Mining History: The Bulletin of the Peak District Mines Historical Society. Volume 15, No. 1, Summer 2002.

STONE MINING HAMMERS AND THEIR HAFTS FROM PRE-HISPANIC MESOAMERICA

Paul T. Craddock, Brenda R. Craddock and Adolphus Langenscheidt

Abstract: Cobbles of hard rock used as mining hammers document the earliest mining the world over. They would originally have been hafted but now almost invariably lack their handles or bindings. In the Americas preservation is more common, with surviving examples of intact hafted hammers from the high altitude deserts of South America, and many wooden handles from the pre-Hispanic mines of Mesoamerica, including some still containing their stone hammers. The various modes of hafting utilised on these hammers give insight into how the ancient hammers from the rest of the world may have been hafted.

INTRODUCTION

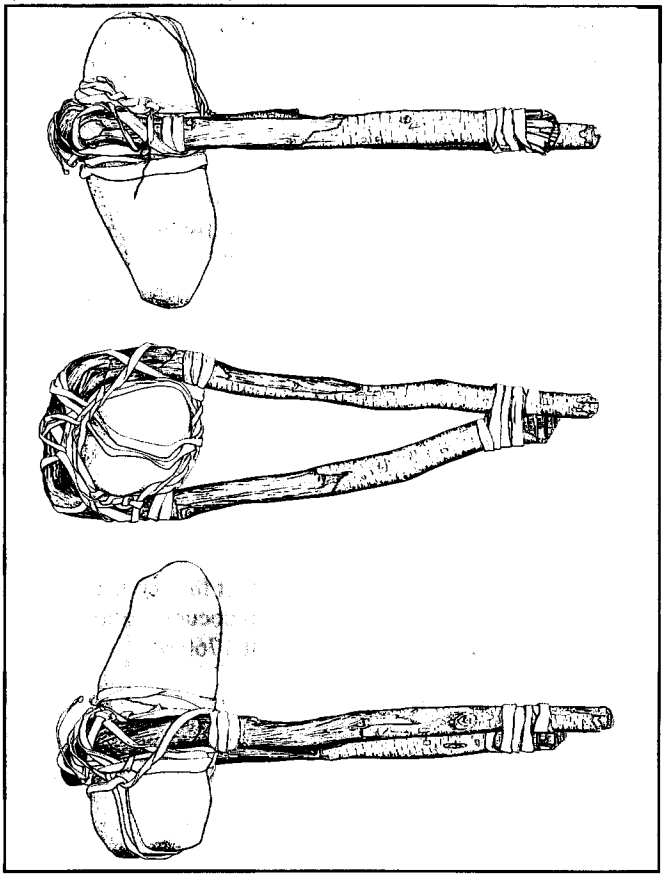
At early mine sites the world over cobbles of the local hard rock have been utilised as mining hammers. The hammerstones found in the Old World almost always lack any trace of their original handles. The presence of midriff notching or even continuous grooving (the latter well exemplified at the Bronze Age Mines at Alderley Edge in Cheshire) on many of the stones strongly suggests the hammers were originally hafted. In addition the experiments of Pickin and Timberlake (1988) showed that it was just not feasible to use the hammerstones directly held in the hands against the rock face. Thus the mining archaeologists of the Old World were left with the frustrating problem of knowing virtually nothing of how the most common mining tool was hafted.

