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A cryptanalytic decipherment of the Indus script

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Abstract
Indus inscriptions hold the key to unlocking the history of pre-Iron Age India and all Indo-European peoples but remain undeciphered for over a century. All prior attempts have been partial, unsatisfactory and unfalsifiable. We decipher the Indus script by treating it as a large cryptogram as described by Claude Shannon. We decipher every sign sequentially using regular expressions and set-intersection. Indus script is discovered to be proto-abugida segmental with signs for consonants and vowels. Indus inscriptions are in grammatically correct post-Vedic Sanskrit. Variants of 76 allographs constitute most signs. Conjunct signs constitute the rest. Our decipherment can read every inscription and we translate 500+ inscriptions including the 50+ longest, 50+ shortest and 400+ medium-sized inscriptions including 100+ inscriptions with conjunct signs. We comfortably surpass Shannon's criteria for a credible cryptogram decipherment. Brahmi glyphs are discovered to be standardized Indus signs. We find significant continuation of Indus linguistic features and cultural elements in post-bronze age India.

KEYWORDS
Indus Valley Civilization; Indus script; Epigraphy; Brahmi; Sanskrit

1. Introduction

Indus Valley civilization was the largest bronze age civilization, spanning over one million square kilometers and having an estimated population of five million (Dixit, 2019). This advanced civilization featured planned cities, drainage, international trade and standardized weights among many impressive accomplishments. Indus civilization has left behind strings of symbols on seals, tablets and a large sign (Dholavira signboard) which is termed "the Indus script." Although the mature Indus civilization is believed to have started around 2600 BCE, we see stage-by-stage evolution from the earliest sites to Bhirrana and Mehrgarh 7000 BCE. These older stages are given different names such as pre-Harappan, early-Harappan and so on to distinguish them from the mature Harappan stage.

1.1. *Geographic and temporal spread*

The earliest Indus seal is from Kunal, dated to 4000 BCE (ASI, 2004). The earliest graffiti appears on potsherds in 4000 BCE Balakot (Ahmed, 2014; Lashari et al., 2020). Seals with Indus script begin in the archaeological record mid-to-late 4th-millennium BCE (BBC, 1999). Seals post-1900 BCE are rare in the archaeological record. Indus

sites in the Thar desert are abandoned but sites in the Himalayan foothills continue till about Jognekhera 800 BCE (Haryana Directorate of Archaeology and Museums, 2023). Indus symbols however continue to appear on Varanasi coins from 800 BCE to Maurya era coins and on megalithic sites in South India to 50 CE (Banerjee and Rajan, 1960; CoinIndia, 2010; Reddy and Sakunthalamma, 2023) and Janapada seals and coins upto 350CE. B. B. Lal noted that 89 percent of megalithic symbols go back to Indus symbols (Lal, 1960). Findings at Keezhadi show usage of both Brahmi and Indus symbols with primarily Indus graffiti from 600 BCE and transitioning to only Tamil-Brahmi around 100 BCE (Ramakrishna et al., 2018; Sivanantham and Seran, 2019). Sealings continued to appear until the Gupta era using Brahmi script (ASI, 1906). Mixed Brahmi-Indus scripts occur in OCP copper hoards (Munjal and Munjal, 2005), Iran (Lahafian, 2013), Tamil Nadu (Subrahmanian, 2010), Sri Lanka (Raghupathy, 1987) and Vietnam (Lien, 2013), ranging over many hundreds of years.

1.2. *The corpus*

There are 4300+ inscriptions from archaeological digs (Wells and Fuls, 2023). More are being unearthed as new sites are excavated. The stratigraphy, location and other details of most later excavations are preserved but many older finds have missing data. The median inscription length is about 5 signs. There are about 50 inscriptions that are 10 signs or longer. Some inscriptions are a single sign or two signs. The seals themselves are small and come in all manner of shapes: square, rectangular, circular and triangular. The square seals are sized about 3×3 to 4×4 cm. Due to the scarce space, we see the crowding of letters to the left side in early inscriptions. The script has a large variety of signs that are hand carved and many signs show abstraction, simplification and rotation, evidently to preserve scarce horizontal space. The oldest layer of Harappa shows only about 71 signs, possibly indicating that some later signs are variants (Konasukawa, 2020).

In addition to seals, we have tablets and tags, that were presumably used to attach to goods for trade. These show heavy wear similar to old coins and are found close to market areas, which may be taken as evidence of use as currency. Many seals indeed resemble Gupta seals and early Janapada coins with an inscription on top, an animal icon in the center and sometimes a staff or standard in front of the animal (Srivatsava, 2021).

The Dholavira signboard is meant to be seen from a large distance to convey information to travelers and may be evidence that the Indus script is a form of writing. Writing on post-fired pottery, personal items such as tools, weapons, bangles and jewelry may indicate that IVC was a literate society. Indus characters have also been found carved in the Kirthar mountains of Sindh (**?**). The broad geographic and temporal distribution along with mixed Indus/Brahmi inscriptions should be sufficient evidence that Indus script represents writing rather than proto-writing or pictorial identifiers.

Although the Indus inscriptions are short, at least one example of a long inscription in an evolved form of the Indus script exists in the form of the Vikramkhol cave inscription. This inscription dated 1500 BCE is considered mid-way between the Indus and Brahmi scripts by archaeologist K. P. Jayaswal (Jayaswal, 1933).

2. Methods

2.1. *Script Analysis*

The oldest evidence of the Indus script is graffiti on potsherds from 4000 BCE Balakot. There are both abstracted and elaborate versions of signs in this phase. Whether the script originally began as a pre-writing system similar to cuneiform cannot be determined using artifacts from this phase. The script seems to have evolved into a uniform writing system over a millennium. By the mature phase ~2600 BCE, inscriptions are fairly consistent over time and space.

2.1.1. Script direction

The preferred script direction seems to be right-to-left as evident from external and internal evidence (Mahadevan, 1977). External evidence such as crowding on the left side on inscribed copper objects, bas-relief tablets, seal impressions (right side on seals), evidence of starting carving letters from the right side and so on was combined with internal evidence such as identical inscriptions appearing as both one and two line versions. This enabled the eventual determination of the direction of most inscriptions. Approximately 83% are determined to be right-to-left and 6.5% are left-to-right. The rest are either single-sign, undetermined or damaged. A mathematical model of the gini-coefficient of the Indus corpus also finds that the Indus script is written right-to-left regardless of the type of script (Ashraf and Sinha, 2018).

2.1.2. The signary

Mahadevan classifies the Indus script into 417 signs, ICIT classifies them into 700+ signs (Wells and Fuls, 2023), treating minor variants as separate signs since a sizable number (1000+) of signs is suitable for a logosyllabic analysis. On the other extreme, S. R. Rao claimed that the script only had 20 or so signs (Rao, 1980). The obvious problem with a low sign count is that the number of legal words formed by adjacent signs drops precipitously. There will be many instances of repeated syllables such as *kakajakaja*, making reading anything but the shortest inscriptions impossible. Rao was forced to claim that the Indus Valley language was monosyllabic. Essentially he acknowledged that he could not find even a small number of legal words formed by the interlocking of his assigned values. Maximizing the signary size increases the possible matches of legal words. For example, if we have a partially deciphered string πAT, we may choose to assign C to π to read CAT. However, if there is another sequence $\Pi\pi T$, we get a higher readability by choosing A for Π to read ACT, even though the signs π and Π look similar. Logosyllabic analysis also benefits from a large signary by claiming related meanings for similar signs, such as Parpola's star  vs planet  for variants of the fish sign. This is a workaround to avoid nonsensical logosyllabic readings such as 'star-star-jar', which may now be read slightly better as 'star-Saturn-jar.'

However, a large signary is untenable on thorough analysis. Inscriptions up to Harappan period 3A show only 71 signs (Konasukawa, 2020). It is improbable for a large signary script to exist from 4000 BCE to 2600 BCE with only 71 signs attested. On examination, we find that many allegedly different signs that are attested post the Harappan period 3A are cursive forms  , simplified abstractions  , embellished  and stylistic variants  or strings of pre-existing signs  . Simplified forms of complex signs are normal in long-lived scripts when the medium is not conducive to cursive development, for example as in Sumerian cuneiform. Cursive forms

naturally evolve on soft writing materials like paper or cloth using ink due to the efficiency of not lifting the writing instrument off the writing surface. This efficiency does not retrofit to carved inscriptions, so non-cursive forms continue to be used on carved medium, even to the present day. We can trace the evolution of cursive forms in Indus sign variants that gradually minimize the number of strokes needed to render the sign. This may indicate that the Indus script was evolving to cursive form before and during the mature Indus phase.

2.1.3. Script Type

Logographic scripts are characterized by low frequency and a large signary. Only a small fraction of the total 417 Indus script signs (27.5%) are attested 10 or more times and only a tiny fraction (6%) have an attestation count of 100+. A significant fraction of the rare signs seem to be stylistic variants, accidentally mirrored signs, cursive forms or word fragments. Gradual abstractions of pictorial signs such as  must be seen as the development of cursive variants of a single sign. The rarity of cursive sequences like  indicates that these are simply strings of their component signs rather than completely unrelated signs. With these considerations, the sign count drops to under a hundred and the script is unlikely to be logographic. This strengthens the case for a syllabic or segmental script.

The pattern of repetitions of the same sign multiple times in the same inscription also supports syllabic or segmental (abugida/alphabetic/abjad/phonetic) script. A non-script should be expected to see repetition in the use of symbols similar to the birthday collision effect. This number crosses 50% when the number of symbols in a single inscription is 25 or more. No Indus inscription is this long, so we wouldn't expect to see any repeated symbols.

$$1 - \frac{\left(\frac{417!}{(417-25)!}\right)}{417^{25}} = 0.52$$

Birthday collision, of course, applies to uniformly random events, while segmental scripts are not uniformly random due to phonotactic rules unique to every language. Therefore more frequently used symbols should see more collisions in smaller-length inscriptions than less frequently used symbols. We see repetitions in the shortest of inscriptions to medium to long inscriptions. About 17% of inscriptions have a repeated sign if we include immediately repeated and bracketed signs. The jar and fish signs are prolific repeaters and the spoked wheel sign occurs 4 times the Dholavira inscription. This is additional support for a non-logographic script. This number is likely to be much higher once allographs are discovered. By comparison in a logosyllabic script, repetitions are extremely rare in short inscriptions. For example, of the 488 subway station names in Beijing, only 3 (0.6%) have a repeated Mandarin sign and none with 3 or more occurrences (wikipedia, 2021).

Words that start with doubled consonants are rare in all languages and certainly absent in Sanskrit and Dravidian. The occurrence of inscriptions starting with a doubled or tripled sign in inscriptions like M-1794  and L-105  is evidence that the script is not alphabetic, but either syllabic or segmental abugida.

2.2. *Cryptanalytic Decipherments*

Some scripts such as the Copiale cipher have been deciphered using cryptanalysis (Knight, Megyesi, and Schaefer, 2011). The corpus of inscriptions in an unknown script represents the ciphertext and the source language represents the plaintext. The key is the assignment of the script signs to its values. The output of the cryptanalysis of the script is its decipherment. This model has worked several times in history. Ephron was able to re-decipher the Ventris-Chadwick decipherment of Linear-B using cryptanalysis (Ephron, 1961). He only found one sign that had a different value, which was later acknowledged as correct by the original decipherers, showing the superiority of cryptanalytic decipherments.

2.3. *Cryptograms*

A syllabic or phonetic script can be modeled as a cipher and solved using proven mathematical methods. A cryptogram simply stated, is a message in a known language encoded in an unknown script. A specific kind of cipher that has been thoroughly studied is the single substitution cipher or cryptogram, where one sign in the script corresponds to a single phoneme, syllable or alphabet. Newspapers and puzzles often carry such cryptograms on their puzzle page. Typically the encoded message is a quote by a famous person and is long enough to be uniquely deciphered. A homophonic cipher is a variant of a cryptogram that assigns multiple signs per phoneme and may be used to model scripts with allographs.

All available ciphertext for a given key constitutes a cryptogram regardless if the encipherer sent the ciphertext in different pieces or logical units or at different times. This may be trivially verified by picking random words from various websites, feeding them into a cryptogram creator and solving on a cryptogram solver such as quipqiup.com.

This is because the cipher is a transformation function and all input to it is the plaintext and all output is the cryptogram:

> If M is the message, K the key, and E the enciphered message, or cryptogram, we have $E = f(M, K)$. In other words, E is a function of M and K. We prefer to think of this, however, not as a function of two variables but as a (one parameter) family of operations or transformations, and we write it $E = T_i M$ The transformation T_i applied to message M produces cryptogram E (Shannon, 1945).

There are two famous historical examples where separately captured messages have been pooled together and used to break ciphers. First, the cipher of Mary, Queen of Scots was cracked by treating 50+ of her enciphered letters as a single cryptogram (George Lasry and Tomokiyo, 2023). Second, the Zodiac-340 cipher was mailed to three separate newspapers and was cracked by analyzing them as a single cryptogram.

The captured ciphertext doesn't need to be contiguous or even the same logical unit of message, because every word of ciphertext reduces the equivocation of the key by increasing the information we have about the legal adjacencies that may appear in the plaintext. Language is a Markov process and the words and sentences in a language form a graph representing the output of the process. These are termed "residue classes" by Shannon. Residue classes are a subgraph of the Markov process. Possession of such a subgraph reduces the equivocation dramatically. The more residue classes that have been intercepted, the larger the subgraph and the smaller the equivocation. On average, $1/\rho$ residue classes of short words will enable the recovery of at least one sign value, where ρ is the redundancy of the language. For most natural languages with $\rho \approx 0.7$,

this works out to 2 to 3 short words.

The dictionary method using residue classes is deterministic and relatively robust against homophonic ciphers as opposed to the frequency method, which is probabilistic and ineffective in a script with many allographs. Residue classes are effectively regular expressions in programming terms and make finding matches simpler. Attempts to use frequency analysis on the Indus script did not yield any results other than the possibility of some relation to the Brahmi script (Kak, 1988). The dictionary method of solving cryptograms is also superior to frequency analysis since it's immune to frequency drift due to the passage of time (Moreno, 2005).

2.4. *Shannon on Cryptograms*

Claude Shannon's groundbreaking *A Mathematical Theory of Cryptography* is a foundational work of modern cryptography, signaling, data compression and information theory (Shannon, 1945). This work addresses the mathematics and cryptanalysis of cryptograms. According to Shannon, an unknown script such as the Bacon/Voynich Manuscript may be modeled as a cryptogram (Bacon, 1401-1599). Our method to decipher the Indus script essentially reuses Shannon's cryptanalysis methods faithfully with the help of modern programming languages.

A cryptogram may have many possible solutions, for example: the encrypted text $\alpha\beta\gamma$ has ≈556 solutions, since any 3-letter word with no repeating letters is a solution. Others like $\epsilon\epsilon\lambda$ only have a unique solution: *EEL*.

The question of the uniqueness of solutions to ciphers in general (as opposed to the hand-crafted examples above) is useful to determine whether a decipherment is valid. Shannon's criteria for a cipher having a unique solution is determined by a quantity termed "equivocation."

2.4.1. Redundancy, Entropy and Equivocation

All natural languages have information content that is represented by symbols. Consider the simple yes-or-no question: "Are you over the age of 18?" The answer to this question may be represented as either of the words *YES* or *NO*. One does not need 5 total symbols to denote this information, *Y, N* or even *1, 0* are sufficient. There are exactly two alternative answers to this question and therefore it represents $log_2 2 = 1$ bit of information. The answer to whether the person is over the age of 18 therefore, can be encoded as one binary digit. Similarly, the information regarding the day of the week requires $log_2 7 \approx 2.8$ bits.

Natural languages use words and not bits and therefore use significantly more symbols than necessary to transmit the same amount of information. Natural languages need to use excess symbols because of dependencies and rules on how symbols are put together to form words and sentences. This means that in natural languages, unlike optimized binary notation, many combinations of phonemes (or letters or syllables) are illegal words and are *meaningless*. For example, for the day of the week, if the first letter is known to be *T*, then the next letter can only be *{u, h}* (for *Tuesday* and *Thursday*). Other letters such as *x, f* are invalid as would give *Tx, Tf*. This inefficiency and excess use of symbols is *redundancy*.

When we decipher a symbol or make a choice of value, we gain information about the plaintext. The quantity of information gained when we make a choice is *entropy*. Its counterpart, the available *meaningful* choices we can make about the unknown is *equivocation*.

The equivocation for the day of the week, given that the first letter is T is two alternatives *{u, h}* or 1 bit. If the first letter is *W*, then the equivocation is zero, since only one alternative, *Wednesday* is possible. Natural languages have ≈70% redundancy regardless of the language and conventional scripts used to write the language. This redundancy can be measured experimentally and is very close to the compressibility of the language. When the equivocation is zero, then by definition, the cryptogram has a unique solution.

2.4.2. Unicity distance

The key space is the number of possible keys in a cipher. For a single substitution cipher, the key space is the number of ways to rearrange the plaintext alphabet to create the cryptogram alphabet. For an English single substitution cipher, the number of keys is $26 \times 25 \times ...2 \times 1 = 26!$ The information contained in the key space is $log_2(26!) \approx 88.4$ bits. A decipherment that reads much less than the information size of the key space is dubious because the information of the deciphered text may exist in the equivocation of the key space itself and may not be connected in any way to the ciphertext. A reliable decipherment, therefore, must decipher plaintext of a length beyond the information size of the key space. After a certain amount of plaintext is deciphered, equivocation becomes zero and the cryptogram has a unique solution. This length is called the *unicity distance*. The reliability of a decipherment that reads beyond the unicity distance may be explained as the impossibility of information being created *ex nihilo*. If meaningful information larger than the key space is extracted, then it must certainly be from the ciphertext and not from the key.

A source language represents the plaintext, consisting of p symbols, each representing a letter, syllable or phoneme. A homophonic cipher of N symbols, $N > p$, may be constructed by mapping each ciphertext symbol to a plaintext symbol. Each ciphertext symbol may be assigned to a plaintext symbol in p ways, thus carrying $log_2 p$ bits of information per symbol.

The number of possible keys in a homophonic cipher with N ciphertext symbols mapped to p plaintext symbols is $< p^N$. Its key space is $|K| \approx log_2 p^N$ bits. The redundancy of the plaintext language is denoted by ρ which is ≈ 0.7 for most natural languages.

A large key space causes a large equivocation resulting in many possible *meaningful* but *false* decipherments. The equivocation is also inversely proportional to the redundancy of the language. Languages with low redundancy will have many more spurious matches compared to languages with high redundancy. The length of the deciphered plaintext that equals the information content of the key is known as the unicity distance and is given by:

$$d = \frac{log_2 p^N}{\rho \cdot log_2 p} = \frac{N}{\rho}$$

A homophonic cipher may be viewed as insulating the ciphertext from the alphabet of the source language as we can see from its unicity distance, which essentially depends entirely on the ciphertext alphabet rather than the plaintext alphabet.

Of the total 417 signs, the 124 “ligatured” signs such as  and  and strings such as  are simply read as if they are their component signs, they add no equivocation and their count must be reduced from the ciphertext alphabet. Similarly, if the same sign can be assigned to multiple phonemes, the count must be increased. Reusing 30

signs of unaspirated phonemes for aspirated adds about 10%, as does reusing 20 dental signs for retroflex. Pooling all sibilants into 20 signs increases the equivocation by 150% for those signs. The two interchangeable signs for $a \Leftrightarrow e$ and for $a \Leftrightarrow o$ add two more signs. The net effect would be adding $(30{+}20){\times}0.1 + 20{\times}1.5 + 2 = 37$ signs. This gives us a new symbol count of $417 - 124 + 37 = 330$ and an effective unicity distance, given the redundancy of Sanskrit at 0.7 (Aniket Anand and Jana, 2013):

$$\frac{log_2 48^{330}}{0.7 \cdot log_2 48} = \frac{330}{0.7} \approx 471$$

Reading the longest 50 inscriptions of length 10 or longer covers this comfortably. Note that this is for segmental decipherments of attested languages. Abjads would require multiplying the signs by the number of vowels and decipherments into unknown dialects are unfalsifiable.

2.5. *Previous decipherments*

It is impractical to enumerate and falsify the 100+ attempted decipherments of the Indus script. Most are not serious attempts, but simply insightful observations and preliminary attempts to read a dozen or so signs and as many inscriptions. These are dubious for the same methodological flaws in the somewhat serious attempts that read larger amounts of text as described below.

2.5.1. Logographic and Logosyllabic

Most attempted decipherments of Indus script are logographic or logosyllabic, avoiding the need for syllables or phonemes to interlock into words. A majority of signs can be claimed to be single words, most inscriptions are read as nouns with occasional generic verbs. This enables short inscriptions to be read as *adjective-noun* or *verb-adjective-noun*. The method starts by assuming the value of a sign and then tries to read a meaning into a short inscription.

Parpola for example, considers the intersecting circles sign  to represent *bangles* and three strokes sign  to represent *hearth* (Parpola, 1994). The reasoning for such an assumption is unexplained. These two signs may as well represent *nuts* and *three* or *wheels* and *baby teeth* or any thousands of competing concepts. The unicity distance of such decipherments is at least the entire corpus. Occasionally, these signs occur in meaningless patterns and need an alternate explanation. For example, when these two signs are combined  , the reading *hearth bangles* would be meaningless, so a new overloaded interpretation is added: *pregnancy bangles*.

Incrementing the key space for every permutation of signs causes the key space to be always larger than the entire corpus. Therefore, all decipherments using this method are dubious. The information content of the readings is from the key and not from the ciphertext. This is why there exist dozens of logographic and rebus decipherments that read a lot of text but in ways completely unrelated to each other. A Rosetta stone would make a logographic decipherment credible since it would double the information content read and go beyond the unicity distance.

In some decipherments, some sign values are borrowed from other scripts. Signs are assumed to have the same value as any similar sign in other scripts. Mahadevan for example, assumes symbols similar to Egyptian hieroglyphs and Sumerian cuneiform

represent the same meaning in Indus script and then tries to connect it to some Indian cultural or mythological context to decode a sign (Mahadevan, 2010). For example, based on his analysis of M-1896  and the similarity of Indus sign with Egyptian hieroglyph O.49 meaning city, Iravatham Mahadevan speculated that Mohenjodaro's ancient name could be Kukkutarma, [kukkuta = Indian fowl] or 'Cocks-city' based on interpreting the 1st CE Chola kingdom city Uraiyur in South India, as the city of the cock. No evidence of chickens have been found in Mohenjodaro. Recent evidence shows that chickens were domesticated in Thailand about 300 years after Indus Valley stopped making seals (Peters et al, 2022). Mohenjodaro and Uraiyur which are separated by 2500 years and 2000 km are alluded to as perhaps connected for narrative support since 'cocks-city' is a meaningless term not backed by any evidence.

It's usually easy to find failures of this method for even short inscriptions. Using the meaning of other signs from his decipherments, H-452  would be *chicken-jar*, M-795  would be *ruler-chicken-jar-bearer*. Every combination of signs requires an expansion of the keyspace to enable a meaningful reading. Logographic decipherments even with borrowed sign values are untenable because the unicity distance is much greater than the corpus size and the information content of the readings is essentially from the key itself.

2.5.2. Borrowed starter set

Eclectic collation of sign values from many different scripts is the central method of some syllabic and phonetic decipherments. Their advantage over logographic claims is that they can use imported sign values as a starter set and discover the values of the remainder using dictionary search and guesswork. S. R. Rao pioneered this technique by claiming that similar-looking Semitic and Indus signs have the same values (Rao, 1980). He used the Semitic starter set supported simply by his assumption that Indus signs eventually developed into Semitic signs.

The defect in this method is that the choice of a starter set is fairly arbitrary. Any two scripts will have some signs that look similar or similar enough with completely different sound values. Roughly 33% of both Linear-B and Caroline Island appear similar to signs from Indus script but Indus inscriptions are unreadable if we borrow their values. Simple signs with lines, circles, half circles or combinations are fairly common across many scripts and similarities increase with the number of signs available. To illustrate the defect in this method, we create a starter set for Latin based on some scripts that have signs common with the Latin alphabet as in Table 1 and it would be incorrect to use it to discover the values of the remaining Latin signs.

2.5.3. Segmental, syllabic, logographic and word-fragment alphabet

Some decipherments use arbitrary word fragments as sign values to fit as many inscriptions as possible. This in itself is not necessarily incorrect as long as sufficient inscriptions can be read. Phonetic and syllabic decipherments would be expected to have some grammar but nearly all prior decipherment claims typically lack grammar, morphology, syntax, subject-verb agreement, plurals, conjugation, declension, prepositions or any other grammatical elements. Often there are supplementary logographic assignments to get around nonsensical readings. One way to justify the lack of grammar is to claim that all Indus inscriptions are names. Short inscriptions can plausibly be argued to be names since names outside sentences are essentially not declined. This also means most long inscriptions often won't be readable.

Table 1. Eclectic decipherment of Latin alphabet from unrelated scripts

Source	Symbol	Value	Source	Symbol	Value
Cherokee	D	a	Inuktitut	P	ki
Cherokee	W	la	Inuktitut	L	ma
Cherokee	I	qua	Inuktitut	U	te
Cherokee	L	tle	Inuktitut	V	pe
Cherokee	T	i	Ethiopic	O	’
Cherokee	H	mi	Ethiopic	M	ṭ

Typically, this method starts with fitting popular inscriptions such as the Pashupati seal and the Dholavira signboard. This force fitting produces garbled readings for many other inscriptions. These are mitigated by assigning word fragments and word stems to some of the remaining signs. Most inscriptions still won't be readable in a known language. The solution is to claim that the inscriptions are in a hitherto unknown dialect. This dialect has no documented grammar, phonotactics or any known language characteristics. The information content here is also entirely from the key, which is not just in the sign values but a major portion of the key is the undefined grammar of the language. Such decipherments therefore are dubious.

In Summary, every prior decipherment uses methods that create a key space that by design is larger than the plaintext read and must be considered dubious.

