

ANCIENT ANATOLIAN METALLURGY

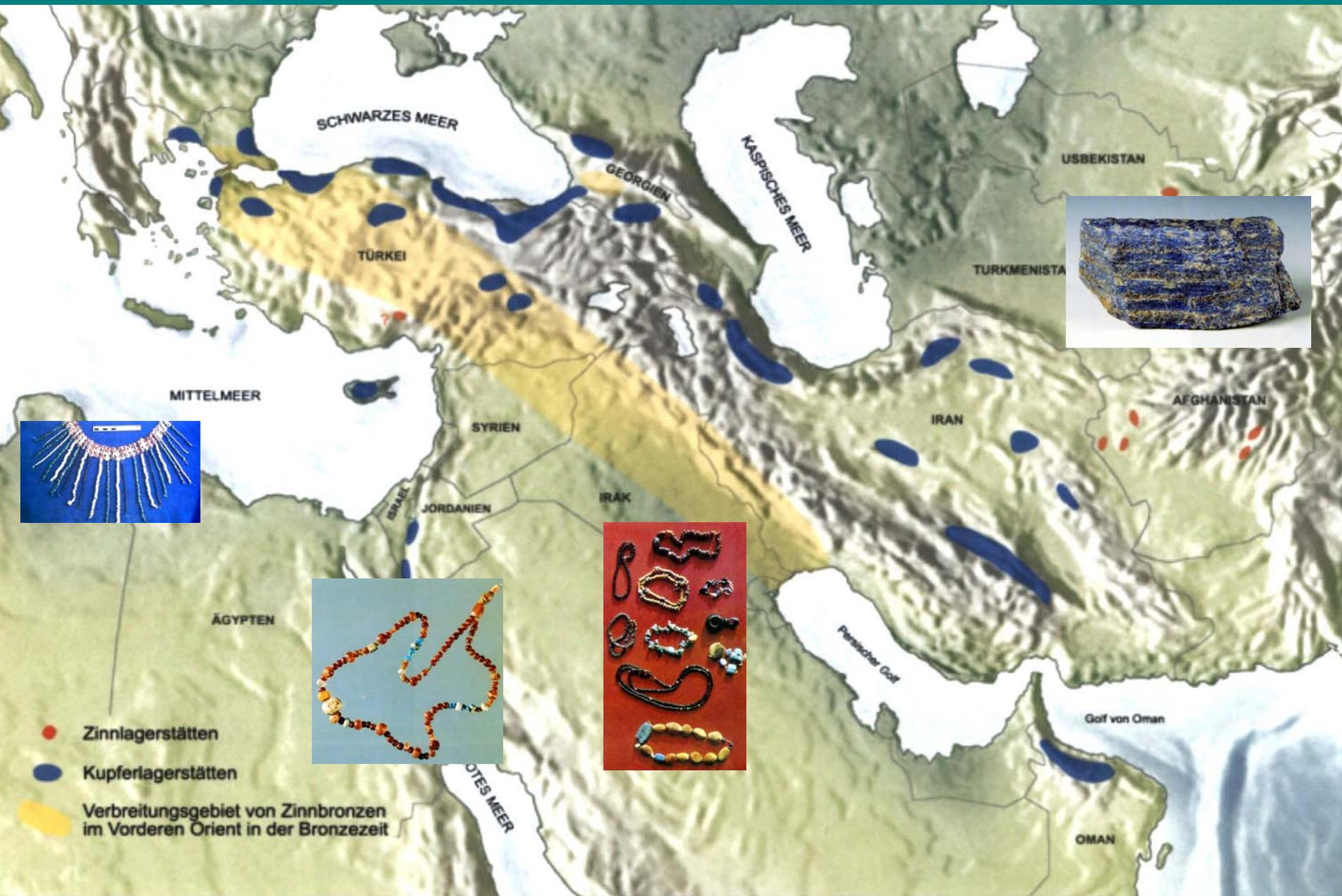
Hadi Özbal

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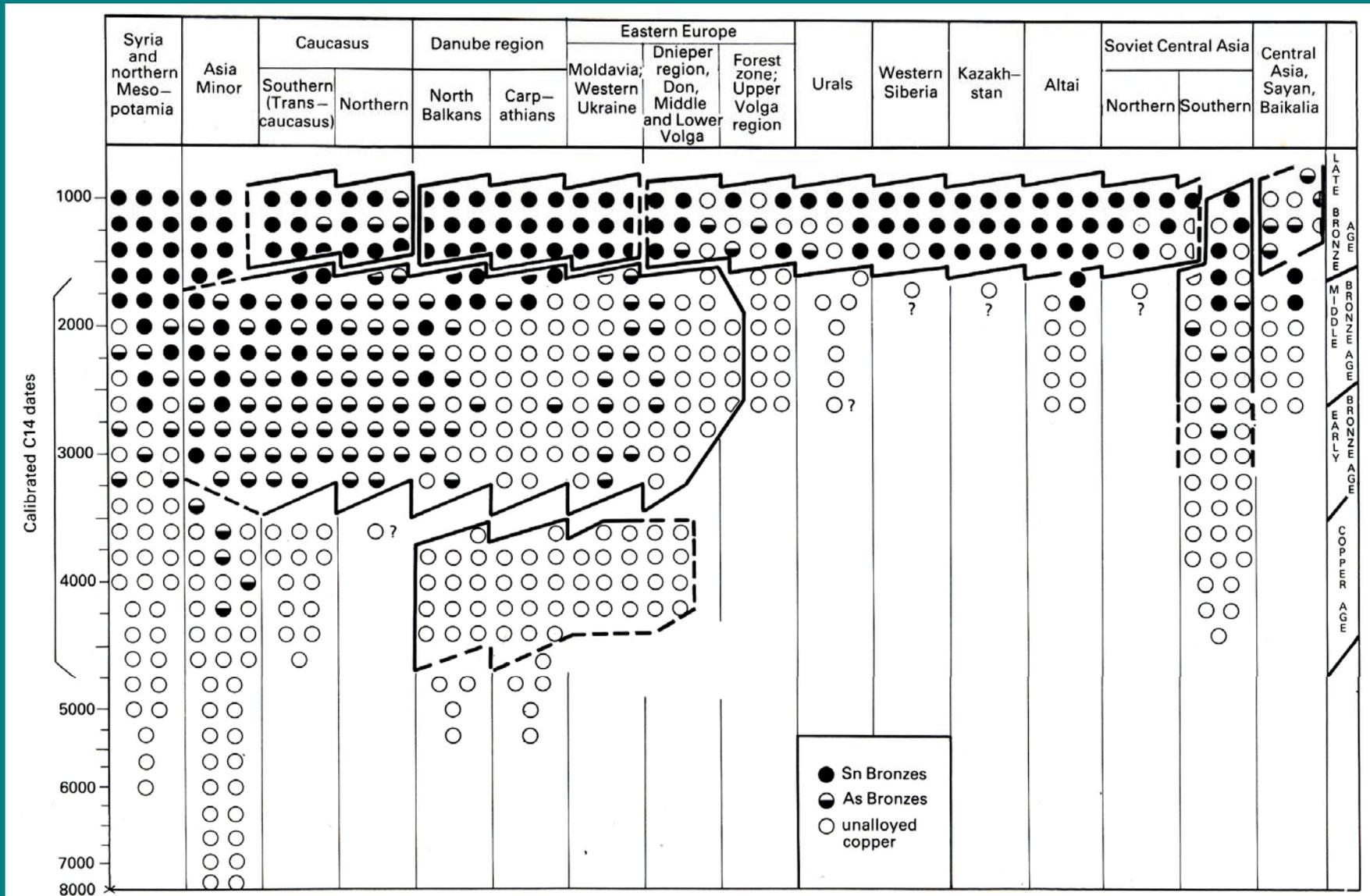
STAGES OF EARLY METALLURGY IN ANATOLIA

- Non-metallic period (prior to 8200 BC)
- Single metal period (after 8200 BC). Mainly native copper is shaped for simple tools and beads.
- Beginning of extractive metallurgy (after 5000 BC). Reduction of copper ores.
- Advanced metallurgy (after 4000 BC). Reduction of polymetallic ores, first alloys of copper, Appearance of silver.
- Industrial Period (after 2800 BC). Production of bronze followed by iron during the 1st millennium BC. Parting of gold.



