endorsed the merchandise regarding fulfillment of certain rules; (iii) the origin and destination(s) of the merchandise; (iv) information about the type and quantity of the commodity packed inside the stamped merchandise package; v) types of commercial regulations that are duly fulfilled by the merchandise. Since, Indus sealing-inscriptions neither encoded anthroponyms or toponyms (see Sections “Indus-inscriptions did not encode names of individual seal-owners”, “Organisational Identities were possibly encoded by iconographies not inscriptions”, and “Toponyms were not encoded by Indus-inscriptions”), nor mentioned the specifics of individual commercial transactions (Section “Specifics of individual commercial transactions were not recorded”), recording commodity-specific information, and rules/regulations could have been their main semantic scopes.

Now, we need to explore, which kind of commodity-related craft/trade regulations might use numerical expressions. Generally, documents like price-tags and tax/license-stamps, that are attached to commodity-packages, need numerical expressions for encoding predetermined prices and fixed tax/tithe rates and/or licensing-fees applicable to specific crafts and commodities. But Indus sealings cannot possibly be price-tags. In a complex and dynamic economy, spread over thousands of distant settlements, it must have been impossible and impractical to predetermine and control prices of commodities by mentioning them on stamp-seals, which often contained identical inscriptions across distant settlements. On the other hand, different guilds and settlement-based authorities collaborating with each other, possibly needed to impose certain fixed tax/tithe rates on specific crafts and commodities, and could have stamped merchandise-packages with seal-inscriptions mentioning the applicable tax-regulations, to endorse payments of those taxes/tithes. Figure 18

and Fig. 19 show examples of modern tax-stamps, and licenses, where a specific set of numerals and metrological units denoting certain tax-rates, license-fees, and licensed-quantities, precede names of taxed/licensed commodities. Similarly, the pattern of Indus-inscriptions, where only a limited range of numerical-signs occur preceding a selective set of logograms/sematograms (Fig. 17), indicates that the numerical-signs possibly signified certain craft/commodity-specific tax-rates or license-fees, and the sematograms occurring immediately after the numerals were possibly names of the taxes/licenses, or the crafts/commodities which were getting taxed/licensed. The limited range of ISC's numerals, and their predictable usage patterns in seals and tablets, can be explained by the fact that tax/tithe rates and license-fees or license-slabs are generally expressible through a very small set of numerals. For example, the rates of modern India's Goods and Services tax (GST), applied since 2017 CE, largely involve only four tax-slabs of 5%, 12%, 18% and 28%, and hence are mostly expressible by just four fractional values. Moreover, while certain common tax-rates are applicable to a large number of goods (5%, 12%, and 18% GST-categories), certain less common tax-rates are imposed on only a selected class of commodities (e.g., 3% GST on gold). Comparably, as recorded in *Kautilya's Arthaśāstra* (e.g., verses 2.22.1–2.22.15), in ancient India of c. 300 BC (or earlier), there were certain fixed tax-rates (the rates depended on commodity-types, commodity-origins, tax-types, etc.) expressed through a fixed set of fractions (one-fifth, one-sixth, one-tenth, one-fifteenth, one-twentieth, etc.), among which, certain tax-rates (e.g., one-sixth) were more common. Similarly, certain ISC stroke-numerals (e.g., the three-short-stroke sign  $\text{|||}$ ) precede a wide range of sematograms ( $\text{⊗}$ ,  $\text{Y}$ ,  $\text{Y}$ ,  $\text{⊞}$ ,  $\text{⊞}$ , etc.), whereas some other stroke-signs are found in more restrictive contexts (e.g., the 9-stroke-sign  $\text{|||||}$  occurs in only five seals and tablets recorded in ICIT).

Here we may clarify that, even though referencing modern documents for explaining 5000 years old administrative tools might seem faulted with anachronism, it is not always so. Formalized data-carriers of ancient times, which served similar functionalities as their modern counterparts, are expected to share certain structural features and semantic contents with their modern counterparts. For example, as discussed by Nissen et. al., (1993 pp.30,68), many of the archaic bookkeeping tablets of Mesopotamia are found to bear close resemblances with “modern documents as punched cards, docketts, clearing checks, balance sheets” etc. So, since the basic nature of taxation and licensing have not changed for millennia, the tax/license related documents of 300 BC, or even modern era, can be used to understand certain features of their ancient counterparts.

Since the tax-rates and license-fees mentioned by ISC's numerals were apparently specific to the craft/commodity related sematograms following them, Indus-inscriptions attached to commodity-sealings (Sealings attached to commodity-packages and storage-structures) possibly directly or indirectly indicated the commodity-types of the sealed packages. So, Functionality-4 (encoding rules and regulations) and Functionality-5 (encoding information related to the contents of the stamped merchandise packages) are applicable to ISC seal-inscriptions. Functionality-6, i.e., indicating the integrity of a locked package, also applies to Indus seals, as it applies to any seal whose impression was used to lock containers (see Sections “Sealings attached to commodity-packages and storage-structures” and “Generalizability of the semantic scopes of sealing inscriptions”).

**Reverse-side numerical expressions in Indus incised and mold-made tablets possibly recorded license fees and license slabs.**

Most of the inscribed Indus tablets excavated and reported till date are already recorded in the ICIT corpus. These include incised copper-tablets, and incised and mold-made tablets made of faience, steatite, and terracotta (Fig. 15a). Among these, around 600 tablets have a single inscribed face, some of which contain iconographies on their reverse faces (mainly the copper-tablets). Interestingly, more than 800 tablets contain two, three, or four inscribed faces, though tablets with two inscribed faces outnumber others.

Now, since tablets were introduced much after stamp-seals (Ameri, 2018 p.147; Kenoyer, 2020 pp.221–223), and unlike seals they could not be used for stamping commodity-packages, we should check whether the tablets contained very different inscriptions compared to the seals. Interestingly, as shown in the examples of Fig. 15b, c, the inscriptions of single-sided tablets, and the obverse-side inscriptions of the two-sided tablets, are either identical or similar to the seal-inscriptions, indicating that Indus tablets had similar semantic scopes as seals. However, as discussed below, the typical numerical-metrological expressions found almost exclusively on the reverse-sides of faience/steatite/terracotta tablets (very few copper-tablets contain sign  $\text{U}$ ) indicate that they had an extended administrative use, which most possibly involved mentioning license-slabs and/or license-fees.

As mentioned before, Indus tablets often share similar inscriptions with Indus commodity-sealings. For example, the inscription  $\text{↑|||U}$ , which occurs independently on certain seals of Harappa, Dholavira, and Mohenjo-daro, and on a sealing/tag of Lothal (L-146), is also included in the tablet-inscriptions  $\text{↑|||U} \hat{\text{x}} \text{⊙} \text{⊙}$  (H-2015) and  $\text{↑|||U} \text{⊙} \text{⊞}$  (M-1396). Now, the Lothal tag L-146 ( $\text{↑|||U}$ ) had an


























impression of some cane-based packing material on its reverse side, indicating that it was used to stamp packages of certain marketable commodity (Frenez and Tosi, 2005 pp.78,93). There-

fore, this frequent sign-sequence  $\text{↑|||U}$ , which did not



encode proper names of places, people, or organizations (Sections “Indus-inscriptions did not encode names of individual seal-owners”, “Organisational Identities were possibly encoded by iconographies not inscriptions”, and “Toponyms were not encoded by Indus-inscriptions”), most possibly encoded some commodity-specific information/regulations. But tablets, unlike stamp-seals, were not used for endorsing merchandise-packages. Tablets were logically designed to signify something about their human carriers. Then why Indus-tablets contain inscriptions found on stamp-seals and commodity-sealings? Since ISC-inscriptions did not encode anthroponyms, the scenario, that a tablet-inscription identifies its bearer by encoding his/her name, and an identical stamp-seal's inscription encodes the same anthroponym to identify the merchandise owned by that individual, is not applicable in ISC's context. Then, how could the same inscription be applicable to both a person (tablet-inscription) and a commodity package (sealing-inscription)? A valid explanation of this might be provided by Functionality-9, where a tablet-inscription encodes the official titles, privileges, responsibilities, and/or licenses/permits of the tablet-bearer. The Indus tablets were most possibly licenses/permits issued to their bearer, for controlling/ practicing certain craft/commodity-specific commercial activities, which were also specified in related stamp-seal inscriptions used for commodity control. Since licenses are often obtained by paying certain taxes and/or






license-fees, they are closely related to tax-stamps, and can contain various tax-related terminologies. For example, in modern USA, ‘by an amendatory act of 1866, the word “special tax” was substituted in the place of the word “license” in the former act’ (Wallace, 1870 p.463), and as shown in Fig. 19, the “special tax stamps” issued to different business owners were actually used as commercial licenses for specific slabs and periods, containing both taxation terminologies (e.g., “revenue”, “special tax”, etc.), and license related terminologies and expression (“keep this stamp conspicuously in your establishment”, “expires”, etc.).

