

## 'Missing link' discovered in Rio Tinto's 5,000 years of mining history

Discovery of stone mining tools among the mountains of ancient slag at Rio Tinto, and other finds in a nearby village, have combined to help establish an almost unbroken sequence of mining operations in this area of Southern Spain, stretching from the 3rd millennium BC to the present day. No other working mine in the world has such a record of longevity.

The "missing link" in Rio Tinto's history was discovered last summer during exploration by an IAMS team, led by Professor Beno Rothenberg.

In 1977, an expedition working on the northern slope of Cerro Salomon — the mountain that dominates the Rio Tinto complex — had established that silver-smelting began there as early as the Late Bronze Age,

well before the Phoenicians developed a large silver industry in the 8th century BC. Last summer, work centred on an area to the east, along the banks of the Rio Tinto, where massive dumps of ancient copper slag are to be found.

It has long been accepted that Rio Tinto was a major source of copper for the Roman Empire, but there was no evidence of earlier mining of the metal in the locality. The object of the IAMS expedition was to find such evidence, if it existed, and to piece together the smelting processes employed to produce the finished copper.

Trial excavations of some of the smaller slag heaps did not at first produce any pre-Roman layers, but at one location two stone implements were found on the surface. These tools were shaped and grooved to fit onto a wooden handle in a fashion well known from the earliest mining picks and hammers found elsewhere in Europe and the Middle East. For many years — perhaps from the beginning of the present century — these tools had been lying on a heap of shale, cut from a nearby mountainside and dumped on top of the Roman slag by road-builders.

Discovery of the tools, which can be dated to at least the 3rd millennium BC, led to a search for ancient mine workings in which they could have been used. Close inspection of the tip in which they had been found revealed several pieces of rock, heavily mineralized with malachite — just the sort of ore the ancients would have been looking for.

Aerial photographs of the district were studied for traces of ancient workings, but recent mining at Rio Tinto has left very little of the "original" surface, and nothing was found.

"For days", says Professor Rothenberg, "I wandered

*continued on page 2*



Site of the 2nd millennium BC cist tomb at Nerva, near Rio Tinto, which helped to provide the "missing link" in the mines' history

## 'Missing Link'

*continued from page 1*

round the eastern side of Rio Tinto, searching systematically for any clues. More pieces of malachite turned up, and eventually one day I found myself in front of a great cliff of shale, topped with gossan. There, I saw a huge cavity, which looked somewhat odd, and on closer examination, I could see a primitive shaft leading into it.

"Our Spanish geologist confirmed that this was most likely an ancient mine, but it was not yet possible to



*Stone mining tools, dating to the 3rd or 4th millennium BC, discovered at Rio Tinto. These are the earliest mining tools yet found in Europe*

determine what material was mined there. However, outcrops of copper or ore could have been located everywhere in this area and the ancient miner would naturally have probed them.

"A few days later, a young amateur archaeologist who lives nearby showed me two stone chisels, or axes, and a small bowl that he had found close to the village of Nerva. When we later visited the spot with him we found the remains of a roughly-excavated cist tomb, related to the Argar culture of Southern Spain, the early 2nd millennium BC. Surface finds indicate the presence of more similar

burials in the area.

"This was the 'missing link' in Rio Tinto's history, the link between the earliest mining — dated by us to the beginning of the Early Copper Age (the Chalcolithic period, 4th-3rd millennium BC) — and Rio Tinto's large silver and copper industry of the 1st millennium BC.

"The discovery of cist tombs near Nerva is not, of course, proof that mining took place there in the 2nd millennium, but it does show that there was a community, and I cannot imagine that people would have come to these mountains for any other reason as the agricultural potential must have been virtually nil. However, this is something that we have to investigate further".

### Tartessian era

A preliminary appraisal of Rio Tinto's mining history indicates that the story began in the 3rd, or perhaps the 4th, millennium BC, with mining with primitive stone tools, and presumably, simple, hole-in-the-ground smelting. The area continued to be inhabited during the 2nd millennium, and then again around 1,000 BC when silver mining and smelting began on a large scale. This was the era of the Tartessians, whose industry and riches first drew the Phoenicians to trade with this part of the world.

Silver mining continued in the Iberian and Roman Periods, though it would appear that the Romans did not at first concern themselves greatly with the actual production of the metal; it was not until the reign of Augustus and the strengthening of the Roman hold over Southern Spain that they took over the operations with hardly any improvements to the metallurgical processes.

Copper is a different story: the slag heaps prove that it was the Romans who began copper production on a big industrial scale. There is also now evidence of iron-making and iron-working in Roman Rio Tinto.

