

BEACH SLAGS OF THE NORTH WALES COAST

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Abstract: This investigation arose from the proposition that large amounts of ore being smelted in prehistory would have produced considerable quantities of slag and smelter waste. The coastal location of the Great Orme prehistoric mines suggested that ore might have been taken by sea to sites with plentiful fuel supplies. One such site, Port Penrhyn, at the mouth of the river Cegin, was the first to be examined and considerable amounts of copper slag were found. However this slag had been brought to the port as ballast in the 18th and 19th centuries by sailing vessels engaged in the slate trade, a practice, it would seem, that has not previously been described. In the main this article deals with slags deposited in the past few hundred years close to prehistoric mining or settlement sites but it is based on the ongoing work of 'The Bronze Age Coast Project'. This project is aimed at understanding the society that exploited the mineral wealth of North Wales in the Bronze Age. As such, this article, is part of a growing body of information that has resulted in other papers and articles on related subjects.

PREHISTORIC MINING AND SMELTING

In 1992, in *Bronze age smelting - A Discussion Paper on possible smelting sites for Great Orme copper ore*, the possibility was discussed that, as in other mining areas, local fuel supplies would not be sufficient for smelting ore. Fire-setting and domestic use would further increase demand. It was proposed that the ore mined on the Great Orme would be taken, perhaps by sea, to sites where fuel - charcoal - could be easily obtained. This recognises the fact that the whole smelting process requires, by weight, far more fuel than ore (Bannerman 1992). After much research into smelting Professor E. Slater has estimated a ratio of 15-20 to 1 of charcoal to ore by weight (pers. comm.). When wood is burnt to produce charcoal there is an 80% reduction in weight, hence to smelt 10,000 tonnes of copper ore would require 150,000 - 200,000 tonnes of charcoal and thus 750,000 - 1,000,000 tonnes of selected hardwood. This illustrates the size of the fuel industry as estimates of ore mined on the Great Orme alone in the Bronze Age vary between 10,000 and 50,000 tonnes.

The aim of the 1992 paper was, as the title implied, to encourage debate, and the examination and investigation of areas indicated by the conclusions drawn, as possible smelting sites. Proven evidence of Bronze Age copper ore smelting in the British Isles is, at the time of writing, very sparse. The absence of prehistoric copper slags has several explanations, perhaps the most popular being that only carbonate ores (e.g. malachite) were smelted in a "non slagging" process, while sulphide ores (e.g. chalcopyrite) were discarded (Craddock 1990). This theory being based upon smelting conducted under laboratory conditions with specimen quality malachite. In fairness, when this work was done, known Bronze Age mines were nowhere near as extensive as the Great Orme and Parys Mountain discoveries have since proved to be. It would be reasonable to suppose that small scale smelting could be practiced using only very pure ore, but, when smelting operations of the scale indicated by the Great Orme mines are considered, it is felt that it is necessary to think on more industrial lines. Furthermore the apparently extensive prehistoric workings on Parys Mountain would have been likely only to have produced sulphide ores.

Increasing skill in smelting high-grade ore would soon lead to more impure ores being used. Mineral extraction without iron tools is extremely difficult and anything that came out of the mine, which looked like copper ore, would be experimented with during the 1,300 years or more that copper was exploited

in North Wales in prehistory. There is a tendency in some quarters to think that because no prehistoric sulphide slags have been found, no sulphide ore was smelted. This reasoning has been illogically extended to imply that therefore there is no point in looking for sulphide slag as any that is found will be from another period. Discussions and work with D. Chapman during some preliminary trials in smelting Great Orme ore indicate that, even with carefully sorted copper carbonate ores, considerable amounts of waste products are produced. Professor Slater has also noted quantities of waste remaining after smelting copper carbonate ores. At all times it is important to remember that of thousands of tonnes of ore were removed from the Great Orme during the Bronze Age. Processing and smelting this amount of ore must have resulted in the production of large amounts of waste material, whatever type of ore was smelted. Recognizing this the author resolved to be as open minded as possible and not to decide what would be found, beforehand.

Thus far, no deposits of Bronze Age slags or smelting waste are claimed, though certain sites must be further examined. Dr. D. Jenkins (pers comm) pointed out that ancient slags might well be buried beneath more recent ones. Slags are evident at many sites, which may point to activity at other times, medieval or otherwise. It must be repeated that in this paper, the object was mainly to enquire into 18th and 19th century slag deposits so that they could be recognized and separated from earlier ones.

It is worthy of mention that what appears to be a very early, possibly Bronze Age, ore processing floor was revealed by the torrential downpour that flooded Llandudno in 1993. Water pouring down the Great Orme at Fynnon Galchog, scoured a gully through a tip of "fines", waste material containing ground dolomite, specks of malachite and other ores, and many pieces of copper stained bone similar to those found in the Bronze age workings.

