

11: Gangue Minerals and Pigment Earths

By Michael Shaw

11.1 Introduction

This paper deals with two separate sets of substances: minerals, which at sometime have been considered to be gangue, and pigment earths.

The idea of an archaeology of the extraction of substances grouped together because they have at sometime been considered not only waste but very inconvenient waste is not without its problems; not least is what to include both in terms of substances and of sites.

The Durham Regional Research Framework¹ has this telling statement which provides a realistic starting point for gangue minerals:

the remains associated with those industries (Barytes & Witherite) still stand but have been largely ignored in favour of the structures associated with the lead industry in the same area, which mainly date to the eighteenth and nineteenth centuries

The fact that recent mines have required planning consent and that that consent has included conditions, which required the land to be returned as far as possible to its pre-mining condition, has cut off almost totally any significant archaeology for post-war mines, mills etc.

Gangue is defined for the purposes of this report as being substances in a vein associated with the ore sought, which had no current value and were either raised and disposed or sorted below ground and left as dead. The definition of gangue is not fixed, leaving considerable debate as to whether for instance the material need be brought to the surface to be gangue or whether the by-products of ore preparation should be so considered. Pigment substances have sometimes been gangue but in many cases have also been the subject of primary extraction, sometimes for millennia.

Of the substances which could be classified as gangue this report deals with barytes, fluorspar and calcite and of the pigments graphite, ochre, raddle, umber and wad. It should be noted that in some places ochre is called raddle and the word wad, whilst generally being used for a black manganese-rich clay is used for graphite in the Lake District (at least). Malachite, azurite, pyromorphite and chalk (as whiting and hearthstone) have also been extracted as pigments, the archaeology of these substances being covered elsewhere in this report (*see Prehistoric Mining Assessment*).

For the purposes of this report, sites can be divided into six groups with varying potential

1. Tips at mines which did not ever work or recover gangue
2. Mines which recovered or later worked gangue
3. Mines opened to work what had been gangue
4. Mines primarily extracting decorative substances
5. Processing sites
6. Transport infrastructure

Of the above categories one and two may well have no archaeology specific to their gangue. Category three, five and six sites will provide the bulk of the information. From category four, a few mines are still working (Rogerley, Co Durham for fluorspar crystals, caverns at Castleton for Blue John and Clearwell for ochres) and at least nominally creating archaeology, though probably destroying more.

With these problems and limitations in mind, what follows naturally focuses more on the potential of orefields and individual mining sites to possess archaeological remains specific to the mining or production of gangue minerals and pigment earths, rather than providing a discourse on archaeological achievements which, as yet, are few.

11.2 Historical background and consumption

11.2.1 Barytes and Witherite

Consumption

Barytes, barite, barium sulphate, BaSO_4 , usually a whitish, dense, flaky, earth or crystalline material, known to the miners as cawke, heavy spar, brites and many variations was almost always treated as gangue until the second half of the 19th century when uses for it began to increase.

The principal properties of barytes which give it value are its density and inertness and the majority of its use was in a comminuted form. Its inert properties made it useful as a filler in paint, paper, etc, and later in plastics. Whereas its density made it particularly suited for use as an oil-well drilling mud. This latter use has provided the overwhelming demand for the material since the Second World War. A combination of these properties enables barytes to provide a significant degree of protection from radiation, leading to its use either as a shield, as happened after the accident at the Windscale nuclear plant in 1957, or as a component of bricks or concrete in hospital and laboratory construction. In its purified form it is the opaque matter ingested as a barium meal for medical use.

Chemical grade barytes (and witherite) was and is used as a feedstock for the production of a substantial number of useful chemicals. Witherite is barium carbonate: it was principally used to produce the same barium chemicals as barytes having the advantages of a greater barium content and being more reactive it was cheaper to process. Various pigments can be made from the barium chemicals and precipitated barium sulphate is a significant white pigment.

Barytes also has a limited profile as a decorative material: lumps from Raygill Mine were used in Victorian rockeries and a brown and white banded pseudo-stalagmitic form was mined at Arbor Low, Derbyshire and polished and sold as 'oakstone'.

