

XI.— *Chapters on the Mineralogy of Scotland. Chapter VIII.*—Silicates.* By
M. FORSTER HEDDLE, M.D., Past President of the Mineralogical Society of Great
Britain, Emeritus Professor of Chemistry in the University of St Andrews.

(Read December 6th, 1897.)

The earlier mineralogists laboured under two great disadvantages. They could not readily, on account of the small number of students of chemistry, call in the aid of that science: and at the time when mineralogy was becoming a distinct branch of science chemistry was in itself crude as well as cumbrous. They were thus forced to rely chiefly upon external properties; and, where crystalline form was absent, they were confined to what may be called physical properties alone.

Their knowledge of the composition of bodies being thus limited and uncertain, the old nomenclature was to a considerable extent founded upon external features alone.

It is the habit of many of the silicates to run out into lengthened crystals, the greatest amount of their concreting material being deposited in the direction of the main axis of the crystal, and when a multiplicity of crystals are concreted, these are thrown out from a common centre of crystallising growth, to radiate through the matrix, very much after the manner of such crystals as have grown in what we term empty or free space, where no matrix is present to interfere with a tendency to divergence. This fact, the evident displacement of that which is not now displaceable, gives us, in the first place, some information as to the condition of the matrix of divergent crystal groups at the time of their formation; and leads us, in the second, to consider whether that matrix was in a very different condition, or held in degree any very different relationship (as a *body foreign* to the substance crystallising in it) from the liquid or the vapour present in those cavities in which we usually find divergent crystalline groups.

The Swedish mineralogist WALLERIUS, who wrote in 1747, was one of the earliest authors who instituted group-arrangements. After considering the gems, and rock-

* Chapter	I. The Rhombohedral Carbonates. Part I,	Trans. R.S.E.,	vol. xxvii. p. 493.
"	II. The Felspars. Part I,	" "	xxviii. p. 197.
"	III. The Garnets,	" "	xxviii. p. 299.
"	IV. Augite, Hornblende, and Serpentinous Change,	" "	xxviii. p. 453.
"	V. The Micas; with description of Haughtonite, a new Mineral Species,	" "	xxix. p. 1.
	VI. "Chloritic Minerals,"	" "	xxix. p. 55.
	VII. Ores of Manganese, Iron, Chromium, and Titanium,	" "	xxx. p. 427
			3 F
VOL. XXXIX. PART II. (NO. 11).			

species, such as felspar, mica, talc, and asbestos, he instituted a family which he termed *Hornbärg* (the *Roche de Corne* of the French); this embraced, as a sub-family, *Skiörl* (Schörl of the Germans).

CRONSTEDT (1758) adopted the same family, and threw into it, "as a convenient pocket," many of the recently discovered species.

It is not altogether easy to make out what species were entitled to get into this pocket, or which side of its medial partition it was intended that they should lodge themselves in, beyond this that *corneus* was to hold "cheap or worthless stones," "mostly of colours from black to dull green."

CRONSTEDT introduced a little more method as regards the "*Skörl*" side of the pocket, making it nearly synonymous with the *corneus crystallisatus* of WALLERIUS, and destined to receive *prismatic minerals* of black, brown, green, and reddish colours, but still having some resemblance to horn in lustre.

He, however, again introduces confusion—a confusion which was continued by WALLERIUS in an edition of 1778—through adopting the term "*Basaltes*" instead of *Skörl*; and HILL, in his work on *Fossils*, 1771, fortifies the error, when, in speaking of the *Shirls*, he says, "as to size we see them from that of barleycorn up to the Giant's Causeway," the columns of which he calls "*Basaltes Hibernicus*" or "*Irish Shirl*."

ROMES DE LISLE, however, in 1783, bringing crystallography to bear, at once got rid of such excrescences as basaltic pillars, hellefintas, and rocks; but on account of chemistry being still a lagging science, he was forced to throw in many new and indeed old species, and to increase the number of adjective distinctions; and though we do find these to be all Silicates, yet he departs from the prismatic elongation by introducing such species as axinite, staurolite, and harmotome.

When chemistry came to lend a hand to the structural erection of the science, the disintegration of the great "*schörl group*" commenced. BERGMANN, by his researches, published in 1780, went far to disband it; the five which lingered last were kyanite, "*blue schörl*"; staurolite, "*cruciform schörl*"; andalusite, "*a red schörl*"; rutile, red schörl; tourmaline, black schörl; and these were extruded from the family in the above order. There is this much indication of these forming a natural group that, with the exception of rutile, they are all silicates of alumina.

It is somewhat singular that the substance—namely, tourmaline—which last retained the name schörl seems to have been that to which the term was first applied. In MATTHESIUS' *Sarepta*, 1562, we find that the name "*schörl*" was used for the "*sterile black little stones*" accompanying tin ore and gold, and which were thus probably *tourmaline*; and as they were metallurgically worthless, it has been suggested that the word originally was derived from the old German word *Schor*, meaning *refuse*.