This area had been suspected as a possible mineral processing area as references exist to "many tons of Roman copper slime" having been removed from there in the 19th century but a recent excavation had proved inconclusive. As the Fynnon Galchog area could be a Bronze Age mineral processing and concentrating site it must surely warrant further investigation. The term "Roman" was indiscriminately applied by 19th century miners to early workings in the Great Orme which have since proved to be Bronze Age, and it would appear that by 500 BC the mines were "worked out" until the advent of more modern mining methods in the 19th century. The area was very carefully

examined but surprisingly no slag was found which could indicate that, though the ore may have been processed there, it was taken elsewhere for smelting, perhaps being loaded onto boats in Porth Helyg which is directly below the Fynnon Galchog area.

INITIAL RESULTS

During preliminary investigations and after finding copper slag at Port Penrhyn, the help of a few of the author's friends was enlisted in examining local beaches. Even before the discussion paper (Bannerman, 1992) was published, previously unreported copper slags were starting to turn up all along the North Wales coast. The largest was a deposit of many tonnes on the North shore at Llandudno, discovered by T. Parry, T. Davies and Dr. D. Smith, fellow members of the Great Orme Exploration Society. This particular find is within a kilometre of the prehistoric mine site, and although it is fairly certain that the deposits are 19th century, it does rather emphasise the point that, until research for this discussion paper was started, the search for copper slag had been none too thorough.

It was therefore decided to 'clear the ground' by first investigating these 18th and 19th Century deposits, taking care of course to keep alert for older deposits at all times.

It also became clear that the amount of slag being found in so many different locations was going to present a problem, in that detailed documentation of every site, would take a very long time. It was further decided therefore to proceed as follows:

1. Classification. To identify and classify slag types.
2. General distribution of sites. To visit as many locations as possible to form a general picture of, and possible reasons for, the deposits.
3. Copper Boats. To research vessels engaged in the copper and other trades.
4. Selected Sites. To examine closely the Llandudno North Shore deposit and other selected sites.

CLASSIFICATION

The commonest slags appearing on North Wales beaches appear to fall into two types which for convenience were called Types 1 and 2. Dr. D. Jenkins was kind enough to prepare reports on two samples A (Type 1.) and B (Type 2.), which are included in the following descriptions:

Type 1

Dark red / brown or black, dense, fine grained with flow marks on some surfaces. In one location, Llanddulas, metallic copper was found attached to, and in association with, this type. Dr. Jenkins states with regard to sample A taken from sandbanks opposite Beaumaris at National Grid reference SH 6040 7535:

This is a uniform dense (S.G.=3.8) slag sample showing a smooth chilled surface with few vesicles, and an internal perpendicular prismatic structure. This is a typical fayalitic slag, and the mineral composition has been confirmed as fayalite (Fe_2SiO_4) by XRDA (X-Ray Diffraction Analysis: 0.252, 0.282 and 0.295nm). Freshly exposed areas of the interior proved to be rich in copper prills, which confirms that this is a slag from the copper rather than the iron industry. It could derive from Mynydd Parys.*

*Small inclusions of metal.

Type 2

Grey / black, rather "frothy" in appearance with white angular inclusions as well as bright green stains and inclusions, and occasional specks of bright blue. In some specimens small particles of what appears to be unburned coke are found. It gives indications of copper with a simple flame test. Dr. Jenkins states with regard to sample 'B' taken from Llandudno North Shore at National Grid reference SH7825 8256:

This shows a surface zone 1-3cm thick comparable to sample 'A' in its structure (i.e. a fayalitic slag). This surface zone overlies a mixture of slag and sub-angular fragments (1-3cm) of shattered/veined white fine-grained rock (quartzite?); overall the sample is less dense (S.G. 2.8). The slag was examined petrographically in thin sections in the hope of identifying the white rock material and so determining the source of the slag. Microscopic examination revealed a fibrous structure typical of fayalite, but the white rock fragments were largely recrystallised, although there are suggestions of an original rounded grain structure (i.e. sorted quartzite?); this might for example derive from the Craig Rofft sandstone, as seen at the Great Orme Mines, or from one of the quartzites around Mynydd Parys. There are superficial green stains suggesting malachite derived from the weathering of copper sulphide ores, and small pink-brown patches (of cuprite?); this again indicates derivation from the copper industry.

A copy of the 1992 discussion paper and a sample of Type 2 slag was sent to Dr. P. Craddock of the British Museum, who observed that, although the specimen sent to him was rather large, such slag had been found elsewhere that dated back to antiquity. Other types of slag from iron works can be found at Port Penrhyn where it was poured in a molten state onto the beach from the foundry there. It has also been noted on the beach of Hirael Bay, Bangor, where there was another foundry at one time. No doubt there is more in other places, as during the Industrial Revolution iron foundries appeared all over the area, as at Llanwrst and Furness in the Conwy valley. Care should be taken to avoid confusing iron and copper slags, which have some similarities. Limonite ($Fe_2O_3 \cdot 3H_2O$) or 'Bog Iron' such as was pointed out to the author by T. Williams at Porth Cwfan, where it can be seen eroding out of a clay bank at high water mark, can also be mistaken for iron slag.