2.6. *Solving a cryptogram*

Shannon's method to solve a cipher:

(1) Determine the language.
(2) Determine the cipher (cryptogram for Indus script)
(3) Determine one or more letters of the key by checking patterns of occurrence (frequency, variety of contact, doubles, reversals)
(4) Use the deciphered key portion as a consistency check by testing other parts of the cryptogram.
(5) Repeat the step above until fully deciphered.

2.7. *Determining the language*

The first step to solving a cryptogram is to guess the language itself. If the language is incorrect, the cryptogram will be unsolvable. Language is a Markov process and the probabilities of symbol transitions are very different even for related languages, which means that a large pattern set representing the corpus of one language cannot be read as another even if symbol values are reassigned. A cryptogram whose plaintext is in one language cannot be forcibly decrypted in another language due to the principle derived by Shannon:

> the amount of uncertainty we can introduce into the solution of the cryptogram cannot be greater than the key size (Shannon, 1945).

2.8. *Meluhhan language*

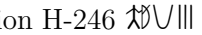
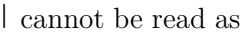
Many languages have been proposed to be the language of IVC, the most credible ones are some form of Dravidian (old Tamil) and Indo-Aryan (Sanskrit). Others such as Sumerian-like language or a lost language have also been proposed without any evidence. We may dismiss them as speculative.

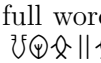
2.8.1. Dravidian as the candidate

There are some reasons why Dravidian is unlikely to be the language of the Indus Valley Civilization. As observed by many others, Dravidian has no words for the most important IVC technologies, products or symbols but instead uses borrowed Middle Indo-Aryan (Prakrit) words such as *iṭṭika* brick, *gajja* barley, *swastika*, *paṭṭa[ṇa]* city, *ūru* city and there are missing words for the rest like the blackbuck, the unicorn, the rhino. It is unlikely that Dravidians forgot the words for the important symbols and technology they invented and continued to use till the present day while retaining their language.

An analysis of Indus inscriptions also rules out Dravidian. Steve Bonta, a PhD in linguistics in both Dravidian and Indo-European attempted to decipher the Indus script as Dravidian for years until he noticed that the Indus inscriptions exhibit multi-stem compounding, which is characteristic of classical Sanskrit and is not possible in Dravidian languages. Dravidian compounds are two-word agglutinative constructs rather than inflexed stem compounds. Consequently, he changed the target language of his decipherment to Indo-Aryan (Bonta, 2023). Bonta's observation has further implications that rule out all agglutinative languages as candidates for the Indus script such as Dravidian, Sumerian, Elamite, Hattic, etc.

Like all agglutinative languages, Dravidian uses fixed affixes to a root to indicate number, gender, noun cases etc. Agglutinative morphologies have a fixed order for these affixes. Cinque argues for a universal order of these affixes whose order reverses based on whether the language is head first or head final (Cinque, 1999). In Dravidian, the plural affix comes before the locative for example. Switching these around results in an illegal word. Also, these affixes by themselves (with rare exceptions) are not words and affixes cannot exist freely without a root or stem. The Indus inscriptions show the same strings of signs in initial medial and final positions, indicating that the Indus script cannot be agglutinative but is rather a fusional language.

We can examine a few seals to see if there is any evidence of agglutinative morphology. Consider the single sign inscriptions H-1497 , H-1546 , H-1514 , H-1462 . The inscription H-246  cannot be read as the sign having multiple affixes since affixes cannot be independent words. Moreover, if is a stem and is the stem with three affixes, then we should not see the affix standalone in one inscription or its signs inscribed in a different order as in H-894  .

It is clear from perusing the corpus that in many inscription pairs like B-9  and Dholavira , common substrings such as are not affixes, but rather stems that are compounded. The terminal jar sign is likely to be a case marker. Thus we can see the full word has a marker H-1953  but is removed for stem compounding in M-1706  and placed terminally. Words that are compounds of 3 or more stems like M-1706 are not possible in Dravidian but rather are characteristic of Sanskrit, especially classical Sanskrit.

We can attempt to decipher the Indus script with Dravidian as the target language using the dictionary method. Since proto-Dravidian has only been reconstructed to

around 800 words, it is likely to cause false negatives and therefore a Tamil dictionary is more suited. We hit many dead ends with Tamil. Firstly, words with triple repeating sequences are not present in Dravidian. So we would be unable to read inscriptions like H-764 ⋃⋃⋃. Secondly, there are only a handful of words that would fit a doubled sign inscription such as H-1182 ||| ||| and H-210 ⋃⋃. These only match the words *koko, kūkū, māmā, tātā*. This would assign one of *ko, kū, mā, tā* to all doubled signs. These signs, however, also exist in permutations of themselves. Such inscriptions do not have matching words in Tamil, so inscriptions such as H-2272 |||⋃ and H-372 ⋃||| would be unreadable. This is an expected result if the Markov process of Tamil and the source language of the Indus inscriptions produce dramatically different graphs and there is no way to read one as the other. At this point, we can confidently rule out Dravidian and indeed all agglutinative languages out of the running for the language of the Indus script.

2.8.2. Sanskrit as the candidate

The question of how Sanskrit/Indo-Aryan could have existed in the Indian subcontinent during the mature phase of the Indus civilization is something we need to address. Heggarty's Bayesian model indicates that Indo-Iranian and Indo-European started to become audibly different around 4000 BCE and were markedly differentiated by 3500 BCE (Heggarty et al., 2023). This gives sufficient time for an old Indo-Aryan dialect to be present in the Indus Valley for the bulk of the inscriptions which are dated post-2600 BCE. The assumption that the Indus Valley was non-IE speaking is based on the narrative that the Indus Valley could not have created Rigvedic poetry with horses and chariots, which were allegedly unfamiliar steppe technologies. This narrative requires us to ignore dozens of publications with evidence of horses from the earliest phases of the Indus civilization and depiction of horse-driven chariots in the subcontinent from the Chalcolithic era (Danino, 2006; Neumayer, 2020). The real issue is not ignoring the evidence, but the presumption that one needs to possess horses to write poetry. Ireland has used peacock imagery without the imposition of any claim that Indians brought Gaelic to Ireland (Sheehan, 2009). And of course, there is poetry on unicorns and dragons in the Rigveda without anyone needing to bring them. Evidence for trade contact between the Indus Valley civilization and Sintashta is evident from the presence of IVC cotton in Sintashta (Shishlina, Koryakova, and Orfinskaya, 2022). This alone may be sufficient for Indus Valley civilization to create horse based poetry. The present hypothesis on the spread of the Indo-European language family is an imperfect model, while Indus inscriptions are actual attestations. If they conflict, the empirical method requires the model to be adjusted and not the attestation.

2.8.3. Indus/Brahmi mixed inscriptions

Indus script signs continue to be embedded in later Brahmi scripts into the Gupta era in both northern and southern India. An inscription from Vaishali ∃Ʊ𑀅 is equivalent to ⋿Ʊ𑀅, which is one of the most popular inscriptions that is attested in 40+ Indus seals (Sinha and Roy, 1969). Every inscription in a mixed Indus/Brahmi script is in the Sanskrit language, even in the southernmost and the oldest sites such as Keezhadi in south India. We know the Indus script intermixed inscriptions in Tamil Nadu sites are not Sanskrit words borrowed into Tamil but actual Sanskrit phrases because they use signs such as the Brahmi 𑀱 *ṣa* which would have been changed to the Brahmi 𑀲 *sa* on borrowing.

Table 2. Names of Meluhhan persons and goods as recorded in Sumerian cuneiform

Artifact-Id	Sumerian	Meluhhan Name		Meaning
CDLI 516366	sa6-ma-ar	समर[MW]	Samara	confluence
CDLI 516366	na-na-sa3	नानस्[MW]	Nānas	distinct
CDLI 525331	szu-i3-li2-su	शैलेश[ŚivaP]	Shailesha	Himalaya
CDLI 212982	sun2-zi-da	संसिद्ध[Bhag]	Samsiddha	accomplished
MS 2814[a]	[szu?]-ib-ra	श्वभ्र[MW]	Śvabhra	offerings pit
L 1426[b]	me-luh-ha	मेलः[c]	Melaḥ (person)	union
CDLI 388265	mes	मेषी	meṣī	Dalbergia
CDLI 228643	dim3-dim3	डिंडिम	ḍiṇḍima	small drum
(Many)[a]	me-luh-ha	मेलाः	Melāḥ (country)	settlements

[a] (George, 2003); [b] (Parpola, Parpola, and Brunswig Jr, 1977); [c] (Devi, 1933); CDLI DB: (CDLI, 2023);

Based on Indus script signs embedded in various Tamil Brahmi and Sanskrit Brahmi inscriptions, the most realistic candidate for the Indus language is Sanskrit.

2.8.4. Sanskrit morphology in the inscriptions

The attestation of triple symbols such as))) would not fit many languages but could be *lit* conjugation (somewhat similar to English perfect tense) of Sanskrit. Some roots with a duplicated consonant become a triple consonant due to reduplication in *lit*. For example, *jajaja* 'I fought' is first person singular perfect of √*jaj* 'to fight.' Similarly *lalala* 'I enjoyed' from √*lal*, *sasasa* 'I slept' from √*sas* etc. In addition, the large number of doubled signs could also be *lit* conjugation in plural second person such as *rara* 'you all gave' from √*rā* or *babha* 'you all shined' from √*bhā*.

2.8.5. Sumerian references to the Indus Valley

Additional evidence comes from Sumerian inscriptions (Parpola, Parpola, and Brunswig Jr, 1977). The Meluhhans are first mentioned in Mesopotamian texts in an inscription of Sargon 2300 BCE. Sumerians traded timber, ivory, carnelian, water buffalo, gold dust etc. with a land named "Meluhha." Meluhhans built large sea-worthy ships capable of carrying large animals across the sea. Only the Indus Valley civilization produced all the products sourced from Meluhha and had extensive ocean trade. Meluhha therefore is nearly unanimously believed to be how the Sumerians referred to the Indus Valley civilization or one of its trading posts.

Meluhhans seem to have settled and intermarried into Sumer and some Meluhhans adopted Sumerian names. There are some names, however, that are not Sumerian. Most of these seem to be attested as proper names in Sanskrit literature. Meluhha itself needs to be both the name of a person and the name of a country as shown in Table 2. One of the names ending in *ibra* could represent many Sanskrit names such as *Vibhra*, *Atibhra* etc. but unlikely in other candidates like Dravidian.

In addition, 90 identified words in Sumerian may be borrowed from Sanskrit (Vyas, 2020). This may be seen as sufficiently strong evidence to attempt decoding the Indus language as Sanskrit. We use Monier-Williams abbreviations throughout the paper to

denote the source of attestation (Monier-Williams, 1899a). For example, Soma सोम[RV] means "Soma as attested in Rigveda" and Samara समर[MW] means "Samara, attested as a proper name in Monier-Williams dictionary."

2.9. *Determining one or more letters using occurrence patterns*

The next step is to guess or decipher the first sign using unusual patterns in the text that will enable us to read one or two syllabic words. We can rely on the fact that every seal is one or more complete words and choose the shortest available seals to avoid the issue of detecting word boundaries on longer inscriptions. With sufficient inscriptions that only have a single common undeciphered sign, we can uniquely determine its value. We can then repeat the steps and use the known signs to decipher the next unknown sign.

All essential information for the cryptanalysis in a cryptogram is in the pattern of occurrences of the symbols and not the symbols themselves. The plaintext ***EEL*** may be enciphered as any of these equivalent cryptograms: *BBA, XXC, GGF*. Shannon calls such a pattern underlying a set of equivalent cryptograms a residue class:

> It is obvious in this case that these cryptograms are essentially equivalent. All that is of importance in a simple substitution with random key is the pattern of letter repetitions, the actual letters being dummy variables. Indeed we might dispense with them entirely indicating the pattern of repetitions (Shannon, 1945).

Cryptanalysis of cryptograms depends entirely on the pattern of positions and repetitions of signs in the ciphertext and does not depend on symbol shape, evolution history of a sign, assumptions on cultural aspects, geography, etc. Indeed, because none of these aspects are inputs, they can be credibly deduced as outputs once sufficient signs are deciphered.

Patterns in the Indus corpus may be represented as regular expressions enabling us to search in dictionaries and determine their values. Solving cryptograms using regular expressions is a known art and we will only touch upon the techniques used for deciphering the Indus script (Goibhniu, 2007).

2.10. *The dictionary method of solving cryptograms*

We illustrate the dictionary method with a simple example of an unknown script encoding text in the English language. There are 26 possible values for each symbol and trying each value would require 26! possibilities, which is infeasible. If we can, however, reduce the number of possibilities to solve an individual letter to two or three options, then the script can be deciphered in under a hundred attempts.

2.10.1. Bootstrapping

Let us suppose we parse through the corpus of the enciphered text and isolate the following words from the ciphertext. Whether these words were collected from one or many messages does not affect the decipherment as long as the values assigned to signs haven't changed.

Words with repeated signs have low equivocation and are great for bootstrapping our decipherment. An inscription pattern like `/^(.)\1.$/` such as $\epsilon\epsilon\lambda$ matches the word EEL uniquely giving us $\{E, L\}$. Other words may decode different signs due to unique patterns such as $PAPAYA$ and $MILLENNIUM$ which can give a different

bootstrapping set.

Bootstrapping can be done even if there are no inscriptions with repeated signs, but it takes a few more words to remove all the equivocation.

2.10.2. Further progress

Once we have a starting set of symbols, we can simply use them to find other symbols. For example, to expand our decoded set of $\{\epsilon, \lambda\} = \{E, L\}$, let us suppose we locate another word $\lambda\iota\epsilon$. We can substitute the values $\lambda = L$ and $\epsilon = E$ and try to find matches for ι using the regular expression `/^L.E$/'`, which matches the words $\{LEE, LIE, LYE\}$. For a homophonic cipher, E can be assigned to both ϵ and ι, so we have 3 candidates for the value of $\iota = \{E, I, Y\}$. We need to find another word that reduces this set. Let us suppose we locate another inscription $\iota\lambda\lambda$, we can substitute the values from our candidates in the new pattern `/^(E|I|Y)LL$/` and we get a unique result $\{ILL\}$. We have now decoded $\iota = I$. Our decoded set expands to $\{E, L, I\}$. We can continue to look for more words to help us decode more signs.

2.10.3. False negatives and false positives

It is pretty clear from the method that the accuracy of the dictionary and the correctness of the regexes have a significant role in the correct decipherment of the script. Missing words may give a false negative and the sign cannot be resolved and it would appear we are at a dead end. At this point, we should check if the dictionary needs to be augmented from the possible candidates. Often not all conjugations, compounded stems or declined forms are available in dictionaries and false negatives should be expected. If a conjugated verb, plural noun or gerund form is obvious, then we may simply add it to the dictionary. If the sign being resolved is in the word stem and the other signs are all known, then it is sufficient to simply match the stem itself. For example, if the word *KNOWING* is missing in the dictionary, and we are trying to resolve `KNO(.)ING`, it's sufficient to just match `KNO(.)`. This is how long compound words in inscriptions can be matched.

On the flip side, a false negative can lead to a false positive. Suppose in our example, the dictionary did not have the words *LIE* or *LEE*, the regex `/^L.E$/'` would match only *LYE* and ι would be resolved to *Y*. This risk can be greatly mitigated by repeating the resolution of every sign using many different subsets of inscriptions, all of which should resolve to the same value. In addition, if there are plenty of attestations for the sign, grammatically correct and meaningful values for all of them reassure us that no false positive has been chosen. Incorrectly decoded signs will not match further plaintext words downstream and quickly result in a dead end making this approach self-correcting. For example, if ι is incorrectly assigned the value *Y* in our example, many plaintext words like *ILL* and *IS* will fail to match despite occasional plaintext words like *DIE* matching *DYE*. With sufficient distinct attestations, it becomes clear which signs are incorrect. Signs which have very few attestations may never resolve purely via dictionary check and a grammar check and a general theme consistency may be required.

2.10.4. Translation and correctness

Translation is a post-decipherment activity and an occasional bad translation does not invalidate the decipherment. Translating ancient inscriptions without spacing or punctuation is challenging on its own. Consider an inscription: *MAYBEFOREMAN*. Purely

based on spacing adjustments, it could be read as *MAY, BE FOREMAN* or *MAYBE FORE, MAN* or *MAY BEFORE MAN*. One way to address this is to look for consistency in themes. If most of the inscriptions are about a workshop or factory, then *FOREMAN* could be the right pick.

The abundance of choices on how to translate an inscription is generally a good sign that the decipherment is nearly correct. If many signs are right but a few of the signs are incorrect, they would typically force a break or the translation would not be in the same themes as the rest of the translation. For example, if the letter *E* was incorrectly deciphered as *T*, we would have *MAYBTFORTMAN*, forcing a word break near the bad letter and we may attempt to read as *MAY BT FORTMAN*. Sometimes the bad letter may be innocuous in one inscription, for example, if *O* was deciphered as *I*: *MAYBE FIREMAN*. While this instance is grammatically correct, many others would have breaks and the text would be nonsensical or incongruous with the general themes of the rest of the inscriptions. These errant signs can be detected using the intersection of the signs in all broken inscriptions and the decipherment process is repeated for such signs with greater thoroughness.

If a decipherment is utterly incorrect, it won't even be possible to make any words, let alone morphologically consistent words and grammatically correct phrases that can be read meaningfully. For example: *mapagakajh* cannot be made into a Sanskrit or English phrase no matter how we dice it. This is because *p* or *ph* never follow *m* in Sanskrit phonotactics, nor do words end in *jh*. Even plausible sounding short strings like *hena, hoja* etc are non-words and it is unlikely that we get many matches because the symbol space of a language is mostly filled with non-words.

A small subset of short inscriptions may be read as an abjad and with wide latitude for word forms, ignoring morphology or syntax with a partially correct decipherment. The grammatically correct reading of the longest inscriptions thus becomes a litmus test for decipherment accuracy.

2.10.5. Adjustments for Sanskrit in an ancient script

From the Meluhhan words and names attested in Sumerian inscriptions, it appears that Meluhhans spoke some form of post-Vedic Sanskrit, but one that is too early to be termed classical Sanskrit. This enables us to use a downloadable Sanskrit dictionary with some caveats. Most dictionaries do not have compound, declined, conjugated or affixed forms so we need to add these forms as needed. Many words like root forms, grammar terminology and those created by medieval lexicographers should be removed. A few words may be potentially lost over the millennia, and we may find some inscriptions unreadable despite deciphering the script accurately.

Indus script is a bronze age script and we have no idea how much fidelity an inscription has to the actual spoken language. Based on very early scripts, our derivation should handle a script that is unlikely to have a *virāma* (i.e., handle a consonant without an assumed *a* vowel). We need to accommodate for the possibility of sign reuse among dentals and retroflexes, aspirated and unaspirated and possibly voiced and unvoiced, similar to later Tamil Brahmi. Doubled consonants may also be written as a single sign(i.e., *datta* written as *data*).

We adjust for these by flattening sibilants together and also dentals with retroflexes and aspirated with unaspirated. Doubled consonants are rare enough that we can only examine them when we run into a dead end. This enables us to use simpler regexes and reduces the chances of user error in derivation. The capture group `(.)` captures a single consonant or a single vowel. To capture either a syllable or consonant without

a following vowel, we would need to use `(..?)` as the capture group. The capture group `(..?)\1` would also capture reduplicated consonants but it's an unwarranted complexity. The capture group `(.+)` may be used to capture conjunct signs like .

2.11. *Sign classification*

Although we have used Mahadevan's 417 signs as valid for a decipherment-neutral metric of correctness, it is by no means authoritative. Indus script is a hand-carved writing system and not a typeset or a tool-based script (unlike say, cuneiform). Therefore, just as every handwriting sample of the same letter is unique, no two instances of any Indus sign are exactly alike. There is plenty of room for stylistic and regional variants and present classifications are subjective for the most part.

2.11.1. Signs and Glyphs

A sign is an idea of visual representation of a member of the script. A glyph is a particular realization of a sign and it's normal to have multiple glyphs that represent the same sign. For example, 𝕬 𝔄 𝔄 *A* are all different realizations of the same sign in the Latin alphabet. To be properly deciphered, the idea of the sign must be articulated clearly, for example, *The first letter A of the Latin alphabet is two vertical lines joined at the top and separate at the bottom with a horizontal connection midway.* This specification is sufficient to read an enormous array of handwriting and stylized fonts. For pictorial signs, something like *the phoneme D is a pictograph of a dog* may be sufficient. Regardless of the breed and orientation of the dog pictured, its intent is unambiguous.

A script made of pictorial glyphs is unlikely to have different signs based on tiny variations such as "fish with two fins" vs "fish with 4 fins." They are likely to represent the same idea "a fish" and therefore different glyphs of the same sign. A rarely occurring sign that is only slightly different from a frequently occurring sign is likely to be a stylistic variant rather than an unrelated sign. Usually, there are unique characteristics for variants of the same sign that help us correctly identify variants. For example, the jar sign is unique for having zero to four small numeric strokes within it . All renditions of this sign are treated as variants. For simplicity, we use the most common rendition in the paper. For example, any of will be denoted as in the derivation section. While variants of most signs are quite apparent, we present a concise list of the most expansive variants in table 3.

Rare mirrored signs like are likely an artifact of carving for seal impressions. Bracketed signs are likely to be word fragments consisting of three or more signs rather than a single unrelated sign simply because the brackets and numerics occur independently for example in M-2069 . These presumptions are validated if we can read nearly *all* bracketed signs as a string of their constituents. Similarly, if conjunct signs like are indeed digraphs, then nearly *all* digraphs should be readable as their constituent signs. Gradual abstractions of complex signs such as should independently be deciphered to the same value.

2.11.2. Stylistic and geographic variants

𝖂hile an ornate rendition of the first sign of an inscription may be used, different glyphs are often stylistic variations that may rarely be mixed in an inscription. For example, Upper Case Is Rarely Mixed With Lower Case except in titles and *italics* are rarely *mi***xed** with **bold**. The scarcity of mixed styles gives us a proof point to verify that

Table 3. Six extensively stylized signs

Sign name	Stylized variants
Barley merchant	
Spider/Insect	
Spider/Insect	
Horse/Equid	
Comb	
Leaf	
Chariot	

Table 4. Discovery of distinct signs and allographs

Glyphs	Inscription		Matches	Result
vs	H-1850		bha**ṭṭ**i	Distinct
	Dholavira		mā**nana** mā**yy**a mā**ll**a	
vs	M-874		**ra**yi **ya**yi	Allographs of *ra*
	H-1182		śa**ra**ṇi	

certain glyphs are indeed variants of the same sign if their values are identical.

When individual variants have sufficient attestations, we may prove each variant individually for example, all 3 variants  may be independently proven to have the value क *ka*. Where sufficient attestations don't exist we can narrow down the possibilities to a handful and attempt to read all the inscriptions meaningfully. For example, by applying the regex method to identify  we do not get a unique value, but narrow it down to र *ra* or व *va*. Based on sign similarity and readability in inscriptions, we can confirm that the sign is a variant of र *ra*.

This method is not only helpful in identifying variants, but it is also self-correcting and an incorrect identification will be easy to identify:

(1) two signs which are different are assumed to be the same
(2) two signs that are the same are assumed to be different

In the first case, regular expression search yields two disjoint sets of inscriptions with two different phonetic values. For example, if we presume the signs and are variants of the same sign, An attempt to narrow the matches from the first set using a member of the second set will yield a null set. This immediately alerts us to the fact that the signs are indeed distinct.

In the second case, both sets will yield the same phonetic value. In fact, this is how we discover allographs as shown in Table 4.

While an optimal reachability graph can be constructed by analyzing the inscriptions, we can use the heuristic of solving signs in descending order of frequency with a few detours as needed.

2.12. *The first sign*

The first sign we decipher is the jar sign 𒀀 representing *an*. It also represents a variety of nasal sounds including *anusvara*, which is a post-vocalic nasal sound. From the dictionary itself, a regex for H-764B 𒀀𒀀𒀀 we get a single match *ananan*, representing *ananaṃ*, which is an accusative of *anana*. Technically, there are other possible matches like *jajaja, lalala* which are legitimate matches. The seal Dmd-1 𒀀 single jar sign matches *ana* and eliminates other alternatives like *ja* and *la*. Finally, many inscriptions with terminal jar signs representing the accusative ending *aṃ* resolve the value of the sign.

After we decipher the first sign, we simply look for other inscriptions that enable us to decipher more signs by substituting the value of the first sign. The vertical bar sign 𒁹 is decipherable with just the jar sign and we keep repeating the steps till all signs are resolved. We continue the process roughly going in the descending order of frequency of signs, to optimize the probability of finding sufficient attestations needed for deciphering the sign. The complete derivation may be followed step by step in Section 8. A computer program that partially reproduces the derivation is available in the supplementary section.

2.13. *Formalization*

Let $G = \{g_0, g_1, g_2...\}$ be the set of symbols whose sound value is known.

Let $X = \{x_0, x_1, x_2...\}$ be the set of all symbols.

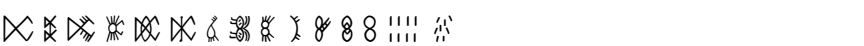
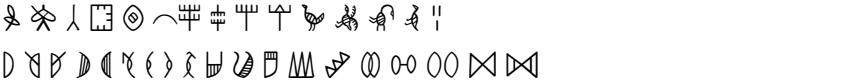
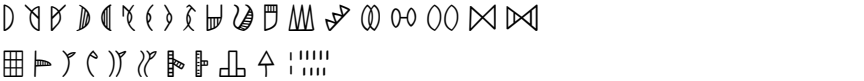
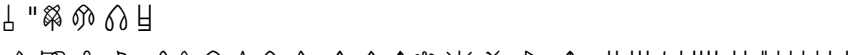
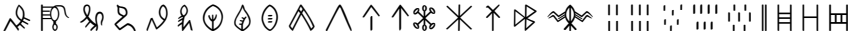
Let $S = \{s_0, s_1, s_2...\}$ be the set of inscriptions where s_i is a vector from symbols in X

(1) Let two inscriptions $s_a = g_i x_a g_k x_c...$ and $s_b = g_j x_a g_l x_f...$
(2) Let set of symbol matches $G_{x_a} = /g_i(.+)g_k./ \cap /g_j(.+)g_l./$
(3) Repeat intersection with new inscription above until G_{x_a} is of unit length
(4) $x_a = G_{x_a}$
(5) $G = G \cup x_a$
(6) Repeat until $G = X$

3. Results

Indus script is made of 76 allographs representing the most common signs shown in section 3.1. The complete derivation can be traced in section 8. A compact one-pager is given in table 5. Long inscriptions and inscriptions with conjunct signs are listed in sections 5 and 6 respectively. Some signs have variants that mark reading direction or word boundaries and they are listed in table 10. Consonant clusters using syncope are shown in table 9. Table 7 shows Indus signs standardized into Brahmi.

