A QUARTZ-ROCK-FILLED SINK-HOLE ON THE CARBONIFEROUS LIMESTONE NEAR CASTLETON, DERBYSHIRE

by

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Summary

Recent excavations west of Castleton have revealed a sink-hole filled with boulders of quartz-rock and covered by loessic soil. Its significance, in relation to the former extent of quartz-rock in the limestone and to the Pleistocene history of the area, is discussed.

Introduction

Recent opencast workings for baryte in and around the Old Wham Vein, near the site of the Portway Mines, about 1½ miles south-west of Castleton, Derbyshire (National Grid Reference SK 128811) have uncovered an outlier of quartz rock in a depression in the Carboniferous Limestone surface. The site is marked on the Ordnance Survey 6 inches to 1 mile map SK 18 SW as "Gravel Pits". No gravel in the geological sense of the term is present, but in Derbyshire lead-mining literature "gravel" refers to ore in loose lumps; this could still be applied to the scattered lumps of galena-bearing baryte recently worked by excavator methods.

The discovery of this outlier of quartz rock and of associated boulders throws some new light on the former extent of the Pindale quartz rock of Arnold-Bemrose (1898), and also has important implications in the interpretation of Pleistocene denudational history.

The Portway Outlier

The most obvious feature of the present exposure is the large number of blocks of a light buff coloured quartz rock lying about the spoil-heaps of the baryte workings. Many of the blocks are a foot or more in diameter; some show what appear at first to be bedding laminae about an inch apart. The laminae are of varying grain-size, but do not show any sedimentary structures. Some of the coarser grained layers show small cavities, a few of which are recognizable as casts of crinoid ossicles and other fossil fragments now dissolved away. Only one short section of the quartz rock has been seen in situ, in the present northern face of the baryte workings. This is a layer about a foot thick lying almost horizontally, with its

ends near to more or less vertical walls of limestone. Although some movement has taken place due to the baryte workings, it seems clear that the layer formed part of the infilling of a cavity in the limestone surface. The rest of the fill seems to be a jumble of blocks of quartz rock, blocks of baryte, a little chert, and limestone altered to a "rottenstone" condition, all in a matrix of ochreous silty clay.

The dimensions of the infilled cavity are impossible to state in the present nature of the exposures, but it appears to have been of the order of 100 feet in diameter, and at least 12 feet deep (the depth of the baryte workings). The presence of vertical limestone walls indicates that it is some form of solution cavity into which the quartz-rock fill has subsided. Where the walls are now exposed in the workings they show a "skin" of rottenstone, which is rapidly weathering away. This "skin" is largely composed of quartz needles.

Among the scattered blocks are three variations deserving comment. The first has clearly been formed enclosing colonial Rugose corals of Lithostrotion type. These are preserved as tubular casts showing little more than the peripheral parts of the septa, so that specific identification is not possible; from their size and general appearance they would be close to L. martini. The second variety is quartz-rock with small cavities lined with amber fluorite cubes, suggesting that the quartz rock originated before at least part of the mineralization process. The third variety is quartz-rock with joints lined with goethite pseudomorphing marcasite. The significance of this last mineral is uncertain, as it is not normally present in the Derbyshire mineral veins. It may indicate the former proximity of the unconformable Edale Shale cover.

