

Electrum, gold, silver: Soma in the Rigveda

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ABSTRACT

The discovery of the ancient courses of the Sarasvati river is the discovery of the millennium and the date of desiccation of this great river (ca. 1700 to 1300 B.C.) is fundamental in providing a broad range of dates for the Rigveda and in establishing the continuity of the Indian civilization from ca. 7000 B.C. The desiccation of river led to migrations of people away from the banks of the river.

Rigveda relates to the period when the river was in full flow, fed by the glacier waters from three sources: (1) Mt. Kailas (S'atadru), (2) Yamuna (erstwhile Chambal river) fed by the glacier waters of Yamunotri and (3) Tons and Giri rivers fed by the Har-ki-dun glacier complex (Rupin and Supin) of the Bandarpunch massif (20 kms. NW of Yamunotri, in W. Garhwal, UP) The banks of the Sarasvati river had nourished the civilization ca. 3000 to 1700 B.C. (Website: <http://www.probys.com/sarasvati>) The river also binds the Rigvedic culture and the Sarasvati-Sindhu civilization since the Sarasvati river is the locus of over 1200 ancient archaeological settlements and sapta-sindhu is the Rigvedic domain. Archaeology has provided C-14 dates for the settlements on the banks of the Sarasvati river and work in historical metallurgy has established the antiquity of the Ganeshwar mines in Rajasthan which provided the mineral sources to sustain the bronze age civilization. Earth sciences have established the secular sequence of desiccation of the Sarasvati river in a period ranging from 4000 to 8000 years Before Present (B.P.) The conclusions from these earth science perspectives are that when the Sarasvati river was in its mighty flow, it had carried the glacier waters which are now carried by Shatadru and Yamuna and that the Rigveda is dated to a period of two millennia starting from a date earlier than 3000 B.C.

The soma yajna is the soul of the Rigveda (a_tma_yajna_asya: RV. IX. 2,10; 6,8). What is soma? Soma was electrum (gold-silver ore) which was purified in the pavitra to yield potable gold and silver after reducing and oxidizing the baser metals using ksara supplied by plants and using bones also as reducing agents. (Kalyanaraman, Indian Alchemy: Soma in the Vedas, Delhi, Munshiram Manoharlal, in press).

Maha_vrata is a remarkable example of the continuity of the civilization and culture on the banks of the Sarasvati). Maha_vrata is the day of the winter solstice which is celebrated as the New Year's Day in Punjab, Assam, Andhra Pradesh and Tamil Nadu (cf. festivals of Rohri, Bogali Bihu, Bhogi-man.t.alu, Bhogi-Pongal; the tradition is to burn out the old and herald the new by using the fresh produce from the harvest.) Aitareya a_ran.yaka which is an integral component of the Rigveda explains the maha_vrata as a ritual and as an allegory.

A decipherment of the script of the civilization has led to the announcement that the inscriptions are lists of bronze-brass-copper weapons produced by the fire- and metal-workers of the bronze-age civilization. The website is: <http://sarasvati.simplenet.com> (kalyan99@netscape.net) The decipherment of the inscriptions of the civilization uses an Indian Lexicon which integrates the lexemes of all the languages of India in semantic clusters. This is a change in paradigm in philology establishing India of the days of the Rigvedic culture and Sarasvati-Sindhu civilization as a Linguistic Area as the bronze age dawned ca. 3000 B.C. and matured for the next two millennia with further advances in philology, philosophy, mathematics, alchemy, architecture, iconography and other cultural phenomena, resulting in the formation of Indian languages.

The epigraphical evidence from Mitanni-Hurrian-Subarean area in Mesopotamia, ca. 17th cent. BC show definite use of the Sanskrit language in toponymy, in references to Vedic deities and in the training of horses. Strict adherence to the assumed Indo-European migrations alone, to a period ante-dating the Sarasvati-Sindhu civilization (ca. 3000 to 1300 BC) or the assumed contemporaneity of the Avestan or a hypothetical proto-Aryan linguistic area (which had its locus in eastern Iran, in late 1st millennium BC) cannot explain this evidence. A simple explanation (without any special pleading) is that some Sanskrit-speaking, seafaring peoples from India had migrated to the Tigris-Euphrates doab crossing the Persian Gulf and had moved upstream of the Euphrates river, in the course of their trade contacts, principally to trade in metallic ores, metals and weapons.

Soma adored in the Rigveda and the cooperative society of the bronze age

Rigveda is a documentation, orally transmitted, of the process of refining soma or electrum (gold-silver ore). This process was nurtured on the banks of the Sarasvati river with links to the Sindhu sa_gara.

Rigvedic workers were also fire-/metal-workers like the armourers who produced weapons using copper and tin/zinc alloys yielding bronze and brass.

The fire-workers also produced lapidary crafts such as stoneware bangles and gem-stones, apart from the use of electrum and bronze for ornaments. The evidence of inscriptions has yielded two silver seals apart from scores of copper tablets used to convey movable property transactions.

d'm = electrum (Egyptian); assem= electrum (Egyptian); somnakay = gold (Gypsy); soma = electrum (RV)(See analysis in: Kalyanaraman, Indian Alchemy (in press).

A NOTE ON THE USE OF ANIMAL BONES IN PROCESSING ELECTRUM

Animal sacrifices are often cited as a part of the ritual. They can also be explained in the context of gold-silver-electrum-quartz metallurgy. Bones and ground-up potsherds in a cupel absorb the lead oxide during the process of cupellation, to leave behind the pure precious metal. (cf. Also the later-day tradition of as'vamedha).

Bones have been used since ancient times in the process of separating silver from lead in the galena ore.

"Two steps are involved in producing silver from lead ores. Lead ore is melted first under the appropriate reducing and/or oxidizing conditions to produce metallic lead. Silver is then extracted from the lead by cupellation by which the lead is oxidised to litharge (lead oxide), leaving behind the silver. For this the lead is heated under strongly oxidizing conditions in a cupel. **The lead oxide so formed is absorbed in the porous material of bone or ground-up potsherds in the cupel, leaving silver metal behind.** This process may be repeated several times to purify

the silver; it is very efficient in freeing silver from such common impurities as copper, antimony, arsenic, tin, iron, zinc (less well for bismuth), in the argentiferous lead." (R.J. Forbes, in: Singer et al., *A history of Technology*, 1954, pp. 573-587).

SARASVATI: SOMA YAJÑA AND THE VEDA

The argument: Rigveda is a metallurgical allegory; soma is electrum ore According to Louis Renou, the immense Rigvedic collection is present in nuce in the themes related to Soma. About 120 hymns out of a total of 1028 hymns or a thousand verses and almost the entire ninth book deal with Soma. Soma is a material and also the only process elaborated in the Rigveda. The rest of the hymns related to Agni, Indra or other facets of vedic life will have to be concordant with this process which seems to constitute the very essence of vedic life, a process integral to the day-to-day living of the vedic seeker. The amšu were pressed and processed almost like a religious act.

Soma yajña in Rigvedic days, in particular, connotes the process of parting/extracting gold and silver from Soma, electrum ore (gold-silver pyrite ore). This may be called auri-faction in alchemical terms; the r̥iṣis or sages who composed riks abounding in philological brilliance, perhaps believed that they were in fact producing gold.

The interpretation of the Rigveda as a metallurgical allegory, in respect of the processing of Soma, declares a change of paradigm in vedic studies.

The oral tradition of transmitting the knowledge of gold-smelting operations was continued over millennia to maintain secrecy. The tradition of secrecy becomes allegorical as the br̥ahmaṅas and Œrautasūtras bureaucratize the process with allegorically-coded manuals for smelting operations. A nexus develops between the brahmins and the ruling classes and the former are generally in the employ of kings, led by a r̥twij and a purohita; and live in the same quarters of the royal palace, where goldsmiths live. The processes indicate that the alchemical tradition sustained by the ruling-priestly class-consortium was auri-fiction; that is, the priests knew that they were not, in fact, producing gold. The state-power was used to monopolize this operation of accumulating gold and silver metals into the state treasuries.

The analysis is advanced with reference to three historical milestones, and three related facets of alchemy as an enterprise:

- (1) Rigveda and aurifaction;
- (2) Śatapatha Brāhmaṇa and aurifaction; and
- (3) Arthaśāstra and alchemy as a state enterprise.

Soma, as a metaphorical elixir of immortality. We have drunk the Soma and become immortal; We have attained the light the gods discovered. What can hostility now do against us? And what, immortal God, the spite of mortals? (R.V. VIII.48.3)

This hymn from the world's oldest recorded oral literature seems to deal with the preparation and use of an 'elixir'. This hymn sets the framework for tracing the Indian alchemical tradition and its science potentials. The trace will perhaps lead us to the earliest alchemical tradition of the ancient world. It is significant that in a contemporary civilization, Gilgamesh of Babylonian myths too sets out to discover eternal life and finds a miraculous plant of immortality growing at the bottom of the sea. He plucks it, leaves it unguarded. It is stolen by a water snake. Water, plant and snake symbolisms are indeed central to all alchemical traditions.

Soma is not a drink

**somam manyate papiva_n yatsampim.santyoś.adhim
somam yam brahma_n.o vidurnatasyas'na_ti kas'cana** (RV. 10.85.3)

"One thinks one has drunk soma after crushing the os.adhi (herbs); soma which bra_hman.as know is never drunk."

(The same hymn as RV. 10.85.3 in AV XIV.1.3).

Chândogya Upanis.ad (V.10.4) is emphatic; soma is not a drink for the mortals:

es.a somo rājā. tad devānām annam. tam deva_ bhakṣ.yanti.
Soma is king. Soma is food for the gods. Gods eat Soma.

'O Soma, guarded by that which is meant to cover you, guarded by him who lives in the high (heaven?), you stand listening to the pressing stones. No earthly one eats you.' (RV X.85.4).

Soma is adored with all the 114 hymns of the ninth book of the Rigveda apart from 6 hymns in other books. He is also adored as a dual divinity with Indra, Agni, Pu_s.an or Rudra in 6 additional hymns. Soma as a word in its basic form and in compound form occurs hundreds of times in the Rigveda. "Judged by the standard of frequency, Soma therefore comes third in order of importance among the Vedic gods. Soma is much less anthropomorphic than Indra or Varun.a, the constant presence of the plant and its juice setting limits to the imagination of the poets who describe its personification. Consequently little is said of his human form or action... Like other gods, he is, under the name of Indu as well as Soma, invoked to come to the sacrifice and receive the offerings on the strewn grass. The ninth book mainly consists of incantations sung over the tangible Soma while it is pressed by the stones, flows through the litter of grass to the gods as a beverage, sometimes in fire (I,94; 5,5; 8,43)...The processes to which it is subjected are overlaid with the most varied and chaotic imagery and with mystical fancies often incapable of certain interpretaion." (A.A. Macdonell, The Vedic Mythology, Varanasi, Indological Book House, 1963, p. 104). This work supplies the references collated in the following two paragraphs.

