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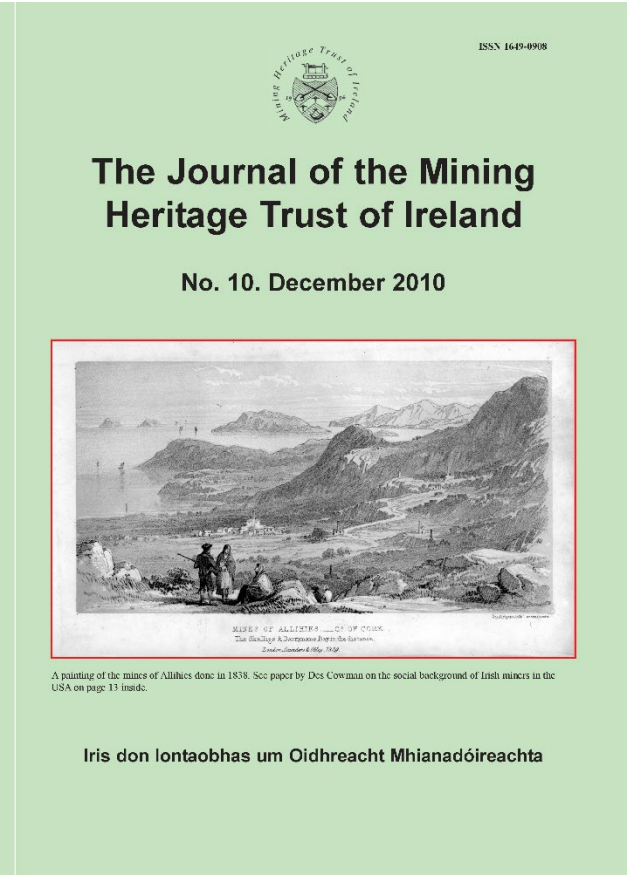

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EVIDENCE FOR EARLY BRONZE AGE TIN AND GOLD EXTRACTION IN THE MOURNE MOUNTAINS, COUNTY DOWN

by Richard Warner, Norman Moles and Rob Chapman

Abstract: We summarise the evidence for believing that the Mourne Mountains of Co. Down were an important source of gold and tin during the Early Bronze Age. We suggest that these metals might have been extracted from buried eluvial/alluvial deposits and we present evidence for what might be the remains of prehistoric stream-works. *Journal of the Mining Heritage Trust of Ireland*, **10**, 2010, 29-36.

INTRODUCTION

The first Irish metalworkers, during the 'Beaker' phase of the Early Bronze Age, began to make copper objects as early as the 25th century BC. Within two or three centuries they were adding tin to make tin-bronze and also fashioning spectacular gold ornaments (both summarised, with references, by Waddell 1998, 123ff; for gold Taylor 1994; Eogan 1994). While there has never been any doubt about Ireland's ability to provide sufficient natural copper for this industry, and Early Bronze Age copper mines have been found, and investigated, in Counties Cork and Kerry (O'Brien 1996; 2004), the origins of the tin and gold used here at that time have always posed problems (Penhallurick 1986, ch. 18, and Budd *et al*. 1994 for the tin; Eogan 1994, 8ff for the gold). The orthodox position has for many years been that the tin and gold were imported - the tin from Bohemia (Evans & Jope 1952, 83) or Cornwall (Herity & Eogan 1977, 116; Penhallurick 1986, 113; Sheridan 2008, 67), the gold either from Cornwall (Penhallurick 1986, 163) or from Iberia (Hartmann 1979, 221). There have, of course, been attempts to 'naturalise' these metals (for instance Coffey 1913, 46; Harbison 1971; Briggs *et al*. 1973; Briggs 1976; Jackson 1979; Northover 1982) but these have, until now, been justifiably resisted for want of evidence of their exploitation, or even of their presence in adequate quantities.