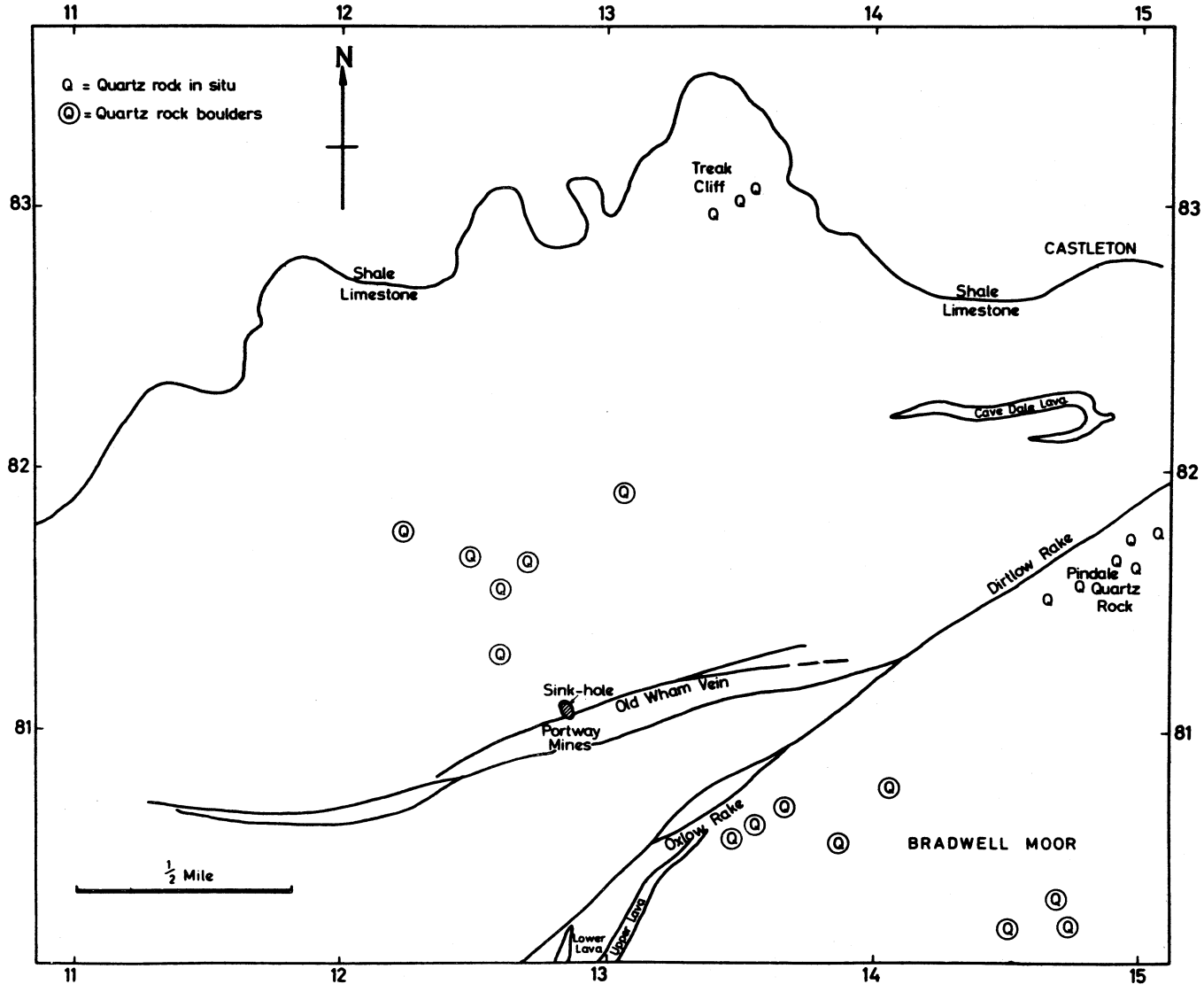
The mineral deposits which have been worked here, firstly for galena and more recently for baryte, are around the Old Wham vein, a branch of the Dirtlow Rake running WSW from Hazard Mine and lying north of Oxlow Rake. Baryte occurs typically in clusters of radiating white bladed crystals up to 3 inches long, with crusts of rather smaller crystals, and with scattered bands of galena crystals. The clusters are usually now found loose, but occasionally can be seen to have developed on what is now a rottenstone, or decalcified quartzose limestone. They are but rarely seen on the quartz rock, or in association with fluorite. Rare deeply-corroded scalenohedra of calcite have been found loose.

In thin section, the quartz-rock at Portway mines is seen to be a mesh of elongate interlocking quartz crystals identical with that described from Pindale by Arnold-Bemrose in 1898. A little fluorite baryte and a very little opaque carbonaceous material, are present interstitially.

The upper part of the working faces shows a soil profile some 3 feet thick, covering limestone and quartz rock alike. At the base of this profile is a layer of boulders of limestone, quartz rock and rare chert, up to about 6 inches in thickness. Above this the bulk of the profile is a layer of ochreous silty clay, which appears to be identical with that described by Pigott (1962) as of partly loessic origin and of Pleistocene age.

The ground surface rises gently from the outlier in both northerly and southerly directions. To the north the ground then drops away steeply towards the limestone-shale boundary, rather more than a mile away. The higher parts of the intervening hill have scattered outcrops of bare limestone suggesting, that if it ever had a cover of loessic soil, this has since been eroded. On this surface there occur occasional blocks of quartz rock, up to 3 feet in length. Some have been utilized in wall building.

Arnold-Bemrose (1898, pp. 176-178) recorded similar scattered blocks of quartz rock to the south of Oxlow Rake (approximately SK 135807) and around Bathamgate and Moss Rake on Bradwell Moor (about SK 1580). These localities have been revisited and the occurrence of the blocks is essentially similar to those north of the Portway outlier.



Text-fig. 1. Location map showing the position of the Portway outlier, the Pindale Quartz Rock and the scattered Quartz-rock boulders, to the south-west of Castleton.

