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ART. XI. *Description of an Ore of Copper from Cornwall.*

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AMONG the many ores of copper which have been raised from the Cornish mines, there is one which has received so little notice, that it has been mentioned only by one mineralogist, and, even in that instance, only with reference to one of its crystalline forms. It is termed by Sowerby, in his *British Mineralogy* (tab. 503, 'grey sulphuret of copper, in dodecahedral crystals.'—This mineral is by no means common, although it has been found in several mines. I possess about twenty specimens, which have enabled me to examine with attention its crystalline forms; some of which at least are not analogous to those of any other substance found in that of the rhomboidal dodecahedron; and it differs so greatly from all the other ores of copper, as to induce both my brother and myself long since to adopt the conclusion, that this mineral differs from those ores, not less in its chemical than in some of its external characters; and, therefore, that its apparent claim to the distinction of a new species ought to be investigated.

This mineral varies internally from lead-grey to iron-black. It rarely occurs massive, but is commonly crystallized in the form of the rhomboidal dodecahedron, either perfect, or variously modified; also, though rarely, in the form of the cube and octohedron, of which the edges and angles are replaced. Externally the crystals are often nearly of a tin-white colour, and very splendid; sometimes lead-grey, with but little lustre; occasionally iron-black and dull.

The fracture is imperfectly lamellar, and uneven, with the appearance (by reflection from surfaces produced by mechanical division) of natural joints, parallel to the planes of the rhomboidal dodecahedron; the lustre of the fragments varies from glistening to shining, and is metallic. Its specific gravity is 4.375.

It is harder than vitreous copper, (*cuivre sulfuré*, Haüy,) and the *fahlerz* (*cuivre gris*, Haüy,) which it readily scratches, and is brittle. Its powder is reddish-grey.

Before the blow-pipe on charcoal it first burns with a blue flame,

and slight decrepitation; to which succeed copious arsenical vapours, leaving a greyish-black scoria, which affects the magnetic needle.

I have observed twenty-seven varieties in the forms of the crystals of this substance; of these twelve are selected (plate II.) as affording a sufficient clue to the whole. The rhomboidal dodecahedron (fig. 1.) may be considered as the primary crystal; and all the twenty-seven varieties as arising from combinations of the planes, though extremely variable in shape, of four modifications, observable in figs. 2 to 7, which, except the small triangular planes of fig. 7, are all more or less common to several substances, assuming the form of the rhomboidal dodecahedron, the cube, or the regular octohedron.

The remaining five figures (8 to 12) require an observation or two. In these there is not that symmetry of form which might be expected to exist in the planes, modifying so perfect a geometrical figure as the rhomboidal dodecahedron. From the symmetrical manner in which these forms are usually delineated, we might expect that when one solid angle is replaced by a plane, the rest should be modified in the same manner, if not precisely in a similar degree; and the same with the edges;—we should at least expect to find them similarly modified, even though the degree should differ. Let us compare figure 9 with figure 5; the planes of the primary form, and those of the first, second, and third modifications are visible in both. Fig. 5 is perfectly symmetrical; while fig. 9, though symmetrical in one sense, is far removed from symmetry in the sense in which figure 5 is considered as being so: one half of the crystals is seen in each figure. In 5 six of the primitive planes are visible, in 9 only five; in 5 three planes of the first modification are seen, in 9 only one; in 5 there are four planes of the second modification, in 9 only two; in 5, ten planes of the third modification are seen, in 9 only two. It is not therefore that some planes are enlarged, so as to diminish others in size, but to their actual exclusion; and hence the want of that symmetry which might be expected when the primary crystal is a perfect geometrical solid. Indeed, this figure, together with the crystals represented by figs. 8, 10, 11,

Fig. 1.

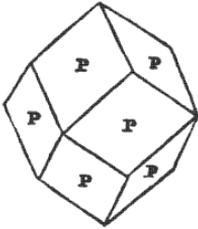


Fig. 2.

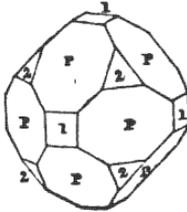


Fig. 3.

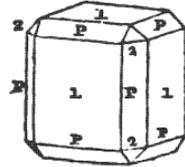


Fig. 4.

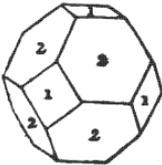


Fig. 5.

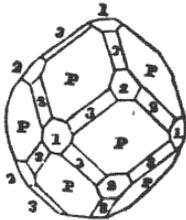


Fig. 6.

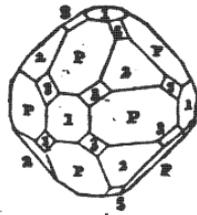


Fig. 7.

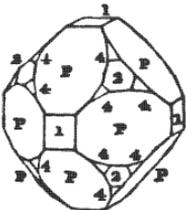


Fig. 8.

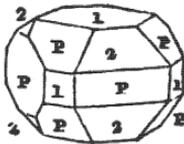


Fig. 9.

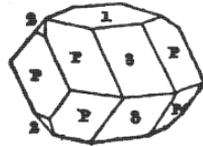


Fig. 10.

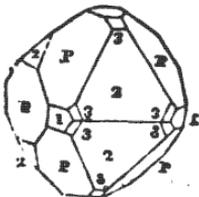


Fig. 11.

