A PETROGRAPHIC STUDY OF ROCKS FROM THE BOX MINE, ATHABASKA LAKE

BY

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PART I

A PETROGRAPHIC STUDY OF ROCKS FROM THE BOX MINE, ATHABASKA LAKE

INTRODUCTION

The following paper is a discussion of the rocks in the vicinity of the Box Mine near Goldfields, Saskatchewan.

A brief description of the Box Mine is given by F. J. Alcock[1], who made an examination of the property during his reconnaissance survey of the Athabaska Region in 1935. A more detailed survey and report of the Goldfields vicinity and the Box Mine was made by H. C. Cooke[2] in 1936. In 1938 Dr. C. O. Swanson made a careful examination of the property. He noted several features which did not jibe with the descriptions of Alcock and Cooke. In order to make a detailed study, specimens were collected from all parts of the mine. (See Maps #1 and 2). Thin sections were made from several of these rocks and examined by the writer and the results set forth here.

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[1] F. J. Alcock: The Geology of Lake Athabaska Region - Geol. Sur. Can. Mem. 196

[2] H. C. Cook: Preliminary Report of Goldfields Area, Saskatchewan - Geol. Sur. Can. Paper 37-3

LOCATION AND TOPOGRAPHY

(a) LOCATION

The Goldfields area lies on the north shore of Lake Athabaska near the extreme northwest corner of Saskatchewan. (See Map 4). The area can be reached by way of the Peace River from the end of the railway or by means of the railway from Edmonton to Waterways and thence down the Athabaska River to Lake Athabaska where regular steamship service is maintained during the summer. Plane service is maintained to the mining camps from Prince Albert, Alberta, and also from Edmonton, Alberta.

(b) TOPOGRAPHY

Goldfields is situated within the Canadian Shield and the topography is typical of this region. It is a hummocky country of ridges and hills separated by depressions that are commonly occupied by lakes or swamps. The whole area is characterized by low relief and disorganized drainage.

GEOLOGY

(a) GENERAL

In order to give a general idea of the time relations and the general lithology of the region Alcock's[1] table of formations is reproduced below.

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[1] F. J. Alcock: The Geology of Lake Athabaska Region - Geol. Sur. Can. Mem. 196

TABLE OF FORMATIONS:

	Athabaska series	Conglomerate, arkose, sandstone, shale. Basalt flows and dykes
		UNCONFORMITY
		Granite
Proterozoic		INTRUSIVE CONTACT
		Gabbro, norite, peridotite, amphibolite
		INTRUSIVE CONTACT
	Beaverlodge series	Quartzite, conglomerate, iron-formation
		UNCONFORMITY
		Granite, granodiorite, quartz-syenite, pegmatite
Archaean		INTRUSIVE CONTACT
	Tazin group	Dolomite, limestone, quartzite, argillite, conglomerate, mica schist and gneiss; volcanic flow and fragmental rocks

(b) DETAILED GEOLOGY

Cooke[1] and Alcock[2] have divided the rocks on the property into three main groups: sediments, granite and basic intrusives. Dr. C. O. Swanson states that there are only two series: sediments and basic rocks intrusive into these sediments.

(1) Sediments

The sedimentary rocks on the property have been extensively metamorphosed. Originally these rocks consisted of pure quartzites and felspathic sands that could be classed as arkose, greywacke, or pebble conglomerate, and are associated with occasional layers of silt and chert. During metamorphism these rocks have been altered, the pure sands becoming massive quartzites and the impure beds are now schists such as mica schist, sericitic quartzite, sheared arkose, etc., or else have become massive and more or less granitic in appearance.

(2) The Mine Granite

The term "mine granite" is used throughout this paper to designate the ore body which is described by Cooke and Alcock as granite and by Dr. Swanson as granitized sediments.

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[1] H. C. Cooke - Preliminary Report Goldfields Area, Saskatchewan - Geol. Sur. Can. Paper 37-3

[2] F. J. Alcock - Geology of Lake Athabaska Region, Saskatchewan - Geol. Sur. Can. Mem. 196

The term is one used by Dr. Swanson in his description of the geology of the mine.

Cooke[1] and Alcock[2] state that the ore body on the property consists of a sill-like granite mass of Post-Beaverlodge age but do not agree on the definition of its boundaries. The rock is described by them as being highly altered but prior to alteration consisted mainly of albite feldspar containing orthoclase, together with quartz and some ferro-magnesian minerals now mainly altered to chlorite.