The reverse-inscriptions of the two-sided Indus-tablets strongly corroborate this license-based conjecture. We know that licenses/permits typically mention different license-fees and corresponding license-slabs. For example, as shown in Fig. 19, in certain modern licenses issued for the same product (e.g., oleomargarine), license-fees were expectedly different for different license-types or license-slabs (e.g., retail vs wholesale dealers). Thus, the texts on licenses are expected to contain certain simple numerical and metrological expressions for encoding the license-slab/license-fee. Revealingly, the reverse-side inscriptions of several two-sided Indus-tablets contain only four types of numerical expressions (Fig. 16), where a rimless-jar-sign , most possibly representing certain containers of standardized volumetric measure (Wells, 2011), get preceded by two, three, four, or six long strokes (, , , ). Here the constructs with two/three/four strokes (, , ) occur in 99% instances —  occurs on only 2 tablets (H-801, H-1881), and one inscribed pottery vessel (H-371) (Fig. 20b). Interestingly, sign  resembles an offering vessel shown in a tablet iconography (Fig. 20d), and sometimes occurs on rims and bodies of vessels accompanied by stroke-numerals (Fig. 20b). Moreover, the triplicated form of  () occurs in certain seal-impressions found on pointed-base goblets (Fig. 20a), possibly denoting a particular denomination of certain volumetric unit. Interestingly, the sequence  also occurs in certain Indus-tablets (e.g.,  in H-764,  in M-495) in similar inscriptional contexts as the sequences , , , or  (Fig. 16d), and sequence  of tablet H-829. This study proposes that the graphical referent of  might have been a standardized-capacity-vessel of IVC, which was used for tax/license-fee collection. Thus sign  possibly signified not only the metrological unit related to the standardized-capacity-vessel, but also its associated use in taxation/license-fee collection. The inscriptional usages of  can be possibly compared to the usages of the cuneiform GAR ideogram () , initially written by a pictogram () , possibly inspired by the bevel-rimmed-bowls of

Mesopotamia (Fig. 20c), which were vessels of standardized capacities, possibly used as grain-based rationing vessels, vessels used for cereal offerings at temples, and bread-molds (Potts, 2009). This GAR ideogram corresponded to the Akkadian word “akalu” and the Sumerian word “ninda”, both signifying “bread”.

Interestingly, “ninda” , which also signified a metrological unit, metonymically signified cereal-rations in proto-cuneiform administrative tablets (Nissen et. al., 1993). Similarly, ISC’s rimless-jar-sign  might have metonymically signified certain

license-fees/license-slabs in reverse-side tablet-inscriptions. The fact that in some tablets the same obverse inscriptions are subjected to all three of the constructs , , and 























(Fig. 16b), can be easily explained by this license-based hypothesis. Generally, for the same licensed activity, different slabs of licenses are applied depending on the licensed-quantity and/or license-duration (Fig. 19). For example, the license-fees for the food-licenses issued by the modern Indian government (<https://foodlicensing.fssai.gov.in>) for the same licensed activities (e.g., milk production by dairies), depend on the licensed quantity (e.g., the quantity of milk produced per day), and license durations (e.g., one to five years). Thus, in license-documents issued for the same licensed activities, different license-slabs can be mentioned. Similarly, the obverse-inscriptions of Indus-tablets, which were similar to seal-inscriptions, most possibly mentioned certain craft/commodity-specific permissions/regulations, whereas their reverse-side inscriptions (, , , ) denoted four standardized slabs of license-fees (three of which were more common), and corresponding license-categories for their obverse-side permits (e.g., ).

Figure 16c shows an intriguing example of how two different but related licensed activities ( and ) occur separately in different tablets along with license-slab information (H-1861, H-1945), cooccur in different sides of a single tablet (H-1863) without any license-slab information, and cooccur in different sides of another tablet (H-1862) along with the license-slab information () , possibly to assign multiple licenses/permits to the same person, for a given slab/time-period.

Importantly, these reverse-side constructs (, , , and ) seldom occur in seals, as seals need not mention license-slabs. However, sign , and its related graphemes , and  modified with infix numerical notations, occur in some seals, possibly denoting another set of metrological notations (cf. , , , , , ) related to taxes/tithes (Fig. 20e, f).

In this context, it is important to mention that according to RPN Rao (2018), constructs like  specified quantities of rationed commodities in certain tablets. Supplementary-File-Section-4 explains why ration-distribution was most possibly not the domain of usage for Indus tablets.

### Archaeological evidences indicate ISC's use in taxation, licensing, craft/trade control, commodity control, and access control

The script-internal evidences (Section “Semantic scopes of Indus-inscriptions: Script-internal evidence”) regarding ISC's role in taxation, licensing, commodity control, and trade/craft control are strongly corroborated by archaeological evidences, as discussed in the following sections.

**Indus systems of taxation and trade-control were complex enough to need writing.** We know that invention of writing in ancient Near East was associated with the necessities of complex commercial administrative and bookkeeping activities (Scott, 2018; Nissen et al., 1993). Interestingly, in at least certain ancient civilizations of second millennium BC, invention of writing was arguably correlated to the emergence of complex taxation systems. For example, the taxation related seal-based administrative system prevailing in the Greek mainland since c. 2400 BC, had gradually shifted to Crete, “where writing was invented (ca. 1900–1800 BCE) to clarify whether people had paid their taxes according to their assessments” (Younger, 2018 p.336). To explain the origin of Aegean writing, Younger (2018 p.345) hypothesizes that, “when the outlying purveyors of commodities and contributors of taxes get too numerous to be conveniently memorized” by the administrative system, “writing needs to be invented”. Since this article argues that Indus seal/tablet inscriptions were primarily used by Indus administrators for taxation and trade/craft licensing, we should first discuss whether Indus settlements needed a sufficiently complex taxation and trade/craft control system that could require a script.

There is a longstanding scholarly debate (Ahmed, 2014 Section-I; Vidale, 2018; Green, 2021; Green, 2022) regarding the nature of the rulers, elites, and/or governing-bodies, who controlled the Indus settlements. Whether the one million square-km area (approximately) across which numerous Indus settlements existed in the peak of IVC, comprised one or more territorial states ruled by centralized authorities, or a commonwealth of city-states, or a system of microstates, or a system of state-less cities, or a combination of these, is still not settled. However, since the “Indus cities are known for their extensive ‘public goods,’ that is, city walls, town planning, street layout, provision of fresh water, drainage system, public baths, etc.” (Ahmed, 2014 p.140), it is quite likely that the rulers/governing-bodies of such settlements needed to tax the population under their control, to collect resources for delivering and maintaining such ‘public goods’ (Green, 2022). However, the taxation schemes of the heterarchical urban governments of IVC possibly depended not only on the contributions of the inhabitants of the urban settlements and/or their surrounding rural territories, but also on external and fast-fluctuating revenues of middle-distance and long-distance trades (see Vidale, 2018 p.6). In the Integration era, Indus urban centers had to manage an extremely complex trade network involving a wide range of raw materials and commodities. For example, the non-local raw-materials (chert blades, grindstones, rock quartz, etc.) used in just one faience and steatite related workshop of Harappa needed a complex network of trade and exchange involving multiple distant regions (Kenoyer, 2005). This indicates the extreme complexity of the taxation and trade/craft control systems of big Indus cities, which had to manage not only an enormous number of raw-materials and manufactured commodities, but also the conflicting interests of various types of local and non-local communities of farmers, artisans, and merchants. Hence, managing such a complex system arguably necessitated certain forms of writing in IVC.