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## International Timna in symposium at September

The first in a series of international symposia, to be held every two years at the major centres of ancient metal production, is to take place from September 14 — 19, 1981, at Eilat in Israel, centred on the Timna Valley and other important sites in the district.

The idea for a bi-annual symposium at the site of some of the most important archaeo-metallurgical discoveries has been initiated by IAMS, but the conferences will be planned and organized in collaboration with scientific institutions of the host country. The event will combine a series of papers and discussions with tours of the archaeo-metallurgical and related archaeological sites. Where possible, tours will include visits to museums and to sites of significance to the cultural background of the ancient metal industries.

The Timna symposium has been convened in collaboration with the Israel Institute of Metal, Technion-Israel Institute of Technology, Haifa, and the Institute of Mining and Metals in the Biblical World, Museum Ha'aretz, Tel Aviv. Mornings have been reserved for visits to the sites; afternoons and evenings for lectures and discussions; and there will be optional additional days for visits to Jerusalem, Tel Aviv (the Timna Pavillion), Haifa, the Negev and Galilee. It is also hoped to arrange visits to Sinai and Egypt.

Application forms and further details can be obtained from:

The Organizing Committee,  
First Symposium on Archaeo-Metallurgy,  
PO Box 29784,  
Tel Aviv, Israel.



# Bronze Age smelting technology probed at Chessington

Copper ingots and slag, comparable to those recovered from furnaces operated in the 13th — 12th century BC in the Timna Valley in southernmost Israel, have recently been produced in experiments in the Geomet Laboratories of Borax Limited, at Chessington, just outside London.

The experiments, carried out under a planned IAMS programme as a post-graduate study by John Merkel, of Minnesota, USA, are designed to ascertain precisely how copper was smelted in the Late Bronze Age.

Earlier experiments by Professor R.F. Tylecote at Newcastle University have thrown much light on the primitive hole-in-the-ground smelting of the Chalcolithic Period (IAMS Monograph No. 1.). Merkel's experiments are concerned with shaft furnaces of a more advanced type, used by Egyptians of the New Kingdom some 2,000 years later when they operated a major copper-producing industry at Timna.

Using materials from the ancient Timna sites, Merkel built at Chessington a smelting furnace on the Bronze Age pattern from which slag is tapped and run out in liquid form, leaving an ingot to be recovered from the bottom of the furnace. Copper ore from the Timna mines is fed into the charcoal-fired furnace and iron oxide is added as a flux, as determined by analysis of ancient slag.

Members of the IAMS Board of Trustees — including Professor Tylecote, under whose supervision Merkel is working — watched the first "tap" being made before they assembled for their autumn meeting.

## Haifa experiments

Meanwhile, parallel experiments are being carried out at the Haifa Technion, based on a mathematical model of the ancient smelting processes, aimed to narrow down the many variables and unknown factors involved. Here, the investigations are being made by a young engineer, Dr. M. Bamberger, working under the supervision of Professors Peter Wincierz, H.G. Bachmann and Beno Rothenberg.

So far, Merkel and Bamberger have worked independently, approaching the problem in entirely different ways. Eventually they will meet and it is hoped that the final result of their experiments will be the production of a complete computer programme which can be applied to any stage in the history of smelting operations, from the primitive processes of the prehistoric metallurgists to the most sophisticated furnaces of the Classical periods.

When the present experiments are concluded it is planned to build smelting furnaces in the Timna Valley, using identical materials and methods as employed by the ancients in order to demonstrate Chalcolithic-to-Late Bronze Age copper smelting during the International Symposium on Archaeo-Metallurgy in September, 1981 (see page 2).



*Reconstruction of a copper smelting furnace as used in Timna in the 12th century BC*

## Degree Course Planned

Archaeo-metallurgy courses at London University, a collective undertaking between IAMS and the Institute of Archaeology since 1976, are to be enlarged with a view to introducing a full degree-awarding course on the subject.

The present course covers mining geology and mineralogy, the archaeology of metallurgical sites, archaeo-metallurgical extraction processes, methods of archaeo-metallurgical research, laboratory practice and exercises. It is now planned to extend the course and include lectures on metal-working, archaeology of metal objects and the history and impact of metal trade.

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## Expedition to Jordan

An expedition to explore the remains of ancient mining and metallurgy in Jordan is to be undertaken next year by Professor H.-G. Bachmann, of the J.W. Goethe-Universität, Frankfurt, a member of IAMS Scientific Committee and a senior lecturer in archaeo-metallurgy at the Institute of Archaeology, London University.



