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STONE HAMMERS AND FIRE-SETTING: A PRELIMINARY EXPERIMENT AT CWMYSTWYTH MINE, DYFED

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Abstract: Stone hammers and charcoal of middle Bronze Age have been located at Cwmystwyth. Experiments were made into firesetting and use of stone hammers for primary mining of indurated rock at the site. Results indicated their use would have been a viable method, and suggests further questions.

Stone hammers occur in large numbers on the spoil tips below the top opencast of the Comet Lode on the Copa Hill section of the Cwmystwyth Mine, Dyfed (SN 816756). They were first noted in the mid 19th century when it was suggested they had "clearly at an early period been used as mining tools" (Smyth 1848 p664). In the late 1930s Oliver Davies (1947) sectioned the tips in three places, found stone hammers stratified within the make-up of the dumps, and postulated a Roman date for these operations. Limited excavation by one of the authors (S.T.) in 1986 in the same area revealed stone hammers associated with charcoal. It was assumed that the charcoal derived from fire-setting activities used in conjunction with hammers in primary hard rock mining. Three radiocarbon dates from charcoal found within the tips centred on 1500 BC: this suggested that mining at Cwmystwyth began during the middle Bronze Age, thus making it the earliest known metal mine in mainland Britain (Timberlake 1988).

Experimental work was carried out at Cwmystwyth in 1987 to test the use of stone hammers and fire setting in primary mining. The site chosen was the top of the backfilled Penguellan Shaft, a 19th century mine where a strong carbonate vein is exposed in a host rock of indurated shale.

Approximately a third of a tonne of timber - principally oak and beech - was taken to the shaft. A stack 3 m long and 1 m deep and 1 m high was built along the face so that the action of the fire could be gauged on both the vein and the country rock. The fire was watched and controlled for four hours. After a further eight hours it was burnt out: by then the timber had been reduced to a fine ash with little remnant charcoal but the embers still emitted considerable heat. The burnt area showed as a patch of distinctive yellow-grey discolouration and, although the action of the fire had crazed the rock, it had only managed to detach a few large pieces. Dousing the face with water had only a minor effect on the rock

A number of water-worn cobbles were collected from the bed of the Afon Ystwyth opposite the mine. They ranged in length from 150 mm to 300 mm and were similar to those found at the Copa Hill opencast (see figs. 1A and 1B). They were used as mining hammers to work the fire-set face. As hand held tools they were found to be quite efficient in breaking down the larger pieces of surface rock already crazed by the heat. The rock behind this surface layer, however, proved more resilient, and did not readily respond to direct battering. The burnt shale broke away in very small fragments under consistent pounding but the hammerstones were only really effective when they could be used against a projecting rather than a flat surface. The carbonate vein tended to bruise rather than break, and a hammering action compacted the surface. It was felt that levers or wedges used in association with a hammerstone would have been effective on this material and experiment showed that small sticks of wood were sufficient to work the crumbly carbonate. Similarly, stone flakes detached from the ends of the hammerstones proved useful as chisels on the harder shale and unburnt vein.

The smaller hammers which could be held in one or both hands depending on the angle of use, proved the best tools for working the face. Their size allowed them to be used with greater precision than the larger stones but their comparative lightness - around 0.75-1.25 kg. - precluded the delivery of a powerful blow. The larger hammerstones, - over 200 mm long - were efficient when used in an angled blow from above the shoulders but were clumsy and hard to control if swung from lower on the body; they were very effective however at barking the operator's knuckles! Nevertheless it was found the larger cobbles could be used to advantage when held in a rope-sling tied around their centres (Plate 1) . This enabled a powerful blow to be delivered which was especially useful for working the bottom of the face. The rope was passed over the shoulder, with one hand holding the slack end, and the other end passed around the hammer's butt to steady and control the angle of swing; this battering-ram action allowed a more powerful blow to be directed against the face than could be obtained with a hand held-stone.

The various methods of use left similar wear marks on the ends of the tools. This was characterised by circular areas of close-pitted bruising identical to that observed on the hammerstones on the opencast dumps. Many of the latter, however, exhibit severe end-flaking coupled, in some instances, with longitudinal fracture of the complete tool. This spalling was not replicated during the experiments on the fire-set rock, but it was obtained when the hammers were used on areas of unburnt shale nearby. This hard shale, although unaffected by stone tools, was easily broken down with a steel pick.

Approximately one hour's mining removed something in the region of one cubic metre of shale and vein

stuff weighing around 1/4 - 1/3 tonne. This figure could have been increased had appropriate bone and wood wedges been available. It proved almost impossible to detach the unburnt rock encountered about 0.3 m beyond the original face and hammerstones left little impression on this surface. Surprisingly, the fire appeared to have had maximum penetration in the area immediately above, rather than in front of the wood stack: this gave the face a distinctive concave or bellied profile. Willies (1987) describing ancient fire-setting activities at Zawar in India records a similar profile in the mine wall but suggests the main impact was in the region of the floor.

