

ON THREE COPPER CAKES FOUND AT BRYNDU, NEAR THE
RHOS GOCH RAILWAY STATION, IN THE PARISH OF
AMLWCH, ANGLESEY.

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FEW subjects have been discussed more warmly or more frequently by those who have devoted their attention to the mining interests of the county of Anglesey, than the question whether the island for the whole or a great portion of its extent forms a fair field for exploration, or may be regarded as having the whole of its metalliferous wealth concentrated in the great ore districts which have been worked for so many years at the Parys Mountain. The arguments on one side have usually been of a negative character. Those who support the theory that, with the single exception of the extensive mines referred to, the island may, from an economic point of view, be designated non-metalliferous, assert in confident terms that had lodes or deposits of value existed they would certainly before this have been discovered, in a district in which so many intelligent and able miners have spent so much time in examination and so much money in trials. Those who maintain, on the other hand, that there is in all probability a great mining future in store for Anglesey, point out the numerous *backs* or outcrops of lodes which traverse the country, and cite instances in Cornwall and elsewhere in which wide areas containing ore in two rich mines were for ages condemned as otherwise utterly barren, and have subsequently developed into the busiest centres of mining industry. The explorations made here and there are, as they say, mere surface scratchings; no company of sufficient means and permanency has as yet undertaken the development of the numerous lodes which may be traced upon the surface, and it is, they assert, totally at variance with the observations of the most experienced miners that a district, which has been proved to contain such enormous masses of ore, should be rich at

one point only. They seldom fail, moreover, to strengthen their case by referring to the numerous remains of mining operations which have from time to time been discovered, and they assert that mines which were worked by the ancients have rarely proved unsuccessful when resumed in modern times. However interesting the discussion may be, and however important an enquiry into the general question at issue, we are forced now to confine ourselves to the consideration of the archaeological point advanced as an argument in the controversy. We turn to it with pleasure. Modern mining, by laying open ancient workings in the Isle of Anglesey, has discovered a field of enquiry full of interest to the archaeologist, and it is possible that a review of certain discoveries recently made, which throw some light upon the mining knowledge and the metallurgical processes of the ancients, may be in time of some slight service to the mining engineer of our own days. The writer therefore hopes that the remarks which he proposes to make on the subject, and more especially on the recent discovery which has elicited them, will prove of interest to the practical miner as well as to the archaeologist to whom they are specially addressed.

About two years ago I received by post, from the Rev. W. Wynn Williams, of Menaifron, in Anglesey, a small piece of metallic copper, broken, as he told me, from a mass which he had been so fortunate as to buy from the finder—a peasant living near Ty Croes Railway station. I saw that it was coarse and unrefined copper, but owing to the smallness of the morsel and its battered condition, I could not say with certainty whether the fragment was from a specimen of native copper or the result of metallurgical treatment of copper ore. Some time afterwards, when at Menaifron, I saw one of the pieces of copper from which the fragment sent to me was broken, and I then perceived at once that it was a round cake of smelted copper. The cakes of which this was one have since been described in an interesting memoir by the Rev. Hugh Prichard, in the "*Archæologia Cambrensis*," fourth series, vol. ii., p. 57. With very slight modifications, the description there given by him of these cakes may be taken as supplying a good general idea as to the form and size of those which the writer has now the good fortune to bring into notice.

On the 22nd of June, 1871, a countryman came to my house and asked to see me ; on being told that I was not at home he left a small piece of copper. On my return I found at once that it was a portion of a cake similar to the one which I had seen at Menaifron ; and being anxious to save any others that the man might have discovered from the battering process which had procured for him that piece, I went to his cottage early next day. He told me that he had found three round cakes of the metal. One of these he had smashed with a pick, in order to see what it was made of ; the other two he produced in the condition in which they were found. I soon bargained with him for the three, and in a very short time was at home cleaning the specimens that were in perfect condition, and putting together the pieces of the broken one. After some time spent in this operation I found that one of the undamaged cakes and the broken one bore, in characters of unmistakeable distinctness, the letters—I V L S—which had evidently been stamped upon the hot metal while it was soft by means of a circular die, and I perceived that the find was not much less valuable than that of the famous cake of Caerhun. I informed the Hon. W. O. Stanley and the Rev. W. W. Williams of the discovery thus made, and have been urged by these gentlemen to write a few remarks upon the cakes and the manner of finding them. I have not, however, had leisure until lately to comply with their request.