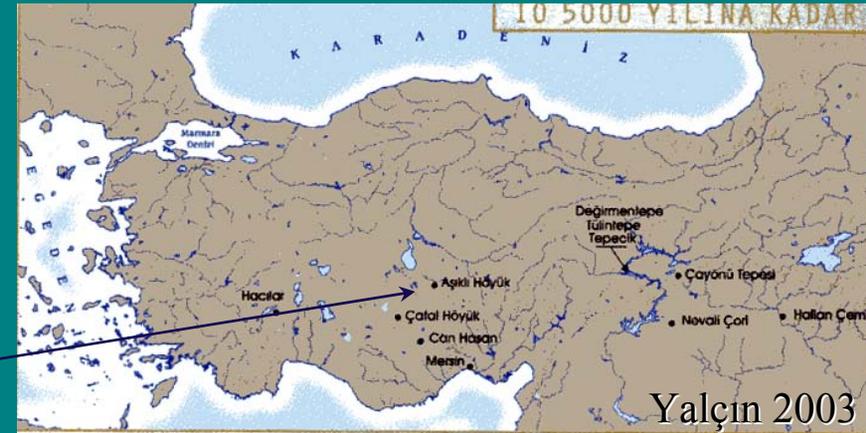
- Zinnlagerstätten
- Kupferlagerstätten
- Verbreitungsgebiet von Zinnbronzen im Vorderen Orient in der Bronzezeit

EARLIEST COPPER AND COPPER ALLOYS

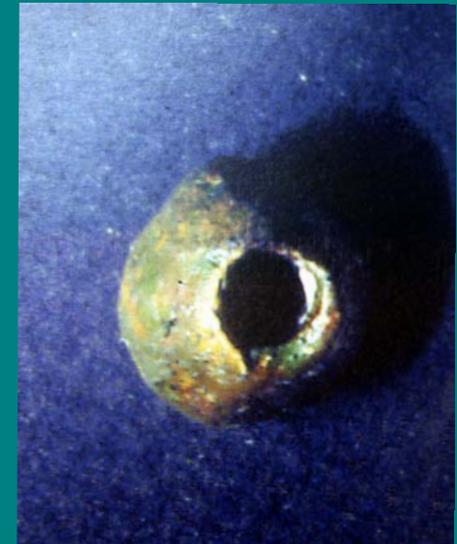
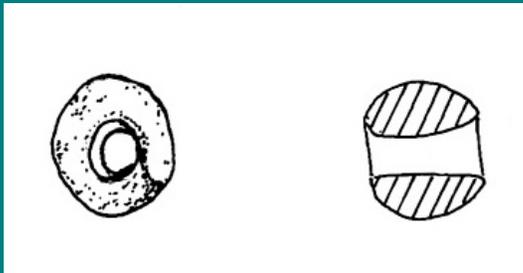


Chernykh, 1992

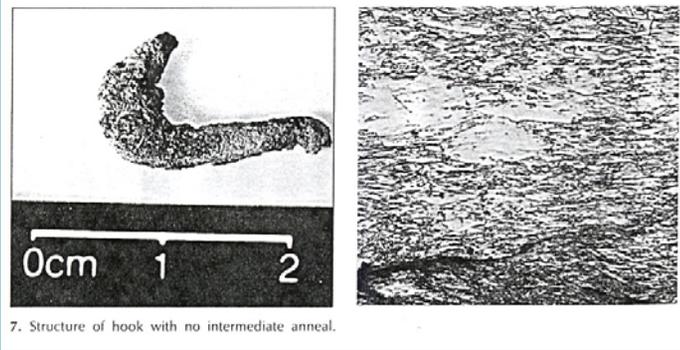
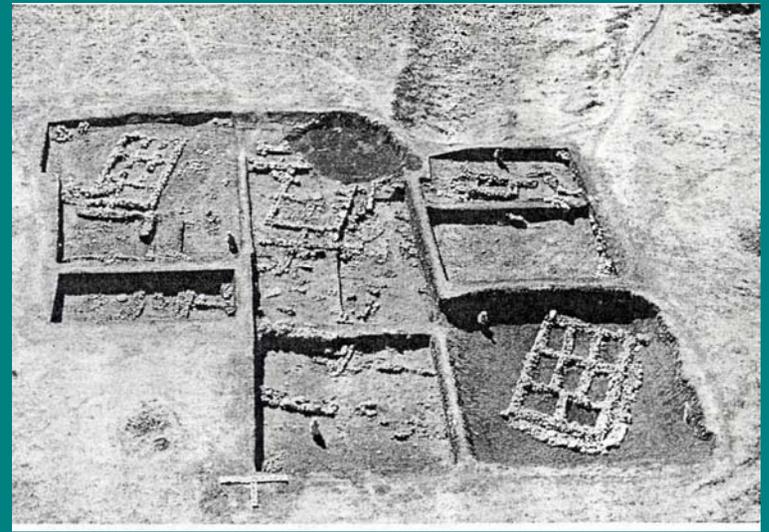
Aşıklı Höyük: A Pre-pottery Neolithic settlement in Central Anatolia



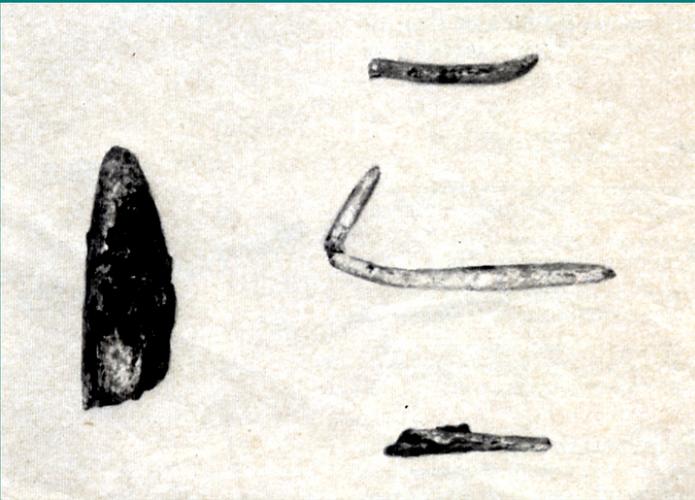
Copper beads made from native copper.



ÇAYÖNÜ

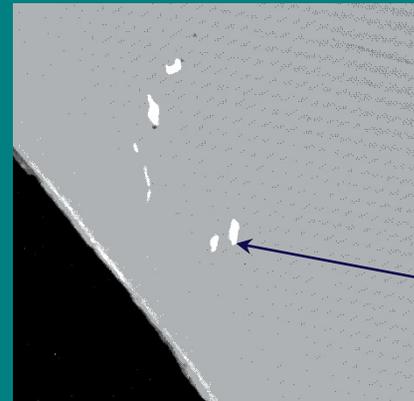
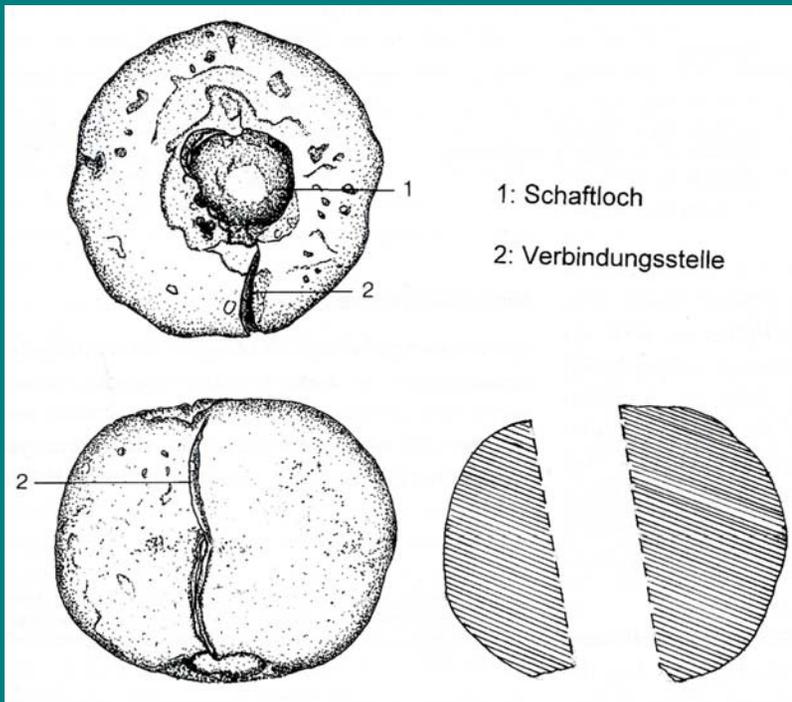


