

they represent the earliest mining and smelting operations yet evidenced in Western Europe, predating previous finds in the Harz mountains of Germany by many hundreds of years. Moreover, remains of habitation have also been found and a direct relationship between the mines and the nearby dolmens of El Pozuelo has been established by pottery finds and other archaeological evidence. It can thus

be assumed that these megalithic structures were in fact used for the burial of the dead of the mining communities. It is also of significance that the dolmens, the earliest-known structures of Europe, spread northwards across the continent through Portugal, Brittany and beyond the English Channel into Cornwall and Ireland, everywhere following the line of long-established mining activities.

The Arabah Project

New discoveries reveal second period of Egyptian mining

A second period of Egyptian mining in the Wadi Arabah, the broad valley that divides Israel from Jordan between the Dead Sea and the Gulf of Elat-Aqaba, has been established as a result of the most recent archaeo-metallurgical investigations in the area.

Ten years ago, discoveries by teams led by Professor Rothenberg finally proved that this area was the site of a copper mining and smelting enterprise by the Egyptians in the 19th and 20th Dynasties (c.1300 to 1150 BC). These activities, centred on the Timna Valley, on the western side of the Arabah, were carried out on a very large scale and could have represented the world's first major "copperbelt". The Egyptians ran the industry with the help of local tribes, including Midianites and other semi-nomadic people; production spanned at least 200 years and was an integral part of Egypt's economic development during this period. The industry declined only when the power of Egypt declined about the middle of the 12th century BC and the expatriate miners left for home.

Until a few months ago there was no evidence that they ever returned; in fact it was widely believed that on their departure the Arabah quickly reverted to its previous state of being a desert no-man's land, and that it remained so for nearly 1500 years until the Romans marched in to garrison the territory and revive its industry in the 2nd century AD.

However, a more detailed survey of the whole of the Arabah, which was begun last year under Professor Rothenberg's direction, indicates strongly that mining was resumed under Egyptian control, probably in the 9th century BC when Egypt reoccupied some of its Eastern provinces.

Further investigations will be made this year in an effort to obtain more information about ancient Egypt's second big mining enterprise in the Arabah.

Smelting by Computer

Meanwhile, experiments are continuing to gather more precise details of the various copper smelting processes employed by the ancients. These experiments involve the reconstruction of furnaces and simulating their operation with local ores and fluxes. As an additional aid, a mathematical model has been prepared and a computer programme is being drawn up which will eventually cover the whole history of

smelting operations from the primitive hole-in-the-ground furnace to the most sophisticated equipment in use today. It is expected that the first smelting experiments using computerized information will begin later this year; they will mark the first occasion on which computer technology will have been applied to ascertain the details of an earlier technology that has its roots many thousands of years ago.

Origins of Iron Production

During the past year, more-detailed investigation has been possible into the origin of the iron which was used to produce some of the votive offerings found in Timna's Egyptian temple. The temple, which was excavated by Professor Rothenberg and his team in 1969, was dedicated to the goddess Hathor, and its well-preserved inscriptions and cartouches provided absolute dating for the period of Egyptian mining in this area. Many of the 10,000 small but precious finds recovered from the temple were, not surprisingly, of copper, but there was also a wide variety of finger-rings and other jewellery made of iron, some beautifully gilded.

The period in which these objects were produced was the Late Bronze Age, and although iron had by then come into limited use as a precious metal, it was a long time before it was to be smelted for its own sake and to begin to replace copper and bronze for implements and weapons. How it first came to be extracted from its ores has therefore remained much of a mystery.

Timna has now provided an answer.

Analysis of the iron from which the votive offerings were made showed a copper content that was much too great for the material to have been derived from the ore that was known to be available in the district. Subsequent experiments indicated that this iron was a by-product of the local copper smelters. Among the fluxes used in the smelting process was iron-oxide which, in the reducing atmosphere of the furnaces was produced as metallic iron, thus providing a high iron content in the copper. In laboratory tests, the iron content was removed and found to be wrought iron, which could easily have been fabricated to produce the sort of objects found in the Timna temple.

Thus it has been proved — in the Arabah at any rate — that the origins of iron smelting lay in the ancient copper furnace, and that the metal which came to

replace copper and bronze in so many of its uses throughout the civilized world, was first produced by accident and not design.

A Study of Mining Tools

The 1980 programme in the Arabah will continue the reinvestigation begun last year. It will include a study of the environmental factors in the area's mining and metallurgical development, and a detailed investigation into the tools employed in the industry and the methods by which they were manufactured.

Sinai

Since 1967, a number of expeditions have been made to investigate ancient mining and metallurgical development in Sinai. Discoveries have uncovered the remains of copper mining and smelting activities dating to the Chalcolithic period and the Bronze Age; they have also thrown new light on some little-understood periods of ancient Egyptian history and have revealed the existence of a culture that has not previously been recognized.

A detailed report is now being prepared for publication and a preview will appear in the next issue of the Newsletter.

Education

Courses of London University

Courses of study in archaeo-metallurgy at London University, a collective undertaking between IAMS and the Institute of Archaeology, continue to attract a full complement of students and have recently been opened to undergraduates.

Since the courses were inaugurated in 1976 the syllabus has widened to include metal-working, and a study of the relationship between the development of metals and the growth of international trade and cultural exchanges in ancient times.

Other activities

Metal and Social History

This project, now in its third year, is concerned with studying the impact of metals not merely on the social structure of civilization, but on the intellectual potential of the individual. Current studies are concentrated on investigating the importance of metal in ancient urban development and the resultant changes in the attitudes and aspirations of the people involved.

Exhibitions

Arrangements have recently been made for a study collection at the British Museum of slag samples and other ancient metallurgical material recovered by the Huelva Project. At a later date a permanent exhibition is to be established in the Classical Department of the Museum, based on the discoveries at Rio Tinto, including reconstructed furnaces demonstrating the ancient processes used in the production of silver and copper.

A study collection is also to be made in the British Museum's Asia Department of finds from Timna and the Arabah generally, with a view to setting up a permanent exhibition.

Publications

The following are in the course of preparation or awaiting publication:

Timna Temple: Awaiting publication

New Researches in Sinai: Material for Vol. 1 will be ready for printing in the Spring of 1980.

Timna Excavations 1974-76: To appear shortly as a special issue of *Anschnitt*, a German mining paper published by the Bergbau Museum, Bochum.

Huelva Project: This is a comprehensive record of the work in Spain prior to the most recent excavations. Completion is expected soon.

Chalcolithic Mining at Chinflon: To be published as a monograph.

The Early History of Rio Tinto (excavations and metallurgy): A forthcoming monograph.

Trustees

During the past year Mr. Robert Rice, chief geologist of Rio Tinto-Zinc Corporation, joined the Board of Trustees, whose members are now as follows:

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