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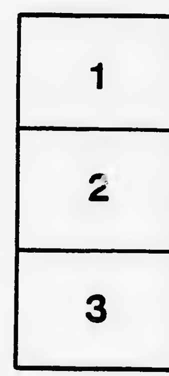

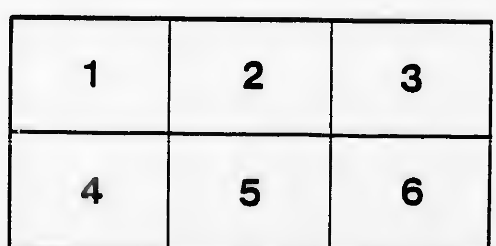

Séminaire de Québec. 1861.

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4

EXAMINATIONS OF SOME FELSPATHIC ROCKS.

BY

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THE oldest known group of rocks in North America is that to which the name of the Laurentian System has been given in the Reports of the Geological Survey of Canada, and is made up of very much disturbed and highly crystalline strata, which are in great part gneissoid and quartzose. Interstratified with these, however, are beds of crystalline limestone, often of great thickness, and holding scapolite, pyroxene, phlogopite, serpentine, fluor, apatite, spinel, corundum, condrodite, sphene, graphite, and other characteristic minerals. Associated with these limestones, there is another rock forming an important member of the group, and consisting chiefly of felspar, with small portions of black mica, green pyroxene, and occasional grains of garnet, epidote, and more rarely of quartz. This rock is often marked by the presence of small portions of hypersthene; from the presence of this mineral, these masses have been described by the New York geologists as *hypersthene rock*. In addition to these minerals we may add ilmenite, or titaniferous iron ore, which occurs sometimes in large masses, and at other times in small disseminated grains, which like the hypersthene appear to mark the planes of stratification. If to these we add small portions of iron pyrites and a little disseminated carbonate of lime, we have the mineralogy of the rock so far as yet known.

The texture of these felspar rocks is varied; sometimes the mass is a confusedly crystalline aggregate, exhibiting cleavage surfaces three or four lines in diameter, with a fine-grained, somewhat calcareous paste in the interstices. Sometimes the whole rock is uniformly granular, while more frequently a granular base holds at intervals cleavable masses of felspar, often several inches in diameter. The colours of these rocks vary from grayish and bluish-white to lavender and violet-blue; flesh-red, greenish and brownish tints are also met with; the colours are rarely brilliant. These felspars seldom occur in distinct crystals, but their cleavage is triclinic, a fact which, coupled with their densities varying from 2·66 to 2·73, shows them to belong to the group of which albite and anorthite may be taken as the representatives. The bluish cleavable varieties often exhibit the opalescence of labradorite, to which species American mineralogists have hitherto referred them; but with the exception of a few analyses by myself, we have no published analyses of any of these felspars. My investigations show, that while all of them are felspars with a base of lime and soda, the composition varies very much, being sometimes that of labradorite, andesine or intermediate varieties, and at other times approaching to that of anorthite. The results of these examinations, as far as yet completed, I propose to give in the present paper, as the first part of the history of these felspathic rocks.

One of the most interesting localities of these felspars is in the parish of Château-Richer, in the county of Montmorenci near Quebec, where they cover a breadth of two or three miles across the strike, bounded by crystalline limestone on one side, and a quartzo-felspathic rock on the other, and rising into small hills. In this region several varieties of the rock appear, but the most interesting is made up of a finely granular base, greenish or grayish-white in colour, holding masses of a reddish cleavable felspar, which are sometimes from one-tenth to one-half an inch in diameter, but often take the form of large imperfect crystals, frequently 12 inches long, and 4 or 5 inches wide. These dimensions correspond to the faces M and T, while the face P, characterized by its perfect cleavage, is from half an inch to 2 inches broad. Twin crystals sometimes occur having a composition parallel to M.

Hypersthene is met with throughout the rock in flattened masses, which although variable and irregular in their distribution, exhibit a general parallelism; they are occasionally 4 or

5 inches in length and breadth, by an inch or more in thickness, and are separated from the granular felspathic rock by a thin film of brownish-black mica. Titaniferous iron ore is also found in grains and lenticular masses, occasionally an inch or two in thickness; these occur in the granular base, and generally near the hypersthene, but grains of the mineral are occasionally found in the crystalline felspar. Quartz in small grains is imbedded in the titaniferous iron, but was not observed elsewhere in the rock, nor have any other minerals than these been detected. In the specimens of the rock which I selected on the spot for examination, the crystalline felspar constitutes from one-half to seven-eighths, while the hypersthene does not equal more than $\frac{2}{100}$dths, and the titaniferous iron more than $\frac{1}{100}$dth of the whole; the amounts of quartz and mica are insignificant. In other portions of the rock, however, the proportion of the ore may equal 5 per cent., and in some parts the amount of hypersthene is nearly as great. By the action of the elements, the surface of the rock becomes of a dull opake white; the cleavable masses of felspar are, however, less affected than the granular portion, and by their obscure reddish colour are distinctly visible on the weathered surfaces; this change extends but a very little distance into the rock. The iron ore of course remains unaltered, but the dark brown hypersthene becomes lighter, and inclines to a pinchbeck-brown.