GENERAL DISTRIBUTION OF SITES

Having already examined sites where slag was predicted and found, it was decided to examine beaches and shorelines where slag might not be expected, such as Penmon Point, which is a rather wild and rocky promontory. It was hoped that this would establish a number of control sites, but after a quite cursory examination at Penmon and other places even more slag came to light. Indeed it seemed that there was scarcely a beach in the area on which the odd lump of slag, Type 1 or 2, could not be found. From the start it was fairly evident that much of the slag being reported was ballast discharged from the 19th century sailing vessels that took copper ore from the mines of North Wales to the smelters at Swansea and Warrington, returning with slag as ballast. However there was also the problem that, apart from obvious ballast banks, slag is present in small quantities in many other places, sometimes just one lump in isolation on a beach of normal pebbles. Furthermore there are also large deposits away from recognised ports.

THE COPPER ORE SHIPS

During the 18th and 19th centuries large quantities of copper ore were mined at Parys Mountain, and to a lesser extent on the Great Orme. Much of this ore was taken to Swansea and



Fig. 1. The sailing flat "John".

Warrington for smelting, for although Parys Mountain was then the world's largest copper mine there was insufficient fuel locally to smelt the ore. Great Orme ore was shipped in reasonably small vessels, 30-90 tons burthen, such as the sailing flat *John*, which is depicted on Llandudno's North Beach near Glan y Mor Terrace in *The Llandudno Copper Mines* (Williams 1979). Smelting works set up around Parys Mountain depended on coal being brought in from elsewhere, often as a return cargo by vessels taking ore to Swansea and Warrington. However there was still the basic fact, as pointed out in *Copper Mountain* (Rowlands 1996 p.30), that three tons of coal were needed to smelt one ton of ore. Once again it made more sense to take ore to fuel. Masters and owners of vessels taking ore to distant smelters would always try to find a return cargo that they would be paid for carrying. When none was available or when the cargo was a light one, i.e. having a low specific gravity, it would be necessary to take on ballast to stabilise the vessel. Copper slag was ideal for this purpose and readily available at the smelting works but as there was no financial advantage to the operation, detailed recording of the process did not have a high priority. During discussions with the eminent maritime historian, the late Mr Aled Eames, he remarked that he could not recall ballast type ever being recorded. Crew agreement lists often indicated a vessel sailed "in ballast" without specifying what type of ballast was taken aboard. This practice resulted in quite large amounts of unrecorded copper slag being brought into the area, which rather confuses the search for Bronze Age slags.

A fairly clear picture of the origins of beach slag was starting to emerge and at Penrhyn Dock the author met Mr. D. Cale, a retired sailmaker (27 January 1994). He was able to give crucial information about the use of slag as ballast. Apparently it was known by the old sailors as "copper dross". The following quotation is revealing:

Copper dross was often used by schooners as ballast. Schooners going to Runcorn with slate from Port Penrhyn would pick it up there as ballast for the trip back. The schooner "Mary B. Mitchell" used to dump her ballast in Hirael Bay, and eventually a bank built up that was known as the Mitchell or Copper bank. It was great stuff because it was so heavy and if I had a boat now I'd use it rather than cast iron, it doesn't rust you see. Smaller local boats were ballasted with copper dross from the Mitchell bank up to quite recently.

One thing that they used to do every year or so, was to beach the boat for painting and take out all the copper dross from the bilges and put it on the shore where it would soon be washed clean by the tide, nothing sticks to it you see. Pillars of slate were also used as ballast but slate is nowhere near as heavy as copper dross. No, copper dross was the best.

This would account for slag being all over the place in small quantities, and further establishes that copper slag was used as ballast by sailing vessels engaged not only in the copper, but also the slate trade as well as by local fishing boats. It also helps to explain a small amount of slag found by T. Parry and the author to the East of Amlwch port on the site of the shipbuilding yard of William Thomas and Sons (Eames 1981).

These slags, being jagged in profile, have good mechanical interlock and would be less likely to shift in heavy weather than for example shingle or other smooth rocks. This is an important characteristic, as shifting ballast can seriously affect the trim and stability of a vessel, and could lead to a capsizing.

SELECTED SITES

Port Penrhyn

Port Penrhyn is situated at the mouth of the river Cegin, which is a sheltered natural harbour. In the 18th and 19th centuries it

