A MINERALOGICAL STUDY OF SOME
GRANITES FROM THE EAST HALF OF
THE SMITHERS MAP SHEET.

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A MINERALOGICAL STUDY OF SOME GRANITES FROM THE
EAST HALF OF THE SMITHERS MAP SHEET.

by

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INTRODUCTION

General Statement

In the east half of the Smithers Map Sheet of northern British Columbia, there are exposed several intrusive granitic rock bodies. These rock masses are believed to have been intruded during two different geological periods. The older group is dated as Pre-Jurassic and the younger group is considered to be Tertiary.

The object of the research presented in this thesis was to carry out a mineralogical study of rock samples from various parts of the intrusions to discover if the mineral contents of the rocks could be used to distinguish between the two age groups. Principal emphasis was placed on the study of the heavy minerals present in the rocks.

Specimens 1, 2 and 3 were collected by the writer. Specimens 27, I196, I212 and I213, with their corresponding
thin sections were kindly lent to the writer by
Dr. A.H. Lang of the Vancouver Office of the Canadian
Geological Survey.

The work was carried out under the supervision
of Dr. C.O. Swanson of the Department of Geology of the
University of British Columbia.

Geographical Distribution of Specimens Examined

Seven rock specimens were examined during the
course of the research carried out in the preparation of
this thesis. Two of these specimens were from intrusions
which are considered to be of Tertiary age. These two
specimens are No.1 and No.27. The other five specimens,
Nos.2, 3, 1196, 1212 and 1213, were from intrusions which
are thought to be of Pre-Jurassic age.

Specimen No.1 was taken from the north side of
Tsa-Lit Mountain which is situated about four miles north
of Mount Nadina, in the south-west corner of the map sheet.
The rock is considered to belong to the Mount Nadina
granite body which has had its age set as Tertiary by
Dr. A.H. Lang.\textsuperscript{1}

\textsuperscript{1} Lang, A.H.; Geol. Surv., Can.; Sum. Rept., 1929,
Part A., Pge. 75
Specimen No. 27 was obtained from a small dioritic stock near Barrett station on the Canadian National Railway. Dr. Lang\(^I\) thinks this stock also belongs to the Tertiary intrusion.

Specimens No. 2 and No. II96 were secured from a large outcrop one-half mile east of Nez Lake in the north-eastern part of the map sheet. This outcrop is part of the granitic basement of the Topley map area which Phemister\(^II\) and Hanson have determined as being of Pre-Jurassic age.

Specimen No. I2I2 was from the same intrusion as the two preceding specimens but one mile to the east.

Specimen No. I2I3 was part of a small stock near the eastern edge of the map sheet, due east from Nez Lake.

Specimen No. 3 was obtained from a bluff on the shore of Babine Lake, north-east from Nez Lake. It is part of the Topley intrusion.

\(^I\) Lang, A.H.; Personal communication.

MAP
To Show
Distribution of Specimens
Scale 1 Inch = 8 Miles
After Map 278A
Canada
Department of Mines
LABORATORY PROCEDURE

Introduction

Two methods of examination were used to study the minerals in the various rock specimens.

The first method consisted of having a thin section made from each specimen, and then examining these sections in the customary petrographic manner. All minerals visible were determined, together with the estimated relative abundance of each.

The second method consisted of separating the heavy minerals from pulverized portions of each rock. These mineral grains were then placed on slides and determined petrographically.

In carrying out the separation and study of the heavy minerals, the routine followed was fixed after the writer had considered various methods as described by Boos, I

Leckie, I ReedII and had received suggestions from Dr. C.O. Swanson and Dr. H.V. Warren of the University of British Columbia.

**Heavy Mineral Separation**

A sample piece of rock from each specimen was taken. The rock was crushed to pass through a 65 mesh screen. All material finer than 200 mesh was screened off and thrown away.

The heavy minerals were then separated from each sample. This separation was effected by the use of a heavy liquid, namely, tetrabromoethane. Since the specific gravity of the tetrabromoethane used was 3, for the purposes of this experiment, any mineral with a specific gravity of greater than 3 is called a heavy mineral. To carry out the separation, the writer used a large glass separating funnel half filled with the heavy liquid. Twenty-five grams of the crushed material was then placed in the liquid and the two substances were thoroughly mixed by shaking and stirring. The mixture was then left to settle. When the heavy parts

I Leckie, P.G.; Mineralogy of the Beach Sands in the Vicinity of Vancouver, B.C., M.A. Thesis, U.B.C.

were separated, they were drawn off through the bottom of the funnel. The material remaining in the funnel was re-stirred and again left to settle. This procedure was repeated until there was no further settling out of heavy material.