Dr. C. O. Swanson states that this mine granite is a thoroughly granitized portion of the sedimentary series and not, as the name indicates, a true igneous body. The reasons given for this conclusion are set forth in the following quotation from the geological report of Dr. Swanson:

"That the mine granite is merely a highly granitized portion of the sedimentary series is shown by the presence of numerous gradations to sedimentary types, not only at the main contacts, but also throughout the granite body. The more the body is studied, the clearer the transitions to sedimentary types appear, and the further they can be traced. It is, of

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H. C. Cooke - Preliminary Report Goldfields Area, Saskatchewan - Geol. Sur. Can. Paper 37-3

F. J. Alcock - Geology of Lake Athabaska Region, Saskatchewan - Geol. Sur. Can. Mem. 196

course, possible that the granitization is due to reaction with igneous liquids, but, if so, the volume of the reaction products is unusually predominant,- so much so that the writer failed to find any portion of the body that could be definitely called igneous."

Some examples of the gradations mentioned in the above paragraph are given in the report and are repeated here.

There is a large, rather uniform body in the upper part of the granite body east of #1 shaft which resembles a rhyolite porphyry and in places grades out into a fine grained felspathic quartzite or mica schist. Another coarser porphyry grades into an arkosic schist and is associated with so-called siliceous granite which itself grades into sericitic quartzite.

(3) <u>The Basic Intrusives</u>

These rocks were originally diabases or related types.

Using Dr. Swanson's classification, these rocks are younger than the sediments which they intrude but older than the metamorphic action and also the mineralizing action as they have been sheared to chlorite and hornblende schists, also in places they are cut by the quartz- pyrite veins and the marginal parts often show good values.

Cooke[1] and Alcock[2] disagreed upon the age of these rocks; Cooke stating that the basic intrusives are younger than the mine granite while Alcock maintained that they are older than the granite body.

It might be pointed out that the problem of the age of the basic intrusives has no significance (apart from deciding whether they occurred before or after granitization of the sediments) if the mine granite body is considered to be sedimentary in origin.

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[1] H. C. Cooke - Preliminary Report Goldfields Area, Saskatchewan - Geol. Sur. Can. Paper 37-3

[2] F. J. Alcock - Geology of Lake Athabaska Region, Saskatchewan - Geol. Sur. Can. Mem. 196

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Related Subjects

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ACKNOWLEDGEMENT

The writer wishes to acknowledge the assistance and advice given by Dr. C. O. Swanson in the work undertaken and also to thank him for his courtesy in giving the writer access to his private report on the geology of the Box Mine.

PART II

PETROGRAPHY

(a) INTRODUCTION

Dr. Swanson, when collecting the specimens for petrographic study did so with the definite idea of obtaining a representative of each rock-type at the mine. Specimens were collected from all parts of the mine and especial attention was given to the contact zones between the granitic and sedimentary groups. Where gradations occured in the rock, two specimens were taken, one of the sedimentary and one of the granitic material. These specimens were designated by the same numbers so that, though there are forty-three specimens in all, they are numbered from one to thirty-two consecutively (there being two number thirty's, two number thirty-one's, etc.).

The exact location of each specimen gathered is shown on maps I and II which show the surface geology and underground workings respectively of the mine.

(b) MEGASCOPIC EXAMINATION OF THE SPECIMENS

The specimens when examined megascopically range in variety from the pure vein quartz (specimen number 3) to a rock resembling a porphyritic granite (specimen 30). When examined closely the rocks, even those most nearly resembling granite, showed an overabundance of quartz. Some of the quartzitic specimens show an almost gneissic structure and many of the rock specimens are pinkish in color, the pink color is apparently due to pink feldspar.

(c) MICROSCOPIC EXAMINATION OF THE SPECIMENS

Fourteen thin sections were made from certain of the specimens collected. A list of the specimens from which then sections were made and a brief description of each is given below:

Specimen 1 - Slide 1 - Quartzite

Specimen 4 - Slide 2 - Granitized quartzite

Specimen 5 - Slide 3 - Hanging-wall quartzite

Specimen 6 - Slide 4 - Porphyry

Specimen 9 - Slide 5 - Quartzite

Specimen 14 - Slide 6 - Red quartzite

Specimen 15 - Slide 7 - Granitized quartzite (?)

