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Notes on the mineral deposits of the Teign valley, Devon.

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RESEARCH into the history of the old mines suggests that two mineralized fissuring systems intersect in central Devon, often carrying commercial ore-bodies. The older of these is the east–west system usually carrying copper, iron, or tin, which has been extensively worked in west Devon, but is less developed on the eastern flank of the Dartmoor granite massif.

The younger north–south series, characterized by its lead and silver ores and baryte is particularly well developed in the Teign valley. This band of mineralization can be traced from the north of Scotland through Brittany and Spain to Algeria. In Devon it appears to be divided into three main fissure bands:

1. Combe Martin to Plymouth.
2. North Molton to Spreyton, with a possible extension south of the Dartmoor granite.
3. Molland to Newton St. Cyres and the Teign valley.

There appear to be other similar bands farther east, now buried under Mesozoic rocks:

4. Watchet to Sidmouth: baryte has been found at Watchet (specimen in the Taunton Museum); sandstone cemented with baryte at Langley near Wiveliscombe;[1] baryte in cavities in the Carboniferous Limestone quarries at Burlescombe;[2] sandstone cemented with celestine at Sidmouth.[3]
5. Mendips to Lyme Regis: baryte at Cannington Park;[4] sandstone cemented by baryte in bore at Lyme Regis.[3]

Plotting the sites of former mining activities shows that these coincide in a most interesting way with the intersections of the north–south and east–west fissure systems.

Superimposed on these two systems is a third which can be traced almost continuously round the Dartmoor granite for a distance of about a mile from the edge of the latter. Presumably it was caused by the contraction of the granite mass as it cooled. At many places it coincides with the other two systems and is strongly mineralized.

The deposition of barium sulphate.—To understand the mineralization of the

[1] Mem. Geol. Survey, Quantock Hills, 1908, Sheet 295.

[2] W. Downes, Trans. Devon Assoc., 1883, vol. 15, p. 453.

[3] Mem. Geol. Survey, Sidmouth and Lyme Regis, 1911, Sheets 326 & 340.

[4] Mem. Geol. Survey, Spec. Rep. Min. Res., 1922, vol. 2, 3rd edit., p. 95. F. S. Wallis, Geol. Mag., 1924, vol. 61, p. 218. [M.A. 2–464.]

north–south vein system, the writer has endeavoured to collect all available information on the probable processes which caused these deposits. While the deposition of galena and pyrite has been fully described,[1] that of baryte has not been so well dealt with. Von Engelhardt[2] has brought to bear on this question the great advances of chemical knowledge of the last four decades. He shows that, the barium atom being closely similar in size to that of potassium, in a cooling magma the barium silicates will crystallize out as felspars (celsian or hyalophane) slightly earlier than the potash-felspars, but that mixed crystals will generally be formed. The practical application of this is that barium deposits may be expected in the neighbourhood of granite or syenite. Barium-micas also crystallize out from the cooling magma.

Both barium-felspars and micas are easily decomposed by rain water charged with carbon dioxide, the barium being taken into solution as a soluble bicarbonate. These solutions, as they flow away into rivers, will meet sulphate ions from the decomposition of pyrite, but the precipitation of the barium sulphate will be hindered by other ions present, and will only take place when the colloidal attraction of the fine muds, being deposited far out at sea, provides the necessary conditions for it to be completed.

Such a process, however, hardly accounts for the large masses of baryte found in fissure veins. In these cases the most probable explanation, which I owe to Dr. K. C. Dunham, is that the sulphate radical was also evolved from the cooling magma, and that the barium sulphate came up as a colloidal solution of high concentration. This would fit in with the ideas put forward by Spurr,[3] and with the fact that large blocks of wall-rock (sp. gr. 2·25) are found entirely unsupported in the massive baryte (sp. gr. 4·0) in the Teign valley mines. Their weight seems to have been entirely supported by their buoyancy in the ascending ore solution, and there is some evidence that they may have even been carried upwards by the rising currents. Baryte seems to have been deposited in the highest parts of the existing fault fissures, which were probably further opened by the pressure of the rising solution and later by the forces generated by the crystallization of the solid ore.