The cake which bears the most distinct impression of the letters is in the possession of the Lord-lieutenant of the county, the Hon. W. O. Stanley, M.P.; the two others I have presented to the British Museum. The accompanying engraving is a beautiful and truthful representation of the first.

The distinctness of the lettering is not in the least exaggerated, while the pimply appearance of the surface is shown with admirable exactness. The upper impression is made upon a hunch, a portion of which appeared to have been flattened down upon the tops of the letters L and S. The broken cake bears a similar hunch, which is stamped in the same way, but not so distinctly, while the second entire cake has neither hunch nor stamp upon the surface. On examining the spot in which these cakes were discovered I found, by the impression still remaining, that they had lain

obliquely one upon another, like thrown quoits, and that their upper edges must have been almost level with the surface of the soil. I examined the place carefully, in the



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Copper Cake, found at Bryndu, Anglesey.

hope of being able to find the marks of ancient smelting in the shape of slags or cinders, but failed to discover any indications that the cakes had been smelted on the spot. I am, however, strongly of the opinion that the furnace or furnaces in which they were produced could not have been far away.

There are ancient mine workings only a few score of yards to the south of the spot, close to the road leading from Pengarnedd to Gareglefn ; and I am told that a man, when raising

stones a few years ago in a quarry in the same place or small field, collected a bag full of rich portions of yellow copper ore. There is also a tradition in the neighbourhood that important mines once existed there, and I was told by the tenant, that in comparatively recent times, application had been made to the landlord by several parties who were anxious to obtain permission to explore the ground and take a mineral lease of the property. About twenty years ago copper ore, in sufficient quantity to be sent to Amlwch to be smelted, was raised on the land of "Four Crosses" farm, a few hundred yards on the other side ; and the cutting of the Anglesey railway, a little to the north of Rhosgoch station, lays bare a very pretty little string of the same ore. The recurrence of the ore in the neighbouring rocks, and the existence of traces of ancient mine workings in such close proximity, make it almost a matter of certainty that the ore from which the cakes were produced was reduced *in situ*. Each cake formed, doubtless, the whole charge of the furnace in which it was melted, and they have every appearance of having been run out at so low a heat that the latter portion flowed into the receiving mould with difficulty ; from which we may infer that the furnace and its accompaniments were of very simple and primitive construction as compared with those employed by the smelters of our days. The *modus operandi* must have resembled closely the processes practised in the present time by some of the natives of certain parts of Asia, and it may reasonably be inferred that the treatment of the ores, prior to the commencement of the metallurgical process, was something similar. Dr. Percy, in his great work on copper smelting, observes : " In tracing the history of a metallurgic art nothing is more striking than the gigantic scale of operation in the present day as compared with that of ancient times. But in some cases no progress has been made, and smelting processes are carried on just as they appear to have been at their commencement. The principles, however, upon which many of these processes have been founded, and the manipulations practised, have remained substantially the same in all ages." It is, therefore, highly probable that the descriptions he gives of the modes of smelting now practised by the natives of Sikkim, Himalaya, and Singhana, in India, give a good idea of the smelting processes anciently carried on in Anglesey, with the only

difference that the Anglesey smelter of the Roman period worked on a larger scale than the modern Asiatic. At Sikkim the ore raised was copper pyrites; the vein stone was loosened by means of fire setting, and afterwards broken up with the hammer and gad. The ore was separated as much as possible from the adhering rock, and then pounded down with a heavy stone mallet, another stone serving as a "knockstone," a term still used for blocks of cast iron serving a similar purpose, on the centre of which, after each blow, the ore was swept together. The ore when pounded was washed in small tyes, and then taken to the furnace. The furnace was formed of a sandy clay, and consisted of a shallow square cavity. The bellows, of which there were two, were seamless bags of goatskin, and formed the skin of the body and fore limbs of the animal. The mouth of the bag was gathered in so as to leave a small opening only, and was worked by a boy, who by alternately loosening and tightening his grasp, as he raised and depressed the bag, produced an effectual though intermittent blast. Charcoal was the only fuel used. The metal *regulus* thus obtained was pounded and kneaded with cow-dung into small balls, which were dried in the sun and then roasted in a shallow furnace. The roasted metal was then refined in the furnace in which the ore had been fused, the result being a cake of copper weighing four to five pounds, and a slag which was subjected to no further treatment. The ore treated at Singhana was also copper pyrites, with a matrix of quartz; it was powdered, mixed with cow-dung, and kneaded into sausage-shaped pieces; these were sun-dried and roasted in circular heaps. The ore was then smelted in a small furnace, with charcoal as fuel, the necessary blast being produced by the goatskin bellows, in form like those described before. Four persons were employed at each furnace, perhaps a man with his wife and two children, who received for their united services ten rupees (about twenty shillings English) per month.¹ Blast furnaces were the only means used in Britain for smelting copper until about the middle of the eighteenth century, when they appear to have been superseded by the reverberating furnaces now employed in the great smelting establishments of South Wales and Liverpool. Whether they were introduced by the Romans or were

