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Assessment of iron ores from Broadhembury (BHFP22)

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Abstract

This site produced a small quantity of iron ore from small extraction pits radiocarbon dated to the Iron Age and Roman periods. Some of the samples derived from the fill of a pit, others were taken from the natural.

The ore was a typical oxide iron ore from the Clay-with-flints, a complex geological unit that overlies the Upper Greensand on the Blackdown Hills. The material represented a variety of crusts forming box-stone textures, with both botryoidal and massive microstructures.

Some of the examples showed a spheroidal microstructure on a scale of 1-2mm, with the internal parts of the spheroids commonly weathering-out. Such a structure might be a primary pisoidal texture or might be diagenetic, produced by, for instance, sphaerosiderite. Such a texture has not been recognised in the ores from Blackdown before, although sphaerosiderite did occur in the ore fines at the base of an early medieval smelting furnace at Langford probably supplied from Blackdown sources.

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Background

This assessment was commissioned by Bryn Morris of South West Archaeology Ltd. The materials described and assessed here arise from excavations undertaken on land south of Hanger Farm, Broadhembury, Devon (site code BHFP22).

The site was dated, by two radiocarbon dates from charcoal in two of the pits of the later Iron Age and Roman period.

This report assesses a small collection of samples of iron ore, partly collected from a fill of pit [121], one of 18 small ore-extraction pits found on the site, and partly taken from the natural.

Assessment

All submitted materials were examined visually in November/December 2025, using a low-powered binocular microscope where required. They have been catalogued (Table 1) and assessed. No instrumental analysis has been undertaken.

Geological background

A geological background to the exploitation of iron ores on the Blackdown Hills was recently provided by Young (2023) in the context of evaluation of ores from extraction pits at Dunkeswell. That background is repeated, with only minor amendment below.

The Blackdown Hills provided a source for iron ore that constituted a major regional resource from the Iron Age until the medieval period. This resource appears to have been of particular significance during the early medieval with five smelting sites dating to between the 7th and 11th centuries having been excavated in recent years (Burlescombe, *Reed et al.* 2006; Culmstock Road South, Rainbird & Young 2015; Churchills Farm, Smart 2018; Culmstock Road North, Young *et al.* 2022; Langford, Rainbird 2020, Young 2021, 2023b). One recently excavated site in Hemyock is slightly later (13^{th}-14^{th} century?; Young 2025). The earlier smelting activity of Iron Age and Roman age has received less recent attention, but some small-scale research interventions (e.g. Griffith & Weddell 1996).

The smelting sites have produced very little iron ore and what has been recovered was generally in very small fragments. The exception to this was at Culmstock Road South, which produced a moderate amount of ore, but of a grade too low to be compatible with the slags generated; these materials have been interpreted as deliberate discards.

One of the few interventions that has recorded the ironstone in-situ was that by Reed (1997), who reported on ores from extraction pits at North Hill, approximately 2km NW of the present site and illustrated ‘nodules’ of up to approximately 400mm and weighing 30kg.

A further round of investigation of the ore resources resulted from work undertaken by Cotswold Archaeology (Nichol 2015; Young 2015) in the NE part of Dunkeswell airfield (approximately 3km NE of the present site). Analysis of ores from that site focused on bulk analyses of a suite of very high-grade box-stone crusts. Box-stones are zones of iron enrichment formed when reduced iron released by weathering reactions passes into oxidised zones around joints or the outside of concretions (typically zones influenced by meteoric waters) where the iron II oxidises to insoluble iron III and precipitates. Such textures may form along the joints in a well-jointed rock or may form around the outside of individual concretions. Thus, iron migrates from the interior to form a box-like rim or crust around the outside (sometimes impregnating the outer section of the rock, sometimes as a precipitate into void space).

Subsequently, further development at Dunkeswell Airfield produced further pits, from which additional ores were analysed (Etheridge 2019; Young 2023a), including some material taken directly from the natural.

Further pits were examined when an area on the NE of the airfield (close to that of the 2015 work) was developed (Bampton 2022), but no analyses were made of the resource exploited.

The accumulation of evidence from many of these sites enabled modelling of the iron ore employed at Culmstock Road North (Young 2020) as a mixture of very high-grade ore (Group 1; such as is seen in the box-stone crusts) and lower grade material including more of the precursor lithology (Group 2). This mixture is envisaged as being the product of the natural range of compositions within the ore, rather than resulting from deliberate blending.

Electron microscopy of iron ore fines from the furnace at Langford (Young 2021) produced further evidence for the incorporation of a wide range of lithologies, including laminated box-stone crusts, sphaerosiderite and iron oxide-replaced sandstones, these latter lithologies probably indicating an input from the Upper Greensand.

Understanding of the geological succession in the Dunkeswell area from which these materials were produced is, however, very imperfect. The unit mapped at outcrop is the Tertiary Clay-with-flints, which lies unconformably on the Cretaceous Upper Greensand. Detailed geological interpretation of the Clay-with-flints has focused more on the better exposed areas near the coast than on the inland zones, perhaps leading to a bias towards the significance of the role of the dissolution of chalk (which overlies the Upper Greensand in those areas) in its generation.