GOLD FROM THE MOURNES, WITH TIN AS A CONTAMINANT

In 2009 it was reported (Warner *et al*. 2009; see also Chapman *et al*. 2006) that the best Irish (or British) match, on the basis of the measured silver and copper values within the gold, for those Irish Early Bronze Age gold ornaments that were certainly native (the lunulae), was with natural gold in the Mourne Mountains. Indeed, so good is this match that, in default of evidence of a better (or even as good) match from elsewhere, we have suggested that the majority of Early Bronze Age lunulae were made from gold sourced from the Mourne Mountains. However, this suggestion suffers from the problem that the quantities that we have discovered by panning from the superficial Mournes streams are insufficient to account for the size of industry indicated by the surviving ornaments - in excess of 100 known lunulae. Three explanations (apart, of course, from our suggestion of origin being wrong) offer themselves. The first is that the streams became impoverished by the activities of the early panners. This happened on the Glengaber Burn in Scotland which was, in the 17th century, a rich gold source but now fails to produce any significant quantity. Secondly, it may be that the gold was recovered from veins which we have failed to discover. Finally the gold might have been dug and washed ('streamed') from deep eluvial/alluvial contexts - a proposal which we explore below.

A feature of the Irish Early Bronze Age gold ornaments is that many of them contain measurable, but variable, amounts of tin (up to 0.4%, averaging about 0.04%) (Warner 2004). This presence persuaded both Hartmann (1979, 218) and Penhallurick (1986, 160ff) that the gold source was likely to have been a placer in a situation where cassiterite grains were also found in sufficient quantity to be a measurable contaminant, conditions that exist in Cornwall and Iberia. The observed tin level in the gold ornaments requires, on average, only a single tin grain to over 2000 gold grains in the collected gold (assuming equal sizes). Tin and gold occur only rarely in the same mineralization and there are no instances of their hard-rock co-occurrence in Ireland. Tin ores are associated with granites, and in Ireland most gold occurs in metamorphosed sediments of Lower Palaeozoic age. Co-existence of tin and gold in a placer environment demands both types of mineralization to be present in the same drainage basin, or to be moved into conjunction by glacial and/or fluvial action. In Ireland the conditions for the presence of both placer gold and tin can be found in the Wicklow mountains and in the Mournes, and in these places they have been found together in streams. The Avoca and Goldmines River area in Wicklow has been associated both with gold (McArdle & Warren 1987; Eogan 1994, 10; McArdle 2003) and with tin (Jackson 1979). In our collecting we found the cassiterite presence in the heavy mineral concentrates in that area to be insignificant, though there might have been enough to act as a contaminant for the gold at the level mentioned above. However, the silver and copper values of the Wicklow gold found by us failed to match that of the ornaments (Chapman *et al*. 2006) and it cannot be considered a major Early Bronze Age source for gold. Both our own work and that of the Geological Survey of Northern Ireland, has shown that cassiterite is present in significant quantities in the streams of the Mourne Mountains, including some that have produced gold. In other words, not only does the Mournes gold match the ornaments in the levels of copper and silver, the Mournes are also able to provide the 'contaminating' tin.