"*Schörl*" is a name still applied to an inferior fibrous, opaque, black tourmaline; it is the sole representative of a great family; but we still use the adjective *schörlous*—as "*schörlous beryl*"—to imply crystals, thinner and more elongated than usual, which are *imbedded in a matrix with more or less of a radiating arrangement*.

It is more especially the minerals retained longest in this old family of the schorls which fall to be considered in the present chapter, and in chemical simplicity the first of these is Andalusite, Al Si , right prismatic.

1. *Red Andalusite, from Auchendoir, Aberdeen.*

“Red Schorl” from Aberdeenshire has been noticed in several old works, but Mr JAMES SOWERBY, the author of *British Mineralogy* (1804), has the credit of first describing the mineral. He does this with precision, but, though he shows what it is not, he draws a false conclusion as to what it is.

His description is as follows:—

“Argilla durissima, *Scotch Corundum*, spec. char. Nearly pure argil; hardest of all minerals, next to the diamond.

“This curious substance was sent me from a dealer in Aberdeen, under the name of Red Schorle from Achen-door. I figure it here because it is a substance which appears to be new to British writers. Upon inquiry I found it was very little known, nor was it to be found in any mineralogical collection in London, nor scarcely in Scotland. Even Mr JAMESON had not previously obtained it. From him I hope for a good account of it.”

Then follows his description, which concludes: “Among a tolerable quantity I found very few with crystallised terminations; the faces, however, are very distinct. We find this fossil has been taken for a rubellite, and KIRWAN’s description in a great measure accords with that idea. But in many respects it has been confounded with the titanite of KIRWAN. May the radiating variety be the substance of which MACQUART says the garnets are formed? He describes it as consisting of straight fibres diverging from a common centre. KIRWAN mentions red schorl, and says rubellites are so called. Another substance resembling this was found by MORVEAU in Poitou, which he presumed to be adamantine spar.”

After showing how it differs from certain of the above, and giving its properties, SOWERBY writes: “This seems undoubtedly the ‘Spath adamantin d’un rouge violet’ of BOURNON, which he now considers a variety of corundum.”

SOWERBY finally points out JAMESON’s mistake as to corundum occurring at Tiree,* and concludes, “therefore, ours is the only thing known at present as corundum in Scotland.”

Though Auchendoir has been given as the locality for this red andalusite, I rather think that both the localities in which I myself found it are in the parish of Kildrummy, and that only the grey variety is found in Auchendoir. These localities lie a few miles to the south-west of the village of Lumsden. The first—the south side of the Peat Hill—affords but few specimens, and these are poor. The second is the southern slopes of the hill of Clashnaree, in Clova.

* The Tiree mineral is greyish-white malacolite.—M. F. H

The specimens all lie loose, being the most enduring portions of veins which have themselves endured after the disintegration of a very micaceous gneiss. To all appearance, indeed, the specimens seem to represent the "branches" or knots upon very thin veins of quartz, which veins can, after considerable search, be seen formed in the rock, and such as I have found were barren of minerals. The loose lying fragments of veins consist of a melange of quartz, andalusite, labradorite, fibrolite, and an ill-defined black mica.* These minerals interlace in a confused manner, there being no approach to a uniformity in growth from the two sides of the vein. The andalusite crystals, indeed, sometimes pass from side to side, lacing the other ingredients together. The mineral is always rudely crystalline, but regular crystals are very rare. The most perfect I have delineated.

Though I have figured them as "complete" in the terminal planes, yet all the crystals I have seen had these planes hemihedrally disposed. The colour is a uniform dull purplish red; but there is this most important fact to be noted, that all the crystals which can be sectioned and examined, though uniform in structure and transparent in thin slices, have a central core which is deep purple, with purple spots at the four corners of the transverse section, after the manner of chiastolite. Well-crystallised andalusite thus seems to have a complex internal structure which is independent of any portion of the matrix being caught up during its concretion into a geometric solid. This fact, not, so far as I know, before noticed, comes to have an important bearing in all speculations as to the question of the mode of formation of chiastolite crystals in clay-slate rocks.

The crystals are sometimes 3 or 4 inches in length, and occasionally an inch in thickness. Rarely, as noticed by SOWERBY, they form a tube-like sheath to a central core of the felspar; there is not here the slightest appearance of any passage into felspar, as assumed by BOURNON; but there is an almost insensible passage into, or intermixture between it and colourless and brilliant lustred fibrolite.

The specific gravity of this red andalusite is 3.121.