¹ Percy's Metallurgy, p. 392, *et seq.*

previously known to the inhabitants of Britain it is impossible to decide with certainty, but as the British Celts had bronze weapons and ornaments, which could hardly have been manufactured from the small quantities of native copper which may have been found near the surface in our own country, we have every reason for believing that the art of reducing copper ore by blast furnaces was practised by the Britons before the time of the Roman invasion.² It is not likely, however, that bronze was sufficiently plentiful at any period in those early times to enable the miner to use it in his arduous operations. Indeed we have ample proofs in the rounded shore stones found so abundantly in and near ancient workings, and which have evidently been used in breaking and pounding the ore, and also in the absence of any kind of tool, that they were the only implements then employed in attacking the rock.

The ores of Anglesey are found almost exclusively in quartz-ore rocks of extreme hardness, so that their raising and the treatment they underwent, before being subjected to the heat of a furnace, must consequently in ancient times have been operations of a most laborious and tedious nature. The setting was probably the only means of detaching the rock, by which labour was to some extent economised, and the raising the ores slightly facilitated; but, as it was necessary to make preparatory excavations, in order to adopt this process with any degree of advantage, and as the pieces of rock thus disengaged would be of large size, and would, therefore, require breaking up and dressing to suit the requirements of the smelter, we may conclude that, in the absence of tools of iron and steel, to which it would have been a useful auxiliary, not much assistance was obtained by the application of heat to the rock.³ As the copper ores, moreover, consist almost entirely of copper pyrites,

² For moulds for casting celts, spear-heads, arrow-heads, &c., found in Anglesey, see *Arch. Journal*, vol. iii. p. 257; *Arch. Cambr.*, third series, vol. ii. pp. 126, 128. The British traded with the Belgæ, exported copper and iron, &c.—W. O. S.

³ Fire setting.—At Fahlun, in Sweden, "fires are kindled in different parts of the mine every Saturday, about noon, which continue burning the whole of Saturday night and all Sunday, with a view to soften the rocks and facilitate their being wrought for ore. Gunpowder

was formerly used for blasting, but this is now applied sparingly, it being the opinion of the most experienced men in Fahlun, that a judicious application of the two methods succeeds better than either of them alone; for, as blasting by gunpowder always leaves a certain number of irregular projections in the rocks, the subsequent process of applying fire to these irregularities tends to soften them and expedite the fall of the ore." Kenwood on the Metalliferous Deposits, vol. i.

with a highly silicious matrix—a class of ore which requires a difficult and complicated metallurgical treatment for smelting—the smelting again must have been no less laborious than the mining and dressing. Small as these cakes under consideration are, it must consequently, at the period to which they belong, have been a work almost of incredible labour to produce them. The application of gunpowder to the blasting of rocks, the use of iron and steel tools, and the marvellous power brought to bear on modern mining operations, through the steam engine, and the results obtained by these agencies, are now so familiar, and so much a matter of course to all, that I fear it will not be easy to appreciate adequately the difficulties experienced by the miners and metallurgists who smelted these pieces of copper. Assuming that the ore from which they were reduced contained the same per-centage of copper as the ores raised in Anglesey in modern times, it was necessary, in order to produce one of these cakes, that no less than a ton of the dry rock should be raised, and that that quantity should be brought into a condition suitable for smelting, by bruising into a fine state, and careful picking, and probably by a subsequent washing.