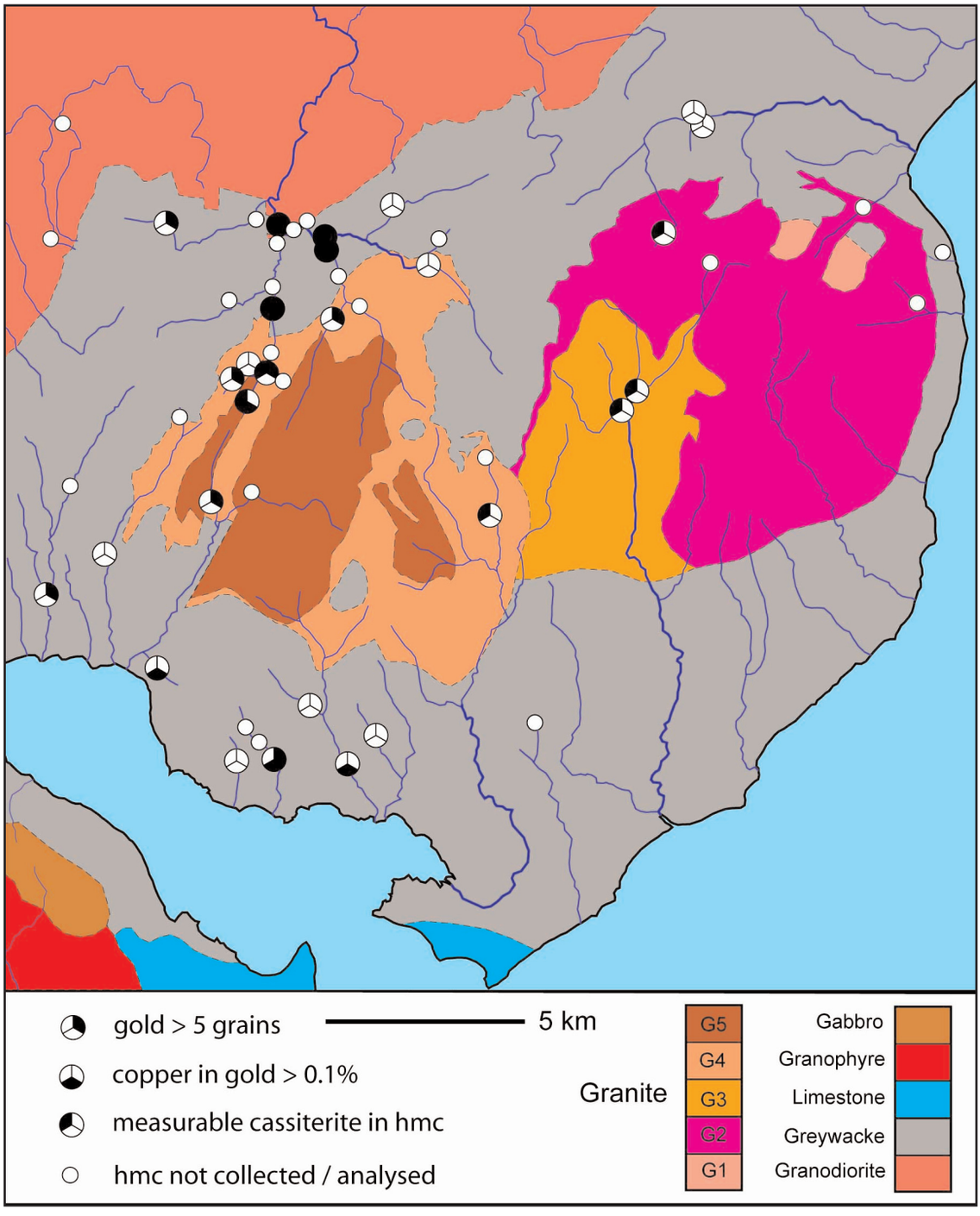


Figure 1. Pie-symbols showing the gold and tin proportions from the Mournes streams. hmc = heavy-mineral-concentrate.

TIN FROM THE MOURNES

Jackson (1979) claimed that there was enough tin in the rivers in the Avoca area of Wicklow to have provided for the whole Bronze Age tin-bronze industry - a claim that has been dismissed by Budd (*et al*. 1994). Penhallurick (1986, 111) dismissed all published claims for the exploitation of native Irish tin on the justifiable grounds that it occurred in insufficient quantities - the claimed occurrences were all trivial.

Most previous reports of placer cassiterite in the Mournes, and elsewhere in Ireland, were notable for the very small quantity present, as Penhallurick stressed. Although we first considered the tin to have been an 'extra' - merely a contaminant - we have since been struck by the fact that the cassiterite that we have found in some of the Mournes streams is present in what could be called 'industrial' quantities. Our pans produced a heavy-mineral-concentrate (HMC) which was treated further in the laboratory to remove all light minerals and analysed by X-Ray Diffractometry to semi-quantitatively identify the heavy minerals present. We found some or much cassiterite in the treated HMC in several streams, reaching a high level in the Leitrim and Trassey Rivers. Our conclusion would now be that, in the Early Bronze Age, the Mournes were an important source of gold and of tin. It is our view that the same techniques were used, by the same miners, to recover both metals, although not necessarily in the same localities. It also seems likely that the primary search was for tin, as the cassiterite is far more easily seen in these streams and while we have found no *in situ* gold mineralisation there are published reports of tin mineralisation (see below).

As we have said above, the addition of tin to the native copper first happened in Ireland at about the same time as the development of the lunulae - in about the 22nd century BC. Indeed the hoard of bronze axes that names one of the three classes of this early tin-bronze tradition (the Ballyvally hoard: Harbison 1969, no. 843-4) was found only 4 km. west of the Leitrim River (in the western Mournes), which has provided a high level of panned cassiterite as well as significant gold of the correct trace-element signature. O'Brien (2004, 564) has suggested that the lunulae found in the south-west of Ireland might indicate trade between that region and Cornwall - gold and tin in return for copper. We support that suggestion, with the modification that the metal-masters of County Down, not of Cornwall, were the trading partners. It is of some interest that the only known mould for a Ballyvally-type axe comes from Co. Cork (Eogan 1993, 105).

