Ironstone working in Norfolk

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My story begins with a telephone call from Ivor Brown, a retired mining engineer who I have known since my days mapping the Coalbrookdale Coalfield. Although long retired, Ivor still has a great interest in historic mines, with the result that his wife always seeks out holidays in areas with no mining history. Thus they found themselves at Weybourne in north Norfolk, waiting for a steam-hauled train to Holt. Ivor looked at the OS map provided by the owner of their holiday cottage, and was surprised to find the words "Weybourne Pits" and "ancient iron workings" almost where they where they were sitting. Clearly this was the end of their relaxing holiday, but many hours in Cromer museum and library failed to find much useful information. Ivor eventually contacted Trevor Ford, who had been his PhD supervisor, and then myself, but my knowledge of the subject could be easily encompassed in one word.

I felt that I should investigate farther so I contacted Steve Booth, who had actually mapped Weybourne during our BGS re-survey of the Norfolk coastal sheets. Steve remembered the site but suggested that the workings were for flint extraction, since they lay within a large area of glacial gravels and sands. I contacted several members of the Norfolk Geological Society and eventually Martin Warren, retired curator of Cromer Museum, who EMGS members will remember once took us on a field excursion to the site of the West Runton Elephant. Fortunately Martin had been looking into the ironworking industry, and was happy to arrange a joint field visit, so on May 3rd 2012 Steve Booth and I went to Norfolk and joined Martin and five other interested people for a day visit. We visited three sites which Martin considered showed evidence of both ironstone extraction and smelting, at Felbrigg [NGR 202402], Briton's Lane [171418] and Weybourne [117417]. Professor Jim Rose had hoped to come but could not make it, so on August 23rd Jim and I and our wives went down for the day and visited the same three sites in much better weather.

Gathering the evidence

All the three sites visited lie within the outcrop of the Briton's Lane Formation (BLF), a gravel and sand deposit of proximal glacial outwash origin. Its age is hotly disputed, from Marine Isotope Stage (MIS) 6 (about 150,000 years old) to MIS 12 (about 450,000 years). It is famous for its large, rounded flint clasts and was traditionally called the Cannon Shot Gravel. The Felbrigg site [202402] lies at c.70m OD at the top of the Cromer Ridge, one of the highest topographic features in Norfolk. It is adjacent to the entrance road to the well-known National Trust property Felbrigg Hall. Here we found an elongate pit up to 3m deep and extending

Excavating a bloomery site at Felbrigg Hall; Jim and Pennie Rose (L) and Sue Hamblin (R). Individual bloomeries are indicated by the low mounds and much scattered slag, and the elongate pit interpreted as an old site of flint gravel extraction is in the right background.

roughly north-south for some 80m. We confirmed that this pit was indeed within the BLF outcrop, but limited augering and digging on both visits found no evidence of ironstone within the gravel. However on the eastern side of the pit was an area some 40m square in which we could easily find large quantities of iron smelting slag, in flat sheets up to 15 cm across.

Martin suggested that altogether this site represented an area of both iron extraction and smelting, with the smelting using a primitive version of a bloomery (the earliest form of furnace capable of smelting iron). There was no evidence of buildings or of sophisticated blast furnaces. Martin pointed out that the 'slag' was all found on the downwind side of the pit, so the miners would have been unaffected by the smoke from the bloomeries. Jim and I were very impressed with the evidence for smelting, and Jim pointed out that gentle undulations in the ground, indicating the ancient bloomery sites, looked just like similar bloomery sites in the Weald of Kent. Excavation with a spade revealed reddened and

A hole dug through an old bloomery site at Felbrigg Hall. Much slag was dug from this hole, and reddening of the loess could only be explained by the heat of smelting.

Uneven ground at the Briton's Lane site, interpreted as pits with surrounding ramparts that were created by shallow mineral excavations with a low extraction rate.

indurated loess at a depth of c.20 cm, which could only be explained by the heat of smelting at the surface or at shallow depth. However we were not persuaded that the adjacent pit was dug for ironstone since there was no spoil mound, a pit with a 100% rate of extraction could only have been dug for the flint and this pit was clearly the source of flint gravel for the Felbrigg estate. On the other hand, ironstone could have been worked here earlier and the worked ground later re-excavated for flints, since previously worked ground would be easier to excavate than unworked ground!

The Briton's Lane site [171418] is a viewpoint at the top of the Cromer Ridge, looking out to the sea to the north at c.80m OD. Here we found very uneven ground, taking the form of a series of small pits surrounded by low mounds. The mounds resembled the spoil mounds that would be expected if the pits were man-made, and we all agreed that the depth of the pits and relative sizes of the pits and the mounds did appear to indicate shallow mineral workings with a low extraction rate, such as would be expected in primitive ironstone mining. Also at this site there is a little monument built of big rounded flints and this did include several lumps of iron smelting slag just like those seen at Felbrigg.

Uneven ground interpreted as old pits at Weybourne.