The part of Soma which is pressed by Adhvaryu (RV. 8,4) is the am.s'u (lit. shoot or stalk). Soma is described as maujavata (RV. 10,34; lit. produced on Mount Mu_javat); also as dwelling in the mountains (giris.tha_) or growing in the mountains parvata_vr.dh: RV. 9,46). In one figure of speech, Varun.a is stated to have placed soma on the rock (RV. 5,85) and in another, the eagle carries off soma from the rock (RV. 1,93). Terrestrial mountains are the abode of soma (RV. 9,2). Soma is the branch of a ruddy tree (RV. 10,94). It is the ruddy or tawny shoot which is pressed into the strainer (RV. 9,92). During pressing with ten reins (i.e. fingers: RV. 6,44), soma is figuratively placed in the heaven, the highest place of the cows (RV. 5,45); other figures of speech are purification with the hands (RV. 9,86), with ten fingers (RV. 9,8.15), by ten maiden sisters (RV. 9.1.6) . Stone (adri; also, as'na, bharitra, parvata, parvata_ adrayah: RV. 8,2; 3,36; 3,35; 10,94).) is

used to crush Soma (RV. 9,67; 9,107); pounding is the verb (RV. 10,85). The stones are on a skin ['chewed on the hide of the cow' (RV. 9,79)]. The stones are placed on the vedi or altar (RV. 5,31). Ten reins guide the crushing stones (RV. 10,94); ten fingers yoke the stone (RV. 5,43) and hence compared with horses (RV. 10,94).

[Rigveda uses the general technique of pressing using stones, though the process using mortar and pestle is known (RV. 1.28); this latter practice is used by Parsis. Avesta also states that Haoma grows on the mountains]

As a juice, Soma is called the rasa, fluid; and in one hymn it is pi_tu (lit. beverage). King Soma when pressed is the am.r.ta (or somyam madhu or lit. soma mead (RV. 4,26; 6,20). Very often, the figure of speech for soma is indu (lit. the bright drop). The drop is for Indra to drink (RV. 9,32.38). The seme, su (lit. to press) describes the extraction process of the rasa. Sometimes the seme, duh (lit. to milk) is used. The drops are poured through a strainer of sheep's wool (RV. 9,69) to remove impurity (RV. 9,78). The strainer is a skin (tvac), hair (roman), wool (va_ra), filter (pavitra), ridge (sa_nu or the top of the contrivance). These terms are used with or without an adjective formed from avi (sheep). The stage of passing through the strainer is called pavama_na or puna_na (from seme, pu: lit. flowing clear). The unmixed, purified soma is offered exclusively to va_yu and Indra (va_yu is adored with the epithet: s'ucipa_: drinking clear (soma). As the juice flows, the comparison is with the 'wave of a stream' (RV. 9,80) or just a wave (RV. 9,64). As the juice accumulates in the vat (kalas'a: RV. 9,60), it is compared to a sea (arn.ava: RV. 10,115) or a samudraa (RV. 5,47; 9,64). As water is poured to mix with the rasa, the stalk roars (RV. 9,74). "Like a bull on the herd, he rushes on the vat, into the lap of the waters, a roaring bull; clothing himself in waters, Indu rushes around the vat, impelled by the singers (RV. 9,76.107)." The roar is likened to the roar of a bull ('As a bull he bellows in the wood (RV. 9,7). Soma is brilliant and coloured yellow and hence compared with the rays of the sun (RV. 9,76.86). Gods drink him for immortality (RV. 9,106); soma confers immortality on gods (RV. 1,91; 9,108) and on men (RV. 1.91; 8; 48) gods love the amr.ta (RV. 9,85); all the gods drink soma (RV. 9,109); all the gods become exhilarated (RV. 8,58); soma is immortal (RV. 1.43; 8,48; 9,3). Soma strengthens Indra in his conflict with the

hostile powers of the air, with Vr.tra (RV. 8,81); soma becomes the thousand-winning bolt (RV. 9,47), wins a hundred forts (RV. 9,48). Soma is a treasure (rayi: RV. 9,48). Soma is a god pressed for the gods (RV. 9,3).

Atharva veda refers to the deficiency in name; this stanza is used, as a primary authority by some scholars, to justify the identification of Soma as the moon, since dars'a is interpreted as the slender crescent of the moon:

'O stem of Soma (somasyams'o), lord of the combatant (yudha_m), you are indeed not-deficient by name (nūno nama); make me, O first sight (darša) not-deficient (anu_nam), both by progeny and wealth.' (AV. VII.86.3).

Soma, has the radical su, to press; pressing is the key process. Soma is that which is pressed. In the developing allegory, Soma is seen to be released from the cover, Vritra or the 'aryan dragon motif or Vritra, who possesses the waters, using the vajra thunderbolt. Buschardt also observes that the mountains which are Vritra's body are also the same on which the Soma plants grow; Vritra-killing and Soma-pressing are one and the same act; Soma-pressing is Soma-killing; killing signifies making him 'whole' and this is creation. Vajra is a concept related to the reducing agents: Lahiri summarizes Buschardt's perceptions succinctly. "Buschardt traced the origin of the vajra, the weapon with which Indra kills Vritra, to the cultic implements the pressing stone used to crush the Soma-stalks, or pestle.

The cultic implements on icons are remarkable records of alchemical legacy. Since the artist wanted to symbolize the representation with great fidelity, he used enormous degrees of freedom in adding to the icons four, six or eight hands; so that on each hand, he could represent the symbolism related to a cult implement such as a kaman.d.alu, an aks.a ma_la, a ladle, a vajra, etc. Many of these implements are alchemist's tools and relate to his apparatus. If this iconographic tradition can be extrapolated to the proto-indus seals, the so-called 'cult object' in front of the unicorn comes alive as a smelter-filter of the lapidary, the centre-piece of his very craft and life-mission.

Sometimes, even àjya (melted butter), sphya (spade of khadira wood), abhri (spade), yūpa (posts in the sacrificial site where the victim used to be bound), the waters etc. are styled vajra... the cult instrument which

happens to be decisive at that particular moment is referred to as vajra...

Linking vajra with the waters finds significant support from dravidian etyma: DEDR 761: Kannada.vajjara, ojgara a spring, fountain; orale oozing, oravu spring; Tamil. ùru to spring, flow (as water in a well); ùral small spring, spring-water, oozing, percolation; Kui. urpa to ooze, spring up; Maltese. orbe to fall in showers. The imagery sought to be evoked by the vedic poet-artisan is relatable to the intense desire to use a weapon that will enforce the flow of the metallic essence, rasa. vajra, therefore, connotes the resin that flows from the male trees!

"Vajra is the cult's demon killing power as such, and Buschardt thought that the origin of vajra must be traced to the pressing stones which play a dominant role in the central moment of the cult, the pressing of the Soma... At the Soma pressing water is poured over the Soma stalks and hence they actually take part in the Soma pressing, that is, Vritra-killing...The separation of Soma and Vritra becomes complete with the purified Soma on the one side, and the crushed lifeless demon on the other. This Soma 'clear flowing' fills up the gathering vessel...Thus the conflict is over." (Buschardt,L., Vrtra: Det Rituelle Daemondrab iden Vediske Soma-kult, Kobenhavn 1945, p.48; loc.cit. Lahiri, A.K., Vedic Vrtra, Delhi, Munshiram Manoharlal, 1984, p.21.)

Crysocole, or copper carbonate, was used by goldworkers as a solder. Two oxides of copper, red and black, were known. Mary, the Jewess-chemist, often refers to the 'little leaf of copper', the copper foil hung on the kerotakis to be subjected to the attack of mercury vapours or of sulphur vapours which was sublimed in the aludel fitted with kerotakis. cf. Hopkins, A.J., Alchemy, 1967, p.108. The 'leaf' motif has a remarkable parallel in Indus script signs and in an exquisitely executed pictorial motif which depicts two 'unicorn' heads surrounding a stylized 'sublimation device', may be kampak.t.am, topped by nine leaves. In the jeweler's art, a process called 'royal cement' is used, which may perhaps be traced to Tvashtri's gilding techniques. "To a large quantity of fused base metal a little gold was added and the whole cooled to form one 'metal', and this solid solution was then shaped into some form such as a ring. This was then etched on the surface by alum or other mordant salt. The surface of the base metal, such as lead, by this process would be

dissolved away, leaving granules of pure gold in relief, thus making the ring appear to be made wholly of gold. This process had been known from very early times." Hopkins, A.J., *Alchemy*, 1967, p.49. Some etyma: RV iv.20.6 vajra mark; in RV. x.108.7 vajrabhir-nryus.t.ah qualifying nidhi; in vi.22.5 vajra-hastam holding vajra in hand. Pali.vajira Indra or Sakka's thunderbolt; diamond. Tamil (lex.) vaccira-kantam yellow orpiment; vaccirakam pericarp of the lotus; vaccirappacai a kind of glue; vacciram a treatise on architecture; vaccira-ya_ppu glue-ing, in woodwork; vaccira-rasam purified mercury. DEDR 5214 Tamil. vaci rain, water; Kannada. basi, bese to drip, drop, trickle. Atharva veda (AV.IX.6) can be interpreted as providing the clearest statement on the smelting process of the Soma yaja which is echoed in later-day alchemical texts:

"...the shed for housing the Soma cars...green sticks that surround the sacrificial altars (as a fence to restrict the range of fire)...The grains of rice and barley that are selected are just filaments of the Soma plant. The pestle and mortar are really the stones of the Soma press. The winnowing-basket is the filter, the chaff the Soma dregs, the water the pressing-gear. Spoon, ladle, fork, stirring prong are the wooden Soma tubs; the earthen cooking pots are the mortar-shaped Soma vessels; this earth is just the black-antelope's skin...The man who supplies food hath always pressing stones adjusted, a wet Soma filter, well-prepared religious rites...he who hath this knowledge wins the luminous spheres."

Metals were not fully distinguished from their alloys; all carried names such as aes, electrum etc. Ayas meant metal. Asem denoted the natural alloy of silver and gold; it also meant any bright metal made with copper, tin, lead, zinc, arsenic and mercury. Twelve or thirteen different alloys were called asem (Needham, Joseph, *Science and Civilization in China*, vol. 5, pt. II, p.45) "At Gungeria, in district Balaghat, 102 pieces of silver plates were discovered along with 424 copper implements. The silver was found to be admixed with 3.7% gold (...1100 B.C. - 800 B.C.). The presence of 3.7% gold in these silver pieces indicates the extraction of silver from electrum..." (Smith, V., 1905, *Indian Antiquary*, pp. 233 ff.; loc.cit. Bharadwaj, H.C., *Aspects of Ancient Indian Technology*, Delhi, Motilal Banarsidass, 1979, p. 138).

Asem was Soma; this hypothesis will be the running-thread of this review of the alchemical tradition of ancient India, dating back to R.gveda. Hopkins states: "The

existence of this alloy (assem) may have been the original cause for the suggestion of transmutation since by adding silver to it, one would get a metal nearly identical with the crude silver from the mine; and by adding gold, something indistinguishable from gold. [The paucity of the Egyptian language may perhaps have been responsible for a confusion. Gold was the 'yellow metal', and the alloy produced was also a 'yellow metal'.]" (Hopkins, A.J., *Alchemy*, 1967, pp. 103-104).

The parallels with the Indian alchemical tradition are apparent: tan:kam gold in dravidian-Chinese becomes t.an.kan.a borax (a reagent!) in indo-aryan, t.an:ka gold coin; the terms hiran.yam, hema-bijam, connote the yellow metal.