Production

Limited mining took place in England until the late 1850s when rather more coherent production started. Production generally increased slowly until the First World War when the cessation of imports from Germany allowed the increase to accelerate. Production increased further during the interwar years to reach a peak in the 1940s but thereafter imports gradually drove levels back down. Shropshire stopped producing in 1948, the

west country followed a decade later and work in the north Pennines had halted by 1999. This left a small level of production from Cavendish Mill in Derbyshire as a by-product from fluorspar mining and milling; work stopped here, at least temporarily, late in 2010. Large deposits found in Scotland have reduced the need for imports and current needs are met mainly by Foss Mine, with large reserves (probably greater than the total mined in the British Isles to date) at Duntanlich.

For many years the UK was the world's only producer of witherite, when the last mine closed in 1969 world production ceased for a number of years with production subsequently restarting in China.

11.2.2 Fluorspar

Consumption

Fluorspar is the commercial term for the mineral fluorite, calcium fluoride, CaF_2 . It can be either massive or crystalline. The crystals are generally isometric, often twinned, though more complex forms occur. It exists in a variety of colours commonly purple, blue, green, yellow and colourless, pink, red, white, brown and black are also known, colour banding is common. Apart from its industrial uses this range of colour and pattern has made the mineral, despite its relative softness (Mohs hardness 4), a semi-precious stone. In the form known as 'Blue John' it has status as a decorative stone.

Industrially three grades are recognised: metallurgical grade fluorite has the most widespread use as a flux in several metal industries. Most importantly, in steel making, it reduces the melting point of the raw material and aids the removal of impurities. Ceramic grade is used in the production of certain types of glass and enamels, while acid grade is used to make hydrofluoric acid from which is produced an important range of fluorine compounds.

A further use not quite in any of the previous categories is to replace glass in some specialist telescope and camera lenses. It also has some very special properties in relation to ultraviolet light having a unique transparency at 157nm wavelength allowing fluorspar lenses to be used for fluorescence microscopy.²

Production

All significant UK production has ceased during the drafting of this section of this report with the pumps at Cavendish Mill being switched off early in November 2010 (though subsequently there has been a suggestion that this could change). The plant was owned by Glebe Mines (a part of Ineos Fluor) who operated the mill with supplies from their own and tributer opencast working in the Peak District. Only acid grade material was produced (with by-products in the form of barytes, galena and limestone aggregate). The last major opencast site was on Longstone Edge. Glebe Mines had been working towards reopening Tearsall opencast and Milldam mine. Commercial mining in the northern Pennines (principally in Weardale) ceased in 1999. Mining is now limited to decorative material with production of small quantities of Blue John from the caverns around Castleton in Derbyshire and well-crystallised specimens for collectors being from Rogerley Mine, Co Durham, which was reopened for the purpose in 1972.³

Mining around Castleton in Derbyshire for Blue John began by the mid 18th century (Ford 2000, 56). Fluorspar's use as a flux is known from at least the 16th century and metallurgical grade production is noted in England from the last quarter of the 18th century, from Critchman (Knowles) Mine, Masson Hill, Matlock for use in lead smelting at Ecton mine, Staffordshire (PDMHS *Newsletter* 138, April 2011) but remained small throughout the 19th century and was mainly a by-product of lead, tin and copper mining in Cornwall and Devon (Cranstone 1993, 17). Production rose from about 5000 tons in the whole of the 19th century to 65,000 tons in 1908 with the development of the steel industry, prices fell over that same period as substantial reserves were exploited (Burt 1984). By the late 1980s production was about 340,000 tons per annum about half of which was from tributaries (Bramley 1991).

11.2.3 Calcite

Consumption

Calcite is a crystallised form of calcium carbonate, CaCO₃. The crystals are trigonal-rhombohedral though they show a considerable variety of habits. Generally clear or white, impurities can colour it. Also known as light spar, calspar and calc-spar, the latter generally used to describe the opaque material. It is the principal constituent of limestone and, when metamorphosed, of marble. It can be used for any industrial/chemical use in place of limestone but as gangue its principal uses have been decorative, both as a range of crystals and crushed as spar chippings or sand in pebbledash, stucco, terrazzo, road surfacing and road 'white lines'.

Production

Began in the mid-19th century though maximum production was not reached until well in the 20th. Mining ceased in the 1970s though open-working continues. It is estimated that around 1,000,000 tons have been extracted to date (Ford 2002). From the 1960s to the 1980s production was about 20,000 tpa, half from Derbyshire, by the end of the century it was down to about 14,000 tpa (Ford 2002), all from that county.