It may convey some idea of the arduous nature of the miner's work in hard silicious rocks, to state, that in Mona mine six able miners, working steadily for one month in the hard rocks, in which the ores mostly occur, can advance no more than six feet in a level driven seven feet high by five feet wide. This gives a solid content of 210 cubic feet, and a weight of about 15 tons of rock disengaged during that time; 1100 steel borers would be blunted, and 70 lb. of the best blasting powder consumed. The rocks are usually devoid of joints or lines of cleavage, which might facilitate their working by means of the pick and the wedge, and it seems almost impossible that any other means than that of boring and blasting could successfully be brought to bear upon them.

The ancient miners, who used stone hammers and wedges, in the course of constant practice must have acquired a certain skill in the use of the primitive tools; but, after making every allowance for their rude skill, and taking into consideration that their operations were confined to the upper portions of the lodes, where the rocks are to some degree softened by the action of the atmosphere, the raising

of a quantity of ore, sufficient to produce one of the cakes, must have been a work of enormous labour, and must have employed a large number of men for a very long time. Engineers of the present day make calculations of the amount of work done by a man under different modes in which he exerts his muscular power. Tables thus made show that, with the machines now in common use, a difference in the principles of their construction, and in the manner of applying the muscular power, makes a very great but easily estimated difference in the amount of useful work performed; for instance, a man raising water from a well with a windlass performs 2560 units of useful work, while the same man working with a pail and rope only does 1054 units of work per minute. When, however, we come to consider the tools and appliances now employed in attacking the rock, and those of the ancient miners of Anglesey, we find the contrast so great and the manner of working so utterly different, that the *data* fail us whereby alone we could calculate the amount of manual labour expended on our cakes; comparison is impossible. I do not think that I shall be exaggerating, when I say, that the charge of copper which formed one of these cakes cost as much labour to the miner and smelter who produced them, as a charge of fine copper does in one of our great modern smelting works. It will not, then, perhaps, be uninteresting to those who have not devoted much attention to metallurgy, to have a rough estimate of the labour that it now costs to reduce ore into metallic copper.

Supposing the ores used to be of an average of five per cent. of fine copper, it would be necessary that 40 tons should be taken to the ore furnaces, to produce a refinery charge of seven tons. This quantity, taking as a standard the average quality of the ores raised in the Anglesey mines, would necessitate the blasting of no less than 420 tons of rock, and would require the labour of about 40 men for one month. The drawing to the surface, the dressing and the cartage would be equivalent to the labour of twenty more men, and the value of the materials used may be estimated safely as equal to the labour of twenty men; while, in respect of the establishment and incidental charges, we may add ten men more. The smelting, including the cost of fuel, may be fairly estimated as representing the work of thirty men.

Taken altogether, then, a charge of copper of seven tons, made of the ordinary ore of the Parys Mountain, requires the expenditure of the labour of 120 men for one month. My opinion being correct as to the proportionate cost in labour of the ancient charges, we have but to take the human labour as a standard of value, to calculate almost to a nicety the value of copper at the time of the Roman occupation of Britain. A charge of fine copper of seven tons, putting the metal at a fair average price of 90*l.* per ton, represents a money value of 630*l.* This sum pays the miner for raising the ore, the merchant's bill for materials, a royalty due to the owner of the soil, the various charges incidental to a mining concern, and any profit which may accrue to the adventurers, as well as all the heavy costs of smelting the ore and reducing the metal to a commercially pure condition.

Each cake must, without doubt, have represented about the same value as a charge of fine copper in our own time, and may, therefore, be said to have been equivalent in those times to a sum of 600*l.* in our own time.