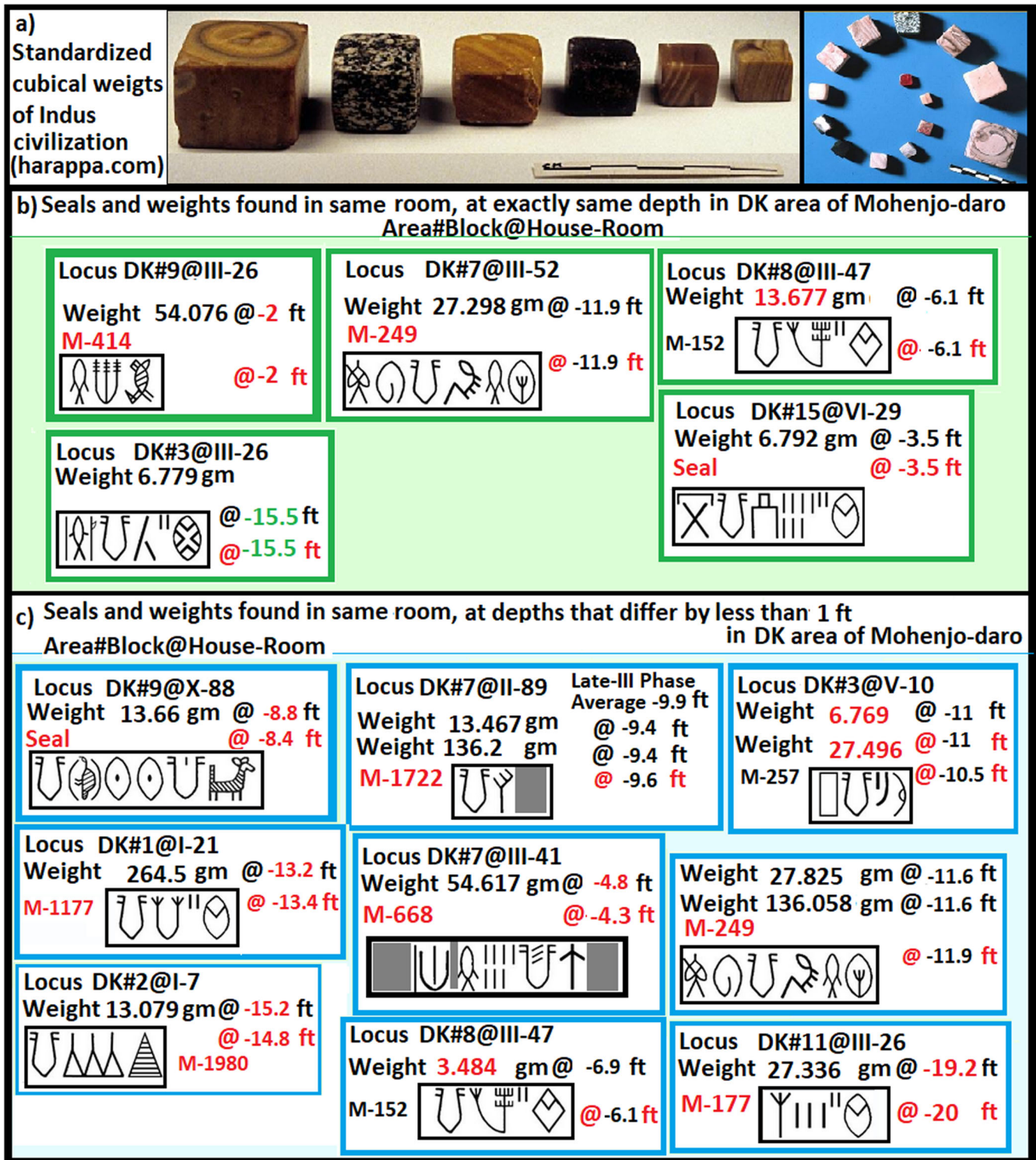
**Inscribed seals correlated with city-gateways.** According to some scholars, the massive brick walls that partially/fully fortified various Indus settlements (e.g., Harappa, Mohenjo-daro, Dholavira, Kuntasi, Surkotada, Chanhu-daro, Lothal, Kalibangan, Banawali, Rojdi), often lacked sufficient defensive planning, and possibly primarily served to exert taxation and trade control (Kenoyer, 2010 pp.109,117; Kenoyer, 1998 pp.56,99,127; McIntosh, 2008 pp.223–227). In some of these fortified settlements, certain side-chambers “flanked the gateway, probably accommodating gatekeepers, who could monitor the flow of people into and out of the city” and could “collect taxes or customs dues on goods being brought into or out of the settlement” (McIntosh, 2008 p.223). For example, “the large southern gateway of mound-E at Harappa, though tall and imposing, was only 2.8 meters wide, enough to allow the passage of one cart at a time, and immediately inside the gate was a large open space where vehicles and people entering the city could be detained as required” (McIntosh, 2008 p.223). According to Kenoyer (1998, p.99; 2010, p.109), seals and weights, which were “devices for control of trade”, were found in “highest concentration” near the city-gateway of Harappa, “which is where goods coming into the city would have been weighed and taxed”. Thus, the Indus seals found near the city-gateways were most possibly used for endorsing the incoming and outgoing commodity packages regarding whether commodity-specific taxes (customs or octroi type) were paid and related trade-regulations were fulfilled. Relevantly, as recorded by Parpola (2018 p.141), “‘Gulf’ seals and stone weights of Harappan type were found in remarkable numbers in a customs house right next to the city gate in Bahrain” of ancient Dilmun. Since ancient Dilmun was greatly influenced by Indus weight system and administrative sealing-technologies (Laursen, 2010), this co-occurrence of gulf-seals and Indus-type weights in Bahrain's tax-collection-center situated near city-gate, strengthens our hypothesis.

Interestingly, as recorded in *Arthaśāstra* (verses 2.21.01–2.21.06), in later historical India of c. 300 BC (or much earlier, as Kautilya's *Arthaśāstra* often documented or built on long-standing economic practices), seal-impressions stamped on merchandise were checked thoroughly at toll-houses erected near city-gateways, to determine whether the merchandise arriving at the gates had proper seal-marks indicating which types of commodities they contained, so that the merchandise could be properly measured and taxed according to the commodity-specific tax-rates (Shamasastri, 1929 p.121).

**Seals correlated with weights used for revenue collection.** The system of Indus weights was standardized across Indus settlements with slight regional variations (Kenoyer 2010), and was also used overseas where it was known to the Mesopotamians as the standard of Dilmun, adopted as far away as Ebla (McIntosh, 2008 p.345). The stone weights were based on the normalized weight (just over 0.1 grams) of the ‘ratti’ (*Abrus precatorius*) seeds (Kenoyer, 1998 p.98). The most common cubical weight weighed around 13.65 grams (approximately 128-times of the ratti-based unit). Indus people used various fractions (1/2, ¼, 1/8, 1/16) and multiples (2, 4, 10, 12.5, 20, 40, 100, 200, 400, 500, 800, etc.) of this 13.65-gram weight (McIntosh, 2008).

Kenoyer (2010, p.117) astutely observes that Indus settlements have yielded “relatively few weights given the size of the cities and market areas”, indicating that such standardized weights were mainly used for “taxation or tithing”, not for “everyday market exchange”. Further, “many of the smaller sites such as Allahdino, have only a single set of weights in the middle range of values, while only the largest sites such as Mohenjo-daro and Harappa have one or two extremely large weights” (Kenoyer, 2010 p.117). As





**Fig. 21 Spatial correlation between Indus civilization's weights, seals, and tablets.** Some examples of standardized cubical weights of IVC (a), and their spatial co-occurrences with inscribed tablets/seals (b, c). Panel a uses certain images of Indus weights available at the Harappa.com website with permission from Harappa.com.

explained by Kenoyer (1998, p.99), “tax collectors or village elders in the smaller settlements would have needed only one or two sets of weights to collect tribute in special commodities and produce”, whereas the heavier sets of weights were needed in the larger urban centers (e.g., Mohenjo-daro, Harappa) or major trading centers (e.g., 1330.68 gm. weight found at Chanhu-daro (Mackay, 1943 p.238)), which were “well suited for weighing tributes coming from

all of the surrounding villages and towns”. As documented by Miller (2013 p.222), “the use of weights for taxation is a hypothesis that most Indus archaeologists would find reasonable, although usually in conjunction with an exchange function as well”. Agreeing with Kenoyer’s implications and Miller’s judgment, this article argues that, as evident from the numismatic and historical records of India (Kosambi, 1996/1956), even after IVC’s decline (c. 1800

BC), and the concomitant and simultaneous disappearance of the physical instances of the highly standardized cubical and truncated-spherical stone weights, IVC's ratti-seed based weight system has continued for millennia in the subcontinent. Hence, the fact that only the physical instances of the standardized Indus weights ceased to be in use after IVC's decline, confirms that those weights were exclusively used in administrative practices. If they were used for weighing commodities in day-to-day transactions, they would have been in circulation in significant numbers in the local markets, or would have been frequently found in goldsmith's and jeweller's workshops, even after IVC's decline. Since the great majority of Indus weights weighed less than 50 grams, these were most likely meant for weighing precious-metals in forms of metal-sheets or bullions, which possibly were one of the convenient modes for collecting certain types of taxes, tributes, or other kinds of payments. Different taxed commodities were possibly measured using different standardized equivalencies related to the standardized precious-metal weights (ancient bullion standards?).

