

Handmade decorated vessel, 'Phoenician' period, seventh–sixth century B.C.

The metallurgical principles underlying this extractive model are quite well known from much later historical and recent periods and were still expounded in early twentieth-century text books of metallurgy, but this is the first time that almost all of its components were actually found, and in a locational sequence, in an early smelting site.

We are, however, still left with one major problem: the much discussed 'Phoenician free-silica slag', i.e. the ball-shaped slag with large unmolten rock inclusions as found in Square A3, does not appear to fit into this process model. A further surprise awaited us here.

The investigation of the cupels and ball slag, although still in a preliminary stage, showed that very little remained of the original ceramic material of the cupels, which was replaced during the cupellation process by lead oxide containing many crystals of metallic silver as well as silver-rich metallic copper. We now have to recognise the free-silica ball-shaped slag as being a product of the melting down of the used cupels, and possibly also of heavily leaded furnace wall fragments (as found in a heap at Locus 13). The rock inclusions would have acted as a 'sieve' to facilitate the separation by gravity of the metal components, i.e. allowing the metal to drip through the porous conglomerate of unmolten rock fragments at a low temperature.

Although the pottery from the excavation has not yet been processed, it all seems to belong to the same 'Phoenician' horizon previously indicated by the survey findings.

Monte Romero is a unique site with its complete sequence from the complex ore deposit to the final cupellation and beyond. The study of the various products of Monte Romero will also provide essential new information for the understanding of many other ancient mining and metal working sites, where only partial and fragmentary evidence of metal production is available.

The historical implications of the appearance of such sophisticated extractive metallurgy at the time of the Phoenician cultural domination of southern Spain will be far-reaching, but more work must be done at the site and on the finds by archaeologists, scientists and historians, before major conclusions can be drawn from the surprising discoveries at Monte Romero.

Beno Rothenberg, Phil Andrews and Ingo Keesmann

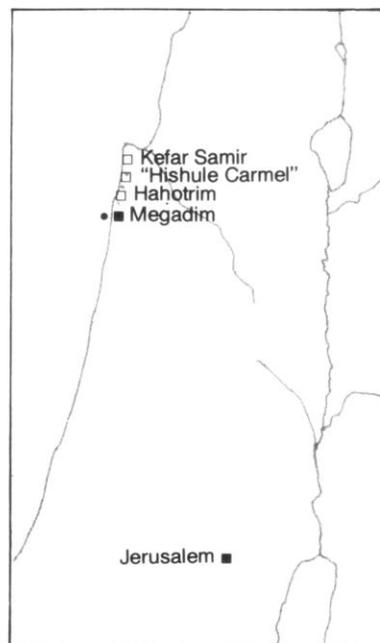
Metal from the Depths of the Sea

In the wake of the discovery in the sea near Haifa, Israel, of ancient tin and copper ingots IAMS announced (*Newsletter No. 1, 1980*) a new archaeo-metallurgical research programme to study ancient metal trade routes as represented by metal hoards found in the sea. Preliminary investigation of the ingot finds strongly suggested the need for further, more intensive exploration in the sea in search of reliably located and better dated metal finds, before the commencement of a full-scale archaeo-metallurgical research programme. E. Galili of the Centre for Maritime Studies, Haifa University (CMSH), reports here on the finds made by recent underwater explorations (surveys and excavations). IAMS, in collaboration with Dr N. H. Gale of the Department of Earth Sciences, Oxford University, has now begun the systematic archaeo-metallurgical investigation of these important and, mostly, unique finds. The extractive-metallurgical aspects and the manufacturing processes of the different types of tin and copper ingots, together with their dating and provenance, will be investigated. This work is expected to contribute important information towards a better understanding of the trade routes of metal in the Ancient World.

The almost straight 2000km. long coastline of Israel did not provide any natural shelters from storms for the ships which sailed along this ancient shipping lane for thousands of years. Once caught in a storm, ships sailing close to the coast, as was normal in antiquity, found themselves trapped and had little chance of survival. Of the numerous ships that sank along Israel's coast in ancient times, about 9% have been found in the 200m.-wide breaker zone close to the shore.

