

with a few spiny tubercles, none of them more than one-fourth as long as the eye. The specimen sent is a dried individual and its colors cannot be made out. There is a small slit behind the fourth gill. The local name at York Factory is "Miller's Thumb," according to Dr. Bell.

27781. *COREGONUS ARTEDI* LeS. var.

The species agrees in all respects with typical *Artedi* from the Great Lakes with the exception of its smaller eye. Two larger examples collected at Moose Factory many years ago also have the eye notably smaller than in *C. Artedi*. The local name at York Factory, says Dr. Bell, is "*tulibi*." It must not be inferred, however, that the species is at all like *Coregonus tullibee*, for it is not closely related to this form. Specimens in alcohol are much desired.

U. S. NATIONAL MUSEUM,
Washington, D. C., March 28, 1881.

ON THE MINERALOGICAL COMPOSITION OF THE NORMAL MESOZOIC DIABASE UPON THE ATLANTIC BORDER.

By GEORGE W. HAWES, Ph. D.

In my opinion the Mesozoic "trap rocks" have excited more interest and received more lithological attention than any other defined rock species upon the Atlantic border. There is, therefore, no rock concerning the geological features and chemical composition of which we are so well informed; but much as it has been discussed, the mineralogical composition has, in part, remained a matter of speculation rather than of definite knowledge. As our methods for determining such points are now much more satisfactory, I think that the final determination of the mineral composition of the normal variety of this rock may be accomplished, and this will be of much interest on account of the wide distribution and the uniform character of these diabases.

I will give a few references to show the development of our knowledge of these rocks and the essential uniformity in their composition.

When Perceval wrote, no attempt was made to determine their composition, and their geological features and distribution were chiefly considered.¹

Prof. J. D. Dana has at different times pointed out the wonderful uniformity of these rocks wherever they occur, intersecting the Mesozoic sandstones on the Atlantic border.² He quotes specific gravity determinations by Professor Brush of New Haven, Professor Cooke of New Jersey, Professor Kerr of Raleigh, N. C., and Professor Howe of Nova Scotia, made upon specimens from their respective localities, and

¹ See Dana's Geology, page 20.

² American Journal of Science, series iii, vol. vi, page 104.

which are essentially alike. Professor Dana considered these rocks as composed of pyroxene, magnetite, and labradorite.

Professor Howe¹ soon afterward made further determinations of specific gravity with the view of illustrating more fully the uniformity of this composition.

Chemical analyses of these rocks have been made by Prof. G. H. Cooke,² Prof. W. G. Mixer,³ S. T. Tyson,³ and Dr. F. A. Genth,⁴ which are all nearly concordant, and show the ultimate composition to be always nearly the same.

The most extensive series of analyses has been made by myself⁵ upon specimens taken from various points in the Connecticut Valley, and a specimen from Jersey City, which was intended to represent the Hudson palisades. These analyses demonstrated the essential uniformity of the composition, all variations being referable to the degree of hydration which represents the extent of the decomposition of the rocks, and the degree of alteration of its pyroxene to chlorite. I concluded that the feldspar was labradorite, but demonstrated that the large kernels in one variety were of anorthite.

Prof. E. S. Dana⁶ began the microscopic examination of these rocks. He confirmed the determination that these rocks are composed of augite, triclinic feldspar, and an iron oxide, and assumed from my analysis that this feldspar was labradorite. Notwithstanding this, these rocks are stated to this day by Credner⁷ to be diorites, that is, hornblendic rocks.

Mr. P. Frazer⁸ has discussed my analysis of West Rock together with the analysis by Professor Genth. He assumed the feldspar to be a labradorite of normal composition, and calculated that labradorite and augite were present in equal proportion.

From these works it is then evident that the unaltered Mesozoic diabases are all very much alike, and are composed of augite, iron oxide, in the form of magnetite and titanite iron, and a feldspar that has been reasoned to be labradorite.⁹ This latter determination is in need of verification.

The method employed by me for this determination was that proposed

¹ Philosophical Magazine, February, 1876.

² Geological Report, New Jersey, page 215.

³ American Journal of Science, iii, vol. vi, page 105.

⁴ 2d Geological Survey of Penna. report of progress in York and Adams counties, page 120.

⁵ American Journal of Science, 1875, vol. ix, page 185.

⁶ Proc. Am. Association Adv. Sci., Aug., 1874.

⁷ Credner, Géologie, page 532. With his ill-defined definition of melaphyr, to which he refers a part of these rocks, they certainly have nothing to do. These rocks had long been demonstrated to be augitic when the last edition of his work appeared, which still states the palisades to be of diorite.

⁸ 2d Geological Survey of Penna., vol. C, report of progress in the district of York and Adams counties.

