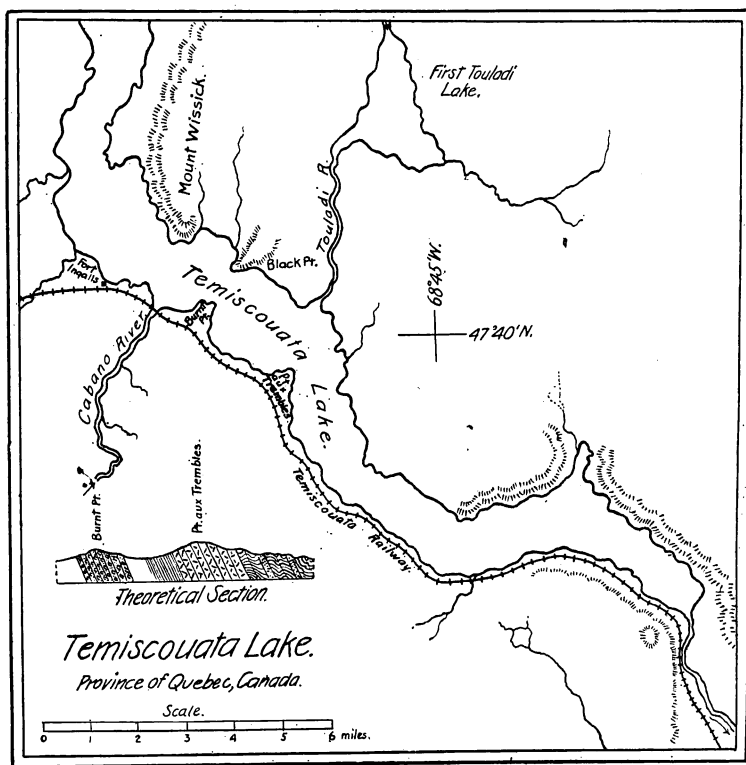


ART. II. — *Volcanic Rocks from Temiscouata Lake, Quebec*; by HERBERT E. GREGORY.

TEMISCOUATA LAKE was explored by the early geologists of Canada, and Logan reported\* the presence at Pointe aux Trembles of 'tough, green sandstone, with pebbles of metamorphic rock.' A survey of the region was made by Bailey and McInnes in 1886-87, and the presence of volcanic rocks noted. Their report in reference to these rocks reads as follows: "It is important to notice in connection with the Pointe aux Trembles sandstones the evidence which they appear to afford of contemporaneous volcanic activity. This is, perhaps,



partly indicated by the color of the rock, which varies from green to red and purple, but is more clearly seen in the abundance of epidote with which the rock is charged and in places

\* Geology of Canada, 1863, p. 423.

its somewhat amygdaloidal aspect.”\* During the summer of 1897, the region was studied by Prof. H. S. Williams, and the specimens then collected were turned over to the writer for examination. The outcrops visited extend along the lake for a distance of 20 miles, as shown on the accompanying map.

*Mount Wissick.*—The rocks examined from Mt. Wissick and the east shore of the lake are fossiliferous limestones, sandstones and shales, without admixture of volcanic materials. The shales and sandstones do not differ from similar rocks found elsewhere. The arenaceous limestone in places is separated into hexagonal prisms, probably from shrinkage, and appears as if composed of vertical columns with quite regular outline. The thin layers of limestone in the slates at the north of Mt. Wissick show under the microscope well-defined oolitic structure in which the little spheres are broken by numerous minute faults.

*West Shore.*—The section on the West Shore extends from Burnt Point, below Fort Ingalls, to the outlet of the lake.

At Burnt Point the rocks are coarse conglomerates made up of materials not much water worn, and show evidence of rapid deposition. Slates and limestones form the most abundant pebbles, and occasionally attain a diameter of 1–2 feet. The total thickness of the conglomerate at this point is about 1000', but such great thickness of the beds is reported to be quite local. Succeeding the Burnt Point conglomerate, to the south, occur thin-bedded shales and sandstones, which contain fossils of Niagara age.†

At Point aux Trembles, the rocks, both along the railroad and on the lake shore, appear at first sight to be greenish sandstones and coarse brown conglomerates. They are interstratified with the other beds of the region, and have practically the same dip and strike. A closer examination, however, shows them to be volcanic. The finer, more sandy beds, contain quantities of volcanic ash, and the coarser ones are conglomerates of typical andesitic fragments, with scarcely any foreign material. Parts of the rock contain very prominent rounded fragments of amygdaloidal andesite. As with the volcanics of northern Maine,‡ so here the gradation from the sandstones of the region to pure volcanic material can be traced; and like the Maine breccias and tuffs, these rocks show more or less rounding of their pebbles and sorting by water. It is believed that the volcanic vents were near some body of water, and that the material fell in or near the water and received a limited amount of wearing before final consolidation.

\* Geol. Survey of Canada—Annual Report, 1887, p. 33M.

† Geol. Survey Canada, Annual Report, 1887, p. 33M.

‡ U. S. G. S. Bulletin 165.

From Point aux Trembles to the foot of the lake—a distance of about 10 miles—the rocks which outcrop are slates and impure sandstones with rare tufaceous material. In places the beds are much folded and traversed by faults of small displacement.