7. Structure of hook with no intermediate anneal.



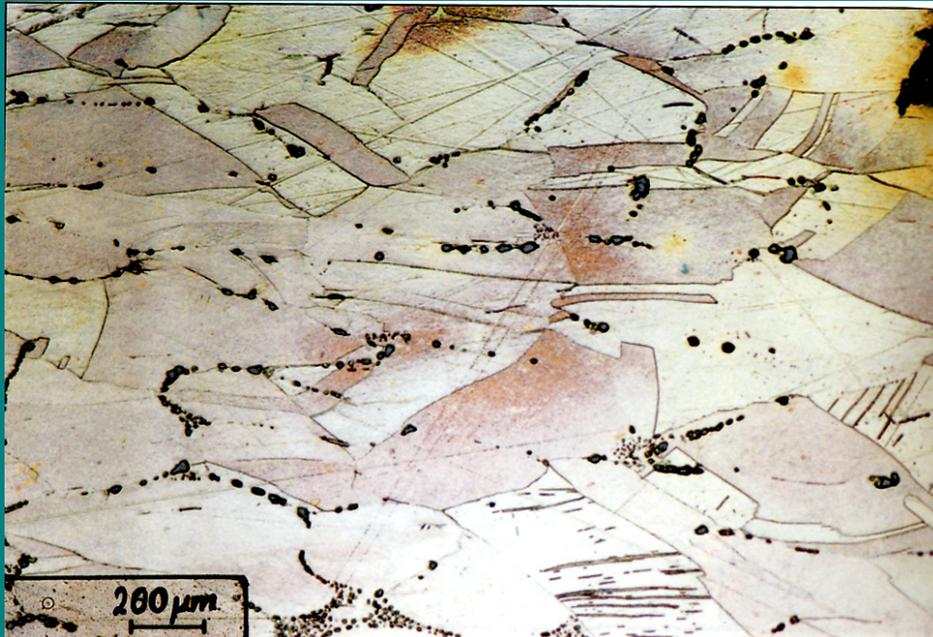
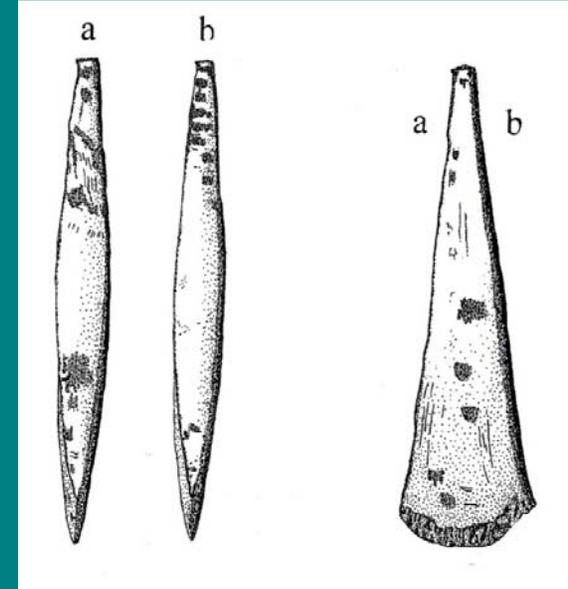
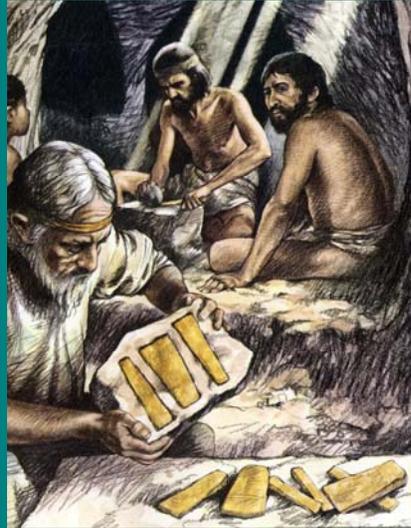
CAN HASAN MACE HEAD

6000 - 5900 BC



Silver crystals

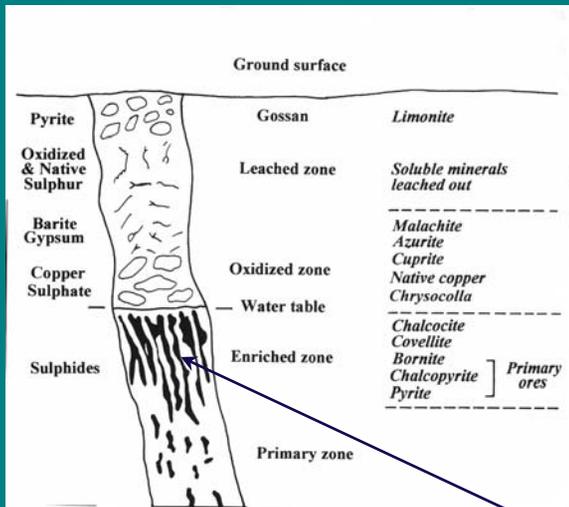
Development Stage: Onset of Extractive Metallurgy (after ca. 5000 BC)



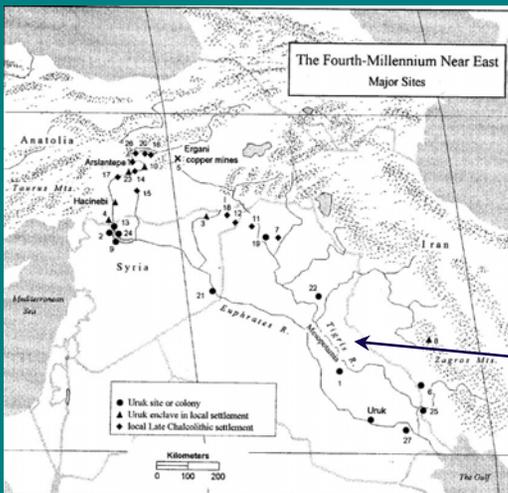
Tools from Mersin
smelted copper
(5000-4900 BC)



Organization/Experimentation Stage: Advanced Metallurgy (After ca. 4000 BC)



(Hendersen, 2000)



(Stein, 1999)

- Utilization of polymetallic ores.
- First unintentional copper alloys that contain arsenic, when tenantite and energite ores are smelted.
- Production of silver by cupellation.
- Establishment of long distance metal trade: The Uruk trade network.

Metallurgy at Arslantepe and İkiztepe



Silver inlay



İkiztepe ceremonial spearhead

% Cu	% As	% Ni	% Zn	% Fe	% Sb
86,4	9.52	0.15	0.05	0.09	0.07

Arsenical copper swords

Use of Silver



Silver artifacts from Arslantepe royal tomb

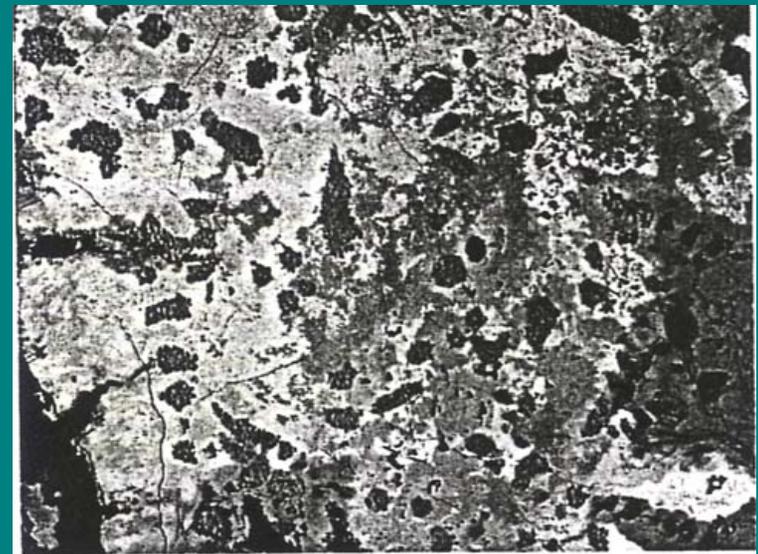


Fig. 8: Fatmalı-Kalecik, litharge No. TR 24/7. Inclusions of silver in lead oxide. Small black spots of silver chloride are scattered on the silver metal (gray). According to EDX measurements, the Ag concentrations in the lead oxide are slightly higher nearby these inclusions than in other parts of the litharge cake. Electron micrograph, BSE image. Length of image about 0.41 mm.