The analysis on 1.302 grammes yielded—

Silica, . . . . .	.442
from Alumina, . . . . .	.036
	<hr/>
	.478 = 36.712
Alumina,	59.678
Ferric Oxide,	2.302
Manganous Oxide, . . . . .	.230
Lime, . . . . .	.860
Magnesia,	trace
Water, . . . . .	.465
	<hr/>
	100.247

Insoluble silica, 4.184 per cent.

* See Chapter V. The Micas (*Trans. R.S.E.*, xxix. (1879) 33).

2. *Andalusite from Marnoch, Banffshire.*

The precise locality is the banks of the stream near the Mill of Achintoul, Kinnordy Castle.

The nature of the ground at Clashnaree—for it is covered with sward and peat—and the consequent impossibility of tracing the specimens into connection with the rock, as well as the confused crystalline arrangement of the constituents of the veins, prevents our arriving at any information which can have a geologic bearing on its formation, simple though it be in composition. This should not be the case, however, as regards its occurrence at Marnoch and elsewhere in Banffshire; though the light thrown therefrom is still obscure. And yet it is not so much that the amount of evidence supplied by the mode of occurrence and internal structure of such substances as the andalusite of Marnoch, the staurolite of Aldernie, the chiastolite of Portsoy, the apophyllite of Kilsyth, and the stilbite of the Long Craig is in itself small, as that we have collected so few observations on the paragenetic formations, and know so little of the physical laws which govern the formation of such crystals as are built up, not according to ordinary polar molecular concretion, but apparently by the sequential interlocking of tessellated structures, each one of which structures seems to have been constructed in defiance of all the recognised laws of crystalline accretion.

As regards internal structural arrangement—the mode of fitting of the molecular or crystallo-molecular bricks of the fabric—the imbedded andalusite crystals of Marnoch yield almost no insight. Because in the formation of the crystals—however that was effected—so much of the matrix has been caught up by the concreting andalusite substance as must be regarded as capable of interfering with the free formation of any definite structure, seeing that it has chemically interfered with the purity of the material attempting to crystallise apart. Possibly its potency to interfere may be all the greater that the intruding substance is present not in the condition of a *magma mica*, but as a perfected mineral formation—biotite mica.

The crystals of andalusite at Marnoch lie all imbedded in a fine-grained schist, which has, when fresh, a pale yellow-brown colour, due to a crypto-crystalline magma of silicate of alumina. This magma is sprinkled throughout with minute crystals of rich brown biotite, granules of quartz, specks of magnetite, and twin crystallisations of staurolite, of less than pin-head bulk. The crystals of biotite lie in all directions, pervading the whole mass; those of staurolite have some disposition to be arranged in special layers; and this is very much more marked as regards the crystals of andalusite, though there are other localities in which it is hardly observable.

The crystals of andalusite are from half to nearly one inch in length, by about one-third of that thickness, and it is to be remarked that though for the most part here disposed in layers, they are very far from invariably disposed upon their sides, as regards the rock bedding, though that position dominates. They are ash-grey in colour, and in section and even to the eye a central lozenge-shaped tessela of darker and clearer shade of colour is seen; while the whole substance of the crystals is also seen to spangle with crystals of biotite. These are equal in size to those generally occurring in the rock, are disposed like these in all directions, and are not very markedly fewer in number.

The analysis of these was made on crystals freed absolutely from the inclosing rock, and with even some portion of their outer surfaces removed to ensure as great purity as possible. They yielded—

On 1·3 grammes—

Silica,	52·538
Alumina,	39·314
Ferric Oxide,	1·094
Ferrous Oxide,	3·267
Manganous Oxide,	·461
Lime,	·861
Magnesia,	·846
Alkalies,	trace
Water,	1·11
	<hr/>
	99·491

Loss, 238 per cent. of water in the bath.

This result shows a very considerable intermixture with all of the ingredients of the rock, notwithstanding which the crystals are hardly affected by the knife, and have a vitreous lustre.

Three theories have been advanced to account for the presence of the crystalline constituents of clay-slates, for they occasionally bulk so largely as to entitle them to the name. According to the first of these theories, the crystals in question are regarded as the product of chemical action in the ocean in which the original material was deposited. The second theory attributes and confines the formation of the crystalline minerals to processes of metamorphism which have taken place subsequent to the solidification of the rocks. The third theory refers them to an aggregative action going on in the still plastic clay-slate mud prior to its solidification.

The first of these theories has been maintained by CREDNER; but against it numerous arguments have been adduced, and especially the difficulty of supposing an ocean capable of depositing from its waters at successive periods minerals of such different chemical composition as actinolite, andalusite, chlorite, etc.

The second theory has received the support of DELESSE, but in opposition to it the existence in the rocks in question of broken crystals which have been re-cemented by the surrounding clay-slate substance has been pointed to.

Striking facts, drawn from the microscopical structure of the rocks, have been adduced by ZIRKEL in favour of the third theory.

Later metamorphic action must not, however, be excluded in seeking to account for the origin of the crystalline constituents of clay-slates.