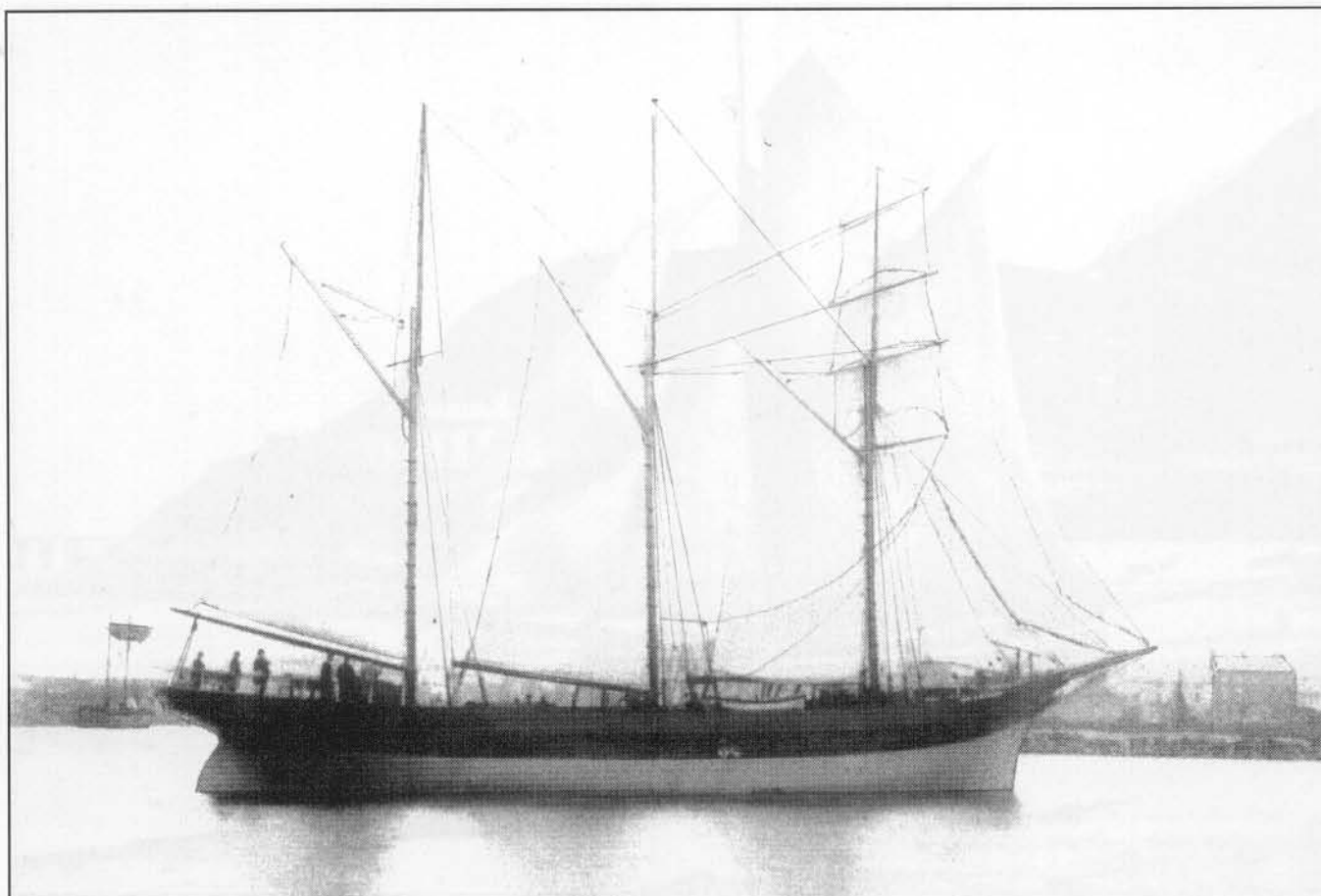


Fig. 2. The schooner "Mary B. Mitchell".

was developed for the export of slate. As the course of the Cegin is dictated by the hard rock geology of the area it is reasonable to suppose that it has followed its present route for many thousands of years. At Llandegai, about a kilometre upstream from the present dock, is a complex Bronze Age site where there is evidence that stone axes from the nearby Craig Lwyd axe factory were further shaped and polished (Houlder 1968). Axes from Craig Lwyd have been found in Europe and offshore islands such as the Isle of Man and Ireland. The proposition then that the tidal mouth of the Cegin was used as a port in prehistory is fair. This is further supported by traces of blue grey estuarine clay revealed by recent dredging which could indicate a 6,000 year old palaeo-channel below the present inter-tidal river bed and the discovery, by the author, in the same area, of a grooved maul (report in preparation).

It was at Port Penrhyn that copper slag was first recognized alongside the "Toc H" centre on the west bank of the Cegin. Here it can be found in some quantity along with nodules of flint much larger than the normal small flints that wash out of glacially deposited boulder clay. Locally there is no other source of flint giving rise to suggestions that the larger nodules had arrived as prehistoric trade goods. It is now believed that the flint nodules arrived as a convenient return cargo in slate boats trading with the South of England.

Flint stones were imported from the south of England to Port Penrhyn, ground in the mill and exported to the Herculaneum pottery works in Liverpool (Ellis-Williams 1988).

While the Port Penrhyn area remains potentially an important prehistoric site its contamination with copper slag, iron slag, flints and other odd deposits from the time of the industrial revolution makes its interpretation rather difficult.

Llandudno North Shore

The slag / ballast deposits on this beach form quite a distinct feature and in an area marked on large scale (1:10,000) Ordnance Survey maps as "stones" there is a large amount of slag present. The author is also has a photograph of a three masted vessel beached on the same contour. Taking advantage of very low tides it was possible to examine the beach along its length, right down to low water mark. Though small sandbanks tend to move about in places, it was possible to ascertain that the majority of the slag was at about, or just below, the half tide mark. No slag was initially evident at low water mark though after storms some well-defined heaps appear through the sand. In the pebbles at high water mark a few small pieces of slag were found here and there. Patches of slag can be found along almost the whole beach around half tide mark, but are most concentrated towards the western end.