The felspar is triclinic in cleavage; the angle of P : M = about 80° 80′. Cleavage with P perfect, with the other planes distinct; P is often delicately striated, and sometimes curved. Hardness =6, and density 2·667 to 2·674. Lustre vitreous, sometimes pearly on P; colour flesh-red, passing into reddish, greenish and grayish-brown; the surfaces sometimes mottled, but the red always predominating.

The following analyses were made of three different specimens, which were carefully selected, and after being pulverized, dried at 212° F. The earthy ingredients were determined after fusion with carbonate of soda, and the alkalies by the method of Dr. J. L. Smith, which consists in igniting for some time the finely levigated mineral with five or six parts of carbonate of lime and three-fourths its weight of sal-ammoniac. The agglutinated mass slakes by the action of water, and yields to that liquid its alkalies in the form of chlorides, with a mixture of chloride of calcium. A second ignition of the undissoved residue with two-thirds the first amount of sal-ammoniac ensures the separation of the last portions of alkali. These processes were adopted in all the analyses here given, with some exceptions to be noticed in their places.

	I.	II.	III.
Silica	59·55	59·85	59·80
Alumina . . .	25·62	25·55	25·39
Peroxide of iron .	·75	·65	·60
Lime	7·73	6·94	7·78
Magnesia . . .	traces	·11	·11
Potash	·96	·96	1·00
Soda.	5·09	5·09	5·14
Loss by ignition .	·45	·30	·00
	100·15	99·45	99·82

In another specimen the amount of lime was found to equal 7·89 per cent. The composition of this felspar is very nearly that of andesine, which, according to Abich, yields silica, 59·60; alumina, 24·18; peroxide of iron, 1·58; lime, 5·77; magnesia, 1·08; potash, 1·08; soda, 6·53=99·82.

The greenish base of the rock is generally finely granular and strongly coherent; the grains possess the cleavage, lustre, and hardness of felspar; the density of carefully chosen fragments was from 2·665 to 2·668. The greenish-white of the powder is changed to a fawn colour by ignition. When pulverized and digested with acetic acid, the mineral loses two or three thousandths of carbonate of lime, with traces of magnesia, iron oxide, and alumina. A portion which had been thus treated and carefully dried gave the following results:—

	IV.
Silica	58·50
Alumina	25·80
Peroxide of iron .	1·00
Lime	8·06
Magnesia . . .	·20
Potash	1·16
Soda	5·45
Loss by ignition .	·40
	100·57

It is therefore a felspar differing but little from the crystalline andesine in composition.

The hypersthene occurs in foliated masses with curved surfaces. Besides the basal cleavages thus exhibited, it cleaves readily with the sides of an oblique prism of 87°, and with its longer diagonal. The hardness of the mineral is 6, and its density 3·409 to 3·417. Lustre vitreous, submetallic; colour blackish-brown, in thin laminæ yellowish-brown; streak and powder ash-gray, the powder turning reddish-gray on ignition. Subtranslucent, brittle, fracture uneven. The fragments which had served to determine the density still contained flakes of felspathic matter between the laminæ; these were, as far as possible, removed in breaking up the hypersthene for analysis. The results of two analyses by fusion with carbonate of soda were as follows:—

	V.	VI.
Silica	51·85	51·35
Alumina . . .	3·90	3·70
Protoxide of iron .	20·20	20·56
Lime	1·60	1·68
Magnesia . . .	21·91	22·59
Manganese . . .	traces	
Loss on ignition .	·20	·10
	99·66	99·98

It is almost identical in composition with the hypersthene from Labrador, analysed by Damour.

The accompanying ilmenite was more or less interpenetrated with felspar and quartz, which could not easily be separated. Its hardness was 6, and the density of selected fragments from 4·65 to 4·68. Colour and streak iron-black, lustre submetallic; not magnetic. When decomposed by fusion with bisulphate of potash, it gave,—

	VII.
Titanic acid	39·86
Peroxide of iron . . .	56·64
Magnesia	1·44
Insoluble quartz, &c. .	4·90
	102·84

A large portion of the iron is to be regarded as protoxide.