A review even of the theories themselves suffices to show that four distinct stages at least may be considered in the series of changes by which the rocks in question may have acquired their present character :—

1st, the deposition of the mud ;

2nd, the formation of minerals during the plastic state ;

3rd, the separation or segregation of other materials after solidification ; and

4th, the action of metamorphic processes.

If such processes have operated locally, it will have to be considered whether they most favour the second or the third of these theories, for they may be *local* in their operation either geographically or geologically. They may have operated in close proximity to igneous outbursts, or to limestone formations where there has been much crushing of the beds, or even when there has been disturbance alone. And, geologically, the change may be apparent throughout the whole sweep of a formation, but only up to a certain thickness of its deeper-seated beds.

TOURMALINE.

This substance, common in granitic veins as it is, does not often occur in Scotland either in well-developed forms or of marked purity. The finest crystal I know of, the terminal portion of which I examined, was found in the coarse granite vein of Rubislaw quarry. It occurred along with microcline, muscovite, beryl, and garnet. It was $8\frac{1}{2}$ inches in length by $1\frac{1}{4}$ in width. It was curved like the figure 6, but was perfectly terminated and formed throughout. Fine crystals are rarely found in granite veins in andalusite schist in North Glen Clova in Aberdeenshire.

Material sufficiently pure for analysis was prepared from several localities, but our want of any satisfactory method of determining boracic acid induced the writer to postpone the analyses, except in the case of crystals which were found in the granitic belt of rock which cuts gneiss near Struay Inn, Ross-shire.

It here occurs in jet-black crystals of some inches in length along with muscovite, orthoclase granular pink, and microcline of a dove blue, garnet and beryl. Its specific gravity is * . In powder it is brown.

* The blank was in the MS. Professor GEIKIE informs me that the specific gravity lies between 3·1 and 3·24 ; Scottish examples being nearer to the latter than to the former value.—P. G. T.

On 1·3 grammes—

Silica,	·457	
from alumina,	·005	
		P.C.
		·462 = 35·538
Alumina,		35·55
Ferric Oxide,		·18
Ferrous Oxide,		7·12
Manganous Oxide,		·307
Lime,		1·108
Magnesia,		3·538
Potash,		1·072
Soda,		·429
Boracic Acid (loss),		10·768
Fluorine,		1·705
Phosphoric Acid,		trace
Water,		2·955
		100·000

Fibrolite, ~~At~~ Si. Anorthic.

This species was first recognised as British by the writer, but there is reason to believe that it was noticed by SOWERBY, although he was ignorant of its true nature.

In speaking of the andalusite of Auchendoir, while stating that it does not merge into felspar, he remarks: "The nearest approach to mixing insensibly is by fibres, which in ours are, however, sufficiently distinct." He also remarks: "The gangue is chiefly composed of a coarse granite intermixed with indurated asbestos."

In the first, if not in the second of these observations, he must refer to fibrolite, and had he laid due weight upon the fact that the fibres were "sufficiently distinct," he would have seen that they must have been a material different from the andalusite which he was describing.

The fibrolite of Clashnaree occurs in three different modes of arrangement. First, as a corded or stalactitic-like coating to the other minerals, somewhat after the manner in which galmei coats galena. Here it forms a kind of sheath which envelopes labradorite, quartz, and andalusite alike. Second, it radiates in bundles of fibres through the labradorite, and these fibres often unite into a mass which resembles okenite. This variety is very tough. Third, it frequently is disposed with its fibres in parallel arrangement to the crystals of the red andalusite; and long slender crystals of the red andalusite are often imbedded amongst the fibres of the fibrolite.

As the fibrolite is white or colourless, and of adamantine lustre, it is easily distinguished, and there is nothing of the nature of a transition; it is a case of the main

axis of dimorphous substances lying parallel to one another, as known to occur with grenatite and kyanite, and with other di-morphs.

In this third form it is somewhat more brittle than in the others, but it is still reduced to powder with extreme difficulty. I with difficulty separated a sufficiency of the fibrolite in its third form for analysis; but when separated it was exquisitely pure and brilliant. It had a hardness fully 7 in the scale.

22·1 grains yielded—

Silica,	38·410
Alumina,	61·426
Ferric Oxide,	·215
Manganous Oxide,	·114
Water,	·23
	<hr/>
	100·395

3. *Fibrolite from Pressendye Hill, Tarland, Aberdeenshire.*

The specimens examined I found in small quantity coating gneiss, in thin veins on the north-west side of the hill, at about 300 yards from its summit.

Its colour was dull white; it was not very lustrous; it was in fibrous and slightly matted tufts, which were very tough. No piece was got large enough for the determination of the specific gravity.