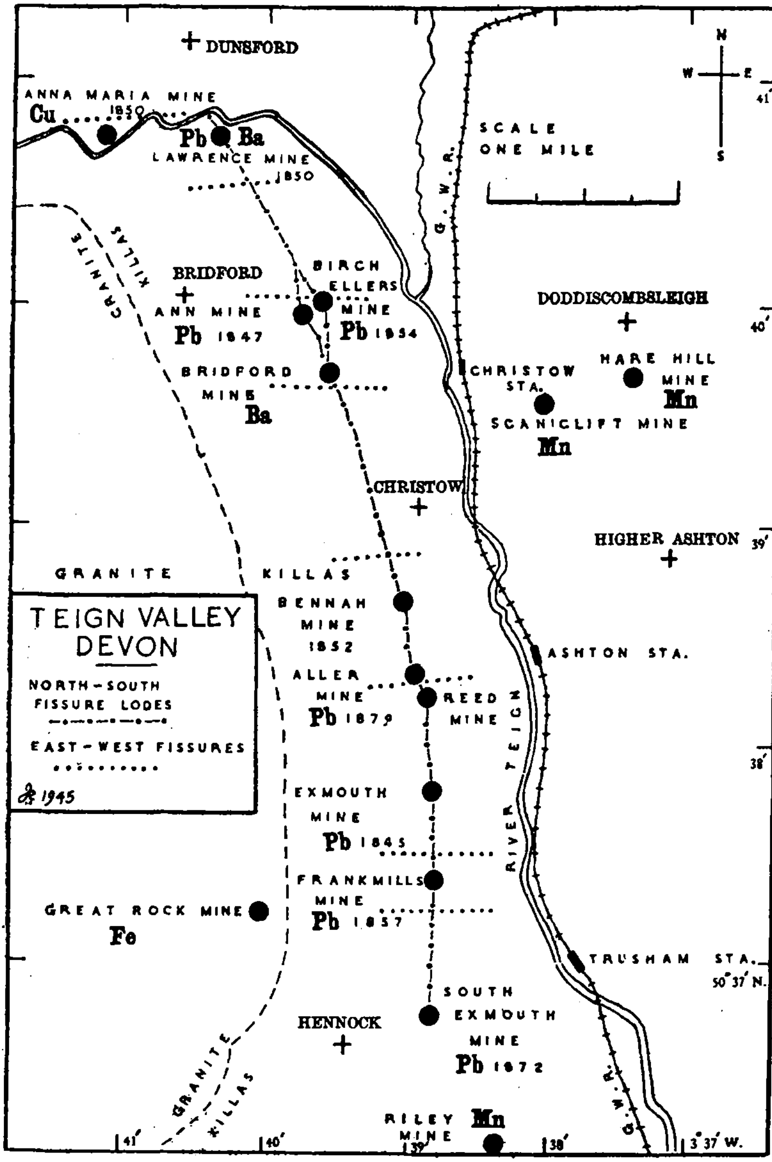
The baryte of the veins is mostly microcrystalline, but in many places platy crystals of some size have developed suggesting that at these spots there was less disturbance of the solution. In the higher parts of the veins there was much botryoidal baryte in spherical masses of large diameter. These showed concentric bands of metallic sulphides arranged as Liesegang rings. Apparently as the barium sulphate crystallized out of the colloidal solution, the concentration of the metallic sulphides increased till a point was reached when they in their turn started to crystallize out till their concentration was so diminished that the barium sulphate could again crystallize out unhindered.

Lead.—It is unfortunate that there is little detailed information of the manner in which the galena occurred in the lead mines of the Teign valley. In the Bridford mine pieces of any appreciable size are rare, the lead ore extracted when the mine was being worked in the early fifties of last century

[1] F. W. Clarke, Data of geochemistry, 3rd edit., Bull. U.S. Geol. Survey, 1916, no. 616, pp. 537–539 and 579–581.

[2] W. von Engelhardt, Die Geochemie des Barium. Chemie der Erde, 1936, vol. 10, pp. 187–246. [M.A., 6–296.]

[3] J. E. Spurr, The ore magmas. New York, 1923.



seems to have been as small crystals in pockets between the wall-rock and the baryte veins. Judging from specimens found on the dumps, at Frankmills and Exmouth mines, one vein had a silica gangue, in which the galena was in more solid form, and occasionally in veins six inches wide. The galena was argentiferous, some 37,000 tons of lead ore having produced 250,000 ounces of silver between 1845 and 1880.

Blende.—This is constantly found as small disseminated crystals in the

Bridford baryte veins, but so far the quantities present have no commercial significance.

Strontium.—The baryte of this district contains a small percentage, probably up to 2 %, of the isomorphous strontium sulphate.

Micaceous iron-ores.—Farther south in the Teign valley, as part of the east-west system, lie the specular iron-ore deposits of the Great Rock and Kelly mines.[1] The ore is presumably of pneumatolytic origin as the granite wall-rocks are heavily tourmalinized.[2] These east–west iron-ore veins are fairly frequent along the eastern flank of the Dartmoor granite, and in the Bovey Tracey to Moreton Hampstead valley they occasionally carry cassiterite or rutile. Clarke (loc. cit.) fully discusses the geochemistry of the formation of haematite.

Manganese deposits.—These deposits from near Doddiscombsleigh to Ashton on the east bank of the Teign, and farther south at Riley and Huish Cross on the west bank, are particularly interesting as they have their counterpart on the west side of the Dartmoor massif, near Brentor and Chillaton. The well-known Huxham, Upton Pyne, and Newton St. Cyres deposits are in a vein which obviously belongs to the east–west fissure system. It would seem that the manganese has been derived from ferromanganese silicates by solution as bicarbonate, and then deposited with much of the silica dissolved from the same source, as bodies of manganese ores are associated with massive chert.

The killas shale wall-rock.—The fissures in the Teign valley are usually inclined within some 10° of the vertical. The walls show slickensides, but so far there has been no means of measuring the actual displacement of these fissure faults. The general impression is that the displacement was only a few feet. The killas shales which form the wall-rocks of the Teign valley veins are little more than mudstones with some disseminated grains of pyrite. This pyrite in the presence of damp air easily oxidizes, breaking up the shale into mud, which causes much difficulty in maintaining underground passages. It may well be that at the time of mineralization, the rocks were permeated with water vapour and partially decomposed, making a weak, almost viscous medium into which the ascending solutions could easily expand and form wide ore-deposits.

[1] F. B. Michell, Mine and Quarry Engineering, January 1945.
[2] Mem. Geol. Survey, Spec. Rep. Min. Res., 1919, vol. 9, p. 47.