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STRUCTURAL FEATURES OF THE PREISSAC-LACORNE BATHOLITH, ABITIBI COUNTY, QUEBEC

(Report and Two Figures)

By

K. R. Dawson

OTTAWA
1954

Price, 50 cents

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(Preliminary Account)

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STRUCTURAL FEATURES OF THE PREISSAC-LACORNE BATHOLITH, ABITIBI COUNTY, QUEBEC

INTRODUCTION

Location of Area

The Preissac-Lacorne batholith is exposed within an area about 40 miles long by 16 miles wide, in Abitibi county, northwestern Quebec. It occupies the greater part of La Motte (16)[1] and Fiedmont (19) map-areas, and extends beyond the southern limits of the latter area.

Means of Access

The batholith is easily reached from Malartic, Val d'Or, and Amos by Quebec highways Nos. 60 and 61. In addition, a secondary highway crosses the western end and another passes within 3 miles of the eastern end of the batholith. Moreover, dirt roads have been bulldozed across sand plains into the interior of this area so that, with the exception of central Lacorne township, the batholith is readily accessible to highways.

Economic Features

The batholith is associated with swarms of pegmatite dykes and, to a lesser degree, with quartz veins. The former carry commercial amounts of beryl, spodumene, and feldspar, whereas the latter carry economic amounts of molybdenite and minor amounts of bismuth minerals. The pegmatite dykes also carry traces of columbite-tantalite (19) and radioactive minerals (14).

History of Geological Investigations

The occurrence of granitic rocks in northwestern Quebec has been known since 1872 when McOuat (15) made a reconnaissance of the region between Lakes Timiskaming and Abitibi. During the succeeding 40 years a series of reconnaissance surveys added to our knowledge of the geology of the region but contributed little to our understanding of the batholith.

In 1913, Wilson (20) published his memoir on the Kewagama Lake area, ushering in the era of detailed geological surveying in that part of the province. The map included the western part of the Preissac-Lacorne batholith, and showed a distribution of the granitic rocks that is much the same as that on more recent maps.

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[1]Numbers in parentheses are those of references listed at the end of this report.

By 1931, a geological map compiled by Cooke, James, and Mawdsley (4) included the entire area underlain by the batholith. The position of the batholithic contacts have been but little changed by subsequent field investigations.

The discovery of molybdenite on Indian Peninsula in Kewagama Lake, by Johnston (3), led to extensive prospecting for that mineral, and eventually it was produced from two mines. As a result, several papers were published that deal with this mineral product of the batholith (9, 11, 17).

Petrographic details of the granitic rocks were few until 1927 when some chemical analyses of the rocks adjoining molybdenite showings were published by Gerrie (9), and it was not until 10 years later that detailed descriptions with analyses were published by Gussow (10). Norman (6) published a preliminary report on the La Motte map-area in 1944 and Tremblay (9) 6 years later published the final report on the Fiedmont map-area. The detailed geology of the north half of Vassan township and the northwest quarter of Senneville township was compiled in 1949 by Ingham (2), Resident Geologist for the Quebec Bureau of Mines.

Methods

The preliminary stages of the present investigation were completed during the summer of 1952, when the writer visited the exposures of the contact zone and studied some of the outcrops in the interior of the batholith.

Field work entailed the examination of critical outcrop areas and the measurement of the attitude of structural features, including joints, dykes, primary and secondary foliation[1], and lineations[2]. In addition, more than three hundred specimens were collected. The hornblendic phase of the batholith lent itself well to structural study, but the micaceous phases revealed such faint structural elements that other techniques, such as the measurement of the traces of structures on joint planes, had to be evolved in order to determine the internal structures.

Office work has included the compilation of the tectonic map, with the contact of the batholith modified from recent aeromagnetic (7, 8) and geological data. It was found necessary to plot the joint data on stereograms (6) in order to determine the most

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[1]Foliation is the property of rocks to break along approximately parallel surfaces. Primary foliation is due to the parallel arrangement of mineral grains and xenoliths formed as the result of movement in magma. Secondary foliation is the product of deformation of a wide variety of rocks (2).

[2]Lineation is the term applied to all parallel linear structural features in rocks (2).

significant systems[1] for map compilation. Where the foliation traces were faint the writer plotted the field data on stereograms using the technique devised by Clark and McIntyre (3) in order to identify the type of structural feature represented.

Topography

The area underlain by the Preissac-Lacorne batholith is characterized by three distinct types of topography: granite highlands, sand plains, and lowlands underlain by lacustrine clays.

The granite highlands have a relief of as much as 500 feet. They carry a light drift cover, with boulder trains in the intervening valleys. Forest fires have denuded many of these hills leaving the bare rock exposed. Here and there small elevated beach deposits occur on the sides of the hills. Originally these hills were covered with dense forest growth consisting mainly of hardwoods but with scattered softwoods.

The sand plains are broad, flat-topped ridges, with a maximum relief of 200 feet. They form a nearly complete cover over the lacustrine clays and low-lying outcrops, and exhibit such features as raised beaches, pothole lakes, eskers, and sand dunes. Where burnt over, they afford an excellent terrain for travel. Originally these sand plains were covered by dense stands of jack pine, with some areas of hardwoods.

The lowlands represent a very gently rolling land form with relief rarely reaching 100 feet above the adjoining waterways. They are dissected by shallow stream valleys, and where the drainage is poor, large muskegs form. Rock outcrops stand as bare knobs protruding through the lacustrine clays. These lowlands are the farm land of the area. The original forest covering these lowlands consisted mainly of dense stands of softwoods.

