13: Salt and other Evaporite Minerals

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13.1 Introduction

The following minerals are covered in this Assessment:

Anhydrite (CaSO₄ - calcium sulphate); converts to gypsum under influence of ground-water

Celestine (SrSO₄ – strontium sulphate); also ‘celestite’ in literature

Gypsum (CaSO₄·2H₂O - hydrated calcium sulphate); includes ‘alabaster’

Halite (NaCl - sodium chloride); also ‘rock salt’ or ‘salt’

Polyhalite (K₂Ca₂Mg(SO₄·2H₂O - hydrated potassium-calcium-magnesium sulphate)

Sylvite (KCl – potassium chloride)

For descriptions of these minerals and their occurrences in England see also Tindle (2008).

Halite has been mined as rock salt since the late 17th century, having been discovered during exploratory shaft sinking for coal at Marbury near Northwich, Cheshire, in November 1670. Prior to that brine springs in Cheshire and at Droitwich, Worcestershire, and elsewhere were, with the output from a large number of coastal sites using seawater, the source of salt produced by evaporation. Alabaster, a fine grained form of gypsum, has however been quarried in the East Midlands for use in sculpture since at least the 14th century (Cheetham 1984, 11-13) and the use of gypsum for making plaster dates from about the same period. Production of anhydrite, celestine and the potassium salts began comparatively recently.

13.2 Applications and Consumption

The expansion of mining and quarrying for salt and the other evaporites came in the 19th century with the development of the chemical industries. Halite was a feedstock for the production of the chlorine used in many chemical processes (Notholt & Highley 1973, Fig 8) including the production of caustic soda (sodium hydroxide) and soda ash (sodium carbonate). Halite (rock salt) was first mined at Winsford in Cheshire in 1844. This is now the site of the only remaining active rock salt mine in England although some halite is produced as the result of development work at the Boulby potash mine in Cleveland. Production at Winsford expanded in the late 19th century to feed, together with brine produced from the Northwich salt fields, the chemical industry in north Cheshire (Male 1958a; Gregory et al 1953). In Lancashire halite deposits were discovered around Fleetwood and Preesall in 1872, during boring in search of hematite (Landless 1979, 38) and were a key to the development of the chemical industry in that area. Anhydrite mining was generally a much later development in west Cumbria, and the Vale of Eden and on Teesside where it again fed a developing chemical industry (Hill & Clemo 1949; Semmens 1970). It was used extensively in the production of sulphuric acid.
Potash, a generic term for a number of potassium bearing minerals including polyhalite and sylvite was discovered at depths of 800 to 1300 metres below the east coast of Yorkshire in 1939 by the d'Arcy Exploration Company whilst drilling for oil (Woods 1973) but was not worked until the mid-1970s at the Boulby Mine, where shaft sinking began in 1968. Another mine is currently proposed to work south and east of the Boulby Mine. The vast proportion of output, peaking at in excess of 600,000 tons per annum in the late 1990s to 2003, is used in the production of fertilisers.

Celestine was worked from the late 19th century through to 1994 by shallow quarrying (only a few metres below surface), principally in the Yate area in south Gloucestershire but also farther south, in Somerset (Sherlock & Hollingworth 1938; Thomas 1973; Nickless et al 1976; Ball et al 1979). It was used initially in sugar refining but subsequently other applications were found as a colorant in pyrotechnics and in the electronics, glass, ceramic and paint and other industries (Thomas 1973; Lane and Hardwick 2013).

13.3 Geology

Evaporite deposits in England are of Permian, Triassic, and to a lesser extent, Jurassic age (Highley et al 1996).

