THE OCCURRENCE OF HALLOYSITE IN DERBYSHIRE

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ABSTRACT

The occurrence of metahalloysite 'nodules' in the silica sand pocket deposits near Brassington, Derbyshire, is recorded for the first time. The geological surroundings are briefly described in an attempt to arrive at an explanation of the genesis of the 'nodules.' The history of attempts to work the deposits as china clay in the 18th century is included.

INTRODUCTION

In 1811 Farey recorded in his list of lead mines in Derbyshire four lead mines near Brassington with either china clay or steatite, thus:

Baldmare, in Brassington, in 3rd toadstone, lead, white ore, ore in toadstone, Gravel.
Ochre, china clay, Gravel.
Green-Linnet, W. of Brassington, in 4th lime, lead, green ore, china clay.
Suckstone, in Brassington, in 4th lime, lead, steatite, china clay.
Upperfield, in Brassington W, in 4th lime, lead, green ore, china clay.

Owing to the exact location of these mines being hitherto unknown and the well-known occurrence of off-white silica sands and fire clays in pocket deposits in the neighborhood, these notes of Farey's have been overlooked. Recently, however, patches of a snow-white clay have been found in Kirkham's and Spencer's sand pits, ¾ mile west of Brassington. As a result of careful local enquiry, largely by Miss Nellie Kirkham (no relation to the pit owners), it is now believed possible to locate these mines. They are all close together. The site of Baldmare Mine is thought to be where Kirkham's sand pit is now and Upperfield Mine was probably close to the present Overfields Barn (see Fig. 1 for localities which are all on 6"1 mile O.S. Sheet SK25SW). The white clay mineral is believed to be that referred to by Farey as china clay or steatite and it has been identified as halloysite, variety metahalloysite, which does not appear to have been recorded previously in Derbyshire. This paper accordingly records the occurrence, the X-ray identification, the history so far as it is known, and makes suggestions about the origin of this unusual deposit.

IDENTIFICATION

The halloysite occurs in two forms (cf. Ross and Kerr, 1935)—a hard waxy white to cream form in pieces up to an inch across, which are enclosed by a soft white powdery form. The two occur together
in nodules commonly a foot in diameter. Both have been identified as the less hydrated form of halloysite, metahalloysite, from X-ray powder photographs (obtained with Cu Ka radiation) which gave lines at:

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<th>d(Å)</th>
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<tr>
<td>7.66</td>
<td>7b</td>
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<tr>
<td>4.41</td>
<td>10</td>
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<tr>
<td>3.58</td>
<td>4</td>
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<td>2.56</td>
<td>4</td>
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<td>2.51</td>
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<td>2.35</td>
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<th>d(Å)</th>
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<td>1.89</td>
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<td>1.84</td>
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<td>1.47</td>
<td>6</td>
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<td>1.28</td>
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<td>1.24</td>
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This pattern agrees well with that in the A.S.T.M. card index and with the figures of Brindley and Robinson (1948) except in the presence here of weak lines at 1.89Å and 1.84Å. The line at 3.97Å observed by Ross and Kerr (1935) for the original material from Liége is not present, nor does it seem to be listed in the A.S.T.M. index. With the same duration of exposure the powdery form gave a much less intense photograph, but showed the same lines.

The identification has been confirmed independently by T. Deans of the Overseas Geological Surveys.

**Occurrence**

The localities at which the halloysite herein described is found are ¼ mile west of Brassington at Kirkham’s sand pits (National Grid...
Reference SK/218541) and at the adjacent Spencer's sand pit (SK/214542), also at Stevenson's spar workings on Gallows Knoll, by Hopton crossroads (SK/263545). Yorke (1961) has also noted occurrences of nodules or bands of white clay in the Brassington (Harborough Rocks) pits, though, as the writer has never seen halloysite nodules there in spite of many visits, it is uncertain whether the same clay is being considered by Yorke. Apparently similar references in the Geological Survey's Mineral Resources Memoirs VI and XIV (Howe, 1919, 1920) seem to refer to the sedimentary off-white clay found in large quantities, and not to halloysite.

The exposures at Kirkham's sand pits are the best at present. The two pits are separated only by a narrow wall of the country rock which is dolomitized Carboniferous limestone. Both are worked to a depth of about 30 feet for white sand for refractory purposes. The overburden is very variable, from little more than the turf and a few inches of black soil, to masses of red clay plunging almost to the floor of the pits. True boulder clay is absent, but a few erratics are present in the soil, including blocks of fresh dolerite. Scattered quartzite pebbles of Bunter type are present in the soil and in both sand and red clay. The red clay is compact and very much cut by slickensided shear planes: indeed its boundary with the unconsolidated sand is at times suggestive of downward intrusion under pressure. Some parts of the red clay contain limonitic box-stones and patches of wad. It is in the shear planes and amongst the patches of wad that the halloysite nodules are found, conspicuous by their whiteness against the background of red and black. The nodules are frequently crusted with an inch or so of wad, and some appear to be elongated along the shear planes. The nodules are found at all depths from just below the soil to the floor of the pit. The nearby Spencer's sand pit shows the halloysite similarly disposed in larger sheared-out masses, close to masses of wad and goethite, the latter being well developed close to the dolomite. Farey's records of occurrence in mines suggest that the halloysite deposits may extend deeper.