Acknowledgments

The writer acknowledges the capable assistance of Messrs. L. B. Halferdahl and D. Hendricks, field assistants. In addition, thanks are due to Mr. B. Joyal, mine manager for Molybdenite Corporation of Canada, and his staff for the specimen material they supplied. The writer is grateful for the advice and encouragement received from all sources.

GENERAL GEOLOGY

Archaean Rocks

The Archaean rocks include altered lavas of the Kinojevis group, hornblende schists of the Malartic group, biotite

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[1]Systems refers to two or more sets of planar structures, such as faults, joints, and dykes, that form characteristic patterns. Set refers to parallel planar structures (2).

and biotite-staurolite schists of the Kewagama group, and pyroclastic rocks, rhyolites, and greenstones of the Blake River group. The Kinojevis group is of interest as it forms the north wall of the batholith in Lacorne township. The rocks of the Malartic group have been intruded by the Preissac mass. The rocks of the Kewagama group are of principal interest in that they constitute the commonest wall-rock of the batholith, whereas the Blake River volcanic rocks are nowhere in contact with the batholith.

Pre-Batholithic Intrusive Rocks

These include the dykes and lenses of metamorphosed peridotites that intrude the Kinojevis, Malartic, and Kewagama groups in the vicinity of the batholith and the older gabbro that outcrops southwest of Lac Fiedmont. The former have been metamorphosed to amphibolites and carry some serpentine; the gabbro has been metamorphosed to amphibolite. Both the metamorphosed peridotite and gabbro are highly magnetic relative to the adjoining granitic rocks and, consequently, provide prominent anomalies on aeromagnetic maps (7, 8).

Batholithic Rocks

These rocks are believed to be genetically related, and to include the various phases that are represented in the batholithic and satellitic masses. They include muscovite, muscovite-biotite, and hornblendic varieties, of which the last are commonly quartz poor. Also included are the pegmatites and aplites and feldspar porphyries associated with the granitic rocks. Petrographic descriptions are being prepared for publication at a later date.

Post-Batholithic Intrusive Rocks

The post-batholithic intrusive rocks are restricted to two sets of gabbro dykes that transect both the batholithic and pre-batholithic rocks; they are the youngest rocks known in this particular area. The gabbro may contain olivine, and does contain significant amounts of magnetite. The rock varies in grain size from very fine grained to coarse, and in texture from diabasic to granular.

STRUCTURAL GEOLOGY

Regional Structures

The Preissac-Lacorne batholith lies in a wide belt of Archaean sedimentary, volcanic, and intrusive rocks that extend 150 miles east of the Ontario-Quebec boundary. These rocks have complex interrelations that are still imperfectly understood. Those immediately adjacent to the batholith strike east and face south along the north and south borders of the area studied, but are subject to variations in attitude at local intermediate points. The area is traversed on the south by the Cadillac 'break', and on the north by the Manneville 'break', both of which strike approximately east-west. Moreover, the batholith is crossed by two sets of regional tension

fractures, which have been filled by gabbro dykes.

Local Structures

The two northern masses of the batholith have been intruded along the axis of an anticline in members of the Kewagama group, forcing the beds apart into somewhat their present position. Flow cleavage observed in the sedimentary beds west of Preissac village and north of Vassan village indicates that tops face south and that there is an anticlinal axis to the north. The northern limbs of this anticline are believed to lie along the north sides of the La Motte and Lacorne masses.

Owing to poor exposures around the Preissac mass, little is known of the attitude of the surrounding amphibolites. However, foliation induced in those rocks appears to conform with the outward shape of the granitic exposures.

The large intrusive masses are separated by septa consisting of sedimentary rocks and altered lavas, and the Lacorne mass contains inclusions large enough to have been roof pendants.

STRUCTURAL FEATURES OF THE BATHOLITH

Size and Distribution of the Batholithic Masses

General Features

The Preissac-Lacorne batholith is unique in that it consists of three large masses and several satellitic intrusions rather than a single large mass with associated satellites. Its aggregate surface area is approximately 40 miles long by 16 miles wide, with its major axis striking east-west. The satellites range in size from a maximum diameter of 3 miles down to a few hundred feet. The batholith extends from the west side of Preissac township east to lot 49, rge. V, Fiedmont tp., and south from the outlet of Lac La Motte to a point east of Vassan village.

Preissac Mass

The Preissac mass is elliptical in plan view, with its major axis striking east-west. It is about 15 miles by 5 miles in surface dimensions, and extends from the west side of Preissac township east to the centre of La Motte township. The mass lies across the central part of Kewagama Lake.

La Motte Mass

The La Motte mass is similar in shape and orientation to the Preissac mass, which lies to the south. It is about 11 miles long by 6 miles wide, and extends east from Kinojevis River near Preissac village to the west shore of Lac La Motte.

Lacorne Mass

The Lacorne mass is somewhat circular in outline, with apophyses extending from the west side to the vicinity of La Motte village and from the east side to lot 49, rge. V, Fiedmont township. The surface dimensions of the mass are about 24 miles by 16 miles.

Satellitic Intrusions

The satellitic masses include the Height of Land, Kapitagama, Malartic, St. Edmond, Senneville, and several other smaller intrusions.