Pernicka 2000

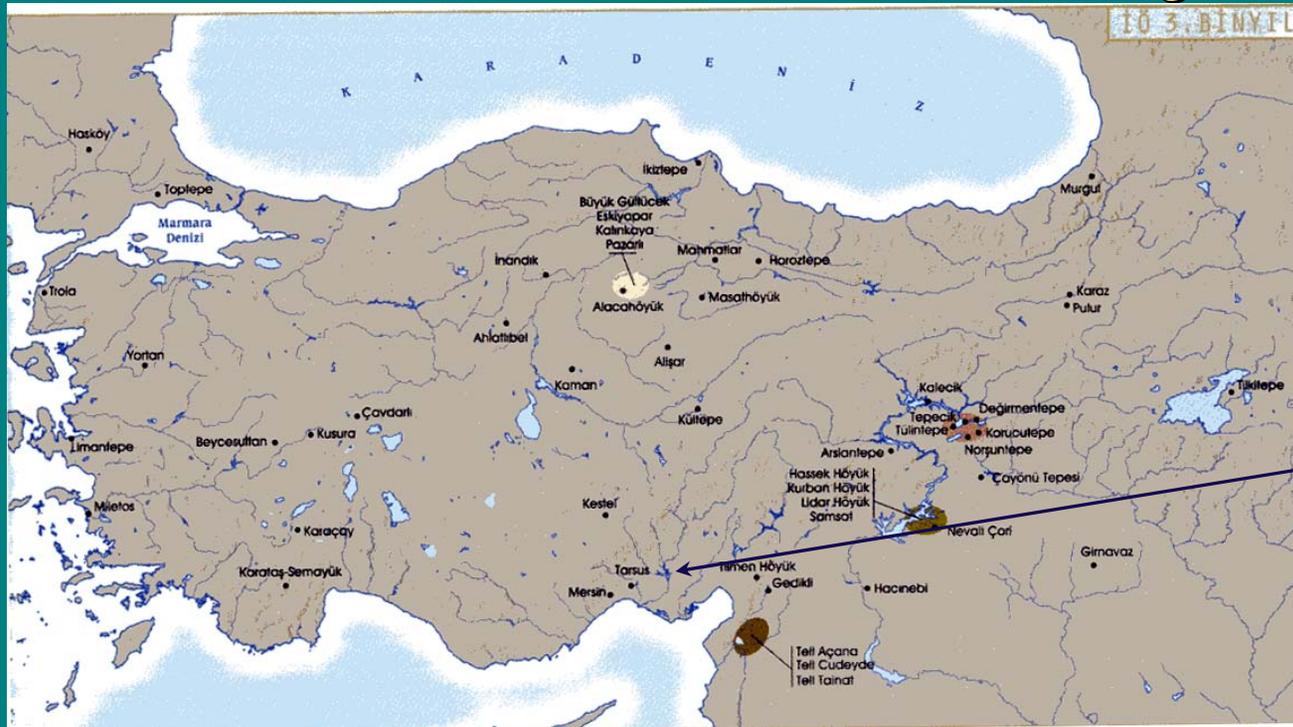
Table 6: Fatmalı-Kalecik, litharge No. TR 24/7. WDX micro-analyses of a silver inclusion in wt%. Abbreviation: n.d. = not detected.

	Ag	Pb	As	Au	Cu	total
1	95.0	6.4	n.d.	0.03	0.01	101.4
2	97.0	5.9	n.d.	n.d.	0.04	103.0
3	88.9	9.4	0.14	n.d.	n.d.	98.4
4	90.1	7.9	0.52	0.04	n.d.	98.6
5	95.6	4.8	0.61	n.d.	0.08	101.1
6	96.5	5.9	n.d.	n.d.	0.08	102.4

Litharge from Fatmalı Kalecik

Industrial Stage: Bronze and Iron Ages (after ca. 2800 BC)

- Earliest bronze objects appear in Anatolia
- Documentation of long distance metal trade
- Mass production of copper
- Earliest experimentations in production of iron and steel
- Full use of iron after ca. 1000 BC
- Parting of Gold



UTILIZATION OF BRONZE DURING EARLY BRONZE AGE

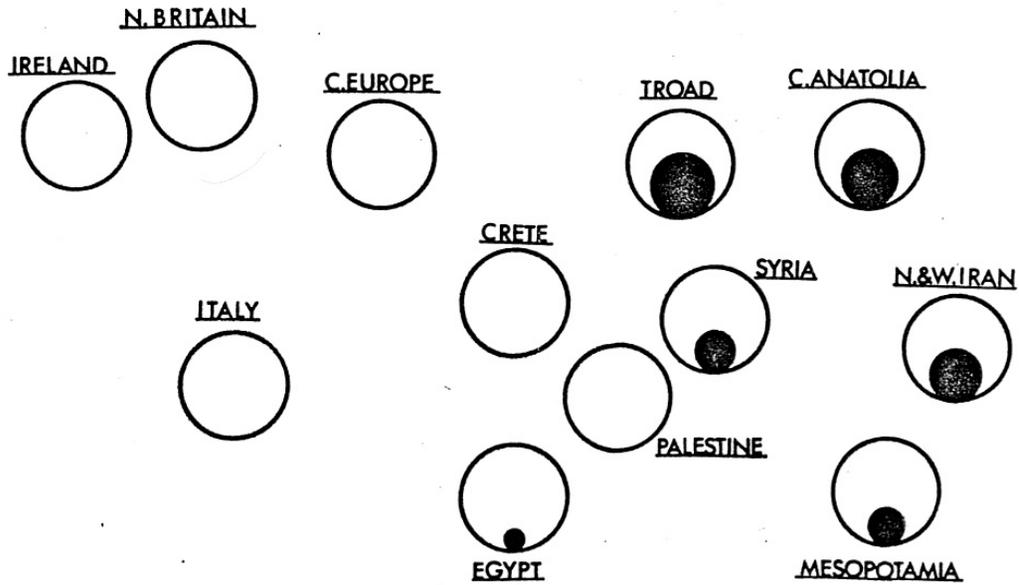


Figure 9 Percentages of copper-based artifacts containing more than 5 percent tin for Europe and the Near East, ca. 2700–2200 BC

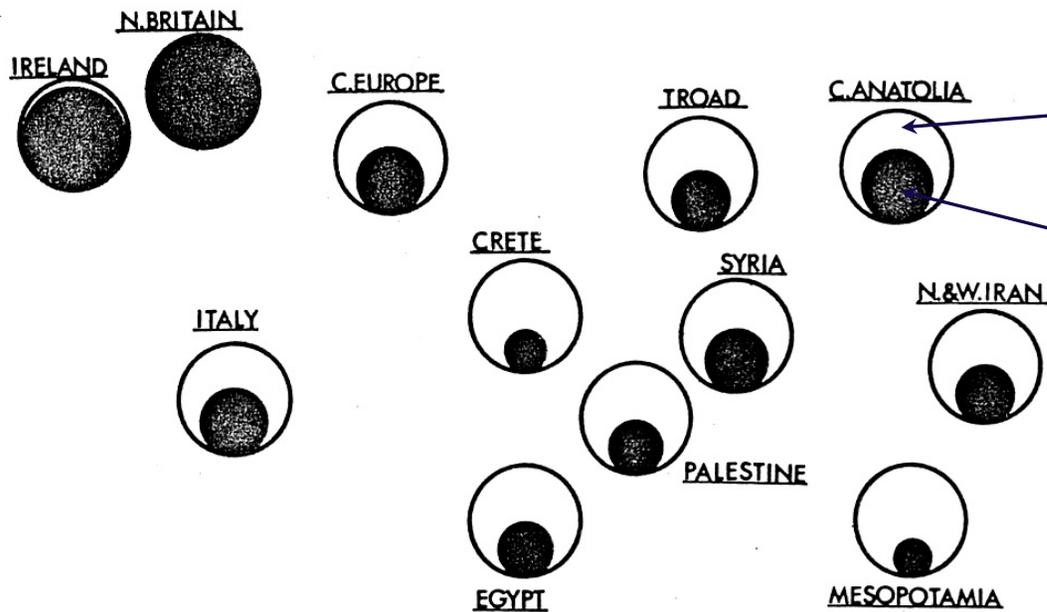


Figure 10 Percentages of copper-based artifacts containing more than 5 percent tin for Europe and the Near East, ca. 2200–1800 BC