The heavy minerals were then filtered out of the tetrabromoethane with which they were withdrawn from the funnel. Next they were thoroughly washed, first with alcohol and then with water, and finally they were dried.

The dried heavy minerals were next carefully weighed. Then they were spread out on a large sheet of white paper and a magnet was passed slowly over them to remove the magnetic parts. When all of the magnetic grains had been removed, these were weighed.

From the weights thus determined, the proportions of the various rocks due to the total heavy mineral content and also to the magnetic heavy mineral content were calculated. These results are shown in table No.1. From this table, it is readily seen that the amounts vary greatly in the rocks of both ages. Consequently, the determination of the proportions of heavy minerals is of no practical use to distinguish between the two ages of rocks.
An attempt was made to separate the minerals on the Haultain "Super-panner" but because of the great range in size of the grains (65 mesh to 200 mesh) the results were not satisfactory.
### Table to Show Percentages by Weight of the Rocks Due to Heavy Mineral Accessories

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Total Percentage By Weight Of Original Rock Due To Heavy Minerals</th>
<th>Percentage By Weight Due To Magnetic Heavy Minerals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>In Original Rock</td>
</tr>
<tr>
<td>1</td>
<td>1.36</td>
<td>1.07</td>
</tr>
<tr>
<td>2</td>
<td>0.70</td>
<td>0.29</td>
</tr>
<tr>
<td>3</td>
<td>1.42</td>
<td>0.70</td>
</tr>
<tr>
<td>27</td>
<td>13.65</td>
<td>6.25</td>
</tr>
<tr>
<td>1212</td>
<td>5.80</td>
<td>2.00</td>
</tr>
<tr>
<td>1213</td>
<td>1.96</td>
<td>0.30</td>
</tr>
</tbody>
</table>

Table No. 1
Microscopic Determination of Minerals

The heavy minerals were determined with the aid of a petrographic microscope by the "immersion" method. First, a clean glass slide was sprinkled with grains of the unknown minerals. This slide was examined under a medium powered objective. Several grains which looked similar were then isolated from the material under the lens and were transferred to a clean slide. These separated grains were next carefully examined and all properties possible were noted such as cleavage, crystal form, extinction, etc. When it was reasonably certain that all of these grains were the same mineral, the index of refraction was determined by immersing the grains in oils of various known indices until an oil was found whose index of refraction was the same as that of the mineral. The immersed grains were then covered with a cover glass and examined under the high powered objective so that the interference figure and birefringence could be determined.

From the properties thus observed, the identification of the mineral was learned by referring to appropriate reference tables.
MINERALOGY

Megasopic Examination of Rocks

Specimen No. 1

This rock is a medium grained, light grey, granitic rock. Biotite is very noticeable throughout and is quite evenly distributed. Pale, opaque, grey to colorless quartz grains occur abundantly in the main body of the rock. The chief constituent is, however, feldspar. This latter mineral occurs as grey to pale greenish grains with a few pinkish crystals of slightly larger size than the other grains in the rock. There is a resultant slightly porphyritic appearance to the rock.

Specimen No. 2

This rock is a medium grained, salmon pink, granitic rock. Quartz is abundant as grey grains. The feldspars are mostly pink, but some few have a greenish tinge. There are a few larger feldspar crystals which give the rock a slight porphyritic appearance. A dark, fine grained mineral occurs spread throughout the rock.
It is probably a chloritic alteration product.

**Specimen No.3**

This is a very light grey, medium grained rock. Hornblende is a common constituent. There is an abundance of colorless quartz. Feldspar is pale greenish white with a few larger, greenish crystals which make the rock decidedly porphyritic.

**Specimen No.27**

Sample 27 is a fine grained, dark green crystalline rock. The crystals are too small to be readily determined with the aid of a hand lens, but two distinct types can be seen. One kind appears light green and the other, quite decidedly darker.

**Specimen No.1196**

This rock is a medium grained, salmon pink, granitic rock. It is composed predominantly of pink feldspar and glassy quartz. Some of the feldspars are rather larger than the general groundmass of the rock and so give it a porphyritic texture which is best seen on weathered surfaces. The fmic mineral appears as if it is altered mostly to chlorite, but some parts resemble biotite.
Specimen No. 1212

This, too, is a medium grained, pinkish, granular rock. It is mainly composed of pink feldspar and chlorite which appears to be an alteration product from hornblende. Quartz is very scarce.