The Height of Land stock is exposed in outcrops northwest of Preissac village as an elongate mass about 2 miles long by $\frac{1}{2}$ mile wide.

The Kapitagama stock outcrops between Kewagama and Kapitagama Lakes, in rge. V, Preissac township. It is about 1 mile by 2 miles in area, with its long axis striking east-west.

The Malartic stock outcrops on the peninsula south of La Motte village, astride the La Motte-Malartic township boundary. It is about $2\frac{1}{2}$ miles long by 1 mile wide, with its long axis striking northwest.

The St. Edmond stock lies east of the village of St. Edmond d'Abitibi and west of Lac Blouin in Vassan township. It is about 3 miles by $1\frac{1}{2}$ miles in area, with its long axis striking east-west.

The Senneville stock is not exposed in outcrops, but has been identified in drill core and outlined by aeromagnetic maps (7, 8). It lies southwest of Lac Senneville in the northwest quarter of Senneville township. The stock is nearly circular in outline, and may approximate 1 mile in diameter.

Other small satellites outcrop on the islands at the south end of Kewagama Lake and Lac La Motte, at the Lacorne mine[1], and north of Lac Roy.

Contacts

General Features

The contact of the Preissac-Lacorne batholith has been mapped using three symbols illustrating known, approximate, and inferred contacts, the last obtained from aeromagnetic data (7, 8). Outcrops that expose the contact commonly have such low relief that it is difficult to measure the actual dip, and, in general, the contact is so poorly exposed that it is difficult to study the outer margin of

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[1]The Lacorne mine is the property of the Molybdenite Corporation of Canada, located in rge. I, Lacorne tp., near Highway 60.

the batholith. Moreover, most of the exposed contacts of the batholith are with sedimentary strata, so that little is known about contact relationships with volcanic rocks.

Information presently available indicates that the batholithic contacts are commonly concordant; that is, the foliation and bedding attitudes determined in the adjacent rocks are approximately parallel with the foliation in the granite. This relationship was also noted where large inclusions of sedimentary rocks or lavas have been incorporated in the batholith.

Preissac Mass

Of the major sections of the Preissac-Lacorne batholith, the contacts of the Preissac mass are probably the poorest exposed. However, sufficient data are available from the nearest exposed wall-rocks to suggest that they are foliated parallel with the border of the mass, and that the long axis of the intrusive body is parallel with the strike of the wall-rocks.

The actual dip of the contact is known only from the Indian molybdenite mine (7) where it dips 45 degrees to the north. Elsewhere, foliation is not well enough developed in the rocks exposed to provide the least clue to the attitude of the contacts.

La Motte Mass

Almost without exception, the granitic rocks of the La Motte mass are foliated parallel with the bedding and foliation of the enclosing sedimentary rocks. However, an exposure of the contact in rge. VIII, La Motte tp., shows a series of sedimentary beds truncated by massive granite.

The western end of the La Motte mass plunges at angles up to 75 degrees to the west, but from a point east of the village of Vautrin the contact dips at a low angle to the north. Between Lac des Hauteurs and Lac La Motte, the dip steepens to 45 degrees to the north, and around the east end of the mass it varies from vertical to 60 degrees to the east. The south contact is poorly exposed, but outcrops in its vicinity indicate dips of 45 degrees south in rges. VIII and IX, Preissac township.

Lacorne Mass

The contact of the Lacorne mass is probably the least concordant to be found around the periphery of the Preissac-Lacorne batholith. It is exposed on the west shore of Lac La Motte but nowhere else around the west side of the mass. At that point, the foliation in the intrusion is parallel with that of the intruded rocks. The enclosing greenstones and sedimentary rocks are truncated by the granite east of Lac La Motte in ranges IV to VII, but the actual contact cannot be observed. The north contact is conformable from Lac La Motte east to Lac Roy, but from there southeast to Lac Senneville the granitic rocks cut directly across the strike of the enclosing formations. The south and southwestern sides of the granite mass are conformable with the enclosing sedimentary rocks.

At most points around the periphery of the Lacorne mass, the attitude of the contact could be inferred only from the foliation in the granitic rocks or in the immediately adjoining wall-rocks. Such information indicates that the contact dips 30 degrees to the north in the vicinity of Lac Lortie; 50 degrees northeast in lots 10 and 12, rge. VIII, Fiedmont tp.; 50 degrees north in rge. VI, Vassan tp., east of the village; and 80 degrees north, northwest of the same place. Elsewhere around the periphery, data are lacking or are not reliable.

Satellitic Intrusions

The Height of Land stock has not been studied by the writer, but an earlier determination on the foliation near its south contact (6) indicates a dip to the northwest. The stock is discordant, as it cuts across the beds of the enclosing sedimentary rocks.

The Kapitagama stock outcrops on the east shore of Kewagama Lake but nowhere else. Although the contact is not exposed, foliation nearby indicates a plunge of 30 degrees to the east, with the enclosing wall-rocks conformable with the granite contact.

The Malartic stock is exposed only in low outcrops along the shore of Lac La Motte. The actual contact is not exposed, but nearby determinations on the primary foliation indicate a dip to the north. However, the wall-rocks are not exposed well enough to indicate whether the foliation is conformable with the walls of the stock.

The St. Edmond stock outcrops along the road east of the village of St. Edmond d'Abitibi, and attitudes measured on primary foliation planes indicate that its north contact dips northerly at angles ranging from 60 to 80 degrees. This contact truncates the adjacent pillow lavas.