Table 5. Indus script phoneme glyphs

Phoneme		Glyphs
अ	a	
आ	ā	
इ	i	
ई	ī	
उ	ū	
ए	e	
ओ	o	
अन् अं	an aṃ	
अस् अः	as aḥ	
क ख	k kh	
ग घ	g gh	
च छ	c ch	
ज झ	j jh	
त थ ट ठ	t th ṭ ṭh	
द ध ड ढ	d dh ḍ ḍh	
न	n	
प फ	p ph	
ब भ	b bh	
म	m	
य	y	
र	r	
ल	l	
व	v	
स श ष ह	s ś ṣ h	

3.1. *Sign values and their reconstructed names*

Phoneme	Reconstructed Sign Name			Sign Glyphs	
अ a	अयुग	ayuga	one[VarBṛS]		1
	आयु	āyu	man[RV]		2
	अग	aga	mountain[Kirat]		3
	अङ्क	aṅka	curve/hook[RV]		4
	आजनि	ājani	stick[AV]		5
	अजशृङ्गी	ajaśṛṅgī	goat's horn[AV]		6
आ ā			repeated अ a		7
इ i	इषीका	iṣīkā	stalk of grass[AV]		8
ई ī			doubled इ		9
उ ū	उद्याम	udyāma	rope[TS]		10
	उदपान	udapāna	well[MBh]		11
	उपनिहन्	upanihan	hammer[ŚBr]		12
ए e	एक	eka	one[RV]		13
ओ o	ओपश	opaśa	pillar[RV]		14
अन् अं	अंशु	aṃśu	soma drink[ŚBr]		15
an aṃ	अंशु	aṃśu	lamp[MaitrUp]		16
अस् अः	अष्टपाद	aṣṭapāda	eight legged[MBh] (spider)		17
as aḥ	अष्टन्	aṣṭan	eight[RV]		18
क ख	कृतम्	kṛtam	dice[ŚBr]		19
k kh	कृतम्	kṛtam	axe[Cutting √कृत् √kṛt]		20
	खातृ	khātṛ	digger/pickaxe[Cāṇ]		21
	कृष	kṛṣa	ploughshare[Gal]		22
ग घ	गाधन	gādhana	arrow[Hariv]		23
g gh					
च छ	चतुर्	catur	four[RV]		24
c ch	छत्र	chattra	mushroom[CarakaS]		25
ज झ	झर	jhara	waterfall[Prab]		26
j jh	झञ्झान्	jhañjān	rain and wind[KāśīKh]		27
त थ ट ठ	तण्डुल	taṇḍula	rice plant[AV]		28
t th ṭ ṭh	ताडुल	tāḍula	fighter; beater[Uṇvṛ]		29
	ताड्य	tāḍya	drum[Mn]		30
	ताल	tāla	small cymbal[BhP]		31
	तर्दू	tardū	wooden ladles[L]		32
	तर्द	tarda	Indian blackbird[AV]		33
	त्र	tra	three[RV]		34
द ध ड ढ	धन्वन्	dhanvan	bow[RV]		35
d dh ḍ ḍh	धान	dhāna	receptacle[RV]		36
	दन्त	danta	teeth[RV]		37
	धानकाः	dhānakāḥ	coins[Car]		38

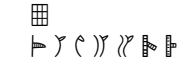
Phoneme	Reconstructed Sign Name			Sign Glyphs	
न n	नाल	nāla	mat of reeds[BhP]		39
	नाल	nāla	stalk[MBh]		40
	नालीका	nālīka	arrow[MBh]		41
	नल	nala	reed[Bhp]		42
	नवन्	navan	nine[RV]		43
प फ	पञ्चन्	pañcan	five[RV]		44
p ph	पञ्चन्	pañcan	hand[RV]		45
ब भ	भक्षपत्त्री	bhakṣapattrī	edible[RV] leaf[RV]		46
b bh	भक्षत्र	bhakṣatra	oven[भक्ष bhakṣa:RV]		47
म m	मत्स्य	matsya	fish[RV]		48
	मत्य	matya	club[AV]		49
	मत्य	matya	harrow[TS]		50
	मत्त	matta	elephant[R]		51
	मन्थ	mantha	churning stick[MBh]		52
	मन्थ	mantha	fire sticks[MBh]		53
	मन्दार	mandāra	a flower[MBh]		54
	मन्दिर	mandira	dwelling[MBh]		55
	मय	maya	horse[VS]		56
	मृक्ष	mṛkṣa	comb[RV]		57
य y	यविष्टि	yaviṣṭhi	barley[RV] seeker[RV]		58
	यव	yava	barley[RV]		59
	यष्टि	yaṣṭi	pearl necklace[VarBṛS]		60
	यष्टि	yaṣṭi	twig[Hariv]		61
र r	रथर्वी	ratharvī	split snake[AV]		62
	रथारिन्	rathārin	chariot[RV] wheel[BhP]		63
	रथ	ratha	chariot[RV]		64
	रथदारु	rathadāru	chariot wood[Pāṇ]		65
ल l	लता	latā	creeper[MBh]		66
व v	वर्ती	vartī	lamp wick[MBh]		67
	वि	vi	two[RV]		68
	वीटक	vīṭaka	betel leaf/nut[Pañcad]		69
	वटी	vaṭī	banyan tree[MBh]		70
	वात्र	vātra	loom [√वे + ष्ट्रन्]		71
स श ष ह	शाखार	śākhāra	squirrel; branch mover[RV]		72
s ś ṣ h	शुक्र	śukra	seed[RV]		73
	शिखर	śikhara	mountaintop[MBh]		74
	शिखा	śikhā	peacock crest[MBh]		75
	श्येन	śyena	falcon[RV]		76
	शाण	śāṇa	weight of four[Hariv]		77
	षण्	ṣaṇ	six[RV]		78
	सप्तन्	saptan	seven[RV]		79
	सोपान	sopāna	ladder[MBh]		80
					81

Table 8. Numeric and pictorial line stroke signs

Numeric from digits 1-10										Pictorial					
ˈ	ˈˈ	¦	||||	⁞⁞	⁞⁞⁞	⁞⁞⁞ˈ	⁞⁞⁞⁞	⁞⁞⁞⁞ˈ	⁞⁞⁞⁞⁞	|	‖	|||	¦	¦¦	⁞⁞⁞
अ	व	त	च	प	ष	स	अस्	न	द	अ	स	ज	न	ष	ज
a	v	t	c	p	ṣ	s	as	n	d	a	s	j	n	ṣ	j

Table 9. Consonant clusters using schwa and double syncope

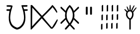
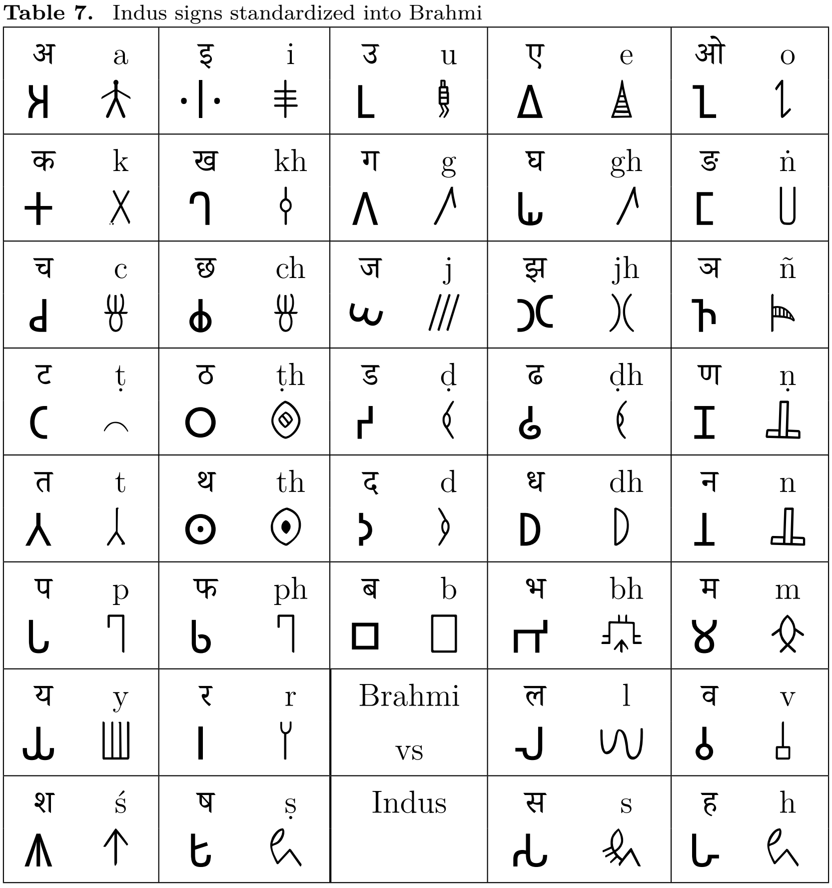
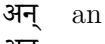
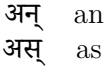
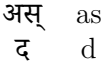
Seal-Id	Inscription	Sanskrit	Transliteration	Conjunct
H-43		शक्र	śa**kra**	क्र kra
H-152a		क्षय	**kṣa**ya	क्ष kṣa
M-43a		मज्ज वमाहन्	ma**jja** vamāhan	ज्ज jja
M-1316		साह वल्लभ बडाद	sāha va**lla**bha baḍāda	ल्ल lla

Table 7. Indus signs standardized into Brahmi



अ	a	इ	i	उ	u	ए	e	ओ	o
क	k	ख	kh	ग	g	घ	gh	ङ	ṅ
च	c	छ	ch	ज	j	झ	jh	ञ	ñ
ट	ṭ	ठ	ṭh	ड	ḍ	ढ	ḍh	ण	ṇ
त	t	थ	th	द	d	ध	dh	न	n
प	p	फ	ph	ब	b	भ	bh	म	m
य	y	र	r	Brahmi vs		ल	l	व	v
श	ś	ष	ṣ	Indus		स	s	ह	h

Table 10. Directional and word-boundary variants

Sign			Marked Variants	Sign			Marked Variants
अ	a			न	n		
अ	a			ब	b		
अन्	an			म	m		
अन्	an			म	m		
अस्	as			य	y		
द	d			र	r		
द	d			र	r		

4. Discussion

Indus script is a segmental script that may be described as proto-abugida. The major difference from Brahmi is that retroflexes use the same signs as dentals and aspirated and unaspirated stops use the same signs. Signs have a default vowel of अ *a* unless overridden by an immediately following vowel sign. No diacritics are used.

Many signs have stylistic variations that have no phonetic distinctions. While signs are distinct in most cases, occasional ambiguities do exist, which are discussed below. Signs may be classed into several groups based on characteristics specific to them.

4.1. *The language*

Many words from classical literature such as the Ramayaṇa and Mahābhārata are attested, but the meanings of many archaic words are from the Vedic corpus. Chain compounds are also a feature of classical Sanskrit. Although the grammar is essentially the same, we refer to the Indus language as post-Vedic, to avoid confusion with the classical literature that began with Pāṇini's *Aṣṭādhyayī*.

4.2. *The inscription content*

The contents of the Indus inscriptions are similar to Janapada coins and Gupta-era seals that they resemble(Azad, 2020). Long seals seem to use a concise Vedic concept as a motto or slogan. This tradition is attested at least from Gupta times and carries on to the present day. For example, a Gupta era seal reads *śaṃkara-vara yānābhyaḥ*(IndMuseum, 5th Century). This translates to "Shiva's blessing for the journeys" which is a concise form of Rig-Veda 7.35.15. This could be a prayer for a journey of trade goods. Another reads *Śivam brihaspate* "[Our] welfare, O bṛhaspati"(MetMuseum, 6th CE). This is a concise form of Rig-Veda 1.89.6. The tradition of using Rigvedic formulas as prayers and mottos continues to the present day in many organizations. The government of India's *satyameva jayate* "Truth alone triumphs" from the Chhāndogya Upanishad, is the most famous. In addition, the various state and local governments of India, Thailand and Indonesia continue to use concise forms of Vedic verses as mottos.

The first few signs often invoke a deity. Most of these are of the meaning of destroyer or roarer. The Vedic god Rudra is both Roarer and Destroyer. This may be because the root *ru* means both roar and kill. Most names are simply constructed by the *-a* affix to the root, which creates the agent-noun from the verb-root (i.e., roarer from roar). In

Table 11. Provisional readings of mixed IVC/Brahmi inscriptions from subsection 1.1

	Source	Inscription	Reading	Translation
1	Keezhadi 600 BCE		चापयशम् cāpayaśam	renowned archer
2	Marungur 200 BCE		अमहस् amahas	the mighty one
3	Annakodai 300 BCE		रर कावात् rara kāvāt	given by Kāva (a Sāman)
4	Vietnam Gold foil 100CE		वराह varāha	Varaha avatar
5	Copper Hoard 1800 BCE		शंखात् किं रठँ डय śaṅkhāt kiṃ raṭaṇ ḍaya	what emanated from the conch?
6	Bet Dwarka (R to L) <1000 BCE		मीरखा ईश mīrakhā īśa	O Ocean expanse! O Lord!
7	Bijar-Ghamchoghai (R to L) undated		रूर रयाः मम मठम् rūra rayāḥ mama maṭham	O fire, the rivers are my home

Paṇinian grammar, this is called the अच् *ac* affix. Although Pāṇini mentions this rule to apply only to a specific set of roots (*pacādi* roots), in practice this affix is universal and can be applied to any root as evidenced in the oldest books of Rigveda [चुद् + अच् = चोद *cud + ac = coda* RV 5.61.3].

The intended meanings of short seals are harder to determine with precision. For example, the inscription H-101a  *parṇa* has an ordinary meaning of leaf, wing, or feather, but is also a proper name of a people, a place, a teacher or a particular tree. For the sake of conciseness, we just translate it simply as "leaf." Most short seals resemble the contents of the seals from the Gupta period and therefore are likely to be names or membership tokens(Azad, 2020). Determining the actual intended meaning of any inscription is beyond the scope of this work. For determining the accuracy of the decipherment, it only matters that the inscription has been read grammatically correctly.

> The only properties of a language of interest in cryptography are statistical properties. What are the frequencies of the various letters, of different digrams (pairs of letters), trigrams, words, phrases, etc.? What is the probability that a given word occurs in a certain message? The "meaning" of a message has significance only in its influence on these probabilities. For our purposes, all other properties of language can be omitted.(Shannon, 1945)

Table 12. Provisional readings for non-Sanskrit seals from Mesopotamia and Dilmun(Laursen, 2010)

Source	Inscription	Reading	Translation	Language
Karzakan		an-an	Sky-heaven	Sumerian
Karzakan		a'aš am	sign of the wild bull	Sumerian
Karzakan		a'aš aga	sign of the crown	Sumerian
Mesopotamia?		kaš an-an	decision of the sky god	Sumerian
Mesopotamia?		maa-a	boat labor	Sumerian
Saar		ḫamu-a	for raft	Old Akkadian
Susa		karānu	wine	Akkadian
Ur		kamānu	cumin	Old Akkadian

Table 13. Validated analyses from past decipherments

Authors	Finding
Mahadevan[a]	Primary direction is Right-to-left
Parpola[b]	Signary contains allographs
Rajesh Rao et. al.[c]	non-IVC language inscriptions in West Asia
S. R. Rao[d]	Language is Indo-Aryan
Hunter[e]	Indus script and Brahmi are related
Sullivan[f]	Brahmi signs in Indus script have identical values
Bonta[g]	Semiotics suggest Indo-Aryan language
Heggarty et. al.[h]	Indo-Aryan and Iranic separated by 3000 BCE

[a](Mahadevan, 1977);[b](Parpola, 1994); [c](Rao et al., 2009); [d](Rao, 1980); [e](Hunter, 1934); [f](Sullivan, 2011); [g](Bonta, 2023); [h](Heggarty et al., 2023);

4.3. *Validations*

Although the results of this decipherment are markedly different from prior decipherments, we validate many important findings of prior decipherments. These are listed in table 13.

4.4. *Allographs*

The script has 76 allographs for the most common signs with a median of three allographs per phoneme shown in Table 6. These allographs seem to have appeared due to mispronunciations when the name of the sign was transmitted orally. This may have happened sometime after the Harappan period 3A when speakers of other Indo-Aryan dialects began using the script as part of the Indus Valley integration phase. This is analogous to the effect of Prakrit on the writing of the Maurya and Gupta eras.

A comprehensive allograph chart is in table 6. An average of a little over 4 variants per allograph for 76 allographs explains the approximately 125+ signs.

4.5. *Line strokes and Numeric signs*

A numeric sign does not encode an actual number, but rather the first syllable of its name. The sound values are shown in Table 8. A sign with eleven strokes does not exist, suggesting the Indus civilization used a decimal system. The name for a single numeric stroke, अयुग *ayuga*, represents the अ *a* vowel. अयुग *ayuga* may have mutated into अइक *aika* which may have been used as the diphthong अइ *ai*. The word एक *eka* evidently evolved from अयुग *ayuga* via अइक *aika*. The other numeric signs are self-explanatory, each representing the initial consonant of its name.

Non-numeric signs seem to have been invented earlier than numeric signs, as evidenced by workarounds to comply with non-numeric signs. Evidence for this is that other अ *a* signs can be doubled to form आ *ā* but not the | vertical stroke since it would be read as ‖ स *sa* and inscriptions work around this by inserting 大 between the two to create |大|. The sign ⁞⁞⁞ *ja* often written as ⁄⁄⁄⁄ representing rain, is not a numeric sign. Its allograph ||| is not to be confused with the numeric sign ¦ read as त *ta*.

4.6. *Sign disambiguation*

Numeric signs in general take all strokes as a single sign. Spacing, stroke size differences and incline differences are used to distinguish two adjacent numeric signs or signs made of simple line strokes.

For example, the sign M-734 reads ||| ||| ⊨Ұ⌂ वरण-जज *varaṇa-jaja*, "chosen[Uṇādi] warrior[Śiś]." The clear space between ||| ||| is unambiguously read as two ||| ज *ja* signs, rather than a single |||||| sibilant sign, which would need to be read as वर्णस् *varṇas*, "color[MBh]." Seal M-1822 |//ᱦᑌ uses incline differences to distinguish |‖ सा *sā* to avoid being read as ||| ज *ja*.

When strokes are arranged in rows, if the upper row has an equal or higher number of strokes than the lower row, then the sign is read as representing the total number of strokes. Inscriptions use spacing to ensure clear separation between distinct signs.

For example, the sign M-1904 reads '''ıııı जज *jaja*, "warrior." The three-stroke sign representing the first syllable is marked as distinct from the other by horizontal and vertical spacing. If there was no clear spacing, the seal would look like ⁞⁞⁞ and be read as a sibilant.

When the upper row has fewer strokes than the lower row, spacing or other indications of separateness become important for an accurate reading. For example, M-948 reads 𝍬ııı"⊗| अववज्य *avavajya* "off[RV] journey[√वज्]", rather than अवपय *avapaya* "desiring[RV] water[RV]" due to slight offset of two rows of strokes. While signs with five or more strokes can appear in one or two rows, signs with two and four always appear in a single row. If they appear in two rows, they are distinctly different signs with distinctly different sound values. Note the differences between " व *va*, ||| ज *ja*, |||| च *ca* versus ¦ न *na*, ¦ त *ta*, ⁞ श *śa*.

4.7. *Vowels*

A vowel sign overrides the default अ *a* vowel of the preceding sign just as in abugida unless it's another *a*, which lengthens to आ *ā*. In practice, a leading अ *a* can be either अ *a* or आ *ā*. Repeated vowel signs make a long vowel. The only long vowels attested are आ and ई. Other vowels such as ऊ simply use the same sign ᛰ to indicate both long and short vowels. ऋ *ṛ* uses signs for र *r* and presumably so do the unattested ॠ *ṝ* ऌ *ḷ*. The signs for Ʊ अन् *an* and ⋈ अस् *as* represent अं *ṃ* and अः *ḥ* respectively and have

vowel length flexibility, the rest are abugida and always read with default vowel *a* or without any vowel and conjunct with the next sign.

4.8. *Diphthongs*

The sequence अइ *a-i* exists as a diphthong in some seals indicating that is possibly used for ऐ *ai* as in H-1056 जमनैः *jamanaiḥ* [√जम् + ल्युट् n.ins.pl of noun from √jam]. An equivalent diphthong for औ *au* is not attested but may be reconstructed as  .

4.9. *Base consonants*

A base consonant sign represents an ordinary consonant with the default vowel अ *a*. Retroflex *ṭ ḍ* and dentals *t d* use the same signs, similar to the usage of the Latin alphabet to write Sanskrit. Aspirated *kh gh ch jh th dh ph bh* use the corresponding unaspirated *k g c j t d p b* signs.

4.10. *Sibilants and nasals*

All signs for श ष स ह *ś ṣ s h* are interchangeable including अस् *as* signs. These are also used as *visarga ḥ* where needed. The usage of the *as* signs for *h ḥ* may reflect a grammatical feature of Sanskrit where a nominative affix *s* becomes *ḥ* in sandhi. The  sign is also used nasal consonants न *n*, ण *ṇ* and ङ *ṅ*. This interchangeability of retroflex with dentals, aspirated with unaspirated, the sibilants among themselves and the same with the nasals may be additional evidence of the presence of multiple Indo-Aryan dialects in the Indus Valley civilization. We see the same effect in the Sanskrit words attested during historic times due to the presence of various Prakrit dialects. For example, Sanskrit सेन *sena* becomes Prakrit षेण *ṣeṇa*, रज्ज *rajja* is written as रझ *rajha* and so on. To Prakrit speakers, these signs are interchangeable in a script. More examples are shown in table 15.

The variant seems to be preferred for ञ *ñ* but in principle, all jar-like signs are interchangeable. Ambiguities that may be caused by the flexible vowel length of jar signs are avoided by adding an अ *a* right after. For example, L-218  would be read as अनवस *anavasa*, Rivedic[6.66.7] word meaning "unstopping" describing the unstoppable march of the storm gods, the Maruts, rather than a fairly meaningless अण्वस *aṇva-sa* "interstice bestowing."

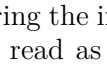
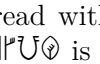
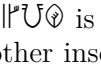
4.11. *Conjunct signs*

A conjunct sign is created by combining two (or rarely more) base signs and represents the sounds of the combined signs. The most common being the signs for अम *ama*, which can take a variety of forms by vertically assembling a rotated curve sign) अ *a* and one of the म *m* signs, giving many possible conjuncts, roofed-fish sign being the most common. In addition to these, there are over 100 rarely used conjuncts that are deciphered in Section 6.

Conjuncts appear to be artifacts of limited space. One type of conjuncts is constituted of two base signs that appear to be ligatured because they touch each other due to crowding caused by lack of space. Extremely rare occurrences of conjunct signs clarify that a conjunct sign is simply two or more normal signs that just happened to touch due to crowding. They may be simply read as if they are separate. Often signs are missed

Table 14. Directional markers on jar signs

Seal-Id	Inscription	Sanskrit	Transliteration	Direction
H-1711		कान्तदान	kāntadāna	←
M-1353		अन्नदान	annadāna	←
M-1304		अनवरम्	anavaram	←
H-1801		अनवरम्	anavaram	←
M-862		अनरम्	anaram	←
M-420		अनाचर	anācara	←
M-1822		अनूषा	anūṣā	←
M-1700		अन्धैः	andhaiḥ	←
Ns-86		अनु	anu	→
M-1336		आनवम्	ānavam	→
M-2062		line1: चर	cara	←
		line2: अंश	aṃśa	→
M-378		वनम् अपर	vanam apara	word boundary
H-454		अनम् वरम्	anam varam	word boundary

during the initial carving and later squeezed if space permits as in C-8  . These are read as if they were normal-sized. If there is insufficient space to squeeze in the sign, then a narrow sign like or may be rotated and placed above the next character as in  . These are simply read as two separate signs with the top sign followed by the bottom within the flow of the text. Occasionally, there is insufficient space to insert a character in the right location, so a proper conjunct is made, for example,  *ji* in M-409  . Such conjuncts appear at the ends of inscriptions where there is no space to insert the missed character, so the missed sign is conjunct to its nearest one and may be read with the (normal sized) base character first and the attached sign following it:  is read as  . Exceptions can be made based on words that are attested in other inscriptions like  *dhakka* but these are rare. The vowel conjuncts may have evolved into Brahmi diacritics. For example, the Indus conjunct may have become Brahmi  *dhī*.

4.12. *Consonant clusters*

Clustered consonants are simply written adjacent but are pronounced with a schwa syncope. Doubled consonants are written as a single consonant. Examples are shown in Table 9.

4.13. *Directional markers*

While the preferred direction of writing is right-to-left as discussed in section 2.1, occasional left-to-right and boustrophedons are also attested. Egyptian hieroglyphs and the Phonecian scripts simply mirror the signs when the direction changes, so boustrophedons are simple to detect. Since the vast majority of Indus script signs are symmetric

and sometimes even the asymmetric signs are inscribed mirrored horizontally, there is a chance that the inscriptions are read in the wrong direction. For large inscriptions, this is usually not a problem, since they would be unreadable the wrong way. However, short inscriptions have the risk of being read incorrectly. This is true for a large number of words in the Indus inscriptions. For example, *tana* can be read as *naṭa*, *anu* as *unna*, etc. which may change the intended meaning. Table 14 shows examples where the inscriptions could be read in the opposite direction with a different meaning. Scribes eventually may have added the marks to err on the safe side, even if no obvious conflict is known.