In Permian successions they occur in formations of the Zechstein Group in eastern England and in deposits of equivalent Late Permian age in Cumbria (Ruffell et al 2006). Gypsum, anhydrite, halite and potash minerals occur in eastern England but, apart from one record of halite (Worley 2005) only gypsum and anhydrite occur in Cumbria. In Triassic successions gypsum, anhydrite, halite and celestine occur in the higher part, the Mercia Mudstone Group, with gypsum and anhydrite present in both the Sidmouth Mudstone and the higher Branscombe Mudstone formations of that Group but halite present almost exclusively in the former and celestine only in the highest part of the latter. The only evaporite exploited in Jurassic rocks in England is gypsum in the youngest (Purbeck) beds in Sussex (Highley 1976; Highley et al 1996).

These deposits result largely from evaporation of water of marine origin in partially or, at times, totally enclosed basins and in bordering dry plains or sabkhas (e.g. Warrington 1974a) though some may have resulted from re-deposition by wind action (Morrison 2005). Deposits which formed in water often show a repeated sequence of minerals, indicating cyclic conditions with the mineralogy determined by solubility. The sequence in which the most important minerals precipitate as evaporation proceeds starts with the least soluble (carbonates: aragonite, calcite and magnesium carbonates) and progresses through gypsum and anhydrite to halite and those, such as polyhalite and sylvite, that are most soluble (Encyclopaedia Britannica).

Calcite (CaCO₃ - calcium carbonate) occurs as an evaporite in many parts of the world but in England the only deposits which have been worked commercially are of hydrothermal origin and are therefore considered in the assessment for gangue minerals.

Gypsum and anhydrite occur in beds or veins, or as nodules in Permian and Triassic rocks in eastern and northwestern England, through the Midlands and into the southwest. In Permian successions they occur in
the St Bees area, west Cumbria and the Vale of Eden, east Cumbria (e.g. Arthurton et al 1978) and in eastern England, from Co. Durham southwards through Yorkshire (e.g. Smith 1974). In the Triassic these minerals occur in formations of the Mercia Mudstone Group, from Lancashire in the northwest and Teeside in the northeast, southwards through the Midlands and into southwest England. The main exploited developments are in the Branscombe Mudstone Formation, in the upper part of the Group. In the East Midlands (Firman 1964) these occur at two main levels in that formation. At the lower level the Tutbury Gypsum is worked in the west (e.g. in Fauld Mine) where it is a single bed up to 3.5m thick; this passes eastwards into a poorly developed nodular deposit (Taylor 1983). At the higher level the Newark Gypsum comprises several beds in 15 -18m of strata (Barnes & Firman 1991; Howard et al 2009). In the Trent valley to the south of Derby (Trafford Wynne 1906-7; Smith 1919; Edwards 1966) and at a few locations in Yorkshire and Staffordshire, the Tutbury Gypsum and its equivalents are fine grained and found in masses suitable for extraction as alabaster for sculpture.

In the south of England, from East Sussex across to Dorset, gypsum is found in strata of Jurassic age (Sherlock & Hollingworth 1938, 10-24; Firman 1984; BGS 2005, 4-5) In Sussex the Mountfield Mine opened in 1876 and production at the Brightling Mine commenced in 1963 (Lake & Shephard-Thorn 1987, 58). The principle celestine occurrences, around Yate in south Gloucestershire, may be diagenetic in origin, after gypsum or anhydrite (Nickless et al 1976). They occur in the Mercia Mudstone Group at a similar horizon to the Newark Gypsum, and in Carboniferous rocks.

The most important halite resource presently worked in the country is in Cheshire and north Shropshire, in the lower (Sidmouth Mudstone) formation of the Triassic Mercia Mudstone Group in the Cheshire Basin (Plant et al 1999). The extent of this resource was not appreciated until as recently as 1960 when a Geological Survey borehole at Wilkesley, in the southern part of the basin, proved the halite to be in two distinct units with a total thickness of 1952 feet at that site (Pugh 1960). On Walney Island, Cumbria, and in the Fylde district of west Lancashire halite occurs in thinner units at several levels in the Sidmouth Mudstone (Wilson 1990; Wilson & Evans 1990); these extend offshore, under the East Irish Sea. In eastern England, Staffordshire, Worcestershire, and Somerset (Notholt & Highley 1973) one halite-bearing unit occurs in that formation. Halite also underlies c.1200 km² of Dorset (Lott et al 1982; Barton et al 2011, fig.4c) where, though developed largely in the Sidmouth Mudstone, it may also occur in the lower part of the Branscombe Mudstone (Howard et al 2008); it has not been worked in that area.