The Lacorne molybdenite mine occurs within a small stock of granitic rocks that is elongated in a northeasterly direction across the general strike of the enclosing sedimentary rocks. Its northern contact strikes north 45 degrees east and dips 70 degrees to the northwest (15).

Nothing is known of the attitude of the contacts of the Senneville stock, the satellitic intrusions on the islands at the south end of Lac La Motte and Kewagama Lake, in rge. VII, La Motte tp., east of Highway 61, or those near Lac Baillairgé and north of Lac Roy.

Foliation

General Features

Foliation is generally best developed in outcrops in the peripheral zone of the Preissac-Lacorne batholith and becomes progressively less apparent towards the centre of the mass. Consequently, the few exposures of the border zone are critical in the interpretation of the structure of the batholith. Primary foliation in the granite has been measured from the attitude of xenoliths or inclusions and from oriented mineral grains and mineral concentrations. Secondary foliation in the granite is limited to local occurrences of shearing, but is widespread in the wall-rocks due to deformation and recrystallization.

Mineral Orientation

Primary foliation is commonly due to oriented flakes of muscovite and biotite or to rod-shaped crystals of hornblende, the common mafic mineral constituents of the granitic rocks. It is attributed to the parallel arrangement of mica flakes around the south sides of the Lacorne mass and along the west side north of St. Benoit village, and is well developed in outcrops along the north side of the La Motte mass and around the west end of the same intrusion. Moreover, the mica flakes show this orientation in the core of the La Motte mass and in local areas of the Preissac mass.

Hornblende-bearing phases of the intrusive rocks show an excellent state of preferred orientation around the northern and eastern borders of the Lacorne mass. The orientation is visible both on horizontal and vertical faces in the same outcrop, so no difficulty is encountered in distinguishing between planar and linear structural elements. Unfortunately, the ease in determining the nature of the structural element decreases towards the core of the mass, and the same uncertainty is encountered in the western nose of the Lacorne mass and in the Malartic stock. However, the writer hopes that further field data will reveal the relative distribution of planar and linear structural elements more clearly.

Mineral Concentration

Less is known about this type of primary foliation because it is more rarely encountered and because insufficient thin section data are available to support field observations. However, two variations of this type of foliation have been observed, namely, alternating light and dark bands due to the concentration of mafic minerals, and banding due to accumulation of feldspar phenocrysts near the wall of the intrusion.

Primary foliation due to concentration of the mafic mineral constituents reaches peak development in the outcrops of biotite granite east of Vassan village. In lots 39 to 43, rges. VI and VII, Vassan tp., this feature has been observed particularly along the south side of the inclusion there. The granitic rock shows parallel bands, some of which are as much as 8 inches thick, though generally only a few inches. They are not strongly coloured, but show sufficient colour contrast for photography. The bands are the result of concentrations of biotite and epidote in bed-like aggregates, and of grain-size variations in the feldspars.

The distribution of occurrences of primary foliation due to the development of bands of feldspar phenocrysts is unknown because of poor exposures of contact zones. However, one such occurrence is exposed in lots 10 and 11, rge. VIII, Fiedmont township. Alternating light- and dark-coloured bands in the contact zone are the result of concentrations of feldspar phenocrysts.

Oriented Inclusions

In general, inclusions should be the source of most primary foliation determinations, but in this batholith they failed to

show an organized pattern in some outcrops, due to poor exposures, to random orientation of the inclusions, or to the fact the inclusions have been drawn out as spindles rather than plates. Consequently, horizontal traces could prove misleading. It is expected that the collection of more field data for plotting on stereograms (3) will permit a more complete evaluation of the structures exhibited by the inclusions.

Inclusions are best exhibited by the horblendic phase of the intrusive rocks, some as spindles forming primary lineations, others contributing to primary foliation, and a third class represented by angular or equidimensional inclusions that have no significant orientation pattern. Inclusions are most abundant in the Lacorne mass and the Malartic stock; they also occur in the La Motte and Preissac masses but are less well preserved there. This is particularly true of the south side of the La Motte mass, where a marked development of plumose muscovite and garnet indicates a more than ordinary amount of assimilation of foreign materials. Moreover, the muscovite-bearing phase of the batholith carries relatively few inclusions as compared with the darker phases.

Shearing

The lack of extensive exposures of the batholithic contacts makes it difficult to assess the significance of shearing along these contacts. However, the abundant evidence of strong to weak foliation in adjoining wall-rocks is some indication that shearing is of fairly widespread occurrence in the contact zones. It is a prominent feature of the rocks in lots 16 and 17, rge. VI, and lots 10 and 11, rge. VII, Fiedmont tp., and near the west end of Lac Roy. At both these places, the hornblendic phase of the batholith is crushed to the state where the feldspar forms fine-grained sugary aggregates with augen-shaped outlines. The augen are surrounded by dark-coloured shields consisting of hornblende, biotite, and epidote, and rarely exceed a few millimetres in maximum diameter. The attitude of this type of foliation is readily observed and measured.

Lineation

General Features

Included under this heading are such primary lineations as oriented mineral grains and inclusions, and a variety of secondary lineations, including rodding, crenulations on flow cleavage planes, and slickensiding on joint surfaces. Of these observed types of lineation, the first two are characteristic of the granitic rocks whereas the remainder have been observed mainly in the adjoining wall-rocks. Lineations due to oriented mineral grains and inclusions are best developed in the border zone of the batholith, but owing to the scarcity of outcrop exposures they are not always available.

