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VOLCANIC ROCKS IN THE KEEWATIN OF MINNESOTA.¹

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THAT the Keewatin rocks northwest of Lake Superior are to a considerable extent composed of volcanic (effusive) material has been stated already by G. M. Dawson,² A. C. Lawson³ and N. H. Winchell⁴. Although the material of much of the Keewatin in Minnesota has been assumed to be volcanic tuff and finely divided, water-deposited ash, the actual number of places where the rocks have been shown to be composed of such volcanic matter is very small. M. E. Wadsworth has described a few sections of fragmental volcanic rocks,—porodites,⁵—and N. H. Winchell has given an account of an agglomerate from Ely.⁶ Aside from these the writer knows of no descriptions of rocks from the Keewatin of Minnesota that are clearly shown to be of volcanic origin.

In the neighborhood of Kekequabic Lake, in the northern part of Lake County, a rock has been found which proves to be a volcanic fragmental. It is in the midst of thick Keewatin strata,—argillites, graywackes, conglomerates, green schists, etc.,—which form the eastern extension of the Vermilion iron range. The rock under discussion varies much in general appearance, but is usually of a greenish color and very compact and tough. The groundmass is aphanitic and in it are numerous, lighter blotches and changes of color, between the blotches, and sometimes in them are black crystals of hornblende; pyrite is also quite common. In certain places rounded and subangular pieces of quartz and argillite are embraced in the rock. Parallel color-banded resembling sedimentary laminae also occur, occasionally quite abundantly, but usually the rock shows no structural planes of any kind, nor any schistose or slaty cleavage. In thin sections the fragmental character of the rock is easily discernible. The fragments are usually angular, and their original nature is not always evident, owing to alteration and to the development of secondary minerals, but it seems that a porphyrite forms most of these fragments. The groundmass of the rock is largely fibrous hornblende. There are also areas of secondary hornblende, both in the groundmass and in the fragments, filling in old crystal outlines; what crystals originally filled these places is not clear, but it is probable that they

were pyroxene phenocrysts. The rock thus appears to be a volcanic tuff completely solidified and more or less altered.

Closely associated with this volcanic tuff, and grading into it, are some peculiar green schists, which, like the groundmass of the former, are made up almost entirely of hornblende. That these schists are composed of water-deposited material is clearly shown by numerous laminae, frequently running at an angle with the schistose cleavage, and in places by rounded quartz pebbles arranged in parallel lines. Under the microscope a section from these schists is seen to consist of closely crowded, green hornblende crystals embedded in a fine, fibrous groundmass also made up of hornblende. The crystals are, in short, stout prisms, averaging about a quarter of a millimetre in length. They are commonly, not completely idiomorphic; the prismatic planes are very generally quite distinct, but the terminal faces are not so often well developed. The ends of the crystals often show fringes or fibrous prolongations running out into the groundmass. At times these fringes are sharply marked off from the crystal proper, being of a lighter color, but the fringe on each crystal is optically continuous with it. These fringes closely resemble the secondary enlargements of hornblende grains and crystals described by C. R. Van Hise⁷ and are probably of a similar nature. As to just what was the nature of the sediment which formed these green schists, it is impossible to decide, but there are several reasons for regarding it as chiefly finely divided, water deposited, volcanic ash now entirely recrystallized.

In the immediate neighborhood of the tuff and green schists is a small area of a fine-grained, purple, porphyritic rock, which proves to be a hornblende porphyrite. This has distinct, elongated phenocrysts of brownish hornblende imbedded in a completely crystalline groundmass of interlacing feldspar laths; in places this groundmass becomes almost granular in structure. From its known relations to the surrounding rocks, the completeness of its crystallization and the absence of structures common to effusive rocks, this porphyrite appears to have never reached the surface, although such a degree of crystallization might possibly have been attained in the centre of a very thick flow.

It seems probable, then, that in Keewatin (Lower Huronian, as that term is used by the United States Geological Survey) time a volcano existed in this locality, that it furnished the deposits of tuff and ash described above, that its lava was of about the composition of hornblende porphyrite, and that the present known mass of porphyrite represents a part of the igneous magma which solidified below the surface.

A more complete account of these volcanic rocks and the surrounding rocks, especially of an interesting augite soda-granite, concerning which a preliminary note has already been published,⁸ will appear in the forthcoming twenty-first annual report of the Geological and Natural History Survey of Minnesota.

—In view of the present interest in German politics, social and political life, and educational affairs, the new work, "Germany and the Germans," by William Harbutt Dawson, is timely. Mr. Dawson, who is well known as the author of "German Socialism and Ferdinand Lassalle," and "Prince Bismarck and State Socialism," has made a close study of German life and institutions at the present day, and the results of his observations are set forth in an interesting manner. "Germany and the Germans" will be published immediately by D. Appleton & Co.

⁷ Amer. Jour. Sci., III, vol. xxx, pp. 231-235, Sept., 1885.⁸ Amer. Geol., vol. xi, pp. 383-388, June, 1893.¹ Published by permission of the State Geologist of Minnesota.² British N. A. Boundary Commission, 1875.³ Geol. Surv. of Canada, vol. iii, pt. i, 1885.⁴ Geol. and Nat. Hist. Surv. of Minn., 15th Ann. Rept., 1887; 16th Ann. Rept., 1888; Bull. No. 6, 1891.⁵ Ibid.; Bull. No. 2, 1887.⁶ Amer. Geol., vol. ix, pp. 359-368, June, 1892.