In eastern England halite occurs in the upper part of the Late Permian Zechstein Group from Teesside southwards, through eastern Yorkshire into north Lincolnshire (Smith, 1974, 1989; BGS 2006a, 4-5). Halite present in the lower part of the Triassic Mercia Mudstone Group in eastern England (Warrington 1974b; Riddler 1981) is in continuity the extensive Röt Halite offshore to the east, in the North Sea Basin. Polyhalite is found as a component of the Permian halite beds in east Yorkshire where exploration work is underway with a view to exploiting it as a source for fertiliser production (Rowley 2012; Sirius Minerals nd). Sylvite is found in association with halite in the Permian potash beds in east Yorkshire. The principal bed, the Boulby which is on average 7m in thickness, overlies a halite bed with a total thickness of around 40m.
A second bed, the Sneaton, overlies the Boulby but is currently not considered of economic value (BGS 2011, 3-4).

13.4 Historical context

Salt has always been in constant demand in England for preserving food and there has been continuity in production from Roman times through the medieval period to the present day. All the coastal counties of England had salt works or “wiches” designed to capture seawater at exceptionally high tides. The resulting salt-rich sands were then washed to extract brine which was evaporated in pans, using wood or peat as fuel, to recover the salt. In addition to the coastal resources salt was obtained from natural brine springs derived from halite-bearing rocks through the dissolution of the halite by circulating ground water in the exposed salt beds or “Wet Rock Head” zone (Taylor et al 1963, 78-79; Evans 1970). These were in Cheshire, around the town of Northwich, at Droitwich in Worcestershire and at localities in Shropshire, including Whitchurch (Stamper 1985), and in Staffordshire (Sherlock, 1921). Unlike coastal salt works, which were an intermittent operation governed by exceptionally high tides, the inland salt producers could continue throughout the year. The brine springs and evaporation pans at Droitwich were referred to in documents from the 7th to 10th centuries, as were the routes by which the salt was traded to a wide area of the west and south-west of England and were, judged on the revenues itemised in the Domesday survey, the major source in the 11th century. Upwich, one of the principal brine springs at Droitwich, has provided archaeological evidence for continued production from at least the Roman period through to the late medieval. Many inland manors had rights to salt works on the coast as had manors remote from the inland salt-producing areas. Such was the importance of salt to the economy of the period that rights around Droitwich, with five springs supporting over 300 salinae or saltworks, included not only manors within the immediate area but some as far afield as south Gloucestershire and Buckinghamshire. The construction of salt boiling / evaporation pans was a significant usage of lead, and they were sometimes referred to as plumbi (Claufton 2011).

The inland brine springs were evidently enlarged into sizeable pits and continued to be exploited through and beyond the post-medieval period (e.g. Ridgway 1958; Male 1958b). It was not until the late 17th century that deep shafts were sunk to directly exploit the salt-bearing strata. A sequence of rocks subsequently referred to as the “Top Rock” or upper halite, which was later found to be in the lower of the two thick halite-bearing units in Cheshire (Pugh 1960), was found by chance in November 1670 at Marbury near Northwich, in north Cheshire, during exploration for coal and was worked until 1781. Those workings were, however, unstable as the percolation of ground water dissolved the salt and led to collapses in the ground above with consequent flooding of the workings. A lower bed the “Bottom Rock” was discovered at Lawton, near Sandbach, in 1779 and, in 1781, at Marston, Northwich. By working the lower bed it was possible to reduce the inflow of ground water as the deeper workings were below intervening mudstones and under the “Dry Rock Head”. Until the mid-19th century the mining of rock salt was confined to the area around Northwich where working continued until March 1928 before finally ceasing when the Adelaide Mine.

