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On some British Pseudomorphs.

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I. SOME BRITISH PSEUDOMORPHS, HITHERTO UNDESCRIBED.

1. **A** PATITE after Cronstedtite; from Wheal Maudlin, Llanlivery, Cornwall.

A specimen in the British Museum, consisting mainly of brown chalybite and decomposed iron pyrites—the latter mostly converted into earthy oxides—bears upon its surface and in its cavities a number of thin prisms encrusted with a botryoidal yellowish substance which covers a great part of the decomposed specimen. On close inspection the needles are seen to be Cronstedtite, mostly but not entirely converted into black limonite, and the encrusting substance consists mainly of phosphate (with a little carbonate) of lime. The latter is sometimes crystalline on its surface.

2. Calcite after Quartz; from Cork, Ireland.

A specimen in the British Museum collection consists of compact grey limestone, containing small doubly terminated prisms of quartz. These have been converted, some wholly, some partly, into calcite. The change has taken place in zones which follow the contour of the crystals, and sometimes, when the conversion has been almost complete, zones of quartz remain alternating with bands of calcite.

Some of the quartz crystals are entirely unaltered. The change is to a massive calcite rather more white than the surrounding limestone; it appears to have begun sometimes in the interior of the crystal, and to have extended thence towards the surface.

This may be due to the change having spread from zones of enclosed calcite, but the specimen is a true pseudomorph, and not merely an enclosure of calcite in quartz.

The replacement of quartz by calcite has been recorded from Bohemia.

3. Calcite after Celestine (?); from Durham.

Several specimens acquired by the British Museum in 1857 are crystals of a brown colour, embedded in calcareous clay, which were found in the Jarrow Docks at Durham.

These have the form of elongated, doubly terminated, acute rhombic pyramids, with curved faces. They resemble in form the well-known "barley-corn" pseudomorphs from Sangerhausen and from Schleswig, and are almost identical in aspect with a similar pseudomorph from Archangel in Russia.

They also resemble the large pseudomorphs from Hunter River, in New South Wales, described by Dana in the *Geology of the United States Exploring Expedition round the World* (see Liversidge, *Minerals of New South Wales*, p. 161). In my opinion all these crystals are pseudomorphs after celestine, which exhibits a remarkable tendency to crystallise in acute pyramids with curved faces (see Williams, *Am. J. Sci.* XXXIX. 183, 1890, and *cf. Min. Mag.* X. 39).

The specimens from Durham sometimes attain a length of $1\frac{1}{2}$ inch; some are compact, and of a uniform brown colour, and have an unevenly drusy surface, as though etched; others have been completely converted into granular and porous concretions of a yellow calcite.

These pseudomorphs have been known by the name of Jarrowite, but have not hitherto been described, so far as I have been able to ascertain.

4. Cerussite after Lanarkite; from Leadhills, Lanarkshire.

A specimen in the British Museum consists of crystallised cerussite

encrusting altered prisms which have the aspect of lanarkite and consist in the interior of mixed carbonate and sulphate of lead.

This replacement has not been hitherto recorded.

5. Chalcopyrite after Calcite; from Cornwall.

A compact mass of chalcopyrite with rough surface, apparently the apex of a large scalenohedron. So far as can be determined with the hand goniometer, it seems to be that of the common scalenohedron {201} of calcite. There is also a little quartz on the specimen.

Such a pseudomorph has not hitherto been recorded.

6. Chalcopyrite after Bismuthite; from Tavistock, Devonshire.

Uneven channelled prisms entirely converted on the surface and to a considerable depth into chalcopyrite. In some instances the core of bismuthite has been partly removed. The accompanying minerals are chalcopyrite, milky quartz and pyrites, upon a matrix of chloritic slate.

7. Chalcopyrite after Bismuthite; from Fowey Consols mine, St. Blazey, Cornwall.

In this specimen the prisms of bismuthite have been entirely converted into a mixture of chalcopyrite and a black material which contains bismuth and sulphur. The pseudomorphs lie for the most part in a matrix, consisting of chloritic slate, quartz, chalcopyrite and erubescite.

The replacement of bismuthite by chalcopyrite has not hitherto been recorded.

Chalcopyrite after Bournonite; from Herodsfoot mine, Liskeard, Cornwall. See No. 18.

8. Chalybite after Bismuthite; from Fowey Consols mine, St. Blazey, Cornwall.

A specimen in the British Museum shows pseudomorphs of chalcopyrite after bismuthite, which have been converted on the surface into a pale blue substance. These are dispersed on chalcopyrite, and they are encrusted with crystallised chalybite. In some instances the altered prisms appear to have been completely replaced by chalybite.

The chalybite lies almost exclusively upon the pseudomorphs, and scarcely at all upon the chalcopyrite.

This replacement has not been hitherto recorded.

9. Chlorite after Mispickel; from Carn Brea, Cornwall.

These are hollow drusy pseudomorphs of chlorite in a form which at first sight appears to be that of the obtuse rhombohedron {110} of calcite. Closer inspection shows that they have the form of mispickel, a combination of the prism {110} with an obtuse macrodome; the prism angle was roughly determined as about 65° . The pseudomorphs are disposed on a matrix of compact chlorite, and are accompanied by a later deposit of tarnished crystals of erubescite and a little chalybite.

The pseudomorph has not hitherto been recorded.

10. Copper after Cuprite; from Cornwall.

A pseudomorphous replacement of cuprite by copper is mentioned by Sillem (*Neues Jahrbuch für Mineralogie*, 1851, p. 385), who gives two localities, namely Penzance and Cuba, but without description.

It is more than probable that his note is based upon two specimens in the British Museum; one of these formerly belonged to the collection of Mr. R. P. Greg, in whose catalogue (dating from the time when the collection belonged to Mr. R. Allan, the catalogue itself having been made by Haidinger) it is entered as from Cuba; the specimen was, however, identified as Cornish, and from Tresavean mine, St. Day, by the late Mr. T. Davies, whose knowledge of Cornish mineral localities was unerring. The other specimen has all the appearance of being Cornish, and was identified by Mr. Davies as from the Relistian mine, Camborne. A third specimen in the British Museum is from Liskeard.