Martin (on the May visit) took this to indicate that this site, like Felbrigg, was used for both extraction and smelting, but Jim (in August) pointed out that the big rounded flints used in the monument were not frost-shattered and hence had not come from the shallow, surface excavations that we could see here. They must have come from quite a deep pit, and since this site belongs to the National Trust, and the Trust's Norfolk headquarters is at Felbrigg Hall, it is quite possible that the flints and the slag in the monument came from the pit that we had just visited at Felbrigg. We finally moved on to Weybourne, where the interest had first begun. Weybourne Pits [117417] lie on the steeply sloping north face of the Cromer Ridge, c.60m OD, just south of the railway station. Here an area of more than an acre is completely covered with small pits surrounded by ramparts of spoil, similar to those seen at Briton's Lane but rather larger. Digging confirmed gravel and sand of the BLF but no ironstone or slag was found. However the pits and their surrounding ramparts did suggest widespread shallow mineral excavation with a low extraction rate, and we can think of no alternative to primitive ironstone working.

Developing the ideas

So would ironstone be expected in the BLF? Well yes, there will be glacial erratics of allogenic ironstone from the Middle Jurassic of Lincolnshire and Yorkshire and from the Early Pleistocene Wroxham Crag, which outcrops on the coast of North Norfolk at around sea level. Jenny Gladstone from the Norfolk Geological Society gave us some pieces of ironstone that she had found in the BLF and Steve had them cut in two, and these clearly resembled siderite from the Middle Jurassic. Will the ironstone in the BLF be anywhere of high concentration? Well yes, the formation of a glacial outwash gives much scope for clast sorting and ironstone is very much heavier than flint so local concentrations will develop. Will these concentrations be obvious to an unskilled population standing on the surface? No, not unless the erratics of alligenic ironstone were to be dissolved by circulating groundwater and redeposited near the surface as an authigenic iron pan. Sheets of iron pan would impede groundwater circulation and lead to notable boggy patches and changes in vegetation. Development of such authigenic deposits in the BLF on the top of the Cromer ridge would not be unlikely, but Steve and I have mapped huge areas of BLF while working for BGS and we have nowhere noted any evidence of an iron pan sufficiently well developed to form boggy areas or affect the groundwater. Thus we must conclude that if the BLF was worked for ironstone, then the excavations must have started off either at random or by a chance discovery of ironstone in a flint gravel pit. Possibly the huge area of workings at Weybourne indicates chance discovery of a concentration of ore, but this ore would have to be in the form of erratics of allogenic ironstone, authigenic deposits would not form on such a steep slope.

Monument built with flints and slag, at the Briton's Lane site.

Flint gravel of the Wroxham Crag, cemented by authigenic hematite ironstone.

Sue Hamblin at West Runton beach, holding clasts of hematite from the Wroxham Crag.

From the Felbrigg site we had concluded that there was definite evidence of smelting on the BLF outcrop of the Cromer Ridge, presumably by primitive bloomeries since there is no evidence of any sophisticated blast furnaces. However, this does not necessarily mean that the ironstone came from the BLF, since we learned from Ken Hamilton of Norfolk Landscape Archaeology that the weight ratio of wood to ore needed for smelting in bloomeries is 7:1. So the ore was always taken to the fuel, while the fuel supply moved rapidly as huge numbers of trees were cut down and burned. Before limestone was used as a flux, very high temperatures were needed for smelting, and a huge amount of fuel was needed to raise 1400°C for several hours. Thus, although we had found quite considerable evidence of ironstone working from the BLF itself, Jim and I wondered about the possibility of ironstone being taken directly from the Wroxham Crag along the coast and carried up onto the Cromer Ridge for smelting, since the ridge in early times would have been completely forested and would have been an excellent source for charcoal. We went to the beach at West Runton [186432] and confirmed that there is indeed a high concentration of hematite iron ore within the Wroxham Crag. This is believed to have formed from the weathering of glauconite which formed in the shallow coastal waters of the Crag sea.

Towards an hypothesis

From these considerations our current hypothesis is that the primary source for the bloomeries up on the Cromer Ridge would be the Wroxham Crag, which crops out along the coast at sea level from Cromer to Weybourne. Mining this mineral would be unlikely because of the huge thickness of unstable glacial sands and gravels which everywhere overlies it, but coastal retreat during winter storms would free the ironstone and being heavy it would be sorted out from the flint by the waves, being left on the beach ready to be collected as needed. The problem with this source of course is that the amount of ironstone yielded per year depends entirely on the weather and is out of any control by the industry, so we suggest that in lean years the BLF was excavated as a further source of ore when supplies from the beach were exhausted. Mining the limited amount of ironstone available in the BLF would not be an obvious economic choice, but labour would have been cheap and would have been readily available at times of year when there was little to do on the farms, and the local labour force would have been in no position to argue about this hard and difficult labour. The Carstone from the Lower Cretaceous, which crops out in the Hunstanton area to the west, would be another source of iron to import to the area, but transport costs and local politics might have made this more expensive than exploiting the BLF locally.

Our main remaining question then is the dating of the workings. The technology of the bloomery has been known from the dawn of the Iron Age, possibly around the sixth century BC in England, and the small, isolated population of North Norfolk could have used this process for a very long time. Martin Warren knows of many more sites which I have not visited and these could have satisfied local demand for a long time, until the development of blast furnaces in the Midlands and the availability of improved roads and then canals and railways made cheap ironware available throughout England. On the other hand, other bloomeries that have been excavated in Norfolk were found with late Bronze Age and early Iron Age pottery and "might be the earliest evidence for ironworking anywhere in the country" (Ivor Brown, 2012, *Mining History*, v18, p56). Some pieces of slag that we excavated at the Felbrigg site have been sent off for Thermal Luminescence dating, but as we have no funds for our research we would be optimistic to expect an early answer.

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