"The use of borax (pheng sha) as a preparatory agent for soldering and brazing (in the molten state it cleans metal surfaces by dissolving metallic oxides) goes back in China to the 11th century, for it is mentioned by Su Sung (kho han chin yin)... Li shi-Chen says that borax 'kills' the five metals, as saltpetre does; presumably this refers to the preparation of metallic salts. The mild and non-irritant antiseptic quality which has given it such wide use in Western and even modern, medicine, was appreciated by the Chinese pharmacists, who prescribed it for all kinds of external, including phthalic, affections." (Needham, J., *SCC*, vol. III, 1959, p. 663).

In the Babylonian Talmud (+2nd century), asemon is a commonly used word referring to bullion (gold, silver or mixed.) Leiden X papyrus (c. +3rd century) says: "no.8. It will be asem, (i.e. electrum, an alloy of gold and silver) which will deceive even the artisans (a tin-copper-gold-silver alloy); no.12. Falsification of gold (a zinc-copper-lead-gold alloy)..." (cited in Needham, Joseph, *SCC*, vol. 5, Pt. II, pp. 18-21). Soma yajña as a ritual, can be interpreted as an elaborate justification for the memories of processing asemon, asem, electrum.

A Tamil lexicon of Winslow (1862) provides a philological trace: Soma man.al, is interpreted as meaning vel.l.i man.al, sand containing silver ore! Soma, Soma man.al, asemon, asem, electrum may perhaps denote the same substance that dazzled and drew travellers of antiquity in search of indus gold. It may perhaps be the same substance [which required the purificatory 'mineral waters']

contained in the kaman.d.alu symbols in the icons of the yaks.a legacy. It may perhaps be the same substance said to be am°tam which was considered to be the elixir of life, of immortality. It may perhaps be the same substance referred to, in sheer poetry, as amritam a_yur hiran.yam. Gold is immortality.

Soma! The very justification for the vedic hymns; the quintessence of the only technological process elaborated in magnificent poetry and philological excursus in the grand allegory, the Rigveda.

These findings are further elaborated in the work: Indian Alchemy: Soma in the Veda, by Dr. S. Kalyanaraman (in press; forthcoming (1998) publication of Munshiram Manoharlal, Delhi).

SOMA

With this background information on the locus of Rigvedic culture and the Sarasvati-Sindhu civilization, we can revisit the archaeological evidence and the textual evidence. The Soma yajn~a is the soul of the Rigveda (a_tma_yajn~asya: RV. IX. 2,10; 6,8). Linking with Indra, Soma is called in RV. IX.85,3 the 'soul (a_tma_) of Indra', the bolt (vajra) of Indra' (RV. IX.77,1) and even 'generator of Indra' (RV. IX.96.5).

What is Soma? Soma which was the 'soul' of the vedic sacrifice was put through three daily pressings, while worshipping all the gods. (Avesta Yasna X.2 mentions only two pressings). Soma/haoma literally means 'extract', from the root su - hu 'to press'. Scores of decipherments have been claimed as summarized by Harry Falk (Soma I and II, 1989, BSOAS, LII, Pt. 1, pp. 77-90). It would appear that a new interpretation is possible: Soma was electrum (gold-silver ore) which was purified in the pavitram to yield potable gold and silver after reducing and oxidizing the baser metals using ks.a_ra supplied by plants and using bones also as reducing agents. (Kalyanaraman, Indian Alchemy: Soma in the Veda, Delhi, Munshiram Manoharlal, in press). This metallurgical, allegorical interpretation is consistent with the decipherment of the script of the civilization revealed through over 3000 inscriptions on seals, tablets, copper tablets and on metallic weapons. The decipherment claims that the inscriptions are lists of

bronze-brass-copper weapons produced by the fire- and metal-workers of the civilization. The dawn of bronze age in the civilization area is attested by many hundreds of artefacts of weapons and tools, apart from exquisite articles of jewellery using gold, silver, electrum, bronze, copper and artificial stones.

In the early stages of the use of Soma, mythology was not the dominant characteristic; it was simply a product which had to be processed. (See also Falk, Harry, Soma I and II, 1989, BSOAS, LII, Pt. 1, pp. 77-90; Falk analyses Soma as a plant and concludes that it was ephedra, used as a stimulant). In the context of the poetics of the Rigveda which abounds in allegories, puns and metaphors, it is hypothesised that only Soma, and Soma alone was a product refined using Agni; all the other references to gods are poetic degrees of freedom to invoke gods into artefacts used in the processing of Soma. Perhaps, even Indra was relatable to the lexeme: *indh* (semant. firewood or charcoal):

i~dhaur.a_ = room for storing wood (H.); *idho_n* = tripod to put over the fire (Kal.); *indhana* = fuel (Pali); *e~date* = fireplace (Wg.); *saminddhe_* = sets fire to, takes fire; *samidha* = ignited; *samidh* = fuel (RV.); *samidha_* = fuel (Pali); *samiha_* = fuel (Pkt.); *su~dhkan.a_* = to be kindled (P.); *negad.i* = large fire lighted for warmth in cold weather or to keep off wild beasts (Te.); *iruntai, iruntu, iruntil* = charcoal (Ta.); *cirun* = charcoal (Pa.); *sindi* = soot (Kol.); *sirin* (pl. *sirnil*) = charcoal, cinders (Ga.); *irk, sirik* = charcoal (Go.); *ri_ka, ri_nga* = charcoal (Pe.); *si_nga* = charcoal (Kui); *ri_nga, ri_ngla* charcoal (Kui)

Gernot L. Windfuhr, [Haoma/Soma: the plant, in: *Acta Iranica* 25 (= Papers in Honour of Professor Mary Boyce, Hommages et Opera Minora, 11) (Leiden, 1985), 699-726, see pp. 703, 707] has pointed out that Soma was neither hallucinogenic nor intoxicant and proceeds to identify Soma as ginseng, a root used as a stimulant. The identification of Soma as a root is questionable because ginseng has no component to connote *am.s'u/asu*.

RV 10.34.1 states: *Somasyeva maujavatasya bhaks.o vibhi_dako ja_gr.vir mahyam accha_n* (an alerting eatable or food from mount *mu_javat*). Soma keeps Indra awake (*vivyaktha mahina_ vr.s.an bhaks.am. Somasya ja_gr.ve* (RV.

8.92.23). Soma is the inspirer or vipra of Angiras (RV. 9.107.6). [cf. an:ga_ra = glowing charcoal (RV.); angar id. (Gypsy). in:gha_l.a = growing embers (Pali); i~gal., i~gl.a_ charcoal-burner (M.); aggi = fire (Te.)] In the context of processing (refining or purifying or smelting) Soma electrum ore or quartz), charcoal is a vital component; since charcoal combines with the baser metals and oxidizes them leaving the residual potable, gold-silver compound which is electrum. When Soma is referred to as indrapi_ta or 'drunk by Indra (indav indrapi_tasya)(PB 1.5.4), the reference is indeed to the reducing action of glowing charcoal embers during the process of smelting the electrum ore. Naturally, Indra received the major share of Soma. (RV. I.2,3; II.41 indicate the sequence of offerings of Soma: va_yu, indra-va_yu, mitra-varun.a, as'vins, indra, vis've deva_h, Sarasvati_.) Thus, Indra, as the chief partaker of Soma, is linked with Soma from the mountains (the ore) and some on the earth (ground in pressing-stones): 'May heavenly drink exhilarate thee, Indra, and also what is pressed in earthly places'. (RV. X. 116,3).

RV. X. 85,3 refers to the Soma known only to the brahmans; this is an early indication of the mystery or secret doctrine that would surround the Soma pressing process in later-day texts. The nature of Soma would be mystified in later texts by references to the moon (the colour of silver component of electrum). Tamil tradition has it in a lexeme: co_ma man.al = sand containing silver ore. (Winslow's lexicon).

The water element is the potable metal; Vr.tra withheld the waters. Indra frees the waters. Soma is described as having 'hanging branches bending down' (naica_s'a_kha: RV. III.53,14) It is not necessary to interpret the term 'ti_vra' (sharp) in the context of taste; ti_vra connotes the sharpness of the metallic components of the ore blocks. a~su = fibrous layer at root of coconut branches, edge or prickles of leaves; a~s = fibre, pith (Or.); a~si~ fine particles of flattened rice in winnowing fan (M.); these lexemes provide a semantic lead to the am.s'u/asu used to describe Soma; the term connotes the streaks of metal, seen like fibres of a stringy fruit or nap of cloth [a~s (B.)]. The am.s'u was ruddy (RV. VII.98,1). The RV reference to Soma 'growing' on the mountains (giris.t.ha_) is explained in the context of the ores obtained from the mines in NW India. (giris.t.ha: RV. III.48,2; V.43.4; IX.18.1, 62,4; parvata_vr.dh: RV. IX.46.1) Hence, the reference to Somam

adrau (RV. 5.85.2) plucked in two rocks. The colour of the Soma filaments contained in the ore block are 'reddish' or 'yellow' (arun.a/arus.a or hari/za_iri). Za_iri = golden-hued (Yasna IX.16,30). RV. 10.97.18, 19 refer to the group of herbs having Soma as their king (Somara_jn~ih); the growth of herbs on the mountains is the obvious reference here. 'Ma_taris'van fetched one of you (Agni and Soma) from heaven; the eagle twirled the other from the cloud-rock'. (RV. I.93,6). The links of Soma with rocks are vivid. (adri: RV. V.85,2; I.93,6)[See Bloomfield, The Legend of Soma and the Eagle, JAOS, 16, 1896, pp. 1-24]. 'High is the birth of thee, the plant; thee being in heaven the earth received'. (RV. IX. 61.10). Yasna (X.4,10-12,17) places haoma on the high mountain haraiti; it is placed there by a skilful god, wherefrom holy birds carried it everywhere to the heights. Rigveda connects Soma with the mount Mu_javant: 'As draught of Maujavata Soma, so doth, the enlivening vibhi_daka delight me' (RV. X.34,1). Griswold notes: 'The mountain Mu_javantt (if it was a mountain and not simply the name of a people), being closely connected with the Gandha_ris (AV. V.22,5,7,8,14) must have been situated somewhere between Bactria and the Punjab. In the Tait. Samh. I. 8,6,2 and the AV. Passages referred to above the Mu_javants are taken as a type of distant folk, to which Rudra with his fever-bearing bow is entreated to depart. In fact Mu_javant is as far off and mysterious as the river rasa_. Possibly both embody dim reminiscences of the undivided Indo-Iranian days." (p. 217). Soma flourished during the rainy season, swelling with milk (RV. II.13,1), strengthened by the rain-cloud, parjanya (RV. IX.82,3; 113,3). Yasna (X.3): 'I praise the cloud and the waters that made thy body to grow upon the mountains.' Later rituals state that Soma had to be purchased from a s'u_dra, who was a trader in Soma who was like the gandharva who held back the celestial Soma. (cf. ks.udraka = maker of minute beads or minor work in gold (Arthas'a_stra: 2.13.37 and 40).

There is a reference to ki_kat.as in the context of the sacrifice: 'Amid ki_kat.as what do thy kine, O Indra? That tribe nor mixture (a_sir or milk for mixing with Soma) pours nor heats oblation; bear thou to us the wealth of pramaganda, give up, O Maghavan, to us the 'low-branched'. (RV. III.53,14). Regarding the ritual purchase of the Soma, TS. 6,1,6,7 states that one buys the Soma with a ruddy, yellow-eyed cow; 'this, one should know, is the form of Soma: then one buys it with its own deity. That became

gold... Those who discourse on brahman say, 'how is it that offspring are produced through that which is boneless, and yet are born with bones?' Because one offers the gold, placing it in the ghee, therefore offspring are born... with bones."