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1 Coastal salt production is outside the remit of this assessment. For further details on the archaeology of coastal salt-making see the work of David Cranstone, particularly Cranstone 2012.
collapsed and flooded. In 1844 mining was begun at Winsford, continuing on a small scale until 1892. It was also discovered and worked on a small scale at Middlewich using shafts from about 1888. After the collapse of the Adelaide Mine in 1928 the Meadowbank Mine at Winsford was reopened and is currently the only operational salt mine in England (Rochester nd - Rock Salt; Sherlock 1921, 55-58). ‘Bastard brine’ was also pumped from abandoned and collapsed mines, and also from brine wells sunk specifically to exploit ‘natural brine’ in un-mined areas across the Cheshire saltfield (Wharmby 1987, 30-31). Pumping in this manner did however lead to severe subsidence and ground collapse problems until the technique of ‘controlled pumping’ (below) was introduced into Cheshire in the early 20th century. Controlled pumping was carried out as far northwest as Agden near Lymm, north of the Warburton fault (Lymm.com 2012).

Rock salt was also discovered at Stoke Prior, Worcestershire, in 1828, at Middlesborough in 1863, at Preesall, Lancashire, in 1872, at Walney Island, now in Cumbria, by the 1890s, in Staffordshire around 1881 (Sherlock, 1921) and at Puriton, Somerset, in 1910 (McMurtrie 1912; Whittaker 1970). Only in the case of Preesall was the salt mined. In Worcestershire, Staffordshire, Somerset and at Walney Island it was exploited by means of wells and extracted as brine but at Preesall shafts were sunk to the halite deposits and brine that accumulated down-dip in the workings was pumped to the main shaft and then to the surface. During the first three decades of the 20th century pillar-and-stall mining was carried out (Landless 1979) and was followed by a return to brine-pumping; Wilson and Evans (1990, pl.16) illustrated a part of the pillar-and-stall workings. From 1892 a new technique (‘controlled pumping’) was introduced at Preesall; in this water is pumped down a pipe within a borehole to dissolve the halite and the resulting brine allowed to flow to surface. In a development of this process compressed air or oil was introduced to effect roof-control. Once the cavity formed reached an optimum size, extraction was moved to a new site about 180m distant and, by this means, stable cavities were created which did not result in surface subsidence. Under later management by Imperial Chemical Industries (ICI) the technique was also used in Cheshire and on Teesside (Notholt & Highley 1973, 18; Landless 1979; Morrison 2005)

Surface subsidence above the salt deposits in Cheshire had been a long standing problem since mining commenced in the 17th century. It was reduced by mining the lower halite bed or ‘Bottom Rock’ but once mines had flooded it was possible to continue extracting brine by pumping. As the brine was replaced by fresh water from surface there was rapid dissolution of the surviving salt pillars in the abandoned mines, resulting in instability and the collapse of large areas of the surface including urban areas particularly in Northwich (Ward 1900; Calvert 1915; Rochester 1985).

Gypsum, particularly in the form of alabaster, was the only other evaporite which was worked to any extent prior to the 19th century. In fact the quarrying of alabaster commenced in at least the 12th century for, although its use in the sculpture of ecclesiastical images dates from around a century later, it was used in construction of the west door to the priory church at Tutbury, Staffordshire, in about 1160 (Cheetham 1984, 12). Although documentary evidence for alabaster sculpture is largely confined to material originating in the East Midlands (around Tutbury and Chellaston) it is very likely that it was also quarried in other areas of England. Fine grained gypsum suitable for use as alabaster is found near Kingston-upon-Soar (Nottinghamshire), in small deposits in Purbeck (Dorset), at Ledsham (Yorkshire) and perhaps near York itself, where there are references to men employed in the alabaster trade in the 15th century (Cheetham
1984, 12-13) although, in the latter case, its status and position on a navigable river meant that high grade material might have been imported coastwise from the Midlands. Firman (1984; 1989a and 1989b) provides a useful critical account of the sources of alabaster for sculptural purposes in the medieval and post medieval periods.