The most common sign, the Ʊ jar sign repeated sufficiently within inscriptions to enable a directional marker of its own, by adding one to four small strokes inside the jar as shown in the first section of Table 14. The strokes appear in non-ascending order. The first jar always has the highest number of strokes and the next sign can either decrease or maintain the number of strokes. Typically, the final jar sign will end up with no strokes. This pattern holds for over two hundred inscriptions with just a handful of exceptions as in the last section of Table 14. The improbability of these strokes to have any kind of phonetic meaning is easily verified by testing the inscriptions against a dictionary. These strokes are a directional marker similar to a fuel gauge, tracking the remaining text portions from full to empty. The directional mark is placed on a nearby sign if the starting sign is numeric or otherwise unsuitable for a directional indicator.

A directional marker may be used even when it's the only jar sign in the inscription to avoid accidental reading in the wrong direction as we see in the second section since the Ʊ jar sign is so often a terminal sign. When the leftmost sign has a directional marker and the rightmost sign doesn't, the seal may be preferentially read left to right as we see in the last section of Table 14. This is most useful for multi-line boustrophedon inscriptions but occasionally also occurs in single-line seals.

Signs other than jar signs can also have one to four strokes to indicate direction or word boundary. Usually, these occur as the initial sign in the inscription and act as a directional indicator and are listed in Table 10.

4.14. *Stylistic variants*

The different glyphs of the same allograph without directional function in Table 6 are likely to be stylistic variations, based on the fact that different forms of a single allograph rarely occur together in the same inscription. Typically when the inscription needs to use the same allograph twice, the scribe seems to choose the same variant or one very close to it. There are a few obvious exceptions, such as fish sign, where variants do occur together.

4.15. *Evolution*

Signs that take up horizontal space undergo rotation  to fit in limited space. Complex and time-consuming signs undergo abstraction  and simplification  . Many variants of the same sign are simply cursive variants, as they are written in a way to reduce the number of strokes on a softer medium. Indus script developed several artifacts that can all be parsimoniously attributed to the lack of horizontal space since inscribed objects were the size of coins. Eliding the final *anusvāra* (ṃ sound) and double consonants were a matter of economy on small seals but are unnecessary on stone and pillar inscriptions, given that the Brahmi *anusvāra* is a simple dot and doesn't even

take up any space. This may be simply due to continued scribing tradition.

Examining the different glyphs attested for some signs shows evidence of the development of cursive forms. For example, the signs that are based on straight lines show curved lined variants such as , , . This is unnecessarily complex in a carved medium but natural in a soft medium using inks or brushes. The author of the inscription seems to have written the text in cursive and the scribe must have carved it as is. Minimizing strokes can sometimes work to the benefit of both carved and soft media, such as , , but some forms are clearly beneficial only on the non-carved media such as , . Ligatures also seem unnecessary on carved media but are natural for ink and brush as in .

4.16. *Evolution to Brahmi*

When we arrange Brahmi signs with their closest corresponding Indus script allograph for the same sound value, we notice that every Brahmi sign seems to be a minor variant or simplification of a pre-existing Indus sign. Indus script glyphs are closer to Brahmi than Brahmi glyphs are to modern Devanagari script. Among the earliest Brahmi are inscriptions from Keezhadi among which there is at least one sample on a potsherd that reads . This is meaningless when read left-to-right but when read right-to-left, reads अरुषम् *aruṣam*, which is a Rigvedic word for the red color of the god Agni, the Sun or cows and horses[MW](Sivanantham and Seran, 2019). This is an early attestation of direction change in Keezhadi. The gradual change from Indus script at the earliest levels, followed by mixed inscriptions and finally only Brahmi on the latest levels may indicate a gradual evolution from Indus script to Brahmi captured in Keezhadi stratigraphy.

Table 7 is an accurate snapshot of the Indus signs chosen to be standardized into Brahmi using the observation that retroflexes and dentals are interchangeable as a group as are non-labial nasal consonants.

4.17. *Script fidelity*

Bronze-age scripts generally do not have high fidelity to their transliteration. Linear B for example, has no consonant clusters. Sumerian is a polyvalent script that has multiple ways to read and write a word and different signs are used based on meaning. Even classical Arabic did not have dots (i'jām) to distinguish different phonemes on many rock inscriptions, despite having multiple forms (initial, media, terminal) for the same phoneme. By comparison, the Indus script has a fidelity similar to Tamil Brahmi with nearly the same sign reuse groups of consonants. Indus inscriptions are fairly readable even after 4-5 millennia with little effort.

4.18. *Religious continuity*

We see several linguistic and cultural features that continued post-Indus phase. The deities in Indus inscriptions are the same as Vedic. The Sun, Soma, Rudra, Indra, Agni, Ushas, Ashlesha and Bharani constellations, the horse *ashva*, Ardhanareeshwara (seals depicting one-breasted human) and pipal tree continue to be revered to this day. Select Rigvedic references related to long inscriptions are noted in Section 5.

Table 15. Post-IVC attestation of script elements(Balasubramaniam, 2005; Bhatt, 1998; Hultzsch, 1925)

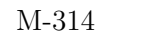
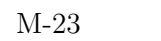
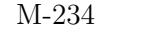
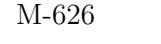
Indus feature	Attestation	Attested as		Read as	
merged dentals/ retroflex	Avanti fish seal Mansehra	देवटाह दुवडश	devaṭāḥ duvaḍaśa	देवताः दुवदश	devatāḥ duvadaśa
merged un/aspirated	Girnar	उस्टान	usṭāna	उस्थान	usthāna
merged sibilants	Kalsi Girnar	दाश, दाष वर्स	dāśa, dāṣa varsa	दास वर्ष	dāsa varṣa
no virāma	Ajagara	अगसतय	agasataya	अगस्तय	agastya
elided doubled consonants	Qutub Iron pillar Girnar	मूर्त्या अगि	mūrtyā agi	मूर्त्या अग्गि	mūrttyā aggi
elided anusvara	Girnar	इद	ida	इदं	idaṃ
अं अन् *aṃ an* flexibility	Qutub Iron pillar Girnar	प्रन्शु अंञ	pranśu aṃña	प्रंशु अन्य	praṃśu anya
initial आ *ā* as अ *a*	Girnar	अरोपितं	aropitaṃ	आरोपितं	āropitaṃ

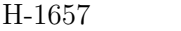
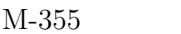
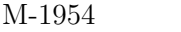
4.19. *Vestiges of Indus linguistic forms*

Indus script characteristics are also attested into post-IVC inscriptions, coins and seals(Bhatt, 1998; Hultzsch, 1925; Solomon, 1998). These are shown in Table 15. The Iron pillar presently in the Qutub complex retains some of the archaic language features of Indus inscriptions(Singh, 2006). It uses a lone consonant to represent a doubled consonant (mūrtyā instead of mūrttyā) and the anusvara अं *aṃ* is denoted अन् *an* (pranśu instead of praṃśu). Indus script provides evidence that the Qutub inscription was not an aberration, but rather that अं *aṃ* was inscribed as अन्.

Inscriptions with mixed Indus/Brahmi signs are now readable such as the one from Marungur(Subrahmanian, 2010). These are shown in Table 11. Indus-seal technology was exported to Mesopotamia and Dilmun in the mature phase(Laursen, 2010). Of the more than 121 seals unearthed, most do not have any inscription. At least 27 have Indus inscriptions shown in Table 12, of which some are readable as Sumerian, Akkadian or Old Akkadian(Association Assyrophile de France, 2006; Gelb, 1957; UPenn, 2006).

5. Long inscriptions with their scriptural references

	Seal-Id	Inscription	Translation
1	M-314	 रवाममम् मन सक्षनरं जठलधार रह rava-amam mana sakṣa-naraṃ jaṭhala-dhāra raha	Honor the powerful Roarer O Sustainer, O Ocean(Shiva) yield to the capable man
		RV 5.45.10 hearing him, the waters receded	
		रव *rava* roarer[√रु + अच्]; अमम् *amam* ams. the powerful[RV]; मन *mana* honor[√म्ना + लोट् 2s.]; सक्ष *sakṣa* capable[TS]; नरं *naraṃ* ams. man[TS]; जठल *jaṭhala* vms. Ocean[Sāy] =समुद्र=Shiva[MBh]; धार *dhāra* vms. Sustainer[MBh 13.14.13]; रह *raha* yield, release[√रह् + लोट् 2s.];	
2	M-23	 दाममन कंसं नः रन्धन dāma-mana kaṃsaṃ naḥ randhana	Great Giver, this cup is for us, O Shiva
		RV 2.37.2 his name is "The Giver" **RV 10.112.6 Filled is the beaker with the meath**	
		दामन् *dāman* giver[RV]; मन *mana* vns. great[=महान् *mahān* Vā.]; कंसं *kaṃsaṃ* ans. cup/jar[AV]; नः *naḥ* for us[RV dp. of अस्मद् *asmad*]; रन्धन *randhana* vms. destroying[Bhp];	
3	M-234	 दाममन कंसं च आस नदन् dāma-mana kaṃsaṃ ca āsa nadan	Great Giver, the cup is taken roaringly!
		RV 10.136.7 Rudra roaring hath drunk from the cup	
		दामन् *dāman* giver[RV]; मन *mana* vns. great[=महान् *mahān* Vā.]; कंसं *kaṃsaṃ* ans. cup/jar[AV]; आस *āsa* taken[√अस् + लिट् 1s./3s.]; नदन् *nadan* roaring[√नद् + शतृँ];	
4	M-626	 कम् माखं कंसं दात नदन् kam mākhaṃ kaṃsaṃ dāta nadan	Excellent sacrificial cup O roaring purified one!
		RV 1.15.2 Drink from the purifier's cup **RV 2.37.1 meath out of the sacrificer's cup**	
		कम् *kam* indc. good/well[TS]; माखं *mākhaṃ* ans. oblation[Hariv]; कंसं *kaṃsaṃ* ans. cup[AV]; दात *dāta* vms. purified[Pāṇ]; नदन् *nadan* roaring[√नद् + शतृँ];	

	Seal-Id	Inscription	Translation
5	H-1657	 धक्क वह मांसजाशवरम् dhakka vaha māṃsaja-āśa-varam	O Destroyer(Rudra), bring us the gift of food full of fatness
6	M-355	 तद्दनम् रव अममञ्जस्सरं tat-dadanam rava amam-añjas-saraṃ	O Roarer, That gift of powerful Soma juice
7	M-38	 शतदारव आम महं माखं śatadā-rava āma mahaṃ mākhaṃ	O Roarer, Giver of plenty! may I serve this great sacrifice
8	M-391	 दाहरव शं जाराङ्किधर dāha-rava śaṃ jāra-aṅki-dhara	O burning roarer, bless us O lover, O Indra, O bearer
9	M-1954	 रव अहत्मन् जरावरान् rava aha-tman jarā-varān	O Shiva, soul of the day, bring us great praises

RV 10.169.1 waters rich in life and fatness: to food that moves, O Rudra

धक्क *dhakka* vns. destroyer[√धक्क् + अच्]; वह *vaha* carry[√वह् + लोट् 2s.]; मांसज *māṃsaja* fat[Suśr]; आश *āśa* food[ŚBr]; वरम् *varam* ams. boon[RV];

RV 9.80.2 powerful Soma, thou to whom the cows have-lowed

तत् *tat* ans. that[RV]; ददनम् *dadanam* ans. present[√दद् + ल्युट्]; रव *rava* vns. roarer[√रु + अच्]; अमम् *amamam* ams. powerful[RV]; अञ्जस् *añjas* Soma[RV]; सरम् *saram* ams. liquid[VS];

RV 1.122.01 bringing sacrifice to bounteous Rudra

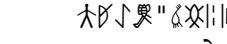
शतदा *śatadā* giver of a hundred[SV]; रव *rava* vns. roarer[√रु + अच्]; आम *āma* serve[√अम् + लोट् 1s.]; महं *mahaṃ* ams. great[RV]; माखं *mākhaṃ* ans. oblation[Hariv];

RV 1.115.2 Like a young man, Sun follows the Dawn
RV 3.45.4 Indra uses hooks to get fruit

दाह *dāha* burning[MBh]; रव *rava* vns. roarer[√रु + अच्]; शं *śaṃ* indc. bless[RV]; जार *jāra* lover of dawn[RV]; अङ्किन् *aṅkin* Indra[RV 3.45.4]; धर *dhara* vms. bearer[MBh];

RV 1.26.9 may the eulogies of mortal men Belong to us

रव *rava* vns. roarer[√रु + अच्]; अह *aha* day[RV]; त्मन् *tman* vms. soul[RV]; जरा *jarā* praise[RV]; वरान् *varān* anp. best[RV];

	Seal-Id	Inscription	Translation
10	M-1688	 वज हान आम् अश्वमोदा[न्] vaja hāna ām aśva-modā[n]	O ancestor, strengthen indeed the delights of possessing horses

RV 1.92.7 confer on us strength ... kine and horses

वज *vaja* strengthen[√वज् + लोट् 2s.]; हान *hāna* vms. departed[VS];
आम् *ām* indc. indeed[MaitrS]; अश्व *aśva* horse[RV]; मोदा[न्] *modān* amp. joy[RV];

11	H-130	 ददा तव वशम् अञ्जदह्न dadā tava vaśam añja-dahra	Grant us your power, O Shining fire

RV 1.36.11 Agni, we extol: his powers shine out preeminent.

ददा *dadā* grant[RV 4.36.9]; तव *tava* your[RV]; वशम् *vaśam* ams. power[AV];
अञ्ज *añja* shining[√अञ्ज् + अच्]; दह्न *dahra* vns. fire[Uṇvṛ];

12	M-359	 तनभव वह अमम् वरम् tana-bhava vaha amam varam	Roaring Shiva, bring a mighty blessing

RV 10.164.2 A happy boon do men elect, a mighty blessing they obtain

तन *tana* roarer[√तन् + अच् RV]; भव *bhava* vms. Rudra[BhP,AV]; वह *vaha* carry[√वह् + लोट् 2s.];
अमम् *amam* mighty[RV]; वरम् *varam* ams. choicest[MBh];

13	H-280	 हट ममद माखवरम् haṭa mamada mākha-varam	I enjoyed, O Shining one the sacrificial gifts

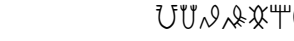
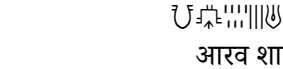
RV 1.83.3 thy power brings blessing to the sacrificer pouring gifts.

हट *haṭa* vns. shining one[√हट् + अच्]; ममद *mamada* enjoyed[√मद् + लोट् 1s.];
माख *mākha* oblation[Hariv]; वरम् *varam* ams. choicest[MBh];

14	M-369	 दमनसत् मम माखम् damana-sat mama mākham	O Subduing Spirit My sacrifice

RV 10.99.6 subdued the demon who roared aloud

दमन *damana* subduing[MBh]; सत् *sat* vns. Universal Spirit[RV];
मम *mama* my[RV]; माखं *mākhaṃ* ams. sacrifice[Hariv];

	Seal-Id	Inscription	Translation
15	M-623	 रसालवाह तमसहरण rasāla-vāha tamasa-haraṇa	O Oblation bearer(Agni), O darkness destroyer
		RV 1.12.2 Oblation-bearer, much beloved **RV 9.66.24 Destroying darkness black of hue**	
		रसाल *rasāla* oblation food of milk/curds[Īśvarasaṃhitā]; वाह *vāha* vms. bearer[BhP]; तमस *tamasa* darkness[Uṇ., Sch]; हरण *haraṇa* vms. destroyer[Suśr];	
16	M-10	 सातावहाम अञ्जसम् तर sāta-āvaha-ama añjasam tara	O mighty bringer of wealth bring Soma
		RV 1.8.1 Indra, bring wealth **RV 2.14.8 to Indra bring ... the Soma.**	
		सात *sāta* wealth[RV]; आवह *āvaha* bringer[RV]; अम *ama* vms. mighty[RV]; अञ्जसम् *añjasam* ams. Soma[√अञ्जस्]; तर *tara* bring[√तॄ + लोट् 2s.];	
17	M-1169	 शतात् अवमम् समञ्जन śatāt avamam sa-mañjana	[My] youngest from a hundred, O shining one!
		RV 5.61.5 hundreds of sheep and steeds and kine	
		शतात् *śatāt* hundred, abnp. शतम् *śatam*[RV]; अवमम् *avamam* ams. youngest[RV]; स *sa* indc. with[RV], मञ्जन *mañjana* vms. shine[√मञ्ज् + ल्युट्];	
18	Ns-60	 इद्धाचलवाह नामनशं तर iddha-acala-vāha nāma-naśaṃ tara	O unwavering shining bearer, overcome the loss of rains
		RV 1.38.6 Let each (calamity), with drought, depart from us	
		इद्ध *iddha* shining; अचल *acala* immovable[RV,BG]; वाह *vāha* vms. bearer[BhP]; नाम *nāma* from नामन् *nāman* water[Naigh]; नशं *naśaṃ* ams. loss[MW]; तर *tara* overcome[√तॄ + लोट् 2s.];	
19	M-714	 आरव शासं अञ्जसभं ārava śāsaṃ añja-sabhaṃ	O Roarer, ruler of honoring council
		RV 1.114.2 Rudra, ruler of heroes	
		आरव *ārava* vns. Roarer[Pāṇ]; शासं *śāsaṃ* ams. ruler[RV]; अञ्ज *añja* honoring[√अञ्ज् + अच्]; सभं *sabhaṃ* ans. council[RV];	

	Seal-Id	Inscription	Translation
20	M-677	 आरव मम अञ्जस् मान ārava mama añjas māna	O Roarer, O my honored Soma

RV 1.84.9 Soma juice prepared amid the many honours

आरव *ārava* vms. Roarer[Pāṇ]; मम *mama* my[RV];
अञ्जस् *añjas* vms. Soma mixture[RV]; मान *māna* vms. honored[MBh];

21	M-577	 आ धन्वचर नशावानन ā dhanvacara naśa ava ānana	Oh Desert Roamer(Indra) protect, O destroyer, O face

RV 1.143.6 praise Him whose face is bright

आ *ā* indc. particle of reminiscence[Pāṇ.]; धन्वचर *dhanvacara* vms. desert Roamer[RV 5.36.1];
नश *naśa* vms. destroyer[√नश + अच्]; अव *ava* protect[√अव् + लोट् 2s.]; आनन *ānana* vns. face[R];

22	M-665	 मतवचःदाहन ताम्र matavacaḥ-dāhana tāmra	O prayer-heeding fire O red one

RV 10.37.10 bless us with fervent heat and lustre

मतवचस् *matavacas* prayer-heeding[RV 1.46.5]; दाहन *dāhana* vms. fire[MBh];
ताम्र *tāmra* vms. red[MBh];

23	Lh-1	 दावरव अम दानरं dāva-rava ama dāna-raṃ	O fiery Roarer, help the giver (of sacrifice)

RV 1.114.4 We call Rudra for help, who fulfills our sacrifice

दाव *dāva* √दु fire[AV]; रव *rava* vns. roarer[√रु + अच्];
अम *ama* help[√अम् लोट् 2s.]; दान *dāna* giving[RV]; रं *raṃ* ams. effecting[Śiś];

24	K-10	 नश्वरनवमाखं naśvara-nava-mākhaṃ	New sacrifice oblation

RV 10.89.3 I sing a new prayer
RV 10.89.17 may we partake of thy new favors

नश्वर *naśvara* perishable[Pur]; नव *nava* new[RV]; माखं *mākhaṃ* ans. oblation[Hariv];

	Seal-Id	Inscription	Translation
25	H-8	 धक्क व अञ्जवरम् आच dhakka va añja-varam āca	O Destroyer, I seek a splendorous gift

RV 1.92.13 bestow on us the wondrous gift

धक्क *dhakka* vns. destroyer[√धक्क् + अच्]; व *va* indc. like; अञ्ज *añja* shining[√अञ्ज + अच्]; वरम् *varam* ams. gift[RV]; आच *āca* I seek[√अच् + लोट् 1s.];

26	M-119	 दा शतधारवहमय[म्] dā śata-dhāra-vahamaya[m]	By the giver, bearing a hundred streams

RV 1.95.10 he makes stream ... and inundates with floods
RV 9.97.29 Sprung from the Gods, a hundred streams

दा *dā* ims. of दा *dā* giver[RV]; शत *śata* hundred; धार *dhāra* stream[RV 9.109.19]; वहमय[म्] *vahamaya[m]* ans. bearing[Hcat];

27	H-103	 हतमदन अञ्जन् आय[म्] hata-madana añjan āya	O Kāmā-killer shining arrival

RV 10.121.6 When over them the risen Sun is shining

हत *hata* Slayer[RV]; मदन *madana* vms. Kāmā[MBh]; अञ्जन् *añjan* shining[√अञ्ज् + शतृँ]; आय[म्] *āya[m]* ams. arrival[RV]

28	M-494	 अना आनर्ष सातादः anā ānarṣa sātā-daḥ	Verily, the giftgiver sets flow

RV 8.93.2 As from a mountain flow the water-brooks, thus flow his gifts

अना *anā* indc. verily[RV]; आनर्ष *ānarṣa* set flow[√ऋष् + लिट् 3s.]; साता *sātā* gifts[RV]; दः *daḥ* nms. giver[MBh];

29	H-268	 दस्म वह अञ्जस्भां dasma vaha añjas-bhāṃ	O extraordinary one flow-forth the shining Soma

RV 8.96.10 brightly-shining, mingled with the milk, the draughts of Soma

दस्म *dasma* vms. extraordinary[RV]; वह *vaha* bring[√वह् + लोट् 2s.]; अञ्जस् *añjas* Soma[RV]; भां *bhāṃ* ans. shine[RV];

	Seal-Id	Inscription	Translation
30	M-396	 असमामतु आत्मतस् asama amatu ātmatas	O unequalled one, serve from the self

RV 4.12.3 the self-reliant God,
RV 2.3.1 Let Agni serve the gods

असम *asama* vms. unequalled[RV]; अमतु *amatu* serve[√अम् + लोट् 3s.];
आत्मतस् *ātmatas* abns. from the self[आत्मन् + तसिल् RV];

31	M-1676	 समव वम तमःमरम् samava vama tamaḥ-maram	O Savior emit darkness removing (light)

RV 1.62.5 with the Dawn, Sun, rays, dispelled the darkness

समव *samava* vms. helper[समव् + अच् RV]; वम *vama*[√वम् + लोट् 2s.];
तमस् *tamas* darkness[RV]; मरम् *maram* ams. death[RV];

32	K-15	 मम रसद सछदानि अर्कार mama rasada sa-chadāni arka-āra	O my healer(Shiva), with roofs may I raise, O Sun

RV 4.5.1 he uplifted as a pillar bears the roof

मम *mama* my[RV]; रसद *rsada* vms. healer[MBh]; स *sa* indc. with[RV];
छदानि *chadāni* amp. cover[BhP]; अर्क *arka* vms. Sun[RV];आर *āra* raise[√ऋ + लोट् 1s. RV];

33	M-1690	 यमहन् अंशं शमम्न् yama-han aṃśaṃ śama-man	O Yama's killer(Shiva), My portion, O calm one

RV 3.62.11 Our portion of prosperity

यम *yama* Lord of death[RV]; हन् *han* vms. killer[RV]; अंशं aṃśa ams. portion[RV 2.19.5];
शम *śama* calm[MBh]; -मन् *-man* vms. containing[R];

34	Ns-9	 अथ अचलत्व मान atha acala-tva māna	Verily, O immovable one O honored one

RV 8.14.9 Firm and immovable from their place

अथ *atha* indc. now/hereby[RV]; अचल *acala* immovable[Bhag]; त्व *tva* vms. one[RV];
मान *māna* vms. honored[MBh]

	Seal-Id	Inscription	Translation
35	H-12	 रव अमम् महमाखं rava amam maha-mākhaṃ	O Roarer, a powerful great sacrifice (to you)
		RV 1.75.5 our mighty sacrifice	
		रव *rava* vns. Roarer[√रु + अच्]; अमम् *amam* ams. powerful[RV]; मह *maha* great[RV]; माखं *mākhaṃ* ans. oblation[Harv];	
36	M-495	 अना आनर्ष सातान् anā ānarṣa sātān	Verily, he set flow the gifts
		RV 8.93.2 As from a mountain flow the water-brooks, thus flow his gifts	
		अना *anā* indc. verily[RV]; आनर्ष *ānarṣa* set flow[√ऋष् + लिट् 3s.]; सातान् *sātān* amp. gifts[RV];	
37	M-900	 रव सहत् मम वरम् rava sahat mama varam	O Roarer, my lasting wish
		RV 6.45.21 satisfy our wish with power and wealth	
		रव *rava* vns. Roarer[√रु + अच्]; सहत् *sahat* ans. lasting[RV]; मम *mama* my[RV]; वरम् *varam* ams. wish[RV];	
38	M-52	 दमवह आ मथमहान् dama-vaha ā matha-mahān	O subduer, O great Churner
		RV 10.24.4 ye Twain churned the united worlds apart	
		दम *dama* subdue[RV]; वह *vaha* vms. bearing[RV]; आ *ā* as[RV], मथ *matha* churner[√मथ + अच्]; महान् *mahān* vms. महत् great[RV];	
39	C-24	 रसतस नमन् संधार rasa-tasa naman saṃ-dhāra	O Roaring destroyer, salutations O possessor of all things
		RV 4.8.1 Your envoy who possesses all	
		रस *rasa* roarer[√रस् + अच् ŚBr]; तस *tasa* vms. destroyer[√तस् + अच् Dhātup]; नमन् *naman* saluting[√नम् + शतृँ]; सं *saṃ* indc. all[RV]; धार *dhāra* vns. possessing[BG];	

	Seal-Id	Inscription	Translation
40	H-20	 अहम् सहं मोक्षम् aham sahaṃ mokṣam	I am capable of salvation

RV 10.52.5 I shall give you freedom

अहम् *aham* ns. I[RV]; सहं *sahaṃ* ams. capable[Kālid]; मोक्षम् *mokṣam* ams. salvation[MBh];

41	Krs-1	 नर्मीं जठल शाय[म्] namīm jaṭhala śāya[m]	O Ocean, (protect) the sleeping Nami

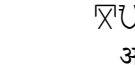
RV 6.20.6 He guarded Nami, Sapya's son, in slumber

नर्मीं *namīṃ* ams. Nami, son of Sapya[RV 6.20.6]; जठल *jaṭhala* vms. Ocean;
शाय[म्] *śāya[m]* ans. sleeping[RV];

42	M-49	 अह अचलवशम् मषम् aha acala-vaśam maṣam	Indeed, pulverizing mountain at will

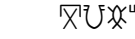
RV 1.55.3 great manly power, so as to bend ... that famed mountain down

अह *aha* indc. Indeed[RV]; अचल *acala* mountain[GārgīS];
वशम् *vaśam* ams. at will[RV]; मषम् *maṣam* indc. pulverized[ŚāṅkhGṛ];

43	M-1052	 आम वाहस्मनाक् āma vāhas-manāk	I served small offerings

RV 10.91.8 sacrificial offerings great and small alike.