For a variety of reasons Pre-Hispanic stone mining hammers often survive in the Americas complete with their wooden handles, and sometimes even with the bindings that held the handle and hammerstone together, giving some insight how similar hammerstones dating from Bronze Age mines elsewhere, would have been hafted. Thus at Chuquicamata, in northern Chile, the fully hafted and bound mining hammers associated with the famous 'copper man' (Bird 1979) and other examples, owe their preservation through two thousand years to the extraordinarily arid and inhospitable environment of the Atacama Desert (Weisgerber 1992; Craddock *et al* 2002) (Fig. 1). In Mesoamerica the wooden handles survive with their hammerstones in part because they are much younger than their counterparts elsewhere, the age of most of them is to be measured in centuries whereas in the rest of the world stone mining hammers have not been used for millennia (Plates 1 to 5). The quarrying and mining of a variety of stones, such as flint (Langenscheidt 1997) and obsidian (Pastrama 1996) as well as semi precious stones such as turquoise and jadeite, and organic materials such as jet, amber and coal carried on in Mesoamerica from at least 1500 BC (Langenscheidt 1997, pp.10-13 and forthcoming). The mining of metal ores only began in Mesoamerica at the beginning of the second millennium AD (Hosler 1994), introduced from South America where metal production has a much longer history. The purpose of this note is to describe and illustrate some of the hammers and their hafts from early metal mines in Mesoamerica, dating in the main to the last few centuries before the Spanish conquest in the early 16th century.

The Materials

The remains of early quarries and mines are to be found all over Mesoamerica from the south west of the United States down to Guatemala (Langenscheidt ed. 1970; Langenscheidt 1985 and 1997; Langenscheidt and Tang-Lay 1978 and 1982; Weigrand 1968 and 1985). As in other parts of the world the miners used a variety of tools as well as the hammers. Wood was used to construct primitive scaffolds and notched tree trunk ladders, as well as for wedges and forming the material of torches. Antlers were used as picks and the individual tines were utilised as wedges, but as in many other parts of the world the hammerstones are the most common surviving tool. The stones for the hammers had of necessity to be harder than the rock or mineral to be mined, although the rock could have been weakened by firesetting. However there is no firm evidence for its use in the Mesoamerican mines studied so far. For this reason the hammerstones were made of medium to fine grained igneous rocks of intermediate composition such as diorite. Andesite and

Fig.1. Three views of the Chuquicamata hammer. (Drawn B.R.Craddock).



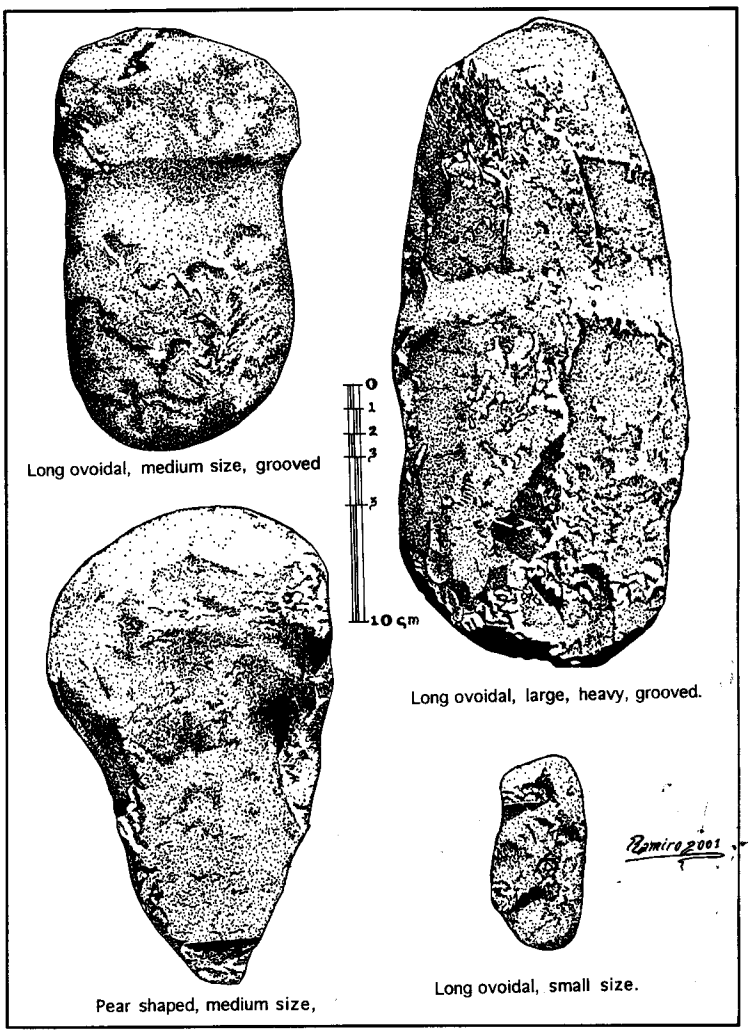


Fig. 2. A selection of stone mining hammers from early mines in Soytal, Querétaro State, in Central Mexico. (Drawn: R. Medina).