Buttercrambe, near York, was one of the sites documented as producing gypsum in the medieval period for calcining in the preparation of ‘Plaster of Paris’, used in York Minster. Other sites, including Purbeck, are known to have been exploited for plaster production from at least the 14th century (Salzman 1923, 100). By the 19th century, wherever gypsum of suitable quality was found it would have been quarried and calcined for plaster and, later, the manufacture of plasterboard. It was also used in the manufacture of Portland Cement. In 1938 the Geological Survey listed over 45 mines and quarries in Cumberland, Derbyshire, Leicestershire, Nottinghamshire, Somerset, Sussex, Westmorland and Yorkshire, all working gypsum in some form (Sherlock et al 1938). In 2006 there were five mines and one quarry still working for gypsum (BGS 2005).

The mining of anhydrite, the anhydrous form of calcium sulphate, is a relatively recent 20th century development. It was rejected by miners working for gypsum as being unsuitable for plaster production and it was not until a use was found in inorganic chemical processes that it was extracted in any quantity. Even as late as 1938 there was only limited exploitation, primarily in Co. Durham (at Billingham and, earlier, from 1924 to 1930 at the Warren Mine at Hartlepool) as a feedstock for the production of ammonium sulphate and in the manufacture of sulphuric acid, with small amounts being used in developments in plaster production (Sherlock & Hollingworth 1938, 8-9). A rise in anhydrite mining came after the Second World War. With increased demand for sulphuric acid a new mine was opened up in Cumbria at Sandwith near Whitehaven (Anon 1961). The Long Meg Mine in the Eden valley, which had produced small quantities of anhydrite in the 1920s, was brought back into production (Tyler 2000) and the Billingham Mine continued in operation until 1971.

Potash mining in England is very much a post-war industry. The only mine in operation, at Boulby in what is now Cleveland, was not opened up until 1968. Prior to that date the source of potash along with other components used in fertilisers came from mines on the continent or from ‘natural resources’ - primarily guano - whilst potash for use in soap production was produced by burning wood and other organic material. With the Boulby Mine in full operation from the early 1970s, England has become a major producer of potash for use as fertiliser and a new mine is proposed to work the undersea polyhalite deposits to the south and east of Boulby (Sirius Minerals nd). The Boulby Mine drives its underground roadways in the halite beds below the potash. It is therefore also producing rock salt, which general goes for highway de-icing, as a co-product (BGS 2011, 5; Rowley 2012).

Although strontianite (SrCO3 - strontium carbonate) is found as a gangue mineral in a number of lead mines in the north Pennines it has never been worked commercially and is not an evaporitic mineral. Celestine has, however, been quarried in the Triassic Mercia Mudstone Group of Gloucestershire and Somerset. A large number of shallow pits were worked in the area around, and to the north of Yate, in South Gloucestershire, from the late 19th century through to 1994 (Sherlock 1938; Thomas 1973; Nickless et al 1976; Ball et al 1979; Benham et al 2006; Lane & Hardwick 2013). The location of some of those pits was
mapped by the Geological Survey in the inter-war period when they were operated by the Bristol Mineral and Land Company (Sherlock 1938, 84) and all the former celestine workings in Gloucestershire were recorded by Benham et al (2006). Working in Somerset appears to have been confined to an area west of Regilbury Court, near Winford, where disused pits of unknown date were recorded, at Leigh Court, at Abbots Leigh to the west of Bristol, where operations were large enough to justify a tramway to the River Avon before working ceased around 1912 and to the south of the Mendip Hills, near Westbury and North Wooton (Sherlock 1938, 87-88; Thomas 1973, fig.1; Nickless et al 1976, fig.2).