Intriguingly, inscribed seals have demonstrated interesting spatial correlations with the revenue-related Indus weights (Fig. 21a) in various Indus settlements, such as Harappa, Mohenjodaro, Chanhudaro, etc. (Wells, 2011 pp.87–89; Kenoyer 1998, p.99; Kenoyer, 2010 p.109; Parpola, 1994 p.114; Vats, 1940 Vol-1; Mackay, 1943 Vol-1). For example, at the bead-factory found in Square-9/D in Mound-2 of Chanhudaro (Harappa-II era), fourteen small weights (all below 64 grams), scale-pans of copper, and an inscribed seal (#C-22) were discovered at room#215, at around +10.4 feet depth (Mackay, 1943 p.243). At location#192 of square-9/D, two weights (<16 grams) and one inscribed seal (#C-55) were found at depths +8.75 and +8.9 feet respectively (Mackay, 1943 p.243). At Harappa, in square M-11/15 of Trench-1 Mound-F, at a depth of 5 ft. 9 in. below surface, 6 inscribed seals and 9 cubical chert weights were found along with terracotta beads, bangles, vases, and conch shells (Vats, 1940 Vol-1 p.85). Figure 21b, c shows certain examples of inscribed seals and weights (gleaned from Mackay, 1938), which were found in the same rooms of the same houses of Mohenjodaro's DK area, either at exactly same depths (Fig. 21b), or at depths that differed by less than 1 feet (Fig. 21c). There are more such instances (e.g., see "Seals found in public city-buildings"), where seals and weights have shown strong spatial correlations.

Importantly, inscribed Indus seals also ceased to be in use after IVC's decline, demonstrating a strong temporal correlation with Indus weights. Evidently, the power structures that collected taxes/licence-fees, and controlled IVC's commerce, collapsed after IVC's decline, rendering both their seals and weights irrelevant.

Interestingly, as recorded by Jamison et al. (2017), an inscribed seal (𑀧𑀢𑀣𑀤𑀥𑀦𑀧𑀨𑀩𑀪𑀫𑀬𑀭) found from Bagasra (#BSR 6719) weighed 13.6 grams. Since this is the weight of the most common cubical weights of IVC, in my view this was no mere coincidence. Possibly, this seal was also used as a handy weight for quickly measuring certain precious-metal bullions, further corroborating the close relationship between Indus seals and weights.

Analyzing all this evidence, we can say that the strong spatial and temporal correlation of the inscribed Indus-seals with the revenue-related Indus-weights indicate that these seals were also used in the tax-collection process. These archaeological evidences have led some other scholars to similar conclusions, that Indus "seals and weights both reveal a common concern with monitoring economic transactions and keeping track of resources, and both would clearly have been useful in mobilizing revenue for collective action" (Green, 2022, p.10).


In this context it should be mentioned that Indus seals are not always found along with weights, even in well-excavated and well-documented contexts with excavated artifacts of undisturbed


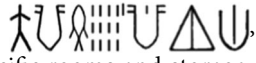
chronological associations. For example, no weights are found along with the sealings at the Lothal "warehouse" (Rao, 1979). This can be explained by the fact that only when the tax-collectors accepted precious metals, or equivalent precious commodities as the mode of tax-payments, they needed the small-range Indus weights, which remained irrelevant in contexts where tax-collection happened in form of other commodities measured by standardized vessels or baskets. Ancient Mesopotamian documents often record such tax-collection baskets ("quppu", "tabnit", etc.) made of perishable materials (Stevens, 2006). Indus tax-collectors must have also used certain standardized baskets and vessels, which being perishable, have not survived. Whether the pointed-base-goblets bearing seal-stamps were some types of standardized vessels used in IVC's commercial administration, should be researched in future studies. Various standardized vessels used for revenue collections are frequently mentioned in the documents of later historical India (e.g., Kautilya's *Arthashastra*, Shamasastri, 1929).



**Seals correlated with craft-areas.** Indus seals are often found concentrated near workshops of lapidary-craft, metal-working, shell-working, etc., (see Kenoyer, 2010; Mackay, 1943; Vats, 1940; Bhan, 2011 pp.340, etc.). While seals found near settlement-gates were most likely used to endorse customs-type tax-collection, seals found near craft-areas were possibly used to collect excise-type taxes. Merchant/artisan-guilds and/or settlement-authorities possibly deputed tax-collectors equipped with suitable seals near such workshops, who endorsed the workshops' manufactured goods by attaching stamped clay-tags on their packages. Alternatively, some of these seals could have been functionally similar to modern excise-stamps which were procured by artisans/traders/workshop-owners, by paying fixed periodic taxes/license-fees, so that they could legalize their merchandise with stamped tags (cf. modern excise adhesive labels).

**Sealings attached to commodity-packages and storage-structures.** As discussed in the Section "Diverse functionalities of ancient inscribed seals and tablets, and their applicability in Indus context", stamp-seals were historically used in very different ways. For example, in ancient Egypt, seals used for stamping papyrus documents served functions widely different from seals used for stamping tags attached to jars, bags, and doors (Nolan, 2018 p.271). Thus, sealings are one of the most crucial objects for understanding the semantic scopes of seal-inscriptions, as their shapes and reverse-side imprints often provide information about the types of objects they were attached to. Unfortunately, compared to other contemporary ancient civilizations, IVC has yielded very limited number of sealings, many of which are also damaged, possibly because they were made of easily perishable materials (Frenez and Tosi, 2005 p.67). ICIT records around 210 inscribed sealings discovered from Allahdino, Banawali, Chanhudaro, Desalpur, Dholavira, Farmana, Ganweriwala, Harappa, Hulas, Kalibangan, Kanmer, Lakhajodaro, Lothal, Mohenjodaro, Nausharo, Rakhigarhi, Rupar, etc., of which around 90 sealings were discovered from Lothal alone. Among these, around 70 were found from a single "warehouse" of Lothal (Rao, 1979 pp.113–114). From the scholarly researches done on Lothal-sealings (Parpola, 2007; Frenez and Tosi, 2005), a lot of insights are obtainable about Indus seal-usages. For example, Frenez and Tosi's pioneering study (2005) reveals that the shapes and reverse-side imprints of these sealings indicate that they were applied on various types of fastening systems used for the closure of rooms, storage furniture, and various "movable" containers. Figure 22a shows how the same







inscription  was stamped on sealings attached to different types of commodity containers, such as wooden boxes, leather sacks, and different types of pottery vessels of different sizes. Interestingly, the same inscription


 is also found on sealings attached to locking systems for rooms and furniture. So, arguably, the commodities which were packed inside the movable containers stamped with ,

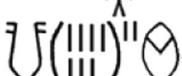

were sorted and segregated inside specific rooms and storage-structures, which were in turn sealed with the same inscription . The eclectic type of containers sealed with  suggests that the packages came from different sources, and were stamped as per certain common regulations applicable to them. (Here the readers should note that, when same inscriptions are found on multiple sealings, it does not necessarily imply that those sealings were stamped by the same physical seal at the same place or time by the same authority.)