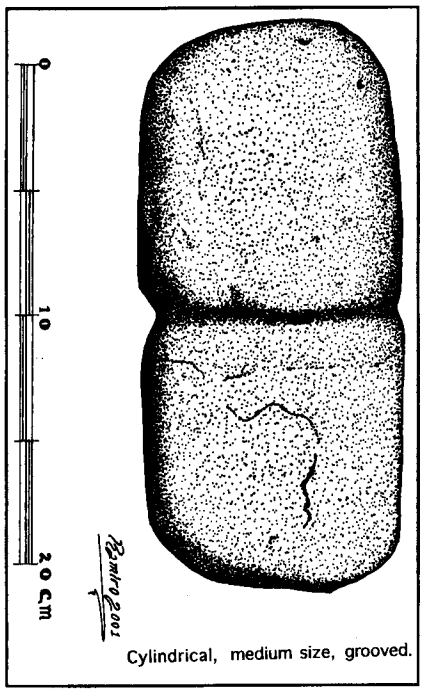
compact basalt were also used. Hammerstones of sedimentary or metamorphic rocks are less common in contrast to the hammers in Britain where hard metamorphic rocks were frequently selected.

The hammerstones were selected from large pebbles and cobbles exposed in creeks and river beds near to the mines. The stones were used as hammers with little or no modification beyond medial grooving in some instances (Figs. 2 and 3, Plates 2 to 4). The most common shape is a long ovoidal, although they can be pear-shaped or cylindrical, depending on the natural shape of the stone. The stones vary in length from 5 cm to 35 cm, and typically weigh between about 100 gms and several kilograms. The very small stones, although utilised, probably in a similar manner to some of the hammer spalls found on the British mines, are not grooved and presumably were not hafted (Fig. 2).

There are also a few massive hammers weighing up to twenty kg. Similar very large hammerstones have been found in some European mines, notably at the Great Orme in north Wales (Craddock 1995, pp.15-25). Experiments at the Great Orme mine have shown that the larger hammerstones could not have been used as conventional hammers wielded by one man. Some of the largest Mesoamerican hammers are grooved as if for conventional hafting, but they must have been held in some form of sling or cradle and swung against the mine face, either held by a two man team, one on each side, or suspended from a frame as a battering ram.

The long hammerstones from Mesoamerica have batter marks caused by use at both ends, but the marks are usually more extensive at the narrower end, in contrast with similar hammerstones found in Britain. In addition to the long hammerstones there are also discoidal hammers that bear no marks of hafting but are battered all around their circumference (Fig. 4). These probably were hand held-tools found only at obsidian quarries.

The long mining hammers usually have grooves pecked around their middle, extending around three sides, to provide a seating for the wooden handle, in contrast to those found in Britain, where with the exception of a few sites such as Alderley Edge, most hammers are unmodified or at best have just a notch. The unique hafted hammers from Chuquicamata, and other some sites in the Atacama Desert of northern Chile, which are also unmodified, show that the arrangement there was to tie the handle to the stone using rawhide with the narrow end of the stone held by a loop or cradle of rawhide (Fig. 1). The hammers would have been swung underhand in a pendulum motion against the rockface. If that was the usual way of hafting the hammerstones then the batter marks sometimes found on the other end must represent a re-use of the stones, maybe as unhafted, hand-held hammers for ore-crushing. The stone hammers from Bronze Age mining sites in the British Isles were sometimes reused both as crushing hammers and as anvils (Craddock and Craddock 1996, Fig. 1c and 1997, Fig. 8).