⁹ I speak now only of its essential original constituents. Biotite and hornblende

by Dr. Thoulet, which, though not invented by him, was brought into general notice by his more successful development of the method.¹

In a solution of iodide of potassium, iodide of mercury was dissolved, and the sp. gr. of the resultant fluid was 3.18.² Some of the diabase from Jersey City, which is particularly fresh, was pulverized till all the grains would pass through coarse muslin. From this powder the dust was separated by washing in water, and the mass of uniformly fine grains was put into the fluid, when the iron oxide and augite sank to the bottom and only feldspar remained on the top. I diluted till the sp. gr. decreased to 3, when some grains of a compound character settled out, and the microscope indicated that the floating mineral was entirely of feldspar. I diluted and made the gravity 2.90, and nothing of consequence fell down, neither did any considerable portion settle from the mass till the sp. gr. had reached 2.69, when at this point the mass of feldspar, on being mixed with the fluid as before, separated into two parts with such facility as to plainly show that two minerals were present. Further experiments on the parts did not result in any further separations, and it was therefore decided to analyze these parts. These analyses were performed by Dr. A. B. Howe, of the Scientific School at New Haven, and were found to be composed as follows:

FELDSPAR IN JERSEY CITY DIABASE.

Sp. Gr. over 2.69.			Sp. Gr. under 2.69.		
SiO ₂	52.84	.88	SiO ₂	60.54	1.01
Al ₂ O ₃	28.62	.278	Al ₂ O ₃	24.11	.234
Fe ₂ O ₃	1.52	.009	Fe ₂ O ₃	1.14	.007
CaO	11.81	.21	CaO	9.15	.163
MgO .....	.46	.01	MgO .....	.27	.107
Na ₂ O	2.38	.038	Na ₂ O	4.11	.066
K ₂ O .....	.86	.009	K ₂ O	1.06	.011
H ₂ O	1.06		H ₂ O .....	.59	
	99.55			100.97	
R O : R ₂ O ₃ : SiO ₂ 1 1 3.3			R O : R ₂ O ₃ : SiO ₂ 1 96 4.09		
R ₂ O : RO 1. 4.7			R ₂ O : R O. 1. 2.2		

It is therefore plain that the feldspathic element in this rock is not any single feldspar. One of the feldspars is very plainly labradorite, and the other has the ratio of andesite. The two feldspars were dis-

have been found in small amount in some specimens. Apatite is uniformly present as a minutely microscopic constituent, and the whole sequence of zeolites and chlorites-with quartz, calcite, and other minerals, are present as decomposition products, but as a rule it is a monotonously uniform mixture of the above three minerals.

¹Thésés présentées à la faculté des sciences de Paris, pour obtenir le grad de docteur. Contributions à l'étude des propriétés physiques et chimiques des minéraux microscopiques. Par M. J. Thoulet.

²This result was obtained by uniting the proportions recommended by Victor Goldschmidt, Ueber Verwendbarkeit einer Kaliumquecksilberjodidlösung, &c. Inaugural Dissertation zu Heidelberg, Stuttgart, 1880.

tinguishable under the microscope, and the optical properties of the grains offered no peculiarities to conflict with the above determination.

The analysis of the anorthite and augite that I picked from West Rock may be added, and our knowledge of this diabase may be said to be quite complete as regards the composition of the fresh rock. I will place together the analyses of the rock and its other components. Professor Genth's analyses, to which I have referred, is more complete than any that I have made, since he determined the traces of lithia, copper, and sulphur. But his analysis was made on more hydrous material; therefore I will use my old analysis of West Rock, New Haven, because the analyzed material was very fresh, bright, and clear, and also illustrates the commonest variety of the rock.

This rock and the following minerals from it have been analyzed:

	West Rock, New Haven.*	Augite in West Rock.	Anorthite in West Rock.
SiO ₂	51.78	50.71	45.95
Al ₂ O ₃	12.79	3.55	34.70
Fe ₂ O ₃	3.59		.64
FeO	8.25	15.30	
MnO .....	.44	.81	15.82
CaO	10.70	13.35	Tr.
MgO	7.63	13.63	1.80
Na ₂ O	2.14	} 1.48	.45
K ₂ O .....	.39		
TiO ₂	1.41		
P ₂ O ₅ .....	.14		
Igniton .....	.63	1.17	.96
	99.89	100.00	100.32

* My analysis with the titanic acid determinations by Dr. A. B. Howe, American Journal of Science, vol. ix, 1875, page 185.

Knowing that the feldspathic element is complex we can now calculate approximately the percentage composition upon the basis of the elements which are peculiar to the species involved. If in this manner neglecting the water we determine the percentage of the mineral constituents, we obtain

Anorthite, 15.52; albite, 22.16; potash feldspar, 2.32; augite, 54.47; titanic iron, 2.68; magnetite, 1.76; apatite, .32; total, 99.23.

