

12th Century BC copper smelter uncovered intact in Timna Valley

For the first time, after many years of search, an ancient copper-smelting furnace, more than 3,000 years old, has been found virtually intact in the Negev Desert of Israel.

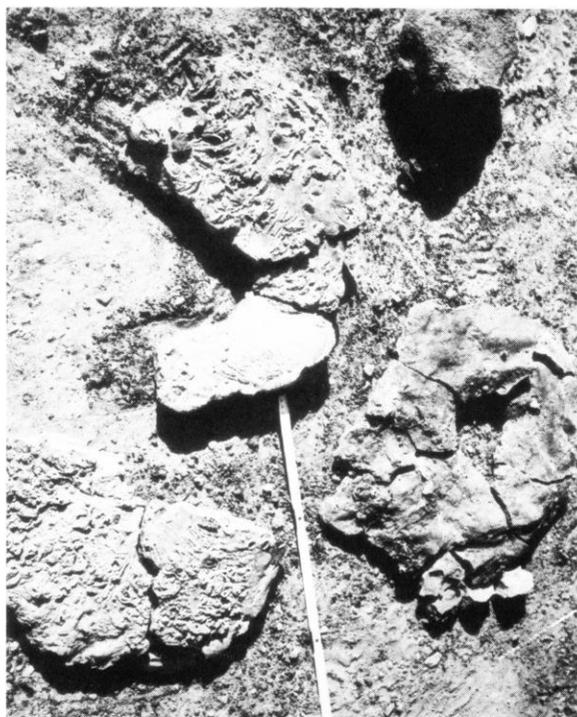
The discovery was made in the Timna Valley, site of one of the world's earliest large-scale copper-producing industries, by an IAMS team while completing a programme of excavation begun in the Wadi Arabah nearly twenty years earlier.

When Professor Beno Rothenberg's Arabah Expedition started investigations in 1964, one of the sites selected for special attention was a small valley, enclosed by rugged hills, between the granite table-mountain Har Timna and a cluster of ancient mining camps under the towering cliffs to the West.

Surveyors marked it on their maps as Site 2, but it quickly became more popularly known as the Mushroom Camp after the solitary mushroom-shaped rock of red sandstone which dominated its landscape. Around this rock great heaps of copper slag were dispersed over a wide area, indicating one of the most important smelting sites in the whole of the Arabah.

During the years that followed, the remains of several smelting furnaces were discovered among the slag heaps, together with a workshop and

Tapped slag from the furnace



The furnace (rear) of the rock-cut smelter with its slag pit in the foreground

storage pit containing ore and crushing and grinding tools.

These and other finds built up a picture of a highly integrated operation which reached its peak between 1300 and 1150 BC. Rich malachite was recovered from mines in the valley and from the foot of the cliffs; the ore was mixed with fluxes and smelted in charcoal-fired furnaces to produce a high-grade metal.

Archaeo-metallurgists were astonished at the smelting technology which reached a degree of sophistication which was little improved upon in medieval Europe 2,000 years later.

The Timna furnaces were lined with clay and fitted with tuyères to inject an air blast, whilst in front of each smelter there was a stone-flanked tapping pit.

However, because the furnace remains were fragmentary, several important questions of design and operation remained unanswered, especially in regard to the use of tuyères and bellows to heat the charcoal-burning furnace to the required temperature. Now, with a complete furnace available for study, scientists are able to get a better understanding of how precisely the ancient smelters produced their copper.

Cut into bedrock

A unique feature of the recently-discovered furnace is that it was cut straight into bedrock. The



Site of the 3,000 year-old rock-cut smelter, fringed by the mountains of Timna

original furnace bottom, about 40 cm in diameter, was found to be well preserved. Furnace walls had been lined with clay mortar but, as with previous discoveries at Timna, the lower part of the lining had broken away.

The back wall, 50 cm high, showed heavy slagging on its upper part, and the position of a tuyère and bellows was clearly to be seen. The tuyère must have protruded about 25 cm above the surface of the rock into which the furnace had been cut. Only one tuyère was used in this furnace, and this was probably the general practice of the time.

The original furnace was probably at least 60 cm high, its uppermost edge being formed with a line of stones set in mortar around the rim of the rock-cut hearth. One of these stones was found *in*

situ, with its clay lining as part of the furnace wall and cemented together with the tuyère.

The slag pit, 60 cm in diameter, was about 10 cm lower than the hearth bottom, and some 20 cm beneath the tap-hole of the furnace.

The tapped slag solidified as a circular slab, with a cast-in hole in the middle to enable it to be removed by a rod or hook and tossed to an adjoining heap.

Radio-carbon tests on charcoal samples collected during the excavation have not yet been completed, but there would seem to be little doubt that the rock-cut furnace dates to a period between the Late Bronze Age and the Early Iron Age, probably the 12th century BC.