EXTRACTING PLACER GOLD AND TIN

The fact that both gold and tin will, upon release by natural agencies, be fluvially concentrated in an identical manner due to their high specific gravity, means that the same extraction methods applied to the eluvial/alluvial deposits will uncover whichever is present. Chief amongst the 'natural agencies' responsible for the release of the metals in the Mournes are Tertiary glaciation, with periglacial weathering and sorting of the glacial till. In the mid-Mournes, the streams running over granite have produced significant cassiterite, but no gold (Figure 1). In the south-west Mournes, highly faulted Lower Palaeozoic meta-sediments, we find only gold, and in the western and north-western Mournes, where the Lower Palaeozoic rocks and granite are in close proximity, we find both. In Cornwall, where tin and gold co-exist, the similar processes of weathering and concentration (Camm and Croot 1994) often provided the Cornish stream-tinners with a useful bonus of gold (Penhallurick 1986, 160).

A good example of the appropriateness of simple hydraulic ('streaming') methods for the search for and extraction of both metals is seen in New Zealand, where gold miners who had worked in Ottago and Coromandel, using simple techniques ultimately derived from Cornwall via Australia, moved to Stewart Island to use precisely the same methodology in the recovery of tin (Petchey 2006). It is striking how similar are the remains of the 19th-century workings in New Zealand to workings of possibly Medieval date in South-West England. It is important to recognise that the gold uncovered in the Wicklow 'gold-rush' of the late 18th century was dug from deep deposits, laid down before the last glacial period (Kinahan 1883; McArdle & Warren 1987). This is well illustrated by a contemporary aquatint of gold-diggers in Co. Wicklow which shows digging and sluicing in use to recover eluvial gold (Whitfield 1993, 21). We should note that in almost all cases of gold and tin recovery from eluvial contexts (and often from alluvial contexts) anywhere in the world the digging-out of fairly deep deposits was general and superficial streams were only used for the supply of the sluicing water (Penhallurick 1986, esp. 153ff).

THE SEARCH FOR FIELD EVIDENCE IN THE MOURNES

The similarities between the stream-workings of Cornwall and Devon (Figure 2), and New Zealand, and the simplicities of the methods used, which were well within the capabilities of prehistoric people, have prompted us to search for signs of the same sort of operation in the Mournes. In other words we have been searching for water races (head- and tail-), sluicing-gullies, hushes, and parallel mounds of waste (see Petchey 2006). It appears likely that the visible signs will depend strongly on the nature of the tin (or gold) 'ground', the nature and depth of the overburden, the topography and the availability of water (Young 2007. This is also a good source of photographs of eluvial stream-works in Cornwall). Because we are working on the hypothesis that the same methodology was used for each metal we are searching all the streams and rivers that have produced evidence of either or both of those metals for any surviving signs of workings. It must be borne in mind that, by and large, it is only the streams whose higher reaches are above normal agricultural or development limits which retain associated land-

Figure 2. Tinners' gullies on Dartmoor, Devon. Photo Jim Morley.