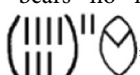
Now, as discussed in the Section “Specifics of individual commercial transactions were not recorded”, the numerical

 notation present in the seal-inscription  could not have recorded quantities of commodities associated to specific commercial transac-

tions. Similarly,  did not record any standardized capacity of the commodity containers, as the same inscription was stamped on different types of packages of different sizes, and also on closure-systems of rooms and storage furniture. Thus, 

possibly encoded information related to certain commodity/craft-specific  tax-rate/licensing-fee. Similarly, the inscription

, containing the numerical notation ,

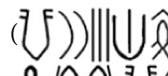
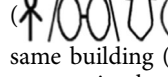
occurred on certain elephant-iconography sealings attached to wooden boxes (Fig. 22c). Many of these wooden-box-sealings (L-161 to L-172) also contained different numbers of fingernail-tallies (Fig. 22c), “apparently to record how many objects were kept inside the sealed box closed with knotted strings” (Parpola, 2018, p.142). On the other hand, the seal’s numeral  arguably represented commodity-specific tax-rates/licensing-fees, collected on the merchandise boxes. Relevantly, a Lothal seal (L-84), which bears no iconography, also contains a similar inscription , indicating that certain commodities stamped at Lothal were subjected to the same rules as were the commodities packed in those sealed wooden boxes.


Importantly, many of the Lothal-tags were baked/dried for longer life (Frenez and Tosi, 2005 p.71), indicating that after detachment from the merchandise, the tags were still preserved, most likely for auditing and bookkeeping. Now, the use of

inscribed tags to endorse commodity packages, the existence of fingernail tallies on these tags, and their preservation for future bookkeeping, strongly suggest that their inscriptions must have implicitly or explicitly encoded commodity-related information. Possibly the number of such tags helped to count the number of stamped merchandise packages of specific taxed commodity-types that were received in the “warehouse” of Lothal. Younger (2018 pp.336,345-346) makes a similar observation about the sealings used in the taxation related bureaucracy of the “Great Houses” of mainland Greece of Early Helladic II period (c. 2400 BC), where inscribed clay sealings attached to tied up jar stoppers, cloth coverings of jars, storeroom-doors, cupboards, lids to chests, baskets, etc., were used “to assist in an audit of commodities brought into the administration: the number of sealings should correlate with the number of commodities as inventoried in the documents. After the audit, the sealings would be destroyed or melted to be used again.”

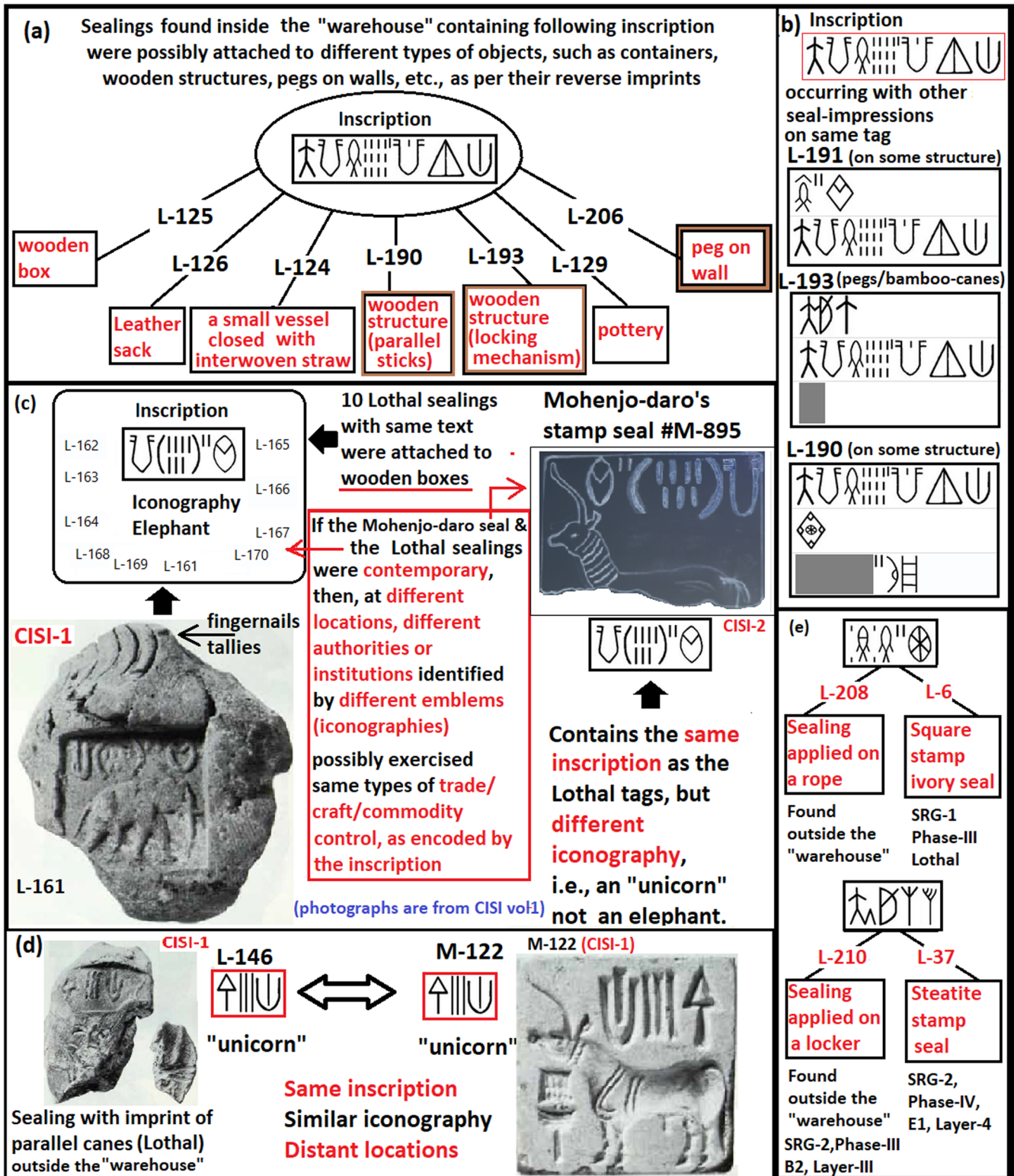
Since the inscriptions of the Lothal-sealings were also present on seals of distant locations like Mohenjo-daro (Fig. 22c), it indicates that the sealing-inscriptions conveyed trade/craft regulations, and commodity-specific taxation/licensing rates, which were standardized across Indus-locations at a given point of time. Figure 22e shows that inscriptions on certain Lothal-sealings (L-208 and L-210) were also found on certain Lothal-seals (L-6 and L-37 respectively), indicating that they might have been stamped locally (Parpola, 2007), though not necessarily with those same physical seals.

Certain Lothal-tags (L-189, L-190, L-194, etc.) carry impressions of multiple seals (Parpola, 2007 p.12) with different inscriptions, and occasionally even different iconographies (e.g., “unicorn” and “rhinoceros”). This possibly indicates that different authorities/institutions identified by different emblems, stamped the same merchandise with different inscriptions, endorsing compliance with their respective trade regulations and taxation rules. Interestingly, even in Allahdino, seal#Ad-3

 with ‘unicorn’ iconography, and seal#Ad-6  with ‘rhinoceros’ iconography, occur in the same building (Building-III Fairservis, 1976 pp.7–10), indicating cooperation between entities identified by the ‘unicorn’-based and rhinoceros-based emblems. Intriguingly, in most sealings, the inscription remains well visible, “while the animal was often not or barely recognizable because not impressed, impressed only in part or obliterated by fingerprints or subsequent seal impressions” (Frenez, 2018 p.172). Now, if the iconographies indicated the endorsing or rule-enforcing organizations and/or departments (see the Section “Organisational Identities were possibly encoded by iconographies not inscriptions”), since in a controlled environment of a “warehouse”, the issuing authorities were implicitly known or separately checked, keeping iconographies in space-constrained sealings might have been redundant for the officials, who needed only the inscriptions to control/audit the merchandise packages.