Percent bronze artifacts
between 2700 - 2200 BC

Copper

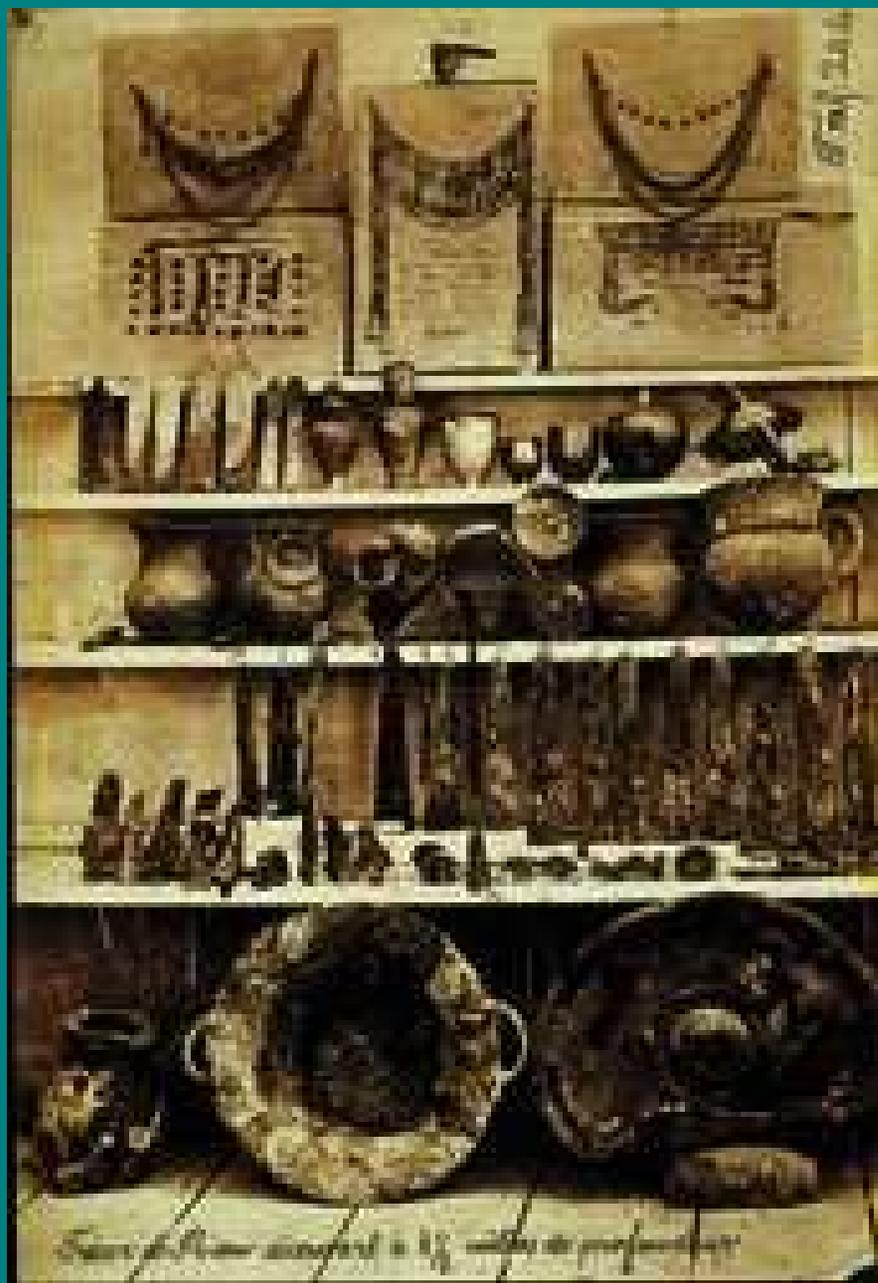
Bronze

Percent bronze artifacts
Between 2200 - 1800 BC

SITES THAT YIELDED BRONZE OBJECTS DURING THE 3rd. MILLENNIUM BC IN ANATOLIA



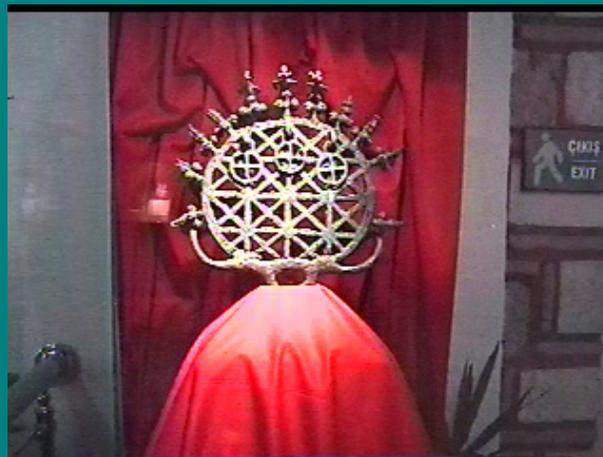
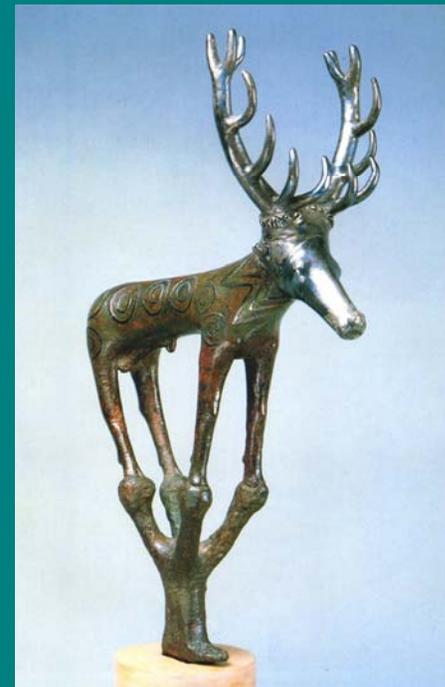
TROIA HOARD EBA II