In August 1993 an archaeological excavation was arranged through The Great Orme Exploration Society with permission from Aberconwy Council, Gwynedd Archaeological Trust and CADW (the Welsh heritage conservation agency). The R.N.L.I. who launch their lifeboat across the beach were also informed beforehand.

Because of the size of the deposit, the difficulty of excavating waterlogged sand, and the short time available around half tide mark, a JCB excavator was employed. Five excavations were opened to a depth of 1.5m. In all instances the slag was not apparent more than 0.3m. beneath the surface of the beach. Beneath the deposits of slag and large shingle, sand or fine shingle underlain with clay, was observed. The impression was gained that the slag had been dumped on the beach and had stayed pretty much in place. Quite well defined patches can still be seen consistent with having been thrown out of a vessel engaged in taking ore from the Great Orme mines to a smelting

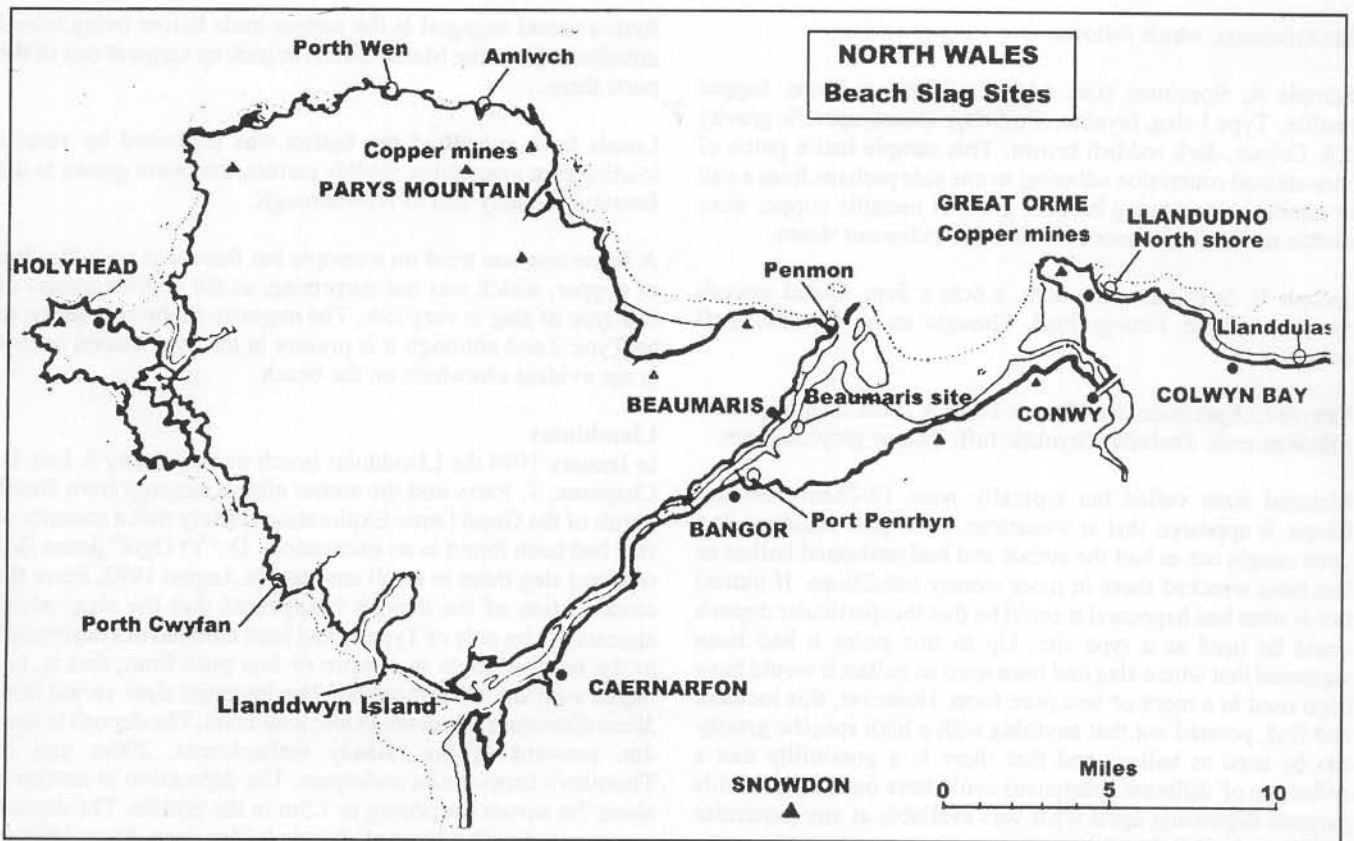


Fig. 3. North Wales: Beach slag sites.

works, and returning with slag and other material as ballast.

Prior to the arrival of the railway in 1862, by which time the mines had virtually closed, the only practical way of moving the ore was by sea. Whether the railway company hoped to benefit in any way from the mines is not certain, but they never reopened. It is much more probable that the branch line was built solely to service the developing Victorian watering place.