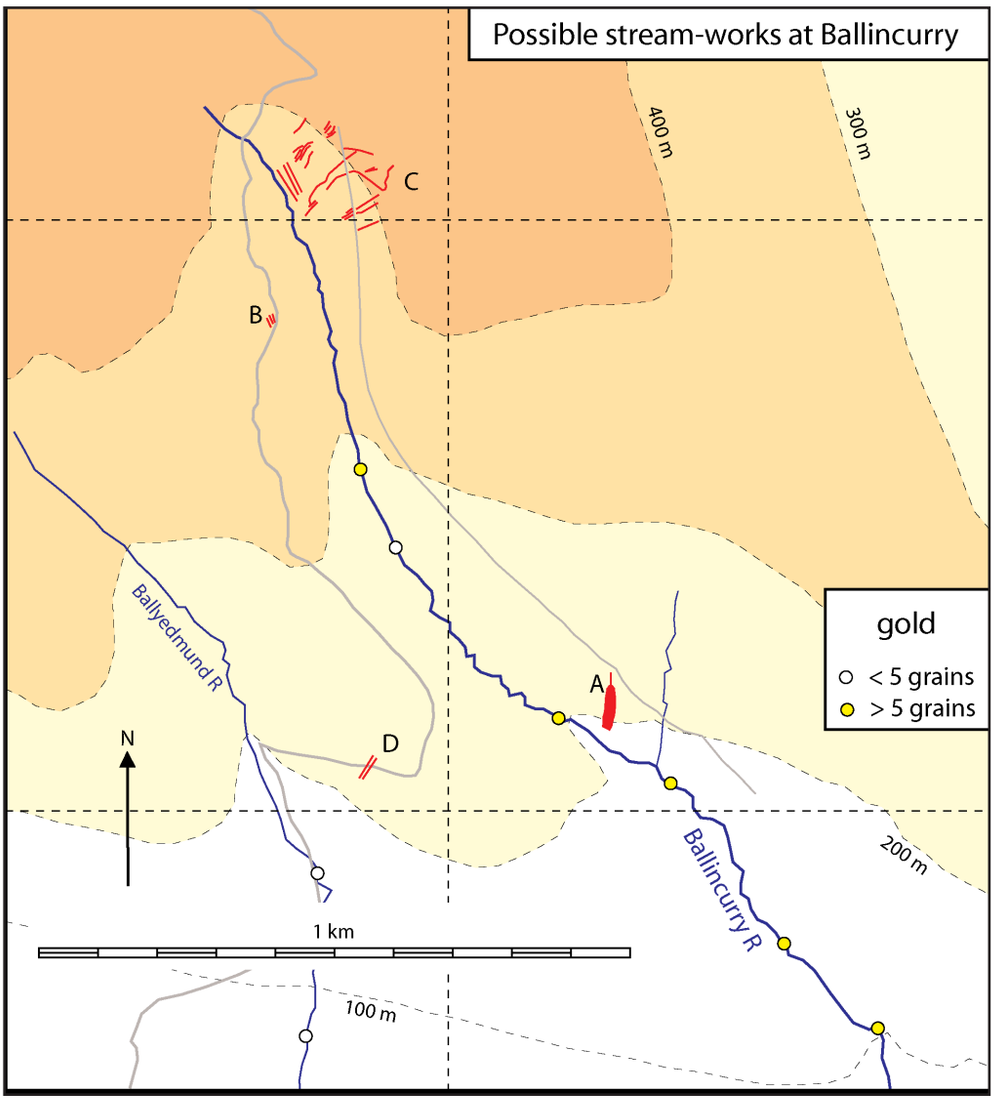
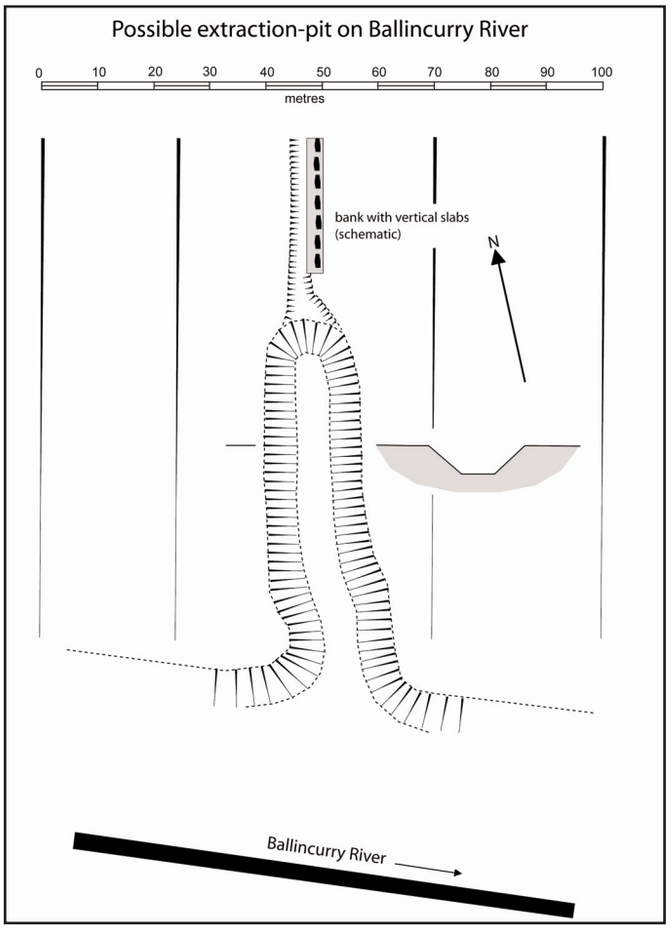