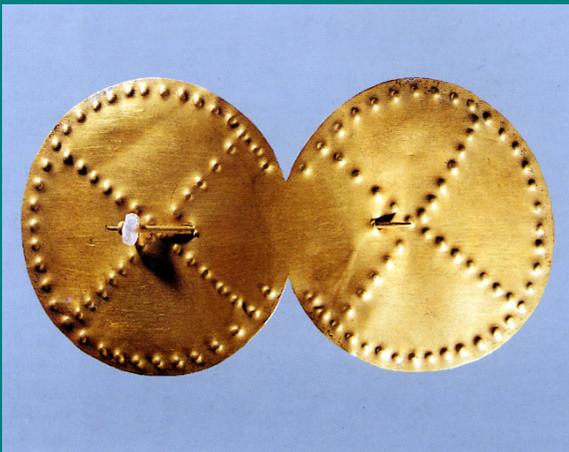
ALACAHÖYÜK EBA OBJECTS



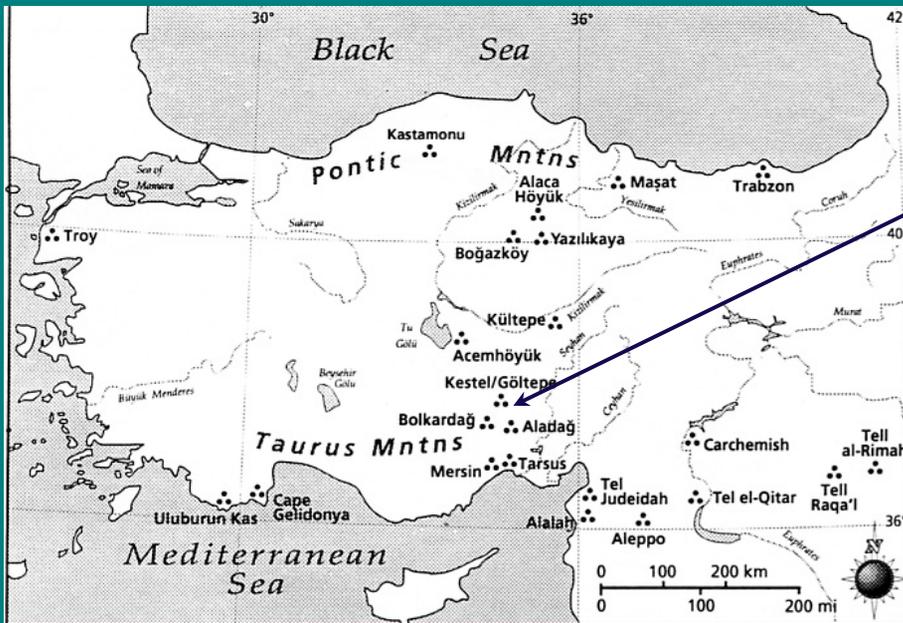
Royal tombs



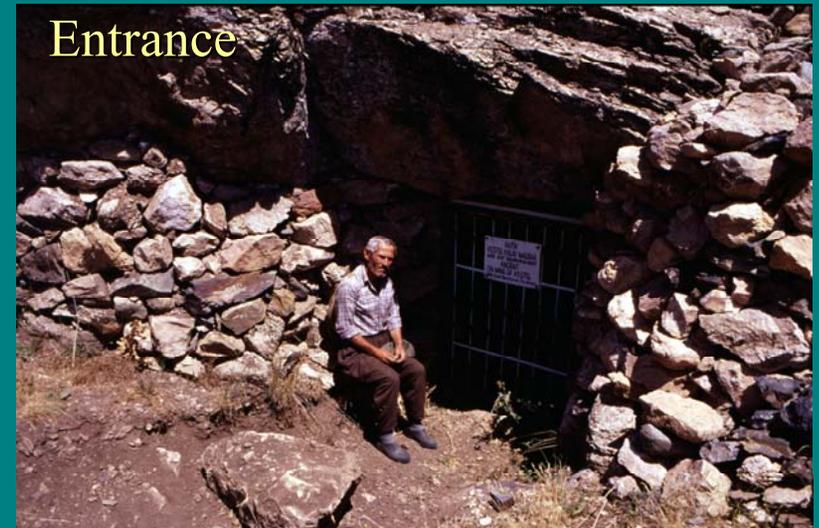
ALACAHÖYÜK GOLD



Kestel Tin Mine



Ore processing



Entrance

KESTEL GALERIES 2800-2200 BC

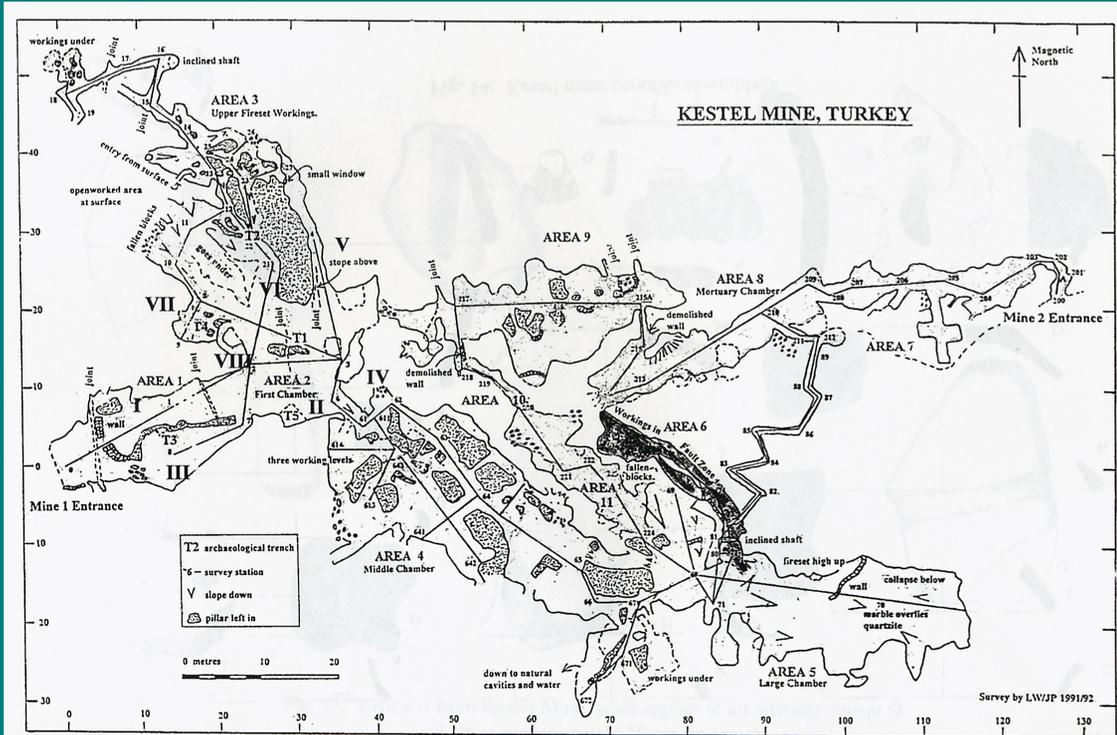
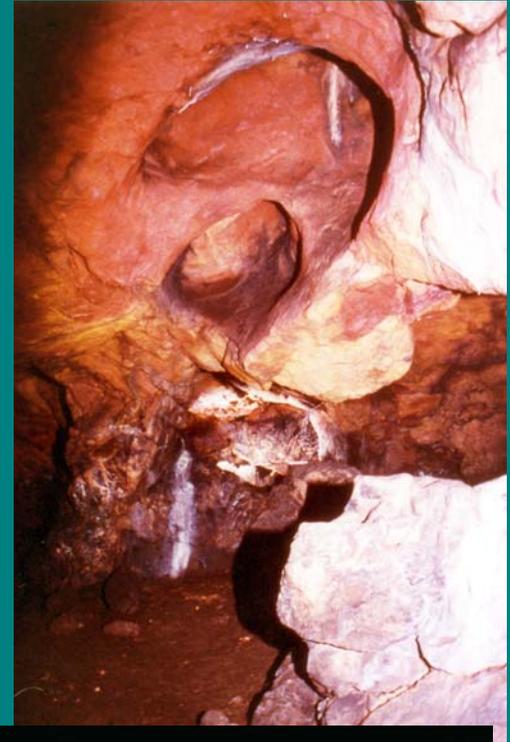
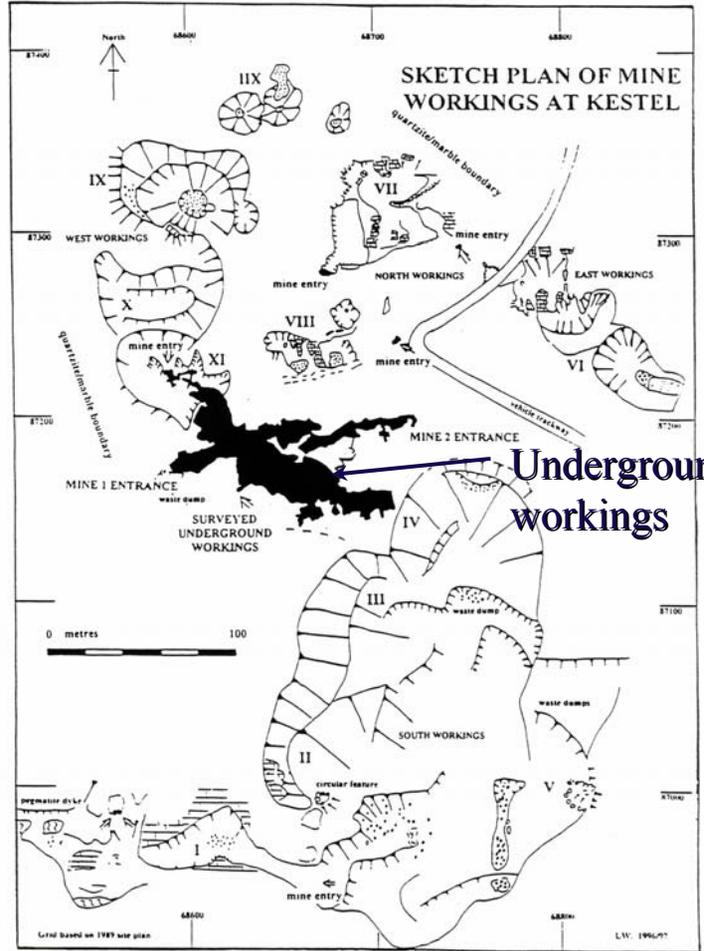


Fig. 15: Plan of Kestel mine. Lynn Willies



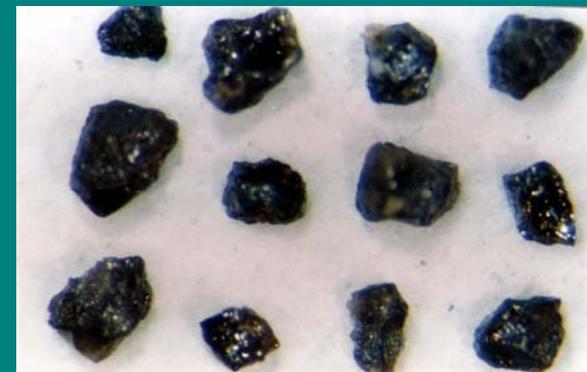


Underground workings



Mining tools from the galleries.

**Kestel
Cassiterite**



GÖLTEPE WORKSHOP



Göltepe grinding
and crushing tools



Excavations at Göltepe



Workshops at Göltepe



Furnace remain



Göltepe Materials

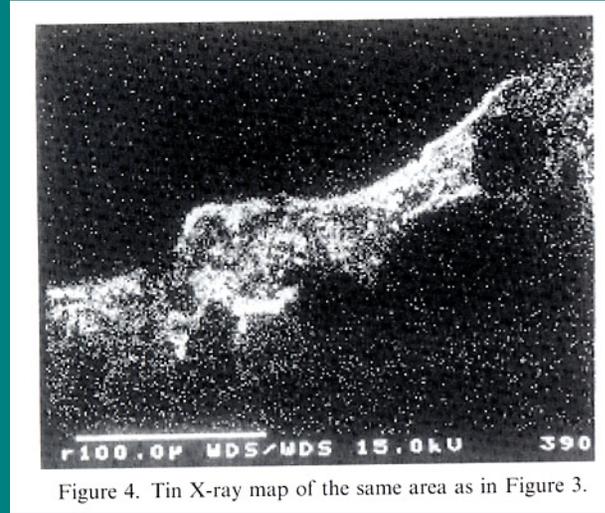


Figure 4. Tin X-ray map of the same area as in Figure 3.