It yielded—

Silica,	39·680
Alumina,	58·822
Ferrous Oxide,	·038
Manganous Oxide,	1·100
Potash,	·860
Soda,	trace
Water,	·320
	<hr/>
	100·820

Dr THOMAS AITKEN of Inverness showed me fragments of granite boulders which he had collected at Auchendown, near Cawdor. These contain a substance of an appearance very similar to the last. There is, however, some suspicion in my mind that this may be merely somewhat plicated plates of a hydrous mica, which show the edges of the plates only. The specimens, having been exposed, are not altogether fresh.

There is one fact which so far increases the probability of this being fibrolite, namely, that a black mica, which has much the appearance of that associated with the mineral at Clashnaree, is present in the Auchendown boulders.

Kyanite, ~~At~~ Si. Anorthic.

There is good reason to believe that this species was first found in Scotland.

SAUSSURE, *fils*, describes it under the name *Sappare*, in *Journ. de Phys.*, xxxiv. 213, 1789. His name *sappare* arose from a mistake in reading a label of the mineral, on which it was called *sapphire*; a copy of this label is given in the *Journ. de Phys.* The specimen thus labelled was from Botriphnie in Scotland, and was sent by the Duke of GORDON to SAUSSURE the father.

In the *Descr. Cat. de l'École des Mines*, p. 154, published by SAGE in 1784, it is called *Talc bleu*; but as the present writer found no "Talc bleu" in the collection of l'École des Mines, and as he among the specimens of kyanite found a Botriphnie specimen of the mineral, it is probable *that* had been the specimen termed the "Talc bleu" by SAGE, and the specimen presented by SAUSSURE, having come from the same original source.

The name *sappare* was used for the mineral by some writers up to 1823, when we find it employed by JAMES SMITHSON who, in virtue of its infusibility, used it as a support in blowpipe experiments.*

Kyanite is no longer got at Botriphnie, and the precise spot where it occurred I have not been able to find. Specimens from this locality are in the collection at Jermyn Street Museum, and in those of Edinburgh, Banff, and, I think, Montrose. They were larger and finer than any now obtained in Scotland. The only associated mineral is margarodite.

The second locality at which this mineral was found in Scotland was in the vicinity of the Burn of Boharm, about a mile above the house of Auchlankart—that at least is the spot where the writer has found it in *North Boharm*.

Dr MACCULLOCH, in writing of it at this spot, gives the following accurate description of it, one which should be pondered in considering the metamorphism of the rock matrix.

"Boharm. This sappare-disthene is said to have been originally discovered in this place. The crystals occur in a quartz vein which traverses a talcose clay-slate. They pass through both without any change of their direction or appearance; seeming to mark a common condition in the schist and the quartz at the period of their formation. Although these crystals in general penetrate and impress the quartz, they are sometimes bent and waved, as if they had accommodated themselves to its irregularities. This is not the case, however, with those imbedded in the talcose slate, which radiate in brushes of rectilinear crystals through its mass. This rock consists of a talcy clay-slate, so penetrated with hornblende as to render its character for an instant doubtful. On an accurate examination it will be seen that the body of the rock is a clay-slate, and that it is interspersed throughout with lamellar and thin crystals of hornblende. These lamellæ are generally disposed at right angles to the lamella of the schist, and are sometimes short and straight, and variously placed, interfering with each other often in every direction. More commonly they diverge from a sort of central axis in curved planes, so

* SMITHSON remarks: "Chemical analysis carries destruction along with it, and bestows knowledge of a substance only at the cost of its existence. One remedy which can be offered for this defect is to reduce the scale of operating, and thus as far as possible reduce the amount of the sacrifice."

that their section, according with that of the lamella of the schist, exhibits an appearance of curved pencilliform groups of acicular crystals, frequently an inch in length, assuming an appearance of great singularity. In this direction the schist is visible, and appears to form the largest part of the stone, while in the cross fracture, the lamellæ of hornblende alone being seen, the whole rock seems to consist of this mineral. Occasionally the hornblende displays crystals disposed in so many different ways that the schist is discernible even in the cross fracture."

To this description I have only to add that the specimens I have obtained from near Auchlankart were all of the *rhætizile* or grey variety, much impregnated with the substance of the schist, in which indeed I alone here found them, but that I found at the same spot—which is at the upper fork of the burn—crystallised staurolite in simple crystals, the mode of the occurrence of which—as regards the quartz and the rock matrix which alike hold them—was precisely as described by MACCULLOCH for disthene. These crystals of staurolite were amber coloured and transparent, but had a central structure, which will be noticed below.

Specimens nearly as fine as those from Botriphnie were formerly found by Colonel IMRIE loose lying in the neighbourhood of Millden and the Burn of Turret, North Glen Esk, Forfarshire. One of these has been figured by SOWERBY, vol. iii. p. 49. Here also margarodite is the sole associate.*

"Near Banchory, in Aberdeenshire," "near Mortlach, Banffshire," and "in quartz near the summit of Ben y Gloe," in blue radiating crystals, in quartz nodules, in clay-slate, in limestone at Ardonald, by Cunningham, are old localities at which this mineral is no longer found.

