

II.—“*Remarks on Gramenite from Smallacombe, and on the Chloropal Group of Minerals.*”

By J. H. COLLINS, F.G.S., *Hon. Sec.*

A FEW years ago, while inspecting some iron ore deposits at Smallacombe, near Bovey Tracey, in Devon, I noticed the occurrence of certain brightly colored green, red and brown clays in considerable quantity.* I took several specimens of the green clay at the time, and on my return home laid them aside in a lumber closet, where they became buried with other specimens, from which they have only lately been disinterred. After so long a stay in a tolerably dry situation I thought they might be regarded as in a normally hygrometric condition, and it was in this state that I subjected them to examination and analysis, with the following results.

Preliminary Examination.—The mineral is unctuous to touch but does not adhere to the tongue, it is somewhat softer than talc. The color is dull green or yellowish green, with a few thin veins of a reddish brown color running through it.

Selecting a piece free from these veins I found the specific gravity was 1.89.

Heated in the matrass it turns dark brown and gives off much water which is neutral to test paper.

Heated on charcoal it becomes dark brown and highly magnetic, but is perfectly infusible.

With borax it gives the usual reactions for oxide of iron, and with microcosmic salt for oxide of iron and silica.

Heated on Platinum foil with carbonate of soda, there is a faint tinge of green, which may be due to a trace of manganese.

Heated in the Bunsen flame, after moistening with HCl, the flame is tinged yellow, and the spectroscope shows the sodium and potassium lines.

* See “Note on the iron ore deposits at Smallacombe. Rep. Miners Assoc. of Cornwall and Devon, 1871, p. 71.

Treated with HCl, HNO₃, or H₂SO₄ the powdered mineral is partially and slowly decomposed and yields a small amount of iron to the solution but is not completely decomposed after 96 hours digestion, 12 being in the heated sand bath.

Treated with solution of caustic potash, the filtered solution diluted, and treated with carbonate of soda, a large amount of alumina is precipitated, showing that it is present in a freely soluble state.

Analysis—3 grams of the mineral scraped in fine shavings was placed over oil of vitriol in a dessicator for 96 hours—by which time it had lost 11·58 p.c. of weight; a further exposure for 12 hours did not reduce the weight. On heating the dessicated mineral for 2 hours at a temperature of 105°C, there was a second loss of 7·22 p.c on the original weight, and on igniting the residue a third loss of 6·61 p.c. The ignited residue was then rubbed up in an agate mortar with 4 times its weight of fusion mixture, and fused in a Platinum crucible. The silica, iron and alumina, were then determined in the usual way with the results given below. The solution freed from iron and alumina yielded ·14 of lime by precipitation as oxalate.

Wishing to determine whether the iron existed in two states of oxidation, I treated portions of the powdered mineral in covered beakers with dilute HCl and dilute H₂SO₄. The pale yellow solutions so produced were tested with the red prussiate of potash but not the slightest change of color took place—shewing the entire absence of proto-compounds of iron.

The results of the Analysis, therefore, stand as below, in column *a*.

	a. analysis	b. theory
Water given off over oil of vitriol	11·58	8·85
" " at 150° C	7·22	
" " by ignition	6·61	13·26
	25·41	22·11
Silica	39·70	44·20
Peroxide of iron	21·94	23·57
Alumina	10·92	10·12
Lime	14	—
Alkalies and loss	1·89	—
	100·00	100·00

These numbers agree as well, perhaps, as could be expected in the analyses of an amorphous mineral with those calculated from the following formula (which I have given in the column headed *b*) viz:—

$3(\text{Fe}_2\text{H}_6\text{O}_6 \cdot 3\text{SiO}_2) + 2(\text{Al}_2\text{H}_6\text{O}_6 \cdot 3\text{SiO}_2) + 15\text{H}_2\text{O}$, which formula may also be written $\text{R}_2\text{H}_6\text{O}_6 \cdot 3\text{SiO}_2 + 3\text{H}_2\text{O}$ where *R* is $\frac{2}{3}$ ths iron and $\frac{1}{3}$ ths aluminium.

A comparison of the above analytical results with the analyses given under Chloropal by Dana* shews that there is a very close correspondence between the Gramenite of Menzenberg, analysed by Bergemann and that from Smallacombe, as under:

	H ₂ O	SiO ₂	Fe ₂ O ₃	FeO	Al ₂ O ₃	MgO	MnO	CaO	K ₂ O
Gramenite, <i>Menz.</i>	23·36	38·39	25·46	2·80	6·87	0·75	0·67	0·56	1·14
Gramenite, <i>Small.</i>	25·41	39·70	21·94	—	10·92	—	trace	0·14	1·89

The only difference of importance here, is, that between the relative proportions of Peroxide of Iron, and Alumina; the Gramenite of *Menzenberg* having considerably less than the theoretical quantity of Alumina—that from *Smallacombe* somewhat more.

In both cases, however, it seems to me that the proportion of alumina is much too great to be regarded as an accidental admixture, and, consequently, the mineral should not be classed as a mere *variety* of Chloropal, but should take rank as a *species*.

Dana gives the composition of the typical chloropals of Unghwar as below, in columns *a*, *b*, and the theoretical composition as in *c*, his proposed formula being $\text{Fe}_2\text{O}_3 \cdot 3\text{SiO}_2 + 4\frac{1}{2}\text{H}_2\text{O}$, but the formula $\text{Fe}_2\text{O}_3 \cdot 3\text{SiO}_2 + 5\text{H}_2\text{O}$, which may be written $\text{Fe}_2\text{H}_6\text{O}_6 \cdot 3\text{SiO}_2 + 2\text{H}_2\text{O}$, agrees much better with his analysis as shewn in column *d*, if we take into account his admitted excess of silica and consequent deficiency of iron and water in the specimens analysed, and this, as will be seen, allows us to assign a convenient general formula to the whole Chloropal group.