11.2.4 Pigments

Consumption

The uses of pigments are fairly self explanatory, though many substances had other uses. Often material which could have been used as a pigment has been mined for its metal content.

Production

Graphite is an allotrope of carbon, a black semi metal also known as plumbago or black-lead. The mineral was known of by the monks of Furness Abbey who are reported to have used it to mark their sheep (Lax & Maxwell 1998) and to rule guide lines in documents⁴. By the late 16th century it was certainly in use as a drawing material and probably for rust proofing iron (grate polish etc) (Camden 1610). The mine passed through many hands including in the early 17th century the Hechsetter brothers, as a private venture rather than as part of their Mines Royal activity. The most significant uses during the 18th century were for moulds

for cannon balls and other iron munitions, crucibles and lubrication for ship's rigging. These uses gave the material immense value, £3,500 a ton being noted c.1800⁴. The material led to the development of the Keswick pencil industry in the late 18th century with locally mined graphite being used for the best quality pencils until stocks were exhausted before the First World war, mining having ceased c.1891. Graphite occurs as pipes, lumps, nodules, sops or bellies up to 1m by 3m, often following quartz strings.

Ochre is an 'earthy material of no fixed composition' ... 'mostly impure goethite (limonite) mixed with clays' (Ford 2003) with a significant iron oxide (Fe_2O_3) content and a range of colours. Red and purple contain anhydrous iron oxide, brown, partially hydrated iron oxide and yellow hydrated iron oxide. It has been extracted for millennia (*see* prehistoric assessment) and is amongst the earliest pigments used by man, its mining and sale continue. Ochre is levigated, i.e. stirred in water to leave the pigment in suspension, this is then dried at low temperature and packed for use (Ford 2003). It is a common material in coal measures, at times being extracted for sale. Few statistics are available but national production between 1919 and 1939 was around 9,000 tons per annum with Derbyshire contributing 5% of that, mainly from coal mines (Ford 2003).

Raddle is also an iron-based pigment correctly produced from fine red hematite (Fe_2O_3). It exists either in clay as ochre when it is levigated or in crystalline form when it is ground and used either as red pigment or as jeweller's rouge. It can be found with ochre and the name raddle is sometimes used for red ochre. There are no production statistics available.

Umber is not as widespread as ochre though related, being a clay based material but having a higher manganese content. It is a sufficiently defined substance to have a formula, $\text{Fe}_2\text{O}_3 + \text{MnO}_2 + \text{H}_2\text{O} + \text{Si} + \text{Al}_2\text{O}_3$. Its dark brown colour depends on its manganese content and on its processing, with heat treated (burnt) umber being more intense. There are few production statistics available but Derbyshire possibly extracted about 10,000 tons of wad and umber from the late 18th to the early 20th centuries (Ford 2001). At the Ashburton Umber Works in Devon, over 7,500 tons were produced between 1873 and 1883 by two separate companies (Hamilton Jenkin 1981, 111).

Wad is an earthy black ore with a higher manganese content than umber. It has no specific chemical composition but is mainly composed of hydrated manganese oxides. It can be used as a dark brown to black pigment, it is an effective drier in paints and apparently, in the days of wooden ships, was used as a preservative against attack by marine worms. It has also been mined and calcined for use in bleach and glass manufacture and is an important ore of manganese.

11.3 Locality: regional and national distributions

11.3.1 Barytes and Witherite

Barytes: This mineral is very widely distributed but has only been mined commercially in the Lake District, the edges of the north Pennine ore field, Derbyshire, Yorkshire, south west Shropshire and isolated mines in Devon and Somerset (and Wales, Scotland and Ireland).

Witherite: For many years, until closure in 1969, Settlingstones Mine in the north Pennines was the world's principal and latterly only producer of witherite. Several other mines in the north Pennines and County Durham including at least one coal mine dug the substance. The only other records of English production are from Anglezarke in Lancashire and from Shropshire where Snailbeach Mine produced about 1000 tons and a few neighbouring mines produced a little.

Fluorspar: In Derbyshire the mineral is generally confined to eastern third of the limestone area from Castleton to Wirksworth. Some was found with tin in Devon and Cornwall. In the mid- and north Pennines it occurs in the widespread mineral veins with fluorspar being the dominant gangue in the centre of the field (and barytes around its fringe).