Specimen 1213

Specimen 1213 is also a medium grained, though somewhat porphyritic, salmon pink, granitic rock. Quartz is plentiful and occurs in patches. This latter is greenish grey in color. The feldspar is pink and although most of the crystals are small, some few larger ones occur scattered through the rock. The femic minerals are fine grained and are very much spread out. Probably most of the femic mineral is chlorite.

Microscopic Examination of Thin Sections

Thin Section No. 1

The microscopic examination of thin section No. 1 revealed that the rock is a granite. It is holocrystalline, phaneric, medium grained and has a hypidiomorphic texture.
The minerals identified consist of orthoclase, oligoclase, quartz, biotite, sericite, titanite, apatite and iron ore. The relative proportions of the major constituents, based on an estimation of relative areas in the thin section, are shown in table No.2.

The mineral classified as orthoclase is not, strictly speaking, orthoclase, but it should be called albitized orthoclase or perthite. The albite is spread through the orthoclase in thin parallel veinlets, and occasionally in small irregular patches. The plagioclase often shows good zoning and is usually partially altered to sericite as is, also, the orthoclase.

Apatite is quite noticeable. It occurs scattered through the biotite and in the quartz. It is most common in and near the biotite. The crystals are very small and occur both as short thick prisms and as long thin rods.

The titanite is light brown in color and occurs very sparingly.

**Thin Section No.2.**

This rock is also a granite. It is holocrystalline, phaneric, medium grained for the most part, and has a general hypidiomorphic texture. However, one patch of poikolitic texture is present in the section.
The minerals identified are orthoclase, albite, quartz, chlorite, apatite, leucoxene, sericite, calcite and iron ore. For relative abundances of the major constituents see table No. 2.

Since there has been much alteration in the rock from which this section was made, the feldspars have partially changed to sericite and an amorphous substance which is probably kaolin; the mica (or hornblende) has changed to chlorite, and the titanite has become leucoxene. Calcite has also become quite plentiful.

In general, the plagioclase occurs as subhedral crystals and the orthoclase as larger, anhedral grains. In one or two places, the orthoclase forms a large mass around a few scattered plagioclase phenocrysts, and thus gives a poikolitic texture. On the other hand, quite commonly there can be seen wart-like myrmekitic intergrowths extending from plagioclase crystals out into adjoining orthoclase crystals.

The quartz has an odd intergrowth with itself. Under crossed nicols, patches of the mineral will extinguish at one time while other patches, intimately interspaced, will extinguish at another time.

The chlorite occurs as small isolated bodies and as one very large patch. A dark opaque mineral,
probably magnetite, is intimately associated with the chlorite. It is probably a "released" product from the alteration action which produced the chlorite.

Apatite occurs as small crystals in scattered patches.

**Thin Section No. 3**

This rock is very much like No.2. It is a holocrystalline, phaneric, medium grained granite with a hypidiomorphic texture. It has present in one place, however, a poikolitic patch where an orthoclase crystal encircles small euhedral crystals of plagioclase, titanite, and hornblende.

The identified minerals include quartz, orthoclase, oligoclase, titanite, hornblende, apatite and iron ore. See table No.2 for proportions of minerals present.

In general, the orthoclase and quartz show no crystal form but occur as irregular masses, whereas the plagioclase usually shows crystal edges and sometimes complete crystal form. Wart-like myrmekitic intergrowths similar to those in section No.2 are quite common. They appear to be outgrowths from slightly zoned plagioclase into orthoclase.

The quartz shows an intergrowth within itself which is similar to that of section 2. Scattered grains
extinguish at the same time.

Extinction in some of the plagioclase crystals passes gradually from the center outward and thus indicates zoning.

Alteration is not very pronounced in this section although the feldspars are somewhat altered as is, also, some of the hornblende.

**Thin Section No. 27**

Specimen No. 27 proved to be a holocrystalline, phaneric, fine grained diorite.

The minerals identified in the thin section were labradorite, diallage, apatite and iron ore. See table No. 2 for relative proportions of these minerals.

There was nothing of very great interest in this specimen. The plagioclase is sub-hedral and usually well zoned. Alteration is slight.

**Thin Section No. 1196**

Once more we have a granite. This section is very much like that of No. 2.

The minerals present are quartz, orthoclase, plagioclase, apatite, chlorite-biotite, leucoxene and iron ore. See table No. 2 for relative proportions of these minerals.
As in section No.1, the orthoclase has veinlets of albite strung through it, and so, it is in reality, micro-perthite rather than orthoclase.