Figure 3. Map of the Ballincurry River area.

scapes well-enough preserved for there to be a chance of recognising ancient workings. The lower reaches have usually been too severely altered in recent times. Consequently we are more likely to be searching for eluvial than alluvial workings. There is, however, in this palimpsest of historical land-use, much difficulty in distinguishing the features of potentially early metal search and extraction activities from natural features associated with periglacial and immediately post-glacial conditions and the farming, winter pasturing, water management and quarrying of the many intervening centuries until the present day (for a similar situation in the North Pennines see Timberlake 2004).

So far we have found potential remains at only one river - the Ballincurry River near Rostrevor (Figure 3). This is a small stream running southwards between promontories of greywacke cut by both dolerite and porphyry dykes. This stream, short though it is (2.5km), has produced a fair number of very small gold grains, which match our ornament trace-element fingerprint best of all the Mournes gold sources. As we would have expected from the geology it did not produce any cassiterite. Several deep gullies run down the valley-slope on the eastern side of the stream and we have no hesitation in explaining most of these as primarily natural run-off channels. However, we have found a short, but wide and deep gully that seems unlikely to have a natural explanation (Figures 4 & 5). It starts quite suddenly and is dug into the valley side, with its base inclined at about 14º - the same as the hill-slope inclination. It is about 20 m wide, 5 m deep and 70 m long. At its head, which is abrupt, there is what appears to be an ancient slab-and-earth wall in line with its axis, with a shallow channel down one side. The foot of the gulley opens just short of the Ballincurry River, at right-angles to it. It does not seem likely that this is a 'hush', so we are inclined to interpret it as an extraction pit, following (or searching for) gold in sediments up to 5 m below the hill-slope surface. We would infer that, while a small race visible at its top might have been sufficient for local ground-sluicing of the diggings, most of the extracted material was moved to the stream edge for full sluicing. There are mounds of debris along the stream at this point.

Nearer the head of the same Ballincurry river, where it passes through a wide, shallow valley, we found a series of parallel banks, and deep, regular gullies as well as obvious natural drainage features (Figure 6). Other groups of short, multiple, parallel banks are to be found in the vicinity. We are provisionally identifying the banks as waste-mounds and at least some of the regular channels as races, or even sluice-gullies (or small hushes). As no significant cassiterite was found in this river, but



gold was fairly plentiful, we would tentatively interpret these features - if they are indeed man-made - as the results of, or attempts at, eluvial gold extraction.

At two sites within the eastern granite area of the Mournes the local streams were cassiterite rich. At Pollaphuca near the head of the Trassey River, which runs through granite, traversed by dolerite and porphyry dykes, the occurrence of thin, cassiterite-bearing, quartz veins in proximity to a greisen vein (Figure 7), has been known for some time (Arthurs and Earls 2004, 263). Exploration in the 1980s (Clifford and Earls 1982) showed the local sediments to be rich in cassiterite. We confirmed this with our own panning - there was no significant gold, but analysis of our heavy mineral concentrate showed a high cassiterite level. Unlike the situation on the Ballincurry river, this granite area is fairly uniformly covered with hill-peat, up to a metre thick. It is therefore difficult to identify disturbances which, if of Early Bronze Age date, would be likely to be under the peat.

In the central Mournes, the Kilkeel river has been artificially damned to form two large reservoirs. A small tributary river, the Miners Hole River, runs into the Silent Valley reservoir, passing through a quarry-like feature called 'The Miners Hole' just before it meets the reservoir (Figure 8). Local tradition (Evans 1951, 46) holds that this name refers to the endeavours of Cornish miners who were brought over by Lord Kilmorey. We have indeed found a newspaper report of a Lord Kilmorey

Figures 4 & 5. Sketch plan and view of a possible gold-extraction pit on the Ballincurry River (site A onfigure 3).