The wooden parts of the wrecked and foundered ships, and the lighter items of their cargo, were washed away by the sea whilst the heavy items sank down to the sand-covered, hard clayey sea bottom. Here, for several thousand years, they have been protected by the sand cover from salvage and re-use by man.

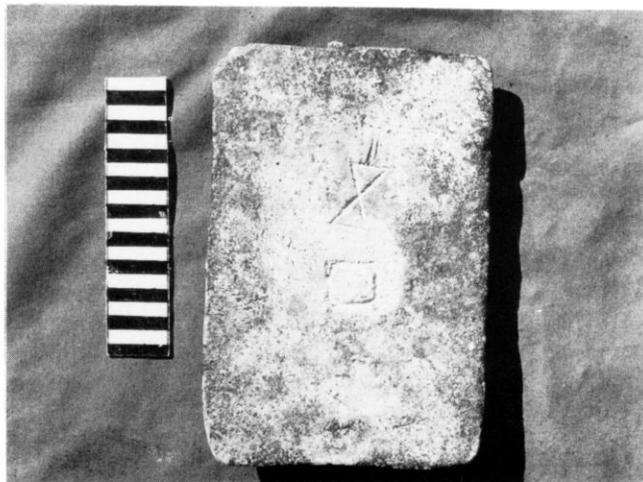
In the last 30–40 years, huge quantities of sand have been quarried away by building contractors and others from many parts of Israel's coast. These activities disturbed the sedimentary equilibrium and thereby created a considerable shortage of sand on the shallow coastal shelf. Consequently, many areas which had been covered by a thick sand layer for thousands of years became uncovered and numerous archaeological sites and objects were exposed. Besides prehistoric settlements which had been swallowed up by the sea, many



ships' cargoes of pottery, stone and metal objects and, of special interest to us here, numerous metal ingots, were found.

The underwater survey and excavations along the northern coast of Israel, which have been carried out since 1980 by CSMH, located and documented many different types of tin, copper, lead and iron ingots, either in groups or as individual finds. This unique collection of ingots is obviously of considerable archaeo-metallurgical and historical significance, especially for the understanding of the early sea-borne metal trade. However, because these ingots were often found without any related remains of the original carrier or other datable archaeological objects, they presented many problems of dating and provenance within the current archaeo-metallurgical research project.

The following are the principal ingot-types found along the northern coast of Israel:



1. Rectangular tin ingots with incised signs

These ingots are brick-shaped, similar to modern gold ingots (though larger and thinner), and weigh between 11–22kg. The marks they bear are apparently related to the Cypro-Minoan script group and appear to have been incised subsequent to casting.

A large quantity of these ingots was discovered in the 70s by a fisherman who gave as their find spot the area of the ancient port of Dor, south of Haifa (*IAMS Newsletter*, No. 1, 1980). He sold them to scrap metal merchants and today only four of these ingots survive: two are in the Museum of Ancient Art, Haifa; another is in the Maritime Museum, Haifa, and the fourth on temporary exhibit at the Haaretz Museum, Tel Aviv.

Subsequent inquiries established that the fisherman had given a false provenance to mislead other potential treasure hunters. It is now also by no means certain that, as originally reported, these ingots were found together with copper ingots. The find spot of this important group of tin ingots is still obscure.