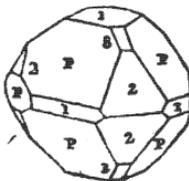
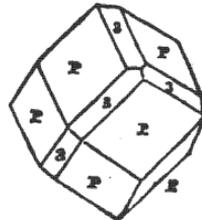


Fig. 12.



and 12, and several others which are not delineated, would have induced the suspicion that the primary form is not a perfect geometrical solid, if some of the rhomboidal dodecahedrons had not been sufficiently brilliant to shew, by the reflecting goniometer, that the adjoining planes meet at an angle of 120 degrees.

It may be said that these crystals are accidental, and ought not, therefore, to be figured in the series of the forms which this substance assumes. To this it may be replied, that some specimens consist only of crystals in these forms, and that if they were omitted, and if only such varieties were given as are perfectly symmetrical, it might be supposed to exist only in the latter; while such specimens as consist only of irregular crystals, might be supposed to belong to some non-descript species. I possess a specimen, of which the crystals belong to the variety described by figure 9, and which are not less in size than the figure itself. In general, however, the crystals vary in size, from the extremely minute to one-fourth of an inch in diameter.

The irregular crystals of this substance, and indeed of many other substances, of which the primary forms are regular geometrical solids, induce the conclusion that the giving to every crystal a descriptive designation, a plan adopted by the celebrated Abbé Haüy, would prove an endless and almost impossible, not to say, an useless, task. It cannot be denied that now and then these designations are intelligible in description; but if the plan be pursued to its extent, about six hundred names will be required for the crystals of the carbonate of lime alone. The most familiar, and upon the whole, the most intelligible, mode, would be to describe a crystal as possessing the planes of the first, third and fifth modifications, &c.; but even for this more simple method, crystallography is not yet far enough advanced in that department which consists in the delineation of all the known forms; until this be done, we cannot hope for a system built upon a generalization of the whole.

This substance usually occurs deposited upon other ores of copper, chiefly the iridescent and botryoidal varieties of copper-pyrites; it is sometimes accompanied by black copper, vitreous copper, and buntkupfererz.

It has been found in the veins of Dolcoath, Cook's Kitchen and Tin Croft copper mines near Redruth, and in Huel Virgin, Huel Unity and Huel Jewel, near St. Die. The specimen which has already been alluded to, as occurring in very large crystals, was raised about forty years ago, and is in the catalogue of my collection 'supposed to be from Treledra near Padstow;' the crystals are very thinly coated by copper-pyrites.

If, however, only one character of this substance were consulted, namely, its crystalline form, it might be assumed to be a variety of fahlerz; for the three planes which are found replacing each solid angle of the tetrahedral crystals of the latter, (Haüy, Pl. 70, o on o, Fig. 81.) meet under an angle of  $120^\circ$ , being precisely the same as that afforded by any two adjoining planes of the rhomboidal dodecahedron, in which form this mineral is found; but the superior hardness of this substance, as well as its fracture and specific gravity, and the effects resulting from the action of the blow-pipe, induce the conclusion that it ought not to be considered as a variety of Fahlerz; nor have any of the mines in which the mineral now under consideration have been found, yielded any tetrahedral crystals. It is to analysis that we must look to decide upon the difference between these minerals.

It is, however, extremely difficult to determine what the essential elements of the fahlerz are. A specimen analyzed by Chenevix, afforded 52 of copper, 23 of iron, and 14 of sulphur; and this being the most simple of the numerous analyses that have been made, (see Haüy, Tableau, p. 254), is almost sufficient to decide its essential elements to be copper, iron, and sulphur. A specimen from Airthrie in Scotland, analyzed by Thomson, afforded 19.2 of copper, 51 of iron, 15.1 of arsenic, and 14.1 of sulphur; while the several analyses of Klaproth shew, that it is sometimes composed in part of lead, antimony, or silver, occasionally even in considerable proportion, and in one instance of five per cent. of zinc. By all the analyses (ten in number) of this celebrated chemist, copper, iron, and sulphur appear to be the *only invariable constituents*; which tends to strengthen the conclusion that they are its essential elements; and that the arsenic, lead, antimony, silver, and zinc, although the

three first have been found to exceed in quantity the copper and iron, are only accidental ingredients; and therefore, since they do not affect the crystalline forms of the fablerz, which are invariably tetrahedral, it may be inferred, that they are only mechanically mixed, not chemically combined with the copper, iron, and sulphur.

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ART. XII. *Analysis of the Copper Ore, described in the preceding Paper.* By Richard Phillips, F.R.S.E. F.L.S., &c.

I. HAVING ascertained that the constituents of this ore are copper, iron, arsenic, and sulphur, I boiled 100 grains of it reduced to powder in nitric acid, until the whole of the metallic matter appeared to be dissolved. Fourteen grains remained unacted upon by the acid; of these a large portion was evidently pure sulphur; by heat nine grains were volatilized, and five remained, which were merely silica, that had been mechanically mixed with the ore.

II. The nitric solution was decomposed by potash, and being heated with excess of it, peroxide of copper and iron were precipitated together. This mixed precipitate was washed until it ceased to be alkaline, and was then dissolved in nitric acid. To the solution ammonia in excess was added; by this, peroxide of iron was precipitated, and the peroxide of copper held in solution; the former being separated, washed and ignited, weighed 13.3 grains, equivalent to 9.26 of iron.

III. The ammoniacal solution of copper was heated, and when the greater part of the ammonia was expelled, potash was added to the solution; and, by continuing the heat, peroxide of copper was precipitated, which being washed and ignited, weighed 56.6 grains, equivalent to 45.32 of copper.

IV. The alkaline solution obtained in III, and the water employed to wash the mixed precipitate of oxide of copper and iron, were evaporated together, and then saturated with nitric acid. This solution contained the sulphur and arsenic converted into acids, and combined with potash. Nitrate of barytes being added, sulphate