Wart-like myrmekitic intergrowths are found extending from the plagioclase crystals out into the orthoclase as described for sections 2 and 3.

The plagioclase is called oligoclase but is very near to albite and should probably be more correctly termed albite-oligoclase.

The alteration has not been very intense.

Thin Section No.121?

This section is very badly altered, so much so, in fact, that the identification of the feldspars was not satisfactorily completed.

Minerals identified include albite, apatite, epidote, sericite and chlorite. Because of the large amount of alteration and of the inability to be sure of mineral identity, no estimate of mineral proportions was attempted with the result that table No.2 could not be satisfactorily filled in.

The albite is the most prominent mineral. It occurs as sub-hedral crystals which are surrounded by a microcrystalline aggregate of other minerals. Prominent
among these small grains are many feldspar crystals which show carlsbad twinning. These are likely to be orthoclase but since no conclusive evidence could be recognized, it was thought best not to name them.

Epidote occurs quite abundantly as aggregates of small grains.

Although no large quartz grains were recognized, under the high power, patches of what looked like micrographic intergrowth could be quite easily seen.

The rock is doubtfully classified as a syenite.

Thin Section No.1213

Alteration is very pronounced in this section as in No.1212.

The minerals identified are quartz, orthoclase, oligoclase, chlorite, sericite, calcite, epidote, leucoxene and iron ore. Approximate relative proportions of the orthoclase and plagioclase are given in table No.2. The remainder of the slide consists of mixed grains of the other minerals.

Although quartz is very scarce in the thin section, from the hand specimen it can be seen that there is sufficient quartz present to classify the rock as a granite.
### Table No. 2

Figures represent percentages and are based on an estimation of relative areas of minerals as observed in thin sections.

<table>
<thead>
<tr>
<th>Thin Section</th>
<th>Quartz</th>
<th>Orthoclase</th>
<th>Albite</th>
<th>Oligoclase</th>
<th>Labradorite</th>
<th>Biotite</th>
<th>Chlorite</th>
<th>Hornblende</th>
<th>Diallage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25</td>
<td>50</td>
<td>18</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>22</td>
<td>18</td>
<td>50</td>
<td></td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>25</td>
<td>52</td>
<td>16</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td></td>
<td></td>
<td></td>
<td>65</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>1196</td>
<td>27</td>
<td>33</td>
<td>35</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1212</td>
<td>?</td>
<td>?</td>
<td>40</td>
<td>?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>?</td>
</tr>
<tr>
<td>1213</td>
<td>?</td>
<td>46</td>
<td>34</td>
<td>?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>?</td>
</tr>
</tbody>
</table>
The Heavy Minerals

The heavy minerals were separated from six of the rock samples. No separation was made from specimen No. 1196.

In all, thirteen different heavy minerals were identified. Their distribution among the six samples and their relative abundances are shown in table No. 3.

Magnetite.

Magnetite is the most abundant accessory mineral. It occurs freely in all six rocks. (See table No. 1 for percentage occurrence in the total rock and in the heavy mineral concentrate.) The mineral occurs as dull black, opaque grains which are highly magnetic. Microchemical tests indicate iron but no titanium.

Biotite.

Biotite is seen only in rocks 1, 2 and 3. It is abundant only in No. 1. Since the specific gravity of biotite is only 3.1 at its maximum, it may be that all of the biotite present in the rocks did not settle out
during the separation. (This point was checked and it was found that much biotite remained with the lighter residue.) The mineral occurs as green plates which often show pseudo-hexagonal cross sections.
### Table to Show the Relative Abundance of the Various Accessory Heavy Minerals

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Magnetite</th>
<th>Biotite</th>
<th>Apatite</th>
<th>Zircon</th>
<th>Titanite</th>
<th>Pyrite</th>
<th>Ilmenite</th>
<th>Rutile</th>
<th>Hornblende</th>
<th>Leucoxene</th>
<th>Chlorite</th>
<th>Dillagage</th>
<th>Epidote</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>F</td>
<td>C</td>
<td>S</td>
<td>F</td>
<td>VR</td>
<td>VR</td>
<td>VR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>R</td>
<td>C</td>
<td>S</td>
<td>R</td>
<td>F</td>
<td>VR</td>
<td>C</td>
<td>VR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>R</td>
<td>C</td>
<td>VR</td>
<td>C</td>
<td>R</td>
<td>S</td>
<td>F</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1212</td>
<td>F</td>
<td>R</td>
<td>R</td>
<td>C</td>
<td>VR</td>
<td>C</td>
<td></td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1213</td>
<td>F</td>
<td>R</td>
<td>VR</td>
<td>F</td>
<td>VR</td>
<td>VR</td>
<td>VR</td>
<td>C</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*F* = Floods *C* = Common *S* = Scarce *R* = Rare *VR* = Very Rare