The composition of this mixture, on adding again the water, would be as follows:

SiO ₂	51.78	Na ₂ O	2.62
Al ₂ O ₃	12.46	K ₂ O .....	.39
Fe ₂ O ₃ .....	.92	TiO ₂	1.41
FeO	10.67	P ₂ O ₅ .....	.14
MnO .....	.44	H ₂ O .....	.63
CaO	10.77		
MgO	7.63		
			99.86

This analysis differs from the one actually performed only in fractions of percentages in the alumina and soda, and I think may be assumed as being nearly correct. The amount of iron in the two analyses is identical, but there is some difference in the state of oxidation, which can readily be supposed to be the result of secondary actions that have taken place in the rock analyzed.

It becomes very easy now to see how extremely diversified the feldspathic element may be in rocks of this nature. The molecules may arrange themselves in very diversified ways, while the rocks remain identical in composition. Circumstances of cooling might cause anorthite to separate in a nearly pure condition, when there would be a compensating acidity in the remainder of the feldspathic element. This is a much more satisfactory explanation than that which I offered at the time I demonstrated the presence of anorthite in the West Rock diabase,¹ for as my analysis showed, the presence of the anorthite did not modify the ultimate composition of the rock. On the other hand pure anorthite might be entirely absent and its molecules might enter into combination with the molecules of the potassium and sodium feldspars, to form one or more intermediate species, as in the Jersey City diabase, and much diversity might exist in this feldspathic element in different localities without the slightest change taking place in the ultimate composition of the rock.

I regard this work as of some importance, since it completes our knowledge of the normal composition of a rock which has a great distribution and very uniform characters, and shows that this rock is more complex in composition than had been supposed. Besides it has been common to consider what feldspar enters into the composition of basic rocks like this, rather than what feldspars. An exquisite balance of composition and circumstance would be necessary to crystallize such a rock with a single feldspar, and we have reason to be convinced that massive rocks are rarely simple as regards their feldspathic constituent.²

It has also an important bearing upon the microscopic determination of feldspars by means of optical properties. The method proposed by Pumpelly, and further developed by Fouqué and Levy, is used for the determination of the species of feldspar by seeking for the greatest angles which elasticity planes make with twinning planes, in the zone with axis perpendicular to the twinning plane. There is of course a pos-

¹ Am. Jour. Sci. 1875, vol. ix, p. 189. I concluded that a minute change in the composition of the rock would be sufficient to allow of the formation of anorthite, which on account of its infusibility would first crystallize from the rock mass, as was evidently the case.

² Fouqué has demonstrated the complexity of the feldspar in Santorin andesites, Santorin et ses Éruptions, page 366.

I have examined the basic rocks at Peekskill, on the Hudson, recently described by Professor Dana, American Journal of Science, vol. xx, page 194. The feldspathic element was easily separated into two parts, one of which was a pink variety of andesite and the other white orthoclase.

sible chance in a section that no crystals should be intersected in a plane possessing the approximate maximum angle between the traces of the twinning plane and elasticity plane, and there is also a possibility that one might examine many sections with approximately equal angles of extinction to the right and the left of the twinning plane, as the method requires, without meeting such as possess an angle characteristic of the species, even were such present; hence the correct determination of the species by this method must remain to a certain degree a matter of chance. But when the feldspathic element is complex, a determination based upon this method would lead one to determine the whole of the feldspar as belonging to the species with the maximum angle of extinction. This method has been applied to a very considerable extent, but the considerations here advanced show that the method, although entirely correct in principle, and certainly of some value in lithological research, is not adapted to the final determination of the exact nature of the feldspathic constituent, and is likely to lead to erroneous conclusions.

All are familiar with the grand diversity of the secondary products that occur in these rocks, and which have enriched the mineral cabinets of the whole world. The contact, modifications, and structural features are none the less interesting; but it is not the intention to consider these questions here. It will be well to record the observation that they are sometimes so modified by quick cooling upon the exterior walls of the dikes in contact with the sandstones that they become cryptocrystalline, and contain long acicular feldspar crystals in a glassy ground mass, and in other microstructures resemble augite andesites. The occurrence of glass has not been heretofore noticed in these rocks. Excepting such local modifications the rocks are always like the ordinary old diabases, and even in microscopic features monotonously alike wherever fresh stones occur.

These rocks so characteristic of our Triassic are additionally interesting on account of the comparative absence of eruptive material intruded in the similar Triassic sandstones of Europe.

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ON THE DETERMINATION OF FELDSPAR IN THIN SECTIONS OF ROCKS.

By GEORGE W. HAWES, Ph. D.

In my recent article upon the composition of the diabases * which intersect the Mesozoic red sandstones upon the Atlantic border, I suggested that the complexity of the feldspathic element in basic rocks is probably much greater than is commonly supposed, and that this complexity is liable to cause a serious error if the method of determination

* This volume, page 129.