

Reviews and Notices.

Chapters on the Mineralogy of Scotland, by PROF. M. FORSTER-
HEDDLE, F.R.S.E.

Trans. Royal Soc., Edinburgh, Vol. XXIX, Chap. VI.—Chloritic Minerals.
Read 3rd March, 1879.

ANOTHER of our esteemed President's interesting "chapters," not less important than those which have gone before.

The author commences his paper with some general remarks upon Mineralogical classification, and upon the use of the terms "chlorite" and "chloritic mineral," as follows:—

There is no department of natural science which is so defective in its general scheme of arrangement as mineralogy; and its sectional grouping is, if possible, still more defective.

Such correlations as are expressed by the terms, "The Micæ,"—"The Felspars,"—"The Garnets," &c., are only admissible if the substances united in such groups are included under one general formula, and function in a more or less similar manner as rock-formers.

Under such methods of arrangement as are in vogue, many substances are left to stand isolated as intermediates,—substances which frequently form important integers in a regular sequence. And when such groups are constituted upon the possession of merely some one general feature, it almost invariably results that there are linked together substances which have nothing else in common.

Mineralogy presents numberless examples of the misleading effect of being guided by mere externals; and the more the *geognostic relations* of minerals are sought out, the more clearly do we see the false conclusions with which we are drawn when we *are* guided by externals alone.

To no group does this apply more emphatically than to that of "*The Chlorites*." Of the twelve minerals which in our systems find a place therein, some are the products of mere solution—some of direct chemical change,—some of metamorphic transmutation. Of these, some are found in sedimentary rocks, some in volcanics, in limestone, in serpentine, in schists, in granite, and in traps.

The extreme injudiciousness of founding a natural history group upon so trivial a character as *colour* alone, is shown by the laxity which has gradually crept in, by the expanding as it were of the name into "the Chloritic group," or "Chloritic minerals."

From the difficulty of discriminating between several substances which fall under such a term, there can be no doubt that it has not unfrequently been adopted as a convenient cover for ignorance.

"I always say *chloritic minerals* when any of my students ask me what they are,—it covers a vast amount of ignorance." This was the remark made to me by a teacher of geology, when we were discussing the green substances which plug the steam holes of amygdaloids. The deductions to be drawn from the present investigation, will show that the term employed instead of covering, *exposed* that which it was intended to conceal.

From the very frequent occurrence of difficultly-recognisable green minerals in volcanic rocks, it is to them that this term of chloritic is now *specially* applied; it is so applied in the belief that the mineral is a chlorite of some kind, and this is conceived to be quite a sufficient amount of knowledge.

In proof that there has been no overstatement in the foregoing remarks, Dr. Heddle refers to Mr. J. Clifton Ward's "Notes on the occurrence of Chlorite . . . in the English Lake District,"* and to the writings of Von Cotta, who, in defining diabase says "and some chlorite" "The green colour of the rock is chiefly owing to its chlorite.

"The most marked feature of its difference from dolerite is its chlorite, and its consequent green colour. If this chlorite be a product of transmutation, then all the original difference between diabase and dolerite probably consists in the level or depth of solidification."

Dr. Heddle continues:—

It is significant that Cotta does not enumerate chlorite among the minerals accessory to diabase, its clefts and veins; while he says "the vesicular cavities are filled with . . . chlorite, glauconite and the like." It is well known that the veins of a rock contain the materials of its general structure in giant development of crystals, while its amygdules contain the products of the transmutation thereof, through aqueous change and transfer.

Lately, however, clearer light is beginning to be thrown on the matter, for we have Dana supporting Rosenbusch, when he says that chlorite is not an essential characteristic of diabase; and those who look in Scotland for chlorite in rocks, in all other respects entitled to the name of diabase, will certainly find none.

If we are to accept and found upon the above admissions, namely, that the amygdules of these so-called chloritiferous vol-

* Since this review was placed in the printer's hands, the untimely death of this most active and able geologist has been announced—to the great and we fear permanent detriment of the Scientific Societies of Cumberland, for whom he acted as a bond of union.

cænicus contain the material which, diffused in a minute-granular or flakey condition throughout their mass, imparts the occasional green tint, then analysis has determined that material to be in no way connected with chlorite, except in colour.

The results of the following investigation go to show that the minerals usually thrown together under the term which I somewhat unwillingly adopted as the heading of this chapter, are to be grouped under two absolutely distinct heads. For the first, the old term of *the chlorites* may be retained; to the second, the term *the saponites* may be applied, from the unctuous feeling, which is a marked characteristic of them all.

So far as the evidence of over fifty analyses, and much contingent observation, entitles me to speak, the members of the first of the groups are found only in sedimentary and metamorphic rocks, never occurring in volcanics; the second are confined invariably to the latter, never being seen in the former class of rocks. The members of the first are not decomposed by chlorhydric acid, and there is no peculiarity in the manner in which their constituent water functions.

The members of the second are (with one exception) readily decomposed by chlorhydric acid, and the mode in which a portion of their constituent water is held in combination is anomalous.

The first are to be regarded as constituents of the rock mass which contains them, paragenetic in time with the minerals associated with them. The second are products of the degradation of the primal constituents of the rock, and are compounds of a more stable nature than the originals which yielded them through a destructive change.

So far as I have yet ascertained, the following members of each of these groups occur in this country.

| | | |
|---------------|-------------------|------------|
| | <i>Chlorites.</i> | |
| Glauconite | Penninite | Chlorite |
| Talc-chlorite | Ripidolite | Chloritoid |
| | <i>Saponites.</i> | |
| Delessite | Hullite | Celadonite |
| Chlorophæite | Saponite | |

As regards *the Chlorites*, after some general remarks upon the physical characters, which the author says "lend scarcely any aid, if they do not even somewhat confuse" as regards their determination, and referring to the dearth of information as to the geognostic relations of minerals, Dr. Heddle proceeds to describe in detail the localities, modes of occurrence of each of the Scottish species, and gives full chemical analyses—these latter being epitomized in table 1.

TABLE 1.

| PENNINITE. | | | | | | | | | | | | | | |
|---|-------|-------|-----------------|-----------------|-----------------|-------|------|------|-------|----------------|-----------------|----------------|---------|------------------------------|
| | S. G. | Si. | Al ₂ | Fe ₂ | Cr ₂ | Fe. | Mn. | Ca. | Mg. | K ₂ | Na ₂ | H ₂ | Totals. | Matrix. |
| Scalpay, Harris | 3·069 | 30·41 | 11·58 | 2·34 | .. | 10·71 | 1·19 | tr. | 30·63 | ·01 | 1·31 | 11·74 | 99·92 | Serpentine |
| Corrycharraig, G. Lochy... | 2·895 | 34·31 | 13·64 | ·36 | tr. | 10·31 | ·23 | 8·97 | 18·04 | 1·36 | ·13 | 12·41 | 99·75 | Mica slate. |
| <i>Kamererite</i> — | | | | | | | | | | | | | | |
| Unst, massive | 3·069 | 29·89 | 12·93 | .. | 5·97 | 1·96 | .. | 3·54 | 29·93 | 1·16 | ·97 | 13·27 | 99·62 | Serpentine |
| Do., crystallised... .. | .. | 32·31 | 7·5 | .. | 7·89 | 2·08 | .. | 3·83 | 32·15 | .. | .. | 14·25 | 98·9 | Do. |
| <i>Pseudophite</i> or (?) <i>Pyrosoclerite</i> — | | | | | | | | | | | | | | |
| Beauty Hill, Aberdeen ... | 2·59 | 34·73 | 12·44 | .. | .. | 2·68 | 1·17 | 1·6 | 34·1 | .. | .. | 13·1 | 99·82 | Gabbro. |
| RIPIDOLITE. | | | | | | | | | | | | | | |
| Blair Athol | .. | 30·3 | 19·4 | .. | .. | 8·23 | ·37 | .. | 29·1 | .. | .. | 13·07 | 100·47 | Limestone |
| Hillswick, Shetland | .. | 32·55 | 13·95 | ·97 | .. | 5·28 | ·16 | ·79 | 32·78 | ·48 | ·06 | 13·17 | 100·19 | Chlorite slate |
| Cape Wrath... .. | 2·823 | 31·03 | 14·85 | 5·73 | .. | 17·42 | 1· | ·36 | 17·42 | .. | .. | 12·48 | 100·29 | Homblendic <i>glaucis</i> |
| <i>Aphrosiderite</i> — | | | | | | | | | | | | | | |
| Bishop's Hill, Argyll... .. | 2·959 | 35·41 | 18·08 | ·48 | .. | 26·47 | ·61 | 1·01 | 8·77 | ·98 | ·52 | 8·03 | 100·36 | Chlorite slate |

TABLE 1—Continued.