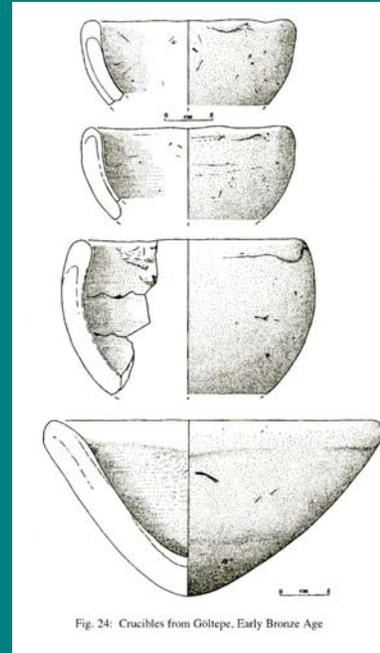


Fig. 24: Crucibles from Göltepe, Early Bronze Age



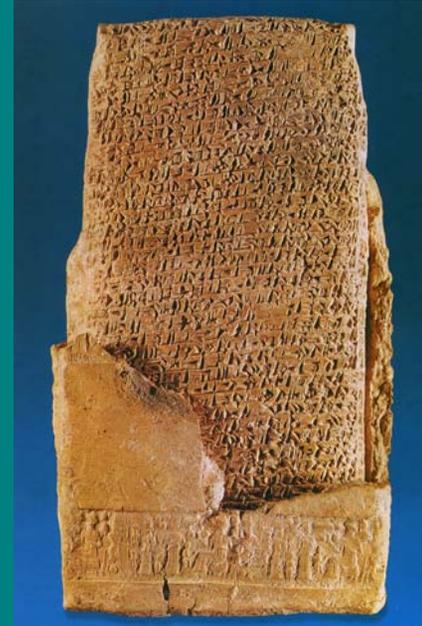
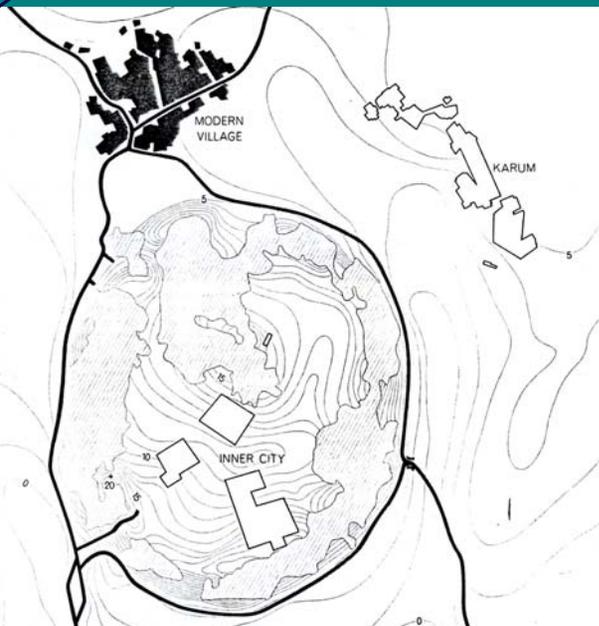
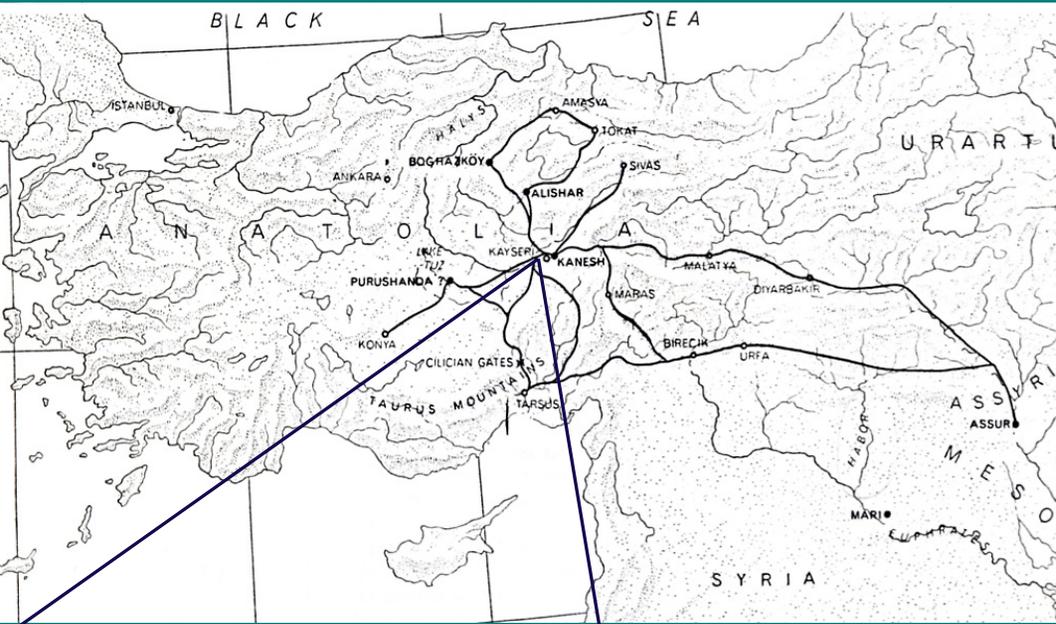
Plate 9: Large storage vessel containing ground ore material, Pithouse 6, Göltepe, Early Bronze Age.



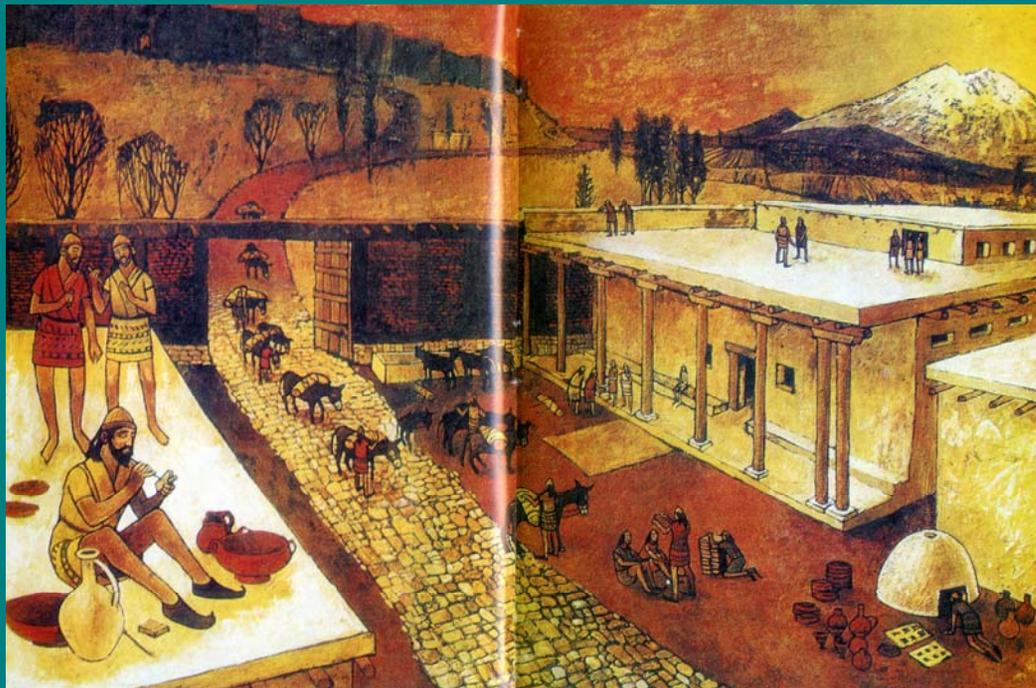
3rd MILENNIUM SITES WITH BRONZE



Beginning of Historical Age

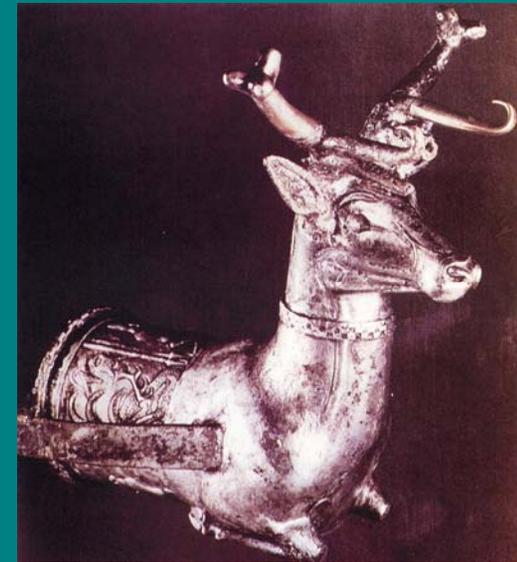
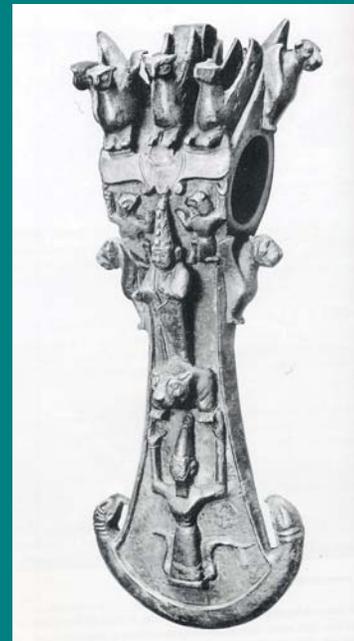