It is remarkable that this pseudomorph is not of more common occurrence. It does not seem to have been described. The characteristics of the specimens are as follows:—

(a). Tresavean mine, St. Day. Very perfect cubes and combinations of cube with dodecahedron, consisting of firmly compacted pure copper, but obvious pseudomorphs. The copper, though crystallised, has a drusy and slightly cavernous surface; it is brilliant, and for the most part brightly tarnished.

There is nothing else on the specimen except angular fragments of vein-quartz, a little copper independently crystallised in rounded crystals, and a trace of some black mineral.

There is no regular orientation of the copper in the pseudomorph.

(b). Relistian mine, Camborne. Crystals somewhat similar to those in the preceding specimen, accompanied by long blade-shaped crystals of copper. On this specimen the metal is not tarnished, and the matrix

consists of schorl cementing a little fragmentary quartz. The schorl sometimes fills cavities in the mass of copper.

Both these pseudomorphs are complete, and no cuprite remains.

(c). Liskeard. A large octahedron of cuprite partly converted into copper.

11. Erubescite after Chalcopyrite; from Cornwall.

These are uneven crystals of very irregular form, but somewhat resembling those from Wheal Towan. They consist partly of chalcopyrite, but have been converted near the surface, and in some instances to a considerable depth, into erubescite.

They are dispersed among quartz crystals, the matrix being clay-slate.

A recently acquired specimen, showing a similar replacement, is from St. Ives Consols mine. Here the resulting substance seems to be a mixture of erubescite and earthy red oxide of copper, and the pseudomorphs are accompanied by crystals of copper glance dispersed upon them, together with a little chrysocolla.

12. Fluor after Calcite; from Derbyshire.

Large scalenohedra of calcite replaced by a mass of cubes of yellowish fluor enclosing chalcopyrite.

These appear to have been epimorphs in which, after removal of the calcite, the cavity has been largely refilled by fluor. Upon one side of the specimen the calcite still remains.

Pseudomorphs of fluor after calcite have previously been described from Breisgau.

13. Galena and Chalcopyrite after Bournonite, from Herodsfoot mine, Liskeard, Cornwall

There are two fine specimens in the British Museum. In these the well-known wheel-shaped groups of bournonite associated with quartz (after barytes) have been corroded and partly replaced by galena, chalcopyrite and tetrahedrite.

The original form of the bournonite tables is well preserved by a thick crust, consisting of large crystals of galena disposed in a regular manner upon the prism faces of the bournonite. The basal surfaces of the bournonite have been for the most part removed, so that the ring of galena surrounds a comparatively thin corroded disc of bournonite, while chalcopyrite and tetrahedrite are dispersed about the cavity so formed and upon the edges of the galena crystals. The tetrahedrite is always

covered with the thin crust of chalcopyrite so familiar in the Herodsfoot specimens.

The galena crystals (which are combinations of cube and dodecahedron) are arranged in such a way that an edge of the octahedron is always parallel to the prism edge of the bournonite; and the general disposition of the crystals suggests that in all probability a cube and dodecahedron face of the galena were parallel to the brachy-pinacoid and the macro-pinacoid respectively of the bournonite.

There is no direct evidence that the galena was not deposited as a crust upon the bournonite prism faces before the decomposition of that mineral; but there is no reason to doubt that the galena, the tetrahedrite and the chalcopyrite have all resulted from the decomposition of the bournonite.

On the other hand, it is remarkable that, whereas bournonite corresponds to a compound consisting of one molecule of tetrahedrite, eight of galena and three of stibnite, there is no trace on these specimens of any antimony compounds such as might be expected to remain after the conversion of bournonite into galena and tetrahedrite.

Sometimes a direct conversion (upon the surface) of bournonite into chalcopyrite has taken place.

A pseudomorph of this nature has not hitherto been described, except from Kapnik.

In Greg and Lettsom's *Mineralogy*, p. 346, it is alluded to as "bournonite filling hollow crystals of galena," a totally false description.

14. Galena after Anglesite; from Derbyshire.

This pseudomorph is only mentioned in Greg and Lettsom's *Mineralogy* (p. 450), without description or locality.

The specimen in the British Museum is from the Allan-Greg collection (see above, No. 10), where it is labelled as from Derbyshire, and has all the appearance of the large crystals formerly found in the neighbourhood of Matlock.

It is a true pseudomorph; the large prism is entirely converted on the surface into a smooth crystalline coating of galena; the alteration has proceeded to a considerable depth, through which the material is a mixture of anglesite and galena; and the interior consists of unaltered anglesite.

There is also a specimen labelled Matlock in the Ludlam collection, now in the Museum of Practical Geology, Jermyn Street.

15. Hæmatite after Fluor; from Lancashire and Cumberland, and St. Just, Cornwall.

The specimens from Furness, Lancashire, are cubes which appear to have been converted into quartz and then covered and partially or entirely replaced by earthy and fibrous hæmatite. They should, therefore, be described as hæmatite after quartz after fluor. Since the cubes do not show the characteristic interpenetrating twinning of fluor, they are often supposed to be pseudomorphs after pyrites, and are so described. In reality the direct replacement of pyrites by hæmatite or by quartz appears to be as rare as that of fluor by silica is common; so that many so-called pseudomorphs of hæmatite after pyrites are doubtless in reality after fluor, which has been altered to silica. This may be true of the specimens from Spitzleite, which closely resemble those from Lancashire and Cumberland. Pyrites is generally transformed into hydrate of iron, and not into hæmatite (see, however, No. 16 below).