In the tradition of the Black Yajurveda, A_pS'. 10,25,11 states that the adhvaryu should buy the Soma with gold saying: " I buy the bright (s'ukra, Soma) with bright (gold), the glittering (candra) with glittering, the amr.tam with amr.tam to match thy cow" (TS. 1,2,7,1); the Soma-dealer answers: "King Soma deserves more than that". Adhvaryu washes king Soma with water and unfolds him (A_pA'. 11,1,11). "Every shoot of thee, O Soma, must swell for Indra..." (TS. 1,2,11,1). The purpose of the yajna is: ' by means of ghee as the vajra and two sacrificial ladles as their arms the gods slew Vr.tra. Vr.tra is the Soma. One should know that they slay Soma, when they sacrifice with ghee in his presence. By means of these mantras one makes Soma swell again." (TS. 6,2,2,4)

The Avestan references to Haoma as a plant can be explained as a ritualistic representation of the Soma refining process of the earlier days on the banks of the Sarasvati river. Yasna refers to the scent of the plant (Yasna, 10,4) but RV does not. There is, however, reference to the intense smell of the type common in the workshop of a metalsmith who uses ks.a_ra (plant-based alkalis) to oxidise the impurities or baser metals in an ore block. Griswold notes that there are only two references to haoma in the Ga_tha_s of Zoroaster, one mentioning du_raos'a ' the averter of death' (Yasna, XXXII.14), the standing epithet of haoma in the later Avesta, and the other alluding to 'the filthiness of this intoxicant'(Yasna, XLVIII.10). These allusions are sufficient to prove that the intoxicating haoma was under the ban of the great reformer (H.D. Griswold, 1923, The Religion of the Rigveda, London, Oxford University Press, p. 14)

Next in importance to Agni and Indra, Soma is addressed in about 120 hymns of the Rigveda. Indra and Varuna gain anthropomorphic status as gods; but Soma is generally represented in its physical nature.

Soma pavama_na. Soma in the process of passing through the refining instrument (potr.). [The actors are: Hotr.,

connected with Indra; the Potr. connected with the Maruts (Potr. is the purifying priest; also the 'cleaning' instrument); the Nes.t.r. linked with Tvas.t.r.; the divine wives, agni_dh with agni, the brahman with Indra and the pras'a_s.t.r. with mitra-varun.a]. ulu_khala (mortar) is used to press Soma (RV. I.28,1,5; gra_van is rendered as a 'press-stone'). This is a reference to the pounding of the ore block to pulverize the ore. In Yasna (XXIV.7; XXV.2) ha_vana (hu = to crush) is 'the utensil in which the twigs of the haoma plant are pounded'. Another method refers to the gra_va_n.ah (press-stones) are placed on the 'ox-hide', held by the hands and with ten fingers and activated through two boards. (RV. X.76,94 and 175). Dhis.an.a_ (RV. X.17,12) is perhaps a reference to a hollow in which the press-stones work. This may be a reference to a hollow covered with ox-hide specially prepared on the sacrificial ground. The ox-hide is referred to in RV. IX.79,4; IX.66,29; IX.101,11 and was used to catch the drops of Soma (apparently, the pulverized bits of the electrum ore block). The later rituals state that the pressing-boards are adhis.avan.a phalaka and are also laid across a sounding-hole dug beneath (See Hillebrandt, VM. I.148). A reference to the sacrificial ground with the hollow is mirrored in the term: r.tasya yoni (RV. IX.64,11,22): the home of the yajn~a. The reference to r.tasya dha_ra_ (RV. IX. 63,14,21) is a reference to the process of flowing through the wool strainer.

Indra's outward appearance flowed away from his semen and became suvarn.am hiran.yam when he had drunk Soma that was exposed to witching. (S'Br 13,1,1,4: S.Br. 12,7,1,1: retasa eva_sya ru_pam asravat; tat suvarnam hiran.yam abhavat; cf. J.Gonda, 1991, The Functions and Significance of Gold in the Veda, Leiden, E.J.Brill, p. 5). [Note: S'Br. 12,7,2,10: lead (s'i_sa) is 'a form of both bronze and gold'; ahi is a snake; na_ga is a snake; na_ga = lead (Skt.)] RV. 4,17,11 relates how Indra gained cows, gold, troops of horses. When Soma purifies itself, Soma wins cattle, chariots, gold, the light of heaven, and water for them (RV. 9,78,4). The river Sindhu is rich in excellent horses, good chariots, good garments, rich in gold (RV. 10,7,5,8). RV. 9,112,2 recounts how the blacksmith searches for a customer who possesses (much) gold. Gold is described as s'ukram hiran.yam (RV. 8,65,11) or shining with a light of its own. "He who buys the (Soma) with gold buys it as sas'ukram" (Taittiri_ya Sam.hita_: 6,1,10,1). Even the sun is equated to gold: hiran.yam prati su_ryah (RV. 1,46,10: sun is equivalent to

gold). Agni is called hiran.yaru_pa (RV. 4,3,1: gold-like). Apa_m Napa_t (the Child, Descendant of the Waters) has a terrestrial form of the earthly fire and is associated with gold (RV. 2,35,10: hiran.yaru_pah; RV. 2.35,9: hiran.yavarn.a_h). Indra and Va_yu's chariot (which is 'heaven-touching') is made of gold (RV. 4,46,4). RV. 2,35,10 reports that Apa_m napa_t in his earthly manifestation as the sacrificial fire, comes out of the golden yoni (yoni hiran.yaya which is Soma's seat (RV. 9,64,20)).

References to electrum may be noticed in RV. 8,45,22 where the metal silver is called 'whitish hiran.ya'; rajata is used as an adjective to mean 'whitish, silver-coloured'. [See A_pS. 5,29,2 which states that rajatam hiran.yam should not be given as a daks.in.a_.]

Pu_s.an has golden ships which sail in the sea (RV. 6,58,3) and bears an axe made of gold (RV. 1,42,6).RV. 9,86,43 refers to Soma as hiran.yapa_va_h which can be interpreted as 'purified golden Soma.'

Soma was poured through through a sieve made of wool. Every hymn of Book IX of the Rigveda refers to the filtering through the strainer. (pavitra = sieve, means of purifying, filter; pu_ = to purify; pavate = he cleanses himself; pavama_na = self-purifying). References to filtering are in : RV. IX.1, 1 and 6; IX.28, 1,2,6. 'Soma while filtering himself, flows thousand-streamed, across the wool' (RV. IX.13,1). In this filtering process, Soma is tawny in colour; and sounds like the thunder of the sky or the bellowing cattle. In RV. IX.97,33 the word 'karman' is used to denote the toil involved in the sacrifice.

Soma is mixed with milk (gava_s'ir = addition of milk to Soma), curd and grain. These are intended to stoke the burning embers and to act as oxidizing agents to remove the baser metals.

The rasa of the Soma is emphasized (RV. 8,3,20; 9,67,8; 15; 9,76,1 describes the rasa as kr.tvya or efficacious, as daks.a or ability. Somya rasa (RV. 9,67,8) is the 'sap, which constitutes the essence, best, beneficial element of Soma'. The colour of the rasa is hari (yellow, tawny)(RV. 9,19,3; 9,25,1; 9,103,4; 9,78,2; 10,96,6 and 7. RV. 8,29,1 refers to Soma as babhru (reddish-brown) and a youth who is applying a golden ointment (an~ji... hiran.yayam) to himself.

RV. 9,107,4 refers to Soma as utsah hiran.yayah: a spring of gold [Geldner, Rig-Veda ubers, K.F. Geldner, Der Rig-Veda ubersetzt, Cambridge, Mass., 1951, III, p. 110). RV. 9,86,43: sindhor ucchva_se patayantam uks.an.am hiran.yapa_va_h pas'um a_su gr.bhn.ate: "purifiers of gold seize in them (i.e. the vasati_vari_ water left standing overnight) the animal (pas'u_), i.e. the bull (Soma) that flies in the upheaving of the river." Thus in this hymn, the gold which is purified refers to the juice of Soma which is golden.

RV. 6,61,7 refers to Sarasvati_ as hiran.yavartani or one endowed with a golden course. RV. 9,8,39; 38 implore Soma to clarify itself while procuring gold.

RV. 9,75,3: ava dyuta_nah kalas'am acikradan nr.bhir yema_nah kos'a a_hiran.yaye = Soma rushed down in the jars with loud cries, held (in hands) by the men in the golden vessel (kos'e).

Soma is pita_ deva_na_m (RV. IX.109,4) or father of the gods.

Hiran.yagarbha, the golden germ was evolved in the beginning (RV. 10,121,1'). Hiran.yagarbha is the title of Praja_pati, who is declared as the only god who encompasses all the created things (ja_tah patir). "(he) who by his might has ever been (babhu_va) the sole lord of the world that breathes and blinks, who rules over these two-footed and four-footed (beings), to what god shall we pay homage with oblation?" (RV. 10,121,3). This reference is considered by some to be a later addition. (for e.g., cf. Edgerton, F., The Beginnings of Indian Philosophy, London, 1965). The Being who evolved in the beginning is also the lord of the snow-clad mountains, the ocean and the river Rasa_. He is the fashioner who tied heaven and heaven. When the waters moved producing Agni, from the waters evolved the asu (life-principle?) of the gods. [Note the use of am.s'u as an epithet of Soma.] Hiran.yagarbha is the only god over the gods: yo_ deves.v adhi deva eka asi_t.

Rigveda riddled with allegory and metaphor enters the philosophical domain with these descriptions of Hiran.yagarbha. Post-Rigvedic texts and philosophical tracts abound in references to Hiran.yagarbha as attested by J. Gonda (opcit., ppo. 217-246). Ma_nava S'rautasu_tra (MS. 6,2,3,9) stipulates the use of stanzas 1,3, 2-7 of RV.

10,121 Hiran.yagarbha su_kta) in connection with the naturally perforated 'brick' (agnicayana). It has been argued elsewhere that the perforated bricks are integral to the later-day alchemical processes of transmuting baser metals into gold. (Kalyanaraman, opcit., in press)

Arthas'a_stra states: pure and impure silver may be heated four times with copper sulphate, mixed with powdered bone (asthituttha) again four times with an equal quantity of lead and again four times with dry copper sulphate (sushkatuttha), again three times in skull and lastly twice in cow dung. (Stanza 88). The use of the skull which is calcium phosphate is a cupellation process for purification of silver. Galena was first smelted to crude lead and silver concentrated by a process called Pattinson Process. The process is based on the fact that if fused argentiferous lead is cooled, a point is reached when nearly pure lead separates in crystals. If crystals of lead were withdrawn by perforated ladles the remaining liquid alloy would become increasingly rich in silver. About 7/8ths of the original lead is removed by this process and the rest of the lead is removed by cupellation process. Separation of silver and other impurities from gold (electrum) was invented before Amarna age, possibly during or shortly after Ur III period (ca. 2200-2000 B.C.)