Table No.3
**Apatite**

This mineral is fairly evenly distributed through all six rocks, although it is present in Nos. 1212 and 1213 to a somewhat lesser extent than in the others. The apatite occurs as colorless prisms which vary in shape and size but are, for the most part, very small. Some crystals are long and thin while others are short and stout. The characteristic hexagonal cross section is well developed. Usually the crystal faces are smooth but sometimes they are badly corroded and give the mineral an opaque appearance.

**Zircon**

Zircons can be found in each specimen, but they are not common. They occur as tiny, clear (or occasionally brownish) tetragonal bipyramids. The most common form is a first order bipyramid combined with first and second order prisms. Another common form is the combination first and second order prisms, first order bipyramid, and ditetragonal bipyramid.¹

¹ Dana, E.S.; A textbook of Mineralogy; figures 912 and 914; Pge. 610.
Titanite

This mineral occurs in all specimens except the diorite, No. 27. It occurs as rather large, sub-hedral to euhedral crystals which are brownish to pale yellow in color. The grains are often in a state of partial alteration to leucoxene so that they have the color and crystal shape of titanite but are quite opaque.

Pyrite

Pyrite occurs as characteristic brass yellow cubes. It is present in very small amounts in all specimens except No. 27.

Ilmenite

Although present to some extent in all of the rocks, ilmenite is plentiful only in Nos. 2 and 1212. It occurs as irregularly shaped grains which have a purplish color in reflected light. The grains are non-magnetic and give positive microchemical tests for both iron and titanium.

Rutile

Rutile is present only in specimen No. 1 where it occurs as brownish orange prisms which have very pronounced striations parallel to the prism faces. A
geniculated twin was seen in a quartz grain.

Hornblende

This mineral occurs abundantly in rock No. 3 and very sparingly in Nos. 2 and 1213. It is present as dark, sea-green prisms which have the characteristic amphibole cleavage.

Leucoxene

Leucoxene is common in specimens 2 and 1213 but is occasionally seen in No. 3 and is absent from the others. It seems to have been formed mostly from titanite, but can sometimes be recognized on and with ilmenite.

Chlorite

Although the specific gravity of chlorite is less than that of the heavy liquid used for the mineral separation, a few grains were distinguished in the residue of specimen No. 2.

Diallage

Diallage occurs only in the diorite, No. 27. In this rock it is very abundant. It is pale bottle green, of a lamellar habit and shows good parting. The extinction angle is usually around forty degrees but in some grains it is zero.
Epidote

This mineral is present only in the much altered specimens Nos. I2I2 and I2I3. The epidote occurs as pale, apple green grains. Some grains show striations parallel to the crystal edges.
CONCLUSION

The material here presented has shown that in the district where the rocks which were examined were obtained, the mineral composition of these rocks cannot be used to any advantage to distinguish between the different aged intrusives.

From table No. I it is seen that the proportions of heavy minerals in the rocks vary greatly in both the Tertiary and the Pre-Jurassic groups. There is an overlapping of values between the two groups and so no dividing line can be set.

Table No. 2 likewise gives no clue to an age distinction between the rocks. The composition of the Tertiary specimen No. I is closer to that of the Pre-Jurassic specimen No. 3 than is the composition of the Pre-Jurassic specimen No. 2 to No. 3. Similarly, there is a very great difference between the two Tertiary specimens Nos. I and 27.

Finally, turning to table No. 3, we see once more that there is no indication of any strict similarity between the members of one group which is not also in
evidence in the other group. All of the minerals common to both Tertiary rocks (Nos. I and 27) are also present in almost identical proportions in all of the Pre-Jurassic ones.

Hornblende was identified in most of the Pre-Jurassic specimens and not in either of the Tertiary ones. This, however, could possibly be due to the fact that the samples were all grab samples and not truly representative of their respective outcrops. In any event, a single mineral does not seem sufficient for a conclusive distinction.

Admittedly the study of six specimens seem inadequate evidence upon which to form an opinion as to the value of a heavy mineral study. However, it does seem to the writer that if there were any mineral peculiarities characteristic of either age of intrusion, they would show up even with the amount of work herewith completed.
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