| CHLORITE. | | | | | | | | | | | | | | |
|----------------------------|-------|-------|-----------------|-----------------|-----------------|-------|------|------|-------|----------------|-----------------|----------------|--------|------------------|
| | S. G. | Si. | Al ₂ | Fe ₂ | Cr ₂ | Fe. | Mn. | Ca. | Mg. | K ₂ | Na ₂ | H ₂ | Totals | Matrix. |
| Fethaland, Shetland ... | 3.002 | 24.3 | 20.56 | 3.57 | ... | 16.72 | .55 | .5 | 22.2 | 1.73 | .05 | 11.55 | 99.51 | Mica gneiss. |
| Ben Derag, Perthshire ... | 2.697 | 24.72 | 21.57 | .62 | ... | 26.16 | .47 | .45 | 12.86 | 1.29 | .56 | 10.89 | 99.7 | Mica slate. |
| Craig-an-Lochan, do ... | 2.852 | 24.29 | 21.18 | 1.10 | ... | 18.74 | .8 | 1.66 | 21.08 | ... | ... | 10.08 | 99.39 | Do. |
| Lude, do ... | 2.852 | 23.92 | 22.98 | 1.11 | ... | 19.54 | .28 | 2.45 | 17.26 | ... | ... | 11.78 | 99.65 | Limestone. |
| Do., do ... | 2.834 | 24.66 | 23.19 | .64 | ... | 20.58 | .29 | .4 | 17.79 | ... | ... | 12.12 | 100.62 | Quartz in ditto. |
| Loch Laggan, Inverness ... | 2.834 | 26.25 | 19.22 | 1.67 | ... | 18.44 | 1.02 | ... | 24.35 | ... | ... | 11.67 | 100.39 | Limestone. |
| Portsoy, Banffshire ... | 2.792 | 26.71 | 20.42 | 3.47 | ... | 13.99 | .73 | ... | 23.9 | ... | ... | 11.17 | 100.39 | Chlorite slate. |
| Girdleness, Kincardine ... | 3.038 | 24.77 | 20.16 | 1.38 | ... | 27.39 | .61 | .9 | 13.34 | ... | ... | 12.05 | 100.39 | Granite vein. |
| CHLORITOID. | | | | | | | | | | | | | | |
| Hillwick, green ... | 3.387 | 24.47 | 41.34 | .38 | ... | 18.52 | .21 | .3 | 6.8 | ... | ... | 6.98 | 99.71 | Mica slate |
| Do., brown ... | 3.356 | 25.36 | 41.74 | 3.89 | ... | 13.33 | .92 | .90 | 6.82 | ... | ... | 6.57 | 100.41 | Do. |
| TALC-CHLORITE. | | | | | | | | | | | | | | |
| Hillwick ... | ... | 39.81 | 11.43 | ... | ... | 7.97 | .26 | 2.80 | 25.68 | 1.2 | 3.15 | 7.91 | 100.19 | Chlorite slate |
| GLAUCONITE. | | | | | | | | | | | | | | |
| Asbgrove, Elgin ... | ... | 49.09 | 15.21 | 10.56 | ... | 3.06 | ... | .55 | 2.65 | 6.05 | 1.21 | 11.64 | 100.02 | Cornstone. |

He then does the same for the *Saponites*—the analyses being here given in table 2.

TABLE 2.

| DELESSITE. | | | | | | | | | | | | | |
|----------------------------------|-------|--------------|-------|-----------------|-----------------|-------|-----|------|-------|----------------|-----------------|----------------|--------|
| | S. G. | Loss at 212° | Si. | Al ₂ | Fe ₂ | Fe. | Mn. | Ca. | Mg. | K ₂ | Na ₂ | H ₂ | Total. |
| St. Cyrus, Kincardine | 2.652 | 2.744 | 32.69 | 13.44 | 4.4 | 6.62 | ... | .86 | 28.77 | ... | ... | 13.25 | 100.02 |
| Bowling Quarry, Dumbarton | 2.573 | 5.7 | 32 | 17.33 | 1.19 | 12.45 | ... | 1.57 | 20.42 | ... | ... | 15.45 | 100.4 |
| Dumbuck, do. | 2.598 | 6.3 | 32.01 | 18.87 | 1.18 | 12.09 | tr. | 1.39 | 19.64 | ... | ... | 15.16 | 100.64 |
| Long Craig, do. | 2.656 | 4.678 | 30.93 | 15.32 | 3.16 | 15.31 | .38 | 1.38 | 18.65 | ... | ... | 14.69 | 99.82 |
| Elie, Fifeshire... .. | 2.672 | 3.389 | 30.69 | 12.83 | 1.63 | 18.32 | 1. | 1.59 | 18.6 | ... | 1.11 | 13.77 | 100.11 |
| Average | 2.63 | 4.562 | 31.26 | 15.56 | 2.32 | 12.96 | ... | 1.38 | 21.22 | ... | ... | 14.52 | ... |
| Formula | ... | ... | 31.53 | 16.28 | 2.3 | 12.61 | ... | ... | 21.02 | ... | ... | 15.76 | ... |

| CHLOROPHLEITE. | | | | | | | | | | | | | |
|----------------------------------|-------|--------------|-------|-----------------|-----------------|------|-----|------|-------|----------------|-----------------|----------------|--------|
| | S. G. | Loss at 212° | Si. | Al ₂ | Fe ₂ | Fe. | Mn. | Ca. | Mg. | K ₂ | Na ₂ | H ₂ | Total. |
| Scur Mohr, Rum | ... | 19.227 | 36 | ... | 22.8 | 2.46 | .5 | 2.52 | 9.5 | tr. | tr. | 26.46 | 100.25 |
| Giant's Causeway, Ireland | 2.278 | 14.156 | 35.99 | 10.49 | 11.89 | 1.63 | .08 | 5.15 | 10.52 | .34 | .76 | 23.2 | 99.99 |
| "Hullite" (hydrated) | ... | ... | 35.06 | 9.21 | 18.42 | 3.25 | tr. | 3.99 | 6.65 | ... | ... | 23.2 | 99.78 |

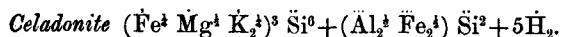
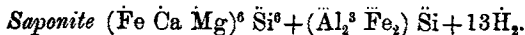
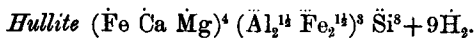
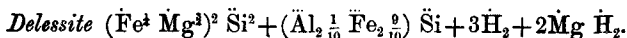
| HULLITE. | | | | | | | | | | | | | |
|---------------------------|-------|--------------|-------|-----------------|-----------------|-------|------|------|------|----------------|-----------------|----------------|--------|
| | S. G. | Loss at 212° | Si. | Al ₂ | Fe ₂ | Fe. | Mn. | Ca. | Mg. | K ₂ | Na ₂ | H ₂ | Total. |
| Kinkell, Fifeshire | ... | 8.029 | 38.59 | 17.34 | 15.97 | n. d. | 1.56 | 3.94 | 8.65 | .67 | ... | 13.48 | 100.2 |
| Carmonay (Hardman) | 1.76 | ... | 39.44 | 10.85 | 20.72 | 3.7 | ... | 4.48 | 7.47 | ... | ... | 13.62 | 99.78 |
| Average | ... | ... | 39 | 13.84 | 18.35 | 3.7 | ... | 4.48 | 8.06 | ... | ... | 13.5 | ... |
| Formula... .. | ... | ... | 38.77 | 12.44 | 19.38 | 3.55 | ... | 4.04 | 8.72 | ... | ... | 13.1 | ... |

TABLE 2—Continued.

| SAPONITE. | | | | | | | | | | | | | |
|----------------------------------|-------|-------------|-------|-----------------|-----------------|------|-----|------|-------|----------------|-----------------|----------------|--------|
| | S. G. | Loss at 212 | Si. | Al ₂ | Fe ₂ | Fe. | Mn. | Ca. | Mg. | K ₂ | Na ₂ | H ₂ | Total. |
| <i>From "Old Red" Volcanics—</i> | | | | | | | | | | | | | |
| Gapoi, Kincardineshire ... | 2.179 | 15.746 | 42.13 | 7.25 | 6.57 | .19 | .13 | .8 | 19.33 | .58 | 2.09 | 21.07 | 100.14 |
| Kinnell, do. (green) ... | split | 14.092 | 42.1 | 5.95 | 4.96 | .18 | .09 | 2.15 | 20.98 | .28 | .46 | 22.93 | 100.08 |
| Do. do. (purple) ... | 2.28 | 14.52 | 42.5 | 5.88 | 4.91 | .12 | .12 | 2.13 | 20.74 | .19 | .47 | 22.75 | 99.79 |
| Glen Farg, Perthshire ... | 2.285 | 12.961 | 36.54 | 9.39 | 2.85 | 5.25 | .15 | 2.5 | 21.62 | ... | ... | 21.68 | 96.97 |
| Wormit Bay, Fifeshire ... | ... | 13.87 | 42.84 | 4.83 | 6.5 | 2.36 | 2 | 2.16 | 21.81 | tr. | ... | 20.7 | 101.39 |
| Tayport, do. ... | 2.282 | 13.96 | 40.11 | 6.49 | 5.61 | 2.37 | tr. | 2.01 | 21.67 | .32 | .21 | 21.6 | 100.38 |
| Catkin Hills (scaly) ... | 2.279 | 15.61 | 41.34 | 10.53 | 1.86 | 3.84 | .09 | 1.22 | 21.07 | .05 | .37 | 19.48 | 99.48 |
| Do. (fibrous) ("Bowlingite") ... | 2.288 | 14.76 | 42.22 | 8.52 | 2.99 | 4.88 | .07 | .92 | 21.23 | ... | ... | 19.49 | 100.31 |
| Bowling, Dumbarton (do.) ... | 2.308 | 12.315 | 38.08 | 6.26 | 4.36 | 4.98 | .23 | 2.97 | 21.46 | .95 | .11 | 20.48 | 99.96 |
| Do. do. (Mr. Dalziel) ... | ... | 12.965 | 36.74 | 5.35 | 5.94 | 6.96 | .08 | 3.06 | 20.22 | .49 | .21 | 21.28 | 100.31 |
| <i>From Secondary Volcanics—</i> | | | | | | | | | | | | | |
| Storr, Skye (olive) ... | 2.296 | 13.652 | 41.41 | 9.08 | 2.05 | ... | .11 | 1.86 | 22.8 | ... | ... | 23.43 | 100.72 |
| Quiraing, Skye (white) ... | split | 15.536 | 42.5 | 5.06 | .85 | ... | .23 | 3.27 | 23.95 | .17 | .45 | 23.68 | 100.14 |
| Do., do. (yellow) ... | split | 15.132 | 40.33 | 8.72 | 1.97 | ... | .13 | 2.8 | 21.71 | ... | ... | 24.34 | 99.99 |
| Average ... | 2.272 | 14.22 | 40.63 | 7.18 | 3.95 | 2.38 | .. | 2.14 | 21.43 | ... | ... | 21.76 | ... |
| Formula ... | ... | ... | 40.81 | 7.5 | 3.88 | 2.62 | ... | 2.04 | 20.61 | ... | ... | 22.73 | ... |
| CELADONITE. | | | | | | | | | | | | | |
| Scur Mohr, Rum ... | 2.574 | 5.99 | 57.72 | .33 | 17.05 | 3.73 | .08 | .6 | 3.84 | 5.55 | .42 | 10.78 | 100.2 |
| Tayport, Fifeshire ... | 2.59 | 5.018 | 52.69 | 5.79 | 9.75 | 5.37 | .31 | 1.6 | 8.54 | 6.21 | .39 | 10.48 | 100.68 |
| Wormit Bay ... | 2.598 | 3.679 | 52.54 | 5.82 | 9.71 | 5.4 | .3 | 1.29 | 8.31 | 6.5 | .64 | 10.41 | 100.93 |
| Giant's Causeway, Ireland ... | 2.63 | 1.364 | 56.41 | 2.14 | 14.07 | 5.09 | .23 | .6 | 5.91 | 8.83 | ... | 6.79 | 100.29 |
| Average ... | 2.598 | ... | 54.84 | 3.52 | 12.64 | 4.9 | ... | .89 | 6.65 | 7 | ... | 9.62 | ... |
| Formula ... | ... | ... | 54.05 | 3.88 | 11.94 | 5.4 | ... | ... | 6.76 | 7.88 | ... | 10.14 | ... |