आम *āma* I served[√अम् + लिट् 1s.]; वाहस् *vāhas* offering[RV];
मनाक् *manāk* indc. small[Kāv];

44	M-634	 ऋतरथरातमनाक् ṛta-ratha-rāta-manāk	bestowed fit small chariot

RV 8.58.15 boy exceeding small, mounted his newly-fashioned car.

ऋत *ṛta* fit[RV]; रथ *ratha* chariot[RV];
रात *rāta* bestowed[RV]; मनाक् *manāk* indc. small[Kāv];

	Seal-Id	Inscription	Translation
45	H-129	 भसरवाम आमंत्र bhasa-rava-ama āmantra	do invite, O powerful shining Roarer
		RV 6.50.4 This day invited the Sons of Rudra	
		भस *bhasa* shining[√भस + अच्]; रव *rava* Roarer[√रु + अच्]; अम *ama* vms. powerful[RV]; आमन्त्र *āmantra* invite[आ + √मन्त्र + लोट् 2s.];	
46	M-1834	 ददानुदम् जननल dada-anudam jana-nala	Giving and restoring Speech maker (Agni)
		RV 10.137.1 restore to life again the man who has committed sin **RV 3.1.19 make our share glorious and adorned with fine speech**	
		दद *dada* giving[RV]; अनुदं *anudaṃ* ans. restoring[RV]; जन *jana* creator[√जन् + अच्]; नल *nala* speaker[√नल् + अच्];	
47	Nd-1	 शमशराङ्गतम्र śama-śara-aṅga-tamra	O red bodied one with calmed arrows
		Sri Rudram/KYV TS 4.1 Your calm arrow ... O red one	
		शम *śama* calm[MBh]; शर *śara* arrow[RV,MBh]; अङ्ग *aṅga* body[Uṇ]; तम्र *tamra* vms. red/dark[RV]; [Sri Rudram: 1.4 यात इषुः शिवतमा, 1.11 यस्ताम्रो]	
48	M-1892	 अरवर्षाराणान् ara-varṣā-rarāṇān	Suitable bountiful rains
		RV 2.27.15 shed in abundance, The rain of heaven	
		अरम् *aram* indc. suitable[RV]; वर्षा *varṣā* rain[TS]; रराणान् *rarāṇān* anp. bountiful[RV];	
49	H-270	 ननम शस्तं जषं nanama śastaṃ jaṣaṃ	I salute the praised destroyer
		RV 8.86.10 Most eminent for power, destroyer in the conflict **RV 10.170.3 he spread wide unfailing victory and strength**	
		ननम *nanama* I salute[√नम् + लोट् 1s.]; शस्तं *śastaṃ* ams. praised[MBh]; जषं *jaṣaṃ* ams. destroyer[√जष् + अच्];	

	Seal-Id	Inscription	Translation
50	H-10	 **बबद अश्ववलर[म्]** babada aśva-vala-ra[m]	I steadied the strong horse
		RV 1.38.12 steady your horses	
		बबद *babada* steadied[√बद् + लिट् 1s.]; अश्व *aśva* horse[RV]; वल=बल *vala=bala* strength[RV]; रम् *ram* ams. possessing[Naiṣ];	
51	M-1123	 **रर ररय[म्]** rara ra-raya[m]	Given speed
		RV 2.31.2 Gods of one, accord speed on our car	
		रर *rara* given[√रा + लिट् 2p.]; र *ra* possessing[RV]; रय[म्] *raya[m]* ams. speed[Pur];	

6. Sign Variants and Conjuncts

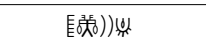
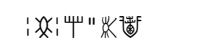
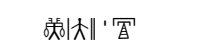
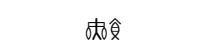
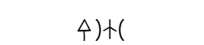
Variants are stylistic and abstracted evolution of symbols. Conjunct signs combine two or more signs and are read as adjacent signs: firstly in the direction of writing, secondly top to bottom and lastly the base character followed by the ligatured character.

(1) Ligatured symbols that are simply touching but otherwise written in normal size and position are read as normal. For example, is simply read as .

(2) Symbols arranged vertically are read from top to bottom. is read as रि as opposed to which is read as ईर

(3) The base character, i.e., the large character is read first and the embedded character is read subsequent. becomes रस्.

	Sign Variant			Inscription		Sanskrit
1			अ a	M-875→	mango[MBh]	आम्र āmra
2			अ a	M-403	nearby[RV]	अन्तर antara
3			अ a	H-777	immovable[RV]	अचर acara
4			अ a	H-829→	youngest[RV]	अवर avara
5			अ a	M-210	distant[RV]	अरण araṇa
6			अ a	M-123	by the great one[Vā]	मनैः manaiḥ
7			आ ā	M-1151	verily[MaitrS] worshipping[√नम्]	आम् नमन् ām naman
8			अक aka	M-1764	ours[RV]	अस्माक[म्] asmāka[m]
9			आका ākā	H-2104	sky[ŚBr]	आकाशम् ākāśam
10			अदा adā	Ad-6	giver of that wealth[RV,RV,RV]	तद्धनदाम tat-dhana-dāma
11			अन् an	M-89	O complete[AV] giver[RV]	अमहानून amaha-anūna

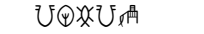
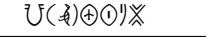
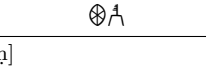
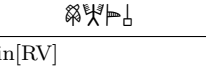
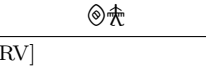
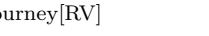
	Sign Variant			Inscription	Sanskrit
12			अन् an	H-228  fisherman [nms. आनायिन्]	आनायी ānāyī
13			अन ana	L-218  unstoppable[RV]	अनवस anavasa
14			अना anā	M-812  indeed, indeed[RV,MaitrS]	अनाम् anām
15			अन्न anna	C-68  speak[अञ्ज्], O foodgiver[MS]	अन्नद अञ्ज annada añja
16			अन्तर antara	M-639  saluting Ashwatta[AV] spirit[RV]	अन्तराश्वत्थ नमन् antara-aśvattha naman
17			आप āpa	H-413  vedic deity(Vasus)[MBh]	आप āpa
18			आभा ābhā	M-742  Splendorous[RV] streams[AV]	अभाम् सरा[म्] ābhām sarā[m]
19			अम ama	M-18  people[RV]	जनम् janam
20			अम ama	M-896  sleeping[AV] at home[RV]	अमाशाय ama-āśāya
21			अम ama	D-51582  O shining[RV] day[RV]	आभामह ābhāmaha
22			अम ama	M-969  serve[√अम् + लोट् 2s.]	आमय āmaya
23			आम āma	H-449  gift[RV] of immortality[MBh]	अमरणम् वरं a-maraṇam varaṃ
24			अमा āmā	RGR-7230  to honor[Mn]	आमान āmāna
25			अर ara	M-713  great[Vā] burning[√दह्] Roarer[√रु]	आरवदहनमन ārava-dahana-mana
26			अर ara	K-45→  power[RV] of flood[RV]	अर्णपय arṇapaya

	Sign Variant			Inscription	Sanskrit
27			आरव ārava	M-1105 Roarer[√रु]	आरव ārava
28			आल āla	M-367 salute[RV] poison[Suśr] remover[RV]	आलवहनमन āla-vaha-namana
29			अश् aś	H-1513  voracious[RV]	अश्न aśna
30			अश् aś	M-821  eating[ŚBr]	अशम् aśam
31			अश् aś	H-1841  to the tansformer[√मस्]	मसदं masadaṃ
32			अश् aś	H-1994 ray[RV] of light[MBh]	भांश bhāṃśa
33			अश् aś	H-1049 O mover[MBh] on horses[RV]	अश्वचर aśva-cara
34			अश् aś	M-243 given[RV] by horsegiver[Mn]	दत्ताश्वद datta-aśva-da
35			अस् as	M-954  my[RV] cart[RV]	मम अनस् mama anas
36			अस asa	M-1724  food[ŚBr] to share[BhP]	आशभाज्य āśabhājya
37			आस् ās	K-17  food[ŚBr]	आशं āśaṃ
38			अशि aśi	H-679 moon[MBh]	शशि[न्] śaśi[n]
39			अश aśa	M-219 sky[RV]	अश्म[न्] aśma[n]
40			आश āśa	M-2088 food[ŚBr]	आश āśa
41			आश āśa	M-1887  obtaining me[RV]	माम् आशं mām āśaṃ

	Sign Variant			Inscription	Sanskrit
42			आशा āśā	H-156 desires[AV]	आशां āśāṃ
43			अश्व aśva	M-1106 indeed[RV] horse[RV] giver[RV]	अना अश्वद anā aśvada
44			ईर īra	M-1170 rising [ईर्:RV]	ईर īra
45			ईरि īri	M-151 desert[MBh]	ईरिणम् īriṇam
46			ईशन् īśan	M-1548 Vanquish[RV], O Shiva[MBh]	सह ईशन् saha īśan
47			उ u	M-20 Beyond[RV] all[RV] waters[RV]	उदसर्वपर uda-sarva-para
48			क ka	H-66 misremembering[Pāṇ,√स्मा]	कामनन् kāmanan
49			क ka	H-513 moment[Śak]	क्षण kṣaṇa
50			क ka	M-68↔ subduing[MBh,Gaut] of Kāma	दमनहानकाम damana-hāna-kāma
51			कर kara	M-57 saluting cloud[R] bringer[MBh]	खरवाहमह नमन khara-vāha-maha namana
52			च ca	H-214 destroyer[छिन्न:AV]	छिन्नि[न्] chinni[n]
53			चर cara	C-13 shield[MBh] like[RV]	चर्मसमम् carma-samam
54			ज ja	M-1848 O destroyer[√जष् Dhātup]	जष jaṣa
55			जर jara	M-898 praise[√जॄ RV]	जरम् jaram
56			जस् jas	Ns-4 sacrifice[RV]	यजस् yajas

	Sign Variant			Inscription	Sanskrit
57			जि ji	M-409  complete victory[RV]	सञ्जि sañji
58			त ta	K-11 one who crosses[MBh]	आतटदं ā-taṭa-daṃ
59			त ta	M-1082 Tanva has served[√अम्]	तन्व आमत् tanva āmat
60			तर tara	M-1792 near[RV] death[RV]	अन्तरं मरं antaraṃ maraṃ
61			तर tara	H-1192 dark[RV] and protected[MBh]	तमत्राणि tama-trāṇi
62			तास tāsa	M-1721 Roarer's[√रु] destruction[√तस् घञ्]	रवतासम् rava-tāsam
63			त्र tra	M-360 powerful[RV] gift[RV]	अमत्रदान amatra-dāna
64			द da	H-7 from Vishnu[MBh], O Giver[Paṇ]	दद एकपदः dada ekapadaḥ
65			द da	M-1793 house[RV] praying[ŚBr]	दमः नमन् damaḥ naman
66			द d	H-792 kind one[ŚBr दया+इनि]	दयी dayī
67			ध d	M-73 wealthy one[RV √धन+इनि]	धनी dhanī
68			धक्क dhakka	M-261 Destroyer[√धक्क्] passing[Nir]	धक्क अतन dhakka atana
69			दा dā	H-1662 O fire[MBh], to my fathers[RV]	दाव ततान् dāva tatān
70			दाद dāda	Umma gift[MBh] of Soma[RV,MBh]	दादाण्वचर dāda-aṇvara-cara
71			धी dhī	M-605 devotion[RV]	धी dhī

	Sign Variant			Inscription	Sanskrit
72			न na	H-74 roaring[RV]	सदान्व sadānva
73			न na	H-295  ancient[RV]	सन sana
74			न na	M-1277 destroyer[√नश्]	नश naśa
75			न na	M-747 no loss[MBh]	न नाशं na nāśaṃ
76			न na	M-986 man[TS]	नरं naraṃ
77			नमा namā	H-1869  inexhaustible[AV] pasture[RV]	नमान्य nama-anya
78			नाशन naśana	M-975  loss[BhP] by intense fire[Subh]	नशनानलसक्ष naśana-anala-sakṣa
79			प pa	H-1024  bind[√मव्] the wager[MBh]	मव पण mava paṇa
80			पद pada	M-777  unequalled[RV] friendly[TS] sign[MBh]	असमामनपद asama-āmana-pada
81			पर pra	M-83  stream[BhP]	प्रसर prasara
82			बत bata	Frm-1329 employing[√भट्+शतृँ]	भटन् bhaṭan
83			बद्ध baddha	K-53 bound[RV]	बद्ध baddha
84			भ bha	M-331 splendor[आभास ābhāsa R]	आभसा ābhasa
85			म ma	H-2125  honor[MBh]	मान māna

	Sign Variant			Inscription	Sanskrit
86			म ma	M-523  confluence[RV]	समर samara
87			म ma	M-1367  death[AV]	मर mara
88			मद mada	C-8  abundant[RV] joy[RV]	मदं महं madaṃ mahaṃ
89			मर mara	H-142  pleasant[TS] spreading[RV] darkness[RV]	कम् तम्रातान kam tamra-ātān
90			मी mī	M-649  ocean[Uṇ]	मीर mīra
91			य ya	H-951  wild[RV] grain[RV]	वनयव vana-yava
92			य ya	M-831  controlled[RV]	यत yata
93			य ya	H-455  O horse-owning[RV] people[RV]	हयवान् जन hayavān jana
94			य ya	C-39  meditate[√ध्यै]	दध्य dadhya
95			य अय ya aya	M-288  protecting[RV] journey[RV]	यायनम् शरण[म्] yāyanam śaraṇam
96			ऋभ् ṛbh	M-2012  Indra's[RV] drink[RV]	ऋभ्वपान ṛbhva-pāna
97			र ra	K-18  that[AV] swan[Mṛga]	तद् वरल tad varala
98			र ra	H-212  wealth[RV]	रयि rayi
99			र ra	H-510 delightful boon[RV]	रमवरम् rama-varam

	Sign Variant			Inscription	Sanskrit
100			र ra	L-48 I moved[√रख्] praying[√नम्] O Aditya[RV 2.1.4]	ररख अंश नमन् rakha aṃśa naman
101			र ra	H-299 delightful[RV]	रण्व raṇva
102			र ra	M-1424→ O pleasing[RV] lightgiver[MBh]	रणभाद raṇa-bhāda
103			र ra	H-2214→ juicy[RV]	रसमत् rasamat
104			र ra	Salut move[RV] away[√व्यय्]	व्यवचर vyavacara
105			र ra	H-1988 this[RV] color[Sarvad]	इमम् रजम् imam rajam
106			र ra	H-172 O hand holder[RV,Kāv]	पाणिधर pāṇidhara
107			रक raka	K-15/2 reached[√ऋ] the Sun[RV]	अर्कार arka-ara
108			रक raka	M-120 go, O cupid's[MBh] arrow[RV]	मदनबाण रख madana-bāṇa rakha
109			रक्त rakta	M-1759 O red one[MBh], who kills[RV]	रक्तवधहन् rakta-vadhahan
110			रण raṇa	M-1771 delightful[RV] lustre[MBh]	रणं भां raṇaṃ bhāṃ
111			रर rara	H-405 give, O sign[RV] of bearer[RV]	रर वहनामन् rara vahanāman
112			रर rara	M-1154 Give[√रा], O great[Vā] noose[RV]	पाशमन रर pāśamana rara
113			रज raja	K-122 granted[√रा] O Shiva[MBh]	रर जट rara jaṭa
114			रस् ras	H-598 separator[√रह्] of despised[Mn]	रहम् अवमतम् raham avamatam

	Sign Variant			Inscription	Sanskrit
115			रा rā	M-84 O producer![Dhatup] the immortals[ŚBr]	धन अमरान् dhana amarān
116			रि ri	Desalpur destroyer[AV] killer[RV]	रिशवधम् riśavadham
117			रि ri	M-918 O Roarer[√रु], O Shiva[Cat]	रव रीर rava rīra
118			री rī	H-1033 Golden[RV,RV] appearance[RV]	हरीवनाम hari-iva-nāma
119			लल lala	M-751A little delight[√लल्]	ललक lalaka
120			व va	MS-5062 shine forth[MBh]	अवभास् avabhās
121			श śa	M-207 Destroyer[√शद् MBh]	शद śada
122			स sa	Louvre unrestrained[RV] speed[RV]	आसज अयतस् āsaja-ayatas
123			सक्ष sakṣa	M-1342 powerful[TS] council[RV]	सभासक्षं sabhā-sakṣaṃ
124			सात sāta	H-325 gains[RV]	सातं sātaṃ
125			सन sana	M-800 saluting[MārkP] destroyer[√चष्,RV]	चषनंश नमन् caṣan-aṃśa naman
126			सर sara	D-9824 Shine[√मञ्ज्] mighty[RV] Shiva[AV]	शर्वाम मञ्ज śarva-ama mañja
127			हा hā	M-203 great[RV] excellence[RV]	महा अनवरं mahā anvaraṃ

7. Very Short Inscriptions

	Seal-Id	Inscription		Translation		Seal-Id	Inscription		Translation
1	Bhirrana		अम्	to fix[TS]	2	M-1203		अम्	to fix[TS]
3	H-367		अम्	to fix[TS]	4	L-106		अस	shine![√अस्]
5	M-842		असि	sword[RV]	6	M-1198		अ	(voc.)[T]
7	M-1905		अ	(voc.)[T]	8	H-481		आ	(voc.)[Pāṇ]
9	C-52		अक्क	O mother[Pāṇ]	10	M-1105		आरव	O Roarer[√रु]
11	K-464		अश	master[RV]	12	M-597		ईश	O Shiva[MBh]
13	H-1113		इ	(interj)[Pāṇ]	14	M-949		क	joy[Nir]
15	H-1113		क	joy[Nir]	16	H-1833		च	also[Pāṇ]
17	M-607		च	also[Pāṇ]	18	M-262		अच	beg[√अच्]
19	M-331		ज	born[Mn]	20	M-85-5		त[म्]	him[RV]
21	D-50318		त[म्]	him[RV]	22	L-66		त[म्]	him[RV]
23	Blk-5		त[म्]	him[RV]	24	H-94		ता[न्]	them[MS]
25	M-996		द	giving[MS]	26	M-326		द	giving[MS]
27	M-470		द	giving[MS]	28	H-1514		द	giving[MS]
29	H-1011		द	giving[MS]	30	K-476		दाद	gift[MBh]
31	M-605		धी	prayer[RV]	32	M-326		न	praised[TS]
33	M-1118		नमन	bow[MārkP]	34	M-1084		नामन्	sign[RV]
35	D-48576		नवन	praising[Nalod]	36	K-53		बद्ध	bound[RV]
37	M-273		भ	O star[Sūryas]	38	K-67		भ	O star[Sūryas]
39	L-105		बभ	shining[√भा]	40	M-1465		प	protection
41	M-410		मा	to me[माम्]	42	M-1898		मा	to me[माम्]
43	L-54		मा	to me[माम्]	44	M-516		मा	to me[माम्]
45	M-1162		य	him[यद्]	46	Lakhanjo		य	him[यद्]
47	K-446		य	him[यद्]	48	C-94		य	him[यद्]
49	M-1563		रः	giving[Śiś]	50	M-604		रः	giving[Śiś]
51	B-12		र	giving[Śiś]	52	M-1641		र	giving[Śiś]
53	M-1205		र	giving[Śiś]	54	M-1233		र	giving[Śiś]
55	M-593		र	giving[Śiś]	56	M-599		र	giving[Śiś]
57	K-462		ह	verily[Ved]	58	D-17490		ह	verily[Ved]
59	M-1642		व	similar[MBh]	60	K-458		ह	verily[Ved]
61	L-66		ह	verily[Ved]	62	B-10		ह	verily[Ved]
63	Bhirrana		ह	verily[Ved]	64	H-1016		ह	verily[Ved]

8. Derivation

8.1. 𑁍 · अन् · an *from* अंशु *aṃśu soma drink*

Seal-Id	Inscription	Sanskrit		Translation
H-764 B	𑁍𑁍𑁍	अननं	ananaṃ	the living[Nir]
Dmd-1	𑁍	अन	ana	breath[ŚBr]
(Many)	𑁍*	*अं	*aṃ	(terminal अनुस्वार)

𑁍 = अन् अं · an am (1)

8.2. 𑀁 · अ · a *from* आजनि *ājani stick*

Seal-Id	Inscription	Sanskrit		Translation
Harappa	𑁍𑁍𑁍𑀁	आननम्	ānanaṃ	face[R]
H-1550	𑀁𑁍	अना	anā	indeed[RV]
H-1919	𑁍𑀁	आम्	ām	verily[MaitrS]

𑀁 = अ · a from 1 (2)

8.3. 𑁐 · द · d *from* धन्वन् *dhanvan bow*

Seal-Id	Inscription	Sanskrit		Translation
C-80	𑁐𑁍	अन्ध	andha	O Soma[RV]
H-1919	𑁍𑁐	धन	dhana	wealth, prize[RV]
M-1637	𑁐	धा	dhā	to place[RV]

𑁐 = द · d from 1, 2 (3)

8.4. 𑀅 · अ · a *from* आयु *āyu man*

Seal-Id	Inscription	Sanskrit		Translation
M-191 H-346	𑀅𑀅𑁆 𑁆𑀅	धा आम्	dhā ām	to place[RV, कर्णे करं धा] verily[MaitrS]

$$\text{𑀅} = \text{अ} \cdot \text{a} \text{ from } 1, 3 \tag{4}$$

8.5. 𑀇 · इ · i *from* इषीक *iṣīkā stalk of grass*

Seal-Id	Inscription	Sanskrit		Translation
M-87A H-2244B	𑀇𑁆𑀅 𑁆𑀇	अधि इद्	adhi id	above[RV] (affirmation)[Ved]

$$\text{𑀇} = \text{इ} \cdot \text{i} \text{ from } 3, 4 \tag{5}$$

8.6. 𑀤 · द · d *from* धन्वन् *dhanvan variant of bow* 𑁆

Seal-Id	Inscription	Sanskrit		Translation
C-15a	𑁆𑀇𑀤	अधीन	adhīna	belonging to[R]

$$\text{𑀤} = \text{द} \cdot \text{d} \text{ from } 1, 2, 5 \tag{6}$$

8.7. 𑀢 · त · t *from* ताडुल *taḍula variant of fighter* 𑀳

Seal-Id	Inscription	Sanskrit		Translation
B-8 H-150	𑁆𑀢 𑀢𑁆𑀤	तन ददान्त	tana dada-dānta	offspring[AV] Given[RV 1.39.9] by pacified one[√दम् + क्त]

$$\text{𑀢} = \text{त} \cdot \text{t} \text{ from } 1, 6 \tag{7}$$

1047 **8.8.** 𑀰 · श · s ***from*** शुक्र ***śukra seed***

Seal-Id	Inscription	Sanskrit		Translation
M-916A	𑀦𑀰𑀰	शशी	śaśī	the Moon[ŚvetUp]
M-482A	𑀦𑁅𑀰	शनि	śani	Saturn[R]

𑀰 = श · s from 1, 5 (8)

1048 **8.9.** 𑀧 · न · n ***from*** नाल ***nāla stalk***

Seal-Id	Inscription	Sanskrit		Translation
M-992a	𑀧𑀰𑀁	अशन	aśana	reaching across[Nir]
M-812a	𑁅𑀁𑀧	अनान्	anān	breathing[ŚBr]

𑀧 = न · n from 1, 2, 8 (9)

1049 **8.10.** 𑀦 · ई · ī ***from*** इइ ***ī long i***

Seal-Id	Inscription	Sanskrit		Translation
M-1824	𑀦𑁅𑁅	अननी	ananī	the living[anana + इनि]

𑀦 = ई · ī from 1, 5 (10)

1050 **8.11.** 𑀏 · ज · j ***from*** झर ***jhara waterfall; cascade***

Seal-Id	Inscription	Sanskrit		Translation
H-246B	𑀬𑀍𑁅𑀏	जनधा	janadhā	nourishing creatures [TBr]

𑀏 = ज · j from 1, 3, 4 (11)

1051 **8.12.** 𓄿 · र · r *from* रथ *ratha chariot*

Seal-Id	Inscription	Sanskrit		Translation
H-842		ऋणी	ṛṇī	debtor[BG]
H-923		जर	jara	aging[RV]
H-305B		अरज	araja	dustless (pure)[R]

𓄿 = र · r from 1, 2, 5, 11 (12)

1052 **8.13.** 𓌳 · र · r *from* रथर्वी *ratharvī multi/split snake*

Seal-Id	Inscription	Sanskrit		Translation
H-1745A		रज	raja	pollen[Prasaṅgābh]
H-585A		जर	jara	aging[RV]
M-1170A		ईर	īra	mover[√ईर् + अच् RV]

𓌳 = र · r from 5, 11 (13)

1053 **8.14.** 𓀀 · च · c *from* चतुर् *catur four*

Seal-Id	Inscription	Sanskrit		Translation
D-33544		चरि	cari	(a name)[Pravar]
M-749A		चर	cara	move[MBh]
H-215B		चण	caṇa	chickpea[MBh]

𓀀 = च · c from 1, 5, 13 (14)

1054 **8.15.** 𑀅 · अ · **a** ***from*** अजशृङ्गी ***ajaśṛṅgī goat's horn***

Seal-Id	Inscription	Sanskrit		Translation
L-20a	𑀳𑀁𑀅	अचर	acara	immovable[RV]
H-70a	𑀳𑀁𑀅	अजर	ajara	undecaying[RV]
H-2173	𑀇𑀘𑁂𑀅	अरणि	araṇi	kindling wood[RV]

$$\text{𑀅} = \text{अ} \cdot \textbf{a} \text{ from } 1, 5, 11, 12, 13, 14 \tag{15}$$

1055 **8.16.** 𑀫 · म · **m** ***from*** मत्स्य ***matsya fish***

Seal-Id	Inscription	Sanskrit		Translation
M-238a	𑀙𑀦𑀫	मसन	masana	transformation[√मस् + ल्युट्]
M-1344A	𑀙𑀳𑀫	मरण	maraṇa	death[MBh]
H-1192A	𑀙𑀫𑀁	चमन्	caman	eating[√चम् + शतृँ]

$$\text{𑀫} = \text{म} \cdot \textbf{m} \text{ from } 1, 8, 13, 14 \tag{16}$$

1056 **8.17.** 𑀯 · व · **v** ***from*** वि ***vi two***

Seal-Id	Inscription	Sanskrit		Translation
H-292A	𑀯𑁂	रव	rava	O Roarer[√रु + अच्]
M-330	𑀯𑁂𑀙𑀙	अना अनर्व	anā anarva	Indeed, O unstoppable one[RV,RV]

$$\text{𑀯} = \text{व} \cdot \textbf{v} \text{ from } 1, 12 \tag{17}$$

1057 **8.18.** 𑁂 · र · **r** ***from*** रथ ***ratha variant of ratha*** 𑁂

Seal-Id	Inscription	Sanskrit		Translation
M-1233	𑀁𑀙𑁂𑀯	वर्णज	varṇaja	born of class[VarBṛS]

$$\text{𑁂} = \text{र} \cdot \textbf{r} \text{ from } 1, 11, 17 \tag{18}$$

1058 **8.19.** ⊛ · र · r *from* रथारिन् *rathārin chariot wheel*

Seal-Id	Inscription	Sanskrit		Translation
M-1119a H-2018		अनर्व शं रज	anarva-śaṃ raja	Bless, O unstoppable one[RV,RV] passion[Uṇ.]