Initially it was rather puzzling that the extreme western end of the North Shore, in the same area as the Ty Gwyn Adit entrance, was comparatively free of slag. Subsequent research revealed traces of a large fish trap thereabouts known as "Clawd y Gorad" (The dyke of the fishtrap). It appears on a photograph of around 1858 soon after which it was apparently removed and about that time the copper mines also ceased production. This 300m long structure, a type 7 fishtrap would have comprised an embankment of stones into which 3m. high posts intertwined with wattle were set (Bannerman and Jones 1999). Obviously it would have been too risky to attempt to manoeuvre a large boat close to such a danger to navigation. This fish trap was actually shown on the 1835 Admiralty chart.

Beaumaris

In September 1993 the author sailed up the straits from Bangor hoping to explore the shore at Penmon at low water, unfortunately a brisk south-east breeze sprang up that would have made anchoring there very uncomfortable. The engine was stopped, sail hoisted, and the vessel proceeded back towards Menai against the ebb. Just after passing Buoy

No.12 a combination of current, veering wind and inattention ran the *Eryri Wen* aground on the sandbanks opposite Beaumaris. Within a short time the ebbing tide left us high and dry. Right at low water, between two sandbanks alongside where the boat had grounded, a two-metre diameter patch of material was noted which seemed to be out of context with the surrounding sandy beach. The material had the appearance of being in a mound buried in the sand. Due to the incoming tide very little time was available to examine the site, or probe the sandbanks to try to determine the extent of the mound beneath the sand. It was, however, possible to take three fairly representative samples of the material, which in places seemed to include iron staining perhaps from corroded fixings or fittings. Dr. D. Jenkins was kind enough to help with their

Plate 1. Slag sample A, Beaumaris (4/9/1993), showing fresh brick with iridescence and copper prills. Size 14 x 10 x 10 cm. (Photo: NVCB.)



identification, which follows:

Sample A: Specimen size: 14cm. x 10cm. x 10cm. Jagged profile. Type 1 slag, fayalite, (Fe₂SiO₄). Dense, specific gravity 3.8. Colour, dark reddish brown. This sample had a patch of iron-stained concretion adhering to one side perhaps from a nail or similar. Upon being broken, prills of metallic copper were visible on the fresh faces as well as an iridescent sheen.

Sample B: Specimen size; 8cm. x 6cm x 5cm. Ovoid smooth profile - pebble. Fine-grained. Thought to be rhyolite. Buff coloured.

Sample C: Specimen size 12cm. x 10cm. x 10cm. Jagged profile - Broken rock. Probably rhyolitic tuff. Colour greyish green.

Material sizes varied but typically were 12-25cm diameter lumps. It appeared that at sometime in the past someone had been caught out as had the author and had jettisoned ballast or had been wrecked there in more stormy conditions. If indeed this is what had happened it could be that this particular deposit could be used as a type site. Up to this point it had been supposed that where slag had been used as ballast it would have been used in a more or less pure form. However, this incident and find, pointed out that anything with a high specific gravity can be used as ballast, and that there is a possibility that a collection of different substances could have been used for this purpose depending upon what was available at any particular port.

As on the North Shore at Llandudno, where the opinion was formed that the slag there was ballast, it was felt that the shingle and broken rock associated with it could also fall into this category. Thus there are two explanations for the appearance of "ballast slag", firstly, that it was jettisoned in a planned manner, in a designated area or 'Ballast Bank' such as exists just to the north-east of Port Penrhyn, or secondly, it was thrown overboard in an emergency.

A third possibility also suggests itself, which is that a deposit of slag could mark the position of, and also help to date and identify a wreck, as the exploitation of North Wales copper occurred in a fairly well defined period. As the vessels that were involved in the transport of ore may also have been used in international trade, the presence or absence of ballast slag in a wreck, almost anywhere in the world, may be a useful indication of the age of the vessel and its previous ports of call.

Llanddwyn Island

In August 1993, the author went with D. Chapman and T. Parry to examine a bank of stones that Dr. C. Jones had pointed out on a slide of the Llanddwyn Island area. Dr Jones had mentioned, in an extramural lecture, that this could possibly be ballast, but that there was no positive evidence. This was an ideal opportunity to test the theory that the presence of slag could help to identify a possible wreck site. An examination of the site, which is a little to the East of Llanddwyn Island, soon revealed a quantity of what appears to be copper slag. The slag, mainly type 1, is mixed with other material but appears to form a large proportion of the whole, and could well be of a similar type to the slag deposits on Llandudno's North Shore. These would seem to date from the middle of the last century, and possibly the Llanddwyn deposit is from that period also. An investigation of this deposit should reveal whether there are any timbers below from a wreck. The amount of material would point to quite a large vessel; a careful estimate would suggest how large. The percentage of slag in the heap, if high, as it appears, may indicate that the vessel came in ballast, possibly from Swansea. It is also possible that the material was jettisoned

from a vessel engaged in the copper trade before being towed unballasted into the Menai Straits to pick up cargo at one of the ports there.

Locals have suggested the ballast was deposited by vessels loading root vegetables, mainly carrots, that were grown in the favourable sandy soil of Newborough.