It has long been known, and is still found at Vanleep, Hillswick, Shetland. At this gash, a chasm in the cliffs of the western shore of Hillswick, kyanite occurs of three markedly dissimilar appearances.

The ordinary blue crystals generally isolated and imbedded in massive quartz are here very rare. Large plumose groupings of a reddish-grey colour, also occurring isolated in massive quartz, are less rare; but the common appearance is that of veins or large isolated nodules of smaller intermatted crystals of an anchovy-red passing into

* I analysed a specimen from Colonel IMRIE's collection, and obtained on 1·3 grammes :—

Silica,	36·384
Alumina,	58·296
Ferric Oxide,	1·609
Ferrous Oxide,	1·123
Lime,	·861
Potash,	·252
Soda,	·423
Water,	1·445
	<hr/>
	100·393
The loss in bath was	·282 per cent.
The insoluble silica,	1·691 "
The specific gravity,	3·538 "

white, and apparently dark green, from an intimate intermixture of chlorite plates. Occasionally a plate or two of talc occurs, and very rarely large and fine crystals of chloritoid. These veins cut the huge beds of quartz which intercept the micaceous strata of the promontory. The locality faces the picturesque sea-stacks of red porphyry termed the Drongs. The crystals analysed were picked white, somewhat tinted with pink.

On 1·2 grammes—

Silica,	·474
from Alumina,	·022
	·496 = 38·153
Alumina, . . . . .	. 56·979
Ferric Oxide, . . . . .	. 1·867
Manganous Oxide, . . . . .	. 153
Lime, . . . . .	. 301
Water, . . . . .	. 2·646
	100·099
Loses in the water-bath, ·701 per cent.	
Insoluble silica, 3·024 per cent.	

From near Millden in Tarffside, Forfarshire. This occurs in large flat crystals of a fine blue colour.

I have found it at the following new localities in Shetland. Cliffhill, near Woodwick, and north-west of Norwick Bay in Unst. *Magnetite* and *garnets* are its associates at the first of these localities; it is in quartzose belts at the last; the rock in both cases being gneiss, and the colour of the mineral pale blue. At the south end of the Wark of Skewsburgh, in the Mainland, associated with *ilmeneite* in quartz veins in gneiss. It is here greyish-white to blue. To the east of the same hill near its north end.

Kyanite has more recently been found at the following localities:—

In minute crystals of perfect transparency and deep blue colour along with green hornblende and red garnet, forming the rock eklogite. This was found by Mr DUDGEON, to the north-east of Obb, in Harris.

Finely crystallised in the form of the figure and of a fine blue colour, at a height of about 1100 feet, on the north-west slopes of Garlat Hill, Cowie Hill, Tarffside, by Mr ROBERT MURRAY. The matrix here was gneiss and the associate finely crystallised chlorite.

In interlacing grey crystals in gneiss far up in bed of the burn which comes from the east into Glen Derry, Loch Callater, Aberdeenshire, by the Rev. Mr PEYTON.

In blue crystals in gneiss in Allt Beg, Glen Rinnies, by Mr JAMES WILSON.

In mica schist at a bridge over the Little Drumlach, in the parish of Enzie, Banffshire,* by Mr WALLACE of Inverness.

* *Min. Mag.*, vol. vi. No. 28. But no description given.

By the writer it has been found—

In small blue crystals in Hebridean gneiss on the hill to the west of Ben Chaipaval in Harris.

In quartzite near summit of Carn Lia, Ben y Gloe, Perthshire.

In greyish-blue crystals, along with garnet, sphene, ilmenite, and chlorite, in mica schist, one mile north of Loch Bulg in Aberdeenshire.

In large blue-grey crystals, along with ilmenite and chlorite, in gneiss on the slopes on the east side of the corry of Meall Buidh, on the south side of the Moor of Rannoch.

In gneiss in the railway cutting west of Mulben, Banffshire.

In bright blue crystals in gneiss near limestone about one mile west of the limestone quarries at Dulnan, Inverness-shire.

Loose lying in grey and blue interlacing crystals on the south slopes of Cruach Ardran, in Perthshire.

In tufts of grey crystals impregnated with the substance of the rock in clay-slate, at the lime quarries of the Burn of Aldernie, Banff.

In large single imbedded blue crystals and fasciculitic tufts, a peculiar yellow margarodite slate, south-east of the lime quarries in Glen Urquhart.*

In quartzose veins in a clay slate which contains rosette groupings of actinolitic crystals in the rocks, about three-quarters of a mile north-west of Sandend in Banffshire. The crystals of the mineral here, an inch or two in length, pass through portions of both matrix and vein, after the manner of rivets, just as described by MACCULLOCH as occurring at Boharm. They appear to have issued from the matrix into the vein, as if formed nearly contemporaneously with the filling of the latter with the quartz; but as the terminations are not distinct, this conclusion is drawn from the greater breadth of the crystals, where they lie in the quartz, than in the schist.