⊛ = र · r from 1, 8, 11, 12, 17 (19)

1059 **8.20.** □ · ब · b *from* भक्षपत्री *bhakṣapattrī betel leaf*

Seal-Id	Inscription	Sanskrit		Translation
M-311A		भणवी	bhaṇavī	Roarer[√भण् + अच् + वी Pāṇ,RV]

□ = ब · b from 5, 9, 17 (20)

1060 **8.21.** · य · y *from* यवश्रेष्ठि *yavaśreṣṭhi grain merchant*

Seal-Id	Inscription	Sanskrit		Translation
H-81A M-209A	 	जय मान्य	jaya mānya	victory[AV] respected[MBh]

 = य · y from 1, 11, 16 (21)

1061 **8.22.**  · अ · a *from* आयु *āyu variant of*

Seal-Id	Inscription	Sanskrit		Translation
L-38 M-1654	 	माय आन	māya āna	illusion[MBh] nose[RV]

 = अ · a from 1, 2, 16, 21 (22)

1062 **8.23.** [illegible] · न · n *from* नालीका *nālīka arrow*

Seal-Id	Inscription	Sanskrit		Translation
M-1206	[illegible]	चमन	camana	eating[Jaim]
M-403	[illegible]	अन्तर	antara	internal[RV]

[illegible] = न · n from 4, 7, 13, 14, 16 (23)

1063 **8.24.** [illegible] · अस् · as *from* अष्टपाद *aṣṭapāda eight legged; spider*

Seal-Id	Inscription	Sanskrit		Translation
H-1513	[illegible]	अश्न	aśna	voracious[RV]
B-1A	[illegible]	ररस्नवमन	ra-rasna-vamana	Emitting[Kālid,Śiś] object[Uṇ]

[illegible] = अस् · as from 1, 4, 9, 16, 17, 19 (24)

1064 **8.25.** [illegible] · क · k *from* कृतम् *kṛtam dice*

Seal-Id	Inscription	Sanskrit		Translation
H-300B	[illegible]	रणक	raṇaka	N. of King[BhP]
M-176	[illegible]	कम्	kam	well[ŚBr]

[illegible] = क · k from 1, 9, 12 (25)

1065 **8.26.**) · अ · a *from* अङ्क *aṅka curve*

Seal-Id	Inscription	Sanskrit		Translation
H-1520	[illegible]	आजक	ājaka	goats[Pāṇ]
M-1658	[illegible]	आभ	ābha	beauty[MBh]
Nuhato	[illegible]	शाण	śāṇa	flaxen[ŚBr]

) = अ · a from 1, 8, 11, 20, 25 (26)

1066 **8.27.** 𑀅 · अम · **ama** ***from*** अङ्क + मत्स्य ***ama conjunct curve + fish***

Seal-Id	Inscription	Sanskrit		Translation
M-686a		सामन्	sāman	wealth[RV]
H-1085		जामा	jāmā	daughter[MBh]
Allahdino		अमं	amaṃ	power[RV]

 = अम · **ama** from 1, 8, 11, 23 (27)

1067 **8.28.** 𑀦 · न · **n** ***from*** नाल ***nāla reed***

Seal-Id	Inscription	Sanskrit		Translation
H-59A		अश्नं	aśnaṃ	a stone[RV]
M-1118A		नमन	namana	salute[MārkP]

 = न · **n** from 1, 16, 24 (28)

1068 **8.29.** 𑀜 · अन् · **n** ***from*** अंशु ***aṃśu lamp***

Seal-Id	Inscription	Sanskrit		Translation
H-550		आञ्जन	āñjana	fat[RV]
M-928A		आनम्	ānam	subdue[RV]
Harappa		अञ्च	añca	curling[RV]

 = न · **n** from 2, 11, 14, 23, 27 (29)

1069 **8.30.** 𑀢 · त · **t** ***from*** तर्दू ***tardū variant of wooden ladles***

Seal-Id	Inscription	Sanskrit		Translation
H-786		त्मन्	tman	self[RV]
L-145		अश्वतर	aśvatara	mule[AV]

 = त · **t** from 13, 16, 17, 23, 24 (30)

1070 **8.31.** 𑀰 · स · s ***from*** सोपान ***sopāna ladder***

Seal-Id	Inscription	Sanskrit		Translation
H-1492	𑀰𑀰	शश	śaśa	rabbit[RV]
H-1533	𑀰𑁆𑀳	अंश	aṃśa	stake[RV]
H-2585	𑀰𑁆𑀳𑀰	शनि	śani	Saturn[R]

𑀰 = स · s from 1, 5 (31)

1071 **8.32.** 𑀱 · अ · a ***from*** अङ्क ***aṅka boldface variant of curve***)

Seal-Id	Inscription	Sanskrit		Translation
M-917a	𑁆𑀱𑁄	शाण	śāṇa	flaxen[ŚBr]
M-1903	𑁆𑀱𑁃	अमान्	amān	measure[√मा + लङ् 3p.]

𑀱 = अ · a from 1, 8, 27 (32)

1072 **8.33.** 𑀲 · अ · a ***from*** अङ्क ***aṅka variant of curve***)

Seal-Id	Inscription	Sanskrit		Translation
M-1569	𑀲𑀰𑀲	आशा	āśā	desire[AV]
M-1137	𑁆𑀲"⊛	रवाण	ravāṇa	roaring[√रु Ved]

𑀲 = अ · a from 1, 17, 19, 31 (33)

1073 **8.34.** 𑀴 · अ · a ***from*** अङ्क ***aṅka variant of curve***)

Seal-Id	Inscription	Sanskrit		Translation
M-951	𑁆𑀴𑁇	अमान	amāna	not standard[Nyāyam]
M-1179	𑁆𑀴	आन	āna	nose[RV]

𑀴 = अ · a from 1, 2, 16 (34)

1074 **8.35.** · म · m *from* मन्थ *mantha firesticks*

Seal-Id	Inscription	Sanskrit		Translation
M-501		अश्मकं	aśmakam	son of Vasiṣṭha[MBh]
M-257		दमन	damana	charioteer[BhP]

= म · m from 1, 2, 3, 24, 25 (35)

1075 **8.36.** · म · m *from* मृक्ष *mṛkṣa variant of comb*

Seal-Id	Inscription	Sanskrit		Translation
M-1989B		मनाक्	manāk	slightly[Kāv]
M-1233a		मणि	maṇi	gem[RV]

= म · m from 1, 5, 25, 26 (36)

1076 **8.37.** · न · n *from* नाल *nāla mat of reeds*

Seal-Id	Inscription	Sanskrit		Translation
M-382A		आनन	anana	the living[Nir]
H-1682		जननजय	janana-jaya	creator[RV] of victory[AV]

= न · n from 4, 11, 21 (37)

1077 **8.38.** · व · v *from* वर्ती *vartī lamp wick*

Seal-Id	Inscription	Sanskrit		Translation
M-925A		नवन	navana	praising[Nalod]
M-1689a		वश्य	vaśya	dutiful[MBh]
H-194		मवरं	mavaraṃ	multitudes[Buddh]

= व · v from 1, 8, 13, 16, 21, 28 (38)

8.39. 𑀰 · श · s *from* शाखर *śākhāra squirrel*

Seal-Id	Inscription	Sanskrit		Translation
H-1080a		शाण	śāṇa	hempen[ŚBr]
M-1829a		शनि	śani	Saturn[R]
H-1830a		शय	śaya	sleeping[Dhātup]
L-35A		मसन	masana	transformation[√मस् + ल्युट]

𑀰 = श · s from 1, 5, 16, 21, 22 (39)

8.40. 𑀫 · म · m *from* मन्दिर *mandira dwelling*

Seal-Id	Inscription	Sanskrit		Translation
M-832a		शमन	śamana	soothing[MBh]
H-892B		शमनी	śamanī	soothing[MBh]
H-854		जमानि	jamāni	may I eat[√जम् + लोट् 1s.]

𑀫 = म · m from 1, 5, 11, 39 (40)

8.41. 𑀁 · अ · a *from* अयुग *ayuga one*

Seal-Id	Inscription	Sanskrit		Translation
Banawali		आन	āna	nose[RV]
H-2570		आचं	ācaṃ	A name[Rājat]
M-1458		आननाचर	ā-anana-acara	to[RV] constant[RV] living[Nir]

𑀁 = अ · a from 1, 2, 4, 13, 14, 23, 37 (41)

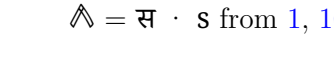
1081 **8.42.** 𑀳 · र · **r** ***from*** रथदारु ***rathadāru Dalbergia tree***

Seal-Id	Inscription	Sanskrit		Translation
H-1975A		कम् तरं	kam taraṃ	pleased[TS] Shiva[MBh]
H-289A		चरण	caraṇa	feet[MBh]
Dholavira		मारण	māraṇa	destruction[Mn]

 = र · **r** from 1, 7, 8, 14, 25, 35, 40 (42)

1082 **8.43.** 𑀰 · स · **s** ***from*** शिखर ***śikhara mountaintop***

Seal-Id	Inscription	Sanskrit		Translation
H-441a		समं	samaṃ	level[RV]
H-201A		मसरं	masaraṃ	measurer[W,RV]

 = स · **s** from 1, 16, 40, 42 (43)

1083 **8.44.** 𑀪 · ह · **h** ***from*** स = ह

Seal-Id	Inscription	Sanskrit		Translation
M-1705		आमहं	āmahaṃ	to[RV] might[RV]
M-1845		आमहं	āmahaṃ	to[RV] might[RV]
M-445		आमहं	āmahaṃ	to[RV] might[RV]
H-474		असहाम्	asahām	impatient[Kathās]

 = ह · **h** from 1, 8, 24, 26, 27, 39, 43 (44)

1084 **8.45.** ⋈ · द · d *from* धानकाः *dhānakāḥ variant of coins* ⦶

Seal-Id	Inscription	Sanskrit		Translation
H-1740	⋈⋈	दद	dada	given[√दा + लिट 2p.]
M-1088	Ʊ⋈"⊛	रवदान	rava-dāna	Roarer's[√रु + अच्] gift[RV]
M-1379	Ʊ⋈⟩	ददान	dadāna	gave[√दान् + लिट् 3s.]

$$⋈ = द · d \text{ from } 1, 6, 17, 19 \quad (45)$$

1085 **8.46.** Y · र · r *from* रथर्वी *ratharvī multi/split snake*

Seal-Id	Inscription	Sanskrit		Translation
D-9093	Y‖‖" 'Ʊ⁂	हनावचर	hana-avacara	killing[RV] domain[Buddh]
M'daro 84-2	Y"	वर	vara	gift[RV]
M-361	Y⊛大	अरर	arara	door[Mcar]

$$Y = र · r \text{ from } 1, 4, 14, 17, 19, 39, 41 \quad (46)$$

1086 **8.47.** 卌 · य · y *from* यव *yava barley*

Seal-Id	Inscription	Sanskrit		Translation
D-16261	卌‖ ' 卌 "|大	आवयाजय	āvaya-ajaya	remove [√अज् + लोट् 2s.] pain[AV]
M-218A	⁝※卌	यमी	yamī	(Yama's) twin sister[RV]
H-48A	卌‖	जय	jaya	victory[AV]
M-1322a	卌‖∆	अजय	ajaya	undefeated[RV]

$$卌 = य · y \text{ from } 2, 4, 5, 11, 15, 16, 17, 41 \quad (47)$$

1087 **8.48.** 𑀥 · द · d *from* धानकाः *dhānakāḥ coins*

Seal-Id	Inscription	Sanskrit		Translation
M-619A		दह	daha	He who burns[√दह् + अच् RV]
H-844A		वदन	vadana	face[ŚBr]
M-190		सदस्य	sadasya	sacrifice attendee[TS]

𑀥 = द · d from 1, 17, 21, 31 (48)

1088 **8.49.** 𑀢 · त · t *from* ताड्य *tāḍya drum*

Seal-Id	Inscription	Sanskrit		Translation
M-228A		मथन	mathana	churn[MBh]
M-459A		तन	tana	offspring[AV]
M-2079A		तद्	tad	there[AV]

𑀢 = त · t from 1, 16, 48 (49)

1089 **8.50.** 𑀫 · म · m *from* मतंग *mataṅga elephant head*

Seal-Id	Inscription	Sanskrit		Translation
M-286a		आनमन	ānamana	saluting[T]
H-921A		त्मन्	tman	the self[RV]

𑀫 = म · m from 1, 7, 29 (50)

1090 **8.51.** 𑀢 · त · t *from* ताडुल *tāḍula fighter*

Seal-Id	Inscription	Sanskrit		Translation
M-1743A		शान्तधर	śānta-dhara	tranquil[MBh] bearer[MBh]
H-1666A		तनाय	tana-āya	gain[MBh] of offspring[AV]

𑀢 = त · t from 1, 2, 4, 13, 21, 39, 48 (51)

8.52. 𑜉 · स · s *from* सप्तन् *saptan seven*

Seal-Id	Inscription	Sanskrit		Translation
M-673		सर	sara	move[√सृ + लोट् 2s.]
Krs-2		समन्	saman	keeping calm[√सम् + शतृँ]
H-9		सम	sama	equal[RV]
H-296		दासमानि	dāsamāni	patronym दासमानः[√दास् + शानच्]

 = स · s from 1, 5, 6, 13, 16, 36, 41 (52)

8.53. ○ · र · r *from* रथारिन् *rathārin variant of wheel* ⊛

Seal-Id	Inscription	Sanskrit		Translation
H-668A		रण	raṇa	joy[RV]
H-841A		ऋणी	ṛṇī	debtor[BG]
H-1951A		रज अश्नन्	raja aśnan	color[√रञ्ज् + लोट् 2s.] while eating[√अश् + शतृँ]

 = र · r from 1, 5, 11, 24, 37 (53)

8.54. 𑜒 · श · s *from* शाखर *śākhāra variant of squirrel* 𑜫

Seal-Id	Inscription	Sanskrit		Translation
H-771		दहस्	dahas	destroyer[√दह् + अच् RV]
M-1202A		दस्रान्तान्	dasra-antān	Dasra's[RV] boundaries[RV]

 = श · s from 1, 22, 30, 31, 48, 53 (54)

1094 **8.55.** [illegible] · प · p *from* पञ्चन् *pañcan hand*

Seal-Id	Inscription	Sanskrit		Translation
H-443A	[illegible]	अमपण	ama-paṇa	powerful[RV] wager[MBh]
H-758A	[illegible]	पान	pāna	drink[RV]
M-967A	[illegible]	(अ)मपरी	(a)ma-parī	attain[AV] power[RV]
H-101a	[illegible]	पर्ण	parṇa	leaf[RV]
D-19655	[illegible]	यजपर	yaja-para	sacrifice[ŚBr] protector[√पृ + अच्]

$$[illegible] = प \cdot p \text{ from } 1, 2, 5, 9, 11, 12, 16, 22, 42, 47 \quad (55)$$

1095 **8.56.** [illegible] · द · d *from* दन्त *danta teeth*

Seal-Id	Inscription	Sanskrit		Translation
M-326c	[illegible]	दधद्	dadhad	wearing[√धा + शतृँ]
H-2336	[illegible]	मादन	mādana	exhilarating[RV]
H-86a	[illegible]	अदन	adana	food[RV]

$$[illegible] = द \cdot d \text{ from } 1, 2, 15, 16, 23, 48 \quad (56)$$

1096 **8.57.** [illegible] · म · m *from* मय *maya horse*

Seal-Id	Inscription	Sanskrit		Translation
H-2024	[illegible]	मंहन	maṃhana	gift[RV]
M-93	[illegible]	मनंजय	manaṃ-jaya	mind[RV] conqueror[RV]

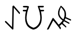
$$[illegible] = म \cdot m \text{ from } 1, 4, 11, 16, 21, 39 \quad (57)$$

1097 **8.58.**  · म · m *from* मत्य *matya harrow*

Seal-Id	Inscription	Sanskrit		Translation
L-52a		आशम्	āśam	food[ŚBr]
M-965a		मनस्वरं	manas-varaṃ	willingly[RV] chosen[RV]

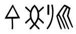
 = म · m from 1, 13, 24, 31, 38 (58)

1098 **8.59.**  · अ · a *from* आजनि *ājani variant of stick* ।

Seal-Id	Inscription	Sanskrit		Translation
M-950a		माखं	mākhaṃ	oblation[Hariv]
M-97A		माय	māya	illusion[MBh]
M-189a		सान	sāna	destruction[√सो + ल्युट्]
L-11a		रवस्रम आनव	ravas-rama ānava	O pleasing[RV] Roarer[RV] O one kind to men[RV]

 = अ · a from 1, 17, 19, 21, 24, 25, 29, 38, 39, 42, 50 (59)

1099 **8.60.**  · ल · l *from* लता *latā creeper*

Seal-Id	Inscription	Sanskrit		Translation
M-13a		दालन	dālana	decay[Suśr]
H-390a		अमलरम	amala-rama	pleasingly pure[AV,MBh]
M-183A		लं मन	laṃ mana	greatly[Vā] pleasing[SBr 5.3.2.3]

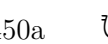
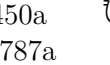
 = ल · l from 3, 4, 9, 16, 19, 23, 27, 35, 58 (60)

1100 **8.61.** 𑀓 · त · t ***from*** ताल ***tāla small cymbal***

Seal-Id	Inscription	Sanskrit		Translation
K-120		जठर	jaṭhara	belly[RV]

𑀓 = त · t from 11, 13 (61)

1101 **8.62.** 𑀅 · अन् · an ***from*** अंशु ***aṃśu variant of drinking vessel*** 𑀁

Seal-Id	Inscription	Sanskrit		Translation
H-450a		जानन् मान	jānan māna	knowing[√ज्ञा + शतृँ] honored[MBh]
M-1787a		अन्वतं	anvataṃ	following[ĀpŚr]

𑀅 = अन् · an from 1, 7, 11, 15, 16, 17, 22, 26 (62)

1102 **8.63.** 𑀀 · अ · a ***from*** अग ***aga mountain***

Seal-Id	Inscription	Sanskrit		Translation
H-139A		अरण	araṇa	foreign[RV]
H-157A		अन्य	anya	inexhaustible[AV]
M-1307a		अदन	adana	eating[√अद् + ल्युट्]

𑀀 = अ · a from 1, 9, 12, 21, 37, 56 (63)

1103 **8.64.** · भ · b *from* भक्षत्र ***bhakṣatra oven***

Seal-Id	Inscription	Sanskrit		Translation
H-136A		मञ्जभर	mañja-bhara	shine[√मञ्ज्] bestower[RV]
M-742A		आभाम् सरा(म्)	ābhām sarā(m)	river[AV] of light[MBh]
M-1777a		सभाम्	sabhām	council[RV]
M-492A		महभण	maha-bhaṇa	mighty[RV] Roarer[√भण् + अच्]

= भ · b from 1, 2, 4, 8, 11, 12, 13, 16, 26, 29, 31, 35, 52 (64)

1104 **8.65.** · ष · s *from* षण् ***ṣaṇ six***

Seal-Id	Inscription	Sanskrit		Translation
H-98A		समन्द्र	sa-mandra	with[RV] pleasantness[RV]
M-1314A		आनहर	āna-hara	(Sarasvati's) nose[RV] severer[MBh]
H-514a		रवस्मय	ravas-maya	Roaring[RV,मयट्]

= ष · s from 1, 6, 12, 13, 16, 17, 19, 21, 23, 26, 41 (65)

1105 **8.66.** · य · y *from* यम ***yama variant of yama***

Seal-Id	Inscription	Sanskrit		Translation
M-1628		नयद	nayada	prudence[R] giver[MBh]
M-1628		रस्य	rasya	savoury[MBh]
M-1628		नस्य	nasya	nasal(breath)[ŚBr]

= य · y from 6, 9, 19, 31, 37 (66)

1106 **8.67.**  · श · s *from* शिखा *śikhā variant of peacock crest* 

Seal-Id	Inscription	Sanskrit		Translation
M-2033A		दशरथ्य	daśa-rathya	ten[RV] chariot horses[RV]
M-1096		अमम् शं	amam-śam	powerful[RV] blessing[RV]

 = श · s from 1, 6, 12, 16, 27, 51, 66 (67)

1107 **8.68.**  · उ · u *from* उद्याम *udyāma coil of rope*

Seal-Id	Inscription	Sanskrit		Translation
M-1773A		उदरं	udaraṃ	belly[RV]
Ad-5A		उदय	udaya	sunrise[ŚBr]

 = उ · u from 1, 21, 42, 56 (68)

1108 **8.69.** · इ · i *from* इषीक *iṣīkā variant of stalk of grass*

Seal-Id	Inscription	Sanskrit		Translation
H-1511		अहि	ahi	Vrta[RV]
M-1632		ईम्प	īmpa	his[RV ईम् = एनम्] protector[RV]
H-2102		ऐ	ai	vocative particle
Luristan		आदिः	ādiḥ	the beginning[ChandUp]

 = इ · i from 4, 8, 16, 24, 48, 55 (69)

1109 **8.70.**  · व · v *from* वरटी *varaṭī wasp*

Seal-Id	Inscription	Sanskrit		Translation
M-212A		वाणिज	vāṇija	merchant[YV] (Shiva)
M-948A		अववज्य	ava-vajya	off[RV] journey[√वज् + ल्यप्]

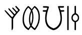
 = व · v from 1, 2, 11, 17, 47, 69 (70)

1110 ### 8.71.  · क · k *from* कृतम् *kṛtam axe*

Seal-Id	Inscription	Sanskrit		Translation
H-3a		अन्नकवष्सभां	anna-kavaṣ-sabhāṃ	open[RV] food[RV] meeting[RV]
M-56A		धक्कः माम् सरन्	dhakkaḥ mām saran	The destroyer[√धक्क् + अच्] moves[√सृ + शतृँ] me
H-1076a		रवाङ्कम्	rava-aṅkam	Roarer's[√रु + अच्] mark[R]
Dholavira Signboard		रकवरारक-अररस्	raka-varāraka-araras	"gem of chosen gems" entrance[Mcar]

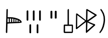
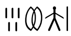
 = क · k from 1,2,17, 18,19,24,25, 27,29,31,35, 37,48,52,53, 62,64,70 (71)

1111 ### 8.72. · क · k *from* कृष *kṛaṣa ploughshare*

Seal-Id	Inscription	Sanskrit		Translation
M-1889A		कान्दर	kāndara	from a valley[R]
H-1987A		वङ्कश्चर	vaṅkas-cara	roam[Bhadrab] about[√चर्]
M-1684a		अक्र	akra	banner[RV]

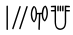
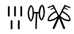
 = क · k from 1, 2, 13, 14, 38, 48, 67 (72)

1112 ### 8.73.  · प · p *from* पञ्चन् *pañcan five*

Seal-Id	Inscription	Sanskrit		Translation
M-1909A		अश्वपन	aśva-vapana	cutting[ŚBr] the horse[RV]
M-1202C		आ-उप	ā-upa	from[RV] above[RV]

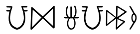
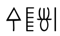
 = प · p from 2, 4, 9, 17, 26, 38, 48, 67 (73)

1113 **8.74.**  · उ · u *from* उपनिहन् *upanihan hammer*

Seal-Id	Inscription	Sanskrit		Translation
M-1822		अनूषा	anu-uṣā	post-dawn[Pāṇ,RV]
M-1180		यूप	yūpa	sacrificial post[RV]

 = उद्याम · u from 1, 2, 21, 31, 73 (74)