13.5 Techniques and Technology

Early mining of salt and the quarrying of alabaster relied to a great extent on manual labour, as at Fauld mine (Trafford Wynne 1906-7, figs 8, 10-12), but from the 19th century onwards as the extraction of salt and the other evaporites expanded there was widespread mechanisation. Extensive use has been made of wheeled / trackless vehicles underground in the working of gypsum, anhydrite and potash. Continuous mining machines are currently used underground in the extraction of gypsum and potash. The late development of large scale underground extraction meant that most mines utilised drainage by electric pumps, although some of the earlier salt mines used steam powered pumps from 1788 onwards for both drainage and brine pumping (Rochester nd - Rock Salt, 2). The techniques employed in shaft-sinking at the Boulby mine around 40 years ago were described by Cleasby et al (1975).

Solution mining techniques as first used in salt extraction caused extensive surface instability but that was overcome by the use of ‘controlled brine pumping’ developed at Preesall in Lancashire and transferred to other salt fields under ICI management (Notholt & Highley 1973, 17-18; Landless 1979; Morrison 2005). Solution mining using controlled pumping was also tried on an experimental basis by ICI for the extraction of potash at Upgang and Aislaby, now in North Yorkshire, in the 1950s and 60s, and documents relating to the installation of pipelines can be found in the National Archives (TNA:PRO BT 356/10262 and 10263).

It was in the processing of salt that techniques unique to the industry were developed. From the Roman period onwards lead pans were used for the evaporation of brine to produce salt. These were replaced by larger iron pans, heated by coal rather than wood fires, in the post medieval period and they continued to be used on a large scale right through into the 20th century. Large ‘salt works’ were established close to the point of extraction, producing a range of salt for various uses. Some halite was also sent to salt refiners on Merseyside and, from the early 19th century onwards, used as a feed stock for new processes, such as the production of alkali by the LeBlanc process, on Merseyside, Tyneside and Clydeside (Rochester nd - Growth).

The real advance in the evaporation of brine to produce salt came in the 1890s with the application of vacuum evaporators to salt production. Considerable savings in fuel over the open pan method was the driving force behind the adoption of vacuum evaporation which is still used today. Large plants were constructed at Winsford and at Runcorn, in north Cheshire, fed by brine pipelines (Morrison nd). Some ‘salt works’, such as the Lion Salt Works at Marston, Northwich, continued to use the open pan methods right up until closure in 1986 (Fielding 2005).
Processing of gypsum for cement, as mineral white or for the plaster trade also required specialist plant that was generally located close to the point of extraction. Gypsum rock, crushed and ground using French buhrstones or Derbyshire millstones before going for use in plaster, was calcined in what were referred to as ‘kettles’ or ‘boiled’ in ‘pans’. Sherlock and Hollingworth (1938, 27) illustrated a flow sheet for the Cocklakes Mine in the Eden valley, Cumbria, which provides a useful explanation of the processes at that period; the grinding processes were reviewed by Fitzgerald (2011, 136-38).

### 3.6 Transport and infrastructure

Pack horse routes linked the inland salt producing areas to their markets in the medieval and later periods (see, for example, Houghton 1932). There was a similar reliance, at least in part, for the transport of alabaster, worked and unworked, in the late medieval period. River and coastal shipping was, however, the most economic method of moving bulky cargoes of salt and alabaster and this was facilitated by the close proximity of extraction points to the river system in England. The alabaster quarries in the East Midlands were located close to the River Trent. In Cheshire the transport of rock salt was improved when the River Weaver was made navigable (Robinson 1958; Rochester nd - Rock Salt, 2). The Weaver Navigation Bill was passed in 1721, but the actual Weaver Navigation canalised river was opened in 1732 with the transportation of approximately 5,200 tons of salt being increased to 18,600 tons by 1760 (Wallwork 1959). Completion of the Trent and Mersey canal, in 1777, right through the salt field in Cheshire, provided further improvements in transport, and the erection of the Anderton boat lift near Northwich in 1875, to link the canal with the River Weaver, was a result of increased traffic in salt.