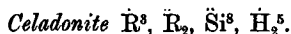
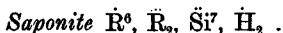
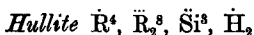
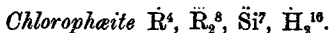
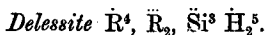
These tabulations present clearly to the eye the distinctive features of these allied minerals, which are therein arranged in the order of their content of Silica.

The following formulæ are then given for the five *Saponites*—



Chlorophæite Formula not evident.

Or, in atoms—



In the above investigation every substance, the nature of which was at all doubtful, of which I could obtain a sufficiency for analysis was examined.

In applying the results of the examination to the consideration of the geognostic relations of these minerals, those of the first or true chlorite type may be dismissed in few words.

With the exception of the occurrences of chlorite at the Girdleness and at Kùbislaw in granite, the minerals of the first class are to be found *only in metamorphic rocks*.

Glauconite, occurring generally in rock which is believed to be of recent origin, may, by its occurrence, aid somewhat in assigning the age of certain doubtful strata.

The second group, which I have called the saponites, belong *solely to igneous rocks*; and, from the mode of their occurrence, there is no room for doubt that *they result from the alteration of certain of the constituents of these rocks*—augite and olivine in all probability.

As regards our power of distinguishing them from each other, this is by no means so difficult as their want of form and general similarity of appearance would at first sight lead one to suppose.

Delessite can be distinguished from chlorophæite by its dull lustre, its minutely granular structure, its opacity, and its colour—in the field; and rapidly in the laboratory by its much higher

gravity, its much smaller loss at 212°, and much smaller total content of water.

From the specimen of Hullite found at Kinkell, I could not by physical properties undertake to distinguish it;—the darker varieties of Delessite at least much resembled that specimen.

From saponite, Delessite can be distinguished by its dark colour and granular structure and its opacity; and in the laboratory by its high gravity and its water.

From celadonite it could not be distinguished either by its structure or opacity, or by its gravity, or satisfactorily by its water content; but its colour, and its solubility in acids, at once suffice to separate the two.

Chlorophæite is readily recognised; when fresh it resembles a green jelly,—when weathered it equally resembles drops of asphalt.

The Kinkell Hullite resembles a dark Delessite, and therefore does not resemble chlorophæite.

Saponite, in its usual green form, is easily known; its extreme softness, greasy lustre, great translucency and soapy structure suffice to define it in the field; the extreme readiness with which it parts with and regains so large a quantity of water equally suffices in the laboratory, while its low gravity is of itself characteristic.

The white variety is by no means so readily identified; halloysite, conite, the magnesian carbonate of lime, agaric mineral, and a peculiar superhydrated vein-serpentine, all closely resemble it.

Celadonite may at once be known by its insolubility in acids; its loose-granular or mammillated structure, its perfect opacity, and brilliant colour, are likewise well-marked characters.

Such are the minerals occurring in Scotland, which are without question to be referred directly to one or other of the above species.

The author then gives a description of the new mineral *Bhreckite*, already described in the *Mineralogical Magazine* (p. 57, vol. 11), and of *Rubislite*, a mineral much like a *Hullite*, in which much of the iron is in a ferrous condition, and which was found in the red granite of Rubislaw.

The paper concludes with the two following “supplements.”

Supplement to Saponite.

In a letter from Professor King, received since the foregoing analyses of saponite were executed, he writes:—

“According to Haughten, saponite occurs with serpentine in Cornwall. Some specimens I collected there I take to be the same mineral; but it is not ‘soft like butter or cheese,’—it is hard, something like

serpentine, and may be actually a white or cream-coloured serpentine. The specimen laid by for you will settle the point. I should like to see your saponite."

This sentence led me to compare the specimens which I have of what I have called the "super-hydrated vein-serpentine" with the descriptions of saponite given by Dana,—and my analyses of these specimens with the column of analyses to be found at page 472 of his work.

While the physical properties assigned to saponite by Dana agree perfectly with those of the specimens which I have analysed, and therefore warrant my assigning the name to the Scotch specimens, it cannot be said that the claim of certain of Dana's specimens to the name is altogether beyond a doubt, and this on account of the most characteristic of the features of the Scotch mineral—namely, the low temperature at which it parts with some of its water—not having been observed in the specimens hitherto ranked as saponite. When, however, the *analyses* given by Dana are considered, there is no room for doubt that some of the substances analysed should not have found a place there, and there is even room for doubt if any but the *thalite* of Owen should.

Nothing, but their having suffered such a loss of water as I have pointed out as likely to occur through exposure to heat during carriage, could entitle us to associate under one name substances varying in their content of water to such an extent as from 10·5 to 20·66 per cent.—a variation which so far explains, though it hardly justifies, Dana's remark, that "analyses give naturally no uniform results for such an amorphous material." Had it been said that the name had been applied to substances which, filling the steam-holes of volcanic rocks, were unquestionably the products of change or degradation,—possibly not always of the same nature, or of the same material,—such a remark might legitimately be made. It is, however, a fairer inference that the analyses give no uniform results, because *different substances* have been included under one name.

And this inference is borne out in a marked manner by a consideration of the peculiar substance which fills the rents in serpentine rocks; and this consideration leaves little or no doubt that the so-called steatite or seifenstein from Cornwall and from all serpentine rocks must be withdrawn from the species, and that the name must, as I have shown above, be in future confined to one of the materials which plug the amygdules or rarely the rents of *igneous rocks*.

The suggestion of Dana's that as, if we suppose the alumina to be present as *kaolinite*, the rest is a silicate allied to *aphrodite*,—as if the

mineral were a mixture of the two,—I cannot regard as sound, for the two reasons that, according to Dana himself, neither kaolinite nor aphrodite occur in volcanic rocks (nothing of the kind is to be seen in the Scotch ones), and because, as he himself states, kaolinite is not decomposed by acid, while saponite is.

Any admixture “as kaolinite,” with a mineral soluble in acid, would after treatment therewith disclose itself by remaining as an insoluble residue.

The features, so far as I have yet attained to the recognition of them, whereby this super-hydrated vein-serpentine can be discriminated from saponite, are the very much smaller amount of its loss of water when heated,—its smaller content of water,—and a peculiar opalescence and girasol appearance, which it presents, when transparent varieties are looked through.

In five analyses of these “vein-serpentines” from Scotland which I have executed, I have found the quantity of total water to lie between 15·16 and 16·58 per cent. ; and of this the loss at 212° ranged from 1·63, which was that of the lowest total, to 3·53, which was that of the highest.

The deduction of these losses, it will be observed, brings the residual water to about the amount normal to serpentine.

Such were the conclusions I had arrived at when the receipt of a box of Irish serpentines from Professor King, containing specimens of the “saponite veins” of Cornwall, collected by himself, enabled me by analyses to speak with more precision on the matter.

The specimens of the Cornish “saponite” were at once seen to be physically very similar to the paler-coloured vein-serpentines of Portsoy. Being apparently somewhat weathered they were opaque, and the girasol appearance could not be seen.

A weathered vein from the serpentine of Polmally, in Glen Urquhart, which was very similar, was analysed along with this Cornish saponite.

It is not necessary here to quote more than the content of water, and loss thereof at 212°: this was—

| | Total water. | Loss at 212°. |
|-----------------------------|--------------|---------------|
| Mineral from Cornwall | 14·133 | 1·166 |
| „ „ Polmally | 15·162 | 1·626 |

This, taken in conjunction with a general accordance with their other components, shows that these specimens are similar to other vein-serpentines, and are quite distinct from the mineral which occurs in volcanic rocks.

As the specimen sent by Professor King is quite similar to other smaller ones which I have seen in the Lizard serpentine, there is every probability that the mineral analysed by Klaproth, Svanberg, and Haughton was the same; and that of the substances classed under the head of saponite by Dana, only those narrated as filling geodes in volcanic rocks properly fall under the title.

Supplement to Chlorite.

I have lately observed what I believe to be a chloritic mud occurring in a form in which it bears a great resemblance to glauconite.

The circumstances of its occurrence are of much interest, and the explanation of these circumstances is attended with no small amount of difficulty.

Immediately to the north of the village of Callander there is a cliff of conglomerate of the Old Red Sandstone; this is here formed of nodules, from the size of a walnut to that of the fist, of gneiss, mica slate, and quartz,—rocks of the immediate neighbourhood.

Rarely, thin interstrata of a finer almost of a sandy grain,—more fitted for building purposes,—occur to the north-eastward of the village.

In several small quarries, opened with a view to work these gritty beds, the characters of the conglomerate may be studied. It has somewhat of a vitrified aspect, and is more broken up by “backs” and “cutters” than is usual to that rock. The dip is to the north-east; the backs run along the strike at distances of about six feet from each other; while the cutters, lying generally at right angles thereto, are much more closely adjacent to each other.