1114 **8.75.**  · छ · c *from* छत्त्र *chattra mushroom*

Seal-Id	Inscription	Sanskrit		Translation
H-1148		छन्न	channa	covered[MBh]
M-1129		दहनछदं	dahana-chadaṃ	cremation[BhP] shroud[BhP]
H-530a		अछिन्न	a-chinna	undivided[छिद् + क्त]
H-642		जटधाचला	jaṭa-dhā-acalā	immovable[BG] Shiva[Hariv,RV]

 = छ · c from 1, 2, 3, 4, 5, 6, 11, 23, 37, 41, 45, 60, 61, 67 (75)

1115 **8.76.**  · म · m *from* मृक्ष *mṛkṣa comb*

Seal-Id	Inscription	Sanskrit		Translation
Ghola Dhoro		मान्ददाचल	mānda-acala	gladdening[VS] mountain[MBh]
M-1955		रवसंधृ	rava saṃdhṛ	O Roarer[√रु], O bearer[MBh]

 = म · m from 1, 3, 4, 6, 8, 13, 17, 19, 26, 60, 75 (76)

1116 **8.77.** 𑀪 · भ · b *from* भक्षपत्री *bhakṣapattrī betel leaf*

Seal-Id	Inscription	Sanskrit		Translation
H-1850A	𑀪𑁆𑀭𑀡𑀻	भरणी	bharaṇī	N. stellar mansion[AV]
M-213A	𑀫𑀪𑁆"𑀪𑀸𑀁	मर्व भां	marva bhāṃ	fill with[√मर्व + लोट् 2s.] shining[RV]
H-5a	𑀦𑀝𑀪𑀲𑀸𑀦𑀤	नट दहभसानद	naṭa daha-bhasāna-da	O dancer[MBh], O giver[Pāṇ] of heat[√दह् + अच्] and shine[√भस् + ल्युट्]

𑀪 = भ · b from 1, 5, 6, 9, 13, 17, 24, 29, 31, 42, 51, 57 (77)

1117 **8.78.** 𑀅 · अ · a *from* अङ्क *aṅka variant of curve*)

Seal-Id	Inscription	Sanskrit		Translation
M-331	𑀅𑀪𑀅	आभसा	ā-bhasā	the shining one[RV,√भस्]

𑀅 = अ · a from 43, 77 (78)

1118 **8.79.** 𑀢 · त · t *from* तर्दू *tardū wooden ladles*

Seal-Id	Inscription	Sanskrit		Translation
M-1913	𑀢"𑁆	रवत	ravata	roaring[ĀpŚr]
M-741A	𑀭𑀢	तय	taya	protector[√तय् + अच्]

𑀢 = त · t from 12, 17, 21 (79)

1119 **8.80.** 𑀫 · म · m *from* मन्दार *mandāra churning stick*

Seal-Id	Inscription	Sanskrit		Translation
M-1826a	𑀣𑀫𑁆	दमन	damana	subduer[MBh]
M-1961a	𑀭𑀫"𑁆	रव मर	rava mara	O Roarer, O Killer[√रु + अच्,√मृ + अच्]

𑀫 = म · m from 6, 12, 13, 17, 23 (80)

1120 **8.81.** 𑀓 · क · k *from* कृष *kṛaṣa ploughshare*

Seal-Id	Inscription	Sanskrit		Translation
H-152a		क्षय	kṣaya	dominion[RV]
H-146		अक्षय	akṣaya	undecaying[BG]
M-1419		क्षयी	kṣayī	consumptive[MBh]

𑀓 = क · k from 2, 5, 8, 21 (81)

1121 **8.82.** 𑀥 · ध · d *from* धान *dhāna receptacle*

Seal-Id	Inscription	Sanskrit		Translation
BM-123208		छदास्त	chada-asta	shroud[MBh,ŚBr]
Ch-5A		अनलवदत्तं	ana-lava-dattaṃ	breath[ŚBr] destroyer's[Mn] gift[RV]

𑀥 = ध · d from 1, 8, 17, 30, 41, 51, 60, 75 (82)

1122 **8.83.** 𑀚 · झ · j *from* झञ्झान् *jhañjān rain and wind*

Seal-Id	Inscription	Sanskrit		Translation
M-1308a		चराजषं	cara-a-jaṣaṃ	moving[MBh] immortal[√जष् + अच्]
H-57a		अजाय	ajāya	for Creator[RV]
M-836A		जनि	jani	woman/wife[RV]
M-1848a		जष	jaṣa	killer[√जष् + अच्]

𑀚 = झ · j from 1, 5, 9, 13, 14, 21, 26, 31, 41 (83)

1123 **8.84.** · म · m *from* मृक्ष *mṛkṣa variant of comb*

Seal-Id	Inscription	Sanskrit		Translation
M-648A		आम अंशमान	āma aṃśa-māna	serve[√अम् + लोट् 2p.] portion[RV] preparation[RV]
H-1706A		मल्लवज्र	malla-vajra	strong[MBh] Vajra[RV]
H-6A		भरसादम्	bhara-sādam	carrying[RV] on horseback[RV]
K-40A		दमधरवार	dama-dhara-vāra	householder's[RV,RV] treasure[RV]

= म · m from 1,2,3, 4,11,12, 13,16,17, 20,22,26, 31,41,42, 48,60,82 (84)

1124 **8.85.** · त · t *from* तर्द *tarda Indian blackbird*

Seal-Id	Inscription	Sanskrit		Translation
M-1204		मम अथा	mama athā	mine certainly[Ved]
M-214		रात ऐ	rata ai	O bestowed[RV]
M-1896		तत्र	tatra	there[RV]

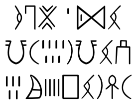
= त · t from 5, 12, 19, 26, 50, 78, 84 (85)

1125 **8.86.** · म · m *from* मत्यय *matya variant of churning stick*

Seal-Id	Inscription	Sanskrit		Translation
M-779		दमन	damana	O Subduer
M-495		मान्याथादस	mānya-atha-adas	honored[RV] surely[RV,AV]

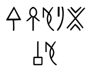
= म · m from 1, 6, 21, 23, 26, 31, 48, 78, 85 (86)

1126 **8.87.** · द · d *from* धन्वन् ***dhanvan variant of bow***

Seal-Id	Inscription	Sanskrit		Translation
H-7a M-159A M-331a		दद एकपदः मदनहान अमादभचाप	dada ekapadaḥ madana-hāna ama-adabha-cāpa	given[Pāṇ] by Viṣṇu[MBh] Kāma[MBh] remover[Gaut] powerful[RV] benevolent[RV] bow[MBh]

= द · d from 1, 6, 14, 15, 20, 25, 26, 36, 41, 45, 52, 55, 73, 78, 80 (87)

1127 **8.88.** · द · d *from* धन्वन् ***dhanvan variant of bow***

Seal-Id	Inscription	Sanskrit		Translation
H-91 M'daro 84-6		कम् दमन दव	kam damana dava	excellent[RV] subduer[MBh] heat[Car]

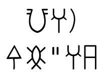
= द · d from 23, 25, 35, 38, 80 (88)

1128 **8.89.** · स · s *from* शिखा ***śikhā variant of***

Seal-Id	Inscription	Sanskrit		Translation
M-1744		धामसादिः	dhāma-sādi	majestic[RV] horseman[MBh]

= स · s from 2, 3, 5, 15, 27, 41, 87 (89)

1129 **8.90.** · म · m *from* मन्दार ***mandāra variant of flower***

Seal-Id	Inscription	Sanskrit		Translation
M-810a M-308A		आमन मम वमन्	āmana mama vaman	affection[TS] my emitting[√वम् + शतृँ]

= म · m from 1, 16, 17, 23, 26, 84 (90)

1130 **8.91.** ⊞ · म · m *from* मन्दिर *mandira dwelling*

Seal-Id	Inscription	Sanskrit		Translation
D-24795	⊞Ʊϕ	उन्नम्	unnam	moist[KātyŚr]

$$⊞ = म \cdot \mathrm{m} \text{ from } 1, 68 \quad (91)$$

1131 **8.92.** ¦¦ · त · t *from* त्र *tra three*

Seal-Id	Inscription	Sanskrit		Translation
H-1711	ƱⵔꞋƱᛁϕ	कान्तदान	kānta-dāna	delightful[GargaS] gift[RV]
H-1713	𝍫‖¦¦◇	रतजय	rata-jaya	pleasing[BhP] victory[RV]
H-351	⁞Ʊ‖)¦¦	तमसानि	tamasāni	dark-colored (pl)[AV]

$$¦¦ = त \cdot \mathrm{t} \text{ from } 1, 2, 5, 11, 12, 31, 35, 47, 48, 72 \quad (92)$$

1132 **8.93.** ⛯ · उ · u *from* उदपान *udapāna well*

Seal-Id	Inscription	Sanskrit		Translation
M-1923	ƱƱ˥ᛡ⛯⁞⁞	शु अपरम्	śu aparam	the future[RV] quickly[Naigh]
M-1224	⁞⁞ᛘ⁞⁞⛯	उस्रीः	usreeḥ	morning-lights[RV]
Unknown	⍏⚲⚵◎⛯‖⛯	उज्झमतं मन	ujjha-matam mana	remember,[√म्ना + लोट् 2s.] relinquishing[Mn] desires[RV]

$$⛯ = उ \cdot \mathrm{u} \text{ from } 1, 4, 5, 11, 13, 16, 23, 42, 50, 55, 61, 65, 80 \quad (93)$$

1133 **8.94.** [illegible] · उ · u *from* उदपान *udapāna variant of well* [illegible]

Seal-Id	Inscription	Sanskrit		Translation
H-720	[illegible]	उन्न	unna	moist[KātyŚr]
H-149	[illegible]	रवम् तुञ्जतर	ravam tuñja-tara	Roarer, the attack protector[Nir]

[illegible] = उ · u from 1, 7, 11, 13, 16, 17, 19, 29, 49 (94)

1134 **8.95.** [illegible] · ए · e *from* एक *eka one*

Seal-Id	Inscription	Sanskrit		Translation
M-1087A	[illegible]	अश्लेषम्	aśleṣam	Hydra constellation[AV]

[illegible] = ए · e from 24, 58, 60 (95)

1135 **8.96.** [illegible] · अस् · as *from* अष्टन् *aṣṭan eight*

Seal-Id	Inscription	Sanskrit		Translation
M-283A	[illegible]	अशर	aśara	unwounded[W]
H-818	[illegible]	अश्मन्	aśman	sky[RV]

[illegible] = अस् · as from 1, 13, 40 (96)

1136 **8.97.** [illegible] · न · n *from* नव *nava nine*

Seal-Id	Inscription	Sanskrit		Translation
H-4a	[illegible]	अन्तम	antama	nearest[RV]
Dholavira	[illegible]	नय	naya	leading[R]
H-23a	[illegible]	नरहान	nara-hāna	departed[VS] man[TS]

[illegible] = न · n from 1, 7, 13, 16, 21, 22, 26, 39 (97)

1137 **8.98.** [illegible] · र · r *from* रथ *ratha variant of chariot* [illegible]

Seal-Id	Inscription	Sanskrit		Translation
H-24a	[illegible]	मञ्ज शरण	mañja śaraṇa	refuge[RV] O Roarer[√मञ्ज् + अच्]
M-255a	[illegible]	मरण	maraṇa	death[MBh]
M-1366A	[illegible]	तर शतम्	tara śatam	a hundred[RV], O Rudra[MBh]

[illegible] = र · r from 1, 7, 8, 11, 16, 29, 39 (98)

1138 **8.99.** [illegible] · य · y *from* यष्टि *yaṣṭi pearl necklace*

Seal-Id	Inscription	Sanskrit		Translation
H-465A	[illegible]	आयान	āyana	arrival[RV]
M-324b	[illegible]	यान	yāna	leading[RV]
M-99A	[illegible]	रान्नव्यं	rān-navyaṃ	giving[√रा + शतृँ] praise[RV]

[illegible] = य · y from 1, 2, 4, 9, 12, 17 (99)

1139 **8.100.** [illegible] · म · m *from* मृक्ष *mṛkṣa variant of comb* [illegible]

Seal-Id	Inscription	Sanskrit		Translation
H-1051	[illegible]	रवासमद्समानि	ravā asamad-samānī	O roarer, the calm[SBr] and equable one[RV]

[illegible] = म · m from 1, 5, 6, 12, 17, 24, 36, 52 (100)

1140 **8.101. · य · y *from* यष्टि *yaṣṭi twig; arm***

Seal-Id	Inscription	Sanskrit		Translation
M-290a		यमी	yamī	(Yama's) twin sister[RV]
H-1922		असमामम् यानि	asama-amam yāni	unequalled[Mn] path[TS] of power[RV]

= य · y from 1, 5, 16, 24, 27, 57, 100 (101)

1141 **8.102. · त · t *from* तर्दू *tardū variant of wooden ladles***

Seal-Id	Inscription	Sanskrit		Translation
H-90A		पश्यन्तः	paśyantaḥ	onlookers[RV]
C-6		आव आमान तत्र	āva āmāna tatra	go[√अव् + लोट् 2p.] there[RV] to[RV] honor[RV]

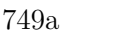
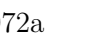
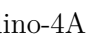
= त · t from 1, 2, 4, 9, 12, 16, 17, 24, 26, 55, 63, 78, 101 (102)

1142 **8.103. · झ · j *from* झर *jhara variant of rain; waterfall***

Seal-Id	Inscription	Sanskrit		Translation
M-1691a		जन्ममाखं	janma-mākhaṃ	birth[RV] oblation[Hariv]
K-30A		जज	jaja	warrior[Śiś]

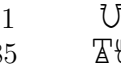
= झ · j from 1, 16, 25, 50, 59, 83 (103)

1143 **8.104.** 𒀸 · ग · g ***from*** गाधन ***gādhana arrow***

Seal-Id	Inscription	Sanskrit		Translation
H-1924A		गजः	gajaḥ	elephant[Mn]
M-1749a		गदाश्म	gadā-aśma	club[MBh] of stone[Pāṇ]
M-972a		गान	gāna	song[Śiś]
Allahdino-4A		घनामाहां	ghanā-māhāṃ	great[MBh] destroyer[RV]

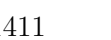
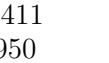
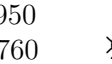
𒀸 = ग · g from 1, 2, 3, 4, 11, 16, 24, 27, 52, 63, 67 (104)

1144 **8.105.** 𒁲 · म · m ***from*** मत्य ***matya club***

Seal-Id	Inscription	Sanskrit		Translation
M-1850a		रवनमन	rava-namana	bowing[Śiś] to Roarer[√रु + अच्]
H-391		दमाममान	dama-ama-māna	this[RV] honored[MBh] house[RV]
M-285		रवमच्छम्	ravam-accham	towards[Ved] the Roarer[√रु + अच्]

𒁲 = म · m from 1, 2, 6, 12, 16, 17, 27, 28, 35, 75 (105)

1145 **8.106.** 𒄑 · म · m ***from*** मन्दार ***mandāra a flower***

Seal-Id	Inscription	Sanskrit		Translation
H-1411		समान	samāna	uniform[RV]
H-950		शमशम	śamaśama	perpetually tranquil[MBh]
M-760		मनस्थम्	manas-stham	stilled[RV] mind[RV]

𒄑 = म · m from 1, 8, 16, 30, 31, 52, 67 (106)

1146 **8.107.** 𑁍 · स · s *from* शाण *śāṇa weight of four*

Seal-Id	Inscription	Sanskrit		Translation
M-260A H-472a	 	रवसमान रसाभं	rava-samāna rasa-ābhaṃ	like[RV] the Roarer[√रु + अच्] essence[RV] of beauty[MBh]

𑁍 = स · s from 1, 4, 12, 16, 17, 19, 26, 64 (107)

1147 **8.108.** 𑁌 · अस् · as *from* अष्टपाद *aṣṭapāda spider variant of* 𑁋

Seal-Id	Inscription	Sanskrit		Translation
M-628a		आशक लवमहान्	āśaka lava-mahān	O bestower[RV] O great reaper[MBh,RV]
H-1708A		असत्त्व	asattva	non-presence[Nyāyam]
M-1262a		बभ अश्नचर	babha aśna-cara	illumined[√भा + लिट 2s.] the moving[Mn] clouds[Naigh]

𑁌 = अस् · as from 1, 13, 14, 16, 17, 24, 25, 38, 41, 49, 60, 64 (108)

1148 **8.109.** 𑁎 · त · t *from* तण्डुल *taṇḍula rice plant*

Seal-Id	Inscription	Sanskrit		Translation
B-28 D-26514	 	चलत यतानाः	calata yatānā[ḥ]	move[√चल् + लोट् 2p.] efforts[RV]

𑁎 = त · t from 1, 4, 21, 60, 75 (109)

1149 **8.110.** ⋀ · स · s ***from*** शिखर ***śikhara mountaintop***

Seal-Id	Inscription	Sanskrit		Translation
Ns-79		वहस्	vahas	bearing[MBh]
M-2063		शाण	śāṇa	hempen[ŚBr]

⋀ = स · s from 1, 4, 17, 31 (110)

1150 **8.111.** ↑ · स · s ***from*** शिखर ***śikhara variant of mountaintop*** ⋀

Seal-Id	Inscription	Sanskrit		Translation
M-264a		शहम्	saham	mighty[RV]
L-98A		सहत्मन्	sahat-man	mighty[RV]
M-1709a		रवमहम्	rava-maham	mighty[RV] Roarer[√रु + अच्]

↑ = स · s from 1, 12, 16, 17, 23, 30, 91 (111)

1151 **8.112.** ↑ · स · s ***from*** शिखर ***śikhara variant of mountaintop*** ↑

Seal-Id	Inscription	Sanskrit		Translation
H-1920		अदशन्	adaśan	not ten[ŚBr]
H-2575		वश	vaśa	O power[AV]

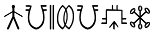
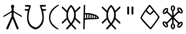
↑ = स · s from 1, 3, 4, 70 (112)

1152 **8.113.** ᔓ · ल · l ***from*** लता ***latā creeper***

Seal-Id	Inscription	Sanskrit		Translation
M-751A		ललक	lalaka	playful[W] happiness[ChUp]
Dholavira		कमलास्र	kamala-asra	red[TS] blood[Ragh]

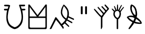
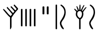
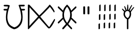
ᔓ = ल · l from 13, 24, 25, 35 (113)

1153 **8.114.**  · श · s *from* शिखा *śikhā peacock crest*

Seal-Id	Inscription	Sanskrit		Translation
M-241a		सभं दहन	sabhaṃ dahana	the council[RV], O Rudra[MatsyaP]
M-1674a		शर्व मनमान	śarva mana-māna	O Shiva[AV], O greatly[Vā] honored[MBh]

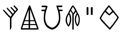
 = श · s from 1, 4, 9, 12, 16, 17, 31, 48, 64, 78 (114)

1154 **8.115.**  · म · m *from* मन्दार *mandāra variant of flower* 

Seal-Id	Inscription	Sanskrit		Translation
M-34A		तम्रवस्मन्	tamra-vasman	red[VS] covering[RV]
M-1823A		अमावचर	ama-avacara	domain[Buddh] of power[RV]
M-43a		मज्ज व महान्	majja va mahān	submerge[MBh] like the great one[MBh]

 = म · m from 1, 2, 13, 14, 16, 17, 24, 34, 39, 40, 83, 109 (115)

1155 **8.116.**  · व · v *from* वटी *vaṭī banyan tree*

Seal-Id	Inscription	Sanskrit		Translation
M-1159		स्ववशं नमन	svavaśaṃ namana[ṃ]	willing[MBh] respects[MārkP]
M-101		रव वनार	rava vānara	O Roarer[√रु + अच्], O forest dweller[Mn]

 = व · v from 1, 12, 13, 16, 17, 28, 31, 63 (116)

1156 **8.117.** [illegible] · र · r *from* रथदारु *rathadāru variant of Dalbergia* [illegible]

Seal-Id	Inscription	Sanskrit		Translation
M-1773	[illegible]	उदरं	udaraṃ	belly[RV]
M-1514	[illegible]	रण	raṇa	joy[RV]
M-1275	[illegible]	अहसम् परम्	ahasam param	first[MBh] day[RV]

[illegible] = र · r from 1, 16, 24, 31, 55, 56, 68 (117)

1157 **8.118.** [illegible] · स · s *from* श्येन *śyena falcon*

Seal-Id	Inscription	Sanskrit		Translation
M-222a	[illegible]	मयस्	mayas	delight[RV]
M-6	[illegible]	सन्नरर	san-arara	existing[√अस् + शतॄ] door[Mcar]

[illegible] = स · s from 9, 12, 19, 50, 101 (118)

1158 **8.119.** ⌒ · त · t *from* ताल *tāla variant of cymbal* [illegible]

Seal-Id	Inscription	Sanskrit		Translation
M-2118	[illegible]	हय च पत	haya ca pata	roarer[√हय् + अच्] and master[√पत् + अच्]

⌒ = त · t from 8, 14, 21, 73 (119)

1159 **8.120.** [illegible] · अस् · as *from* अष्टपाद *aṣṭapāda variant of spider* [illegible]

Seal-Id	Inscription	Sanskrit		Translation
M-976	[illegible]	रणाक्ष	raṇa-akṣa	eye[RV] of Roarer[Pur]

[illegible] = अस् · as from 9, 12, 25, 41 (120)

1160 **8.121.** · अस् · as *from* अष्टपाद *aṣṭapāda variant of spider*

Seal-Id	Inscription	Sanskrit		Translation
M-1975		दासवारम्	dāsa-varam	dāsa[RV] restrainer[RV]

= अस् · as from 1, 6, 38, 41, 117 (121)

1161 **8.122.** · ओ · o *from* ओपश *opaśa tuft of hair*

Seal-Id	Inscription	Sanskrit		Translation
H-1924		ओजस्	ojas	vigour[RV]

= ओ · o from 11, 24 (122)

1162 **8.123.** · र · r *from* रथदारु *rathadāru variant of Dalbergia*

Seal-Id	Inscription	Sanskrit		Translation
H-1522		ररर	ra-ra-ra	possessing[Naiṣ]
L-45		तनामनामन् पर	tana-ama-nāman para	love and desire fulfill[पृ + लोट् 2s.] the mark[RV] of the destroyer[√तन् + अच्]

= र · r from 1, 16, 27, 28, 49, 55 (123)

1163 **8.124.** · व · v *from* वात्र *vātra loom* √वे + ष्ट्रन्

Seal-Id	Inscription	Sanskrit		Translation
M-899		व्यय	vyaya	sacrifice[R]

= व · v from 21 (124)

9. Derivation Sequence

	Phoneme			Reconstructed Name		
1		अन्	an	अंशु	aṃśu	soma drink
2		अ	a	आजनि	ājani	stick
3		द	d	धन्वन्	dhanvan	bow
4		अ	a	आयु	āyu	man
5		इ	i	इषीक	iṣīkā	stalk of grass
6		द	d	धन्वन्	dhanvan	variant of bow
7		त	t	ताडुल	taḍula	variant of fighter
8		श	s	शुक्र	śukra	seed
9		न	n	नाल	nāla	stalk
10		ई	ī	इइ	ī	long i
11		ज	j	झर	jhara	waterfall; cascade
12		र	r	रथ	ratha	chariot
13		र	r	रथर्वी	ratharvī	multi/split snake
14		च	c	चतुर्	catur	four
15		अ	a	अजशृङ्गी	ajaśṛṅgī	goat's horn
16		म	m	मत्स्य	matsya	fish
17		व	v	वि	vi	two
18		र	r	रथ	ratha	variant of ratha
19		र	r	रथारिन्	rathārin	chariot wheel
20		ब	b	भक्षपत्री	bhakṣapattrī	betel leaf
21		य	y	यवश्रेष्ठि	yavaśreṣṭhi	grain merchant
22		अ	a	आयु	āyu	variant of
23		न	n	नालीका	nālīka	arrow
24		अस्	as	अष्टपाद	aṣṭapāda	eight legged; spider
25		क	k	कृतम्	kṛtam	dice
26		अ	a	अङ्क	aṅka	curve
27		अम	ama	अङ्क + मत्स्य	ama	conjunct curve + fish
28		न	n	नाल	nāla	reed
29		अन्	n	अंशु	aṃśu	lamp
30		त	t	तर्दू	tardū	variant of wooden ladles
31		स	s	सोपान	sopāna	ladder
32		अ	a	अङ्क	aṅka	boldface variant of curve
33		अ	a	अङ्क	aṅka	variant of curve
34		अ	a	अङ्क	aṅka	variant of curve
35		म	m	मन्थ	mantha	firesticks
36		म	m	मृक्ष	mṛkṣa	variant of comb
37		न	n	नाल	nāla	mat of reeds
38		व	v	वर्ती	vartī	lamp wick
39		श	s	शाखर	śākhāra	squirrel
40		म	m	मन्दिर	mandira	dwelling
41		अ	a	अयुग	ayuga	one
42		र	r	रथदारु	rathadāru	Dalbergia tree
43		स	s	शिखर	śikhara	mountaintop

