Notes on a Granite Contact Zone, Near Halifax, N. S.

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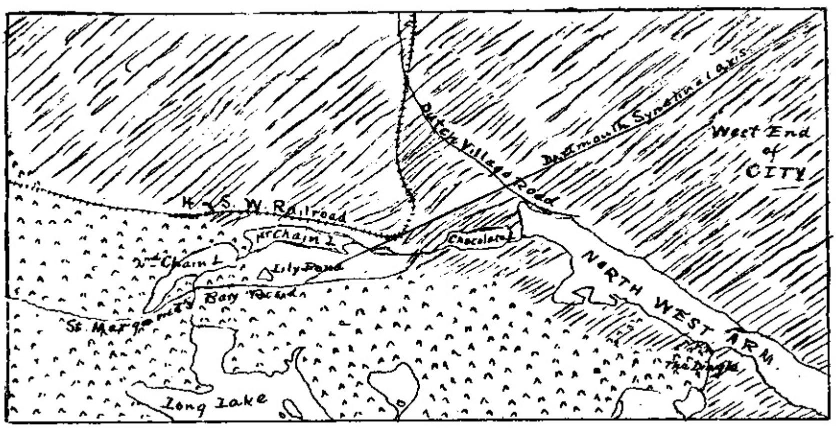
A "Quebec and Maritime Provinces" excursion forms part of the programme of the Twelfth International Geological Congress which meets in Toronto in August of this year. According to the first planned arrangement, the party when at Halifax was to have visited a contact zone of the granite and slate in the vicinity of Chocolate Lake. Owing, however, to a change in the date of meeting of the Congress and some re-arrangement of itineraries, the party reaches Halifax on Sunday morning and departs early the following day. The proposed trip to this interesting locality was consequently abandoned. But while it was in contemplation some preparation was made for it. Dr. Young, who has charge of the excursion, together with Mr. Faribault and the writer of this paper, examined the rock of the district and procured specimens wherever there was any noticeable difference of texture or mineral constituents. From these specimens a series of microscopic sections were made. These thin sections the Geological Survey very kindly placed at the disposal of the writer for the preparation of this paper.

The granite batholith which forms the bed-rock of a large portion of the western part of the Province meets the metamorphosed sedimentary rock close to the southwestern shore of the North West Arm. The boundary line is irregular. Running in a general northwesterly direction from the Dingle, it passes south of Chocolate Lake, follows pretty closely the main road to Lily Pond, bends around between First and Second Chain Lakes, and thence has a westerly direction until it crosses the Halifax and Southwestern railway and turns north. The granite is an intrusive of probably Devonian age. It evidently cooled and solidified under a great thickness of pre-existing rock, which has since been largely eroded. In the granite are found patches of darker, finer-grained material, which is probably the remains of blocks of the older rock partially assimilated. The effect of the high temperature of the intrusive magma produced a marked change in the overlying and surrounding rock masses. This change consisted largely in the development of new minerals out of some of the original constituents of the rock. As far as surface observations go, for upwards of a mile from the contact the influence of the heat was felt. A belt or zone of metamorphosed rock thus surrounds the igneous mass. Where the intruded rock varied in composition, the resultant metamorhpism differed somewhat. Of this contact zone the part more directly under discussion lies to the northwest of Chocolate Lake. (See map). In the northern and eastern



Map, showing Contact Zone — Granite [symbol] · Slate [symbol],
Sketched from C.G.S sheet N° 919. Scale: 1 mile = 1 inch.

section of this area, is the intruded rock, a black slate with a general easterly-westerly strike, and a south dip of 65° in the north which gradually decreases as the trough of the Dartmouth Synclinal is approached.

The original mineral composition of the slate beds varied somewhat. This is evident in the difference now seen in the rock; some are carbonaceous, others siliceous, while almost all the rock contains pyrite in varying proportions. This slate forms a part of the Upper Division of the Gold-Bearing series. The Halifax and South Western railroad passes through the area, and the numerous cuttings afforded means of easily obtaining material for examination. Samples of the slate were taken at intervals along the railroad from the point where it crosses the Dutch Village Road up to the contact with the igneous rock. Within this belt, metamorphism is excellently well shown. Even at the edge of the area, the furthest point from the nearest surface contact, metamorphic alteration is evidenced by the spotted appearance of the slate. Beyond this, doubtless, the rock is also altered, the zone being wider than the extent studied. Additional work could be done in tracing the result of the metamorphism from this point back into the unaltered slate. All through the contact zone the slate has a spotted appearance easily recognized, while as the granite is neared, long slender well-formed crystals are seen in the rock. The presence of these crystals from the cleavage faces of which the light is reflected, serves easily to distinguish it from the less altered spotted slate.

Microscopic examinations of the sections reveal a marked similarity between this granite contact and those more or less celebrated ones described from the Barr-Andlau of the Vosges Mountains, the Lake District of England, and elsewhere. The "base" of the slate, which is fine textured, is composed of sericite, minute grains of quartz and feldspars, graphite and other black carbonaceous particles. Probably very little, if any, of the original detrital material is present,

FIGURES × 62.