The backs, in those cases in which they have stood open, are invariably filled with one of the varieties of the substance to which the names of *reddle*, or *keely* or *keels* has been attached: the cutters are as invariably lined, and usually no more than lined, on each side with sheets of cockscomb barytes, which sometimes carry vitreous copper, malachite, and calcite.

The dull red of the vertical sheets of reddle is everywhere besprinkled with spots and blotches of a vivid green, of the colour of glauconite,—these spots are circular in form, or consist of a number of confluent circles, each circle being of about the size of a large bean.

The contrast of these colours is so striking as to arrest the attention of the passer-by; it is found upon examination to be due to the occurrence in the pseudo-vein of reddle, of “concretions” of granular pale purple carbonate of lime, of a discoid form; and to these concretions

being invested by the glauconite-like material, disposed in a laminated manner.

Portions of the calcareous concretions,—of their green coating,—and of the reddle, were examined in the laboratory, after isolation each from the others.

The concretions did not appear to have any structural arrangement of particles, being similar to a very fine-grained saccharine marble; they dissolved readily and totally in acid, without leaving any save a glauconitic residue; and neither they nor their associates contained any trace of baryta.

The glauconite-like matter was found to be insoluble in all acids; but after treatment therewith and agitation in much water, it separated into minute colourless pearly scales (like mica), and a green powder, which was also minutely scaly.

The reddle had a laminated arrangement of its particles parallel to the sides of the vein; it resembled a red sandy clay, and glistened with minute scales of mica. Treated with chlorhydric acid it yielded readily a ferruginous solution, but left behind the greater part of its bulk as a green powder, similar in appearance, and also in its insolubility similar to that which presented itself originally with a green hue.

From the evident admixture of scales of mica, it may be doubted if an analysis of these green powders—probably identical—would definitely disclose their nature; but the above chemical features sufficiently show that they cannot be any one of the saponites, unless it be celadonite, and their being the latter is contradicted by their scaly structure.

Their insolubility in acids equally proves that they cannot be glauconite; and, having regard to the occurrence in the conglomerate of quartz nodules with a chlorite which is very similar to that of Cruach Ardran and the hills surrounding it, there is every probability that the green portion consists of chlorite alone.

While the impurity of this substance prevents a more accurate determination, enough has probably been attained to, in the direction of indicating several points of marked interest connected therewith.

The following questions present themselves for being answered:—

By what process were these veins filled? The ready reply,—neither by infiltration nor injection, but by exfiltration,—goes but a little way. Conglomerated rocks are more pervaded by a system of *inosculating holes* than by fissures,—but I broke many pieces of the rock without being able to detect in its cavities any green matter in the course of

being transported to its resting place in the vertical rents; but an ex-filtration of reddle-like matter may be observed, and this may obscure a concomitant chloritic transfusion.

Then, *What is the action whereby the segregating calcareous matter repels the hematitic*,—thus operating as a pseudo-bleacher?

And lastly, *How comes it that the one set of rents are lined with baryte, with vacuous interspaces; while that which lies at right angles thereto contains no trace of baryte, but is totally filled with a clay-like material?*

An explanation which may be said to lie upon the surface—namely; that the first mentioned set had been of earlier formation, and had been the seat of a process which had reached its termination before the formation and filling up of the latter,—does not meet the facts of the case, because the rock-rents which form the “backs” seem to have been antecedent to those existing as “cutters”; for the former pass numbers of the latter, while these but very seldom cut across the former.

The rock seems to be *still* purveying hematitic and chloritic matter to the cracks which form its “faces”;—*is there a polarity in the guidance of its decomposition*, acting so as to fill its minor and secondary rents with barytes and with copper,—enabling them at the same time to reject the slimy plug which chokes the backs, that they may at least aspire to the dignity of being true mineral veins?

Some questions of weighty mining import might possibly be answered through a study of this narrow field;—the points of chief mineralogical interest are the occurrence of a chloritic mud in a form simulating glauconite,—and the singular manner in which a large quantity of chlorite may be entirely masked by a comparatively small quantity of peroxide of iron.”

REINITE (*Neues Jahrb.* 1879, *Heft*, 3, 4. page 286 oder *Zeitschrift f. der Naturwissenschaften in die Provinz. Sachsen und Thuring.* 1879, has been so named by K. von Fritsch after its discoverer Professor Rein, who found it at Rei Japan; it has been described by O. Luedecke. Reinite occurs with large contemporaneously formed quartz crystals, of which many exhibit a beautiful fracture according to + R. For investigation one large crystal was employed: form tetragonal, the fundamental pyramid (111), whose polar angles were very slightly truncated by the pyramid of the second order (101). The appearance of large sub-crystals with the axis inclined to the chief crystal is frequent. The polar angle (111) : ($\bar{1}\bar{1}$) is 103 32'. The relation of the axis $a : c$ is as 1 : 1.79 : the angle (111) : (101) was

measured as $141^{\circ} 15' - 14^{\circ} 30'$ with the hand goniometer. $H=4$, Sp. Gr.=6.640; cleavage imperfect (110); fracture uneven; color dark-brown; streak brown; lustre vitreous-metallic; opaque. Before the blowpipe behaves itself according to N. H. Rose, like a Wolfram containing a large amount of iron. HCl , HNO_3 , and H_2SO_4 , do not decompose the tungstate of iron even when boiling.

Composition according to E. Schmidt:—

| | |
|----------------------|---------|
| Ferrous Oxide.. .. | 24.33 |
| Tungstic Acid | 75.47 |
| Lime | a trace |
| Magnesia | ,, |
| Tantallic Acid | ,, |

Reinite is therefore pure tungstate of iron with the formula $FeWO_4$, and is connected in its chemical relations with Hübnerite and Wolfram. As tungstate of iron and tungstate of manganese both crystallise in monoclinic forms, so their simple union must also be monoclinic, which is the form assumed by Hübnerite. As also the tungstate of iron, as Reinite has arranged itself in five symmetrical planes, so it is to be assumed with every probability that the tungstate of iron as well as the tungstate of manganese are isodromous.

T. A.

HELDBURGITZ.—(*Zeitschrift für die gesammten Naturwissenschaften Bd., II, Heft 2, page 291, 1879.*)—In the felspar of the Phonolite of Heldburg in Coburg, O Luedecke discovered a few fragments of minute columns associated apparently with Zircon, the largest of which was 3 mm. long, $\frac{1}{2}$ mm.— $\frac{1}{4}$ mm. thick. Crystalline system tetragonal: Combination of (110) (100) (111.)

Values the of following angles were measured and calculated:—

| | Measured. | Calculated. | Difference. |
|--|---------------------|---------------------|-------------|
| $(\bar{1}\bar{1}\bar{1}) : (\bar{1}\bar{1}\bar{1})$.. | $86^{\circ} 40' 8$ | $86^{\circ} 37' 5$ | + 3' 3 |
| $(\bar{1}\bar{1}\bar{1}) : (\bar{1}\bar{1}0)$.. | $136^{\circ} 37' 5$ | $136^{\circ} 41' 2$ | — 3' 7 |
| $(\bar{1}\bar{1}0) : (\bar{1}\bar{1}\bar{1})$.. | $136^{\circ} 44' 1$ | $136^{\circ} 41' 2$ | + 3' 9 |

The relation of the axis a to the principal axis $c=1 : 0.7500$, or as 4 : 3, measurements approach those of Zircon and Oerstedite. External characters resemble those of Guarinite. Hardness less than steel; color yellow; streak white; adamantine lustre; transparent; before the blowpipe infusible; chemical composition unknown; titanitic acid absent.

T. A.

HERRENGRUNDITE.—[Urvölgyte.].—*Min. und Pet. Mitt. Tschermak : Band II, Heft III and IV, p. 311—324.*—This hydrated cupreous sulphate of lime, from Herrengrund (Hungary) was briefly referred to in the last number of the Mineralogical Magazine. It occurs in an unworked part of the copper mines of Herrengrund (Urvölg) near New Sohl in the N.W. of Hungary. It was at first taken for Brochantite and for Langite.

Morphological relations :—The mineral forms laminated groups, dark-green to bluish in colour, upon a yellow-quartz conglomerate. These groups are so symmetrical that they present ball-like aggregates with rough surfaces and dark-green satin-like lustre. Single crystals do not occur: but the lamellæ can be examined separately, and shew striking parallel lines which at their terminations experience a truncation, at their sides a bevelling. With the plane of the lamellæ the truncated surfaces form right angles, with each other an angle of 130° approximately. Cryst. system Rhombic, the parallel lines correspond to the brachydiagonal; plane of the lamellæ, the basal pinakoid OP : the two truncated surfaces which touch in the brachy-diagonal are the prism surfaces ∞P ; whilst the bevelled surfaces represent the brachydome $P\tilde{\alpha}$. In this way the combination $OP, \infty P, mP\tilde{\alpha}$ is formed. According to Schafarzik the angles $OP : mP\tilde{\alpha} = 130—131^\circ$; $mP\tilde{\alpha} = 102^\circ$. According to Winkler the angle $OP : P\tilde{\alpha} = 130\frac{1}{2}—131^\circ$. Besides the surfaces in this dome another surface appears without a corresponding one on the opposite side, which gives to the combination a monoclinic aspect, though the cause of the defect is dependent not on the imperfection of the developement, but is produced by unequal central distance. According to Dr. Brezina however, the crystalline system is monoclinic with a slight angle.

Elements : $a : b : c = 1.8161 : 1 : 2.8004, \beta = 91^\circ 9' 5''$.

Optical relations : In revolving the Nicol very much dichroism—bluish-green, greenish-yellow. With the crossed Nicols the maximum of extinction occurs in the direction of the parallel lines: if a thicker lamina be taken, an axis image appears on the plane, consequently the mineral is biaxial, the axis lying in the plane of the brachydiagonal section: axis angle great: both images perfectly symmetrical: dispersion of optical axis $\rho \angle v$. The bisection occurs with the principal axis, and consequently the optical peculiarities favour the view that it belongs to the rhombic system. With polarised light the thin plates shew strikingly those colours conditioning dichroism: thicker plates on the contrary shew a lively play of colors, and from these experiments it is evident twinning frequently occurs—the twin planes being parallel with the brachydiagonal.