On the Lancashire specimens, which are from Dalton-in-Furness and from the Stank mine, the tendency of fibrous hæmatite to form botryoidal and rounded masses has caused the edges and corners of the cubes to become completely rounded on the surface, although the pseudomorph in the interior is generally quite a sharp cube. A central cavity is often partially filled with crystallised calcite.

A specimen from Hodbarrow mine, Millom, Cumberland, precisely resembles those from Lancashire; and similar cubes encrusted with black limonite occur on the specimen from Wheal Owles described below, under No. 22.

These pseudomorphs have not been hitherto described.

16. Hæmatite after Pyrites; from Cumberland.

This specimen is an undoubted example of the conversion of pyrites into hæmatite. The crystals are characteristic combinations of a striated cube with the pentagonal dodecahedron π {210}. They have been entirely converted into a material which, though in the interior of the crystals rather dark coloured for hæmatite, is in reality the anhydrous oxide, since it only loses 0.8 per cent. of its weight on ignition.

Similar pseudomorphs from Torquay, Devonshire, have been described by Solly and Hutchinson in this Magazine (Vol. VIII., 1889, p. 183).

A replacement of pyrites by hæmatite from Donegal has also been recorded (without description) in Hall's *Mineralogist's Directory*.

17. Hæmatite after Calcite ; from Furness, Lancashire.

These specimens, from the Stank mine, are scalenohedra completely replaced by earthy and fibrous red hæmatite. The edges and corners of the pseudomorphs are rounded in the same way as in those of hæmatite after fluor.

18. Hæmatite and Limonite after Calcite ; from Bristol.

A flat surface of sharply crystallised scalenohedra twinned upon the basal plane, resembling in aspect the well-known pseudomorphs from Spitzleite.

The only British localities previously recorded for this replacement are Cornwall (in Greg and Lettsom, p. 249) and Parkside mine, Cumberland (in Hall's *Mineralogist's Directory*).

The replacing material is partly limonite, and in one specimen consists mainly of limonite. Here the fibrous structure shows that the original pseudomorph was hæmatite after calcite, and that the hæmatite has been converted into limonite.

19. Hæmatite and Redruthite after Pyrites ; from St. Just, Cornwall.

A group of large cubes entirely converted into a material which consists mainly of crystalline hæmatite, but contains also a proportion of copper which appears to be present, partly at least, as redruthite. The specimen is from the Levant mine. Another specimen from Cornwall is a large cube coated with earthy melaconite. The interior is a compact mineral containing sulphur, iron and copper, possibly also a mixture of hæmatite and redruthite.

Limonite after Calcite ; from Bristol. See No. 18.

20. Limonite after Cronstedtite ; from Wheal Jane, Truro, Cornwall.

In some of these specimens the typical crystals of cronstedtite have been completely transformed into limonite.

The pyrites upon which they were situated has also been altered to limonite, but only to a very slight depth, below which the material is quite unaltered.

This replacement has not previously been recorded.

21. Limonite after Fluor; from Redruth, Cornwall.

Cubes of black limonite, with rounded edges and corners, from Cook's Kitchen mine, seem to be in all probability pseudomorphs after fluor. Where these have been broken the original substance is found to have been entirely removed, and the fibrous structure of the enveloping substance shows that it was formerly hæmatite. The cubes are therefore to be described as hæmatite epimorphs after fluor, which have been converted into limonite. The limonite also encrusts accompanying crystals of quartz.

Sharp cubes consisting of a mixture of quartz and limonite from Wheal Owles, St. Just, may also be pseudomorphs after fluor. The centre of the cubes consists mainly of granular quartz.

22. Limonite after Hæmatite; from Wheal Owles, St. Just, Cornwall.

The specimen referred to above (under 15) consists mainly of sharp cubes, consisting of quartz (pseudomorphs after fluor) coated or superficially replaced by limonite. These are accompanied by crystals having the form of hæmatite, which have been completely transformed into limonite.

The replacement has only been previously recorded by Collins (*Min. Cornwall and Devon*, p. 80), on doubtful authority, as from Restormel.

23. Magnetite after Picrolite; from Scalpa, Isle of Harris, in the Hebrides.

In a specimen of picrolite from this locality the fibres have been largely converted into magnetite, in which the structure of the original mineral is well preserved.

The specimen somewhat resembles one from Piedmont, in which a similar replacement has taken place. It has not been previously recorded from a British locality.

24. Malachite after Cerussite; from Redruth, Cornwall.

A specimen in the British Museum, formerly belonging to the Allan-Greg Collection, consists of a mass of small green crystals upon a quartzose matrix. The crystals consist entirely of malachite, but they have the form of rhombic tables with bevelled edges sometimes irregularly grouped together, but sometimes twinned like cerussite. Some of the crystals also have the aspect of acute pyramids. Mr. G. F. H. Smith has kindly measured some of these crystals, and finds their angles to be approximately those of cerussite. The locality is mentioned by Hall,

Marcasite after Pyrrhotite ; from Cornwall. See No. 28.

25. Plumbo-resinite after Barytes and Pyromorphite ; from Roughten Gill, Cumberland.

Familiar in most old collections are the specimens from Roughten Gill, in which pyromorphite in crystals or botryoidal groups lies upon a sky blue mineral encrusting the matrix. The blue mineral is probably generally regarded as silicate or carbonate of zinc.

On one specimen in the British Museum, which formerly belonged to the Allan-Greg collection, the blue mineral encrusts thin tabular crystals of barytes, and upon the epimorph are dispersed small yellow crystals of pyromorphite. Greg and Lettsom mention carbonate of zinc after barytes without the locality, and the label which accompanies the specimen leaves no doubt that this is the specimen to which their allusion refers.

The blue mineral was found by Mr. Prior to be neither carbonate nor silicate of zinc, but the phosphate of lead and aluminium known as plumbo-resinite.