ASSYRIAN TRADERS AT KARUM

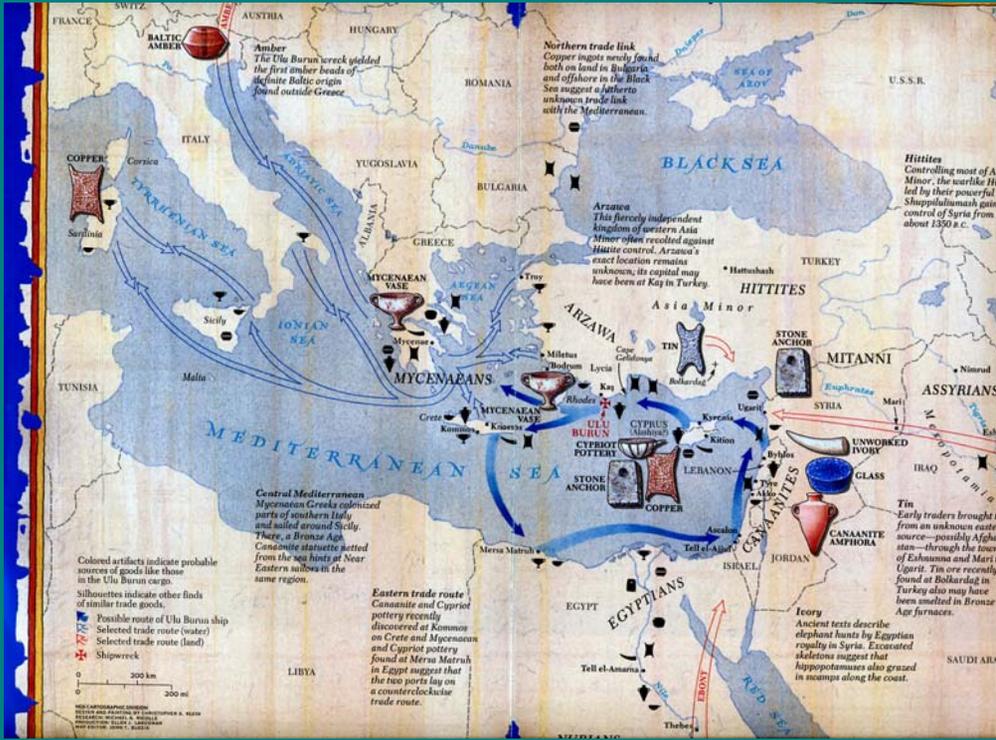


Acemhöyük Silver Workshop

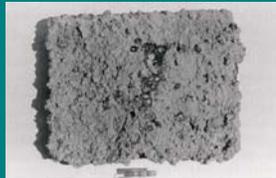
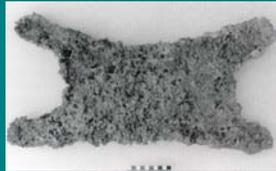
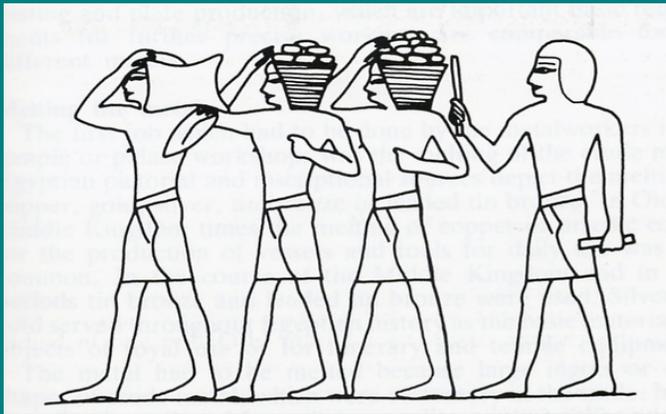
Middle and Late Bronze Ages: The Hittite Empire



Mass Production of Copper



Uluburun Shipwreck (1350 BC)
Rows of ox hide copper ingots.



Tin ingots

EARLY IRON ARTIFACTS FROM ANATOLIA





Alacahöyük: 2800-2500 BC, Low Ni. Anatolian Civilizations Museum, Ankara



Hittite Sword: Blade is steel, handle is bronze. Essen Ruhr Museum

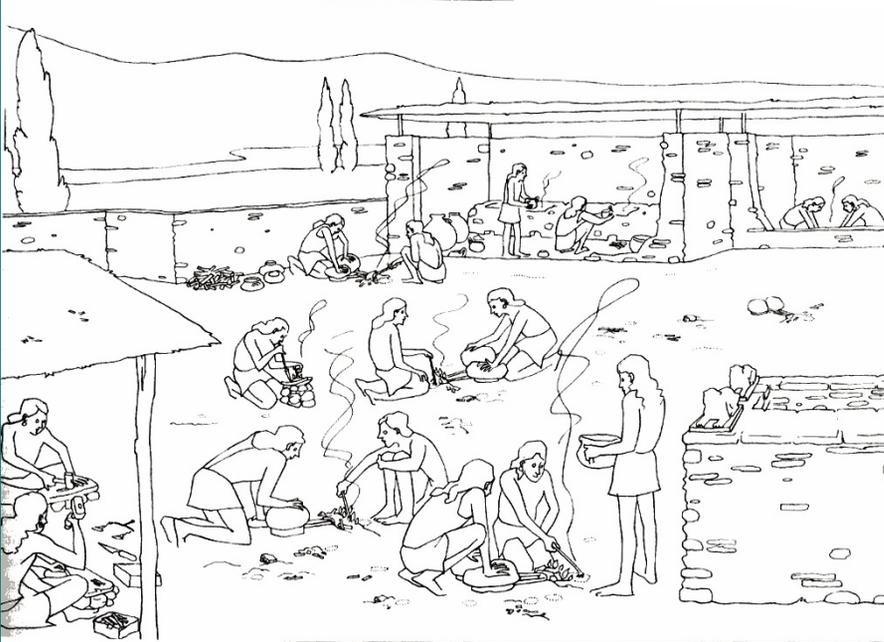
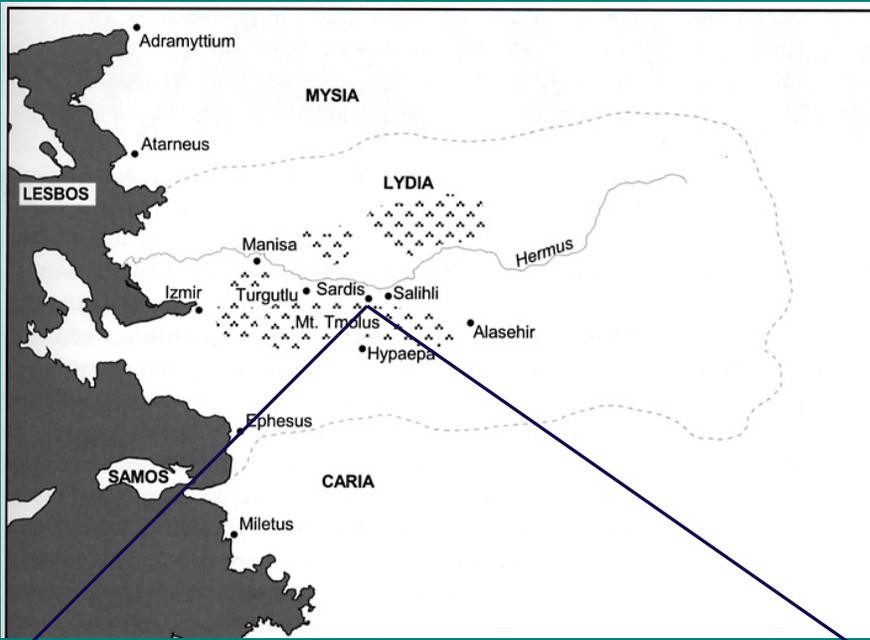
HATTUSHILI III'S (1282-1250 BC) LETTER TO AN ASSYRIAN KING

....concerning the good iron which you mentioned in your letter, the store in Kizzuwatna has run out of good iron. I wrote you that it is not a suitable time to produce iron. They will produce iron but they have not finished yet. When they have finished, I will send it to you. Now I am sending you (sword/dagger) point.....

Karagündüz Necrapole, Van.
11th and 10th Century BC.



SARDIS: The Capital City of Lydians



PARTING GOLD