The Quartz-Rock and Mineralization

As was hinted by Arnold-Bemrose (1898), the quartz rock appears to be an authigenic replacement of limestone associated with mineralization in the Dirtlow Rake-Pindale area, a mile to the east of Portway Mines. A fact not previously recorded is that the quart-rock is clearly cut off by faulting along Dirtlow Rake (SK 151819) showing that the replacement of the limestone took place before the faulting and infilling of the vein there. The Portway outlier is situated on the Old Wham Vein, which is a branch of Dirtlow Rake. The present exposures show little of the walls of the Old Wham vein, but the visible outcrops are not silicified. The main part of the Portway outlier is a few yards off the line of the vein, to the north, and (as described above) the quartz-rock is apparently part of a sink-hole fill, indicating a former cover of quartz rock over this area. The scatter of residual blocks on the hill to the north, and on Bradwell Moor, suggests a very much wider extent of the quartz rock than has previously been recognized. The Portway outlier thus shows again that the quartz rock is older than mineralization, and it also shows that baryte and some fluorite mineralization occurred outside the actual vein, probably as some form of "flat" deposit. The outlier throws no light on the source of the mineralizing fluids or on their direction of flow.

The Quartz Rock as a Stratigraphical Horizon

"Where the (Upper) lava does not outcrop its place is taken by silica blocks" - so said Shirley & Horsfield (1940, p. 276), implying a genetic effect between lava extrusion and the formation of the silica rock above Pindale and thus using the silic rock as an equivalent stratigraphic horizon. The Portway outlier occurs in limestone of D_1 age somewhat above the Cyrtina septosa horizon, i.e. at about the level of the Lower Lava. This does not outcrop in the vicinity (the nearest occurrence is about $\frac{1}{2}$ mile to the south beyond the Oxlow Rake), nor is it known from mine shafts or debris. It is doubtful whether the Upper Lava did extend over this area; if it did, the solution subsidence of the Portway outlier may have let down the quartz rock to its present position. The scattered blocks to the north are in a similar stratigraphic position, but those on Bradwell Moor are at a much higher stratigraphic horizon, far above the Upper Lava, in the D_2 beds. These are known to have scattered way-boards of tuff - now usually in the condition of the clay.

Other occurrences of quartz rock in Derbyshire are around Bonsall (Arnold-Bemrose, 1898) where there are several lavas and tuffs nearby, and in Gratton Dale (SK 202600), again where there is the Gratton Dale lava nearby.

The correlation of these latter lavas has been discussed by Shirley (1959) and, whilst they are all in upper D_1 or lower D_2, the lavas cannot be used as stratigraphic markers from one area to another. The quartz rock is thus seen to be associated with lavas or tuffs at different horizons; whilst it may be used as a field indication of the presence of a lava in the vicinity, it is dangerous to use quartz rock as a stratigraphic marker.

The Portway Outlier in the Pleistocene

The sink-hole outlier of quartz rock described above is in a comparable topographic position to the better-known Pocket Deposits at the southern end of the Derbyshire Limestone massif (Yorke 1961, Ford 1966 - in press), but there the resemblance ends. The Portway sink-hole is not in dolomite, nor does it contain the refractory sands and clays of the typical pocket deposits. These latter have been assigned to a Tertiary age, (Ford 1966a) and are clearly overlain by Pleistocene till.

The Portway sink-hole overlies the presumed course of the Perryfoot - Castleton underground drainage (Ford and King 1966) and it seems likely that it originated at least in part by solution collapse of a vein cavern in the Old Wham vein.

The fill of the sink-hole, as has been outlined above, is composed of blocks of quartz rock and vein minerals as solution residuals; it is covered by the silty loam soil claimed to be partly loessic origin in one of the early glacial phases (Pigott 1962). No till and no erratics have been found. The residual blocks on the hill to the north, and those on Bradwell Moor, are all of quartz rock; no erratics have been found.

In view of the occurrences of till with erratics of north-western origin (Lake District and Western Highlands) in the Bakewell and Stoney Middleton areas, in Monsal Dale, above Tunstead Quarry in Great Rocks Dale, and on the site of the Derwent Dam (Dale 1900; Jowett & Charlesworth 1929; Dalton 1945, 1953; Fearnsides 1932; Straw & Lewis 1962) the question arises as to whether the Portway outlier is evidence of an unglaciated enclave in the Castleton area. The outlier and particularly the residual blocks on the hill to the north are clear evidence of solutional weathering of the limestone, both on the surface and underground. This occurred both before and since the accumulation of the loessic soil, and it is precisely in such situations where erratics could be expected to occur. The occurrence of till between Doveholes and Bakewell (see Dalton 1945, fig. 1, for a map of the probable direction of flow of the Doveholes ice-tongue) strongly suggests the former existence of a glacier passing down the Wye valley, but in the vicinity of the Portway outlier there is no evidence of either ice erosion or of the introduction of erratics by melt-water streams. This suggests that the Portway outlier was not covered by active streaming ice and may even have been an unglaciated enclave.

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