These crystals, like those at many other of the above localities, are in parts colourless or pale yellow.

In lenticular quartz nodules, often morion, and sometimes prase, with pyrite, in chialstolite slate, west of the clay-slate quarry near Portsoy, sometimes colourless.

* This yielded on 1·3 grammes :—

Silica,	37·53
Alumina,	58·105
Ferric Oxide,	2·089
Lime,	·129
Magnesia,	·076
Potash,	·252
Soda,	·741
Water,	1·198

100·12

Its specific gravity was 3·016.

EPIDOTE.

1. From Balta Island, Shetland. Occurs in a geo which cuts the island near the centre of its eastern cliff-lined shore. The epidote occurs in crystals of half an inch in size, imbedded without any associate in a quartz vein which cuts gabbro. The epidote is pale pea-green, the quartz somewhat granular.

On 1.396 grammes—

Silica, . . . . .	.531
from Alumina, . . . . .	.01
	<hr/>
	.541 = 38.753
Alumina,	26.986
Ferric Oxide,	7.898
Ferrous Oxide,	1.806
Manganous Oxide, . . . . .	.501
Lime,	20.378
Magnesia, . . . . .	.786
Potash, . . . . .	.25
Soda, . . . . .	.21
Water,	2.376
	<hr/>
	99.944

Insoluble silica, 7.578 per cent.

2. The above occurrence of epidote certainly in no way bears out the theory of its resulting as a product of the alteration of hornblende. This, however, may have been the case at the next locality which I quote. This is Nudista in Hillswick.

It here occurs in dull, soft-looking crystals of an olive-green colour, of about an inch in length. These crystals radiate through large foliated crystals of dark green hornblende, cutting the foliations transversely. The specific gravity of this epidote is 3.396.

On 1.304 grammes—

Silica, . . . . .	.484
from Alumina, . . . . .	.009
	<hr/>
	.493 = 37.866
Alumina,	24.722
Ferric Oxide,	9.961
Ferrous Oxide, . . . . .	.361
Manganous Oxide, . . . . .	.536
Lime,	23.104
Magnesia, . . . . .	.766
Water,	2.822
	<hr/>
	100.138

3. From North Quin Geo, Hillswick. Epidote occurs here filling a small vein. It forms stellate groups of rich green crystals over an inch in length.

The analysis on 1.503 grammes yielded—

Silica,	36.127
Alumina,	20.574
Ferric Oxide,	14.921
Manganous Oxide, . . . . .	.306
Lime,	23.025
Magnesia, . . . . .	.306
Water,	4.568
	<hr/>
	99.827

Insoluble silica, 7.734 per cent.

The ferric oxide is to the alumina as 1 to 2.

4. From Delnabo, Glen Gairn, Aberdeenshire. Out of the old limestone quarry. It occurs imbedded in green prehnite, in radiated crystals of a pale green colour.

On 1.501 grammes —

Silica,	38.374
Alumina,	26.087
Ferric Oxide,	10.388
Manganous Oxide, . . . . .	.738
Lime,	21.647
Magnesia, . . . . .	.239
Water,	2.441
	<hr/>
	99.914

Insoluble silica, 7.812 per cent.

The ferric oxide is to the alumina as 1 to 4.

WITHAMITE.

This red variety has been found only at one spot. This is a projecting spur of amygdaloidal felspathic porphyry, which touches the road through Glencoe upon its north side, about three miles above the turn of the glen. The epidote occurs in the little druses, very rarely in bright green crystals. It is then associated with byssolite and chlorite. Much more frequently it occurs in the red modification. It forms very minute acicular crystals of a brilliant blood-red colour. These crystals radiate from the sides of the druses, a narrow layer of a milky saussurite-like substance sometimes intervening. The crystals are red and yellow respectively in two directions, at right angles to one another (MACKNIGHT and BREWSTER). Minute specks of quartz sometimes occur.

On account of the extremely minute quantity in which this substance is found, the purifying of the sample analysed was executed with extreme care.

On 1·3 grammes—

Silica,	·543
from Alumina,	·019
	<hr/>
	·562 = 43·23
Alumina,	23·09
Ferric Oxide,	6·675
Ferrous Oxide,	1·131
Manganous Oxide,	·138
Lime,	20·003
Magnesia,	·884
Potash,	·962
Soda,	·935
Lithia,	·253
Water,	2·4
	<hr/>
	99·701

Insoluble silica, 1·957 per cent.

This result is by no means a satisfactory agreement with the composition of epidote.

ZOISITE.