"Sumerian literary texts refer to gold from Aratta (Pettinato 1972: 79). Gudea records receiving gold from the mountain of Hah(h)um (Statue B, col. VI. 33-5; Liverani 1988), taken to lie in that part of modern Turkey near Samsat on the Upper Euphrates, and from Meluhha... Various texts refer to the almost mythical land of gold known as (H)arallu, perhaps somewhere in the Iranian hinterland (Komoroczy 1972; Groneberg 1980: 20)...Documents relevant to the Dilmun, trade in the later third and earlier second millennium BC indicate that some gold was still reaching Ur up the Gulf at this time, but whence it came, perhaps Meluhha, is not stated (Oppenheim 1954: 7; Leemans 1960: 120-1, is more cautious). The renowned resources of Egypt and Nubia (cf. Lucas 1962: 224-8) contributed most certainly in the fourteenth century BC to Mesopotamian royal gold holdings (Edzard 1960; Wilhelm 1974)...The tribes of Hama were richer in gold than those of Harran..." (Moorey, 1994, opcit, p. 220).

Gold in the civilization

Gold objects recorded from Mohenjo-daro, Harappa, Chanhudaro, Lothal and Kunal are: bangles/bracelets, pendants, amulets and necklaces, armlets, ear-pendants, earrings, earstuds, beads, brooch, fillets, finger-rings, terminals, caps, netting needles, cone, gold foil/gold leaves, pin, waste pieces of gold.

The terms connoting gold in Rigveda are: hiran.ya, suvarn.a, ja_taru_pa, candra, harita. Gold objects mentioned in the Rigveda are: rukma (golden chain or disk), nis.ka (neck-ornament of gold beads or coins), sraj (gold string interspersed with jewels).

Soma, the heavenly nectar of life in golden jars (kalas'a) is the fountain of gold: "Soma flows on for us as winner of the kine, winner of thousands, ears, water, and light, and gold; He whom the Gods have made a gladdening draught to drink, the drop most sweet to taste, weal-bringing, red of hue." (RV. IX. 78.4; Griffith, RV, Vol. II, p. 335).

Nis.ka-gri_va connotes a gold ornament worn on the neck, won through soma:

"Svaitreya's people, all his men, have gloriously increased in might. A gold chain Br.haduktha wears, as through his Soma, seeking spoil." (RV. V.19.3; Griffith, RV, Vol. I, p.482). Perhaps, nis.ka was also a currency (RV. I.126.2). Gold is used in the purchase of Soma: S'rautasu_tras: Baudha_yana (6.12-13; 14-15); Bha_radva_ja (10.16.2-18.14); A_pastamba (10.24.1-27.8); Ka_tya_yana (7.7.3-8.25): "After having handed over king Soma to the Soma-seller, the Adhvaryu should ask him: "O, Soma-seller, is your soma available for purchase? He should reply: "It is available for purchase." The Adhvaryu should (offer to) purchase it for ten (objects), (namely) seven cows and the three (objects, that is to say), gold, a piece of cloth, and a she-goat..." (Satya_s._ad.ha, .2)(R.N.Dandekar, S'rautakos'a, vol.II, pt. I, p. 129).

The place of sacrifice is also golden (RV. V.67.2; IX.64.20). Even weapons are of gold. "The kanvas sing forth agni's praise together with our maruts' who wield thunder and wear swords of gold." (RV. VIII.7.32). Gold is won from the earth, washed and cleaned and purified (RV. I.117.5).(cf. M.N.Banerjee, "On Metals and Metallurgy in Ancient India", Indian Historical Quarterly, Vol. III, March 1927, no. 1, p. 123).

[Ball writes: "Gold is mined for, in quartz veins 3 miles to the north of kandahar city... The gold is sometimes chiselled out in pure granules and sometimes in large nuggets..." (V. Ball, Manual of the Geology of India, III, pp. 208-9). Ball also refers to an old record of the discovery of a gold mine in Afghan Seistan and also notes Bannu, Peshawar, Hazara, Rawalpindi, Jhelam, Ambala and certain Punjab Himalayan princely states such as Kangra as gold-panning centres.]

Gold is won from the rivers; Sindhu was full of golden beds and hence is called 'golden' and 'of golden stream' (RV. X.75.8; VI.61.7; VIII.26.18). "Rich in good steeds is Sindhu, rich in cars and robes, rich in gold, nobly-fashioned, rich in ample wealth". (RV. X.75.8). "This river with his lucid flow attracts you more than all the streams. Even Sindhu with his path of gold." (RV. VIII.26.18).

The path is golden (hiran.yavartani)(RV.I.92.18; V.75.2;3; VIII.5.11;8.1). Praja_pati is the progenitor of the universe and is hiran.yagarbha (the golden foetus): "in the beginning rose hiran.yagarbha, born only Lord of all created beings. He fixed and holdeth up this earth and heaven what God shall we adore with our oblation." (RV. X.121.1; Griffith, RV, Vol. II, p. 566).

Gold (hiran.yam) was the objective of the Vedic singers (RV. VI.47.23; VII.78.9). The prayers refer to gold that glitters (RV. X.107.7), that gives wealth (RV. II.34.11; VII.66.8), that is self-luminous (RV. V.87.5). The singers seek: "The Sea and all the Deities shall give us him with the golden ear and neck bejewelled. Dawns, hasting to the praises of the pious, be pleased with us, both offerers and singers." (RV. I.122.14; Griffith, RV, Vol. I, p. 169)

Gods Indra, Mitra, Varun.a etc. were often described as golden in hue (RV. I.46.10; I. 167.3; I.139.2; II.35.10; IV.3.1; IV.10.6; VI.16.38; VII.45.2; X.20.9) driving from golden seats (RV. IV.46.4; VIII.5.28; VIII.22.9) in golden chariots (RV. I.30.16; I.35.2; 56.1; 139.4; IV.1.8; IV.44.4; IV.44.5; VI.29.2; VIII.1.24; VI.66.1; VIII.33.4; VIII.46.24), having shafts or poles (RV. I.35.4; 5; VIII.5.29), wheels and axles all bright as gold (RV. I.64.11; 105.1; 139.3; 180.1; VI.56.3; VIII.5.29) with golden reins for the horses (RV. VIII.22.5) who had golden

manes (RV. I.122.14) and were bedecked with golden ornaments.

Gods As'vins and Maruts and the asuras alike adorned themselves with magnificent jewellery using gold rings (RV. VIII.32.29) gold ear-rings (RV. VII.56.13; I.166.10; I.64.11; V.54.11; II.34.3; VI. 16.38) golden necklets and armlets (RV. VII.56.13; I.166.10; I.64.11; V.54.11; II.34.3; VI.16.38). "Your rings, O maruts, rest upon your shoulders, and chains of gold twined upon your bosoms. Gleaming with drops of rain, like lightning-flashes, after your wont ye whirl about your weapons." (RV.VII.56.13; Griffith, RV, Vol. II, p.55)

References to pur (urban settlement), ayas (metal), and samudra (sea) in the Rigveda indicate that the culture was not exclusively pastoral but had sea-faring, trading activities and used metals to build-up urban settlements:

varma si_vyadhvam. bahula_ pr.thu_ni purah kr.n.udhavam
a_yasi_radhr.is.t.a_ (RV. X. 101.8)

'stitch ye the coats of armor, wide and many; make metallic forts, secure from all assailants'.

ra_yah samudra_ns'chaturu asmabhyam soma vis'vatah a_
pavasva sahasrin.ah (RV. IX. 33.6)

'from every side, O Soma, for our profit, pour thou forth four seas filled full of riches thousandfold'.

Sources of gold: Coimbatore (Hadabanatta, Kavudahalli and near Porsegaundanpalayam), Wynaad and Kolar (Marshall 1931: 674). "South of the Caucasus, in Armenia, the famous metal workers, the Chalybes, are credited with rich mines. This probably means the deposits near the Taldjen River, close to Artwin... The Muruntau mountains in the Kyzyl Kum desert has the largest deposit of gold (Forbes 1971: 166; Kalesnik and Pavlenko 1976: 202)... The discovery of the famous Fullol Hoard in the Hindu Kush of northern Afghanistan (Tosi and Waradak 1972: 9-17) contained a number of gold objects with Mesopotamian and South Turkmenian motifs. This proves that the region (the Oxus basin-northern Hindu Kush) was as important to the Middle East for gold as it was for lapis lazuli. Incidentally, the Harappan trading posts at Shortugai are also in the same region (Francfort and Potter 1978:29).

Gold, silver Lead

Gold is known at Mokal, Afghanistan. (T.A. Wertime, Science 182, 1973, p. 884). "X-ray micro-analysis has shown that inclusions in the bead are composed of an alloy of platinum-iridium-osmium and gold. These three metals form rare alloys, found mostly in placer deposits...supplies from this area could have joined caravans carrying lapis-lazuli using Helmand valley route via Shahr-i-Sokhta to the Persian gulf and then have arrived by the ships carrying the lapis, carnelian, tin and gold from Meluhha to Sumer." (K.R. Maxwell-Hyslop, *Sources of Sumerian Gold*, Iraq, XXXIX, 1977, p.p.85-86).

"Gold from the north and from Egypt, as well as silver and the other metals, has been discovered in large quantities in the royal tombs of Ur. The Sumerians already knew how to refine it and remove its impurities. Certain objects from the royal tombs at Ur--the headdress of Meskalamdug, for example--are very solid, but very often gold was used simply for 'gilding'. At Khorsabad, for example, the bitumen-coated trunks of palm trees were covered with a bronze facing that simulated the scales of the palm tree; then gold leaf, annealed to make it flexible, was burnished and nailed to this bronze facing with small nails.

"Silver, more common than gold, was used in the same manner; before coins came into existence it was a unit of exchange used for the payment of purchases, as by barter. Refining of gold was necessary in view of the impurities this metal contained; King Burraburias of Babylon complained to Amenhotep IV (circa 1370-1352 BC) that the gold received from him contained three-quarters of its weight in impurities. The fine gold used in the objects found in the tombs at Ur was approximately 75 percent pure gold. The refining method used was a variant of our cupellation, as is indicated by the purification of five minas of gold by means of successive stages in the furnace; on the first round the gold was reduced to four minas, five shekels, on the second to three and two-thirds minas. The Mesopotamians knew how to alloy and harden gold, which permitted it to be used for weapons." (Maurice Daumas, *opcit*, p. 133).

"...ancient empires... began to concentrate upon importing the crude metals from these distant smelters. The rulers of

the city-states would then release the imported raw material to their own metal-workers for finishing... For the efficient extraction of metals from their ores some form of furnace is needed and, for certain purposes, the fire must be forced by draught. In the simplest operations of smelting, the pieces of ore are mixed in layers with the fuel, and the metal is afterwards collected in a lump from the hearth... Metal-workers were among the earliest specialists in craftsmanship. Neolithic farmers or their women had woven and spun, made their own shoes and pots, and dug their own flint, but the advent of the smith ushered in a new era, in which the urban civilizations of the great river valleys rapidly developed. Thence itinerant smiths ventured into the barbarian fringe to seek ores, and thus spread knowledge of the working of these coloured stones. The awe in which smiths were held is reflected in innumerable legends...

"Strabo and others report that, in the Caucasus, alluvial deposits were worked by washing over a layer of fleeces. The gold particles would adhere to the grease in the wool--hence the basis of the legend of the Golden Fleece... In cupellation, lead is added to the crude gold, and the metals fused together in a porous clay crucible or cupel. The lead and other base metals are oxidized by a current of air. The resulting molten litharge, containing all the base-metal oxides, is partly blown off by a blast of air, and partly absorbed by the walls of the cupel, leaving a button of refined gold or, if silver was originally present in the ore, of gold alloyed with silver. Agatharchides (second century BC) is quoted by Diodorus (III, 14, 3-4) as describing the removal of silver as well as the base metals by a modification of the cupellation process: 'The workers place the crude gold in a clay vessel, and add a mass of lead, a little salt and tin, and barley husks. Then it is closed with a tight-fitting lid, sealed with lute, and heated for five days and nights in a furnace. After a suitable interval for cooling, nothing is found of the other materials in the vessel, but only pure gold' (Abbreviated).