A flame test was tried on a sample but there was no indication of copper, which was not surprising, as the copper content of this type of slag is very low. The majority of the slag seems to be Type 2 and although it is present in the oval shaped heap it is not evident elsewhere on the beach.

Llanddulas

In January 1994 the Llanddulas beach was visited by S. Lee, D. Chapman, T. Parry and the author after a message from David Smith of the Great Orme Exploration Society that a quantity of slag had been found in an excavation. D. "Yr Ogor" Jones first reported slag there in small amounts in August 1992. From the cross-section of the deposit it appeared that the slag, which appeared to be only of Type 1, had been dumped in a depression in the beach shingle in a more or less pure form, that is, not mixed with any other material. The fragment sizes varied from 30cm diameter right down to less than 1mm. The deposit is sited 4m. seaward of the railway embankment, 200m east of Thornley's caravan site underpass. The depression in section is about 7m across deepening to 1.5m in the middle. The deposit was covered with a layer of shingle 0.75m deep. From 1921 to 1970 this area was used as a rubbish tip, and the impression was that the slag dated from either before this time or more likely, that it was used as fill to level out the beach for access before dumping commenced. The large amount of fine and small size particles raised questions as to whether it had been used as ballast, and the possibility that it had come from an unrecorded local smelting site was considered. On further reflection however it was felt that it was ballast dumped from a vessel engaged in loading ore from mines inland from Llanddulas. A small amount of metallic copper was found adhering to, and in association with, the slag - the first found at any North Wales beach site (one specimen 8cm x 3cm x 1cm).

Porth Wen

A few lumps of slag, Types 1 and 2, were also found on the beach at this location on the north coast of Anglesey where refractory bricks were produced at one time. This would seem to indicate that vessels carrying bricks for lining smelters from Porth Wen were also using copper slag as ballast on the return voyage.

CONCLUSIONS

The length of time the practice of using slag for ballast went on for is still an open question, but where copper slag is discovered on, or near, the shore, there is the possibility of it marking: -

1. In large amounts, the wreck of a schooner, flat, or other type of sailing vessel engaged in trade. Where small amounts are found on wild, rocky and exposed coastlines this may mark where a vessel has been wrecked and smashed to pieces in some violent storm.
2. In large amounts, an area where vessels were beached to discharge ballast prior to taking on cargo such as copper ore, as in the case of Llandudno's north shore, or slate at Port Penrhyn and Hiraef Bay.
3. In small amounts, when found on relatively sheltered

beaches or in inlets or harbours, a site where small boats had been hauled out for cleaning and painting.

4. A much earlier site as proposed in the introduction.

Obviously the presence or absence of copper slag or dross could be useful in the identification of wrecks, and not only locally, for sailing vessels using North Wales ports traded, and came to grief, all over the world. These slags tend to remain fairly clear of growth, possibly because they are slightly poisonous, and their distinctive appearance makes them easy to identify in the field, once a researcher knows what to look for. To date, as far as is known, no work has been done on identifying slags underwater. Dr.C. Jones raised the possibility that they may be detectable with a magnetometer, which would be rather useful, as long they were not dismissed as natural iron-rich rock of some type.

The 19th century slag deposits on the North Shore at Llandudno demonstrate another spin off for this research, in that they demonstrate that the beach where they were dumped about 150 years ago has not been subjected to significant coastal erosion since that time. Clearly discernible patches of ballast can be identified at the half tide mark and as the dig revealed, the original beach is immediately below them. Thus they establish a time horizon as well as calling into question claims that the North Shore at Llandudno is subject to erosion and requires extensive sea defence work.

The pollution aspect of the slags is possibly worthy of enquiry in that copper leaching out of them may affect shellfish. This effect could perhaps be significant for any such organisms that were in the immediate vicinity of a deposit, especially as Type 1 slag seems to contain quite significant amounts of copper.

At both the Beaumaris site and on Llandudno's North Shore, jagged, broken rock was observed in association with copper slag. At other sites such as the Conwy Morfa, where there is very little slag to be found there are patches of angular rock which have quite a different appearance from the predominant shingle and sand. These lumps of what appear to be recently broken rock seem to be out of context with the rest of the beach material, and the question must be asked whether these are also ballast marking a wreck or landing place.

THE BALLAST TRADE

The supply of ballast for shipping, though very important, is not well reported. The inclusion of the following helps to illustrate its organisation.

After the first draft of this paper was circulated Bryan Hope of Moelfre very kindly sent the author a copy of a proposal made by three Amlwch men, Hugh Thomas of Dafarn Drip, Owen Owens of Laethdy Beach, and John Roberts of Tre'r Darth in 1819:

... to enter into a contract with the proprietors of the Mona and Parys Smelting works at Amlwch Port for the entire of the copper dross conveyed to Liverpool. The proposers will pay 6d. per ton for every ton of copper dross shipped on board vessels for Liverpool, to the Proprietors of the smelting works or the clear yearly rent of £150 per annum which will be paid quarterly for at least 10 years because of heavy expense (Mona Mine mss No. 213).