The occurrence of plumbo-resinite at Roughten Gill is first mentioned in the 3rd edition of Dana's *System* in 1850. It is not mentioned in the 2nd edition of 1844.

Plumbo-resinite pseudomorphous after barytes has not hitherto been recorded.

The elaborate description in Blum's *Pseudomorphosen*, Vol. I. p. 273, of pseudomorphs of silicate of zinc after pyromorphite from Caldbeck Fell probably relates to this substance.

26. Pyrites after Barytes ; from Liskeard, Cornwall.

This pseudomorph is mentioned by Collins, from Herodsfoot mine, on the authority of Pearce, but has not been described.

The British Museum collection contains several specimens of well-defined hollow epimorphs of pyrites ; in no case is any trace of the original mineral remaining, and the only evidence of its nature is the characteristic form of the rhombic tables, a combination of {001} and {110} so familiar in barytes. On one specimen from Wheal Trelawney, which consists practically of a continuous crystal of pyrites completely covered with sharp impressions of barytes crystals, the prism angle bounding the tabular hollows could be measured from the sides of the casts by the reflecting goniometer, and was found to be $78^{\circ}30'$.

On the other specimens the epimorphs consist of small cubes of

pyrites massed together irregularly. A somewhat similar specimen from Tavistock seems to consist of marcasite.

There is also a specimen from Liskeard in the Jermyn Street Museum.

27. Pyrites after Barytes; from Cumberland.

This consists of a large hollow epimorph of the same form as the preceding, and composed of small polysynthetic cubes of pyrites. The hollow has been entirely filled with drusy prisms of milky calcite, a combination of $\{2\bar{1}1\}$ and $\{110\}$. The calcite is also dispersed over the surface of the epimorph.

This occurrence has not been previously described.

28. Pyrites and Marcasite after Pyrrhotite; from Cornwall.

These pseudomorphs are thin hexagonal plates, consisting entirely of cubes of pyrites which have completely replaced the original mineral. They are implanted upon a matrix consisting of blende and massive pyrites. The associated minerals are a little quartz and pearlspar. The cubes of pyrites which constitute each hexagonal plate are for the most part arranged in regular position, and parallel to each other.

In one specimen from Wheal Seaton, Camborne, the pseudomorphs are beautiful hollow plates with a drusy surface, and with large pyramid faces.

Another Cornish specimen shows the plates in the more characteristic form of low hexagonal pyramids, but the material here appears to be marcasite. These are associated with blende. These pseudomorphs have not been described before; they are well known from Freiberg.

A specimen in the Jermyn Street Museum is from Redruth.

29. Pyrites after Quartz and Fluor; from Cornwall.

An epimorph in which pyrites, in thickly accumulated somewhat rounded and drusy crystals, completely encrusts milky quartz. These are accompanied by large hollow octahedral epimorphs, possibly after fluor, from which the original mineral has been entirely removed, leaving only small milky crystals of quartz upon which the original octahedra were deposited.

The specimen was originally in the Allan-Greg collection, and the locality is given on the authority of the label which accompanies it.

Pyrites after quartz has not hitherto been recorded among British pseudomorphs, and pyrites after fluor only from Alston.

30. Quartz after Barytes; from Liskeard and Devonshire.

Pseudomorphs of chalcedony after barytes are mentioned by Greg and

Lettsom as having been recently found at Herodsfoot mine and Wheal Mary, in Cornwall; and quartz after barytes from Durham is recorded by Hall.

Excellent pseudomorphs of quartz after barytes are common from Herodsfoot mine at Liskeard, accompanying bournonite. These appear to have been originally epimorphs of quartz after very thin tabular plates of barytes, in which the barytes has been subsequently removed and replaced by quartz. There is no trace of barytes left upon these specimens.

Epimorphs of quartz after barytes also occur at Wheal Mary Ann, Liskeard, and probably also in Devonshire.

It is remarkable that these epimorphs have not been previously described.

31. Quartz after Barytes (?); from Blackwell Down, Somersetshire.

Two specimens in the British Museum from this locality consist of a fibrous mineral which has been entirely replaced by quartz. The fibres are curved and show a tendency to arrange themselves into radiating groups, and are pinkish in colour. Mr. Prior has kindly examined one of these specimens at my request, and finds it to contain barium.

The mineral overlies quartz on a matrix of quartzose ironstone. Blackwell is one mile south-east of Nailsea, and seven miles south-west of Bristol.

32. Quartz after Bournonite; from Liskeard, Cornwall.

Among the metallic minerals upon which quartz is deposited bournonite is conspicuous. On the specimens from Liskeard the wheel-shaped groups of bournonite are frequently plated with a layer of quartz. In one specimen from the Herodsfoot mine the bournonite has been partly removed or converted into a mixture of galena and chalcopryrite, as described above under 13, and the result is a hollow epimorph of quartz after bournonite.

This has not been previously recorded.

33. Quartz after Silver; from Cornwall.

A specimen from the Allan-Greg collection, labelled Cornwall, consists of quartz crystals, among which are dispersed groups of crystallised chalcopryrite, accompanied by overlying crystals of marcasite. A still later deposit of quartz is a mass of wiry form, which, on close examination, is seen to consist of minute crystals completely enveloping fine threads of black mineral, to which the wiry form is due. The mineral

appears to be argentite, doubtless itself a pseudomorph after native silver.

The large quartz crystals which constitute the main part of the specimen are themselves overlaid with a deposit of secondary quartz, which lies smoothly on the pyramid faces, but gives a drusy surface to the prism faces; and upon them are scattered a few hollow pseudomorphs of quartz after curved rhombohedra of calcite (or dolomite).

The history of this interesting specimen is very clearly told by the succession of minerals. The original minerals were quartz succeeded by chalcopyrite, marcasite, chalybite and native silver in order. The silver has been converted into argentite. Then has come a secondary deposit of quartz, which has completely coated the chalybite and the argentite, and has increased the earlier quartz crystals, but has almost absolutely avoided the other metallic minerals.