*Excavating the site of an ancient copper mine at Chinflon*

## Fourth mine discovered at Chinflon

New significant discoveries were made by IAMS field workers last summer at Chinflon, in the mountains a few miles south of Rio Tinto where a "cottage" copper industry, with mines, smelters and nearby habitation, dating to the Chalcolithic period, was identified five years ago.

In previous work, three mining systems were investigated, one of which was completely excavated. Exploration has now revealed a further mine with four shafts leading into a large cavity, filled with washed-in material. Excavation has so far reached a depth of 10-12 metres, and more than 30 stone mining tools and numerous pieces of pottery have been recovered.

An interesting feature of the latest discovery is that it appears that the mine was cleared out in comparatively recent times — possibly at the beginning of the present century — with a view to assessing its production potential. The first mine excavated at Chinflon in 1978-79 was also refilled, but in this case the filling was done by the ancient miners, as they developed another enterprise alongside, by simply dumping their material into the old shaft.

The stone mining tools discovered at Rio Tinto

last summer are similar to those which have been found at Chinflon over the past five years, thus indicating that prehistoric copper mining in this part of Spain, though small in its operations, was much wider spread than hitherto assumed.

A preliminary report on the work done by IAMS up to 1979 has recently been published in *Scientific Studies in Early Mining and Extractive Metallurgy*, British Museum Occasional Paper No. 20. A full report will be published as an IAMS Monograph in 1982.

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### Ingots from Sea

Preliminary reports from the British Museum Research Laboratories, which have been examining ingots recovered from a ship wrecked off the coast of Palestine more than 2,500 years ago (see Newsletter No. 1.), indicate that the tin probably came from Spain and the copper from Cyprus or Anatolia.

Lead isotope research, now being undertaken at Oxford University, is expected to determine the precise origins shortly.

# Chalcolithic copper mining in Sinai's 'empty desert'

Since 1967, numerous expeditions have been made into South and Central Sinai to locate and investigate relics of ancient mining and metal production, and related habitation. These expeditions were led by Professor Rothenberg as a continuation of his previous work in the adjacent Arabah, and the survey map today shows more than 700 ancient sites, of which more than half are in Sinai.

Several key sites have now been excavated; they include a number of smelting installations dating to the Chalcolithic and Early Bronze Age (early 4th millennium to early 3rd millennium BC), as well as to the days of Dynastic Egypt.

The Sinai peninsula has hitherto been regarded as an empty desert. With the exception of some turquoise mines, operated by expeditions from Dynastic Egypt and excavated at the beginning of the present century by Flinders Petrie, there were no permanent Egyptian settlements in Sinai and the only remains of their presence are mining camps and temples.

Professor Rothenberg's expeditions have established that, long before the Pharaohs, much of South and Central Sinai had a fairly large, semi-nomadic population which developed its own culture, including the practice of metallurgy. This culture, known as the "Timnian culture", after the site of its first discovery in the Timna Valley, spread from the Nile Delta across Sinai into southernmost Palestine, and was closely related to the Maadi culture of Lower Egypt (the Delta).

## First 'Copper King'

Egyptian documents, dating to the days of the first Dynasties, refer to a bitter struggle between the kings of Upper Egypt, and the "Asians" of the north and the Sinai desert. Professor Rothenberg considers these "Asians" to be identical with the indigenous inhabitants of the "Timna" settlements which were abandoned or destroyed during the "Unification" of Egypt. According to pictorial and hieroglyphic records, this process of total subjugation reached its peak during the 3rd Dynasty, and by this time the "Timnian" settlements of Sinai had ceased to exist.

Rothenberg's expeditions have established that copper, as well as turquoise, was mined by Pharaonic incursions into Sinai. Numerous copper mines have been identified and investigations point to the fact that Ammenemes III (1842-1798 BC) was the first great "copper king" of the Egyptians. His enterprise was later paralleled by Ramesses II and III, of the New Kingdom, who developed the large smelting site of Bir Nasib, in South Sinai, and the big copper works in the Timna Valley.

Egyptian activities in Sinai ended in the 12th century

BC with the retreat of Egypt from its eastern provinces, and Sinai became Bedouin country without a history. The Roman period saw a renewal of mining in Sinai, and Rothenberg has identified the Roman road from Aila (present Aqaba) to Clysma (Suez), marked on the famous *Tabula Peutingeriana*, as a route to the mines of South Sinai. Countless Nabataean-to-Byzantine rock-drawings and inscriptions were carved into the rockfaces all along this road, at first by miners and perhaps metal merchants, and later by Christian and Jewish pilgrims on their way to Mount Moses and its monasteries.

A first summing up of the work in the peninsula appears in *Sinai*, Rothenberg-Weyer, published recently by Kummerly and Frey, Bern, and a detailed scientific report is planned for publication in the IAMS series, *Metal in History*.