Calcite: As possibly the most common vein mineral calcite is very widely distributed but does not seem to have been extracted everywhere it occurs. Derbyshire has produced the most, Shropshire produced a considerable quantity from about 10 mines, otherwise English production includes a little from Yorkshire and the Mendips (with several Welsh mines producing a substantial quantity).

11.3.2 Pigments

Generally widespread (with the exception of graphite) and often worked in small quantities or as a secondary (or lower) product. The Peak District seems to have been something of a centre with 'paint' mines in Manifold Valley and Dovedale area and paint mills at Milldale in Dovedale, Via Gellia and High Tor at least (Ford 2003, Paulson 1997).

Ochre: Very widespread though it may not have been worked specifically to any great extent outside south west England, Derbyshire and the Welsh borders. Incidental working at coal mines and very small scale workings will have been spread across most of the country.

Raddle: Hematite is wide spread though its working as a pigment is not; such workings are known in Staffordshire, Peak District and south Yorkshire around Hartington, Dovedale and Cauldon Low (Ford 2003).

Umber: Not as widespread as ochre but has been extracted in the West Country at Ashburton in south Devon, Combemartin and North Devon Mine, and Cumbria at China Clay Umber mine (Harestones).

Wad: This occurs in quite a number of places but is only known to have been worked extensively as a pigment in Derbyshire where about 30 mines have produced it (Ford 2001).

Graphite: Effectively the only graphite mine (anywhere) was Seathwaite⁵ Mine, Borrowdale, Cumbria (where it was called wad) (Lax and Maxwell 1998) though a little was claimed to have been found at Bannerdale Mine nearby. This latter being noted in various publications with one reference to the 'Bannerdale Pencil' (Wilson 1922). An enterprise known as East Portlemouth Consols on the south Devon coast in 1859-61 was claimed to have been working plumbago but no production was recorded (Hamilton Jenkin 1974, 141).

11.4 Geologies in brief

Barytes, calcite and fluorspar

In England these are generally vein minerals frequently occurring with lead, zinc, copper, iron and other metals and in the case of witherite, coal (Collins 1972).

In the North Pennines barytes and fluorspar both occur in lower Carboniferous sediments. In the south Pennines (Peak District) they occur in various measures of the limestone below shales, though this distribution is affected by volcanic beds (toadstones). Generally fluorspar is found to east and barytes to west, though not all that clearly defined, there is some overlap.

In Cumbria barytes occurs in lower Palaeozoic rocks. In Shropshire it occurs in Precambrian and Ordovician rocks, while in Devon and Somerset it is found within Devonian and Carboniferous rocks.

Witherite

Much rarer than barytes it occurs in lower Carboniferous strata in a few mines in the north Pennines as a vein mineral, like barytes in connection with lead etc but also as a vein mineral in coal measures (Collins 1972, 27). The small Shropshire deposits were in Ordovician Mytton Flags.

11.5 Historical research

The history and archaeology of gangue minerals have rarely been the focus of research or recording. This may be for a number of reasons: possibly because the substances have been considered to be waste at some stage in their history; possibly because they were not generally mined for their metal content and did not have the 'alchemy' of smelting; perhaps because they were a less important mineral that enabled a 'proper' mine to survive a few more years or because they generally came late and don't have exciting stone engine houses, mystique or antiquity.

Worse, the remains of purely gangue mines are still seen as industrial dereliction not industrial heritage and money is probably more forthcoming for site 'reclamation' (i.e. levelling of archaeological evidence) than conservation. Being realistic some of those mines don't have much worthy of preservation though it is very important that they are studied and recorded.

Some surveys were carried out from the 1960s onwards and the results contained in society libraries, e.g. Shropshire Caving and Mining Club (SCMC) or deposited in archives such as the L H Butcher collection at Weston Park Museum, Sheffield. Collections of photographs also exist and both these sources should help inform future archaeological research.

Mining for other than fuel or metal ore is, with small scale exceptions (only flints and pigments?) not an activity which developed significantly until the mid-19th century and then quite spasmodically with some mines producing a product which other mines in the same area treated as waste.