Specimen 16 - Slide 8 - Hanging-wall seriticized quartzite

Specimen 20 - Slide 9 - Seriticized quartzite grading into granite

Specimen 25 - Slide 10 - Footwall quartzite

Specimen 30s- Slide 11 - Quartzite

Specimen 30g- Slide 12 - Granitized quartzite

Specimen 31s-Slide 13 - Quartzite

Specimen 31g- Slide 14 - Granitized quartzite

The above descriptions are field terms used to designate the hand specimens when they were collected.

Under the microscope, a general similarity in all the slides was noted, especially in those from specimens taken in the gradation zones (i.e. specimens 30s and 30g). Several features were noted in these slides which supported the contention of Dr. C. O. Swanson that the material comprising the mine granite is a metamorphosed or granitized sediment and not, as stated by Cooke[1] and Alcock[2], a true igneous rock.

The special features noted include:

(1) The abundance of free silica

(2) The presence of rock fragments

(3) Textural features

(4) Inclusions

(5) The feldspars

(1) <u>THE ABUNDANCE OF FREE SILICA</u>

This is the most conspicuous feature of all the slides. In every slide examined, quartz is the predominating mineral present. The quartz occurs in two ways in the slides: (1) as the principle constituent of the fine-grained groundmass which is typical of all the slides and (2) as larger grains and aggregates of grains scattered throughout this groundmass.

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[1] H. C. Cooke: Preliminary Report, Goldfields Area, Saskatchewan - Geol. Sur. Can. Paper 37-3

[2] F. J. Alcock: Geology of Lake Athabaska Region, Saskatchewan - Geol. Sur. Can. Mem. 196

With the aid of an eyepiece containing a grid of four hundred squares, counts were made on several of the slides to determine the approximate percentage of each of the principal minerals. An average count on any of the slides yields over sixty per cent quartz, a percentage much higher than that found in any normal true igneous rock. As an example, the average count for slide twelve, specimen 30g, a rock which, in the hand specimen resembles granite, yields approximately seventy-five per cent quartz, eighteen per cent feldspar and seven per cent sericite, chlorite and material too find-grained to be accurately determined. The counts were made exclusive of vein quartz which is quite distinct and easily recognized as such. Cooke[1] states that the solutions which introduced the quartz of the quartz veins have permeated the whole rock, even the pore spaces, and deposited quartz. In this way, he explains the abundance of free quartz in the rocks. A close examination of the slides reveals features that disprove this theory. Where quartz veins or the edges of quartz veins were visible in the thin sections, the boundaries are clean-cut and definite and the veins show no diffusion or grading out into the surrounding rocks. If Cooke's hypothesis were true, it would seem reasonable that some part of the granite body w ould have escaped the silicifying action and

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[1] H. C. Cooke - Preliminary Report Goldfields Area - Geol. Sur. can. Paper 37-3

would show a true granite composition. Although the specimens were gathered from all parts of the body of the mine granite, no rock of true granite composition was found among these specimens.

The abundance of quartz in the slides can be seen fairly well in Plate I, page15, and Plate II, page16.

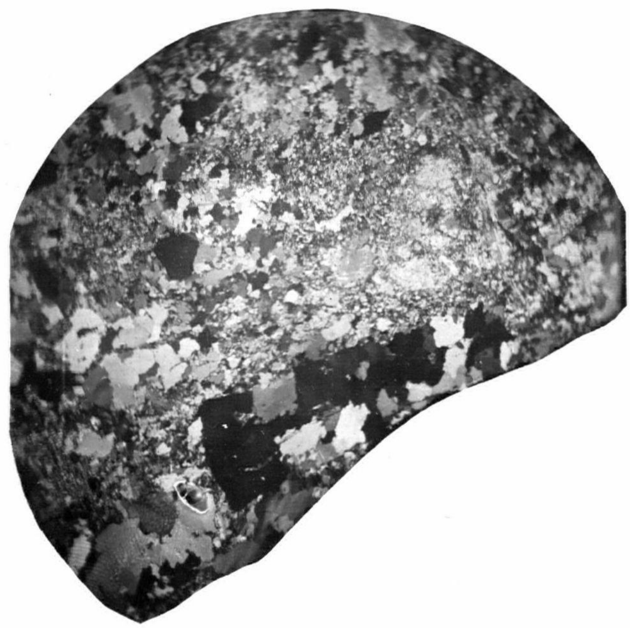
(2) ROCK FRAGMENTS

In many of the slides occur aggregations of quartz grains which strongly resemble rock fragments. These can clearly be seem in Plate I, page 15 , taken from slide 9, specimen 20, and in Plate II, page 16, taken from specimen 31g. These rocks in the hand specimen resemble a true granite and were collected from the body of the mine granite. Similar aggregations of quartz grains were found in the slides from the quartzite specimens and the fact that these fragments were noted in the sections from the quartzite as well as in those from the mine granite would preclude the possibility that the fragments occur as inclusions or xenoliths in a granite body.