	Phoneme			Reconstructed Name		
44		ह	h			स = ह
45		द	d	धानकाः	dhānakāḥ	variant of coins
46		र	r	रथर्वी	ratharvī	multi/split snake
47		य	y	यव	yava	barley
48		द	d	धानकाः	dhānakāḥ	coins
49		त	t	ताड्य	tāḍya	drum
50		म	m	मतंग	mataṅga	elephant head
51		त	t	ताडुल	tāḍula	fighter
52		स	s	सप्तन्	saptan	seven
53		र	r	रथारिन्	rathārin	variant of wheel
54		श	s	शाखर	śākhāra	variant of squirrel
55		प	p	पञ्चन्	pañcan	hand
56		द	d	दन्त	danta	teeth
57		म	m	मय	maya	horse
58		म	m	मत्य	matya	harrow
59		अ	a	आजनि	ājani	variant of stick
60		ल	l	लता	latā	creeper
61		त	t	ताल	tāla	small cymbal
62		अन्	an	अंशु	aṃśu	variant of drinking vessel
63		अ	a	अग	aga	mountain
64		भ	b	भक्षत्र	bhakṣatra	oven
65		ष	s	षण्	ṣaṇ	six
66		य	y	यम	yama	variant of yama
67		श	s	शिखा	śikhā	variant of peacock crest
68		उ	u	उद्याम	udyāma	coil of rope
69		इ	i	इषीक	iṣīkā	variant of stalk of grass
70		व	v	वरटी	varaṭī	wasp
71		क	k	कृतम्	kṛtam	axe
72		क	k	कृष	kṛaṣa	ploughshare
73		प	p	पञ्चन्	pañcan	five
74		उ	u	उपनिहन्	upanihan	hammer
75		छ	c	छत्र	chattra	mushroom
76		म	m	मृक्ष	mṛkṣa	comb
77		भ	b	भक्षपत्री	bhakṣapattrī	betel leaf
78		अ	a	अङ्क	aṅka	variant of curve)
79		त	t	तर्दू	tardū	wooden ladles
80		म	m	मन्दार	mandāra	churning stick
81		क	k	कृष	kṛaṣa	ploughshare
82		ध	d	धान	dhāna	receptacle
83		झ	j	झञ्झान्	jhañjān	rain and wind
84		म	m	मृक्ष	mṛkṣa	variant of comb
85		त	t	तर्द	tarda	Indian blackbird
86		म	m	मत्यय	matya	variant of churning stick
87		द	d	धन्वन्	dhanvan	variant of bow
88		द	d	धन्वन्	dhanvan	variant of bow
89		स	s	शिखा	śikhā	variant of

	Phoneme			Reconstructed Name		
90		म	m	मन्दार	mandāra	variant of flower
91		म	m	मन्दिर	mandira	dwelling
92		त	t	त्र	tra	three
93		उ	u	उदपान	udapāna	well
94		उ	u	उदपान	udapāna	variant of well
95		ए	e	एक	eka	one
96		अस्	as	अष्टन्	aṣṭan	eight
97		न	n	नव	nava	nine
98		र	r	रथ	ratha	variant of chariot
99		य	y	यष्टि	yaṣṭi	pearl necklace
100		म	m	मृक्ष	mṛkṣa	variant of comb
101		य	y	यष्टि	yaṣṭi	twig; arm
102		त	t	तर्दू	tardū	variant of wooden ladles 
103		झ	j	झर	jhara	variant of rain; waterfall
104		ग	g	गाधन	gādhana	arrow
105		म	m	मत्य	matya	club
106		म	m	मन्दार	mandāra	a flower
107		स	s	शाण	śāṇa	weight of four
108		अस्	as	अष्टपाद	aṣṭapāda	spider variant of
109		त	t	तण्डुल	taṇḍula	rice plant
110		स	s	शिखर	śikhara	mountaintop
111		स	s	शिखर	śikhara	variant of mountaintop 
112		स	s	शिखर	śikhara	variant of mountaintop
113		ल	l	लता	latā	creeper
114		श	s	शिखा	śikhā	peacock crest
115		म	m	मन्दार	mandāra	variant of flower
116		व	v	वटी	vaṭī	banyan tree
117		र	r	रथदारु	rathadāru	variant of Dalbergia
118		स	s	श्येन	śyena	falcon
119		त	t	ताल	tāla	variant of cymbal
120		अस्	as	अष्टपाद	aṣṭapāda	variant of spider
121		अस्	as	अष्टपाद	aṣṭapāda	variant of spider
122		ओ	o	ओपश	opaśa	tuft of hair
123		र	r	रथदारु	rathadāru	variant of Dalbergia
124		व	v	वात्र	vātra	loom √वे + ष्ट्रन्

10. Conclusion

The ability to read well beyond the unicity distance alone should be sufficient proof of correct decipherment of the Indus script. This decipherment has many additional compelling attributes. This is the only cryptanalytic decipherment and the only one that uses well-established mathematical models and methods instead of guessing sign values based on their appearance. This decipherment is the only full decipherment and the only one where every sign and every stroke has been resolved, the only one that is programmatically reproducible, the only one where the decipherment can be followed sign-by-sign by the reader, the only decipherment that reads Semitic and mixed inscriptions in addition to native IVC inscriptions, the only one that reads over 500 inscriptions including all 50 longest inscriptions grammatically correctly in an attested language, the only one that validates research spanning almost a century from Hunter to Heggarty. In addition, we have uncovered a remarkable number of additional evidence such as reconstructed names of the signs, reasons for their allographs, and the clear correspondence of derived sound values to known Brahmi values. We also show how the constraints and habits of the Indus script carry on to Brahmi inscriptions of the early historic era. Such a strong result is a first in any ancient script decipherment and should be taken as plenary proof of decipherment of the Indus script.

11. Data Availability Statement

A programmatic decipherment of the first 40 signs is openly available in the GitHub repository at https://github.com/yajnadevam/ScriptDerivation. This paper uses the Indus script font from the National Fund for Mohenjodaro under open license(Kumbhar and Buriro, 2017). Brahmi and Devanagari fonts are from Google Fonts under Open Font license(Google, 2021, 2022). Adinata font for Tamil Brahmi is under Open Font license (Rajan, Sharma, and Sankar, 2021). The Indus corpus reference used is Interactive Corpus of Indus Text(Wells and Fuls, 2023). Corpus of Indus seals and inscriptions volumes are also the primary reference(Parpola et. al., 1991). Rigveda translations in section 5 are from Griffith(Griffith, 1896). The dictionary used for decipherment derivation is the downloadable Monier-Williams dictionary(Monier-Williams, 1899b). Attestation data of individual words are from Monier-Williams dictionary(Monier-Williams, 1899b), the Purana Index(Dikshitar, 1955) and Wisdomlib(Hiemstra, 2023).

12. Disclosure Statement

The authors report there are no competing interests to declare.

References

Ahmed, Mukhtar. 2014. *Ancient Pakistan - An Archaeological History: Volume II: A Prelude to Civilization*. Foursome Group. https://books.google.com/books?id=HbvTBAAAQBAJ&pg=PA364#v=onepage&q&f=false.

Aniket Anand, Deshmukh, and Soumya Jana. 2013. "Chronology of Sanskrit texts: An information-theoretic corroboration." In *2013 National Conference on Communications (NCC)*, 1–5. https://web.archive.org/web/20160806054822id_/http://www-personal.umich.edu:80/~aniketde/NCC%20paper.pdf.

Ashraf, M, and S Sinha. 2018. "The "handedness" of language: Directional symmetry breaking of sign usage in words." *PLOS one* 1–16. https://doi.org/10.1371/journal.pone.0190735.

ASI. 1906. *Archaeological Survey Of India Annual Report 1903-4*. Government Printing, India. https://archive.org/details/in.ernet.dli.2015.207529/page/n195/mode/2up?view=theater.

ASI. 2004. *Indian Archaeology 1998-1999 - A review*. Archaeological Survey of India. https://web.archive.org/web/20120508064754/http://asi.nic.in/nmma_reviews/Indian%20Archaeology%201998-99%20A%20Review.pdf.

Association Assyrophile de France. 2006. "Sureth Dictionary." https://www.assyrianlanguages.org/akkadian/list.php.

Azad, Uma Shankar. 2020. "Seals and Sealings of Pataliputra (From the Maurya Period up to the Gupta Period)." *Heritage: Journal of Multidisciplinary Studies in Archaeology* 632–647. http://www.heritageuniversityofkerala.com/JournalPDF/Volume8.2/37.pdf.

Bacon, Roger. 1401-1599. "Voynich manuscript." https://collections.library.yale.edu/catalog/2002046?child_oid=1006204.

Balasubramaniam, R. 2005. *Story of the Delhi Iron pillar*. Foundation Books pvt Ltd. https://books.google.com/books?id=FruHOlKlbJAC.

Banerjee, N. R., and Soundara K. V. Rajan. 1960. "Sanur 1950, 1952: A megalithic site in district Chingleput." *Ancient India* 15: 2–28. https://asi.nic.in/Ancient_India/Ancient_India_Volume_15/article_1.pdf.

BBC. 1999. "'Earliest writing' found." Last accessed 18 March 2022, https://web.archive.org/web/20220318234228/http://news.bbc.co.uk/2/hi/sci/tech/334517.stm.

Bhatt, S. K. 1998. *Nishka-the Rig Vedic Money*. Academy of Indian Numismatics and Sigillography.

Bonta, Steven. 2023. "A Partial Decipherment of the Indus Valley Script: Proposed Phonetic and Logographic Values for Selected Indus Signs and Readings of Indus Texts." *academia.edu* https://web.archive.org/web/20230913171235/https://www.academia.edu/105163460/A_Partial_Decipherment_of_the_Indus_Valley_Script_Proposed_Phonetic_and_Logographic_Values_for_Selected_Indus_Signs_and_Readings_of_Indus_Texts.

CDLI. 2023. "The CDLI Collection." https://cdli.ucla.edu/.

Cinque, Guglielmo. 1999. *Adverbs and Functional Heads*. Oxford University Press. https://www.academia.edu/58433772/Adverbs_and_Functional_Heads.

CoinIndia. 2010. "The Coin Galleries: Mauryan Empire." http://coinindia.com/galleries-maurya.html.

Danino, Michael. 2006. "THE HORSE AND THE ARYAN DEBATE." *Journal of Indian History and Culture* September 2006 (13): 33–59. https://www.researchgate.net/publication/237413669_THE_HORSE_AND_THE_ARYAN_DEBATE.

Devi, Yashoda. 1933. *The history of Andhra country (1000 AD - 1500 AD)*. Gyan Publishing House.

Dikshitar, Ramachandra. 1955. "The Purana Index." https://www.sanskrit-lexicon.uni-koeln.de/scans/PUIScan/2020/web/index.php.

Dixit, K. N. 2019. "Origin of Early Harappan Cultures in the Sarasvati Valley: Recent Archaeological Evidence and Radiometric Dates." *Journal of Indian Ocean Archaeology* 88–141. https://web.archive.org/web/20170118032736/http://server2.docfoc.com/uploads/Z2015/11/21/vESLakMBYz/45a03572f94e7a873d7c350293cca188.pdf.

Ephron, H. D. 1961. “MYCENAEAN GREEK: A LESSON IN CRYPTANALYSIS.” *Minos: Revista de Filología Egea* 63–100. https://revistas.usal.es/dos/index.php/0544-3733/article/view/2088/2140.

Gelb, I. J. 1957. *Glossary of old Akkadian*. University of Chicago Press. https://isac.uchicago.edu/sites/default/files/uploads/shared/docs/mad3.pdf.

George, Andrew. 2003. “CUNEIFORM INSCRIPTION OF DEFEAT OF OMAN and INDUS VALLEY.” https://www.schoyencollection.com/history-collection-introduction/sumerian-history-collection/cuneiform-indus-valley-ms-2814.

George Lasry, Norbert Biermann, and Satoshi Tomokiyo. 2023. “Deciphering Mary Stuart’s lost letters from 1578-1584.” *Cryptologia* 47 (2): 101–202. https://-doi.org/10.1080/01611194.2022.2160677, https://doi.org/10.1080/01611194.2022.2160677.

Goibhniu. 2007. “Perl uses for Cryptograms - Part 1: One-liners and Word Patterns.” https://web.archive.org/web/20170223171834/https://www.perlmonks.org/?node_id=636818.

Google. 2021. “Noto Serif Devanagari font.” This work is licensed under the Open Font Licence. To view a copy of this license, visit https://scripts.sil.org/cms/scripts/page.php?site_id=nrsi&id=OFL, https://fonts.google.com/noto/specimen/Noto+Serif+Devanagari/about.

Google. 2022. “Noto Sans Brahmi font.” This work is licensed under the Open Font Licence. To view a copy of this license, visit https://scripts.sil.org/cms/scripts/page.php?site_id=nrsi&id=OFL, https://fonts.google.com/noto/specimen/Noto+Sans+Brahmi/about.

Griffith, Ralph T. H. 1896. *The Hymns of the Rigveda*. Munshiram Manoharlal Publ. Vedaweb version https://vedaweb.uni-koeln.de/rigveda/view/index/0, http://www.sanskritweb.net/rigveda/griffith.pdf.

Haryana Directorate of Archaeology and Museums. 2023. “Excavation Sites A and M.” https://web.archive.org/web/20230330043817/http://archaeologyharyana.nic.in/sites/default/files/Excavation%20sites%20A%20and%20M.pdf.

Heggarty, Paul, Cormac Anderson, Matthew Scarborough, Benedict King, Remco Bouckaert, Lechosław Jocz, Martin Joachim Kümmel, et al. 2023. “Language trees with sampled ancestors support a hybrid model for the origin of Indo-European languages.” *Science* 381 (6656): eabg0818. https://doi.org/10.1126/science.abg0818, https://www.science.org/doi/abs/10.1126/science.abg0818.

Hiemstra, Gabe. 2023. “Wisdom Library.” https://wisdomlib.org.

Hultzsch, E. 1925. *Inscriptions of Asoka*. Clarendon Press. https://archive.org/details/InscriptionsOfAsoka.NewEditionByE.Hultzsch/page/n110/mode/1up?view=theater.

Hunter, G. R. 1934. *The script of Harappana and Mohenjodaro and its connection with other scripts*. Kegan Paul, Trench, Trubner & Co Ltd. https://ufdc.ufl.edu/AA00013642/00001.

IndMuseum. 5th Century. “Terracotta sealing.” https://indianculture.gov.in/artefacts-museums/sealing-397.

Jayaswal, K. P. 1933. “The Vikramkhol inscription.” *Indian Antiquary: A Journal Of Oriental Research* 62: 58–60. https://archive.org/details/in.ernet.dli.2015.537235.

Kak, Subhash. 1988. “A Frequency analysis of the Indus script.” *Cryptologia* 129–142. https://www.ece.lsu.edu/kak/IndusFreqAnalysis.pdf.

Knight, Kevin, Beáta Megyesi, and Christiane Schaefer. 2011. “The Copiale Cipher.”

Association for Computational Linguistics 2–9. https://web.archive.org/web/20111112013300/http://www.aclweb.org/anthology-new/W/W11/W11-12.pdf#page=12.

Konasukawa, Ayumu. 2020. "https://www.youtube.com/watch?v=UWNzMDfN28I." .

Kumbhar, Shabir, and Amar Fayaz Buriro. 2017. "Indus script font." License "Indus Script font is available to be downloaded for further studies, computational exercises and statistical analysis, free of charge; the only encumbrance is that user acknowledge our website.", https://web.archive.org/web/20210308035522/http://www.mohenjodaroonline.net/index.php/indus-script/corpus-by-asko-parpola.

Lahafian, Jamal. 2013. "Rock Art in Kurdistan Iran." https://www.researchgate.net/publication/276033365_Rock_Art_in_Kurdistan_Iran.

Lal, B. B. 1960. "From the Megalithic to the Harappa: tracing back the grafitti on the pottery." *Ancient India* 16: 4–24. https://asi.nic.in/Ancient_India/Ancient_India_Volume_16/article_1.pdf.

Lashari, K., Sindh (Pakistan). Department of Culture, Tourism, and Sindh Archives. 2020. *Studies on Indus Cript: Conference on Indus Script Mohenjodaro 2020*. National Fund for Mohenjodaro, Culture, Tournism, Antiquities and Archives Department, Government of Sindh. https://books.google.com/books?id=gjWCzwEACAAJ.

Laursen, Steffen Terp. 2010. "The westward transmission of Indus Valley sealing technology: origin and development of the 'Gulf Type' seal and other administrative technologies in Early Dilmun, c.2100–2000 BC." *Arabian archaeology and epigraphy* 96–134. https://onlinelibrary.wiley.com/doi/10.1111/j.1600-0471.2010.00329.x.

Lien, L. T. 2013. "Brahmi Inscription from Archaeological Sites in Southern Vietnam during the 1st Millennium CE." *Advancing Southeast Asian Archaeology* 402. https://publications.spafajournal.org/index.php/spafapub/catalog/view/37/53/158-1.

Mahadevan, Iravatham. 1977. *The Indus Script*. Archaeological Survey of India. https://archive.org/34/items/TheIndusScript.TextConcordanceAndTablesIravathanMahadevan/The%20Indus%20Script.%20Text%2C%20Concordance%20and%20Tables%20-Iravathan%20Mahadevan.pdf.

Mahadevan, Iravatham. 2010. "Akam and Puram : 'Address' Signs of the Indus Script." https://rmrl.in/wp-content/uploads/42-Akam-and-Puram.pdf.

MetMuseum. 6th CE. "Impression from a Property Seal." https://www.metmuseum.org/art/collection/search/77782.

Monier-Williams. 1899a. "Monier-Williams dictionary Sanskrit abbreviations." https://en.wiktionary.org/wiki/Appendix:Sanskrit_abbreviations.

Monier-Williams. 1899b. "Monier-Williams Sanskrit-English Dictionary, 1899." https://www.sanskrit-lexicon.uni-koeln.de/scans/MWScan/2020/web/index.php.

Moreno, Marsha Lynn. 2005. "Frequency Analysis in Light of Language Innovation." https://mathweb.ucsd.edu/~crypto/Projects/MarshaMoreno/TimeComparisonFrequency.pdf.

Munjal, Sanjay, and Arvin Munjal. 2005. "(Brahmi inscription on Anthropomorphic figure)." *Prāgdhārā* .

Neumayer, Erwin. 2020. "Chariots in the Chalcolithic Rock Art of Indian." https://www.harappa.com/sites/default/files/pdf/WHEELS%20in%20Indian%20Rock%20Art%20Erwin%20Neumayer.pdf.

Parpola, Asko. 1994. *Deciphering the Indus script*. Cambridge University Press.

Parpola, Simo, Asko Parpola, and Robert H. Brunswig Jr. 1977. "The Meluḫḫa Village: Evidence of Acculturation of Harappan Traders in Late Third Millennium

Mesopotamia?" *Journal of the Economic and Social History of the Orient* 20 (2): 129–165. http://www.jstor.org/stable/3631775.

Parpola et. al. 1991. *Corpus of Indus seals and inscriptions, Vol 1,2,3.1,3.2,3.3*. Suomalainen Tiedeakatemia.

Peters et al. 2022. "The biocultural origins and dispersal of domestic chickens." *PNAS* 119 (24). https://www.pnas.org/doi/pdf/10.1073/pnas.2121978119.

Raghupathy, P. 1987. *Early settlements in Jaffna: An archaeological survey*. P. Raghupathy.

Rajan, Vinod, Shriramana Sharma, and Udhaya Sankar. 2021. "Adinatha Tamil-Brahmi font." This work is licensed under the Open Font Licence. To view a copy of this license, visit https://scripts.sil.org/cms/scripts/page.php?site_id=nrsi&id=OFL, http://www.virtualvinodh.com/projects/adinatha.

Ramakrishna, K. A., N. K Swain, M. Rajesh, and N. Veeraraghavan. 2018. "Excavations at Keeladi, Sivaganga District, Tamil Nadu (2014 - 2015 and 2015 - 16)." *Heritage: Journal of Multidisciplinary Studies in Archaeology 6* 30–72. http://www.heritageuniversityofkerala.com/JournalPDF/Volume6/2.pdf.

Rao, Rajesh P. N., Nisha Yadav, Mayank N. Vahia, Hrishikesh Joglekar, R. Adhikari, and Iravatham Mahadevan. 2009. "A Markov model of the Indus script." *Proceedings of the National Academy of Sciences* 106 (33): 13685–13690. https://doi.org/10.1073/pnas.0906237106, https://www.pnas.org/doi/abs/10.1073/pnas.0906237106.

Rao, S. R. 1980. "Indus script and language." *Annals of the Bhandarkar Oriental Research Institute* 61: 157–188.

Reddy, Bhaskar, and V. Sakunthalamma. 2023. "Indian Numismatics: Punchmarked Coins of the Janapadas." https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000829IC/P001738/M028921/ET/1523266853P09-M04-PunchMarkedCoinsoftheJanapadas-ET.pdf.

Shannon, C. 1945. *A Mathematical Theory of Cryptography*. Alcatel-Lucent. https://www.iacr.org/museum/shannon/shannon45.pdf.

Sheehan, John. 2009. "'A peacock's tale: excavations at Caherlehillan, Iveragh, Ireland." *The Archaeology of the Early Medieval Celtic Churches* 191–206. https://www.academia.edu/3123538/The_Peacock_s_Tale_excavations_at_Caherlehillan_Kerry_Ireland.

Shishlina, N. I., L. N. Koryakova, and O. V. Orfinskaya. 2022. "Exotic Cotton Textile of the Bronze Age from the Southern Trans-Urals." *Nanobiotechnology Reports* 17 (5): 691–700. https://www.academia.edu/94620659/Exotic_Cotton_Textile_of_the_Bronze_Age_from_the_Southern_Trans_Urals.

Singh, Unpinder. 2006. *Delhi: Ancient History*. Berghahn Books. https://en.wikipedia.org/wiki/Iron_pillar_of_Delhi.

Sinha, B.P., and Sita Ram Roy. 1969. *Vaisali excavations (1958 - 1962)*. Directorate of Archaeology and Museums. http://asi.nic.in/asi_books/71048.pdf.

Sivanantham, Dr. R., and M. Seran. 2019. *Keeladi: An Urban Settlement of Sangam Age on the banks of river Vaigai*. Department of Archaeology, Government of Tamil Nadu. https://web.archive.org/web/20231015164905/https://www.vinavu.com/wp-content/uploads/2019/09/Keeladi-Book-English-18-09-2019.pdf.

Solomon, Richard. 1998. *Indian Epigraphy*. Oxford University Press.

Srivatsava, O. 2021. *(New Dimensions of History and Archeology)*. B. R. Publishing Corporation.

Subrahmanian, T. S. 2010. "Tamil Brahmi potsherds found at urn burial site." https://www.thehindu.com/features/friday-review/history-and-culture/

Tamil-Brahmi-potsherds-found-at-urn-burial-site/article16483663.ece.
Sullivan, Sue. 2011. *Indus script dictionary*. Sullivan, Sue.
UPenn. 2006. "The Pennsylvania Sumerian Dictionary." http://psd.museum.upenn.edu/nepsd-frame.html.
Vyas, Shail. 2020. "Indus Musicians in Mesopotamia." https://osf.io/preprints/socarxiv/kce5x/download&usg=AOvVaw228Fmhab2qMXq19nY5AenT&opi=89978449.
Wells, Bryan, and Andreas Fuls. 2023. "Interactive Concordance of Indus Texts (ICIT): An Online Database of Indus Inscriptions and Iconography." https://www.indus.epigraphica.de.
wikipedia. 2021. "List of Beijing Subway stations." https://en.wikipedia.org/wiki/List_of_Beijing_Subway_stations.

Appendix A. Evolution of Brahmi signs

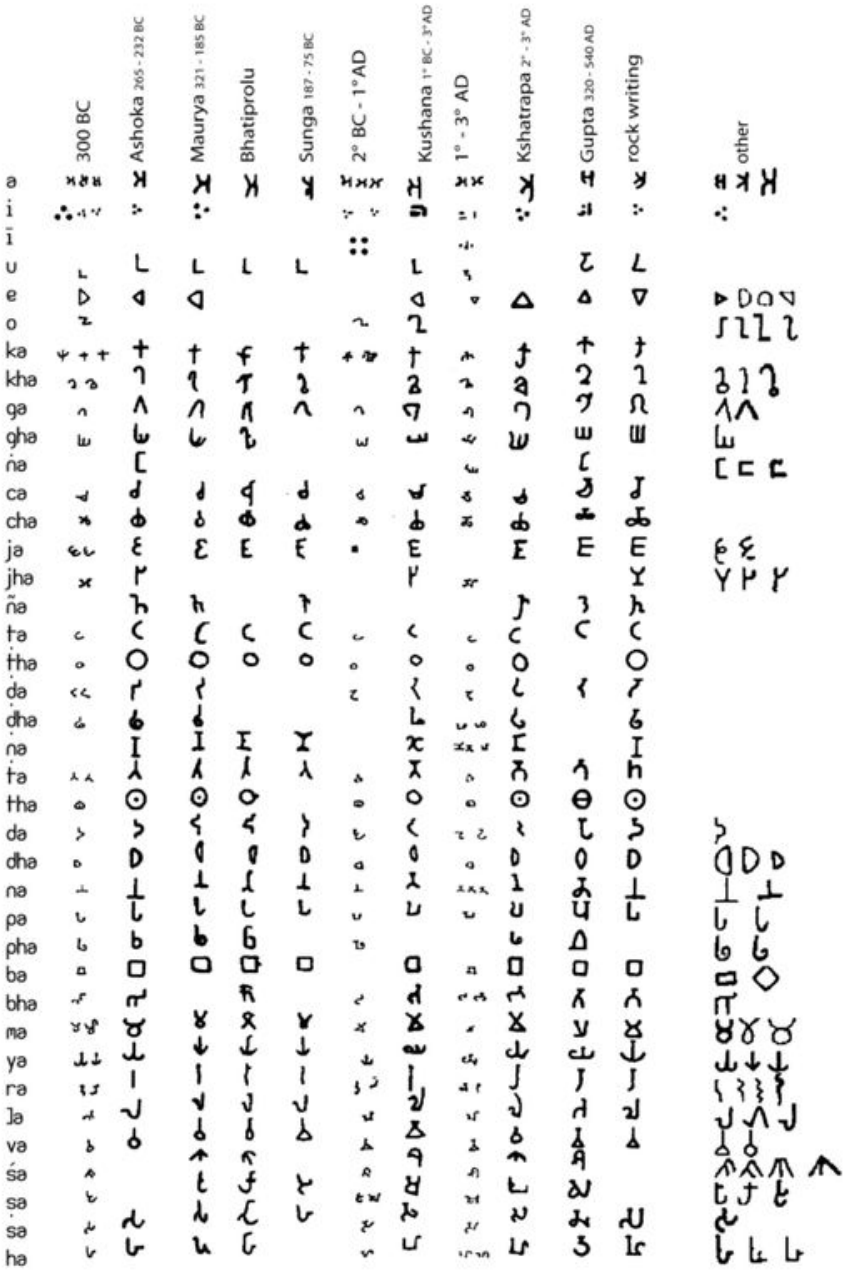


Figure A1. Evolution of Brahmi signs: Wikimedia Commons