This specimen illustrates the value of a study of epimorphs as indicating the tendency exhibited by a given mineral to crystallise only upon certain minerals, and not upon others. In this connection the reluctance of quartz to crystallise upon the metallic minerals is strikingly conspicuous. A survey of any mineral collection brings this fact to light at once; and among the very complete list of pseudomorphs enumerated in the first volume of Roth's *Allgemeine und chemische Geologie*, the only pseudomorph of quartz after a metallic mineral mentioned is that after galena. Pseudomorphs of quartz after pyrites recorded by Carne¹ are not supported by any other authority (see below, p. 279).

Epimorphs of quartz after silver or argentite have not been previously recorded.

A specimen in the British Museum collection from Freiberg presents a precisely similar encrustation by quartz of wiry silver altered into argentite.

Redruthite after Pyrites; from St. Just, Cornwall. See No 19.

34. Redruthite after Erubescite; from Redruth, Cornwall.

A specimen in the Ludlam collection, now in the Museum of Practical Geology, Jermyn Street, appears to be a single cube of erubescite in a quartz geode, converted into redruthite.

¹ *Trans. Roy. Geol. Soc. Cornwall*, 1846, VI. 28.

II. BRITISH PSEUDOMORPHS FOR WHICH THE EVIDENCE IS INSUFFICIENT OR INCORRECT.

(Many of these may be genuine, and it is hoped that their present provisional separation may lead to the re-identification of such).

Analcime after Calcite is recorded by Greg and Lettsom, but without description.

Aragonite after Witherite is recorded by Greg and Lettsom, but without description or locality.

Barytes after Analcime is recorded by Greg and Lettsom, but without description or locality.

Bournonite after Galena, from Herodsfoot mine; recorded by Greg and Lettsom; see above, No. 13.

Calamine after Barytes is Plumbo-resinite after Barytes (see above, No. 25).

Calamine after Galena is recorded by Greg and Lettsom, but without description or locality.

Chalcopyrite after Blende, from Cornwall, is recorded by Greg and Lettsom, and also by Collins and by Hall, but the evidence seems doubtful.

Chalcopyrite after Chalybite is mentioned by Greg and Lettsom without description or locality, and by Hall as from St. Just.

Chalcopyrite after Dolomite is recorded by Carne as from Huel Tolgus, and is mentioned by Collins, but the evidence in favour of this being a pseudomorph is insufficient.

Chalcopyrite after Pyrites (in cubes) is mentioned by Carne, but the statement is not repeated by Collins, and has no further evidence to support it.

Chalybite after Galena is recorded by Greg and Lettsom, but without description or locality.

Chalybite after Selenite, from Devonshire, recorded by Greg and Lettsom, is probably after Barytes.

Chlorite after Albite is recorded by Collins, but without description.

Chlorite after Fluor is recorded by Greg and Lettsom, but without description or locality.

Chlorite after Garnet is recorded by Greg and Lettsom, but without description or locality.

Chrysocolla after Cerussite and Galena, from Leadhills; recorded by Greg and Lettsom.

Chrysocolla after Cupro-uranite, from Cornwall, is recorded by Greg and Lettsom, but requires confirmation.

Cuprite after Chalcopyrite is recorded by Greg and Lettsom, but without description or locality.

Fluor after Felspar is recorded by Collins, on the authority of Pearce.

Galena after Barytes is recorded by Greg and Lettsom, without description or locality.

Green-earth after Barytes is recorded by Greg and Lettsom, but without description or locality.

Hæmatite after Barytes, from Ulverstone, is recorded by Greg and Lettsom, but requires confirmation.

Hæmatite after Galena is recorded by Greg and Lettsom, but without description or locality.

Hæmatite after Marcasite is recorded by Greg and Lettsom, but without description or locality.

Hemimorphite after Pyromorphite is Plumbo-resinite after Pyromorphite (see above, No. 25).

Kaolin after Fluor is recorded by Greg and Lettsom, but without description or locality.

Limonite after Dolomite is recorded by Collins on the authority of Pearce, but requires confirmation.

Limonite (?) after Felspar, from Carnmouth, is recorded by Collins, but requires confirmation.

Limonite after Psilomelane, from Hoy in the Orkneys, is recorded by Greg and Lettsom; but see *Min. Mag.*, iii., 237.

Limonite after Staurolite, from Ireland, the so-called Crucite, has been shown to be after mispickel.

Magnetite after Pyrites, from Tarbet, is recorded by Hall, but requires confirmation.

Malachite after Chalcopyrite is recorded by Greg and Lettsom, but without description or locality.

Malachite after Linarite, from Red Gill, Caldbeck, Cumberland. A specimen of altered linarite in the Jermyn Street Museum may be an example of conversion into Malachite.

Marcasite after Calcite. This pseudomorph is mentioned by Greg and Lettsom from the "Tamar mines, Beerferris, Devonshire, in low hexagonal prisms, slightly modified." There is a specimen in the Greg collection answering to this description, but labelled Cornwall; and there

is no such specimen from Beerferris. It seems to be one of the pseudomorphs described above, under 28, as after pyrrhotite.

Marcasite after Dolomite, from Liskeard. A specimen in the British Museum may be a pseudomorph after dolomite.

Mica after Pinite is recorded by Greg and Lettsom, but without description or locality; there is no evidence that it differs from the nacrite after pinite, mentioned below.

Mispickel after Albite is recorded by Greg and Lettsom without description or locality, and as doubtful. Collins mentions a pseudomorph of pyrites after Albite, from the Consolidated Mines, without description.

Nacrite after Pinite is recorded by Greg and Lettsom, but without description or locality.

Plattnerite after Pyromorphite, from Leadhills; recorded as doubtful by Greg and Lettsom.

Prehnite after Quartz is recorded by Greg and Lettsom, but without description or locality.