Nine of these cakes have now been found in Anglesey, making together a value of 5400*l.* Why a quantity of metal representing so enormous an amount should have been buried in the earth, and ultimately lost sight of, will probably for ever remain a puzzle to the antiquary. They are the only discovered relics of what must have been a trade of great importance, and furnish us with a curious instance of self-repetition in the history of the metallurgical art. Anglesey must have been regarded by the Romans as exceedingly rich in copper; and, judging from the number of cakes found, and the smallness of the quantity of copper then in use, it must for a time have been almost the sole source of supply of that metal. The traces of the exclusive mining and smelting operations had been obliterated, and although vague traditions existed amongst the people that mines had been worked in the island, no one attached any importance to them, or suspected that operations of such magnitude had been prosecuted in ancient times.⁴ Seven-

⁴ Tradition of Ancient Mining in Anglesey.—“Wer hatte nicht glauben sollen, dass ein Tuch volle Kupferwasser und eine alte Sage, dass die Römer hier auf Kupfer gebaut haben sollten nicht

schon weil fruher auf die Entdeckung dieses Bergwerke geleitet haben wurde.” Briefe über die Insel Anglesea, vorzüglich über das dalige Kupfer Bergwerke, von A. C. L. Linlin, Leipzig, 1800.

teen centuries had passed away, when the discovery of the great ore masses of Parys Mountain made Anglesey again the mistress of the copper market, and drew complaints from Cornwall and other mining districts that her mines threatened to stop all the other mines of the world.

It will, I have no doubt, appear at first sight almost absurd to attach such a high value to an article which, in our time, is comparatively abundant and low-priced, but I do not think that I have over-estimated the amount of labour expended on the cakes in question ; and, as we cannot establish a standard of comparison which fluctuates so little, from age to age, as the labour of man, and what he is able to perform, we cannot probably be very far wrong in accepting the valuation that I have put upon them.

In these days of easy and speedy transit, and rapid interchange of commodities, the products of the various countries vary but little in price at the different marts of the world, nor have there, with the exception of the recent depreciation in the value of gold, and the consequent apparent advance in the value of all other merchandize, been any very great or sudden changes in the value of articles of necessity and luxury. But in the first century it was very different ; the relative values of the various articles of commerce were generally out of all proportion to those which they bear in these days. Gibbon says—"The most remote countries of the ancient world were ransacked to supply the pomp and delicacy of Rome. . . . Amber was brought over land from the shores of the Baltic to the Danube, and the Barbarians were astonished at the price which they received in exchange for so useless a commodity." Further on the historian says that "a pound of silk, now worth four or five shillings, was esteemed not inferior in value to a pound of gold." Putting gold at a value of 4*l.* per ounce, or 48*l.* per pound troy, and taking it as a standard, we find that silk was esteemed by the Romans at about 213 times its present worth. Reasoning similarly in regard to the value of the cakes of copper, and accepting my valuation of them as founded upon an estimate of their cost in labour, it will be seen that copper was valued by the Romans at about 440 times its present price. The difference in the relative values of silk and copper is perfectly intelligible ; silk was an article of luxury worn only by women of the wealthiest families ;

and however small the quantity brought to Rome by the merchants who carried on the Oriental traffic, it was in consequence very limited in its use, and the object of comparatively little competition. Copper, on the contrary, was an article of the first necessity, and being largely used in the manufacture of bronze and brass,⁵ and the supplies limited, each consignment from Britain was probably bought up with eagerness.

The carriage to Rome must have been tedious and exceedingly slow, and was performed by men or by beasts of burthen. Whichever of the two modes of conveyance was adopted, it is sufficient proof of the high value attached to the copper, that it was found to pay to transport it by such costly means; the route was possibly, first, to some creek in the south of England; from thence across the Channel to Gaul; then by land to Marseilles, or some other port on the shores of the Mediterranean Sea, and thence by sea to its destination. If a ton of copper were so conveyed in the present day, its value would be consumed before it reached Dover.

The cakes lately obtained are in the condition known to smelters as that of "coarse copper," and would probably be found by analysis to contain from 97 to 98 per cent. of pure copper, while the commercial copper of the present day contains from 99 to 99·5 per cent., the usual impurities being iron, oxygen, and sulphur. The cakes have not been subjected to the process of refining, and it is a most interesting question, whether that art was understood in ancient times or not. The operation is one of great nicety, and demands of the refiner the exercise of a skill acquired only by experience and practice. It fits our modern copper for the purposes of rolling and the manufacture of the various alloys, in which it takes so prominent a part.

⁵ Manufacture of Alloys of Copper and Zinc by the Romans.—"Whatever doubt there may be as to the authority of the discovery of zinc, there can be none as to the fact that brass, that is a yellow

alloy of copper and zinc, was produced early in the Christian era, if not before its commencement." Percy's Metallurgy, p. 521.