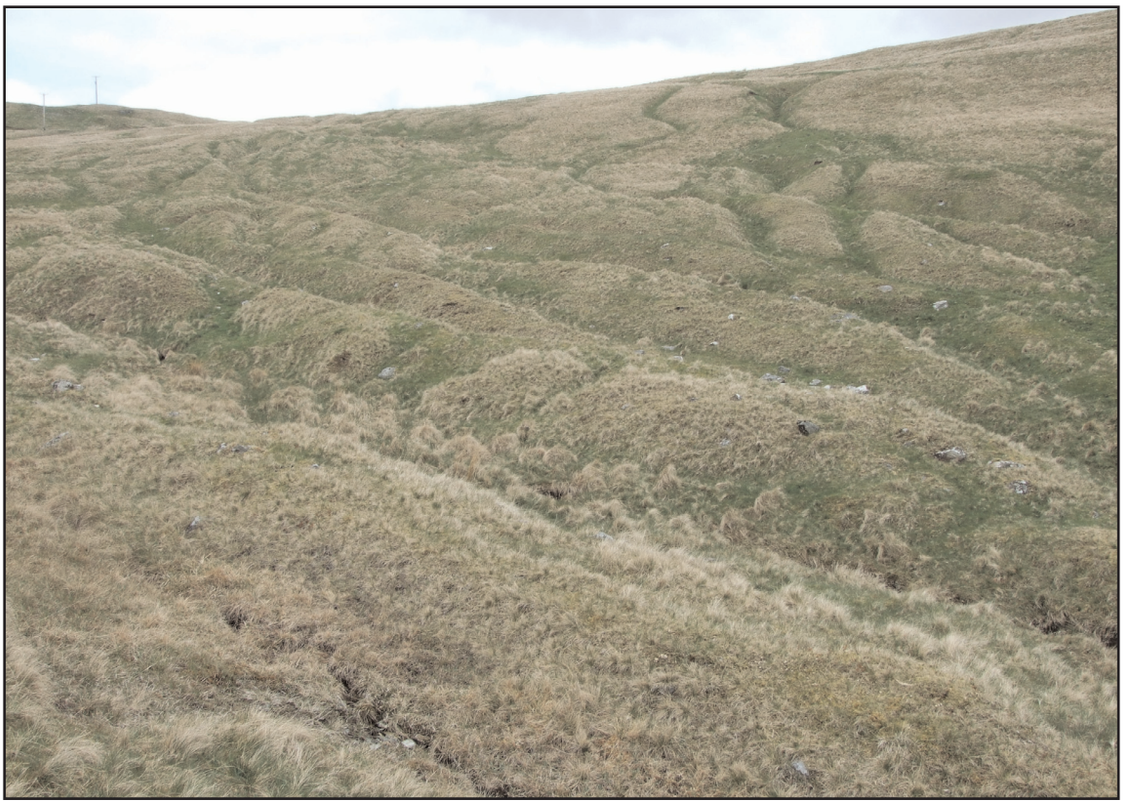


Figure 6. Possible workings on the Ballincurry River (site C on figure 3).

bringing over miners in 1875 to search for lead at other localities, but the name Miners Hole is found on a map of about 1835 and it is clear that tradition is in error. At the Miners Hole there are exposures of haematite-rich greisen, which might contain, or signal, cassiterite (Clifford and Earls 1982), and our panning of this stream and the nearby Kilkeel River indeed produced significant cassiterite.

FUTURE WORK

This short article is exploratory, and it is to be hoped that readers will contact the authors with observations. It is obvious that, if these features are for gold or tin extraction, investigation of them should produce evidence of those metals. Hopefully, facilities will become available to allow some excavation, soil

Figure 7. Greisen on the Trassey River, near which are cassiterite-bearing quartz veins.

Figure 8. The 'Miners Hole' in the Kilkeel River valley.

analysis and radiocarbon dating. Meanwhile, we are sampling river-channel and overbank sediments in the western Mournes to investigate whether these sediments might hold a record of early eluvial/alluvial tin mining, as has been found on Dartmoor (Thorndycraft *et al*. 1999) where Medieval tin streaming enhanced the tin concentrations in such sediments. We have found plentiful charcoal low in the banks of the gold- and tin-rich Leitrim River and this will, hopefully, be radiocarbon-dated. A further line of investigation might be a comparison of the tin-isotope ratios of the axes of the Ballyvally hoard and both Cornish and Mournes cassiterite (see Haustein *et al*. 2010).

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