The third occurrence, near Hopton crossroads, has only been seen in a trial hole so far. This is within a confused area of ground where the tips from old open lead workings have recently been bull-dozed back into the open cut which has walls of dolomitized limestone. Immediately south of the old workings Mr. Stevenson has opened a small pit (6 feet deep at the time of writing) and has obtained baryte nodules of an unusual spongy appearance, quite unlike the usual Derbyshire caulk, from within a sand pocket—this is the first undoubted record of any of the vein minerals being found actually within the silica-sand deposits. The trial hole with halloysite is some 3 feet wide and 1 foot deep and is only 3 yards from the nearest point of the baryte working. The halloysite appears to be enclosed in a mixture of wad and red or buff clay. Some of the halloysite closest to the wad was light blue in colour.
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**ORIGIN**

Halloysite has generally been found to be of supergene occurrence, and in many cases has been found in associations where sulphuric acid derived from the weathering of pyritiferous shales has acted on the aluminous matter present (see Ross and Kerr, 1935; Grim, 1953; Deer, Howie and Zussman, 1962). Bates (1962) has also observed halloysite as a tropical weathering product of basalt in Hawaii, and Eyles (1952) has noted metahalloysite as a common constituent of laterites in Antrim.

As the circumstances of the present find still leave the origin obscure, only the salient features will be noted here. Pyritiferous sediments or vein materials are not present in the immediate vicinity, i.e. in the sand pits, nor is basalt despite Farey’s record of toadstone at Baldmare Mine, which appears to be due to a misconception then current that the sands and clays of the pocket deposits were all decomposed toadstone. It is remotely possible that some of the red clays represent relics of a lateritic soil developed from residuals of basalts in the former cover of limestones which has been eroded away—if the basalts extended over this area. There are no thick shales in the vicinity though there was almost certainly once a cover of Millstone Grit over the Derbyshire limestone massif. With these negative observations, only the limestone itself, dolomitized or not, with the numerous lead-baryte-calcite veins, or the pocket deposits remain. It is difficult to see how a clay mineral could have been derived from limestone or dolomite, but it is notable that amongst the mineral-vein deposits of Derbyshire this part is particularly noted for white ore (cerussite) and, to a lesser extent, calamine. It is possible, then, that oxidation of these has provided the sulphuric acid. No undoubted primary veins have ever been found in the pocket deposits (the baryte noted above must be secondary or residual) but cerussite has been found in the tops of veins in close proximity to the sand pockets, e.g. Baldmare Mine above.

The sands of the pocket deposits which lie in large solution hollows have been recorded as often having a pellicle of kaolinite around each grain. Thus it is suggested that the origin of the halloysite may have been in the leaching of this kaolinite pellicle and its alteration by sulphurous ground waters derived from the weathering of the sulphide ores.

The date of this reaction is uncertain since the age of the pocket deposits is not yet known with certainty. Although often referred to as Trias there are difficulties in accepting this and a later date of formation by redeposition of derived Triassic and some Millstone Grit material is more likely. In another pit, at Friden, Derbyshire, wood (Yorke, 1961) and pollen (Shotton, private communication) have been found in the highest sub-drift clays and suggest a late Tertiary or early Pleistocene date. Thus the origin of the halloysite could have been in the Pleistocene.

It may be noted that Berthier’s (1826) original description of halloysite from a now unknown locality at Angleur, near Liège, in
Belgium, was in solution cavities with alteration products (unspecified) in Carboniferous Limestone, close to zinc and iron veins, and not far from the Tertiary unconformity. Although Berthier's description of the locality is very vague and brief it may be that the present occurrence is a close analogue of the original.

**History**

Josiah Wedgwood, of pottery fame, recorded in his commonplace book *ca.* 1775, that Mr. Gell of Hopton had found a fine white clay near Brassington. After tests Wedgwood rejected it in favour of Cornish clay. This may or may not refer to the halloysite, but it is notable that the next year (1776) William Duesbury, founder of the Crown Derby China works in Derby, acquired an interest in Suckstones Mine at Brassington. Apparently by using the old lead mining laws he obtained possession of 24 meres of vein ranging north-south with a branch to the east (a mere is 29 yards in this area). This vein cannot now be located accurately but the north-south line of workings shown on Fig. 1 may be the vein in question. Unfortunately, although the deed to the mine still exists (Barrett, in 1955, gave a transcription of Duesbury's deed) there is no record of what, if anything, was worked, and it seems likely that Duesbury bought the mine hoping it had struck a rich deposit of china clay but was unlucky. Duesbury also acquired an interest in the Innocent Mine at Carsington (SK/250539) which is also in an area of sand pits and oxidized mineral veins, but the tips are grassed over and it is not known whether halloysite occurs there. The only other references appear to be based on Farey, or Pilkington (1789) who referred to "porcelain clay of a most delicate white colour and a very fine texture from a lead mine near Brassington. Some years ago a small quantity was used at the porcelain works at Derby. What is gotten at present is sent to the potteries in Staffordshire."

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**References**

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