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## Publications

Two IAMS book publications are at present with the printers:

B. Rothenberg, *The Mining Sanctuary of Timna*; and B. Rothenberg — A. Blanco, *Studies in Ancient Mining and Metallurgy in South-West Spain*.

IAMS Monograph Number One, Rothenberg-Tylecote-Boydell, *Chalcolithic Copper Smelting*, is still available at bookshops or directly from IAMS London office. The monograph series is shortly to be continued.

A full report on the excavations of the ancient mines and smelting camp No. 30 at Timna has been published (in German): H.G. Conrad — B. Rothenberg (ed.), *Antikes Kupfer im Timna-Tal*, available from Deutsches Bergbau Museum, Bochum, W. Germany.

A first review of the Sinai explorations 1967-1978 by the Arabah Expedition, affiliated to IAMS, is published by Kummerly & Frey, Bern, Switzerland: B. Rothenberg — H. Weyer, *Sinai, Pharos, Miners, Pilgrims and Soldiers*, (also in French and German editions).

Papers on Timna metallurgy by Prof. H.G. Bachmann and Dr. P. Craddock, members of the IAMS research group, and by Prof. B. Rothenberg on the ancient mines of Chinflon (S.W. Spain) have recently been published in *Scientific Studies in Early Mining and Extractive Metallurgy*, British Museum, Occasional Papers, No. 20 (obtainable from British Museum, Great Russell Street, London WC1B 3DG).

Prof. R.F. Tylecote's *Metallurgy in Archaeology*, which has become a standard text book and was out of print for many years, will soon be republished in a revised, enlarged edition.

# Timna discovery writes new chapter in Biblical history

During excavation of one of the larger copper smelting camps (No. 30) operated by the ancient Egyptians in the Timna Valley, in Israel, a thick layer of solid, tapped slag, was found to overlay the slag heaps of the 13th-12th century smeltermen.

This slag indicated a considerably higher standard of extractive metallurgy than that previously associated with the Timna operation in New Kingdom times. At first it was difficult to date these remains but, based on some archaeological indications, a 9th century BC origin was assumed (see IAMS Newsletter No. 1, p. 3).

Recent petrographic studies and radiocarbon dating have, however, resulted in a new archaeo-metallurgical and historical concept. It is now believed that the slag was produced as a result of more sophisticated smelting which took place in the early 10th century BC in an enterprise of Pharaoh Shoshenk I, of the 22nd Dynasty of Egypt.

After the loss of its Asian provinces and the pressure

of the Sea People and the Israelites, Shoshenk invaded Juda and Israel about the year 927 BC, shortly after the death of King Solomon. His campaign was described in some detail on the walls of the Amon-Temple at Karnak, and there is also an account in the Bible, including the plunder of King Solomon's Temple treasures in Jerusalem. (1 Kings, 14, 25-26).

Following the capture of Jerusalem, the forces of Shoshenk (in the Bible, "Shishak") marched south, but it was never known whether or not they reached the Red Sea. The discovery of Egyptian remains of the early 10th century BC in Timna is the first archaeological evidence of Shoshenk's take-over of the Arabah and its copper mines. The place-name "nqb" (shaft, cave) which appears in the Karnak inscription may in fact specifically refer to the Timna mines, now believed to represent the world's first big copperbelt.

The identification and dating of the Timna remains are part of a large-scale archaeometric research programme of modern scientific processing of the Arabah and Timna discoveries, undertaken since 1978 by the Scientific Committee of IAMS and funded by the Volkswagen Foundation.

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## Sir Mark Turner

It was with deep sorrow and a sense of personal loss that trustees of IAMS learned of the death of Sir Mark Turner on December 13.

Sir Mark had been a trustee since 1975 when he succeeded the late Sir Val Duncan as chairman of the Rio Tinto-Zinc Corporation. Sir Val was a founder-trustee of the Institute and it was on his suggestion that IAMS began its exploration of ancient metal mining and smelting in the Huelva province of Southern Spain, in which the Rio Tinto mines are situated.

Sir Mark showed equal enthusiasm and support for IAMS's work in this, and in all other, fields; he was a regular attendee at trustee meetings whenever his extensive world-wide travelling permitted, and his shrewd judgment of affairs was highly respected and appreciated by his colleagues.

He will be sorely missed.

Additional copies of this Newsletter can be obtained from IAMS secretarial office, Institute of Archaeology, University of London, 31-34 Gordon Square, London WC1H 0PY. Telephone: 01-387 6052.

Produced by A.J. Wilson

Printed by Borax Consolidated Limited.