Prehnite after Scolecite is recorded by Greg and Lettsom, but without description or locality.

Pyrites after Blende is recorded by Greg and Lettsom, without description or locality.

Pyrites after Chalybite is recorded by Collins, without description or locality.

Pyrites after Coal is recorded by Greg and Lettsom, without description or locality.

Pyrites after Galena is recorded by Greg and Lettsom, without description or locality.

Quartz after Anglesite is recorded by Greg and Lettsom, but without description or locality.

Quartz after Datolite, so called Haytorite, has been shown to be chalcédony after datolite.

Quartz after Felspar, from Boscage! Downs; recorded by Carne.

Quartz after Galena is recorded by Greg and Lettsom, but without description or locality.

Quartz after Hæmatite, from Huel Edward, is described as an epimorph by Carne; it is not quoted by Collins, and requires confirmation.

Quartz after Pyrites, from North Roskear, has been recorded by Carne (octahedral quartz); it is not quoted by Collins, and requires confirmation.

Redruthite after Copper is recorded by Greg and Lettsom, without description or locality.

Salt after an unknown mineral is recorded by Collins (see the description by Ormerod).

Steatite after Barytes is recorded by Greg and Lettsom, but without description or locality.

Talcite after Andalusi e, from Wicklow (?), is recorded by Hall.

Uranium-ochre after Uranite is recorded by Greg and Lettsom, but without description or locality.

Vanadinite after Hemimorphite is recorded by Greg and Lettsom, but without description or locality.

III. PRELIMINARY LIST OF BRITISH PSEUDOMORPHS WHICH MAY BE REGARDED AS ESTABLISHED ON FAIRLY SATISFACTORY EVIDENCE.

In this list the known existence of a specimen is recorded in preference to evidence which may be found in the literature; many occurrences are here accepted on the authority of a competent observer where the locality is definitely stated, even though not described.

Albite after Analcime, from Edinburgh and Kilpatrick; recorded by Greg and Lettsom.

Albite after Laumontite from Edinburgh; in the British Museum; recorded from Kilpatrick by Greg and Lettsom.

Albite after Stilbite, from Kilpatrick; in the British Museum.

Amphibole after Augite, from Wales; see Harker, *Min. Mag.* VIII. 32.

Analcime after Laumontite, from Kilmalcolm, Renfrewshire; in the British Museum.

Analcime after Prehnite, from Paisley, Renfrewshire; recorded by Hall.

Apatite after Cronstedtite, from Wheal Maudlin, Cornwall; see above, No. 1.

Barytes after Barytocalcite, from Alston; in the British Museum.

Barytes after Witherite, from Hexham and Dufton; in the British Museum; see Greg and Lettsom, and *Neues Jahrb. f. Min.* 1895, I. 252.

Bindheimite after Jamesonite, from Endellion, Cornwall; specimens of jamesonite in the British Museum are altered into a brown mineral, probably a mixture of various oxides of antimony as described by Brooke from Lostwithiel, and by Sillem.

Calamine after Fluor, from Derbyshire; in the British Museum.

Calamine after Calcite, from Matlock, and from the Mendips; in the British Museum.

Calcite after Aragonite, from Eskett, Ennerdale, Cumberland. A specimen in the Ludlam collection, Jermy Street Museum.

Calcite after Celestine (?), from Jarrow; see above, No. 3.

Calcite after Galena, from Wanlockhead; recorded by Greg and Lettsom.

Calcite after Leadhillite, from Leadhills; recorded by Greg and Lettsom.

Calcite after Quartz, from Cork; see above, No. 2.

Cassiterite after Felspar, from St. Agnes; well known in all collections; this replacement is also recorded from St. Austell by Collins; see *Min. Mag.* IV. pp. 8, 112.

Cassiterite after Quartz, from St. Agnes; the so-called stannite.

Cerussite after Anglesite, from Leadhills; in the British Museum; there is also a specimen from Derbyshire which may be after anglesite.

Cerussite after Galena, from Leadhills; in the British Museum; the replacement is also recorded from Cornwall by Carne.

Cerussite after Lanarkite, from Leadhills; see above, No. 4.

Cerussite after Leadhillite, from Leadhills; in the British Museum; the pseudomorph is a mixture of cerussite and pyromorphite.

Cervantite after Stibnite, from Eskdale; recorded by Hall.

Chalcedony after Barytes, from Cornwall; recorded by Greg and Lettsom.

Chalcedony after Datolite, from Haytor, Devonshire; well known as haytorite; also recorded from North Roskear mine by Greg and Lettsom.

Chalcedony after Calcite, from Liskeard, in Cornwall, and from Haytor, in Devonshire; both these localities are represented in the British Museum.

Chalcedony after Dolomite, from Penzance and Redruth, in Cornwall; in the British Museum.

Chalcedony (or Hornstone) after Fluor, from Menheniot, in Cornwall, and from Beerlston, in Devonshire; both these localities are represented in the British Museum; the latter are well known.

Chalcopyrite after Bismuthite, from Fowey, Cornwall, and Tavistock, Devonshire; see above, Nos. 6 and 7.

Chalcopyrite after Bournonite, from Liskeard; see above, No. 13.

Chalcopyrite after Calcite, from Cornwall; see above, No. 5.

Chalcopyrite after Redruthite, recorded by Greg and Lettsom; and by Collins from Cornwall; in the British Museum from St. Just.

Chalcopyrite after Tetrahedrite, from Herodsfoot mine, Liskeard; these beautiful pseudomorphs due to superficial alteration are common in all collections. This replacement is recorded from the Levant mine by Greg and Lettsom; in the British Museum from St. Austell.

Chalybite after Barytes, from Virtuous Lady mine, Tavistock, Devonshire; these hollow epimorphs are familiar in all collections.

Chalybite after Bismuthite, from Fowey, Cornwall; see above, No. 8.