The opening of the Trent and Mersey Canal also provided transport opportunities for the alabaster / gypsum quarries in Derbyshire. The canal was used by quarries at Aston-on-Trent from the late 18th century and a tramway linking them to the wharf was in use from 1812 until the early 20th century (Heath 1977).

The construction of the mainline railway network in the second half of the 19th century not only advanced the movement of salt but provided a basis for transport of the other evaporites, particularly gypsum and anhydrite, with many mines and quarries having direct links to either branch lines or the mainline itself (Sherlock and Hollingworth 1938, 25-55). The Preesall Mine was connected by rail to a jetty on the River Wyre where the product could be loaded onto vessels of up to 1600 tons displacement (Sherlock 1921, 73; Landless 1979, 38). Within many of the mines and quarries, narrow gauge tramways, with locomotives, were in use: as at Fauld (Trafford Wynne 1906-7, fig. 7) and at Hawton, near Newark (Howard and Tod 2001).

Even when operations still relied on river or coastal shipping, as with the celestine quarries at Abbots Leigh near Bristol (Sherlock et al 1938, 88), transport to the shipping point relied on tramways.

Aerial ropeways were employed to link a number of mines at Kirby Thore in Cumbria to the processing mill in the 1930s (Tyler 2000, 254) and many operations later moved to the use of long conveyor belt systems for the same purpose. A 5.6 km aerial ropeway was also used between Brightling Mine and Mountfield works in Sussex (Lake et al 1987, 92). Pipelines were, and still are, used for long distance movement of brine and one is planned for the transport of polyhalite in suspension at the proposed York Potash operation in east
Yorkshire. At Walney Island the brine was pumped to a holding reservoir, from where a pipeline led to the salt pans (Cubbon 2013).

Settlements in the salt fields of Worcestershire and the Cheshire basin developed around the brine springs from the Roman period onwards. In the latter case, as production expanded those settlements grew and the salt works moved to the outskirts of the towns. As the industry expanded further, particularly with the advent of rock salt mining, some employers provided dedicated housing for their workers. In 1775 the Barons Croft Salt Works at Northwich had provided workers housing and by the early 19th century there were other similar terraces around Northwich. Brunner Mond and other companies provided housing up until the 1920s when the task passed to local authorities. Even then the large companies encouraged the building of housing by providing land to local authorities for that purpose and, with the expansion of social housing after the Second World War, council houses were specifically allocated to workers in the salt industry (Squire nd). At Walney Island a substantial settlement was planned but only a few cottages were built and these still survive (Brian Cubborn pers comm)

Outside the salt industry there is little evidence of dedicated housing although some operations, particularly gypsum / anhydrite mining, in rural areas would probably have justified at least a small number of dedicated workers’ cottages.

13.7 The archaeology of salt and the other evaporites

Archaeological investigation of salt and the other evaporites has focussed almost exclusively on the processing of the product once extracted, and this is dominated by work on salt works, largely the earlier Roman to medieval sites (Fielding & Fielding 2006). It has to be noted, however, that investigation of rock salt mining in Cheshire is severely hampered by the subsidence and flooding that attended abandonment of the mines. For example, the Adelaide Mine opposite the Lion Salt Works, and the last to work in the Northwich area, is now represented by an extensive area of water infilling the surface subsidence area.. The emphasis has been on the history and archaeology of brine processing, be it from brine springs, brine pumping or as the result of rock salt extraction. Such a site at Upwich in Worcestershire, a multi-period site from Roman through to medieval, was investigated in detail in the late 1990s (Hurst 1997). Similar work has been carried out in Cheshire where two medieval ‘salt houses’ were investigated at Nantwich (McNeil nd).