The following observations made by Bryan Hope are also most interesting:

What can be deduced from this document, is that approximately 6000 tons of copper dross were already being exported annually to Liverpool at that time, and that the three men were simply bidding for the exclusive rights to that trade. Bearing in mind the thousands of tons of slag that would have been produced over the years in the Amlwch smelters, the fact that comparatively little is evident locally, suggests that an extensive market existed for what would otherwise have been a waste product. As has been rightly said in the paper, the specific gravity and good interlocking properties of rough copper slag made it ideal ballast material, and there can be little doubt that this was its intended purpose.

Ballast suppliers, it would seem, considered anything with a reasonably high specific gravity as "grist for the mill" as this anecdotal record of the ballasting of the sailing ship *Moshulu* at Belfast in 1938 shows:

At the quay we took in our ballast, fifteen hundred tons of coarse dark sand used in the manufacture of pig-iron, huge lumps of paving stone, granite blocks, and the best part of a small house. At the same time the stevedores added two dead dogs, but we did not discover this until we reached Australia in January, the hottest month of the year (Newby 1956).

SLAG IN BUILDINGS

It is evident also, that some of the slag was cast into building blocks. Michael Faraday, for example, records that prior to his visit to Amlwch in 1819, he had inspected Vivian's copper smelter at Neath, where he had noticed that many of the walls were built of slag blocks. Similarly, a row of dwelling houses in Amlwch is built entirely of them, and examples can still be seen in the walls close to the harbour, as well as in the floor of a building which formed part of the original Treweek shipyard, known locally as Iard Ochr Draw.

Examination of slag blocks in a gatepost in Penysarn near Amlwch suggests that the slag was poured into sand moulds whilst in a molten state to produce standard size blocks. Is this another case of the 19th century and Victorian passion for finding uses for everything? Slag as a decorative material may seem extreme yet Frances Lynch of the History and Archaeology Department of Bangor University related the following to me while we were examining a slag deposit near Menai Bridge. Apparently a relative of hers had a large Victorian house in Liverpool in the garden of which was an original shaded "Fernery" constructed of slabs of black copper slag which nicely complemented the greens of the mosses and ferns.

It has also been observed that copper slag "gravel" has been used to repair a cart track at Dulas Bay near Parys Mountain.

The use of copper slag in buildings, gardens and on roads, especially in areas on shore where prehistoric smelting sites may be suspected should be noted by archaeometallurgists!

This then is a record and a description of finds to date. It has, of course, thrown up many more questions and possible future lines of research. The possibility that the source of a slag might be identified from quartzite inclusions has been suggested by Dr. D. Jenkins. Also worthy of consideration is that the typology of slag with reference to age based upon advancing technology may provide a dating method for sites. More detailed descriptions of sites with drawings could also help to provide more information, as might information on vessels in the copper trade with relative tonnages of ballast.

Hopefully, a new method of finding and identifying wrecks and

landing places is emerging. It would seem that not only is copper slag an easily recognisable ballast material, but that jagged lumps of rock should also be noted as possible ballast, especially if they are not of a type found occurring locally. Identification of the source of any slag or rock type could indicate a vessel's last port of call; however, as has been remarked earlier, ballast slags were sometimes re-used by other vessels and, as always, caution should be observed before drawing any conclusions. These slags are a distinctive feature of the North Wales beaches and are, in many cases, the only memorial that remains of the sailing ships which were once ballasted with them.

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REFERENCES

- Bannerman, N.V.C. 1992 Bronze Age Smelting A discussion paper on possible smelting sites for Great Orme ore. *The Journal of the Great Orme Exploration Society*, (3) p.7-16..
- Bannerman, N.V.C. and Jones, J. 1999 Fish trap types: a component of the maritime cultural landscape. *The International Journal of Nautical Archaeology*. 28:1 pp70-84 The Nautical Archaeology Society. London
- Craddock, P. 1990 Copper Smelting in Bronze Age Britain; Problems and Possibilities. pp.69-71 IN *Early Mining in the British Isles*. Plas Tan y Bwlch Occasional Paper No.1. Plas Tan y Bwlch, Blaenau Ffestiniog, Gwynedd. LL41 3YU.
- Eames, Aled. 1981 *Ships and Seamen of Anglesey*. p271. Anglesey Antiquarian Society. Llangefni, Ynys Mon.
- Ellis-Williams. M. 1988 *Bangor, Port of Beaumaris*. Gwynedd Archives, Caernarfon,
- Houlder. C. 1968 Llandegai. *Antiquity* XL11 (in press).
- Newby, E. 1956 *The Last Grain Race*. Martin Secker and Warburg Ltd.
- Rowlands, J. 1996 *Copper Mountain*. Anglesey Antiquarian Society. Llangefni. Ynys Mon.
- Slater, E. 1994 *The Smelting of Oxide Copper Ores*. Historical Metallurgy Society lectures 21.5.94 Flag Fen.
- Doonan, R. 1994 *Late Bronze Age copper smelting in the East Alpine Region*. Historical Metallurgy Society lectures 21.5.94 Flag Fen.
- Williams, C.J. 1979 *The Llandudno Copper Mines*. *British Mining* No.9. Published by the Northern Mine Research Society.

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