"Evidently, at any rate in the first stage of this operation, while the access of air is prevented, the carbonaceous barley would act as a reducing agent. In this period, the metals would be fused and the silver converted to silver chloride by the salt. Later, we must suppose that air is admitted, perhaps through cracks; the barley husks

would then burn away, and the base metals would be oxidized and absorbed by the crucible. Perhaps the lid is finally removed, and the heating continued for a short period longer to bring about the cupellation...

Silver and lead were closely associated because both were obtained from the same mineral, galena. This is predominantly lead sulphide, but usually has a small proportion of silver. Its occurrence is widespread, and it is often associated with copper ores. Its brilliant metallic appearance may have attracted the attention of the early copper-smelters. The few galena deposits of Egypt were worked for eye-paint only, and in any case the lead produced later from these ores contained little silver...

"It is doubtful whether the rich deposits of India, Afghanistan, and Persia played a part in the ancient Near East, where much more importance must be attached to the many galena deposits rich in silver in the Armenian mountains, and in the central part of western Asia Minor. Classical tradition and archaeological evidence both point to north-eastern Asia Minor as the birthplace of silver. The 'land of the Chalybes', so important an early centre of metallurgy, was the mining district of the Hittites, whose very capital bears a name written with the ideogram for silver. Asia Minor held an almost complete monopoly of silver production, and Sumerian and Assyrian cities sent their merchants to the Hittites to acquire the silver and lead produced in that country.

"Earlier potentates like Sargon the Great and Gudea, ruler of Lagash, dispatched expeditions to acquire these metals in the 'silver mountains' of Armenia. The Cappadocian tablets (ca. 2000 BC), however, show that there were at that time permanent settlements of Mesopotamian merchants in the land of the Hittites, buying crude and refined silver, pure lead, and pigs of lead, all in sealed containers to prevent pilfering during transport. From the accounts, it is evident that several qualities were produced.

The silver was usually sold in bars, and about four times as much silver as lead was sent to the home country...

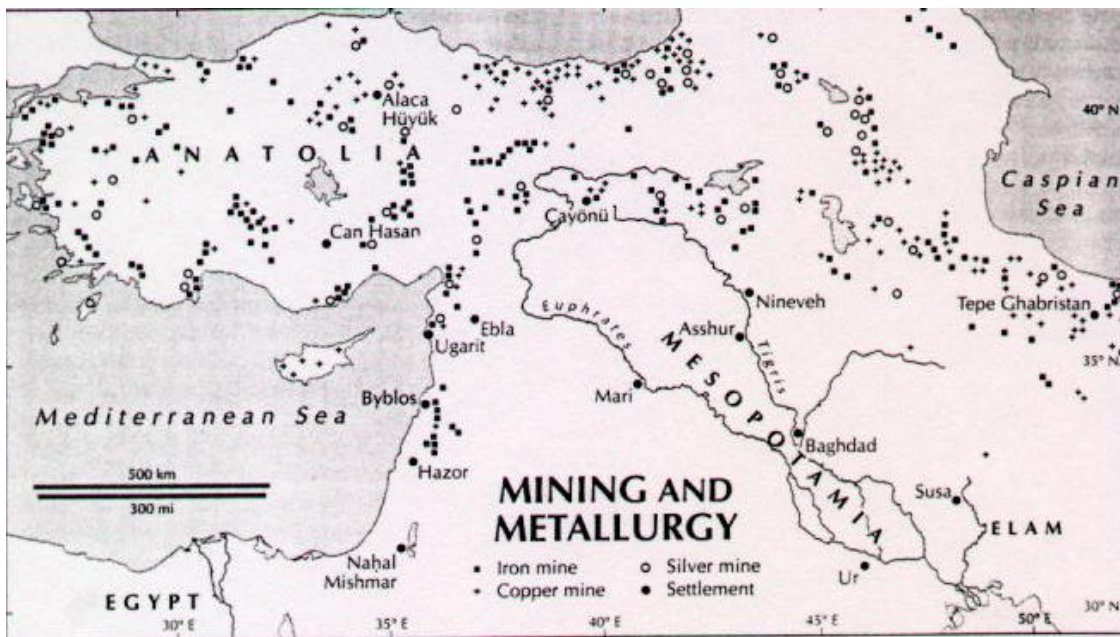
"By the first millennium BC, silver and lead were common metals all over the Near East, except in Egypt, where the phase of metallurgy was delayed for another 400 years. The amounts of these metals taken in tribute and booty by

the Assyrian king Tukulti Ninurta II (889-884 BC) afford evidence of extensive production. Between 400 and 1000 kg of lead and 100 kg of silver were captured during his expedition into the northern mountains, which shows that the region between Lake Van and Lake Urmia was already producing them in large quantities. In Egypt, on the other hand, though importation had begun, the comparative value of silver to gold was still as high as 1:2 at the time of the Persian occupation. The Persian victory of Egypt took advantage of this strange situation, and enriched himself by introducing a silver coinage into the country.

"Supplies of silver became plentiful in Egypt only in Hellenistic times, when the price of silver dropped to only one-thirteenth of that of gold. The production of silver and lead was responsible for the introduction into general metallurgy of the methods of working sulphide ores and of cupellation. The working of galena entails partial desulphurization by roasting, followed by reduction of the product, litharge (lead oxide). A simple hearth-furnace or a sloping trench sufficed. The fule and ore were thoroughly mixed together, or built up in alternate layers. Natural or artificial blast supplied the necessary air. A proportion of the sulphur escaped as sulphur dioxide, but some remained as unchanged galena and lead sulphate. When the correct stage of desulphurization was reached, the temperature was raised, and the litharge, lead sulphate, and galena interacted to form lead, which collected at the bottom of the furnace, while the remaining sulphur escaped as sulphur dioxide. The charcoal added as fuel would prevent re-oxidation. The product was a lead-silver alloy harder than pure lead; it contained many impurities, such as antimony, copper, tin and arsenic. This ancient process combined the two modern stages of roasting and reduction. Though the technique was comparatively simple, the chemical reactions were correspondingly complex, and the ancient metallurgist had not yet sufficient knowledge to control them fully. The inevitable result was a small yield... silver was obtained from silver-bearing lead by cupellation. The litharge slag could be used as such, or reduced with charcoal to lead. Finds of pure silver at Ur, at Troy (six bars of puresilver), and at other places, as well as historical data, lead us to conclude that cupellation was invented in north-eastern Asia Minor in the first half of the third millennium BC.

"The firing-pot and the dropping of base metals are frequently mentioned in the Bible (Prov. xvii.3; Jer. vi.29-30; Ps.xii.6). By about 60 BC, cupellation was well known. Liqutation, a method of extracting gold and silver from other sources such as certain crude coppers, was perhaps also known at this time in the Near East. It involved alloying the crude metal with lead and slowly melting it. The lead flowed away with the precious metals in solution, leaving a porous mixture of the remaining base metals. Liqutation was followed by cupellation...

The silver:gold value-ratio gives an interesting indication of the supply of silver. It was comparatively high in the earlier periods in Mesopotamia (1:8), and rose still higher to 1:6, in the reign of Hammurabi, perhaps because of disorder in Asia Minor and Armenia. It fell soon afterwards to 1:10, and remained at that level for a very long period. In Neo-Babylonian and Persian times the ratio varied between 1:12 and 1:13." (Charles Singer, et al (eds.), *A History of Technology*, Oxford Clarendon Press, 1954, pp.576-585).



Map depicting iron, silver and copper mines and ancient settlements of Mesopotamia and Anatolia. The clustering of copper mines west of Afghanistan and of iron mines in western Anatolia is analogous to the clustering of copper mines in Rajasthan area and of iron mines in the Ganga-Yamuna doab (Bihar).



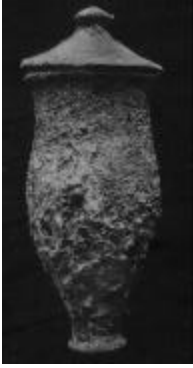
Miniature jar fitted with a cork-like, hollow, baked clay stopper; containing microbeads mixed with fine ash; the jar was buried under a house floor at Zekda (23.53N and 71.26E), Banaskanta District, Gujarat (Hegde, K.T.M. et al, 1982, Pl. 21.2).



Gold jewellery, Mohenjodaro (After Marshall, Pl. CXLVIII). The jewellery was found in a silver vase. The large necklace is made up of barrel-shaped beads of a translucent, light-green jade. Each jade bead is separated from its neighbours on either side by five disc-shaped gold beads, 0.4 in. dia made by soldering two cap-like pieces together. Seven pendants of agate-jasper are suspended by means of a thick gold wire. The pendants are separated one from another by a small cylindrical bead of steatite capped at each end with gold. The smaller necklace (No. 7) inside the large one is made up of small globular gold beads, all of which are cast. The spacers were made by soldering two of these beads together, and it is probable that the beads were originally strung into a bracelet of two rows. The two bangles (Nos. 1 and 4) were each made of thin sheet gold wrapped over a core (dia. 3 in.) No.2 is a conical gold cap (1.3 in. high) beaten out from a plate of gold; it is perhaps a hair ornament.



Two silver bracelets were also found with this hoard. (Marshall, Pl. CLXIV)



Silver vase, Mohenjodaro (After Marshall, Pl. CXLVIII). The silver vase contained gold jewellery.



Jewellery, Mohenjodaro (After Marshall, Pl. CXLIX). No.3 is a gold bracelet. (Other bracelets are made of blue glazed faience or a vitrified clay, dark brown or black on the surface, sometimes with very minute inscriptions). The gold spacers found with these beads show that they were originally threaded in six rows with semi-circular terminals of gold. The small beads were cast and the spacers cut out of sheet metal. No.4 below this bracelet is made of minute gold beads, globular and cylindrical in shape, interspaced with tiny globular beads of steatite, perhaps of original blue glaze. The small cylindrical pendants on the necklace are made of gold and glaze; the loops of thin gold ribbon wire. No.5 is of beads of various coloured stones, such as riband-jasper and carnelian, alternating with small gold beads; some beads are capped with gold. No. 6 is a string made of gold and glazed steatite cylindrical beads in five rows held by eight five-holed spacers. No. 7 is of flat gold beads, beads of onyx, green felspar and turquoise matrix and small globular beads. Nos. 1 and 2 are dome-shaped caps of the pendants with small gold loops inside. (After Marshall, Pl. CXLIX).



From inside out: No.1: A necklace of very fine beads of jade, jasper, carnelian, chalcedony and agate. The first bead is of gold; No. 2: beads of jasper, carnelian,

agate, lapis-lazuli and six of silver; No.3: stones of diverse materials, colours and shapes including two cleverly cut onyx eye-beads; No.4: extraordinary variety in shape, markings and colour. A long flat bead, oval in section was a favourite shape. This necklace also includes several skilfully cut 'cat's eye' onyx beads. (After Marshall, Pl. CL). Silver was used more freely than gold at Mohenjodaro. Maybe, silver was extracted from sulphide or chloride form, mixed with metals such as lead or copper. Gold used in Mohenjodaro, resembles electrum.