1. This mineral was first found by me in Britain in Glen Urquhart, Inverness-shire. It occurred in the most southerly of the limestone quarries, about a mile north-east of Milltown. It was found only in one large nodule of calcite of about a hundredweight, crystals of a grey to a pale bluish-white colour, about one inch in length, interlaced in the calcite. There was a very little quartz; a few specks of chalcopyrite and brushes of light green actinolite in association with the mineral.

The crystals, and indeed the mineral, has the general appearance of tremolite, but the cleavage leaves no room for doubt. The form is well seen in these crystals, but there are no terminations. The cleavage face seems a twin face, as there are repeated re-entering angles which produce a coarse striation. The crystals are brittle. The cleavage face is somewhat pearly; fractures are vitreous. The specific gravity taken on three pieces gave 3·004, 3·111, and 3·014.

On 1·303 grammes—

Silica,	·484
in filter,	·019
from Alumina,	·013
	<hr/>
	·516 = 39·60
Alumina,	31·083
	<hr/>
Carry forward,	70·683

Brought forward,	70·683
Ferrous Oxide,	2·071
Manganous Oxide,	·078
Lime,	23·336
Magnesia,	trace
Potash,	·566
Soda,	1·056
Water,	2·412
	100·202

Insoluble silica, 1·55 per cent.

2. From an adjacent quarry; the mineral being very similar, but the matrix was quartz. The specific gravity is 3·014.

On 25 grains—

Silica,	41·56
Alumina,	29·901
Ferrous Oxide,	3·205
Lime,	22·142
Magnesia,	·332
Potash,	·345
Soda,	·684
Water,	2·19
	100·359

Insoluble silica, 2·31 per cent.

3. From the same quarries, but in large crystals of about 2 inches by $1\frac{1}{4}$. These large crystals were lying loose in the quarry, the calcite having apparently been dissolved away by rain. They were slightly browned on the outside, but lustrous when broken. Three determinations of the gravity gave 3·312, 3·322, 3·318.

On 1·301 grammes—

Silica,	·48
from Alumina,	·034
	·514 = 39·508
Alumina,	30·827
Ferrous Oxide,	2·52
Manganous Oxide,	·077
Lime,	22·813
Potash,	·681
Soda,	·9
Water,	2·505
	99·831

Insoluble silica, 2·334 per cent.

4. From Laggan, Dulnan Bridge, Inverness-shire.

This was given me by Sir ARCHIBALD GEIKIE. It was got in quartz veins in the limestone quarry. It occurs in pale brown crystals entirely imbedded in the quartz. The crystals are lustrous and well defined; the associates are chlorite and sahlite. In the near neighbourhood there is much kyanite. The specific gravity is 3·438.

On 1·2 grammes—

Silica,	·463
from Alumina,	·002
	<hr/>
	·465 = 38·75
Alumina,	28·144
Ferric Oxide,	6·547
Manganous Oxide,	·916
Lime,	22·026
Magnesia,	·416
Water,	3·333
	<hr/>
	100·132

Loses in the bath, ·155 per cent.

5. From Loch Garve, Ross-shire. This locality was found by the late W. H. BELL. It is that in which the mineral occurs in much largest quantity in Scotland, and also in much the largest crystals. It occurs in a quartzose vein, which, starting from near the centre of the south shore of the lake, strikes right up the hill for two or three hundred feet. Sometimes it is almost massive, occasionally in crystals of a stouter habit than those of Urquhart. The colour is ash-grey to white, passing to pale yellowish-brown. It is translucent. The specific gravity is 3·268.

On 1·34 grammes—

Silica,	40·066
Alumina,	30·834
Ferric Oxide,	1·58
Ferrous Oxide,	·48
Manganous Oxide,	·22
Lime,	23·66
Magnesia,	·476
Potash,	·504
Soda,	·428
Water,	2·100
	<hr/>
	100·348

Insoluble silica, 2·2 per cent.

IDOCRASE.

From Delnabo, Glen Gairn, Aberdeenshire. Idocrase occurs abundantly, passing when massive almost insensibly into garnet in the old limestone quarry. The portion taken for the analysis was a portion of a magnificent dark brown crystal of about $7\frac{1}{2}$ inches in length by nearly 1 inch in width, which was fractured by the blow which disclosed it. Its specific gravity was 3.43.

On 1.302 grammes—

Silica, . . . . .	.45
from Alumina, . . . . .	.022
	<hr/>
	.472 = 36.251
Alumina,	18.626
Peroxide of Iron, . . . . .	.932
Ferrous Oxide,	5.036
Manganous Oxide, . . . . .	.844
Lime,	33.935
Magnesia,	1.574
Potash, . . . . .	.568
Soda, . . . . .	.329
Water,	1.78
	<hr/>
	99.875

Insoluble silica, 1.483 per cent.