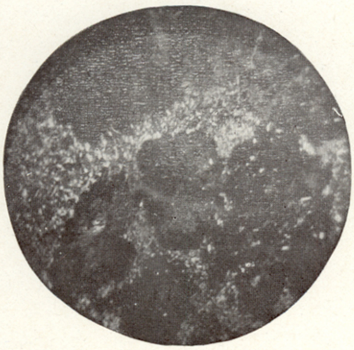


Fig. 1.—Cordierite slate (*crossed nicols*).

Fig. 2.—Andalusite—cordierite slate.

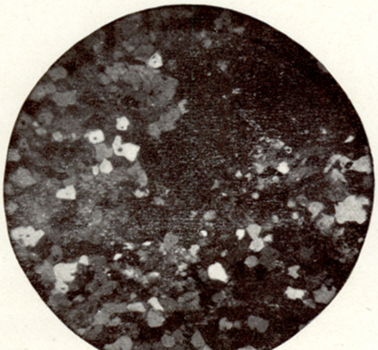


Fig. 3.—Siliceous slate (with pyrite) (*crossed nicols*).

Fig. 4.—Granite (*crossed nicols*).

the minerals enumerated above being largely recrystallisation products. Originally, the rock was probably a carbonaceous clay slate or shale. The grains and shreds all lie for the most part with their long axis in the same direction—that of the slaty cleavage. The re-crystallization is doubtless the result of pressure through a long period of time, and is itself the cause of the cleavage, normal to the pressure. This occured during the long time in which the folding was going on, which is evidenced in the present attitude of the rock and was prior to the intrusion of the granite. The proportion of the minerals of the "base" varies in the sections examined, in some sericite is more abundant, in others quartz, while in others there is more carbonaceous material. This difference is probably due to constituent varieties of the original beds. Pyrite is abundant in some laminae, in others almost absent.

Recrystallisation was probably completed before the contact metamorphism began. The first change brought about by the granitic intrusion was likely the production of a clear, brownish biotite in shreds and irregular crystals. Cleavage lines are rarely pronounced and inclusions are rare. Associated, and sometimes intergrown with it, is a colourless, slightly pleochroic mineral with rather high refraction, probably phlogopite. The biotite flakes are set at various angles to the cleavage planes and were, therefore, not affected by the pressure. It also occurs as inclusions in minerals to be described further on, which fixes its position in the time scale of metamorphism.

The spots so characteristic of the slate are found to be fibrous, ovoid and irregular patches of partially decomposed cordierite (Fig. 1). Unaltered portions occur at and about the centre of the patch, while the edges consist of a yellowish chloritic substance. The refractive index and double refraction are low. A faint bluish pleochroism is observable in one or two places. The crystal outline, which can be seen only between crossed nicols is mostly prismatic with occasionally the characteristic pseudo-hexagonal form and twinning in segments and in included laminae. Irregular lenticular forms also occur. In the cordierite are inclusions of carbon, biotite, and quartz. These are remnants of the minerals which furnished the material for the formation of the cordierite and are consequently older than the containing mineral The inclusions are arranged in lines parallel to the cleavage of the slate showing that the cordierite was formed after the cleavage and was not influenced by the pressure.

Within the area extending from the edge of the granite into the contact zone for a few hundred yards is the rock already referred to as being distinctive on account of the well developed crystals that appear in it. Here the influence of the hot granitic mass was most intense, and hence the metamorphism most pronounced. In the rock in this part of the belt are found the minerals already described as occurring in the other part, and in addition, fine andalusite crystals (Fig.2). These last occur as clear prism forms with prismatic cleavage. Where wedge shaped outlines are found, the extinction is in the direction of the wedge length, from edge to edge of the prism. The refraction is higher than that of the cordierite, the double refraction low. In an occasional spot on a crystal, the characteristic rose-red pleochroism is seen. Portions of some of the crystals are clouded with inclusions, while other parts are quite clear. All the other minerals of the rock form inclusions in the andalusite, so that it appears to have been the last to form. Its variety, chiastolite, occurs quite often in the slides. The carbonaceous inclusions are arranged in the cross section of the prism diagonally, the bulk of it occupying the corners of the prism, paralleling in a rough way the extinction of the crystal.

The only contact metamorphism noticed in the siliceous beds is the production of a few flakes of mica with perhaps a trace of scapolite and sillimanite (Fig. 3). A crystal of andalusite occurs in a slide from a small granite dyke that extends into the slate. This doubtless resulted from the absorption of some of the slaty material, although no further evidence of such was found.

There is no evidence of any gases or vapours from the molten granite having been a factor in the alteration of the slate of the area studied.

Something like the following would be a sequence of events for this area. In Pre-Cambrian time, fine sediment containing a good deal of carbonaceous material was deposited in the water some distance off shore, on a slowly subsiding sea-bottom. This became consolidated into a carbonaceous shale. Pressure set in from the direction of the Atlantic seaboard, and continuing through long periods of time threw the great thickness of rock into high folds. The pressure converted the shale into a slate. Then in Devonian time came the intrusion of the granite, the heat from which changed the slate within the sphere of its influence into a cordierite-slate, and near the contact, where the alteration was greatest, into an andalusite-cordierite slate. During parts of the long periods that have elapsed since then, as well as in previous periods, erosion processes have been at work, resulting in the present day aspect of the area.