Barytes and Witherite

Some barytes was mined from the early 18th century. In 1729 the London Lead Company sent some to London from their mine at Nether Heath in Shropshire for unspecified purposes (Rhodes 1970) and Josiah Wedgwood used substantial quantities in his Jasperware which he perfected in the 1770s; this product also contained a small amount of witherite from Anglezarke mine. Despite this high profile use, relatively little research has been done with the exceptions of mines at Anglezarke in Lancashire (Williamson 1963), the Teign Valley in Devon (Schmitz 1975) and Shropshire (M Shaw 2007; 2009). A small amount was taken from a mine in Yorkshire in 1788 for an unspecified purpose ⁶.

Fluorspar

Though the mining of fluorspar seems to go back further than that of barytes available research into its history like that of barytes is patchy. The 18th century use is covered in PDMHS *Newsletter* (**138**, April 2011), Blue John in Ford (2000) and the subject more generally in Bramley (1991) and Dickinson (1965) amongst others.

Calcite

The mining of this mineral came even later on the scene than the above and is even less researched but see Ford (2002), R P Shaw (1995), R P Shaw (2002).

Pigments

With the exception of graphite and with the possible exception of prehistoric sites (*see* prehistoric assessment) little research has been carried out on specifically pigment mines. Some work has been done on the Derbyshire paint and colour industry (Paulson 1997) and in south Gloucestershire (Williams 2010) and on ochre in the Forest of Dean (Strassburger nd)

Graphite mining has been very well researched being limited in scale and a high value product. Camden mentions it before 1610 and numerous writers (and cartographers) since have visited and noted the activity⁷. Seathwaite mine in Borrowdale, has been researched by the RCHME who have published an earthwork survey of surface remains and a documentary account (Lax & Maxwell 1998)⁸ and an underground survey has been published by Wilkinson⁷. The Bannerdale site has also been researched (Adams 1995, Hewer 1984).

11.6 Technology

The methods used to work both gangue minerals and pigments are those used for vein minerals. Deep mining, open-casting and in a few cases working deposits in natural caves occurred, this latter usually for ochre or Blue John. Processing the various substances varied considerably and is dealt with case by case below.

11.7 Field archaeology

11.7.1 Barytes and Witherite

Extractive sites These minerals have generally been mined, some recovered from tips and a substantial quantity from opencast working notably in Cumbria. There are two types of site remains: 1) of lead etc mines where the remains are not significantly related to barytes and: 2) mines developed for barytes, the latter are more or less all 20th century with concrete, brick, steel or galvanised corrugated iron buildings/ruins/foundations and, if left, steel headframes and chimneys. Underground many would have used tramways with haulage systems.

Processing – mineral to be used for the chemical industry often left mine sites as a gravel, that for dense/filler uses required crushing and usually washing/bleaching, which has not infrequently been carried out at the mine site but equally often at centralised mills, the latter probably increasingly. Any remains will be similar to those above.

Movement of materials – barytes mines have generally been in fairly remote locations and used tramways, road haulage and in a significant number of places aerial ropeways. Where tramways were used there are usually some remains of embankments, cuttings, abutments etc. Road haulage remains whether by horse, steam or internal combustion are indistinguishable from the generality though in several cases e.g. Cow Green, roads were specially constructed to serve mines (Fairburn 2005). Ropeways, especially in areas of low agricultural value, will have left foundations which may be interesting to locate, as for example at Force Crag in Cumbria and Bog Mine in Shropshire where the bases of the pylons survive.

Sources of power – initially purpose built barytes mines used steam power but as the 20th century progressed electric pumps and winders became the norm, often with the need for on-site generation either by directly by coal or using producer-gas plant. Remains of these electrical systems are scarce and fragmentary. Petrol and later diesel pumps and winches supplemented electricity. A similar pattern is seen at the mills.