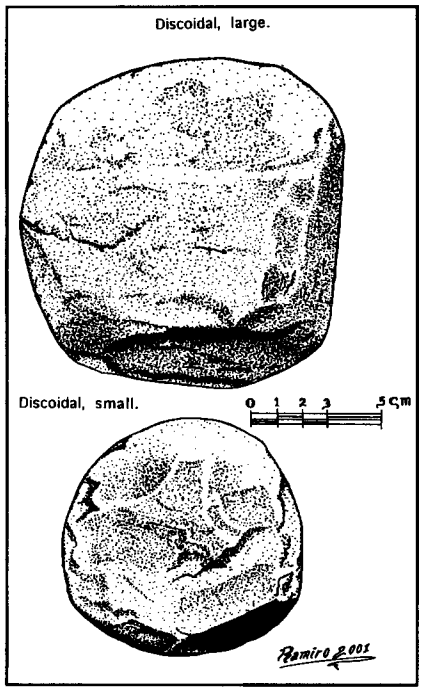


Fig. 3 (far left). Cylindrical mining hammer with a medial groove, from an early mine near Sombreta, in Zacatecas State, Mexico.

Fig. 4 (left). Discoid hammers from an obsidian Mine near Otumba, in Mexico State.

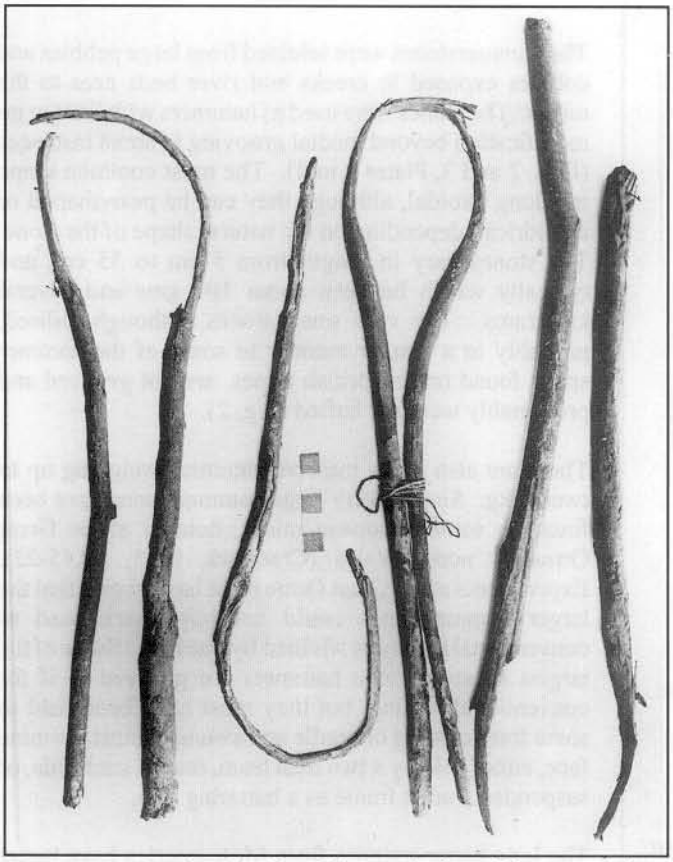
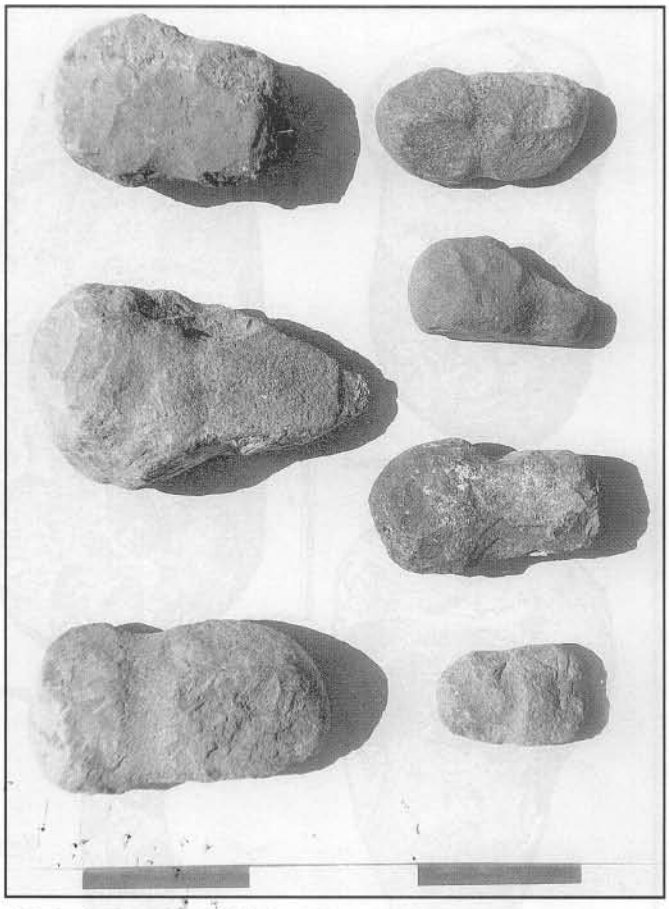