Another variety of the lime-felspar rock from Château-Richer is pale greenish or bluish-gray, with occasional reddish grains, and is finely granular. The lustre is vitreous upon the cleavages, but waxy elsewhere. The only foreign mineral observed in the rock was brownish-black mica in small scattered patches. The density of the greenish-gray portion was 2·681, and its analysis gave,—

	VIII.
Silica	55·80
Alumina	26·90
Peroxide of iron	1·53
Lime	9·01
Magnesia	·27
Potash	·86
Soda	4·77
Loss by ignition	·45
	99·59

In Château-Richer and its vicinity there are found boulders of a well-defined variety of the felspar rock, which has not yet been met with in place. The base is a coarsely granular felspar of a light reddish-gray colour and vitreous lustre, exhibiting everywhere distinct cleavages, and holding imbedded small bright grains of ilmenite, surrounded with thin films of brownish mica. The imbedded crystals of felspar are numerous, and are often 3 or 4 inches in length and breadth by an inch in thickness. The faces of perfect cleavage are beautifully striated, and the smaller crystals, which are often slender and well defined, are sometimes curved. Hardness, 6; density, 2·680 to 2·692; lustre, vitreous; colour, pale lavender blue, with pearly opalescence. Semitransparent, fracture conchoidal. Analysis IX. is a cleavable fragment from a boulder found at Château-Richer, and X. and XI. are from a similar and larger mass in the neighbouring parish of St. Joachim.

	IX.	X.	XI.
Silica	57·20	57·55	57·35
Alumina	26·40 }	27·10	27·30
Peroxide of iron	·40 }		
Lime	8·34	8·73	
Potash	·84	·79	
Soda	5·83	5·38	
Loss by ignition	·65	·20	·25
	99·66	99·75	

The district of Montreal also affords extensive exposures of these same felspar rocks, associated with crystalline limestone, in the counties of Leinster and Tenebonne. In the townships of Rawdon and Chertsey they are often fine-grained and homogeneous, and constitute an exceedingly tough rock, with an uneven subconchoidal fracture, and a feeble vitreous lustre; this variety is bluish or grayish-white in colour, somewhat translucent, and exhibits here and there the cleavage of grains of felspar. Great bodies of this rock are almost free from foreign minerals, while other portions abound in a green granular pyroxene, arranged in thin interrupted parallel layers with ilmenite. These layers of pyroxene are seldom more than 4 or 5 lines in thickness, and may be an inch or two apart, while those of ilmenite are still thinner, and often enclosed in the pyroxene, along the surfaces of which deep red grains of garnet are occasionally seen. These different minerals appear in relief upon the white weathered surface of the rock, and give a picture of its stratified structure, which is, however, not less apparent upon the surfaces of recent fracture. Small, rounded, bluish masses of cleavable felspar are frequently disseminated in the same planes as the other minerals. In some places the pyroxene appears to pass into, or is replaced by, foliated hypersthene. A homogeneous fragment of this rock from Rawdon had a density of 2·691. It was bluish-white, granular and translucent, and gave by analysis,—

	XII.
Silica	54·45
Alumina	28·05
Peroxide of iron	·45
Lime	9·68
Potash	1·06
Soda	6·25
Loss by ignition	·55
	100·49

In connexion with this variety, which has nearly the composition assigned to labradorite, I may give the analyses of two felspars which differ from it principally in their greater amount of lime. No. XIII., from the township of Morin, belongs to the same area as the last, and forms large cleavable masses in a fine-grained base. Its density is 2·684 to 2·695, and its colour greenish-gray, passing into bluish-gray, with an occasional pearl-gray opalescence. The greenish paste of this felspar is softer than the others, and yields with effervescence about four hundredths of carbonate of lime to dilute acids; the insoluble residue has nearly the composition of the felspar. No. XIV. is a cleavable, lavender-blue, opalescent variety, from a rolled mass found in Drummond, Canada West, and having a density of 2·697. The determination of the alkalies in this was not made by the same process as in the other analyses, and probably does not give the full amount.