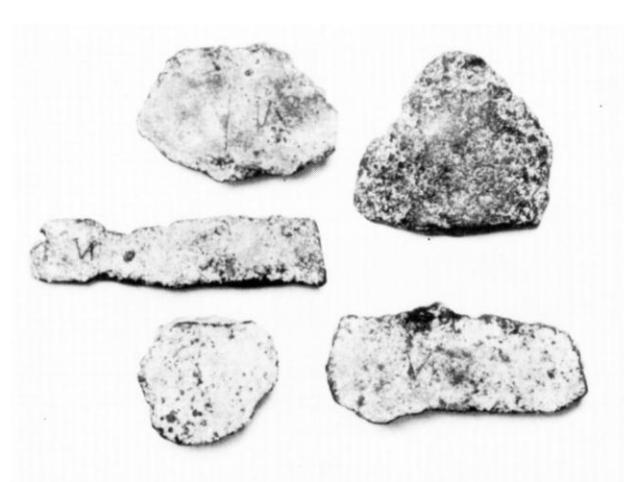
Some of the ingots were published, including some chemical analyses, by R. Maddin *et al.* in *Expedition* 19, 1977. Although the apparent Cypro-Minoan signs could indicate a late second millennium date, similar signs are known from Iberia at much later dates. Rothenberg suggested (*IAMS Newsletter*, No. 2, 1981, 4), based on some preliminary analyses at the British Museum Research Laboratory, that these tin ingots may have originated from the Iberian peninsula.

2. Round copper ingots

These ingots are of a fairly regular bun shape, but each is of a different size and weight (10–20kg.). They were found by the same fisherman (mentioned above) in the early 70s, probably in the area of Megadim. About two tons of copper ingots were found together in two large piles, which must have sunk together with the ship, and it seems likely that more copper



ingots are still to be found at the site. Several of these ingots were acquired many years after their sale to a scrap metal merchant. Two are now in the Haifa Maritime Museum; one at Haifa University and several on temporary loan to the Haaretz Museum, Tel Aviv.



3. Irregular bun-shaped tin ingots

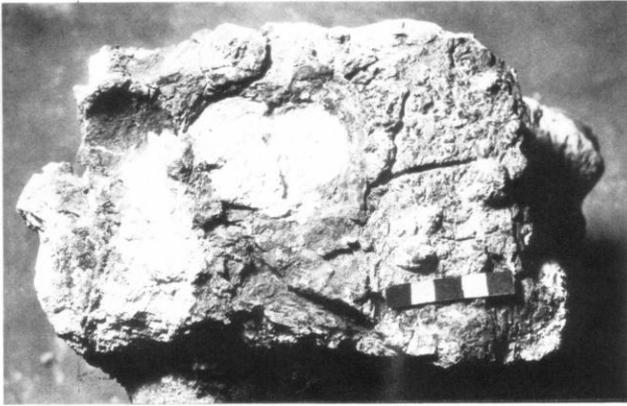
A hoard of five irregular bun-shaped (flat top and curved body) tin ingots was found near Kefar Samir by the CSMH in 1982, together with one 'ox-hide' copper ingot (No. 4 below), and four stone anchors. Their weight varies between 2–4kg. Different signs of Cypro-Minoan character were found chiselled into the upper surface of the ingots, which were dated by the excavator to the 14th–12th centuries B.C. (see E. Galili *et al.* in *Int. J. of Nautical Archaeology* 14, 1985; also includes chemical analyses). Some of these ingots appear to have formed parts of larger examples, a fact which could indicate that the ship was a 'sailing smith's workshop' (see G. Bass, *Cape Gelidonia*, 1967), especially as they were found together with copper ingots (No. 4, below).



4. Ox-hide copper ingot

This ox-hide copper ingot of a type common in the Mediterranean in the 15th–12th centuries B.C., was found together

with the tin ingots described above (No. 3). It weighs 16.5kg. and has an elliptical mark, as yet unexplained, on its upper surface. Several copper fragments cut from other ox-hide ingots were also found in this area of Kefar Samir.



5. Plano-spherical tin ingots

A cargo of ten semi-spherical ingots (flat top and semi-spherical body) was found in a single heap at Kefar Samir in 1981. They were heavily corroded and had a gross weight of c. 100kg. Near this hoard was a surprisingly well-preserved tin ingot of similar shape, weighing 27kg. It also was originally semi-spherical but had been cut in antiquity and a hole made through it.