Plate 1. Wooden handles found in association with stone mining hammers (Plates 2 and 3) found in Pre-Hispanic mines in the Sierra Gorda, Mexico. (Photo. A. Langenscheidt, from Langenscheidt et al 1970).



Plates 2 (above) and 3 (below) Stone mining hammers found in association with the handles shown in Plate 1, found in Pre-Hispanic mines, in the Sierra Gorda, Mexico. (Photo. A. Langenscheidt, from Langenscheidt ed. 1970).

The hafting of the hammerstones

As already stated, only in the Americas do the handles of the mining hammers survive, but there seems to be a significant difference between the preparation of the hafts from northern Chile and those in Mesoamerica. In both regions a single piece of roundwood, from woody shrubs, typically between 15 to 30 mm in diameter, stripped of twigs etc. but with the bark otherwise intact, was bent around the middle of the stone to form the handle (Fig. 1 and Plate 1). The handle of the hammer from Chuquicamata was identified as being of algarrobo wood (*Prosopis chilensis*). The most common wood used for the Mesoamerican handles, as exemplified by those from the Sierra Gorda (Plate 1), have been identified as being of *Amelanchier denticulata*.(HBK) Koch, a dicotyledeinous shrub that grows in the vicinity of the mines. In South America the wood of the handle was twisted through about 180 ^{0} to break up the cellulose in order that the fibrous component could be more easily bent around the stone. However, the surviving handles from Mesoamerica all seem to have been made more bendable by paring the roundwood down to the centre on the side that was to be against the hammerstone (Plate 1). This would seem to weaken the handle just where it needed to be strongest, and many of the handles have indeed broken at this point. The Chuquicamata hammers were held in place with rawhide, and some such arrangement, either with rawhide or cordage, must have been used on the Mesoamerican hammers as the surviving handles have little notches cut into them to prevent the binding from slipping. The two ends of the roundwood forming the handle of the Chuquicamata hammer were bound with rawhide, but at least some of the Mesoamerican hammers were bound with cords made from bast etc. (Plate 1). One end of the