An attempt was also made at dressing burnt pieces of carbonate vein by vertical pounding on a hard surface (Plate 2). This proved to have been much easier than might have been expected as the heat from the fire had left the veinstuff in a friable state, and it turned to a coarse powder when pounded. The ore, being more solid, was easily extracted from the gangue by hand-picking. Pieces of unburnt vein were much harder to break. This suggests that fire-setting may have had a secondary role in improving the efficiency and ease of the beneficiation process.

The experiment was essentially uncontrolled. It was designed to suggest questions rather than provide answers and a number of factors - such as the possible disturbance to the face of Penguellan Shaft from weathering and the historic use of chemical explosives - have to be born in mind when looking at the results. Nevertheless, this preliminary experiment has shown that stone tools and fire-setting can be employed in basic hard rock mining and has demonstrated that stone cobbles can be held in a rope sling without any modification of the stone's surface. The effectiveness of stone hammers as mining tools appears to refute the belief (Briggs 1984 p38) that such crude implements could only have been used for ore dressing.

The experiment suggests a number of interesting points:

Is water quenching an essential part of fire-setting?

Can stone hammers be used alone, or are wedges and levers of bone and wood an essential part of the process?

How effective are stone, bone, and wood tools compared to metal ones?

What temperatures are necessary for efficient fire-setting?

Do certain tool-types relate to particular functions such as mining and dressing?

Are different tools and methods employed on different types of vein and country rock?

Future work, hopefully, may answer some of these questions.

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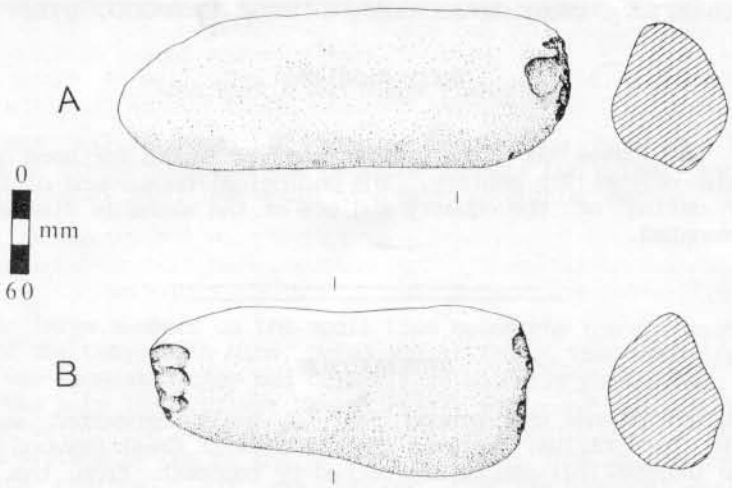

Fig.1. Comparison of an experimental hammerstone (A) with one found in the Copa Hill opencast (B).

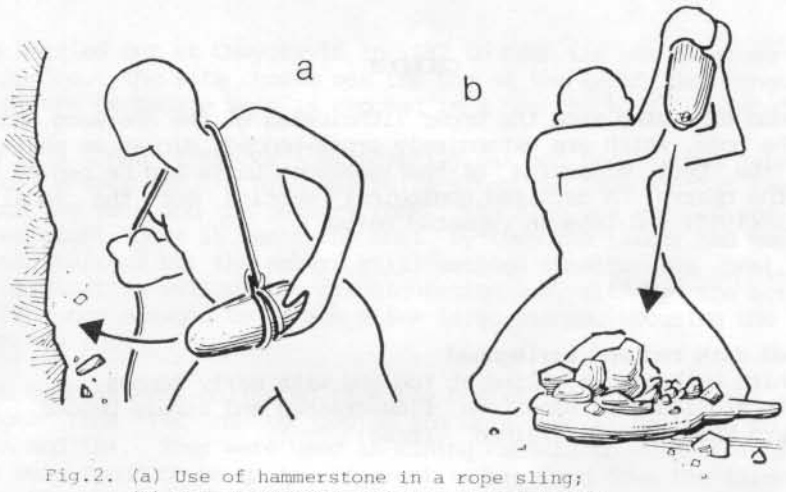

Fig.2. (a) Use of hammerstone in a rope sling;
(b) Use of large hammerstone for vertical pounding and ore-dressing.

Plate 1. Use of hammerstone in rope sling against fire-set face.

Plate 2. Ore-dressing with hammerstone.