Infrastructure – generally having developed either in long term mining areas or during periods of increasing personal mobility, communities have not developed specifically around barytes mines to a great extent, though there is at least one terrace in the north Pennines built for barytes miners and named after a Shropshire mine (Wrentnall Cottages at Langdon Beck to serve Cow Green Mine (Fairburn 2005)). Twentieth century development in some places will have continued as a result of barytes enabling a mine to stay in production for longer but these effects may be too subtle to quantify, though the following quote from the *Durham Regional Research Framework* suggesting research ‘to develop a wider appreciation of life in lead mining settlements after the decline of the major lead companies’ is significant (Petts & Gerard 2006, 193).¹

11.7.2 Fluorspar

The above headings under barytes deliver very similar results for fluorspar. Probably the earliest mines dug primarily for fluorspar other than Blue John date from just into the 20th century and fewer perhaps will have used steam power. Underground many would have used tramways with haulage systems, a few, including Sallet Hole and Milldam were on a scale to use road haulage. Processing will also have been less likely to have

taken place at the mine site. Modern processing methods are well described in Bramley (1991). The Blackdene processing plant was acquired and shipped to Morocco after closure and may still remain and could possibly provide some information (*pers com* B Moore - via mining-history email discussion group).

11.7.3 Calcite

Effectively see the above entries for fluorspar and barytes.

11.7.4 Pigments

The small scale of this industry means it has left even less to study, Seathwaite Mine, Borrowdale being an honourable exception. Ochre has been the subject of a field study in the Forest of Dean (Strassburger nd)

11.7.5 Graphite

The RCHME carried out a measured survey of the site of Seathwaite in 1995 on behalf of the National Trust⁸. Adits and an open pit survive as do the remains of guard houses and other buildings. A washing floor can be identified, washing constituting the only preparation required before the graphite could be used. Unusual survivals are three (of five original) boundary markers erected for John Banks (of Kingston Lacy, Dorset) in 1752. At Bannerdale two small ruins survive, a hut may be related to the graphite mining there.

The material will originally have been moved by men or packhorses, though later a short tramway along an adit to the washing floor was constructed. During the mines heyday all the (legitimately obtained) material was shipped to London in casks, even that which was destined for the Keswick pencil works.

11.8 Archaeological recording (by district)

11.8.1 Peak District (South Pennines ore field)

Barnatt and Penny (2004) have dealt with the survival of and threats to the Peak District's lead legacy. This publication acknowledges that gangue minerals, where exploited for their own economic value, have a history that often cannot be disentangled from that of lead. The report makes it clear that the suggestions made within it have as much effect on gangue mineral archaeology as they do on lead, but (chap 1.4) modern gangue mineral mining is realistically seen as having been one of the problems for the survival of mining archaeology in that area. Much of earlier interest has been destroyed, not least by reworking of the tips in attempts to exploit gangue minerals. The report also makes some very important points with regards the need to raise awareness and interest in these remains.

However, some assessment has been carried out on hillocks in Derbyshire which relate to gangue (chap 4.23), while some fluorspar extraction sites are now of archaeological interest and some are hosts to important plant communities (chap 3.19).

Also within the report Appendix C contains 'detailed descriptions of the archaeological interest at all entries within the inventory of regionally important lead mining sites in the ... ore field'.

11.8.2 Yorkshire

As in all other areas most economically worked gangue was taken from tips or mines previously worked for lead, the exception being barytes from Raygill Mine near Skipton. A significant number of other mines produced barytes, fluorspar and calcite decreasingly into the 1990s. Remains as elsewhere are partial with many foundations. 'At the former Dales Chemicals plant on Grassington Moor there are a few more significant remains of settlement dams and a circular de-sanding tank (*pers com M Gill*). There are similar remains at the Clay Cross fluorspar plant at Dry Gill, Appletreewick. Both these plants were connected to the National Grid and could have remains of power lines or transformers (*pers com M Gill*).

11.8.3 Shropshire

Very little fluorspar has been won from this orefield. Claims by the mine's management were made in the official statistics (*see Burt 1990*) that at Snailbeach Mine 900 tons of purple fluorspar were extracted between 1874 and 1879, over a quarter of national production (Burt 1990). However, at least one load did not fetch the price expected and some (Dunham 1945, 107) have questioned if this load was purple calcite. If this was the case for one load then the rest might also have been calcite. If fluorspar was being worked here, the archaeology will have been destroyed by later mining.

Barytes and witherite were well represented in the county with lead mines often turning later to this mineral. Also there were several purely barytes mines including Huglith which must have been one of, if not the largest in the country between the wars. Archaeology studies have been carried out at Snailbeach and Tankerville Mines (*see lead assessment*). Some limited surface recording has been done at Huglith (Heathcote 1980) and Cothercott (Shaw 2003), though much remains to be done (*see also Shaw 2007; Shaw 2009*)

A survey has been carried out on the remains of the two ropeways serving barytes mines (Poyner & Shaw, *forthcoming*).