### *Petrography.*

The ordinary stratified rocks of the region present no peculiarities which require detailed description. The volcanic series consists of fine tuff and coarse amygdaloidal conglomerate or breccia.

*Fine Tuff.*—The fine tuff appears in the hand specimen as a dense bluish-grey sandstone in beds a few feet in thickness. Under the microscope its true character is revealed, and it is found to consist of tiny fragments of andesite, broken crystals of plagioclase and olivine, and areas of devitrified glass with rare quartz grains and biotite shreds. The andesite has a hyalopilitic groundmass, which varies in amount of glass, so that some fragments appear to be practically all glass with only a few scattered laths of plagioclase. The larger crystals of andesine have albite twinning and are largely kaolinized. The olivines are represented in the slide by areas of serpentine with characteristic outlines and cleavages shown by dotted ore grains. Iron ore is sprinkled quite generally through the section.

*Volcanic Conglomerate.*—The volcanic conglomerate consists of subangular pebbles of andesite and amygdaloidal andesitic bombs, embedded in a finer matrix of red and green grains of the same material. The pebbles range in size from  $\frac{1}{2}$  inch to 6 inches in diameter, and show in the hand specimen phenocrysts of plagioclase, and occasionally epidote and augite. The embedded bombs form a conspicuous feature of the rock. They are quite spherical and are distinctly different in appearance from the matrix. Amygdules, about the size of bird shot, make up fully one-half of the bomb and are filled with green balls of chlorite—rarely with calcite. Some of the larger amygdules are seen to be occupied by chalcedony inside the chlorite lining.

*Microscopic Examination.*—The microscope shows the general matrix of this coarse type to consist of crystals of feldspar, pyroxene and olivine, and fragments of andesite, devitrified glass, and jasper. Iron dust, a small amount of calcite, and a few shreds of biotite, are also present. The feldspar crystals consist of a few orthoclases, and many rather small andesines, with albite and carlsbad twins. The pyroxene crystals are represented only by their outline, in a base peppered with iron dust. The olivines are fragmentary crystals, and largely replaced by serpentine and iron. The bulk of the sec-

tions examined is formed of fragments of pyroxene-andesite of a type sparingly porphyritic with small stout phenocrysts set in a groundmass, having in some places a glassy base, in others being made up almost entirely of ragged feldspar microlites, arranged with flow structure. The fragments of devitrified glass present show occasional cusps, which represent expanded steam cavities. No close line, however, can be drawn between the fragments of glass and the fragments of andesite containing a few feldspar microlites in a glassy base. The dark-red iron dust is not generally distributed through the rock, but is present along the cracks of the olivine crystals, and it also gives color to the glassy fragments.

*The Amygdaloidal Bombs.*—The section cut from one of the amygdaloidal bombs reveals the composition and structure of an extrusive basic andesite. The minerals present as phenocrysts are plagioclase, pyroxene, olivine and iron ore, with infiltrated quartz and calcite in the amygdules. There is also a considerable development of minerals of the chlorite group, perhaps largely delessite. The plagioclases are short, rather square crystals with ragged ends and strongly-marked albite and pericline twinning. Many of them are bent and curved and irregularly broken. In composition they are between andesine and labradorite. Augite occurs as stout crystals always partly decayed and replaced by chlorite or epidote, or rarely by calcite. Olivine crystals are about as abundant as augite and show their characteristic parting along cracks now filled with iron. Serpentine has generally replaced the olivine. Iron ore occurs in a few ragged grains. The groundmass is of feldspar microlites usually untwinned and with little evidence of flowage. The structure was hyalopilitic, but the glass filling the interstices is devitrified and stained brown with iron. The steam cavities now filled and converted into amygdules, though very abundant, have exerted little influence on the arrangement of the feldspars in the groundmass—a fact which suggests that these cavities formed in part before any crystallization of feldspars had occurred.

All the amygdaloidal cavities are filled with secondary products which have a uniform arrangement. They are lined with a coating of a malachite-green mineral of the chlorite group, arranged in radial forms. Most of the smaller cavities are completely filled with this substance and appear on the rock surface as embedded green pellets. The larger cavities have the chlorite lining fractured, and fragments of it have floated in toward the center, leaving means of access for later infiltrations. Similar phenomena have been observed in certain

volcanic rocks in Maine.\* The inside filling of the amygdules is silica or rarely calcite. The material next to the chlorite lining is chalcedony, with well-developed mammillary structure. The center of the cavity is a mass of quartz grains separated from the chalcedony by a definite boundary. It thus appears that the amygdules were filled by three or four successive periods of infiltration.

*Summary.*—While the mere description of these rocks and the determination of their volcanic origin is, in itself, chiefly of local interest, these facts have, however, important bearings on the general geological history of the Atlantic coastal region. That they are interbedded with Niagara sediments helps to determine the time when wide-spread volcanic activity gave rise to the numerous small areas of tuffs and lavas in the Maine-Quebec region, while this fact throws additional light on the physical conditions obtaining in that period. And finally, the recognition of so much distinctly contemporaneous volcanic material in well-bedded sediments affords another plea for the study of the sedimentaries by microscopic analysis.

\* U. S. G. S. Bulletin 165, Plate xrv.

Yale University, New Haven, Conn., March, 1900.