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GEOLOGY OF TICHBORNE (East half) MAP-AREA

ONTARIO

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H. R. Wynne-Edwards

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GEOLOGY OF TICHBORNE (EAST HALF) MAP-AREA, ONTARIO

The rocks of Tichborne map-area form part of the Grenville structural province and lie within the Frontenac Axis, a southeasterly extension of the Canadian Shield that reaches the St. Lawrence River at the Thousand Islands. The land surface is rugged and rocky, but topographic relief rarely exceeds 150 feet, and the map-area rises gently from 450 feet to 650 feet from southeast to northwest.

Flat-lying Palaeozoic sedimentary rocks overlie the Precambrian less than 5 miles south of the map-area, but only a few small outliers of sandstone and conglomerate (map-unit 11) are preserved within it. Map-units 1 to 7 are metamorphosed sedimentary and possibly volcanic rocks (map-unit 6) and form a number of lithologically distinctive units traceable for long distances parallel to their foliation. They are representative of the Grenville Series and are similar to rocks already described to the east (Wynne-Edwards, 1959, 1962; Wynne-Edwards and Hay, 1963). Like these, they are metamorphosed to granulite and upper amphibolite facies. Within Tichborne map-area the grade of metamorphism in these rocks decreases from southeast to northwest, there being an accompanying mineralogical change in map-unit 6 from aluminous diopside-brown hornblende-(hypersthene) to green hornblende-diopside (or garnet). Map-unit 7 (granulite) is not as well layered as the other metasedimentary rocks and appears to be low in the stratigraphic sequence, possibly forming a basal unit in the southeastern part of the map-area.

Granitic rocks associated with the Grenville Series include white leucocratic pegmatite, granite and diorite (map-unit 10) found as small masses within the marble (map-unit 1), and a homogeneous, pink, albite-microcline alaskite (map-unit 9) similar to the Rockport type exposed along the St. Lawrence River to the southeast (Wynne-Edwards, 1963a). The coarse-grained, perthitic monzonite or syenite of map-unit A, although largely confined to the plutonic gneiss complex (map-units A to Dc) described below, also occurs within the Grenville Series in places. Rocks consisting of intimate mixtures of map-units 9 and A and the Grenville Series are mapped as migmatite (map-unit 8).

The Grenville Series is largely confined to the eastern half of the map-area, where it is folded into a pattern of large, upright, dominantly northeasterly plunging folds. The stratigraphy in these folds is commonly repeated in a section perpendicular to the plunge and this is attributed to the refolding of previously upright folds about the same axis as a result of prolonged nonuniform laminar flow during deformation (Wynne-Edwards, 1963b).

The western half of the map-area is a complete contrast to this metasedimentary terrain. The geology changes abruptly along a line that roughly follows the southwest-northeast diagonal of the map-area, itself marked by a broad but discontinuous mylonite zone through Bobs Lake. West of this boundary, plutonic rocks (map-units A to Dc) predominate, and the Grenville Series is represented only by narrow, sinuous, steeply dipping zones such as those through Parham and Crow Lake. In place of the granular texture, regular stratiform foliation, and large, well-defined folds in the Grenville Series, the plutonic gneisses (map-units Da, Db, and Dc) are characterized by streaky lenticles of quartz and dark minerals, cataclastic texture in places, and a gneissosity and lineation produced by mineral orientation rather than by compositional layering. The gneisses most typically are grey, leucocratic, and homogeneous, and contain very little potassium (map-unit Da). They consist of about 40 per cent quartz, 40 per cent antiperthitic calcic oligoclase (An_{30-35}), hypersthene, and minor biotite, magnetite, and apatite. In many cases, however, the principal mafic minerals are green hornblende and brown biotite, and in these rocks the plagioclase is somewhat less calcic (average An_{25}), showing that this mineralogical change is the result of the reaction:

2 anorthite (in oligoclase) + 11 hypersthene + 2 water + potash =
hornblende + biotite + 2 quartz

In some specimens the reaction is only partly complete. The streaky and cataclastic texture of the gneisses suggests that the rate of penetrative deformation somewhat exceeded the rate of recrystallization, so that during the reaction above single crystals of hypersthene were drawn out to form lenticular aggregates of smaller hornblende and biotite grains.

Pyrope-almandine garnet is an essential constituent of some zones in these gneisses, and such zones have been mapped separately as unit Db. For some miles west of the main contact with the Grenville Series, the streaky gneisses contain potash feldspar, which locally give the rocks a pinkish colour: these are distinguished as map-unit Dc. In unit Dc the plagioclase is less calcic and the pair hornblende-biotite (rather than hypersthene) more widely developed than in map-unit Da. This is taken as an indication that the presence of K_2O, as well as the availability of water, promotes the reaction above from left to right. The rocks mapped as unit B (dioritic granulite) are similar to the gneisses of map-unit Da, but contain little or no quartz, and a higher proportion of dark minerals (most commonly hornblende and biotite). As in map-unit Da, potash feldspar is absent or present in very small amounts.

Small bodies of anorthositic gabbro (map-unit 6) (Harrison, 1944) occur within the plutonic gneiss complex. Certain masses, most notably the one near Tichborne, are predominantly a coarse, subophitic aggregate of purplish andesine labradorite in crystals up to 6 inches long, large pyroxene grains showing lamellar intergrowths, magnetite, and apatite. Most specimens show evidence of cataclasis and are altered to varying degrees to a finer grained mosaic of green hornblende, brown biotite, scapolite, and andesine. In other gabbro bodies, especially the elongate mass between Thirteen Island and Desert Lakes, this metagabbro is dominant, and the originally coarse-grained gabbro is found in only a few outcrops near its southern end. Dykes of this fine-grained metagabbro cut the coarse-grained, subophitic gabbro in all the bodies mapped, and suggest that the gabbro was remobilized or remelted by high grade, post-crystalline metamorphism in the presence of water vapour (Yoder and Tilley, 1962).