Oriented Mineral Grains

The prominent lineations include those due to the geometric arrangement of such minerals as the micas and hornblende.

The linear features are generally poorly developed in the biotite-bearing phase of the granitic rocks, but a more detailed study will indicate their true significance. The hornblende-bearing intrusive rocks, on the other hand, commonly show strongly developed mineral lineation.

Lineation due to the parallel arrangement of mica flakes is developed in the granite exposed north and east of Lac des Hauteurs. Insufficient data are available to give an indication how widespread this phenomenon is.

Hornblende grains in the hornblende-bearing phase of the granite are commonly well oriented to form a mineral lineation. This type of lineation is well developed along the east shore of Lac La Motte and along the north side of the Lacorne mass. It is also characteristically developed in the Malartic stock.

Oriented Inclusions

Spindle-shaped inclusions may be oriented in such a manner as to produce another type of lineation. This structural feature is best developed in the hornblende-bearing phase that outcrops in parts of the Lacorne mass and in the Malartic stock. Insufficient data are available to indicate the importance of the feature.

Rodding

Rodding has not been observed in the granitic rocks, but does occur in wall-rocks adjoining the batholith. It has been developed in bedded rocks in lots 5 and 6, rge. VIII, Fiedmont township.

Crenulations on Flow Cleavage

Crenulations on flow cleavage are developed in the sedimentary strata north of Vassan village and farther west near Preissac village. The cleavage is distinctive as it makes a clearly defined angle with the bedding, and superimposed upon the cleavage are crenulations that do not exceed an inch in amplitude. The structure is confined to the more micaceous beds, and is useful as an indication of the attitude of the sedimentary rocks in the wall of the batholith in those areas.

Slickensides

A limited number of the unmineralized joints in the granite show slickensides on their walls. Moreover, quartz veins in the granite occasionally have slickensides on their walls.

Dykes

General Features

Dyke rocks of various types are associated with the Preissac-Lacorne batholith, including pegmatite, aplite, dykes that are partly pegmatitic and partly aplitic, feldspar porphyry, and dykes similar in appearance to the granitic rocks themselves. No lamprophyre dykes were observed in association with the granitic rocks. In addition, there are two sets of post-batholithic gabbro dykes that have intruded the batholith. With the exception of the gabbro, these dyke rocks follow joints that form a part of the structural pattern of the intrusive rocks.

Pegmatites and Aplites

From the economic point of view, the pegmatites are important because they contain beryl, spodumene, feldspar, and minor amounts of columbite-tantalite and radioactive minerals. Because of the recent work of Rowe (18) on the internal structures of these pegmatites little further need be said regarding them. They include both simple and structurally complex types, and are most abundant in the muscovite-bearing phase of the batholith. Insufficient data are available on their attitudes to permit a comparison with the attitude of the joint systems.

Feldspar Porphyry

Dykes of feldspar porphyry reach a maximum development in the peripheral zone of the batholith. They are more abundant than indicated by the map owing to the lack of outcrops in critical areas. Those observed do not exceed 5 feet in width.

Feldspar porphyry dykes outcrop on the shore of Lac La Motte in rge. V, La Motte tp., near the Lacorne mine, west of Lac Lortie, and on the high hills in rge. I, Fiedmont tp. (19). Because of the low relief of most outcrops their attitudes can rarely be measured.

Granite Dykes

A few granite dykes have been observed along bedding cleavage and filling tension joints in the rocks adjacent to the batholith. They rarely exceed 5 feet in width and are commonly vertical.

In rge. VIII, La Motte tp., east of Highway 61, granite dykes outcrop in well-bedded sedimentary rocks that have been metamorphosed to staurolite schists. The dykes stand vertically, and occur either in crosscutting tension fractures or parallel with the bedding foliation. Those following tension fractures commonly contain fragments of the wall-rock, stand vertically, and have uniform width. The others show the development of 'boudins' or sausage-shaped masses along their strike.

Gabbro Dykes

Two sets of gabbro dykes cross the batholith at several places where they have followed post-batholithic tension fractures. They strike respectively north 30 degrees east and north 55 degrees east and dip vertically. Nothing is known of their relative ages, but they commonly form multiple intrusions or else carry large inclusions of granite, as illustrated by the dyke east of Preissac village. The dyke north of Lac des Hauteurs and the one east of St. Benoit appear locally as a series of parallel sheets separated by granite septa. The dykes vary in width from a fraction of a foot to 250 feet. They are associated with alteration of the enclosing granitic rocks, which megascopically appears as a noticeable reddening in what is normally a white rock.

Joints

General Features

Joints are the best developed of the internal structures in the batholithic rocks, and several hundred measurements have been taken on them. Owing, however, to the faint traces of either lineations and foliation on outcrops it was found impossible to classify the joints in the field as cross, longitudinal, and diagonal joints (1). As a result, measurements were collected for each regular fracture exposed on the outcrops examined, and these were plotted on stereograms (6). This technique was utilized as a means of reducing the data to a limited number of sets for map compilation.

The gabbro dykes, which extend across the batholith, indicate that at least two systems of joints have been developed, the older one restricted in its occurrence to the batholith, and a younger system widely distributed in the rocks of the area. The former is genetically related to the intrusion of the batholith, whereas the latter are post-batholithic in age.