Aggregates of feldspar grained alone and some of both quartz and feldspar grains were noted but these are not common and not as large as the aggregates of pure quartz grains.

It was noted that these fragments often give the rocks a pseudo-porphyritic appearance. What appears to be a phenocryst in the hand specimen is often seen to be an aggregation of quartz grains when examined under the microscope.

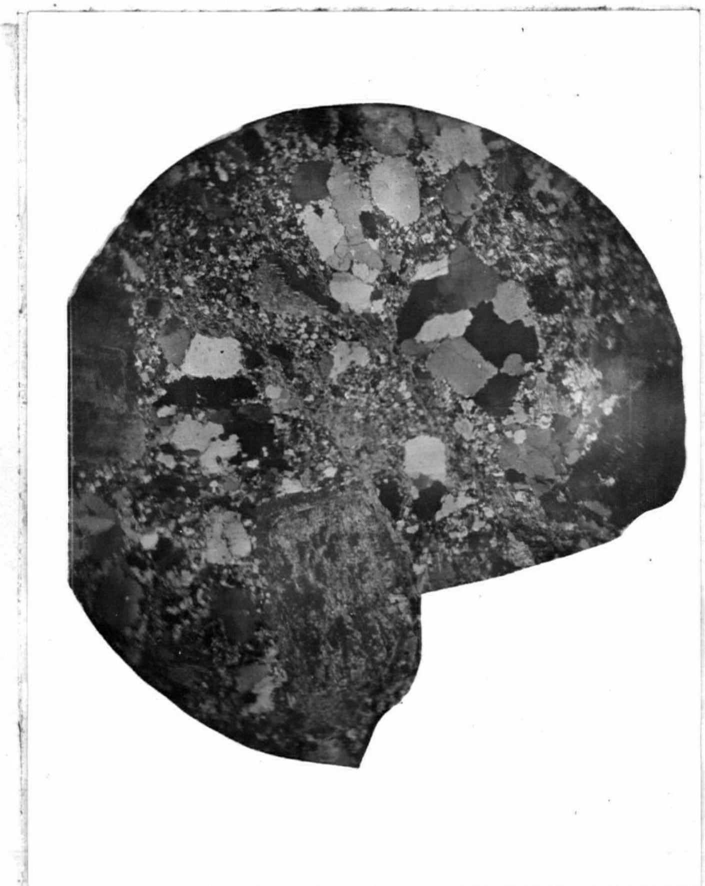
PLATE I



Rock Fragment: the form and size of this fragment can be clearly seen in this picture. Several smaller fragments can be seen but not so clearly. An idea of the fairly fine grained groundmass and the abundance of quartz typical of all specimens can be obtained from this picture.

Slide 9, Specimen 20 X nicols

PLATE II



Rock fragments and feldspar phenocrysts can be plainly seen here.

The feldspar consists of perthite. The fine grained groundmass and abundance of quartz are visible here as in Plate I.

Slide 14, Specimen 31g X nicols

The presence of these rock fragments in the specimens collected from the mine granite strongly suggests a sedimentary origin for this rock.

(3) TEXTURAL FEATURES

The textures of the rocks examined vary greatly. Some specimens are medium grained with no large crystals while others exhibit a strong porphyritic texture.

In order to distinguish between the mine granite and the hybrid rocks Cooke[1] relies on texture, classing all the rocks of medium to coarse grain as granite and those with uneven grain as hybrid rocks.

This basis of classification of the rocks did not seem valid to the writer. Examination of the hand specimens and the thin sections revealed some quartzites containing large grains or phenocrysts of feldspar and large grains of quartz and others having a uniformly medium-grained appearance while the mine-granite specimens, although all have a porphyritic appearance, show a great variation in the number and size of the phenocrysts of quartz and feldspar.