At a are specimens of fillets consisting of thin bands of beaten gold with holes for cords at their ends. The long carnelian beads of the necklace or girdle are 4.85 in. in length by 0.4 in. dia. The shorter beads are 3.25 in. in length. These beads are of a bright translucent red colour. They were bored from both ends, the holes averaging 0.17 in. dia. At each of the necklace or girdle there is a semi-circular terminal of hollow bronze like a flattened cup. The globular beads at each end of the stone ones are of bronze. Nos. 7, 8 and 11 are gold studs, 1.2 in. dia. apparently intended for the ears. Nos. 3-5 and 12-14 are gold needles. A number of bead-caps made of gold, coppery-red to pale yellow in colour are above No.9 which is a turquoise bead capped with gold. (After Marshall, Pl. CLI).



Jewellery, Mohenjodaro. No. 13 shows waste pieces of metal, probably the hoard of a goldsmith. (After Marshall, Pl. CLII).



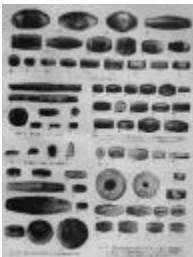
Beads: terracotta, shell, ivory, copper, silver, gold, steatite, Harappa and Ur (After Vats, Pl. CXXXIV).



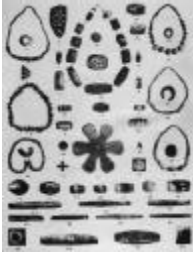
Beads: steatite disc, painted steatite, faience: black, yellow, white, variegated, blue or green (After Vats, Pl. CXXXIII).



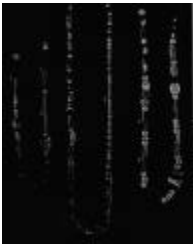
Beads: natural steatite, burnt steatite (After Vats, Pl. CXXXII).



Beads: agate, carnelian, jasper, chert, chalcedony, milky quartz, etched carnelian, limestone, stalagmite, marble, calcite, hornblende, serpentine, deorite, lapis and jadeite (After Vats, Pl. CXXXI).



Miscellaneous beads, Harappa (After Vats, Pl. CXXVIII).



Long barrel-cylinder beads from the Royal Graves of Ur; Akkadian Period (ca. 2250-1894 B.C.); 'a' is of dark green stone; bead 'b' is carnelian and 6.4 cm. long; bead 'c' is carnelian; Chakrabarti, D.K. 1982, Pl. 24.2. (UPenn Museum: 30-12-566 and 567; 32-40-227)



Terracotta figurines, Mohenjodaro, wearing jewellery (cf. Allchin, 1982, Fig. 8.14)



Jewellery from House 2, Trench IV, Mound F, Harappa (After Vats, Pl. CXXXVII).



Personal ornaments, unguent vases and inlay objects, Harappa (After Vats, Pl. CXXXVIII and CXXXIX).



Gold bead; Early Dynastic necklace from the Royal Cemetery; now in the Leeds collection.



Gold jewellery (two views) found in a Royal Tomb, Ur; the eight-petalled star is a motif found also in Kunal, Haryana, India.

Partly excavated burial of a lady-in-waiting to a Sumerian royal family of 2500 B.C. was moved intact from Ur to the University Museum of Pennsylvania. Amid the rich ornaments of gold may be seen the teeth of their wearer. From: Samuel Noah Kramer, 1957, *The Sumerians in: Old World Archaeology, Readings from Scientific American*, San Francisco, WH Freeman and Co.



Sumerian electrum helmet from the Royal Cemetery at Ur; early Dynastic III Period, ca. 2400 B.C.; After Prichard 1969b: 49, no.160; Parpola, 1994, p. 254. This helmet was made of beaten gold, in the form of a wig with a most elaborate hair-style. There is a knot of hair tied at the back, a twisted plait and a headband, and there are guards for ears and cheeks. It belonged to Mes-kalam-dug, the 'Hero of the Good Land'; he was perhaps a prince; a cylinder-seal with his name was later found in a queen's grave.



Ur, Ram in the thicket, Upenn Museum

The tiara from Kunal has eight petals and is reminiscent of the tiara in Pu-abi's grave

In Ur. A similar eight-petalled tiara adorns the 'ram in the thicket' made of gold plate, also found in Ur, Mesopotamia.



Kunal: Silver

ornaments



Kunal: spiralled silver bangles



Discular beads of gold with axial perforation, Mature Harappan, Lothal



Discular beads of silver
with axial perforation, Early Harappan, Kunal



Perforated jar (Use in gold purification, parase).
Its use will be further explained in the lexicon. (Pots and pans301kb.)

Potable gold:

'golden fleece' and replicating age-old processes in a Gold Museum

"...the origin of the legend of the Golden Fleece...The Argonaut legend was known to Homer...the search was for gold and woolled sheepskins were suspended in a stream to collect gold dust from running water. The skin was then suspended between trees to allow it to dry. Support for this view (which was first put forward by Strabo (xi.2.19; who died in AD 19) is gained from the statement in the legend that, when Jason snatched the golden fleece 'from the shimmering of the locks of wool there settled on his fair cheeks and brow a red flush like a flame.'... finer fleeces tend to have more grease; gold particles being not easily wetted, would stick readily to the grease. Sand particles on the other hand are wetted and would not stick (Barnes, J.W. 1973: Jason and the Gold Rush, Proc. Geol. Assn., 84, 482-5). (M.L.Ryder, The last word on the golden fleece legend? in: Oxford Journal of Archaeology, Vol. 10, No. 1, March 1991, pp. 57-60).

Alchemical tradition is documented in a text dated to the mid-second millennium BC in Mesopotamia; this is reminiscent of the Rigvedic agnis.t.oma which lasts for days and nights!

"For 5 shekels of pappardillu stone you mix one-third mina of mountain honey, 10 shekels of TA, one su_tu of milk, 4 shekels of red alkali and one-half sila of wine...You test on glowing charcoal... you pour into a stone bowl of algamis'u-stone (steatite)...lute with dough...you heat it for a full day on a smokeless fire. You take out and..for five days, it is (not?) reliable. You soak it in (liquid)...You boil alum and...in vinegar. You steep (the stone) in lapis lazuli-coloured liquid and place it in the

fire...Property of Nebuchadnezzar, king of Babylon." (Text 1, Bab. K. 713; A. Leo Oppenheim, RA, 60, 1966, pp. 29-45).



Ams'u! Leaf formation on gold from the Mother Lode, Nevada country, California (Encyclopaedia Britannica). "Gold in rocks usually occurs in invisible disseminated grains, more rarely as flakes large enough to be seen and even more rarely as masses or veinlets. Crystals about 2.5 cm. (1 inch) or more across have been found in California."



ore

Quartz containing gold



Pellets of gold ore (which look like plant stems)



Mortar and pestle used to crush the quartz



Molten gold being poured from a crucible into a vessel



a crucible into mould

Pouring molten gold from



Gold nuggets



Touchstone to test the quality of gold

Purification of electrum: ancient metallurgical processes related to gold, silver, lead

Sources of Sumerian gold (2nd half of 3rd millennium BC) "... (gold) bead... alloy of platinum-iridium-osmium and gold... found mostly in placer deposits.. At Muteh... NW of Isfahan.. most important deposits of gold known... Damghan lies on the lapis-lazuli trade route to Mesopotamia... lapis mines along the Kokcha river in the Afghan Hindu Kush... apart from possible Arabian and Indian gold.. Gold is known at Mokar and supplies from this area could have joined caravans carrying lapis-lazuli using the Helmand valley route via Shahr-i-Sokhta to the Persian gulf and then have arrived by the ships carrying the lapis, carnelian, tin and gold from Meluhha to Sumer." (K.R. Maxwell-Hyslop, Iraq, XXXIX, 1977, pp. 83-86).

Pliny described electrum as an alloy of gold and silver with one part of silver to four of gold. Normally, in mineralogy, argentiferous gold containing 20-25 per cent of silver is referred to as electrum. "Many of the rare analyses of Mesopotamian 'gold' show that it is in fact electrum, but whether a natural or a deliberate alloy is not invariably clear... Silver may only be separated from gold by a complicated process; but base metals may be slagged off by repeated meltings of native gold in an oxidizing atmosphere, routine in many goldsmithing techniques. Natural electrum can have a substantial copper content... Gold, whose distribution is almost universal, occurs either in veins of quartz rock (reef gold) or in alluvial sands and gravel (placer gold); a distinction found in the textual sources (hura_s.um s'a abnisu; hura_s.um s'a ma'e_s'u)... In its native state gold is always alloyed with silver in proportions that vary greatly; sometimes also with copper and traces of iron and other metals... Reef gold occurs as irregular masses in quartz veins or lodes. The mining process consists first of freeing the gold particles by crushing and sifting the ore, then of separating the gold by making use of the metal's higher density. The classic description of gold-mining in antiquity is that by Agatharcides, preserved by Diodorus Siculus (iii.12-14, 3-4) who, in the second century BC, visited and graphically described the rigours of gold-mining in Egypt (cf. Lucas 1962: 224ff.)... (Royal cemetery at Ur)... a spearhead (U.9122) has 30.30 per cent gold, 59.37 per cent silver, and 10.35 per cent copper (Woolley 1934: 294: table III). The famous rein-ring from RT 800

(Pu-abi) has an equid of electrum (whether natural or artificial is an open question), comprising 65.60 per cent gold, 31.45 per cent silver, and 2.65 per cent copper, whilst the ring on which it stands is virtually sterling silver (93.5 per cent silver, 6.10 per cent copper, and 0.08 per cent gold). Bowls from PG 755 are also gold-silver-copper alloys (Woolley 1934: 294)... Cupellation will remove metals from silver or gold, but by itself will not remove silver; adding salt enables silver to be removed from gold (cementation)...

Agatharcides (2nd century BC) describes how in Egypt gold-bearing ore was found and washed until more or less pure gold dust remained. This dust was put "into earthen pots. They mix with this a lump of lead according to the mass, lumps of salt, a little tin and barley bran. They put on a closely-fitting lid carefully smearing it with mud and heat it in a furnace for five days and nights continuously; then they allow the pots to cool and find no residual impurities in them; the gold they recover in a pure state with little wastage. This processing of gold is carried on round about the most distant boundaries of Egypt." (Healy 1978, 154) "The procedure was tested in 1974 (Notton 1974) with an alloy of copper and silver containing 37.5% of gold. It was found that heating the pots filled with the alloy and salt gave the highest gold recovery rate of 93%. Including tin, lead or charcoal reduced the efficiency to less than 80%. Healy concluded that the account given by Agatharcides 'seems to be an example of the conflation of at least two processes' (154)..Arthas'a_s'tra mentions salt among the articles necessary for purifying gold: KA 02.14.23 mu_kamu_s.a_ pu_tikit.t.ah karat.ukamukham na_li_sam.dam.s'o jon:gani_suvarcika_lavan.am tad eva suvarn.am ity apasa_ran.a ma_rga_h". (Diodorus-III,14,3-4; loc. cit. Harry Falk, Refining gold in ancient India : ad JUB 3.17,3 in: Acta Orientalia 1997: 58, 47-51).