Most outcrop areas exhibit at least three sets of joints, one parallel with the nearby contact, the second normal to the contact, and the third in intermediate positions. Additional field data should clarify the role played by these joints during and following the intrusion of the batholith.

The joints occur in outcrops as regular barren fractures, with massive rock on either side, and as fractures with slickensides developed on their walls. Moreover, they may be cemented by quartz, quartz and feldspar, quartz and epidote, quartz and muscovite, aplite, feldspar porphyry, and granite.

Exfoliation Planes

General Features

Exfoliation planes are widely exhibited by the massive phases of the granite, particularly where the outcrops stand in some relief. The granite splits into subhorizontal slabs that range in thickness from a foot to 5 or 6 feet. These are fairly uniform in thickness

and have considerable lateral continuity, useful features in any quarrying operations. The exfoliation planes commonly dip at low angles parallel with the slope of the outcrop in which they occur.

Good examples of this structure are to be found in the La Motte mass of the batholith at such points as east of Lac des Hauteurs. On the higher outcrops in that vicinity, the planes warp around the gentle north slope of the hill and dip to the north. Locally, the western sides of such hills are a series of steps owing to the development of these planes. A similar occurrence has been observed along the power line in rge. IX, La Motte township, and in outcrops south of Lac Legendre. The planes are also developed, but to a lesser degree, in the muscovite phase of the batholith east of St. Benoit.

INTERPRETATIONS

Mechanics of Intrusion

General Features

The lack of extensive zones of migmatization in the rocks surrounding the batholith, the lack of gradational contacts, the random distribution of inclusions, the movement of inclusions away from possible sources of supply, and the intrusive nature of the contact in certain sections, all tend to support the premise that the Preissac-Lacorne batholith is an intrusive mass rather than a granitized area of Archaean sediments and lavas.

Migmatization

Evidence of migmatization of the wall-rocks is limited by the lack of exposures of the contact zone; however, a partly migmatized band of sedimentary rocks outcrops north and east of Vassan village. Sufficient movement has taken place at these points to disorganize the regional attitude of the rocks, and streaks and lenses of pegmatite and granite have been introduced along the contorted bedding foliae. These rocks are not, however, completely replaced, but retain sharp contacts with the adjacent granitic rocks.

Sedimentary rocks show a limited amount of migmatization around the west end of the La Motte mass, but along the south contact there is a marked development of plumasite and garnet, which probably indicates incorporated sedimentary material.

Pre-batholithic lavas and peridotites in contact with the granite, as in the area between Highway 60 and Lac La Motte, have been metamorphosed into amphibolites, but there is little field evidence to indicate any migmatization of these rocks. The hornblendic phase of the granite is in contact with the metamorphosed lavas west of Lac Lortie, but there again the rocks are not migmatized.

Distribution of Inclusions

The granite, particularly the hornblendic phase, carries swarms of inclusions that can be grouped into three main classes: fine-grained amphibolite; amphibolite and biotite schists in which

feldspar metacrysts occur, and a fibrous amphibolite. The distribution of the inclusions is commonly unrelated to the type of rock in the nearby walls of the batholith, and in no case do beds of wall-rock fade out progressively towards the centre of the batholith. Consequently, there has been no passive replacement of the wall-rocks, such as would form gradational contacts between the intruded and the intrusive rocks.

Certain large inclusions in the Lacorne mass have been moved from the vicinity of the walls and have been rotated so that their foliation parallels that of the enclosing granite, but does not correspond with that of the nearby wall-rocks. Moreover, an inclusion of pillowed lava is exposed in rge. VII, Vassan tp., several hundred feet from the west contact of the Lacorne mass, which at that point is in contact with sedimentary rocks. Consequently, there seems to have been sufficient movement during the intrusion of the magma to carry large inclusions away from their point of origin in the wall-rocks.

Nature of Contacts

The contacts of the various batholithic masses are generally conformable, and the foliation in the granites is normally about parallel with that in the adjacent wall-rock. However, the contact is intrusive in rge. VIII, La Motte tp., where the bedding of the sedimentary rocks is truncated by the massive biotite granite. Moreover, the sedimentary rocks in that vicinity are intruded by a series of dykes of granitic composition.

Intrusive breccias are not commonly developed in the periphery of the batholith. Instead, the adjacent sedimentary rocks have been moved sufficiently to disorganize the bedding foliation. Moreover, there has been an injection of thin lenses and dykes of granitic or pegmatitic material. This feature is well illustrated southeast of the Lacorne mine, and is demonstrated to a greater or lesser degree wherever sedimentary rocks are in contact with the granite.

Contacts with lavas or other dark-coloured rocks are associated with the development of foliation and a coarsening of the grain size, so that it is impossible in many places to detect any disruption of the primary bedding structures. No evidence of brecciation has been observed, but the foliation indicates movement along the contact, and the lack of a wide zone of migmatization discredits the passive replacement of lavas.

Direction of Movement

General Features

Interpretations regarding the direction of movement in the batholith are based upon such structural features as primary foliation and lineation, the distribution of inclusions, and, finally, the orientation of bedding planes in the inclusions relative to that observed in the nearby wall-rocks. Of these, the primary foliation is the commonest feature, closely followed by lineation, whereas

the remaining features are most significant in the hornblendic phases of the batholith.