	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>
Silica	46·00	45·00	42·70	41·86
Peroxide of iron	33·00	32·00	38·00	37·21
Alumina	1·00	·75	—	—
Magnesia	2·00	2·00	—	—
Water	18·00	20·00	19·30	20·93
	100·00	99·75	100·00	100·00

* System of Mineralogy, p. 461. Anal. No. 16.

A careful consideration of the various analyses of minerals of the chloropal group given by Dana, leads me, therefore, to propose that the following species and varieties should be regarded as a series of types to which all future discoveries in the group may be referred.

CHLOROPAL GROUP—General Formula	$R_2 H_6 O_6 3Si O_2 + 2H_2 O$
Chloropal	$Fe_2 H_6 O_6 3Si O_2 + 2H_2 O$
Nontronite	...	$(4.5 Fe 1.5 Al)_2$	$H_6 O_6 3Si O_2 + 2H_2 O$
Gramenite	...	$(3.5 Fe 2.5 Al)_2$	$H_6 O_6 3Si O_2 + 2H_2 O$
*Keffekilite	...	$(2.5 Fe 3.5 Al)_2$	$H_6 O_6 3Si O_2 + 2H_2 O$
Bole	...	$(1.5 Fe 4.5 Al)_2$	$H_6 O_6 3Si O_2 + 2H_2 O$
**Montmorillonite	$H_6 O_6 3Si O_2 + 2H_2 O$

The calculated percentages will then be as under:—

	Chloropal	Nontronite	Gramenite	Keffekilite	Bole	Montmorillonite
Silica	41.86	43.00	44.20	45.48	46.82	48.27
Peroxide of iron	37.21	30.58	23.57	16.17	8.32	—
Alumina	—	4.92	10.12	15.62	21.44	27.60
Water	20.93	21.50	22.11	22.73	23.42	24.13
	<u>100.00</u>	<u>100.00</u>	<u>100.00</u>	<u>100.00</u>	<u>100.00</u>	<u>100.00</u>

We may then include under *Chloropal*, the analyses 1, 2, 4, 5, 6, 10, 11, 12, 13, 15 (*Chloropal*, p. 461 *Dana*), several being admittedly impure specimens.

Under *Nontronite*, we have analyses 7, 8, 9 (*Chloropal*, p. 461 *Dana*).

Under *Gramenite* we have analysis 16, and perhaps *Fettbol* analysis 17 (*Chloropal*, p. 461 *Dana*).

Under *Keffekilite* we have the analysis by John (*Keffekilite*, p. 478 *Dana*).

Under *Bole* we have analyses 16, 17, 18, 19, 20 (*Lenzinite*, p. 477 *Dana*), and analysis 11 (*Montmorillonite* [*Erinite*] p. 460 *Dana*).

Under *Montmorillonite* we have analyses 1, 2, 3, 4, 5, 6, 7, 8, 10 (*Montmorillonite*, p. p. 459-60 *Dana*).

The "hardness" of the whole group (excluding certain siliceous specimens of *Chloropal*, which pass into opal), will be below 2; the Sp. Gr. from 1.7 to 2.4; the color may be white or grey (*Keffekilite*), yellow (*Nontronite*, *Bole*), red or brown (*Bole*, *Montmorillonite*), green or yellowish green (*Chloropal*, *Gramenite*); all are opaque, usually compact or earthy, slightly unctuous, generally feebly adherent to the tongue, all are infusible and give off much neutral water in the closed tube.

* *Dana*, p. 478. ** *Dana*, p. 459.

Doubtless, it might be shewn, that the members of this group of highly hydrated ferric-aluminic silicates pass into each other in many instances by insensible gradations—but the extremes of the series are decidedly too far apart to allow of their being brought together as one species, and I believe this simple mode of subdividing the group will be found convenient, without, in any way doing violence to nature, and, as it introduces no new names, I hope it will be accepted as a step in the elucidation and classification of the puzzling Clay group of Minerals.

DISCUSSION.

DR. LE NEVE FOSTER was glad to see the systematic grouping of minerals of related composition which Mr. Collins had suggested, and hoped that he would follow up the subject by working out other groups in a similar manner. In this way the science of Mineralogy might, he believed, be much simplified, and he would deserve the thanks of all Mineralogists.

MR. KITTO would have preferred the entire abolition of some of the names, as there appeared to be very small differences between some of these amorphous substances, and specimens of the same variety from different localities would probably shew different results on analysis.

MR. C. H. RICHARDS, a visitor, asked whether the peculiar greenish color of the Smallacombe Gramenite might not be due to the presence of sulphate of iron.

MR. LETCHER expressed his gratification, as a student, at the convenient grouping which Mr. Collins had suggested.

MR. COLLINS replying to Mr. Richards said, that the absence of an acid reaction with the water given off on heating the mineral in a matrass shewed the absence of sulphate of iron, or sulphuric acid in any form.

Replying to Mr. Kitto, he observed that it seemed hopeless to look for the abolition of names, unless the minerals to which they had been applied were proved to be identical in composition, or other properties. For example, when Prof. Church first noted the occurrence of Chloropal at Carn Grey, near St. Austell, he did not

think that name sufficient, and spoke of it as *that variety of Chloropal known as Gramenite*. In future, if his classification were adopted, it would be sufficient to call it Gramenite, as he had supplied a definite meaning for that term. No doubt Gramenites from different localities would still differ in composition, but the differences could not be great, or the mineral would cease to be Gramenite, and would naturally take its place as some other member of the group.