Although no salt mines are listed in the National Record of the Historic Environment (NRHE) there has been extensive research carried out to identify the location of all known workings in Cheshire. The ‘survey of abandoned salt mine workings and brine shafts in Cheshire’ (Wharmby 1987) was driven by the need to identify all abandoned workings with a view to mitigating the associated subsidence risks. Since that date there has been extensive remedial work, particularly in urban areas, and access to abandoned underground working for archaeological purposes is highly unlikely. The survey does, however, provide a useful gazetteer of sites should the opportunity for surface investigation arise. Whittaker (1970) noted the existence of remnants of the Puriton salt works in Somerset, and Landless (1979) provided a plan of the Preesall salt mine site, and noted ‘widespread and obvious’ surface remains.
Archaeological interest in alabaster arises primarily from its use in ecclesiastical sculpture from the 14th century onwards. The product and its distribution have been researched at length by a number of scholars, more recently by Cheetham (1984, 2001 & 2003). Attempts have been made to link sculptures to particular geological sources of alabaster but with only limited success (Cheetham 1984, 13, citing Beasley 1978). Finds of tools and other evidence for the early extraction of alabaster from quarries in the Chellaston area of Derbyshire and at Tutbury in Staffordshire have attracted comment from time to time (Cheetham 1984, 12) but with little, if any, archaeological follow up. Similarly, stabilisation work on abandoned gypsum mine workings in advance of the construction of the Derby southern by-pass does not appear to have been accompanied by any archaeological investigation (Cooper & Saunders 2002). A number of gypsum mines in Cumbria, East Sussex and the East Midlands were listed in the Monument Protection Plan (MPP) Step 3 report for Lime and Plaster. At least one site, Brickyard Plantation, Aston upon Trent, has been the subject of archaeological assessment (Elliott et al 1995) and the Acorn Bank Gypsum Works at Temple Sowerby in Cumbria has been surveyed and is listed in the National Trust HER (National Trust ENA1387) but it is not clear if that survey included the extraction site itself (Maxwell 1997). There are currently eight gypsum mines listed in the National Record of the Historic Environment (NRHE). The extraction of potash and salt were included in the Historic Seascape Characterisation for parts of Co. Durham, Teesside and east Yorkshire (Baker et al 2007, 83-85).

Tyler (2000) provides a comprehensive social history of gypsum and anhydrite mining in Cumbria, albeit unreferenced, and includes some sketch plans for sites which can be interpreted in the future. Otherwise there has not been much interest in recording and interpreting the remains of the industries in Cumbria. Further south, in the East Midlands, there has been interest over a long period. Evidence for gypsum working in Derbyshire was examined by Sarjeant in the 1960s (1962 and 1963), and Firman (1984; 1989a and 1989b) has documented and attempted to interpret a number of alabaster working sites in the East Midlands from a geological perspective. The work of the latter provides an insight into the archaeological potential for the quarrying of alabaster and, along with Barnes, the mining of gypsum in Nottinghamshire (Barnes & Firman 1991). The Fauld Mine in Staffordshire has also attracted interest if only for the fact that it was partially destroyed in the largest explosion on British soil whilst being used as storage for high explosives during the Second World War (Waltham 2001; McCamley 2004, 77-139). The surviving features of the Hawton Gypsum Mill, near Newark in Nottinghamshire, were surveyed for Nottinghamshire County Council archaeology service by Structural Perspectives Ltd in 2000 and provided the basis for a detailed assessment of the grinding processes used on that site (Fitzgerald 2011).

Overall, there has been little archaeological investigation of the extractive processes for salt and the other evaporites.

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Sources

Primary Sources

National Archives (TNA: PRO), Board of Trade papers -

BT 356/10262 - Upgang, Whitby, Yorkshire; laying of pipelines by ICI

BT 356/10263 - Upgang, Whitby, Yorkshire; laying of pipelines by ICI

National Trust ENA1387 - Survey of Gypsum Works, Acorn bank