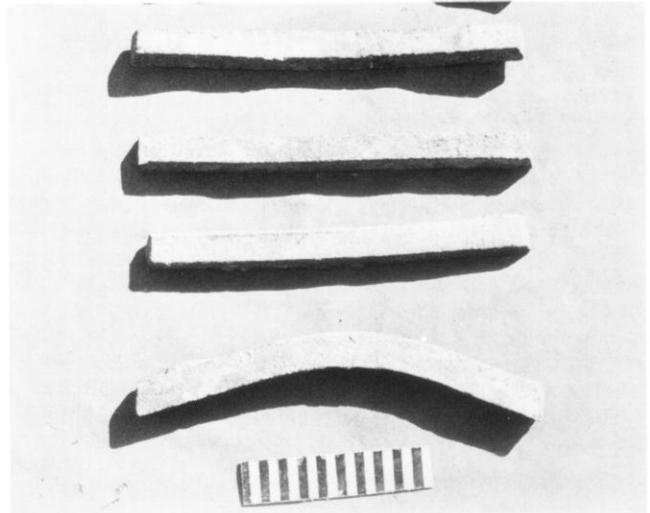


This hoard, which also contained lead ingots (see No. 6), could be dated by an Egyptian 'sickle' sword found in the same context, to the 13th–12th centuries B.C.



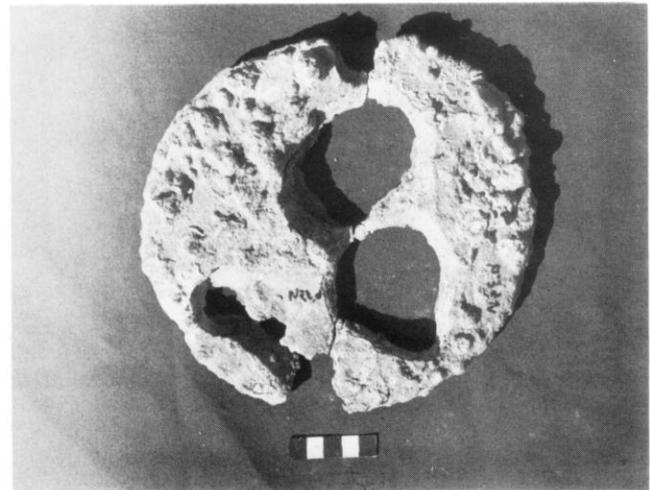
6. Small lead ingots

These small, round and roughly rectangular lead ingots weigh 1–6kg. each and carry an undeciphered Cypro-Minoan mark (see A. Raban and E. Galili, *Int. J. Naut. Arch.* 14, 1985).



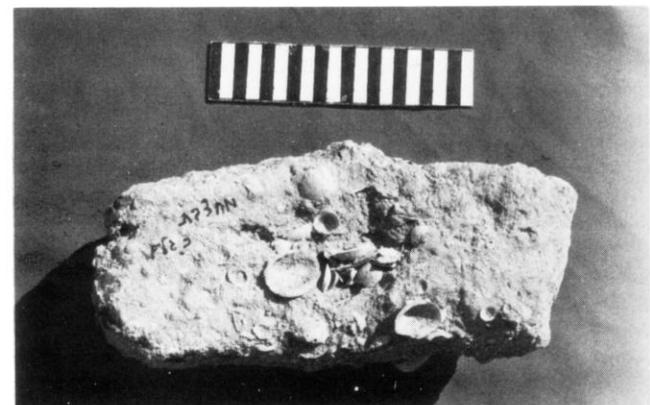
7. Bar-shaped, trapezoid tin ingots

Several bar-shaped ingots with trapezoid section were found in the area of Kefar Samir. It is possible that a number of coins of the 4th–3rd centuries B.C. from the mint of Tyre found next to the ingots may date them by association.



8. Disk-shaped tin ingots

This solitary and, so far, unique ingot type was found in the early 70s near Megadim but, since it was a stray find, it has no archaeological context and is not datable.



9. Iron pigs

Ten oblong iron 'pigs' weighing 8kg. each were found south of Kefar Samir, next to a Roman shipwreck.

Besides the metal ingots described above, the collection of the CSMH contains a large number of sea-borne metal objects which will also be investigated in the ingot research programme.

E. Galili

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