Lustre and color.—Both are of two kinds, vitreous, and mother of pearl like : dark emerald-green to a bluish sea-green. Glassy lustre at peripheral surfaces, and in those of the less bent laminated aggregates occasionally a peculiar coppery lustre. Plane OP seen obliquely shows a mother of pearl lustre ; whilst on a thin lamina it is vitreous. At the peripheral surfaces dark-green ; in the plane of the laminae a blue to light-green colour, but some varieties have only a uniform dull greenish-blue colour.

Cleavage.—In three directions, most perfect in the plane of lamellæ, and if heated this takes place in thinner leaves also. Cleavable in the direction of the brachy-diagonal. When rubbed between the fingers it breaks up in this plane, and in rare cases cleavage is seen parallel to the surfaces of the prism. Cleavage accordingly OP perfect ; ∞ P perfect ; ∞ P imperfect. Hardness 2·5—3 ; density 3·132 (Winkler.)

Composition :—

| | | |
|------------------|---------|----------|
| H ₂ O | .. .. . | 16·726 |
| CuO | .. .. . | 42·520 |
| CaO | .. .. . | 8·587 |
| S O ₃ | .. .. . | 24·620 |
| SiO ₂ | .. .. . | 0·332 |
| FeO | .. .. . | 0·142 |
| Mn. Mg | .. .. . | (traces) |
| | | <hr/> |
| | | 99·927 |

Position in the mineral system:—It must be placed near Brochantite, Langite, Linarite, and Cyanotrichite, but it is most closely allied to the first two, as indicated by the physico-chemical distinctions now to be spoken of. Brochantite in powder under the microscope always appears green without a trace of blue ; Langite on the contrary pure blue, thicker masses deep blue, thinner azure blue, at the most with a shade of green. Herrengrundite in thick fragments is emerald-green, yet never possessing the intensity of Brochantite ; in thinner layers it is greenish-blue. It is distinguished, however, by its chemical relations. By the wet method, all three are soluble in HNO₃ and give with excess of ammonia an azure-blue solution, in which a drop of oxalic acid produces a white precipitate with Herrengrundite, but none with Brochantite or Langite. The flame reactions are still more characteristic, Brochantite and Langite give only the blue-copper flame, whilst Herrengrundite gives both the yellowish-red lime flame and the blue copper flame. Cleavage of Brochantite under the microscope has been observed in three directions. In Langite the optical axes lie in the brachy-diagonal section ;

the observed combinations nearly agree; the three species are thus very nearly allied.

Paragenetic relations :—Herregrundite about 1 mm thick is found covering a bed of finely granular white gypsum, and is of two kinds—an earlier and a later formation; the later is a dark-green, strongly shining mineral, its normal condition—the older is dullish-blue, and appears to be covered with a white powder. The occurrence of the mineral with gypsum is significant, but still does not appear to suffice for the formation of the cupreous sulphate of lime. Here this hydrated sulphate of copper and the constituent parts of gypsum have crystallized together in such a way that the Brochantite or Langite substance maintains a preponderating influence, and thus maintains also the rhombic type. On the other hand if, according to Prof. Schenck we group the molecular relations as $6 \text{H}_2\text{O}$, 4CuO , 2SO_3 , 1CaO , next withdraw a molecule of gypsum (CaO , $\text{SO}_3 + 2 \text{H}_2\text{O}$) the remainder may be combined in the following way, 3CuO , $\text{SO}_3 + \text{CuO H}_2\text{O} + 3 \text{H}_2\text{O}$, a formula showing that Herregrundite is more nearly allied to Langite than Brochantite. A fact still more clearly brought out is the composition of Herregrundite, from which it may be considered that a molecule of Langite and a molecule of gypsum have crystallised together, which may take place with the basic hydrated sulphate of copper on separating from a water containing gypsum. From the experiments of Schenck of Schemnitz, it appears that the gypsum of Herregrundite dissolves in 3000 parts of water, *the water of crystallization of Brochantite, and only a very small quantity of Brochantite*. The question now arises here is the Gypsum and Brochantite contained in Herregrundite. Is it a mixture or a double salt? In favour of its being a double salt the fact exists that the percentage of sulphuric acid goes half to the gypsum and half to the Brochantite. Investigations also evidently show that the mineral is to be regarded as a product of the crystallizing together of gypsum and a substance like Brochantite or Langite, exhibiting at the same time its easy decomposition and mode of dissociation under the action of water and dilute muriatic acid. In all chemical experiments also the individual peculiarities of gypsum and Brochantite always appear: then the striking peculiarity is seen, that nitric acid dissolves the Herregrundite without a gypsum precipitate, whilst muriatic acid does not: the explanation being that the nitric acid is a better solvent of gypsum than the muriatic. But both hydrated sulphates manifest a strong tendency to crystallise together, which in different relations can take place apparently in varying proportions—the green color being more connected with the Brochantite, the chemical composition and optical peculiarities with the Langite.

From further investigations into the occurrence of these hydrated carbonates of copper, the paragenetic relations may be stated as follows, commencing with the youngest member:—1st a *Herrengrundite* bright shining emerald-green, forming considerable masses. β *Herrengrundite* dull bluish-green substance, similarly grouped aggregates formed of minute laminae. *Azurite* forms single granules. *Malachite* as a botryoidal crust of fibrous structure. *Pitticite* amorphous, blood-red, very rare. *Gypsum*, short white fibres, in rare instances forming layers from 10-12 mm. thick.

Herrengrundite is derived from tetrahedrite and chalcopyrite, both of which occur in layers in scattered patches in the quartz conglomerate of the district. It has also been found at Erbstollen, in small amount. At the depth of a metre below it water was found. *Herrengrundite* has also been seen directly in contact with coarse tetrahedrite, though it is usually found upon gypsum or malachite.

The veins at Herrengrund occur in grauwacke and mica schist, the latter being the under, the former the upper layer, above which a triassic limestone is met with, in which the veins show no continuation, though it may have supplied the lime for the formation of the gypsum.

T. A.

ON A NEW PROCESS FOR THE MICROSCOPIC STUDY OF VERY MINUTE CRYSTALLINE GRAINS (M. J. THOULET, *Bull. d. l. Soc. Min. d. France, II*, 7).—The author embeds the particles of mineral in a cement, which, when set, he slices and polishes for microscopic examination. The mineral powder, to be examined, is mixed with ten times its volume of oxide of zinc, and enough silicate of soda (or preferably, of potash) is added to make a thick paste. This paste is then transferred to a mould, made by laying a thin ring of glass upon a sheet of paper. In a few days the mass will have set hard, and can be removed from the mould, ground, and polished like a natural rock, as it possesses great tenacity. On examination under the microscope, the sections of mineral that it contains are easily distinguished in the midst of the surrounding opaque material.

H. L.

ON A NEW PROCESS FOR TAKING THE SPECIFIC GRAVITY OF A MINERAL IN MINUTE GRAINS (M. J. THOULET, *Bull. d. l. Soc., Min. d. France, II*, 7).—The first stage of this process is the preparation of a float of wax, containing a minute fragment of some mineral, so that the sp. gr. of the whole shall be between 1 and 2; the author employs a splinter of orthoclase and surrounds it with wax, till it forms a mass of about the

size and shape of a grain of wheat, which has then to be carefully weighed. The fragment or fragments, whose sp. gr. is to be taken, and the weight of which is exactly known, are attached to the float by a gentle pressure of the fingers. The whole is then immersed in a solution of iodide of mercury in potassic iodide, and the solution is gradually diluted with water until it has exactly the same sp. gr. as the float, which may be known by the latter neither rising nor sinking in the solution. The sp. gr. of the solution is now taken; let it equal Δ . The float is taken out of the solution, washed, and the fragments of mineral carefully removed with a forceps. The float is returned to the solution and water is added, till the sp. gr. of the float and solution are again equalised. The sp. gr. of the solution is then once more determined; let it equal D . Then P being the weight, V the volume, and D the sp. gr. of the float,

$$V = \frac{P}{D}$$

If p be the weight, v the volume, and d the sp. gr. of the mineral,

$$v = \frac{p}{d}$$

and Δ being the sp. gr. of the float with the mineral attached,

$$\Delta = \frac{P + p}{V + v} = \frac{P + p}{\frac{P}{D} + \frac{p}{d}}$$

$$\text{whence } d = \frac{p \Delta}{P + p - \Delta V}$$

H. L.

ON A NEW MINERAL SPECIES, DISCOVERED IN THE DISTRICT OF GUEJAR, SIERRA NEVADA (M. E. CUMENGE, *Bull. d. l. Soc., Min. d. France, II, 7*).—This mineral, which has been named Guejarite by the discoverer, occurs well crystallised in a veinlet of spathic iron ore. The following is its analysis:—

| | | |
|----------|---------|---------|
| Sulphur | .. .. . | 25 |
| Antimony | .. .. . | 58.5 |
| Copper | .. .. . | 15.5 |
| Iron | .. .. . | 0.5 |
| Lead | .. .. . | traces. |

99.5

These figures correspond to the formula $2 \text{Sb}_2 \text{S}_3, \text{Cu}_2 \text{S}$, the small quantity of iron found being due to a slight admixture of copper pyrites.

The mineral occurs in brilliant crystalline plates, 20 mm. long and 7 mm. broad; its color is steel-grey; sp. gr. 5.03; hardness 3.5.