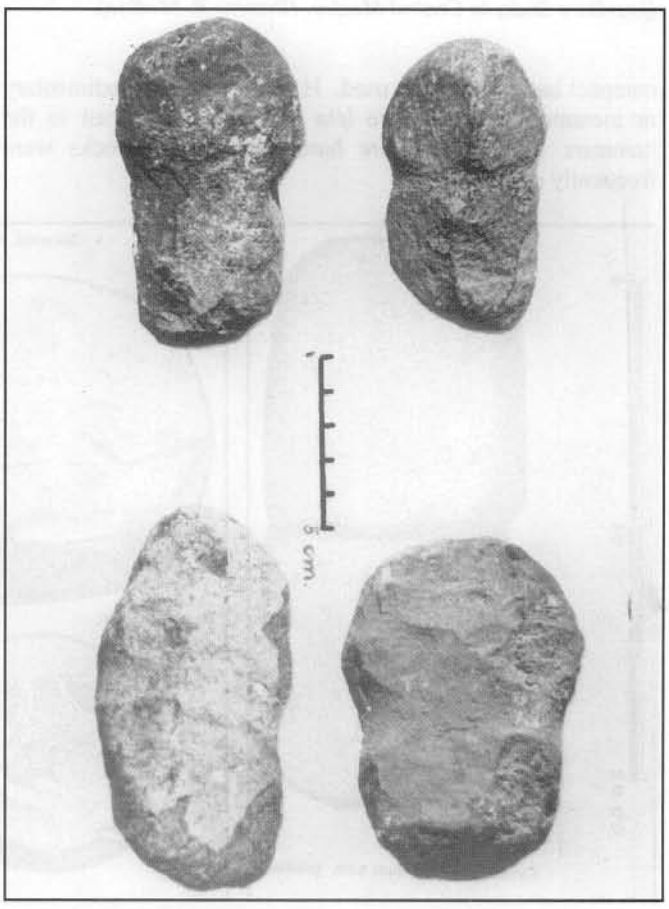


Plate 4. Typical stone tools from the pre-Hispanic vermilion mine near Guadalcázar in San Luis Potosi province, Mexico. The upper two are grooved hammers, note the cylindrical hammer on the left has a double groove, probably the result of re-hafting. Beneath are two grinding stones for crushing the ore (scale 10 cm). (Photo. P.T. Craddock).

Plate 5. Mining hammer complete with handle, photographed insitu where it was abandoned centuries before deep in an Indian vermilion mine in the mining district of Soyatal in the Sierra Gorda (Photo. A. Langenscheidt).

Plate 6 (below). Depressions in the ground above the mercury mines near Guadalcázar. Each depression indicates a mine. (Photo. P.T. Craddock)

Chuquicamata handle had clearly been hammered to 'fray out' and broaden the end, possibly to stop the binding from riding up and slipping off; similar broadening is seen on some of the Mesoamerican handles illustrated here.

Plate 5 shows a hammer, complete with its wooden handle which has also broken at the point where it was pared. This hammer was found in 1970, deep inside a mine designated the Mina Tepalcates (Shards Mine), in the mining district of Soyatal in the Sierra Gorda in the state of Querétaro in central Mexico. The hammer lay on a pile of deads, presumably where it had been abandoned. It was photographed *in situ* but left in place until proper boxes and packing were available before attempting to lift it. Unfortunately when the team returned next day the hammer and its handle had gone, and the photograph is the only record of a very important discovery.

Other pre-Hispanic mines producing the mercury-based minerals vermilion and cinnabar are found elsewhere in Mexico, as exemplified by those near Guadalcázar, in the San Luis Potosi province of central northern Mexico (Plates 6, 7). The mines were worked probably between the 13th and 15th centuries AD, by the local Indian peoples, and there are abundant remains of their occupation around the mines. The vermilion produced there is likely to have been used as a pigment both locally and traded to the Aztecs and other cultures to the south, and possibly the native metallic mercury that occurs there was also used (Pendergast 1982).