Barley husks would burn away and the base metals oxidized and absorbed by the crucible (silver is converted to silver chloride by the salt.) (R.J. Forbes, in: Singer et al., A history of Technology, 1954, pp. 573-587).

For cupellation, the gold is alloyed with lead in a special clay vessel, known as a cupel, and the product oxidized by a strong current of air blown into the surface of the molten metal. The base metals are consumed, or drossed, as the oxides formed are absorbed by the porous walls of the

cupel, whilst gold and silver survive. Precisely what form cementation took before the classical authors offer descriptions of it (Diodorus Siculus, III.xiv.1f. (after Agatharcides); Strabo, III.ii.8) is a matter of continuing debate. Notton (Notton, JHF, 1974, Ancient Egyptian Gold Refining: a reproduction of early techniques, Gold Bulletin, 7(2), 50 ff.) experimented with the method described by Diodorus Siculus and it proved very successful. A series of tests were conducted in a nine-carat alloy (in the absence of a suitable gold ore). In the first, salt and the gold alloy were smelted under various circumstances. After five days heating at 800deg. C, gold recovery was high. It was less so when salt, brick dust, and the alloy were used and also when tin and lead were added in two different ways. The presence of tin to a greater extent, lead to a lesser, inhibited the recovery rate. On the evidence of these experiments, earlier suggestions about ancient methods of cementation gain extra credence. The Sardis excavators argued that 'the gold is hammered into thin sheets, which are then stacked in a vessel with layers of dry 'pickling mixture' like common salt or alum, and heated for a long time, c. 700 deg. C. Silver especially combines with salts and the gold is left pure (Ramage A. 1970, 'Pactolus North' in GMA Hanfmann and JC Waldbaum, 'The Eleventh and Twelfth Campaigns at Sardis' (1968,1969), Bulletin of American Schools of Oriental Research (Jerusalem and Baghdad) 199: 22-3) . Comparable techniques may have been current in Mesopotamia by at least the Old Babylonian period, to judge from the appearance in the Mari texts of the term lurpianu (a salt?), which is associated with the preparation of gold in contexts suggesting cupellation or a comparable process (Limet.H., 1986, Textes administratifs relatifs aux metaux (Archives Royales de Mari 25, Paris): 288)... The role of assaying in ancient Mesopotamia, in which a sample is removed for analysis, is no clearer. Assay by fire, used in a qualitative not a quantitative way, is described in the Leyden Papyrus (X, no. 3: Oddy, W.A., 1983, Assaying in Antiquity, Gold Bulletin, 16(2), 52-9), but how early such tests were used is unknown: 'If the gold is pure, it keeps the same colour and remains pure like coinage after heating. If it appears whiter it contains silver; if rougher and harder, it contains copper and tin; if black and soft, it contains lead.' The use of a touchstone (Lapis Lydius, i.e. black chert) to test the relative purity of gold (its approximate carat value in modern terms) is attested by classical authors from at least the sixth

century BC (Theognis, 417; Pindar, Pythian, X.67). Theophrastus (de Lapidus, 45) attributes them to the river Tmolus in Turkey. In this case it is siliceous schist (flinty state), black in colour, usually for this purpose deep black, fine-grained; but other black stones may be used.. Streaks are taken from gold alloys of known, graded composition for comparison with streaks taken from the metal to be assayed (cf. Oddy 1983; Moore and Oddy 1985)... Eluere (1986: 59) has shown that two stones from a late third-millennium grave at Telloh (called a 'goldsmith's tomb') exhibit no traces of gold and are not suitable for use as touchstones; the same is likely to be true of an example identified at Larsa in a 'jeweller's hoard' (cf. Arnaud et al. 1979: 20-1, 23, fig.8). These haematite objects are either weights or burnishing stones, as may be the case with a gold-streaked stone reported from Assur (Pedersen 1985: 123, n.7); this type of stone is not appropriate for use in a touchstone...

Sumerian literary texts refer to gold from Aratta (Pettinato 1972: 79). Gudea records receiving gold from the mountain of Hah(h)um (Statue B. col. VI. 33-5; Liverani 1988), taken to lie in that part of modern Turkey near Samsat on the Upper Euphrates, and from Meluhha. In far less explicit terms the names of various mountains reputed to have gold sources are also recorded (Limet 1960: 94). Various texts refer to the almost mythical land of gold known as (H)arallu, perhaps somewhere in the Iranian hinterland (Komoroczy 1972; Groneberg 1980: 20). Shu-Sin (c. 2037-29 BC) refers to gold from 'Su-land', probably in western Iran, though its location is still open (Edzard, D.O., 1959-60, Neuen Inschriften zur Geschichte von Ur III unter S'usuen, Archiv fur Orientforschung (Graz) 19, 1-32): 16-18) and from (Mar)daman, possibly identical with Mardin in south-east Turkey (ibid.: 7; Edzard and Farber 1974: 118). Documents relevant to the Dilmun, trade in the later third and earlier second millennium BC indicate that some gold was still reaching Ur up the Gulf at this time, but whence it came, perhaps Meluhha, is not stated (Oppenheim, A.L., 1954, The Seafaring Merchants of Ur, Journal of the American Oriental Society (New Haven, Conn.) 74, 6-17: 7; Leemans, W.F. 1960, *Foreign Trade in the Old Babylonian Period as revealed by texts from southern Mesopotamia* (Leiden): 120-1, is more cautious; cf. Leemans, W.F., 1957-71, Gold, Reallexikon der Assyriologie und vorderasiatischen Archaologie (Berlin) 3, 504-31). The renowned resources of Egypt and Nubia (cf. Lucas 1962: 224-

8) contributed most certainly in the fourteenth century BC to Mesopotamian royal gold holdings (Edzard 1960; Wilhelm 1974). Then, for the first and only time in its history, Babylonia may have adopted the gold standard and large amounts of gold came from Egypt to assist Kurigalzu I in his major building projects (Brinkman 1972: 274-5; Muller 1982; Powell 1990: 79-82). Hittite inventory texts of the thirteenth century BC record gold from Babylon and Lukka (Lycia) (Kosak 1982: 195)...

So far as is known, there were no sources of gold exploited in antiquity in Mesopotamia, Syria, or Palestine; but the metal is widely reported on the periphery of this region (Maxwell-Hyslop 1977): in Turkey, where there is a preponderance of sources in the west and south-west (Jesus 1980: 82 ff.); in Egypt and Nubia (Lucas 1962: 224-8); in considerable quantities in western and southern Arabia, not least in Ophir (I Chron. 29: 4; 1 Kgs. 10; Job 22: 24; cf. Maisler 1951), being well known to both biblical and classical authors (Diodorus Siculus, III, xlv. 6 ff.; Strabo, xvi. 4,18,22: Periplus, 36, etc.); in greater Iran, notably in the north of the country and eastwards into Transoxiana and the region of modern Afghanistan, where there are substantial vein and placer deposits (Dunlop 1957; Chmyriov et al. 1973). Diodorus Siculus (II.xxxvi.2) and Pliny (Natural History, xxiii.66) refer to rich sources in India, though traces are no longer easy to detect (Allchin 1962; Ratnagar 1981: 106 ff.) With so wide a range of potential sources within her orbit, many of them in regions whence she is known to have received other metals. Mesopotamia is likely to have had a variety of choices if and when supplies were for some reason blocked in any particular locality. It will be immediately clear that the ancient texts already considered indicate import at various times from all the potential sources zones listed here.

The wide distribution of potential sources does not ease the quest for a scientific method through which Mesopotamian gold sources might be 'finger printed'. It is known that platinum group elements (hereinafter called PGE) such as ruthenium, rhodium, palladium, osmium, iridium, and platinum occur in gold objects from the ancient Near East both in solid solution and as inclusions.. On the evidence of the inclusions of the platinum-iridium alloy in a number of Sumerian and other ancient gold objects, notably Lydian gold coins supposedly of gold from the Pactolus valley in western Turkey, Young (W.J. 1972; cf. Whitmore and Young

1973) argued that this region has been an important source of Sumerian gold. Within a few years Ogden (1977), after a comprehensive review, concluded that direct correlation of a gold object and its metal source through the PGE inclusions was not feasible. Maxwell-Hyslop (1977) also questioned the Whitmore and Young hypothesis, pointed to other more likely and closer sources for Sumerian gold, both in eastern Turkey and in Iran... The gross distinction seems to be that the Sumerians drew upon sources of gold other than those most easily accessible to western regions...

Silver... Silver is found in nature both as a metal and in its non-metallic state. It also occurs in practically all gold. Native silver is rare (20 per cent is abundant as gold; 0.2 per cent as abundant as native copper) and is usually found in quantities not worth melting to make larger, workable lumps (Patterson 1971)... The principal ores of silver are the sulphides (argentite: silver glance) and the chlorides (cerargyrite: horn silver), which yielded up their metal by simple smelting. It has long been generally assumed that most of the silver used in the Near East in antiquity was extracted from argentiferous lead ores, notably galena (lead sulphide) and cerussite (lead carbonate)...it appears, Aegean silver was largely produced from galena.

Two steps are involved in producing silver from lead ores. Lead ore is melted first under the appropriate reducing and/or oxidizing conditions to produce metallic lead. Silver is then extracted from the lead by cupellation by which the lead is oxidised to litharge (lead oxide), leaving behind the silver. For this the lead is heated under strongly oxidizing conditions in a cupel. The lead oxide so formed is absorbed in the porous material of bone or ground-up potsherds in the cupel, leaving silver metal behind. This process may be repeated several times to purify the silver; it is very efficient in freeing silver from such common impurities as copper, antimony, arsenic, tin, iron, zinc (less well for bismuth), in the argentiferous lead. Silver derived from argentiferous galena will be characterized by gold contents from zero to about 0.5 per cent, lead contents between 0.01 per cent and 1 per cent, or rarely a little higher (Gale and Stos-Gale 1981: 107). Silver derived from the native metal, with or without admixture of cerargyrite (a 'dry silver' ore very easily reduced to silver metal), will generally contain

less than 0.01 per cent gold and significant quantities of mercury (ibid.). It is possible that silver was recovered sometimes from the cementation process through which electrum was purified into gold. But there is, as yet, no hard evidence for this from literary, archaeological, or analytical sources, in the area and time range considered here.

It has recently been suggested that liquation, using lead metal to extract silver from copper, thought first to have been described by Agricola in the Renaissance, had already been practised in the Late Bronze Age in installations excavated at Ras Ibn Hani in Syria (Bordreuil et al. 1984: 404-8, figs. 4-5). This identification is doubtful. The Old Babylonian texts from Mari cited in support of the existence of this process in the Near East in the second millennium BC do not sustain the case. They indicate that 'mountain copper' was 'washed' (?purified/refined) to produce 'washed copper' and that lead was used with silver to produce 'washed silver'; but they do not show that lead was added to copper to produce 'washed silver'; but they do not show that lead was added to copper to produce 'washed' silver, which is what would be expected if they are to be taken as evidence for the extraction of silver from copper by liquation (Bordreuil et al 1984: 4071 citing Durand). That lead was plentiful in excavations at Ras Ibn Hani is not relevant to this question. What matters is the method of purifying, and there is no reason to suppose it was liquation either at Mari or at Ras Ibn Hani (cf. Muhly, J.D., 1988, The wider world of lead ingots, Report of the Department of Antiquities (Cyprus, Nicosia) 263-5).