M. C. Friedel has investigated the crystallisation of Guejarite. He finds that it belongs to the rhombic system. The prism (100) is the predominating form, a distinct cleavage being parallel to it; numerous other prisms, several brachydomes and the basal plane (001) also occur. The angle (110) ($\bar{1}10$) = $101^{\circ} 9' 12''$, and the relation between the parameters is—

$$h : D : d = 0.7841 : 1 : 0.8220.$$

Guejarite is thus isomorphous with Wolfsbergite ($Sb_2 S_8, Cu_2 S$) in which species the angle (110) ($\bar{1}10$) = 109°

H. L.

ON THE MICROSCOPIC EXAMINATION OF SOME NATURAL AND ARTIFICIAL SPINELS (M. J. THOULET, *Bull. d. l. Soc., Min. d. France, II, 8.*)—The following is a list of the spinels examined by the author:—Artificial spinels, for the most part prepared by Ebelmen: chromite, chromite of manganese, chromite of magnesia, chromite of zinc, chromite of lime and glucina, ferrite of zinc, ferrite of magnesia, hausmannite, aluminate of iron, zinciferous spinel, and aluminate of zinc.

Natural spinels: Chrome iron-ore, hercynite, automolite, creittonite, franklinite, and pleonaste.

Each specimen was examined under the microscope, its specific gravity taken whenever possible, and its magnetic powers noted; the following are the chief conclusions thus arrived at by the author.

(1.) The greater the amount of iron in a spinel, the less is its transparency.

(2.) All spinels, when reduced to the thickness usual for microscopic observations are transparent or translucent, except magnetite, which is entirely opaque; thus hercynite, franklinite, hausmannite, creittonite, and chromite are translucent, though stated by Dana to be opaque.

(3.) All spinels have under the microscope a shagreen-like surface, and this character is more clearly marked the greater the hardness of the mineral; this rough surface does not appear in quartz and in substances softer than quartz.

(4.) No chrome iron or chromite is magnetic; such specimens as show magnetism, owe this property to an admixture of opaque grains, which appear to be magnetite.

(5.) The natural spinels known as hercynite, creittonite, and gahnite, are more or less mixed with oxide of iron; this explains the varying proportions of iron found in different analyses.

(6.) Ebelmen has remarked that in preparing artificial chrome spinels, the crystals first formed are the most strongly coloured by

chromic-oxide. The microscopic examination of chrome iron-ore confirms this observation, showing ferriferous grains, more or less opaque, agglomerated round the translucent yellow ones; a kind of liquation of the material richest in chromium has taken place, this being first isolated and surrounded by a series of minerals richer in iron, and terminated by magnetite.

(7.) The anisotropic action of the chromite of glucina and lime, closely related to the polarising properties of cymophane or aluminate of glucina gives support to the theories which tend to show that glucina is a sesquioxide.

H. L.

ON THE DEHYDRATION-ELLIPSOIDS OF RHOMBOHEDRIC CRYSTALS (*L. Schncke, Zeitsch. f. Kryst., u. Min., P. Groth, IV, 3*).—According to some experiments made long ago by Mr. Pape, when a crystal, into the composition of which water enters, is heated, spots of decomposition (dehydration) are formed on the various planes, which spots generally shew an elliptical outline, being in fact such figures as are produced by the intersections of the respective planes with an ellipsoid which is characteristic of each crystalline body, and occupies a constant position with reference to the axes of the crystal. Supposing the decomposition to start from the centre of the crystal, it will usually extend with unequal rapidity in different directions, the surface of the dehydrated portion forming at each moment an ellipsoid, the dehydration ellipsoid. This behaviour corresponds to that of the conductivity for heat, and of several other properties of crystals, each of which may be represented by the radii vectores of an ellipsoid as a function of the direction. But Mr. Pape has observed one startling difference, namely that in rhombohedral crystals the dehydration-ellipsoid is a sphere, whilst the other properties are represented by ellipsoids of rotation, the axis of rotation being parallel to the main axis. These observations were made on three substances:—

| | |
|---------------------|--|
| Plumbic dithionate | ($\text{Pb S}_2 \text{O}_6 + 4 \text{ aq.}$) |
| Strontic dithionate | ($\text{Sr S}_2 \text{O}_6 + 4 \text{ aq.}$) |
| Calcic dithionate | ($\text{Ca S}_2 \text{O}_6 + 4 \text{ aq.}$) |

The author of this paper has re-examined the results obtained by Mr. Pape, and, after very numerous observations, finds that the surface of dehydration of the above-named rhombohedral salts is not a sphere, but is a very close approximation to an ellipsoid of rotation. The method of experimenting was the following:—The crystals were heated in a hot air bath, and as soon as small spots of dehydration (usually between 0.02 and 0.04 mm. in diameter) were produced, the

crystals were removed, and the major and minor axes of the ellipses measured by means of a micrometer. The author gives at length the numerical results obtained, and finds therefrom that the first-named salt has an elongated dehydration-ellipsoid, the ratio of the vertical to the horizontal axes being 11:10, whilst the two latter salts have a compressed dehydration-ellipsoid, the ratio of the axes being approximately 10:12.

H. L.

ON SERICITE (*H. Laspeyeres, Zeitsch. f. Kryst u. Min., P. Groth, IV, 3*).—Numerous authorities have attempted to show that Sericite is a separate mineral species, but the author of this paper contends that it is merely a massive potash mica. He analysed it by boiling the finely divided mineral for several hours a day during 5 months in pure hydrochloric acid; 19·021 per cent. was left unattacked, being principally quartz, and the decomposed mineral was found to contain—

| | | |
|---------------|---------|--------|
| Silica | .. .. . | 45·361 |
| Alumina | .. .. . | 32·919 |
| Ferric Oxide | .. .. . | 2·048 |
| Ferrous Oxide | .. .. . | 1·762 |
| Lime | .. .. . | 0·494 |
| Magnesia | .. .. . | 0·895 |
| Potash | .. .. . | 11·671 |
| Soda | .. .. . | 0·724 |
| Water | .. .. . | 4·126 |

 100·000

The composition agrees well with that of a potash mica, and this view of the constitution of Sericite is moreover supported by a careful examination of the physical properties of the mineral.

H. L.

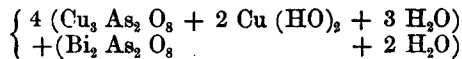
ON ARSENIATES FROM THE JOACHIMSTHAL (*A. Schrauf, Zeitsch. f. Kryst., u. Min., P. Groth, IV, 3*)—*Mixite* a new hydrated arseniate of copper and bismuth. This mineral occurs in the so-called "Geistergang," at a depth of 20 metres, and was found by Mr. A. Mixa. Its mineralogical characteristics are as follows:—Color, emerald-green to bluish-green, streak somewhat paler; hardness 3-1; sp. gr. 2·66; the most delicate fibres are almost transparent. The mineral occurs as an efflorescence on impure yellow bismuth ochre; in scattered grains; and in spherical reniform aggregations, granular in the centre, and concentrically fibrous towards the exterior, the fibres appearing under the microscope as six-sided prisms. The angle of the prism is about

55°, and as the direction of maximum extinction is inclined 6°—9° to the edges of the prism, the crystalline system must be monoclinic or triclinic.

The mineral is easily recognised by its behaviour towards dilute nitric acid; when immersed in it, it is immediately covered with a film of a brilliant white powder of arseniate of bismuth, while the arseniate of copper enters into solution. The mean of three analyses gave:

| | |
|--|--------|
| Cu O | 43·21 |
| Fe O | 1·52 |
| Ca O | 0·83 |
| Bi ₂ O ₃ | 13·07 |
| As ₂ O ₅ | 29·40 |
| P ₂ O ₅ | 1·05 |
| H ₂ O | 11·07 |
| | 100·15 |

The formula corresponding to this composition is Cu₂₀, Bi₂, As₁₀, H₄₄, O₇₀, which may be rationalised thus:—



The minerals that accompany mixite are various species of decomposed bismuth ores and Tennantite, mostly somewhat decomposed and containing some bismuth; chalcocite and bismuthite also occur with it.

Wapplerite. The author gives a long series of goniometric measurements of this mineral, which justifies the assumption of the following system of parameters:

$$a : b : c = 1 : 1.11002 : 0.29037$$

$$\alpha = 90^\circ 13' 55'' \quad \beta = 95^\circ 20' \quad \gamma = 90^\circ 10' 35''$$

Good crystals shew a very close approach to monosymmetry, which may be induced to some extent by twinning.

Wapplerite is distinguished optically by showing “dispersion croisée,” the arrangement of the colors being the opposite to that which obtains in the case of borax.

Pharmacolite. In addition to the planes already known to occur in this mineral, the author has observed the pyramid (11 $\bar{1}$); he gives a list of goniometric measurements of some crystals, and compares the angles found with those calculated, taking the following system of parameters: $a : b : c = 0.61373 : 1 : 0.36223$, $\beta = 96^\circ 46' 6''$. The results obtained are fairly concordant.

DAVREUXITE (M. L. L. de KONINCK, *Bull. de l' Acad. roy. d. Belg.* (2) 46 No. 8, August, 1878; *Zeitsch. f. Kryst. u. Min., P. Groth., IV*, 1).—This mineral was first found by Dumont in quartz veins in the slates of the Ardennes at Ottré, but was mistaken for asbestos; the author has found it in small quantities at Sart-close (Salm-Chateau.) It consists of very thin transparent needles, white to flesh-colored, sometimes containing a little admixed quartz. It is infusible in the Bunsen flame, and but slightly attacked by acids. The following is the mean of three analyses :

| | | |
|--------------------------------|---------|--------|
| H ₂ O | .. .. . | 4·19 |
| Si O ₂ | .. .. . | 55·94 |
| Al ₂ O ₃ | .. .. . | 33·59 |
| Mn O | .. .. . | 5·25 |
| Mg O | .. .. . | 1·10 |
| | | 100·07 |

Traces of iron present.

The author estimates that $\frac{1}{3}$ of the material analysed consisted of quartz, and therefore subtracts 16·63 per cent. from the Si O₂ found by analysis. He thus obtains for Davreuxite the formula H₄ (Mn. Mg.) Al₆ Si₆ O₁₈*

H. L.

ON A NEW RESIN FROM KÖFLACH IN STEIERMARK (BY C. DÖLTER, *Mitth. d. naturwiss. Vereins f. Steiermark*, 1878; *Zeitsch. f. Kryst. u. Min., P. Groth, IV*, 1).—This resin occurs in layers about 1 inch in thickness in the Tertiary lignites at Lankowitz; color dark-brown; thin splinters reddish-brown, translucent; fracture conchoidal; sp. gr. 1·2—1·25. Soluble in ether and carbon disulphide, insoluble in alcohol and in caustic potash.