Several large bodies of monzonite and quartz monzonite (map-unit A) form an essential part of the plutonic complex. These rocks have a mortar texture and consist of large, subrounded grains of oligoclase and mesoperthite set in a finer-grained feldspar matrix. The dark minerals are fresh green hornblende and biotite, altered pyroxene (typically a pseudomorph of serpentine and calcite), together with titaniferous magnetite, sphene, and apatite. Strongly sheared varieties are common, notably in the elongate body between Eagle and Sharbot Lakes.

East of the map-area, this monzonite unit has been termed the Frontenac type (Wynne-Edwards, 1963a), where it forms homogeneous plutons in the Grenville Series. In Tichborne map-area, however, the monzonite is largely confined to the plutonic gneiss complex and in places grades into map-units B, Da, Db, and Dc. Map-unit A also both grades into and is cut by the pink alaskite of map-unit 9, and again the transition is plainly traceable from the typical mortar texture of the Frontenac type monzonite in this area, through rocks where only scattered large feldspar grains are present and the granular feldspar matrix predominates, to the typical two-feldspar - quartz mosaic of the alaskite itself.

The great contrast between the western and eastern halves of the map-area, in rock-type, mineralogy, and texture, can be explained by the existence of an older crystalline basement complex (map-units A to Dc) upon which the Grenville Series (map-units 1 to 7) was laid down (Leech and others, 1963). In the western part of the area the basement complex predominates, the Grenville Series being represented only by narrow, sinuous, infolded zones. The crystalline basement rocks were already relatively dry so that their unremobilized portions were recrystallized to quartz-hypersthene-antiperthite gneisses during the Grenville metamorphism. Recrystallization in these rocks was retarded because of the lack of water, and the deformation was therefore partly cataclastic. Where the initial water content was higher, however, or where water was later introduced, the pyroxenes reacted to form hornblende and biotite in all the basement rocks, and an anatectic melt or vapour phase was generated, that from the gabbros crystallizing as the hornblende-biotite-scapolite-plagioclase rocks which locally were sufficiently mobile to penetrate the overlying Grenville Series, and that from the more silicic gneisses forming firstly the monzonites of map-unit A by partial melting, and secondly the homogeneous melts that gave rise to the discrete bodies of quartzose alaskite (map-unit 9). Both map-units A and 9 appear to have been sufficiently mobile to rise from the basement into the overlying Grenville Series, and there is good evidence east of the map-area (Wynne-Edwards, 1964a) that anatectic granites similar to map-unit 9 were generated within these metasedimentary rocks themselves, where the initial water content was higher. The preponderance of the potash feldspar-bearing map-units A, Dc, and 9 in the basement complex close to the contact with the Grenville Series may also be due to the introduction of water and alkalis released from the overlying metasedimentary rocks during metamorphism.

The Grenville Series has been assigned a tentative Middle Proterozoic age (post-Hudsonian, pre-Grenville) (Leech and others, 1963) for two main reasons (Wynne-Edwards, 1964). First, the Grenville Series, unlike the basement complex, appears to have undergone only one metamorphic and tectonic cycle (the Grenville orogeny at 950 m.y. ±). Second, the carbonate-rich lithology of the Series is not found in the older structural provinces that border the Grenville, although units are known to cross the Grenville front in many places.

Numerous pits and mineral prospects for industrial minerals, iron, and lead are found in the map-area, but there is no current production. The largest mines were the Richardson, east of Thirteen Island Lake, which produced a total of 228,690 tons of feldspar at different times between 1901 and 1948, and the Glendower, on the shore of Thirty Island Lake, which produced 50,000 tons of magnetite between 1865 and 1888. A complete list of the mineral deposits of the district has recently been compiled (Hewitt, 1964).

REFERENCES

Harrison, J.M.
1944: Anorthosites in southeastern Ontario, Canada; Geol. Soc. Am. Bull., vol. 55, pp. 1401-1430.

Hewitt, D.F.
1964: Geological notes for maps nos. 2053 and 2054, Madoc-Gananoque area; Ont. Dept. Mines, Geol. Circular No. 12.

Leech, G.B., Lowdon, J.A., Stockwell, C.H., and Wanless, R.K.
1963: Age determinations and geological studies; Geol. Surv. Can., Paper 63-17.

Wynne-Edwards, H.R.
1959: Westport map-area, Ontario; Geol. Surv. Can., Map 28-1959.

1962: Gananoque map-area, Ontario; Geol. Surv. Can., Map 27-1962.

1963a: Brockville-Mallorytown map-area, Ontario; Geol. Surv. Can., Map 7-1963.

1963b: Flow folding; Am. J. Sci., vol. 261, pp. 793-814.

1964: The Grenville province and its tectonic significance; Geol. Assoc. Can. Proc., vol. 15, pp. 53-67.

Wynne-Edwards, H.R., and Hay, P.W.
1963: Coexisting cordierite and garnet in regionally metamorphosed rocks from the Westport area, Ontario; Can. Mineralogist, vol. 7, pp. 453-478.

Yoder, H.S., and Tilley, C.E.
1962: Origin of basalt magmas: an experimental study of natural and synthetic rock systems; J. Petrol., vol. 3, pp. 342-532.