	XIII.	XIV.
Silica	54·20	54·70
Alumina	29·10	29·80
Peroxide of iron	1·10	·36
Lime	11·25	11·42
Magnesia	·15	traces
Potash } by diff.	3·80	·23
Soda } by diff.	...	2·44
Loss by ignition	·40	·40
	100·00	99·35

At La-Chute on the Rivière du Nord, there is a felspar rock associated like the others with crystalline limestone, and holding in a greenish granular base a cleavable felspar resembling andesine in composition. Its lustre is vitreous, and the face of perfect cleavage, as in all these felspars, is finely striated. Density, 2·687; colour, lavender-blue, passing into sapphire-blue; semitransparent. Its analysis gave—

	XV.
Silica	58·15
Alumina	26·09
Peroxide of iron	·50
Lime	7·78
Magnesia	·16
Potash	1·21
Soda	5·55
Loss by ignition	·45
	99·89

The bytownite of Thompson appears to be one of these granular felspar rocks, and can scarcely be distinguished from some of the varieties just described. In 1850 I examined an authentic specimen of the mineral, and found it to have a hardness of 6·5, and a density of 2·732; it gave by analysis,—

	XVI.	
Silica	47·40	47·30
Alumina	30·45	
Peroxide of iron	·89	
Lime	14·24	
Magnesia	·87	
Potash	·38	
Soda	2·82	
Loss by ignition	2·00	
	99·05	

I remarked at the time, the undoubted felspathic character of the mineral, which I described as corresponding to the thiorsanite of Genth, and as probably anorthite with an admixture of quartz*.

The frequent association of ilmenite with these felspars, derives additional interest from the fact, that the immense deposits of this ore at Bay St. Paul are accompanied with a lime felspar. Here, besides many smaller masses, a body of titaniferous iron ore, 300 feet long by 90 feet wide, is exposed on the side of a hill, and a still larger mass is said to occur in the vicinity. The

* See this Magazine, S. 4. vol. i. p. 324. Also Report of the Geological Survey of Canada for 1850–51, p. 38, where analysis XIV. has also appeared.

ore is coarsely crystalline; its colour and streak are iron-black, and its lustre submetallic; it affects the magnetic needle very feebly. Hardness, 6; density, 4·56 to 4·66. Its analysis gave me titanic acid, 48·60; protoxide of iron, 37·06; peroxide of iron, 10·42; magnesia, 3·60=99·68. Disseminated through portions of the ore, are small, garnet-red, translucent grains, which have an adamantine lustre, a conchoidal fracture, and a hardness of 6. They are found by analysis to be pure oxide of titanium, and are to be referred to the species rutile or brookite.

We have in the rocks which have been the subject of these examinations, a series of felspars in which the amount of silica varies from 47·40 to 59·80 per cent., and that of the lime from 7·73 to 14·24 per cent., the amount of the alkalies decreasing as that of the lime augments. These results only help to confirm the conclusion which may be drawn from all the previous analyses of triclinic felspars, that there are no defined limits for those species which, like vosgite, labradorite, andesine, and oligoclase, have been created between albite on the one hand, and anorthite on the other. I therefore proposed some time since to regard all of the intermediate felspars as mixtures of these two species, which, being homœomorphous, may be supposed to crystallize together in indefinite proportions. Multiplying and expanding the received formulæ of albite and anorthite, I represented them as follows (silica being SiO, and alumina $alO=(Al^2O^3)\div 3$)*:—

		Eq. wt.	Density.	Eq. vol.
Albite . .	$(Si^{48}al^{12}Na^4)O^{64}$	$=1054·4$	$\div 2·62$	$=402·4$
Anorthite .	$(Si^{32}al^{24}Ca^8)O^{64}$	$=1118·4$	$\div 2·72$	$=405·0.$

The composition and density of the intermediate felspars permit us to regard them, for the most part, as mixtures of a soda-albite and a lime-anorthite. In the analyses of many albites and anorthites, however, we have evidence of similar admixtures; for some albites contain from 1 to 2·5 per cent. of lime, and anorthites from 3 to 4 per cent. of alkalies. Of a like significance is the constant presence of a small amount of potash with the soda of these felspars, and the magnesia, sometimes amounting to 5 per cent. in anorthite, leading us to infer the existence of lime and potash-albites (orthoclase?), and soda and magnesia anorthites. The difficulties presented by the varying composition of these felspars are obviated by admitting such a mixture of species as constantly takes place in the crystallization of homœomorphous salts from mixed solutions, and this consideration should never be lost sight of in the study of mineral chemistry.

It was not until after I had published this view of the constitution of the triclinic felspars (a view which must also be ex-

* American Journal of Science, 2nd series, vol. xviii. p. 270.

tended to the scapolites), that I became aware that Th. Scheerer had recently proposed to regard all felspars as combinations of anorthite with labradorite, anorthite with albite (orthoclase), or labradorite with albite*. It was gratifying to find that this distinguished chemist had already arrived at a solution of the problem of the felspars not unlike my own, but I must object to admitting labradorite as a distinct species, or as having any higher value than oligoclase, andesine, or the felspars X. and XV. in the present paper.

Montreal, Canada,
March 1855.

* Poggendorff's *Annalen*, vol. lxxxix. p. 19, cited in Liebig and Kopp's *Jahresbericht*, 1853, p. 805.