Chalybite after Calcite, from Marazion, Cornwall; in the British Museum; recorded from Beeralston, Devonshire, by Greg and Lettsom.

Chalybite after Dolomite, from Wheal Owles, St. Just, Cornwall; recorded by Collins.

Chalybite after Fluor, from Virtuous Lady mine, Tavistock, Devonshire; these hollow epimorphs are also well known, and are fully described by Blum; in the British Museum is also a specimen from Alston, Cumberland; and it is recorded from Wheal Maudlin, Cornwall, by Greg and Lettsom, and from Fowey by Hall.

Chalybite after Pyrites, from Devonshire; in the British Museum, and recorded by Greg and Lettsom.

Chlorite after Axinite, from Dartmoor: in the British Museum; described by Blum.

Chlorite after Felspar, and Magnetite, from Cornwall; recorded by Collins.

Chlorite after Mispickel, from Carn Brea, Cornwall; see above, No. 9.

Chrysocolla after Chalcophyllite, from Wheal Unity (?), Cornwall; a specimen in the Jermyn Street collection consists of hexagonal plates of chalcophyllite completely converted into chrysocolla.

Chrysocolla after Chalybite, from Roughten Gill, Cumberland; a specimen in the Jermyn Street collection appears to be rhombohedra {100} converted into chrysocolla.

Chrysocolla after Cuprite, from Cornwall; in the British Museum; these pseudomorphs generally consist of a mixture of chrysocolla and malachite; the best specimens are from Wheal Phoenix, Liskeard; they sometimes have globular phosphate of copper dispersed upon them.

Chrysocolla after Felspar, from Cornwall; Semmons, *Min. Mag.* II. 200.

Chrysocolla after Malachite, from Roughten Gill; a specimen in the Jermyn Street collection.

Copper after Cuprite, from Cornwall; see above, No. 10.

Covellite after Chalcopyrite, from Wheal Maudlin, Cornwall; recorded by Greg and Lettsom.

Covellite after Harrisite, from Wheal Falmouth; Davies, *Min. Mag.* I. 113.

Dolomite after Calcite, from Cornwall, and from Beeralston and Tavistock, in Devonshire; in the British Museum.

Erubescite after Chalcopyrite, Cornwall; see above, No. 11.

Erubescite after Redruthite, from Redruth, Cornwall; recorded by Greg and Lettson, but not by Collins; there are specimens in the British Museum; see the description in Blun. A specimen from Wheal Damsel in the Jermyn Street Museum appears to consist of a mixture of erubescite and copper pyrites.

Ferrite after Augite, from Scotland; see Heddle, *Min. Mag.* V. 28, VII. 134.

Fluor after Calcite, from Derbyshire; see above, No. 12.

Fluor after Quartz, from Trowlesworthy Tor, Devonshire; Bonney, *Min. Mag.* vi. 48.

Galena after Anglesite, from Derbyshire; see above, No. 14.

Galena after Bournonite, from Liskeard; see above, No. 13.

Galena after Pyromorphite, from Wheal Hope, Truro, Cornwall. These pseudomorphs (formerly known as "Blue Lead") are well-known

Gilbertite after Quartz, and Orthoclase, Cornwall; see Solly, *Min. Mag.* VII. 141; Collins, ii. 94.

Göthite after Pyrites, from the Restormel Mines, Cornwall; recorded by Collins.

Green-earth after Augite, and Calcite, from Kilpatrick; recorded by Hall and by Greg and Lettson.

Hæmatite after Calcite, from Furness and Bristol; see above, Nos. 17, 18.

Hæmatite after Chalybite, from Cornwall; *Min. Mag.* ii. 94.

Hæmatite after Fluor, from Furness, Millom and Redruth; see above, Nos. 15, 22.

Hæmatite after Pyrites, from Cumberland and Devonshire; see above, No. 16.

Hemimorphite after Calcite, from Matlock, Derbyshire; recorded by Hall; see Allan's *Mineralogy*, p. 44.

Hemimorphite after Galena, from Wanlockhead; recorded by Greg and Lettson.

Hemimorphite after Vanadinite, from Wanlockhead; recorded by Greg and Lettson.

Kaolin after Felspar, from Cornwall.

Kyanite after Staurolite, from Wicklow, Ireland; recorded by Greg and Lettson.

Laumontite after Analcime, from Kilpatrick, Dumbartonshire; in the British Museum.

Limonite after Calcite, from Bristol; see above, No. 18.

Limonite after Chalybite, from St. Just, Cornwall; there is a specimen in the British Museum from Botallack mine; this occurrence is recorded by Carne; the same replacement is also recorded from Mawddach in Wales, see *Min. Mag.* III. 127.

Limonite after Cronstedtite, from Truro; see above, No. 20.

Limonite after Fluor, from Redruth; see above, No. 21.

Limonite after Garnet, from Belstone, Devonshire; recorded by Collins on the authority of Davies.

Limonite after Göthite, from Restormel, Lostwithiel, Cornwall; recorded by Greg and Lettsom.

Limonite after Hæmatite, from St. Just; see above, No. 22.

Limonite after Marcasite, from Dorset, Lewes in Sussex, Moneyash in Derbyshire, St. Just in Cornwall; specimens from all these localities are in the British Museum. The pseudomorph is recorded from Stromness, in the Orkney Islands, by Greg and Lettsom; see also *Min. Mag.* III. 224.

Limonite after Mispickel, from Clonmel, Co. Waterford, Ireland; the so-called "crucite" common in all collections.

Limonite after Pyrites, from Cornwall, and from Hoy, is recorded by Greg and Lettsom, by Carne and by Heddle.

Magnetite after Picrolite, from Scalpa, Hebrides; see above, No. 23.

Magnetite after Cerussite, from Redruth, Cornwall; see above, No. 24.

Malachite after Chalcophyllite, from Camborne, Cornwall; recorded by Semmons in *Min. Mag.* VI. 162.