Analysis after subtracting 1·90 per cent. of ash :—

| | | |
|---|---------|--------|
| C | .. .. . | 82·23 |
| H | .. .. . | 10·28 |
| O | .. .. . | 7·49 |
| | | 100·00 |

Formula C₂₀ H₄₃ O₂. Melting point 98°, but the resin softens at a far lower temperature. Electric on friction. This resin is hence a retinite closely related to Jaulingite.

H. L.

* Thus in the German original the formula should read H₄ (Mn., Mg.) Al₆ Si₆ O₂₄.

NOTES ON MINERALS (A. VON LASAULX, *Zeitsch. f. Kryst. u. Min.*, P. *Groth*, IV, 2).—*Titanomorphite*—Amongst the gneissic rocks that form the crest of the "Hohe Eule" (in Silesia) there are numerous hornblendic rocks, some of which are so rich in garnets, that they may be called garnet-amphiboles. In a quarry of this rock there occur numerous nodules of rutile, varying from microscopic size up to that of a nut; each rounded nodule, composed at times of several closely coherent grains, is surrounded by a pale greenish white zone of a finely fibrous structure, the fibres being arranged radially and normal to the exterior surface, on approaching which they gradually assume a granular structure. The rutile nodules but rarely shew their characteristic brownish-red color; they are often quite black like Ilmenite, and contain an ochre-yellow kernel of rutile; they are of the variety of rutile known as nigrine, and consist, as has already been pointed out by Rammelsberg, of a mixture of Ilmenite with rutile. The thickness of the crusts of Ilmenite round the kernels of rutile is variable, and some specimens contain no kernels at all. All, however, are surrounded by the white substance above-mentioned, but in varying quantities. This substance has been referred erroneously to various mineral species, but the author has long supposed it to be a titanate of lime, and has named it Titanomorphite.

Titanomorphite forms as already stated granular fibrous aggregates, but even the minutest fibres are composed of rows of distinct granules. By means of exhaustive optical observations made on sections through some of the larger granules, the crystalline form of the mineral has been determined with some certainty. The mineral is biaxial and highly double refracting; it is optically positive; dispersion of the axes very strong; $2E=45^{\circ}-50^{\circ}$; thus agreeing very closely with the optical properties of Titanite; it is therefore monoclinic.

The following are the values of the principal angles in

| | Titanite. | Titanomorphite. |
|----------------------------------|-----------|-----------------|
| (001/ $\bar{1}$ 02) .. | 39° 17' | 40° |
| (001/110) .. | 85° 45' | 86½° |
| ($\bar{1}$ 02/10 $\bar{1}$) .. | 21° | 19°—20° |
| (10 $\bar{1}$ /110) .. | 40° 34' | 41¼° |
| (110/110) .. | 46° 8' | 45°—47° |
| (123/123) .. | 43° 48' | 43°—45° |

These figures shew a very close isomorphism between the two minerals.

The following is an analysis of Titanomorphite, made by Dr. Bettendorff :—

| | | |
|-------------------|----|--------|
| Ti O ₃ | .. | 74·32 |
| Ca O | .. | 52·27 |
| Fe O | .. | trace. |
| <hr/> | | |
| 99·59 | | |

This composition agrees well with the formula CaO, 2 TiO₂; so that titanomorphite is not only physically and optically isomorphous with titanite, but their chemical compositions also correspond.

| | | |
|----------------|-------|---|
| Titanite | .. .. | Ca Si ₂ O ₈ + Ca Ti ₂ O ₆ |
| Titanomorphite | | Ca Ti ₂ O ₆ + Ca Ti ₂ O ₆ |

thus affording a fresh instance of the isomorphism of titanite and silicic acids.

Idocrase from Gleinitz and from the Johnsberg, near Jordansmühl (Silesia).—Idocrase, forming incrustations of a yellow or peach-blossom color, has long been known to occur on a decomposed mica-schist on the south-eastern side of the Johnsberg; the idocrase of Gleinitz similarly forms layers 1—2 inches thick, in serpentine, which layers consist of columnar aggregates with well-developed crystals projecting into the cavities. These crystals are colorless or pale-greenish, rose and amethyst-colored; the latter color is, however, never spread over the whole crystal, but is confined to the polar extremities. The other varieties only shew a feeble dichroism, but the amethystine portions are strongly dichroic, being pale-green in the direction *c*, and peach blossom-colored along *a*.

When a section perpendicular to the axis is examined in parallel polarised light, the phenomena that have been described by Mallard appear, the square plane being divided into four equal, triangular segments; in convergent polarised light the crystals are seen to be uniaxial. Sections parallel to the axis shew that the crystal consists of thin concentric layers. In this case the anomalous behaviour towards light is a sign, not of a pseudosymmetrical crystalline form, but of an anomalous mode of growth of the crystals.

The following forms have been observed in the well-developed crystals :—

(1) $\infty P (110)$, $\infty P \infty (100)$ $P (111)$ $P \infty (101)$ $o P (001)$ and $\infty P 2 (120)$; the ordinary form of Idocrase from Wilni.

(2) Prisms predominating; prisms and a ditetragonal pyramid (3 P 3) alone occur; rarely P, never oP.

(3) Pyramids predominating, prisms scarcely developed at all; only P, P ∞ and oP occur. This is a very rare form.

The peach-blossom colored crystals from the Johnsberg are always of the first type.

The following are analyses of two samples by the author, No. I being that of the colorless crystals from Gleinitz, and No. II of the peach-blossom colored crystals from the Johnsberg.

| | I. | II. |
|--------------------------------------|-------|-------|
| Si O ₂ | 37.57 | 37.32 |
| Al ₂ O ₃ | 16.30 | 16.87 |
| Fe ₂ O ₃ | 1.82 | 2.57 |
| Fe O | 2.76 | 2.38 |
| Ca O | 36.26 | 34.46 |
| Mg O | 1.75 | 0.67 |
| Mn O | — | 3.23 |
| Na ₂ O not determined | — | — |
| H ₂ O | 3.01 | 2.22 |
| | 99.47 | 99.72 |

It thus appears that the red tinge of the Johnsberg crystals is due to MnO, and this variety may therefore be designated a manganese-idocrase.

Gismondine from the basalt of Schlauroth near Görlitz. The author has undertaken an elaborate optical examination of some small pseudo-quadratic crystals, obtained from a geode in the above basalt. As the planes of the crystals did not exceed 2—3 mm. in length, and were too imperfect for goniometric measurement, optical examination had to be resorted to, to determine the crystalline system of the mineral. Sections parallel to the pseudo-quadratic base, parallel to an edge, and parallel to a diagonal of this base were examined.

Although the author has been unable to determine the ratios of the parameters, he has succeeded in arriving at the following conclusions: All crystals of *Gismondine* are twins of asymmetrical individuals, which latter consist of combinations of very simple forms; pairs of dome planes, and quarter pyramids, either by themselves or combined with the former. The twins are either simple interpenetration twins formed in accordance with the law: "twin-plane a brachydome," or else double twins obeying the above law, and the following: "twin-plane a macro-diagonal section." As the relations of the axes approach very nearly to those of orthoaxial symmetry, the twin forms show pseudo-rhombic or pseudo-quadratic symmetry.

The interpenetration groups from the Schiffenberg, described by Streng as consisting of six crystals, are thus in reality composed of twelve individuals, and the forms thus produced approximate very nearly to those of the regular system. In respect therefore to the mode of twinning, Gismondine evidently corresponds closely with Phillipsite and Harmotome.

The differences and divergencies between the angles of the pseudo-quadratic base, and those of the polar edges are caused by the different inclinations to the vertical axis of the two brachydomes, both of which can be planes of twinning; but more especially by the modes of combination of the planes which form the lateral pseudo-quadratic edges, and which condition their position.

The differences between the angles of Gismondi's Zeagonite are decidedly within the limits of the differences observed in Gismondine, and there is no doubt but that these two minerals should be considered to form only one species.

H. L.

ON PEROWSKITE (H. BAUMHAUER, *Zeitsch. f. Kryst. u. Min., P. Groth. IV, 2*)—The author has investigated the crystalline form of Perowskite from various localities by an examination of the figures produced by etching the planes of the mineral. The re-agents employed were hydrofluoric acid, bisulphate of potash, caustic potash, etc. He finds that perowskite is rhombic, the ratios of the parameters being 1 : 1 : 0.711, the principal planes being ∞P , oP (forming a pseudo-cube) P , $\infty \bar{P}\infty$, $\infty \bar{P}\infty$, (forming a pseudo-dodecahedron), and $2 \bar{P}\cdot\infty$, $2 \bar{P}\infty$, (forming a pseudo-octahedron). The twins are always extremely complicated, but P and ∞P appear to be the most commonly occurring twin-planes.

H. L.

CRYSTALLOGENESIS.—(CHEVALIER CHARLES DE HAUER, *Imp. Geol. Inst., Meeting January 13th, 1880*).—The presence of a small proportion of Borax in a solution of Sulphate of Magnesia gives rise to uncommonly perfect and completely developed crystals, nearly all of them with hemimorphous terminations. When the proportion of borax is not excessively small, a second pair of planes appears at the pointed extremities, these however are always of very subordinate extension.

The form of the crystals is essentially different according to the proportion of borax in the solution, and becomes apparent by admixture of a very small quantity of this substance. When this proportion is considerable, the crystals of sulphate of magnesia

become notably harder, assuming the form of very shortened prisms, so that the terminal surfaces nearly touch each other. Such crystals, when adherent by one of their terminal surfaces, have the aspect of tetrahedra, which they keep when allowed to grow up to a considerable size. The crystals, formed in a solution containing much borax, are characterized by a great number of terminal surfaces, especially when grown up to a notable size. Some of them have on one termination no less than eight surfaces. The proportion of borax in the solution being very great, the terminal surfaces of the crystals, instead of being smooth and specular, are covered with hemispherical or circular prominences and shallow serpentine furrows, the prismatic surfaces remaining unaltered. These deformities disappear when the crystals are allowed to continue their growth within a solution containing a lesser proportion of borax.