Calcite became an important product at a number of the county's mines in the 20th century, notably Snailbeach, where production re-working the 'white tip' was carried on as a one-man operation into the 1980s. All that archaeology was effaced with the re-grading of the tip in the 1990s.

11.8.4 SW England and Gloucestershire

There are no known fluorspar remains and little left at barytes mines. Mines were standard twentieth century vein mineral mines, generally the site was cleared as mine closed (Cranstone 1993, 18). At Bridford Barytes Mine in Devon, abandoned in 1958 (Richardson 1992, 83) waste heaps and water-filled settling ponds are all that remain following demolition (Clark 1995, 15-17), although detailed field investigation would undoubtedly reveal more.

Some calcite will have been formed in veins but, apart from some mining in the Mendips it does not seem to have been exploited. Ochre production has left remains in the forest of Dean and south Gloucestershire.

11.8.5 North Pennines and Cumbria

There are some survivals within this orefield associated with gangues and pigments. Petts and Gerard (2006) noted headgear at Grove Rake, and evidence at Middlehope Old Mine. They also stated that such are not often listed or scheduled (Petts & Gerard 2006, 113).

English Heritage has undertaken investigation at Force Crag zinc and barytes mine site, the results of which are to be found in two research reports (Oswald *et al* 1999; 2008). This is a Scheduled Monument and is on the 'at risk' list. An archaeological survey was carried out at Seathwaite Mine for the National Trust (Lax 1998).

A measured survey was carried for the National Trust as referred to above (Lax 1998). At Bannerdale levels remain open, one being called the Graphite Level, there are also surface remains (Adams 1995).

The above assessment has not attempted to note coal mines where ochre production has occurred, presumably little if any direct remains exist.

11.9 Crosscutting themes

Given the nature and date of the mining of what had sometime been gangue materials, many of the possible themes are crosscutting both with earlier mining and communities but also with the reuse of sites; a few as industrial estates, transport yards or single factories and many as official or unofficial tips and/or scrap yards. Aspects of life in a mining community after the cessation of lead mining have been collected by Francis (2000) and in a series of recordings, including many onetime barytes miners, made and held by Shropshire Mines Trust;⁹ similar important interpretive material will exist in other areas. The uses of calcite, some fluorspar and the pigments, being principally decorative, could provide important context for archaeologies of human expression through material culture, particularly in the 19th and 20th centuries but also in much earlier times too. Pigments have at once multifarious and nebulous other connotations ranging from the earliest cave paintings, through cosmetics, medicine and building decoration to canvas preservation for Brixham's fishing fleet (Red Sails in the Sunset)¹⁰. There is no specific infrastructure related to the industry though its security concerns were notable with the guardhouses to stop miners leaving with graphite, an armed raid and an Act of Parliament to make it a felony to steal the substance. The likes of Black Sall and the Dandy Wad Stealer are still remembered and in the former case 'celebrated' as 'Hare and Hounds' on the fell each Whit since 1898¹¹.

Notes and Internet Sources (see separate download for abbreviations)

1. Petts D and Gerard C, 2006, *Shared Visions, Durham County Council*
<http://content.durham.gov.uk/PDFRepository/NERFFBook2.pdf>
2. <http://en.wikipedia.org/wiki/Fluorite>
3. <http://www.ukminingventures.com/WeardaleMines.htm>
4. <http://www.conistonlocal.co.uk/striking-black-gold-in-the-lakeland-fell-tops-1.692082?referrerPath=home>

5. It seems to be called Borrowdale Mine more frequently than Seathwaite.
6. Chatsworth MSS: 12/02/1788 Letter from G. Bradley to B. Hotham, via M Gill
7. <http://www.aditnow.co.uk/documents/Borrowdale-Graphite-Mine/Graphite-at-Seathwaite-June-2012.pdf>
8. <http://www.aditnow.co.uk/documents/Borrowdale-Graphite-Mine/History.pdf>
9. <http://shropshiremines.org.uk/index.htm> CD recordings of miners' (inter alia) memories, held by SMT recorded 1998 - 2000
10. <http://en.wikipedia.org/wiki/Brixham>
11. <http://upnoutside.wordpress.com/tag/seathwaite>

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