A major study by Isaac (1981) demonstrated that, at least locally, the unit includes a Tertiary sedimentary succession including soil horizons dating to the Paleocene and Eocene.

Later studies by Gallois (2009; by which date many of the localities described by Isaac were no longer accessible) emphasised the role of dissolution of the Chalk as well as Tertiary deposition in the formation of the ‘Clay-with-flints. Importantly however, Gallois (2004b) demonstrated that the Upper Greensand was also affected by dissolution.

The stratigraphy of the Upper Greensand itself is also better known in the coastal zone, where it has been the subject of several detailed studies (Hart & Williams 1990; Gallois 2004a; Gallois & Owen 2018, 2019). In the Blackdown Hills, not only is the Chalk absent, but the Upper Greensand differs from its development in the coastal belt. Trerise (1960) assigned the Upper Greensand of the Blackdown Hills to its own facies, ‘The Blackdown Facies’. The succession in the Blackdown Hills probably only includes the lower part of the succession observed at the coast (mainly the Foxmould Member), but this differs from its typical exposure on the coast in being heavily leached and decalcified. Trerise commented (1960, 22) that ‘the non-calcareous sediments are more richly ferruginous than usual, suggesting that the leaching may have been accompanied by the decomposition of glauconite to limonite’. The intensity of this weathering in the Blackdown Hills has been linked to the absence of the Chalk below the sub-Tertiary unconformity in this area. Chert is also a recognised significant component in the Upper Greensand (e.g. Trerise 1961) and is specifically noted as being a component of ‘The Backdown Facies’.

To complicate the geological context still further, the Clay-with-flints was further disturbed during the Pleistocene. In areas with a topographic gradient, such disturbance resulted in the formation of deposits mappable as head. The influence of Pleistocene cryoturbation on other sections may be more cryptic.

Results

General

The samples are typical, in a general sense, of the iron ores from the Clay-with-flints of the Blackdown Hills. They include box-stone fragments, together with thicker agglomerations of complex ferruginous crusts, some fine and massive, others botryoidal.

Details

Descriptions of the samples are presented in Table 1.

Significant details include the presence of veined white inclusions in several pieces. These are suggestive of the final stages of incorporation of a sedimentary protolith into the mineralised material.

Another significant detail is that some of the pieces showed a spheroidal microstructure on a scale of 1-2mm, with the internal parts of the spheroids commonly weathering-out. Such a structure might be a primary pisoidal texture or might be diagenetic, produced by, for instance, sphaerosiderite. Such a texture has not been recognised in the ores from Blackdown before, although sphaerosiderite did occur in the ore fines at the base of an early medieval smelting furnace at Langford probably supplied from Blackdown sources (Young 2021).

Interpretation

The assemblage is of potential significance for two reasons: firstly, it expands the geographical extent of investigated ore assemblages and secondly, it presents some petrographic features which differentiate it in detail from other occurrences.

Given the complex origin for the Clay-with-flints (as discussed above), it is not surprising that petrographic differences should exist between different locations. Different geochemical processes involved in the origin of different textures also have the potential to have developed different trace element chemical signatures even where the rock is a highly iron-rich.

Further work

An enhanced ability to provenance the production of iron to particular sources of ore using the slag composition, and in due course, as the use of slag inclusions as a provenancing tool for iron metal increases, to provenance iron to source too, is highly desirable. SWARF Research Aims 38h and 47b promote the further investigation of the Blackdown Hills iron industry both in terms of production and its impact of the economy – and provenancing is a tool at the heart of such investigations.

The detailed analysis of these materials is capable, therefore, of providing further information of archaeological significance.

It is recommended that bulk chemical analyses (majors and traces, by XRF/ICP-MS) are made of typical bulk ore from this site and specifically of the lithology with the spheroidal texture. Investigation of this unusual texture should also involve petrographic description by aSEM.

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Table 1: catalogue of submitted materials. Weights in g.

Label	Weight	Number	Notes
ironstone from [123]	107	51	main piece is box stone; fragment is maximum of 60mm across with crust locally up to 10mm, but mostly thinner; fine black internal botryoids; main crust is dense, shows red intercalation between more 'leathery' zones; outside is yellow-brown striped, often appears convoluted and with patches of dark botryoids; mainly fine but locally coarse
		51	small pieces, all very dense, and mostly including botryoidal crusts; no coarse sediments; one piece has a white inclusion
		1	chert
ironstone from [0]	126	10	mostly brown/khaki fragments of the complex outer crusts from box-stones, 1 piece shows red shiny mm-scale surficial botryoidal coat; three pieces have white clasts that weather back, these clasts are themselves veined and appear to be host rock remnants
in-situ ironstone	585	2	ores with complexly agglomerated weathering crusts; variegated, brown/red/yellow; early material seems fine and hard, later is botryoidal, similar to that seen in the box-stone example from (123), but here looking as if they form part of a thick sheet
	326	3	Box-stone and slab fragments in an apparently pisolitic texture; weathered yellow ochre and harder pisoid outsides/cement; possibility pisoids are actually former sphaerosiderite?

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