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Timna revisited

Desert Smelting Recaptures Industry of the Ancients

Copper smelting recently returned to the Timna Valley in southern Israel when metal was produced from a replica furnace, constructed of local materials, and using local ores. It was operated by a process similar to that followed by miners who worked on the same spot more than 3,000 years ago.

The desert smelter was built and worked by John Merkel, a young American, as the culmination of his doctoral research with IAMS at the Institute of Archaeology, London.

Archaeological evidence for the ancient copper smelting furnaces at Timna comes from the excavations of Professor Beno Rothenberg, leader of the Arabah Expedition and director of IAMS. The scientific study of ancient mining and metallurgy has developed upon these important discoveries.

Two major stages in the evolution of copper extraction are represented at Timna. The beginnings of

copper smelting date back roughly 5,000 years with a primitive hole-in-the-ground furnace. Experiments by Professor R.F. Tylecote and his students at the University of Newcastle-upon-Tyne demonstrated this furnace type.

During the 2,000 years of the Bronze Age this primitive furnace was replaced by an increasingly efficient shaft furnace and an advanced smelting process. At Timna, in the 13th and 12th centuries BC, Egyptian expatriate miners and local people used this improved technology to develop what has come to be accepted as probably the world's first major copperbelt, providing ancient Egypt with much of its metal needs.

As part of the continuing post-excavation analysis of Timna, the recent experiments were designed to demonstrate how copper was smelted at the end, or technological climax, of the Bronze Age.

Chessington furnace

In preparation for the work at Timna, Merkel carried out no fewer than 27 smelting experiments in a laboratory at Geomet Services of Borax Limited, Chessington, Surrey. These experiments eventually produced large, circular tapped slags and plano-convex copper ingots, comparable with the ancient specimens.

At Chessington, the laboratory furnace was built of firebrick, fuelled with charcoal and operated with an electric airblower. As the experiments progressed these modern materials were gradually replaced, working towards a furnace which could be built with local materials in the desert at Timna. For example, the firebrick was replaced with a simple coiled clay structure, built into a sandpit. The electric



John Merkel stokes his desert furnace at Timna

continued on page 2



Volunteers pump air to the furnace while John Merkel checks the slag composition. A crucible furnace and crushing stones can be seen in the foreground

Desert smelter

continued from page 1

airblower was substituted with three pairs of human-powered pot-bellows — a style copied from an ancient Egyptian tomb painting (at Thebes, circa 1450 BC). A similar replacement schedule was implemented for the modern analytical aids, such as gas, temperature and chemical analysis.

For the Timna experiment, copper ore — chalcocite and malachite — was collected on the surface from the same areas as the ancient mines. Chemical analysis of the 3,000 year-old slags had determined that iron ore had been used as a flux; recent erosion in the neighbourhood disclosed enough ore on surface to meet the requirement. Many hard stones, used by miners as long ago as the Chalcolithic Period to crush the copper and iron ores, have been found at Timna, and these were re-employed to prepare the ores for smelting.

The location for the experiments was selected near Timna Site 2, a major smelting site in the whole of the Arabah, and known locally as the “Mushroom

Camp”, being distinguished by a beautiful, solitary mushroom-shaped rock of red sandstone. The site best represents the advanced technology of the Late Bronze Age and is one of the keys to Timna’s mining and metallurgical history.

Fired at dawn

Here, Merkel built his smelter, from local clay and stones, to the same dimensions of the ancient furnaces whose remains lay scattered all around. Volunteers were recruited to operate the bellows, and soon after dawn one morning the furnace was fired and smelting commenced.

The heat, from both the furnace and the sun, was almost unbearable but, watched by spectators numbering no fewer than 20 at any one time, the volunteers pressed on through the morning and into early afternoon. An Israeli television team filmed the proceedings and radio and newspaper correspondents

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Desert smelter

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stood by.

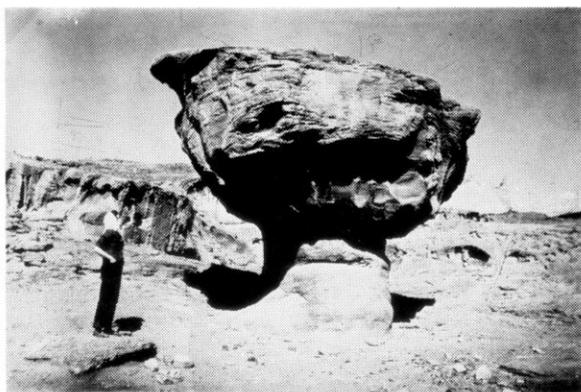
When the furnace was cool and could be safely dismantled, more than 1kg of copper metal was recovered.



Erecting a break to shield operators from the intense heat of the furnace

The metal was separated from a rich copper matte and slag by crushing. Refining was carried out by remelting in a clay crucible, the final product being around 99% copper. The crucible furnace was also copied from archaeological examples excavated at Timna Site 2, and was blown from a single pair of bellows.

The metallurgical products from the experiment closely matched the ancient specimens found nearby. A collection was saved for comparison, and the furnace was repaired for display in the Timna Valley Preserve. Together, the remains of the ancient furnaces and the experimental reconstruction, now present a complete picture of copper smelting for visitors to the "Mushroom Camp".



The "Mushroom" at Timna Site 2

And for one day, the enterprise and skill of a young researcher brought Timna's archaeological remains dramatically back to life.

Haifa experiments in line with Merkel results

In parallel with John Merkel's work at Chessington and Timna, a mathematical model of ancient smelting processes was built at the Haifa Technion by a young engineer, Dr. M. Bamberger, working under the supervision of Professors Peter Wincierz, H.-G. Bachmann and Rothenberg.

A smelter has recently been constructed, based on Dr. Bamberger's model, and first reports indicate that its results are in line with those produced by Merkel.

Thus the two researchers, working independently and approaching the same problem in entirely different ways, have achieved the same end-result. The significance of their work will be reflected in the production of a computer programme which can be applied to any study of the history of smelting processes from the primitive operations of the pre-historic metallurgists to the most sophisticated furnaces of the Classical periods.

Royal School of Mines chief joins IAMS committee

A closer relationship between IAMS and the Royal School of Mines is foreshadowed by the appointment to IAMS Scientific Committee of Professor C.T. Shaw, Head of the Department of Mineral Engineering Resources, Imperial College of Science and Technology.

Professor Shaw's experience and advice will be particularly valuable in planning the development of the archaeo-metallurgy courses at London University — a collective undertaking between IAMS and the Institute of Archaeology since 1976 — with a view to introducing a full degree-awarding course in 1982.

A graduate of Witwatersrand University, South Africa, Professor Shaw was also awarded the degree of M.Sc. in mineral exploration by McGill University, Canada.

In 1959 he joined Johannesburg Consolidated Investment Company, with which he held a number of appointments, including head of the computer division and director of the group laboratory, and was chief consulting engineer and an alternate director of JCI when he left South Africa in 1977 to take up the position of Associate Professor of Mining Engineering at Virginia Polytechnic Institute and State University.