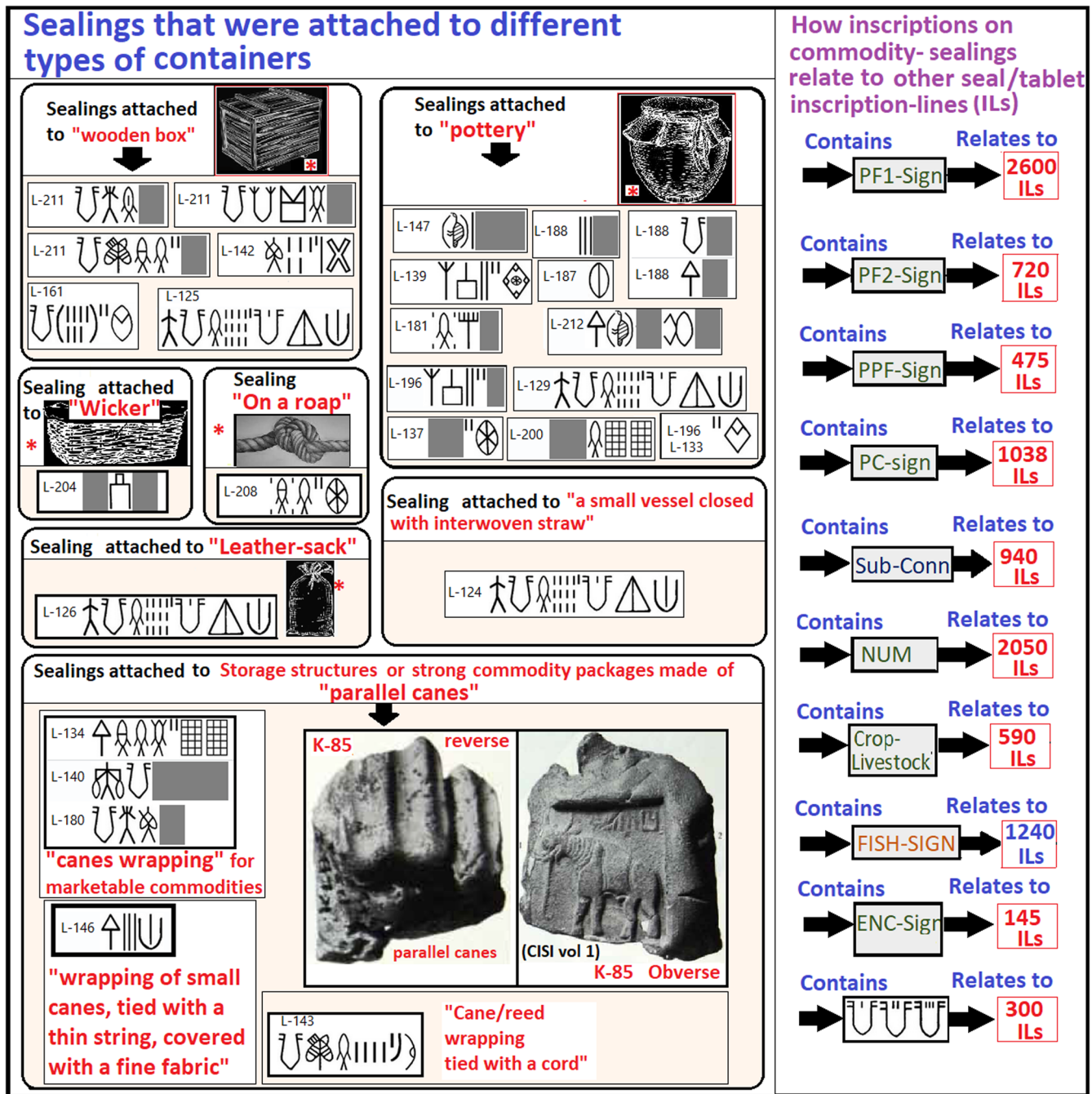
Like the Lothal-sealings, the sealings of Dholavira also occurred on commodity-packages. For example, reverse side imprints of Dholavira sealings ASI#4608  and ASI#49292 (inscription not mentioned) suggest that they were attached to some square/rectangular box and some door-handle, respectively (Bisht, 2015 pp.309,319). So, the conclusions drawn based on the Lothal-sealings should be generally applicable to the commodity-sealings found from other Indus settlements.

The above discussion shows that the seal-inscriptions, which were used for stamping commodity-sealings, could directly/indirectly indicate the commodity-types packed inside the



**Fig. 22** Certain important features of inscribed Indus sealings. Examples of certain sealing-inscriptions (a-b), similar seal-inscriptions (c-e), and the types of objects those sealings were possibly attached to (a-e). The images of sealings L-146, L-161, and M-122, shown in c and d, are taken from CISI vol.1, with the permission of the Archaeological Survey of India. All other images of artifacts are drawn by the author as representative examples of the original artifacts.



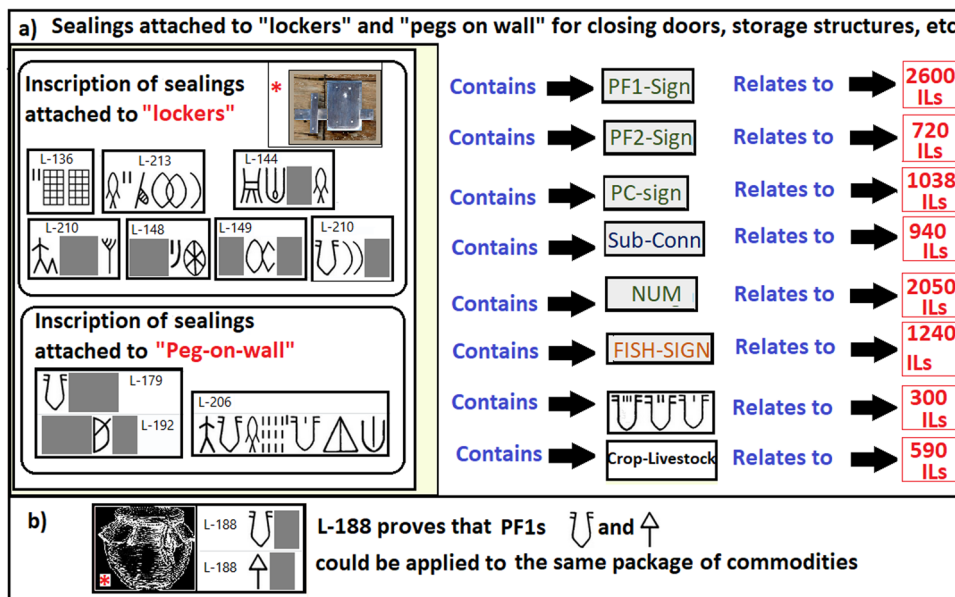


**Fig. 23 Comparing structural features of certain sealing-inscriptions with the general structural features of Indus inscription-lines (ILs).** The figure uses the image of sealing K-85 from CISI vol.1 with the permission of the Archaeological Survey of India. The pictures of containers marked with \* are not depicting actual containers found from IVC. They are the author’s representative sketches of the inferred container-types the sealings were attached to, based on their shapes and reverse-side impressions.

stamped container by specifying commodity-specific tax/trade-regulations (Functionality-4, and Functionality-5 of Section “Diverse functionalities of ancient inscribed seals and tablets, and their applicability in Indus context”), and could also indicate the integrity of the sealed packages as such sealings were often placed on the locking-systems of containers (Functionality-6).

**Generalizability of the semantic scopes of sealing inscriptions.** Even though the commodity-sealing inscriptions were most possibly used for encoding commodity-specific information/regulations (see Section “Sealings attached to commodity-packages

and storage-structures”), since the great majority of Indus-inscriptions come from seals/tablets, not from perishable sealings, one must explore whether the seal/tablet-inscriptions, which are not yet found on sealings, encoded messages of similar semantic scopes. This section argues that since the commodity-sealing inscriptions share the same formulaic structures and sign-usage patterns as the majority of the seal/tablet inscriptions, the semantic scopes of most of the Indus-inscriptions arguably revolved around commodity control, trade/craft-control, licensing, and taxation, thereby bearing out the Functionalities 4, 5, 8, and 9 (Table-1, Table-2).



**Fig. 24 The generalizability of inscriptions of sealings that were possibly attached to some 'lockers' and "pegs on wall".** Comparing structural features of certain sealing-inscriptions with the general structural features of Indus inscription-lines (ILs) (a), and showing the applicability of different phrase-final signs on different seal-inscriptions present on the same sealing (b). The pictures of containers and structures marked with \* are not actual containers and structures found from IVC. They are the author's representative sketches of the inferred container types or structures the sealings were attached to, based on their shapes and reverse-side impressions.