Preissac Mass

The almost total lack of mineral lineation or primary foliation in this mass makes it impossible to comment on the directions of movement that took place in it.

La Motte Mass

Evidence of mobility during the intrusion of the La Motte mass is restricted to primary foliation, with a minimum of linear structural elements. Wherever data are available, these indicate movement parallel with the walls, and the structural data show the existence of an elongate dome parallel with the axis of the mass but lying south of the axis.

Near Lac des Hauteurs, flow lines indicate that the magma moved up and south at angles ranging from 40 to 60 degrees. At the west end of the mass, north of Preissac village, the movement has been upward and to the east at an angle of 75 degrees. Weak foliation along the south side of the mass, north of Kewagama Lake, indicates that movement has taken place parallel with the walls.

Lacorne Mass

The Lacorne mass shows both planar and linear elements of movement, which were controlled by the proximity of the contacts. The linear elements vary in their orientation from point to point from directions normal to the strike of the contact, west of Lac Lortie, to parallelism with the contact, west of Lac Fiedmont. West of Lac Lortie, movement has been upward at an angle of 30 degrees towards the south, whereas at Lac Fiedmont it has been upwards at 20 to 40 degrees towards the northwest. This indicates the existence of a structural dome south of Lac Roy where the reversal of the structural elements takes place. A similar dome lies between lots 10 and 20, rge. IV, Fiedmont township.

The contact, in the area between lot 40, rge. VI, Vassan tp., and Lac Baillairgé in Lacorne township, is dominated by evidence of planar movement. Linear elements developed in the nearby sedimentary rocks indicate movement upwards at an angle of 30 degrees from the southeast. The primary foliation was slightly disturbed by a large inclusion east of Vassan village. North of Lac Baillairgé, the large inclusions are oriented so as to indicate an upward movement from the northwest. Consequently, a structural dome must occur somewhere east of the Lacorne mine.

Less is known about the structural elements in the eastern and western extremities of the Lacorne mass; nevertheless, primary foliation and lineations indicate movement parallel with the walls. Moreover, the movement in the western extremity has been upward at a steep angle towards the west.

Satellitic Intrusions

The western side of the Kapitagama satellite is characterized by strongly developed primary foliation and lineation. These indicate that the dominant movement was upward towards the west at an angle of 30 degrees.

The Malartic satellite is exposed only on the shore of Lake La Motte, but sufficient is known about it to indicate that movement took place parallel with the north contact.

A little primary foliation in evidence in outcrops along the north side of the St. Edmond satellite indicates that movement took place parallel with the walls and upward from the south.

Shape of the Batholith

General Features

Much of what is known about the shape of the Preissac-Lacorne batholith is inferred from structural data collected from outcrops in the border zone. In most places the dip of the contacts cannot be determined directly, because of the low relief of the outcrops.

The various exposed intrusive masses are believed to be joined at depth, because of lithological similarities and the evidence gained from structural data. White, muscovite-bearing granite is common to all three major masses, and the biotite variety, characteristic of the border zones of the large masses, is the dominant rock type in the series of satellites surrounding the batholith. The Malartic satellite is lithologically identical with the hornblendic phase of the Lacorne mass, yet they have no surface connection.

Structurally, the Preissac, La Motte, and Lacorne masses show evidence that their contacts dip towards each other. Thus, the sedimentary and other rocks intervening at the surface do not separate the batholithic masses at depth.

Preissac Mass

The Preissac mass is elliptical in outline, with its long axis trending east-west, and is quite regular in plan, with the exception of the embayment near Rivière Cadillac. According to Norman (7), the north contact of this mass at the abandoned Indian molybdenum mine dips at an angle of 45 degrees to the north, as would be expected of a batholithic mass. The contacts surrounding the remainder of the intrusion are so poorly exposed that nothing is known of their attitude.

La Motte Mass

The La Motte mass is elliptical in outline, with its major axis striking east-west. The mass is regular in shape except for a slight bluntness of the eastern extremity.

The eastern contact of this intrusive mass dips at angles ranging from 50 to 85 degrees to the east, indicating that the sedimentary rocks that separate the La Motte mass from the Lacorne mass at the surface do not separate them at depth. The northern contact of the La Motte mass dips at shallow to moderate angles to the north, as is implied in the definition of a batholith. This angle varies from 65 degrees, between Lac La Motte and Lac des Hauteurs, to 10 degrees near Kinojevis River at the west end of the mass. The western end of the mass plunges at an angle of 75 degrees west, whereas the south side dips 45 to 65 degrees to the south at points east of Preissac village. Consequently, this mass is dome shaped, with the axis of the crest line parallel with the major axis of the present surface exposures, but south of it.

Lacorne Mass

The Lacorne mass is roughly circular in outline, with apophyses extending from both the western and eastern sides. It is not strictly batholithic in shape, as its contacts do not dip outward beneath the adjacent rocks at all points around its periphery. However, there is an outward dip that ranges from 30 to 50 degrees in the section of the north contact west and northwest of Lac Fiedmont. The reverse is true of the southern contact, which dips 80 degrees east at points south of the Lacorne mine and from 50 to 80 degrees north in the outcrops east of Vassan village. The northerly dip continues along the north side of the mass to the vicinity of Lac La Motte, but along the north side of the western projection the dip changes to 50 degrees to the south. In the vicinity of the narrows of Lac La Motte, primary foliation dips 85 degrees to the west, implying a steep dip of the western extremity in that direction. The southern contact of the western projection dips to the northwest, suggesting that at least part of the intrusion in that area is floored. The Lacorne mass originally had steeply dipping walls, and may have been overturned slightly towards the southwest.