What has been observed concerning the action of borax, likewise takes place when crystals are growing in a mixture of sulphate and chromate of magnesia, whatever the mutual proportions of these ingredients may be. Mixed solutions of sulphate of magnesia with sulphate of nickel or of cobalt in varied proportions give rise to green or red crystals, identical in form with those of unmixed sulphate of magnesia, and showing, when somewhat increased, all the irregularities and deficiencies of their terminations as observed on those of unmixed sulphate of magnesia. The presence of borax acts likewise on the mixed solutions here in question, giving rise to well-developed crystals with hemimorphous terminal surfaces, preserving this character during their further increase. This, however, only takes place when in the mixed solutions, the proportion of sulphate of magnesia considerably prevails over that of the sulphates of nickel or cobalt. The addition of borax causing a precipitation of cobalt and nickel, some drops of a free acid must be added to the solution. The epimorphous crystals, arising out of these mixed solutions in variable succession, are beautiful and easily obtained. In some of them, the sulphates of magnesia and nickel, of magnesia and cobalt, of magnesia and the sulphato-chromate of magnesia, are superposed on each other, and the pellucidity of these crystals is such, that the limits of the single strata are distinctly perceptible. The immediate contact of the solution of sulphato-chromate of magnesia with the crystals containing nickel or cobalt, must be avoided, which is done by allowing a stratum of pure sulphate of magnesia to be deposited on the surface of these crystals.

Chlorate and Bromate of Soda. The presence of some sulphate of soda in a solution of chlorate of soda provokes the formation of tetra-

hedral crystals with the angles replaced by three-planes, and subordinate hexahedral surfaces. When a hexahedral crystal of chlorate of soda, with traces of hemihedry, is plunged into a solution of sulphate of soda, it assumes soon the tetrahedral form in the course of its increase. When the proportion of sulphate of soda is considerable, the tetrahedral crystals show no traces of hexahedral surfaces.

Bromate of Soda is only obtained in a regular octahedral form, or in such with somewhat prevalent threefaced octahedral surfaces. A solution of this bromate, mixed with as much of chlorate of soda as it will admit, produces only hexahedral crystals without any indication of hemihedral surfaces. Each of these salts, separately treated, gives *transparent* crystals, while those issuing from a mixture of both, are *opaque* and milk-white.

Crystals in solution of Isomorphous Substances. Saturated saline solutions take up notable quantities of some other salt without regard to their different degrees of solubility. The saturated solution of a salt proves inactive towards the crystals of a substance isomorphous to it, when this last substance is less soluble than the salt contained in the solution. Thus episomorphous crystals may be obtained by increase within a solution of an isomorphous substance, while any other crystals disappear when immersed in it.

Dr. Klocke asserts that, having shaken during a long time a crystal of alum, immersed in the saturated solution of a more soluble variety of alum, he observed on the surface of this crystal microscopical etched figures. This fact proves again that crystallization does not proceed according to strict geometrical precision. Dr. Klocke however, goes too far in his conclusions by parallelizing this minimum of solubility with the mutual action of isomorphous salts, and by denying these last to be an exception to the general rule. This assertion would at once annihilate a series of fundamental laws, deduced from experiments and observations, although their geometrically precise concordance with facts cannot be proved.

COUNT M.

SPHERICAL CONCRETIONS. (G. WUNDT., *Imp. Geol. Inst., Meeting March 2nd, 1880.*)—The dark-grey shaly clays of Vils (Tirol), ranked by Gumbel among the "Allgäu" shales (Upper Lias), have proved by their organic remains, collected by the late Prof. Oppel, to be middle Cretaceous, cœval with the Gault.

The clays here in question, intercalated between two zones of Jurassic marble, include spherical concretions, varying from the size of a walnut to that of a fist, grey, with rough surface and uncommonly

ponderous. They appear very compact and hard, as a compound of sand and cement. Crystalline aggregations form their superficial crust when broken, the transverse section appears grey, compact or fine-grained, occasionally somewhat crystalline and bright, like fine grained dolomite; the centre is generally a coarse crystalline white nucleus, from which occasionally radial fissures proceed to the outer crust. The stratification of the beds including these concretions, is undisturbed, although similar disturbed and upheaved beds likewise include concretions. These last ones being neither crushed nor deformed, they must be inferred to have come to existence subsequently to the violent disturbances undergone by the strata. The uncommon weight of these concretions reminds one of the spheroidal concretions of phosphate of lime in the Cretaceous rocks of Russian Podolia; they are, however, only compounds of carbonate of lime and of gypsum.

COUNT M.

GYMNITE OF PREGRATTEN (TIROL). (CHEVALIER FR. DE HAUER, *Imp. Geol. Inst., Meeting February 17th, 1880*).—This mineral appears under the form of a very thin, earthy, light-green crust, on Serpentine, reminding one of the Gymnite on the surface of chromates of iron from Texas and Alt-Orsova (Croatia). A qualitative analysis manifested the presence of nickel and water, with silica, magnesia, and alumina as accessory constituents, but no trace of cobalt. The gymnite from Pregratten, seems to stand next to the variety from Michipicoten, which, according to Hunt, contains 8 per cent. of alumina; and like this, it is very soft.

The nickel-gymnites of Alt-Orsova, and of N. America appear associated with Chromite; the variety from Pregratten appears as a superficial crust on dark-green serpentine, with granules of magnetic oxide of iron, and with mere traces of chromium. A green mineral ("Emerald-Nickel") had been found long ago at Pregratten, in the form of a crust in the fissures of larger crystals of magnetite, interspersed in decomposed chrysotile. According to Petersen, the oxide of nickel may be derived from the olivine, transformed into serpentine and chrysotile.

COUNT M.

WITHERITE FROM PEGGAU (STYRIA). (M. C. DOELTER, *Imp. Geol. Inst., Meeting March 2nd, 1880*).—It appears in the form of crystals, rarely exceeding the length of 5 millimeters, on compact Witherite (Carbonate of Baryta), separated from quartzose limestone by bands of brown crystalline sulphuret of zinc. The form of the crystals is P. 2P \propto oP, with a somewhat vaulted basis, and depressions on the pyramidal surfaces.

COUNT M.

TERTIARY ERUPTIVES OF SCHEMNITZ, HUNGARY.—*Greenstone Trachytes (Propylites)*.—(DR. E. HUSSAK, *Imp. Geol. Inst.*, meeting March 2nd, 1880).—They are highly decomposed, their fundamental substance is compact, light or dark greenish-grey, interspersed with white decomposed felspar, amphibole, and light-green decomposed pyroxene. Microscopical investigation shows a micro-crystalline structure, greenish amphibole or mica, decomposed into calcite or epidote, highly decomposed plagioclase with abundant particles of calcite, and monoclinous felspar; apatite is scarce, and pyroxene is always wanting. These Trachytes closely resemble the so-called “Ancient Diabasic Porphyries”; they belong, however, decidedly to the Tertiary Eruptives. A variety of them includes pyroxene, decomposed into a viriditic substance, less frequently into calcite or epidote, iron pyrites in abundance and titanate of iron, entire or decomposed. Other varieties include quartz, alone or with pyroxene.

Grey Trachytes (Amphibolic Andesites).—They are light-grey, whitish, reddish or brown, with undecomposed vitreous felspar, large prisms of black amphibole and lamellæ of mica. The microscope shows the fundamental substance to be composed almost exclusively of felspar, with a slight proportion of a granular vitreous substance. The unaltered plagioclases include an abundance of vitreous substance, together with prismatic crystals of pyroxene and apatite. Tridymite is not of rare occurrence, titanite is entirely wanting. The amphibolic andesites, like the micaceous ones, include a notable proportion of light-green, very dichröitic pyroxene. One variety has a totally vitreous or sphærolitic brown or uncoloured fundamental substance, abundantly interspersed with brown amphibole, mica, and light-green dichröitic pyroxene.

Dacites (Andesites with Quartz and Amphibole).—They are very abundant in pyroxene; their fundamental substance is composed of plagioclase and pyroxene, interspersed with amphibole and mica. The quartz includes a vitreous substance. Another variety is a genuine dacite, whose prevailing components are large fragments of brown amphibole, brown mica, undecomposed plagioclase and irregular granules, including a vitreous substance.

Younger (Pyroxenic) Andesites.—This variety, formerly ranked among grey trachytes or basalts (*Beudant's* “Trachyte semi-vitreux”) has by far the greatest extension in the environs of Schemnitz. They are plagioclase-pyroxenic rocks without any olivine. The fundamental substance consists of interwoven microliths of pyroxene and felspar, either grey or filled with a brown vitreous substance, in which granules of magnetite are abundantly distributed. These microliths are either narrow and lengthened, or short prisms, or rounded. The

plagioclase is constantly undecomposed, bright, uncommonly abundant in vitreous substances, of distinct zonal structure. The pyroxene, generally undecomposed and light-green, appears in the well-known form of octangular transverse sections, the pinacoids generally prevailing over the prisms; it is highly dichroitic. It is rarely decomposed into viridite or bastite. This last mode of decomposition proceeds from transverse fissures, and is manifested by the formation of green longitudinal fibres. Vitreous substance is included in uncommon abundance; microscopical tridymite and small rounded sphaeroliths are of local occurrence. The red rocks, spotted with black, of the Ceykova Valley, described by Baron Andrian, (*Ann. Imperial Geological Institute*, 1866, p. 396), are genuine pyroxenic andesites, locally penetrated with oxide of iron, which forms a pellicle over nearly every one of the microscopic crystals of pyroxene of the fundamental substance. In this substance, bright black fragments alternate with red ones of euristic appearance. Vitreous substance is abundant; while vitreous feldspars and microscopical prisms of black pyroxene are interspersed. The proportion of silica in the rocks here in question varies between 57 and 61 per cent.

COUNT M.