As discussed in the Section "Certain important structural features of Indus-inscriptions", ISC-signs can be categorized into certain functional sign-classes, such as PF1-signs, PF2-signs, PPF-signs, NUM-signs, MET-signs, ENC-signs, Conn-signs (including Sub-Conn or subordinating connectives, and coordinating connectives), PC-signs, Crop-Livestock signs, and Core-Informational-signs (Fig. 4 to Fig. 12). Each of these functional-classes arguably encoded specific types of information. Now, inscriptions that contain signs from same functional classes at specific segments, arguably encoded messages of similar semantic scopes. For example, both the inscriptions



PC-signs followed by subordinating-connectives/postpositions; end with PF1-signs preceded by PPF-signs; and contain fish-like signs in their core-informational parts. Hence, even when their actual Pre-connective-signs ( and ), Connective-signs ( and ), Pre-Phrase-Final-signs ( and ), Phrase-Final-

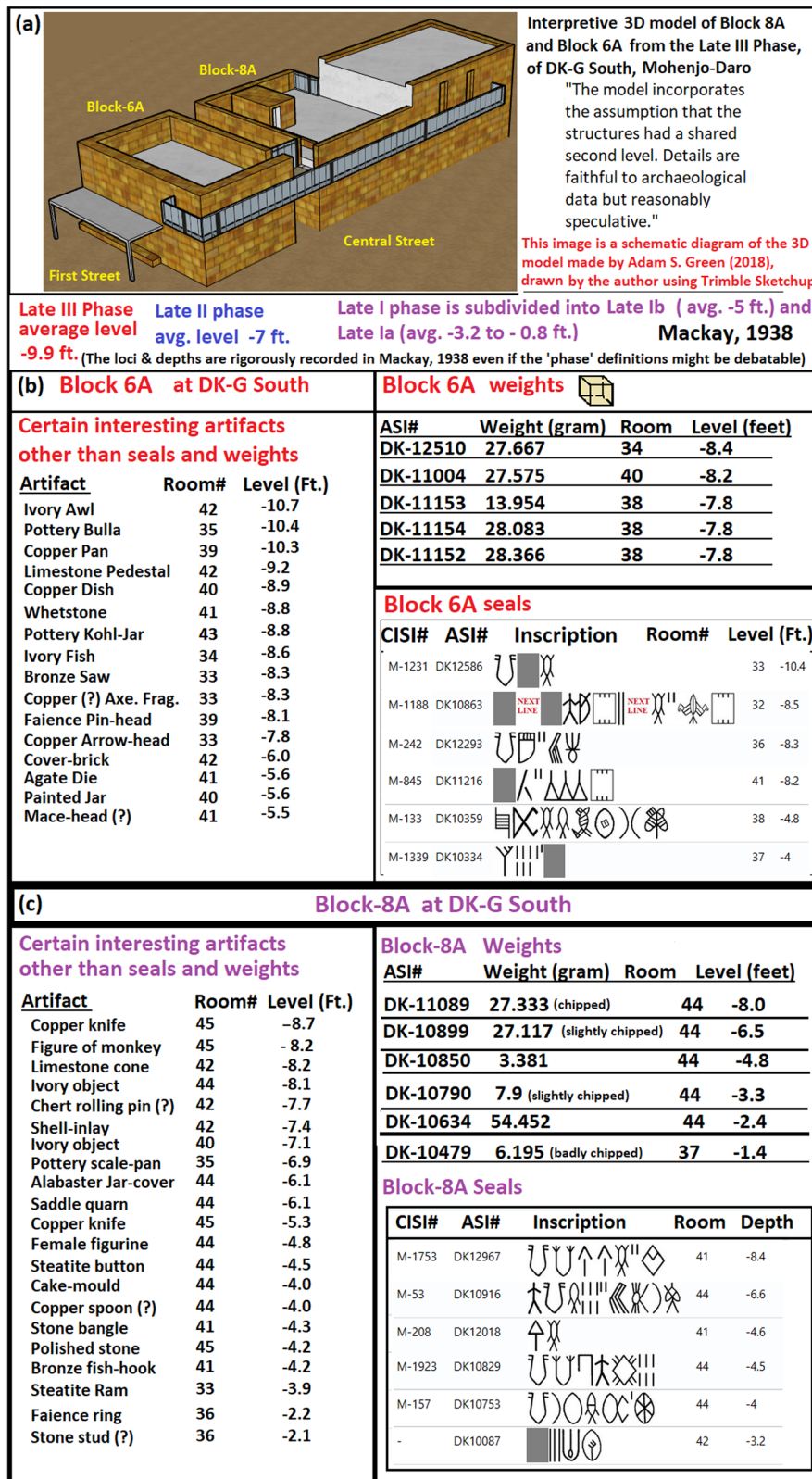
Type1-signs ( and ), and Core-informational signs ( and ) differ, the semantic domains of these two inscriptions remain similar. This is comparable to the scenario where the structures and semantic domains of modern stamps and licenses shown in Fig. 18 and Fig. 19 remain similar, even when the texts (tax-rates, taxed-quantities, license-types, license-rates, expiry-dates, etc.) encoded in their corresponding segments differ. This is because, the type of information encoded in corresponding segments of these permits/licenses remain similar. Similarly, since the commodity-sealings' inscriptions and the other seal/tablet-

inscriptions contain members of the same functional sign-classes in their corresponding inscriptional segments, the general semantic scopes of Indus seal/tablet inscriptions must have been similar to the semantic scopes of these commodity-sealings. To further establish this point, Fig. 23 and Fig. 24 show how various commodity-sealings and storage-structure-sealings contain members from different sign-classes, and through that how they relate to many other inscription-lines containing sign-members from those sign-classes. Figures 23 and 24 provide approximate counts of the Indus inscriptions-lines (ILs) that contain members of different sign-classes. Such counts are given approximately, because in certain inscription-lines some signs occur in a position different from the usual positions of their class-members. For example, certain PC-signs sometimes occur in the PF1-positions (cf. PC-sign in PF1-position in inscription of seal M-998). Moreover, some newly excavated inscriptions are not yet recorded in the corpora.

The examples shown in Fig. 23 and Fig. 24 make it clear that the inscriptions of the commodity-sealings are semantically associated with a large number of seal/tablet-based inscription lines, and almost all the functional sign classes of ISC are applicable to the trade/craft regulations and/or tax-regulations mentioned on the stamped merchandise-packages of IVC. So, the semantic scopes of majority of Indus seal/tablet inscriptions can be safely associated with commodity control, i.e., taxation and licensing of commodities and related trades, crafts, and distribution of commodities, etc.

**Inscribed objects rarely found in religious contexts.** Unlike many Egyptian seals, Indus seals/tablets were never present among grave-goods (Shinde, et al. 2018). While a few seals/tablets (e.g., M-1181, M-1185, M-1186, M-1540), bearing certain narrative/figurative iconographies, might have had certain secondary amuletic/magico-religious usages, the commercial contexts of several seals/sealings/tablets strongly indicate their primarily use as administrative tools. We can compare functionalities of such narrative/figurative seal/tablet iconographies with the religious





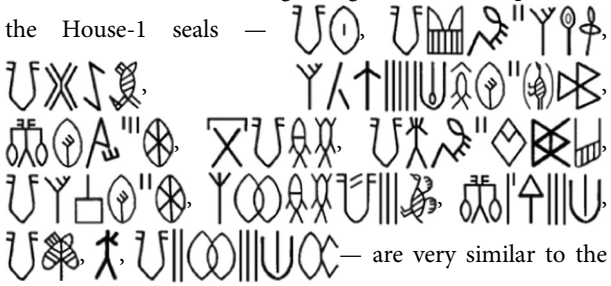
**Fig. 25 Seals and weights found in certain public structures of Mohenjo-daro.** An Interpretive 3D model of two public structures from Mohenjo-daro, re-drawn by the author after Fig. 8 of Green (2018) (a), and certain artifacts found in these structures at different levels (b, c).

iconographies found on various currency coins of both historical and modern India. While religious iconographies on such currency-coins, such as the popular “Gaja-Lakshmi” motifs of ancient Ujjain and Gupta coins (Singh, 2009 pp.438,512), depict

the religious beliefs of their issuers/users, their primary use remained commercial.