Few of the Mesoamerican hammers or their handles retain any evidence of the binding that must once have existed. The Soyatal hammer and handle had no trace of binding yet the wood of the handle survived well, suggesting that it must have been something different and more perishable than cordage, or just conceivably, more valuable. The most likely candidate here is rawhide, as has been identified on the South American hammers. Strips of rawhide make a very good binding material. It is very strong and, applied when wet, it is possible to make a tight binding that then shrinks on drying to become even tighter. Also the rawhide is a little sticky and, again on drying, this glues the handle and binding together and this seems to survive the shock of usage. Finally it is surprisingly durable, providing something does not eat it! A broken handle is useless, but a rawhide binding could be unwound and reused. It might be argued that unlike the rest of the world, including even South America, Mesoamerica had no large domestic animals and thus no source of rawhide and or tradition of utilising skins. In fact this is not true, although there were no suitable domestic animals, deer were abundant. They were hunted for their meat and their skins were used, amongst other things to form the parchment for the well known painted books (Sharer 1994, p.720). In addition, of course, the antlers were used as mining tools.

It is possible that the binding on the Soyatal hammer may have been deliberately removed after the handle broke. The binding on the hammer from Chuquicamata comprised two separate strips identified as coming

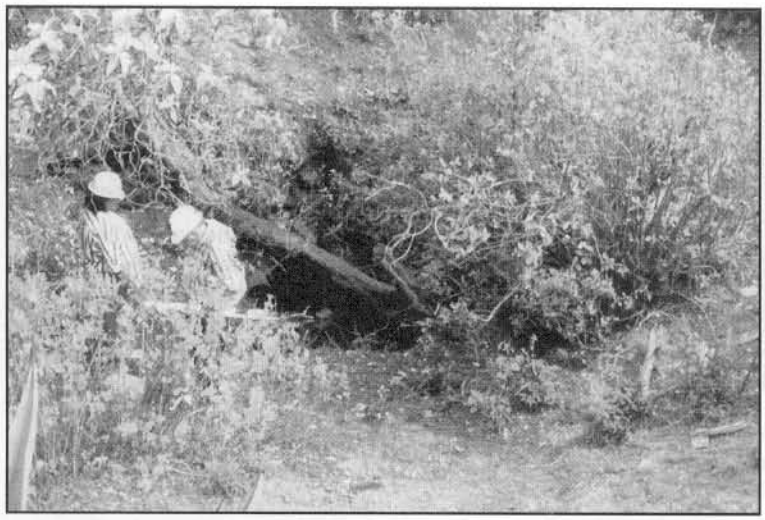


Plate 7. Typical entrance to one of the many small mine near Guadalcázar. (Photo. P.T. Craddock).

from either an Alpaca or Llama (Cartwright in Craddock et al 2002), one of which is at least two metres in length, far longer than was necessary for the hafting, and about 50 cm of its length was just wrapped around the handle serving no purpose (Fig.1). It would have been easier and neater just to have cut it off after the last knot, but clearly the maker wanted to preserve the piece as a continuous length, presumably so that when, inevitably, the strip did break there was a good chance there would still be a usable length preserved for further use.

Discussion

The archaeological excavation of hard rock copper mines at various locations in the British Isles, in common with those elsewhere in the Old World, have produce little direct evidence for hafts and none at all for the binding, with the exception of a length of twisted hazel from the Bronze Age mine at Cwmystwyth, in central Wales (Craddock *et al* 2002, Fig. 3 and Plate 15). Thus the survival of hafted mining hammers in the Americas is important for the understanding of how similar hammerstones could have been hafted elsewhere. The hafting of the mining hammers used by the Early Mines Research Group in the mining replication experiments benefited from the detailed study of the mining hammer from Chuquicamata, specifically the use of separate pieces of wood to form the two sides of the handle was abandoned in favour of one piece, as was already used on some of the hammer hafts (cf Craddock 1995, Fig. 2.12 and Fig. 2.15).

What is clear from the study of the Mesoamerican and South American hammers illustrated here, is that more than one method of preparing the wooden handle of the haft could be used to make it bend around the stone more easily. Presumably this depended to some degree on the nature of the wood available, some woods will not twist or bend significantly without breaking.

Until such time as hammer hafts are discovered in the Bronze Age mines of the Old World, we shall have rely on the American examples, exemplified by the example illustrated in Plate 5, to give us some idea of the methods of hafting used.