Satellitic Intrusions

The writer believes that the satellitic intrusions are unroofed cupolas that join the main granite mass at depth. The St. Edmond satellite is somewhat elliptical in plan, with its longer axis trending east-west. Primary foliation attitudes indicate that it widens with depth, and the north contact dips towards the Lacorne mass.

The Malartic stock is typical of the hornblendic phase of the batholithic rocks, which is best developed in the Lacorne mass. What few data are available suggest steeply dipping walls and a stock-like shape.

The Kapitagama satellite is elliptical in plan, with its longer axis trending east - west. Primary foliation and lineations indicate a plunge of 30 degrees to the east. The rocks within it are lithologically similar to those in the nearby Preissac mass.

Magnetic Field of the Batholith

General Features of the Batholithic Area

The area underlain by the Preissac-Lacorne batholith is characterized by a low-intensity magnetic field of the order of 2,000 gammas or less, in which the contours are widely spaced. The Kewagama sedimentary rocks show a magnetic field with approximately the same intensity and pattern of contours, but associated with a greater number of magnetic depressions. These magnetic similarities make it difficult to separate the two rock types on the basis of such data. The peridotites show high anomalies of 2,500 gammas or more; the altered lavas show anomalies intermediate between the first two and the peridotites; and certain of the gabbros show characteristic high anomalies.

Preissac Mass

The Preissac mass is characterized by slightly closer spacing of aeromagnetic contours than either the La Motte or Lacorne masses, but still exhibits a continuous low with similar gamma values. Owing to the scarcity of outcrops, the aeromagnetic data have been relied on heavily for information regarding the shape of this intrusive body. The writer's interpretation is based upon the 2,000 gamma contour and the available geological information. The re-entrant near Rivière Cadillac is due to a tongue of peridotite that enters the mass from the northeast. No evidence has been observed that supports the occurrence of a narrow septum crossing the mass from east to west, as shown on earlier maps.

The gabbro dykes crossing the west end of the Preissac mass show the same behaviour as observed in the La Motte mass. The dyke that strikes approximately north 25 degrees east is non-magnetic, whereas the one striking north 40 degrees east shows the characteristic elongate anomaly.

La Motte Mass

The La Motte mass shows the widely spaced pattern of contours characteristic of the batholith, but its contacts cannot be located by aeromagnetic means alone owing to the common occurrence of similarly weakly magnetic sedimentary rocks in contact with the granite. It has been noted that there is a wider spacing of the contours along the north side of the mass than along the south side, a feature that might indicate a shallow dip to the north and a steep dip to the south (2), if this were not nullified by the presence of sedimentary rocks to the north and peridotites to the south.

The gabbro dyke that crosses the mass at its west end on a strike of north 25 degrees east shows no magnetic anomaly, whereas the one midway of the mass, striking north 40 degrees east, shows two anomalies, which are believed to represent two separate dyke segments within the batholithic mass.

Lacorne Mass

Aeromagnetic data reveal the border of the Lacorne mass with reasonable accuracy from a point north of Lac Chaptes east to Lac Roy where the hornblendic phase of the granite is in contact with irregular lenses of peridotite. Moreover, the border is well defined from the south end of Lac Fiedmont southwest to Rivière Fiedmont because of the gabbro mass in contact with the granite. The contact is also well defined from the north end of Lac Blouin west to the vicinity of Vassan village, due to the contrast between the relatively magnetic lavas and the granitic rocks. Similarly, the contact in the vicinity of La Motte village is moderately well defined by the difference in the magnetic susceptibility between the granitic rocks and peridotite. Elsewhere, the position of the contact is indefinite, particularly at points where the granitic rocks have intruded the sedimentary rocks of the Kewagama group.

The Lacorne mass has been extended to include the granitic rocks that outcrop east of Lac Fiedmont, mainly on the basis of aeromagnetic data. The low readings and contour pattern suggest such a continuity.

Gabbro dykes exposed in the west side of the Lacorne mass show characteristic elongate anomalies, which tend to confuse the pattern generated by the granitic rocks.

Local highs in this area probably indicate the presence of either large inclusions or patches of hornblendite. This might explain the arrangement of the contours east of Lac Baillairgé and the high anomalies encountered around the southern side of the mass.

Satellitic Intrusions

There is no magnetic evidence to indicate the presence of the Height of Land stock nor the satellites north of Lac Roy and La Motte village.

The Kapitagama stock is reasonably well outlined by a low anomaly centred on the north end of Kapitagama Lake, and there is little to indicate that it extends any great distance east of the lake.

The small stocks exposed on the islands in the south ends of Kewagama Lake and Lac La Motte produce small, but definite, low anomalies. This is also true of the small stock southeast of Vassan village.

The Malartic stock is somewhat elliptical in outline, according to aeromagnetic data, and is separated from the Lacorne mass to the northeast by a band of peridotite. Its extent both to the northwest and to the southeast is well exhibited by the aeromagnetic anomaly.

The St. Edmond stock is outlined by a somewhat elliptical anomaly that is confused near its eastern extremity by a magnetic crosscutting gabbro dyke. The Senneville stock has been compiled on the map from aeromagnetic data and drill-hole intersections, as there are no known surface exposures.

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