On the occurrence of silver ore in the Perran mine, Perran Uthnoe, Cornwall.

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THE deposit known as the Wheal Sedgman lode is inclined to the west a few degrees from the vertical, and runs in a direction about 10° W. of N. (magnetic) through the parish of Perran Uthnoe, near Marazion, Cornwall. In its course seawards from the approximately E. and W. lode formerly worked in the Great Wheal Neptune mine, it traverses the North and South Trebarvah tin and copper lodes. It is crossed by the shore-line on Perran Sands, about 500 yards to the west of Trevean cliff. Between that spot and Cuddan Point, to the S.E., where it is again laid bare, it has been superficially removed by marine denudation. The numerous N. and S. diabase dikes of the district show in places much disseminated pyrrhotite, and one of them runs nearly parallel to the east side, or foot wall, of the Sedgman lode. The bed-rock of the district is a pyritous bluish killas, which, where it forms the 'country', or walls adjoining the lode, is finely laminated and very variable in hardness, being occasionally represented at its junction with the lode by a clay. In breadth the Sedgman lode varies from 6 feet to 18 inches. In the northern part it consists of a series of roughly parallel bands of quartz and chalybite. The quartz is crystalline and of a pure white, and carries a little bright mispickel, with blende, pyrite, and chalcopyrite. The chalybite is externally pale buff and internally nearly white, and contains some cavities enlarged by aqueous erosion without oxidation and others lined with lenticular crystals of the same mineral. This spathic and wide portion of the lode is practically non-argentiferous, the chalybite containing only half an ounce of silver to the ton: the invariable experience, as Mr. G. D. McGrigor informs me, is that where there is chalybite, there is no silver ore. The Sedgman lode within 200 yards to the south of the Great Wheal Neptune deposit consists of more or less argentiferous, friable, and ochreous or harder, chocolate-coloured, and quartzose

limonite with parallel seams of ferruginous, highly compact, splintery quartz, which passes into crystalline quartz only in the less argentiferous parts of the lode. This quartz (locally called the 'cab-course') is found to be best developed where the limonite is richest in cerargyrite, the prevalent silver ore, although this mineral has only once been observed implanted on hard quartz.

The amount of silver obtained in driving on the course of the lode to a depth as yet not exceeding 18 fathoms has varied from over 11,000 to as little as 2 ounces to the ton of limonitic ore. In proportion as the workings have been carried south, the richest ore has been discovered progressively deeper; i. e. the line of most complete silverization, or secondary enrichment, of the original lode corresponds roughly to that of the contour or shoreward trend of the overlying land. This fact illustrates the remark of the late J. G. Goodchild[1] that, speaking generally, one may say that around certain points where the occurrence of ore in any given set of veins reaches a maximum elevation above the sea, the upper limit of occurrence of the ore in the several veins falls successively to lower and lower levels in proportion to their distance from those highest points. He further makes the interesting observation, in dealing with the North of England lead-veins, that 'the parallelism between the deep-seated phenomena and the surface features points to former variation in the downward increment of temperature connected with the shape of the ground when the veins were formed'.

In the Sedgman lode it is the lower and more friable, or gossany, limonite that has proved the more argentiferous. Another noteworthy fact is that the deposition of hornsilver has been greatest at irregular intervals along oblique lines having a sharp slope seawards. In consequence, within a few feet in depth, the richer ore may appear on opposite sides of a narrow shaft.

Besides cerargyrite, no other silver ores have so far (March 1907) been found in the Perran mine, save a little galena, a few ounces of massive argentite, forming a nucleus of the ordinary lode-stuff, and a small specimen of wire-like native metal. The cerargyrite occurs either intimately mixed with the limonite and crystallized in usually much distorted small cubes and cubo-octahedra upon its free surfaces or in malleable and sectile masses from an ounce or two to several pounds in weight. Of numerous analysed examples of the cerargyrite not one has yielded more than traces of bromine.

[1] J. G. Goodchild, 'Some observations upon the mode of occurrence and the genesis of metalliferous deposits.' Proc. Geol. Assoc., 1889, vol. xi, pp. 45–69.

Visible cassiterite has been come upon twice in the working of the lode, and the refuse from the dressing of the ore has been found to contain about 0·1 per cent. of 'black tin'. There is evidence also that the ore contains some 5 grains of gold to the ton.

History of the Lode.—On examination of the lode and of hand-specimens therefrom it becomes patent that, as with Cornish mineral-veins in general, siliceous solutions were largely concerned both in the production of the original Perran deposit, and in bringing about modifications therein. What such solutions can effect is well exemplified in various districts in the west of England, e.g., in the production of the greisen of the Bunney mine and of the Rock Hill clay-pit, in St. Austell parish, of Kit Hill, and of Cligga Head. There broad or narrow courses of granite in the direction of planes of fracture have been first kaolinized and then deprived of their kaolin and furnished with fresh quartz, varying quantities of secondary mica, commonly much schorl, cassiterite crystals, and occasionally fluor. In the northern part of the Sedgman lode, the alternation of bands of chalybite and quartz, the presence of slickensides one behind another, and the inclusion in the chalybite of fragments of brecciated killas testify that the original fissure was enlarged and gradually filled during a succession of earth-movements. The normal tints of the chalybite and quartz here found and the unmodified condition of their disseminated mineral contents indicate that any lode-water that may have reached them after deposition was free from oxidizing agents. The blueness of the neighbouring killas points to the same conclusion.

The fissure having been occupied by chalybite and quartz, the chalybite along a considerable extent of the lode, but not in the northern part, was subjected to the action of a siliceous solution that contained a limited supply of available oxygen, but was rich in silver and in chlorine, the last-named element possibly owing its presence to the access of sea-water to abyssal regions. It is interesting to note in this connexion that the multitudinous fluid-containing vesicles of the quartz of a fluor-kaolin-rock in a quarry between Nanpean and Trethosa, in Cornwall, near the Mineral Railway, mostly contain each a cube of salt besides the usual bubble. The effect of the second aqueous invasion of the Sedgman lode was largely to decarbonate, hydrate, and oxidize the chalybite in its southern portion, forming limonite, to add considerably to the quartz already there existing, and to cause the irregular deposition of silver chloride in cavities and on free surfaces. Why the lode was not similarly attacked in its whole length might be as difficult

to explain as the sporadic kaolinization of granite that is observable in some of the St. Austell clay-pits.

Since, in the alteration of chalybite to limonite, four molecules of carbon dioxide became nascent for every molecule of oxygen taken out of solution, the vein-water was rendered a powerful solvent of the residual chalybite. That it had been deprived of any available oxygen it may originally have contained is evidenced by the lack of adventitious superficial coloration of the quartz in some of the cavities in limonite from the interior of which chalybite has been removed, and also by the fresh and unaltered condition of the surface of masses of chalybite still in part occupying other of those cavities. The ultimate oxidation of ferrous carbonate dissolved out of the lode may account for much of the ferruginous staining and cementation of the rubbly and brecciated material at its out-crop.

The cassiterite of the lode is possibly of late origin in its history, and may have been derived from the source of supply of the E. and W. lodes of the district of Perran.

For free access to the Perran mine and its products during the preparation of this paper, I am indebted to the courtesy of the managing owner, Mr. G. D. McGrigor.