Malachite after Cuprite, from Redruth, Cornwall; in the British Museum.

Marcasite after Barytes, from Tavistock, Devonshire; see above, No. 26.

Marcasite after Pyrrhotite, from Cornwall; see above, No. 28.

Nacrite after Andalusite, from Wicklow, Ireland; recorded by Greg and Lettsom; Hall calls it talcite.

Olivenite after Quartz, from Marke Valley mine, Liskeard, Cornwall; an epimorph in the British Museum.

Olivine after Spheue, from Sutherland; Heddle, *Min. Mag.* V. 189.

Pectolite after Analcime, from Edinburgh; in the British Museum.

Pinite after Cordierite, from Cornwall, Perth and Dublin; see Collins, *Min. Mag.* X. 8. There are specimens from Cornwall in the British Museum.

Plumbo-resinite after Barytes and Pyromorphite, from Roughton Gill, Cumberland; see above, No. 25.

Prehnite after Analcime, from Hartfield, and from Kilpatrick; in the British Museum.

Prehnite after Pectolite, from Edinburgh; in the British Museum.

Pseudophite after Labradorite, from Aberdeen; Heddle, *Min. Mag.* III. 138.

Pyrites after Barytes, from Cornwall and Cumberland; see above, Nos. 26 and 27.

Pyrites after Calcite, from Herodsfoot mine, Liskeard, Cornwall; recorded by Collins; there is a specimen in the British Museum consisting of marcasite and pyrites. It is also recorded by Greg and Lettson from Tavistock.

Pyrites after Fluor, from Alston, is mentioned by Greg and Lettson, p. 280; from Cornwall, see above, No. 29.

Pyrites after Pyrrhotite, from Cornwall; see above, No. 28. A specimen in the Jermyn Street Museum is labelled Redruth.

Pyrites after Quartz, from Cornwall; see above, No. 29.

Pyromorphite after Barytes, from Leadhills; in the British Museum.

Pyromorphite after Galena, from Leadhills; in the British Museum.

Pyromorphite after Leadhillite, from Leadhills; in the British Museum (the pseudomorph is a mixture of pyromorphite and cerussite).

Quartz after Barytes, from Liskeard, from Devonshire, from Somerset, and from Durham; see above, Nos. 30, 31.

Quartz after Bournonite, from Liskeard; see above, No. 32.

Quartz after Calcite, from Gwennap, from Botallack mine in St. Ives, from East Pool Mine in Redruth, and from Bodmin, Cornwall (Fowey Consols, Jermyn Street Museum); from Clifton and from Haytor; specimens from some of these localities are in the British Museum, the others are recorded by Greg and Lettson and by Hall. In a very perfect specimen from Wheal Alfred in the Jermyn Street Museum curved polysynthetic rhombohedra are completely replaced by clear quartz.

Quartz after Chalybite, from Redruth, Cornwall; there is a specimen in the British Museum; it is also recorded from Botallack mine by Carne.¹ From Cook's Kitchen mine (Ludlam collection).

Quartz after Dolomite, from St. Just, Cornwall, and from the Orkneys; recorded by Greg and Lettson; from Trevartha (Ludlam collection).

Quartz after Fluor, from Wheal Alfred and Botallack mine, and from Caradon (Ludlam collection) in Cornwall, from Devonshire, from Alston, from Clifton, from Shropshire, and from Durham; some in the British Museum, and the others recorded by Greg and Lettson, and by Hall.

¹ *Trans. Roy. Geol. Soc. Cornwall*, 1822, II. 307.

Quartz after Orthoclase, from St. Austell, Cornwall; recorded by Collins; *Min. Mag.* i. 57.

Quartz after Silver, from Cornwall; see above, No. 33.

Quartz after Stilbite, from Kilpatrick (recorded by Greg and Lettson), and from Dumbarton (in the British Museum). This seems to be a complete replacement of the mineral by quartz.

Redruthite after Galena, from Perran, Cornwall; see *Min. Mag.* Vol. I. p. 114. The specimen is in the British Museum.

Redruthite after Pyrites, from St. Just, Cornwall; see above, No. 19.

Redruthite after Erubescite, from Redruth, Cornwall; see No. 34.

Sandstone, Shale and Clay after Salt, from Cheshire; recorded by Greg and Lettson.

Saponite after Calcite, from Derry, Ireland; recorded by Greg and Lettson.

Scheelite after Wolfram, from East Pool mine, Cornwall; see Collins, *Min. Mag.* II. 92, and *Handbook to the Mineralogy of Cornwall and Devon*.

Serpentine after Pyroxene and Amphibole from Scotland; see Heddle, *Trans. Roy. Soc. Ed.* 28, pp. 491, 501, 530.

Steatite after Analcime, from Edinburgh; recorded by Greg and Lettson.

Steatite after Faroelite, from Magee Island, Antrim; recorded by Hall.

Steatite after Felspar, from Wheal Coates, St. Agnes, Cornwall; in the British Museum.

Steatite after Pectolite, from Ratho, Edinburgh; in the British Museum; see Heddle, *Phil. Mag.* XVII. 46.

Tourmaline after Felspar, from Cornwall; recorded by Collins.

Vanadinite after Galena, from Wanlockhead; recorded by Greg and Lettson.

Wad after Calcite, from Leadhills; recorded by Greg and Lettson.

Witherite after Barytes, from Dufton; recorded by Greg and Lettson.

Wolfram after Scheelite, from Wheal Maudlin; in the British Museum.

For fuller references to the literature, and for additional mines, see Collins, *Handbook to the Mineralogy of Cornwall and Devon*, p. 80, and Spencer, Index of Subjects, *Min. Mag.* Vols. I.-X. p. 65.

For a recent discussion of pseudomorphs of Calcite after Celestine or Gaylussite, see van Calker, *Zeits. f. Kryst.* (1897) 28, p. 560.