When slides taken from specimens gathered in the gradation or contact zones were examined, a marked similarity in

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[1] H. C. Cooke - Preliminary Report Goldfields Area, Saskatchewan - Geol. Sur. Can. Paper 37-3

texture and mineral composition was noted. The slide taken from the sedimentary rock contained more sericite and showed a slightly more schistose texture than that taken from the granitized material

No quartz grains were noted in the slides having even faint crystal outline, many of the smaller quartz grains having rounded and most of the larger grains ragged borders. The ragged borders may have bden formed during recrystallization and growth of the quartz grains.

The feldspar grains exhibit a stronger tendency to appear as euhedral or subhedral crystals. An example can be seen in the large crystal of perthite in Plate II, page 16. Feldspar grains were also noted with ragged or sutured borders against the finer grained quartz groundmass. Again this may be due to recrystallization and growth of the feldspar grains during metamorphism of the rock.

(4) INCLUSIONS

Although there appears to be some evidence of recrystallization and growth of quartz grains during metamorphism, no inclusions of foreign material were noted in the grains. The explanation for this may lie in the superabundance of quartz in the rocks.

In the more granitized specimens some feldspars were found containing inclusions of quartz and sometimes of other feldspars. These occuurrences are not numerous but where they occur they indicate a building up or growth of the feldspars rather than their breaking down in a true igneous rock.

It may be that inclusions are found in the feldspars and not in the quartz, because the feldspar has greater recrystallizing power and the crystals grow fast enough to include foreign material rather than push it aside.

(5) THE FELDSPARS

Many of the feldspars in the slides examined show extensive alteration, possibly by the mineralizing solutions. Perthite is abundant in the slides, also albite, albite-oligoclase, oligoclase and orthoclase.

It was noted that there was a marked difference in the amount of sericite in the quartzite and granitic specimens, the quartzite containing more sericite than the more granitic rock. It is possible that a chemical action took place between the sericite and quartz to form orthoclase during the process of granitization.

Apart from the inclusions and ragged borders mentioned under the heading Inclusions, the feldspars offer no definite evidence as to the original character of the rock. No incongruous feldspars were found in any of the slides examined.

CONCLUSION

In Part I of this paper the writer has attempted to give a clear picture of the problem involved, -- Is the ore body of the Box Mine a true igneous body, or is it a granitized sediment? -- and at this point would again like to quote Dr. Swanson:

"At first thought, the difference between a true granite, and a body of sediments that look like granite, might not seem very significant. But the resemblance is really only superficial. The internal structures in the two cases follow separate principles, and for this reason the setting of the ore deposits takes on quite different aspects, depending on whether the country rock is considered igneous or sedimentary."

In Part II have been set forth the criteria which, to the writer, point conclusively to the sedimentary origin of the granitic body. A brief summary of these criteria follows:

In the field, gradations occur from rocks of granitic appearance directly into rocks of sedimentary type, such as mica and arkosic schists.

Under the microscope, the two most conclusive features are:

(1) The abundance of quartz in all the slides examined; the amount far exceeding that found in any normal granite of igneous origin.

(2) The presence of rock fragments which strongly suggest a sedimentary origin.

Less indicative features are: texture, rounded borders of some quartz grains, ragged borders of other quartz grains and some feldspar grains and inclusions of foreign material in some of the feldspar grains.

In the mind of the writer, these rocks should be classed as granitized sediments and not as a true igneous body.

EXPLANATION OF MAPS

Maps 1 and 2 are taken from Dr. Swanson's report of the mine. They are reproduced here to show the locations of the different samples taken. The position of each sample is marked by the number of that sample within a circle.

Map 1 shows the surface geology of the mine and an idea of the different lithological units can be obtained. The red marks the general contacts of the mine granite and the others are the different sedimentary and metamorphosed series.

Map 2 covers the underground workings of the mine up to the date of examination.

Map 3 is taken from the report of H. C. Cooke[1] and shows the surface geology of the mine as mapped by him. The map is self explanatory.

H. C. Cooke - Preliminary Report Goldfields Area, Saskatchewan - Geol. Sur. Can. Paper 37-3

GEOLOGY
BOX MINE
#1 Shaft
#2 Shaft
1040
1060
1080
1100
1120
1140
1160

MINE PLAN
BOX MINE

1938

GEOLOGY OF BOX PROPERTY

GOLDFIELDS, SASKATCHEWAN