In this context, we should discuss Jansen’s (1985) speculations about the religious usages of certain seals found in House-1 of

Mohenjo-daro’s HR-A area. House-1 was a public building, identified as a temple by Jansen (1985). While agreeing with Jansen’s conjecture regarding certain religious functionalities of House-1, this article questions his inference that the unicorn-iconography seals found in House-1 had mainly ritualistic functionalities. This article argues that:

- i. In ancient civilizations, temples often performed various socioeconomic roles including collection of state taxes. Several such examples from ancient Egypt, Mesopotamia, and Israel, are discussed in the book *Temples, Tithes, and Taxes: The Temple and the Economic Life of Ancient Israel*, by Stevens (2006).
- ii. In House-1, inscribed seals have often accompanied standardized Indus weights, which were possibly used for collecting taxes in the form of precious commodities (see Section “Seals correlated with weights used for revenue collection”).
- iii. Since the structures and sign-usages of the inscriptions of the House-1 seals —  — are very similar to the structures and sign-usages of other seal/sealing/tablet inscriptions found in strictly commercial contexts, the usages of the House-1 seals cannot be considered as primarily ritualistic.
- iv. The unicorn-iconography is found on more than 65% of Indus seals/sealings, many of which are found in commercial contexts, but not any identifiably religious contexts.

These points are discussed in further details in Supplementary-File-Section-5.



**Seals found in public city-buildings.** Various large and small public structures, which are identified as ‘hostels’, inns equipped with lodging rooms and storage spaces (‘khans’), ‘offices’, and “institutional spaces for the implementation of governance”, have been reported not only from larger urban sites like Mohenjo-daro, Lothal, or Harappa, but also smaller Indus sites like Vainiwal (Green, 2022 p.11; Mackay, 1938; Green, 2018). While, future studies should undertake the enormous task of exploring the existence and/or distribution patterns of Indus seals, weights, and other administrative tools in different types of public structures, the presence and co-existence of seals and small-range standardized weights in the comparatively well-analyzed structures called Block-6A, and Block-8A, of DK-G-South area of Mohenjo-daro (phases Late-III to Late-I), which were identified as an ‘office’ and a ‘hostel’ by Mackay (1938, pp.76,92), and reconfirmed to be an administrative building and a public structure by Green (2018; 2022), corroborates this article’s hypothesis that inscribed Indus seals were used in commercial administration (see Fig. 25). Supplementary-File-Section-6 provides further details regarding the archaeological contexts of Block-8A and Block-6A (which was even equipped with a brick-bench to sit a large number of people), and the reasons why they can be safely correlated to administrative functionalities (Fig. 25).

In this context, we should also note that the presence of seals in the residential houses of urban Indus settlements (Green, 2022 p.10), can be explained by inferring that the privileged officials/

merchants/artisans, who were assigned with such seals, and lived inside such cities, kept their seals safe with them in their residences.

**Identical seal/tablet-inscriptions found across distant settlements.** The fact that just like the standardized Indus weights, identical or near-identical seals/tablet-inscriptions are also found in commercial contexts across distant Indus settlements (Fig. 14, Fig. 22c, d), indicate that such inscriptions encoded certain standardized regulations enforced across settlements (i.e., Functionality-4 of Section “Diverse functionalities of ancient inscribed seals and tablets, and their applicability in Indus context”). Since distant settlements usually have different administrative rules imposed by local rulers/governing-bodies, such identical regulations expressed through identical Indus-inscriptions were possibly not related to the potentially distinctive non-commercial administrative rules. These identical seal/tablet-inscriptions most possibly encoded certain trade/craft regulations, taxation rules, and barter-based equivalencies, that had to be standardized across distant IVC settlements, which extensively traded with each other in the Integration-era.

**Disappearance of Indus seals comparable to disappearance of Mesopotamian tax tablets.** The abrupt cessation in the usage of inscribed Indus seals/tablets, after the dissolution of IVC’s urban centers, can be compared to the demise of the inscribed “Bala” taxation tablets of ancient Mesopotamia, which were integrally related to the rotational taxation imposed on provinces by Ur-III’s Neo-Sumerian state/empire (Sharlach, 2004). In the final years of ruler Ibbi-sin, when the superstructure of the UR state dissolved under the attack of the “Martu” tribes, the dismantling of the centralized taxation also destined the sudden disappearance of the “Bala” tablets (Kuhrt, 1995 p. 70). I venture that in a similar way, when the decline of Indus economico-political units happened (for contentious reasons), it wiped out IVC’s large-scale organized trade, and related taxation and trade-controlling devices, such as seals, tablets, and standardized cubical weights. Considering the inertia of religious beliefs, and practices, if Indus seals/tablets were used as magico-religious amulets, their use would have continued even after IVC’s decline. Similarly, if Indus seals/tablets encoded anthroponyms or toponyms, they would have continued encoding names of local traders and/or origins/destinations of merchandise, despite IVC’s decline.

**Inscribed Kanmer tablets for gate passes and access control.** Archaeologists Kharakwal et al. (2012 p. 832), have conjectured that certain round-shaped baked-clay pendants with identical impressions  of the same seal on their obverse, and different scribbled signs on their reverse (including a Kanmer-specific “wild ass” sign), were possibly “identity cards or passports of the Kanmer Harappans”. Kanmer being a highly fortified rural site situated near an agate quarry, this sematogram  depicting a walking person with a harrow/rake/scrapper like implement attached to his waist, arguably represented people of certain specific occupation signified by the implement, who needed gate-passes to cross the fortified area of Kanmer (Functionality-9 of Table-2).

Now, since the evidences discussed in Sections “Inscribed seals correlated with city-gateways”, “Seals correlated with weights used for revenue collection”, “Seals correlated with craft-areas”, “Sealings attached to commodity-packages and storage-structures”, “Generalizability of the semantic scopes of sealing inscriptions”, “Inscribed objects rarely found in religious



contexts", "Seals found in public city-buildings", "Identical seal/tablet-inscriptions found across distant settlements", "Disappearance of Indus seals comparable to disappearance of Mesopotamian-taxtablets", and "Inscribed Kanmer tablets for gate passes and access control" indicate that Indus inscribed seals/tablets were used in taxation, licensing, trade/craft-control, commodity control, and access-control, they must have encoded information and rules related to these semantic scopes, as indicated by the script-internal evidences discussed in Section "Semantic scopes of Indus-inscriptions: Script-internal evidence".

## Conclusions

This article challenges various existing scholarly speculations, including the popular notions that ISC-inscriptions phonetically/logo-syllabically encoded toponyms and anthroponyms, or ISC's numerals recorded quantities of commodities involved in specific commercial transactions. Two important conjectures are argued in this article:

- i. Use of Indus seals as revenue-stamps, which possibly recorded names of taxed commodities, licensed crafts, tax rates etc.
- ii. Use of Indus tablets as licenses issued to tax collectors and/or merchants and artisans, which possibly recorded the licensed commercial activities through their obverse-side seal-like inscriptions, and the license-fees/license-slabs through their reverse-side numerical-metrological expressions.

Relevantly, some of these conjectures were earlier discussed in the author's preprint article (Ansumali Mukhopadhyay, 2018), about which archaeologist Massimo Vidale (2018) commented that "We should seriously consider from manifold viewpoints the possibility that these tokens [Indus seals/tablets] were systematically used to regulate prestation, transactions and tax flows across the walled compounds and external communities which formed and gave life to Harappan early cities (attempts in Ansumali 2018)." The readers, who feel that attributing the semantic scope of ISC-inscriptions to primarily taxation, trade/craft licensing, commodity control, and access-control, is too specific and too rigid an interpretation, are requested to go through Supplementary-File-Section-7. The author hopes that the conjectures argued in the present article will facilitate future attempts of decoding Indus-script inscriptions by narrowing down their semantic scopes.

## Data availability

The corpora of Indus script, which are analyzed in this study, are available at the following places. i) The Interactive Corpus of Indus Text (ICIT), which is a Ph.D. project from Bryan Kenneth Wells, finished in 2006, is published (ISBN 978-1-84217-994-9) and can be ordered at <http://www.oxbowbooks.com/bookinfo.cfm/ID/90121>. The online and more enhanced version of ICIT is available at <https://www.indus.epigraphica.de>. It is accessible based on permission granted by Bryan K. Wells and Andreas Fuls. This corpus is also available in the book: Fuls, Andreas. 2022. *Corpus of Indus Inscriptions*. *Mathematica Epigraphica* 3, Berlin: independently published. ii) <https://induscript.in/> Mahadevan, Iravatham & Roja Muthiah Research Library (2021), The Indus Script Web Application (IM77/IDF80) iii) The photographic corpora of inscribed Indus objects, compiled by Asko Parpola and his colleagues, referred to as CISI in this article, are available in the CISI volumes cited in this article.

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## Author contributions

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