REFERENCES

Bird, J.B., 1979 The "Copper Man": A prehistoric miner and his tools from northern Chile, in *Pre-Columbian Metallurgy of South America*, ed. E.P. Benson. Dumbarton Oaks, Washington D.C. pp. 303-27.

Craddock, B.R., 1990 The experimental hafting of stone mining hammers, in *Early Mining in the British Isles*, eds. P. Crew and S. Crew. Plas tan y Bwlch Occasional Paper 1. Snowdonia National Park Centre. p.58.

Craddock, B.R. and Craddock, P.T., 1996 The Beginnings of Metallurgy in South-West Britain: Hypotheses and Evidence, in *The Archaeology of Mining and Metallurgy in South West Britain*, ed. P. Newman. Peak District Mines Historical Society / Historical Metallurgy Society, London. pp.52-63.

Craddock, B.R., Cartwright, C.R., Craddock, P.T. and Wray, W.B., 2002 A Hafted Stone Mining Hammer from Chuquicamata, Chile, in *Mining and Metal Production through the Ages*, eds. P.T. Craddock and J. Lang. BMP, London. pp.52-68.

Craddock, P., 1995 *Early Metal Mining and Production*, Edinburgh University Press, Edinburgh.

Craddock, P.T. and Craddock, B.R., 1997 The inception of metallurgy in South West Britain: hypotheses and evidence, in *Prehistoric Extractive Metallurgy in Cornwall*, P. Budd and D. Gale (eds.). Cornwall Archaeological Trust, Truro, Cornwall. pp.1-15.

Hosler, D., 1994 *The Sounds and Colors of Power* MIT Press, Cambridge, Ma.

Langenscheidt, A., (ed.), 1970 *Minería Prehispánica en la Sierra Querétaro*, Secretaria del Patrimonio Nacional, México.

Langenscheidt, A., 1985 Bosquejo histórico de la mineria prehispánica de México, *Quipu* **2** 1. Sociedad Latinoamericana de Historia de la Ciencia y la Technologia, México. pp.37-58.

Langenscheidt, A., 1997 La mineria en el área mesoamericana, *Arquelogia Mexicana* **V** 27. pp.6-15.

Langenscheidt, A., forthcoming An Overview of Early Metallurgy in Mesoamerica, *Journal of the Historical Metallurgy Society*.

Langenscheidt, A. and Tang-Lay, C., 1978 La minería Prehispánica en la Sierra Gorda, in *Problemas del desarrollo histórico de Querétaro*, INAH-SEP, Gobierno del estadode Querétaro.

Langenscheidt, A. and Tang-Lay, C., 1982 Mining and Mining technology in Ancient Mesoamerica, in special issue of *Anthropology* **6** 1 / 2. eds. P.C. Weigrand and G. Gwynne. pp135-48.

Pastrana, A., 1966 *La explotación azteca de obsidiana en la Sierra de las Navajas*, Tesis de Maestria, ENAH, México.

Pendergast, D.M., 1982 Ancient Maya Mercury, *Science* **217**. pp.533-4.

Pickin, J. and Timberlake, S., 1988 Stone hammers and firesetting, *Bulletin of the Peak District Mines Historical Society* **10** 3. pp.165-7.

Sharer, R.J., 1994 *The Ancient Maya*, 5th ed. Stanford University Press, Stanford, Ca.

Weigand, P.C., 1968 The Mines and Mining Techniques of the Chalchihutes Culture, *American Antiquity* **33** 1. pp.45-61.

Weigand, P.C., 1985 Evidence for complex societies during the Western Mesoamerican Classical Period, in *The Archaeology of the West and Northwest Mesoamerica* . Westview Press, Boulder and London.

Weisgerber, G., 1992 'Der Kupfermann' Indiaischer Bergbau vor Columbus, in *Amerika 1492-1992 Neue Welten, Neue Wirklichkeiten*, Georg Westermann, Brauschweig. pp.159-67.