# PETROLOGY OF THE "ARCHAEAN" SEDIMENTS IN THE WEST HAWK LAKE AREA

A Thesis

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Master of Science

by

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# PETROLOGY OF THE ARCHAEAN SEDIMENTS IN THE WEST HAWK LAKE AREA, MANITOBA.

## CHAPTER I

## INTRODUCTION

### Purpose of Study

The Archaean sediments of the West Hawk Lake area are interbedded with the volcanic rocks (andesites and basalts) and form a belt which strikes eastward across the Manitoba-Ontario boundary. This Archaean belt of rocks is surrounded by intrusive granitic rocks and has been metamorphosed into biotite and amphibole schists.

The purpose of the study of the Archaean sediments and volcanics of the West Hawk Lake area was to determine the type of sediments present, the degree of metamorphism on a regional scale, and whether there are any local effects due to the intrusives or other causes.

### Location

The West Hawk Lake area is situated in southeastern Manitoba along the Ontario-Manitoba boundary (Plate I). This area is part of the Whiteshell Forest Reserve. Manitoba Highway No.1 crosses the area making it very accessible.

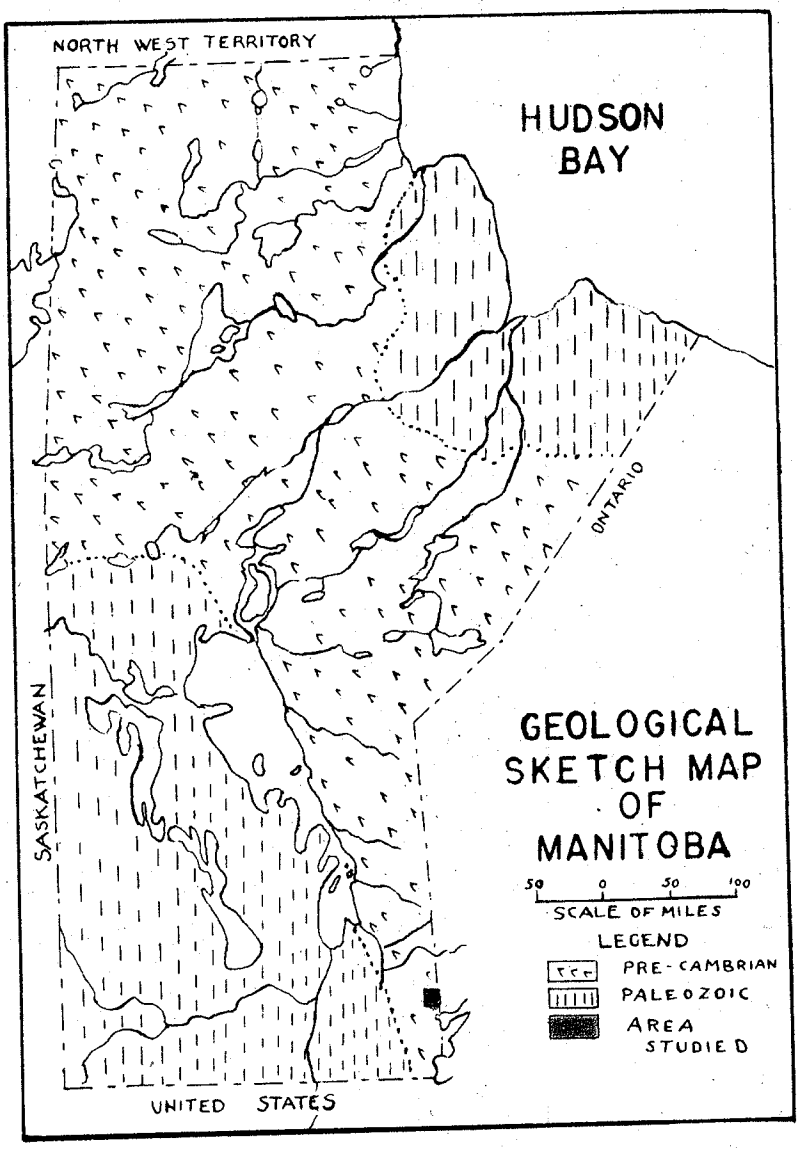
NORTH WEST TERRITORY
HUDSON BAY
ONTARIO
SASKATCHEWAN
UNITED STATES
GEOLOGICAL SKETCH MAP OF MANITOBA
50 0 50 100
SCALE OF MILES
LEGEND
PRE-CAMBRIAN
PALEOZOIC
AREA STUDIED

PLATE I

## History of the Area

Prospectors were attracted to the area by the numerous occurrences of pyrrhotite, molybdenite, gold, scheelite, spodumene and tin. There are numerous pits and shafts scattered throughout the area as evidence of this intensive search. No large commercial deposits were found. The Penniac Mine was the only property developed for production. This venture was a very small gold producer for a short period. Two other development shafts; the Goldbeam and Sunbeam Kirkland were sunk by Goldbeam Mines Limited in the Falcon Lake stock, but not enough ore was found for commercial production.

## CHAPTER II

## GENERAL GEOLOGY OF THE AREA AS DESCRIBED IN PREVIOUS LITERATURE

### Review of the Literature

A.C. Lawson of the Geological Survey of Canada mapped the area in conjunction with the Lake of the Woods-Shoal Lake region and was the first geologist to examine the volcanic and sedimentary belt, but did not describe it in great detail. He mentions the presence of andesites, basalts, agglomerates, siltstones, graywackes, arkoses and conglomerates.

E.S. Moore studied the area briefly in 1913 for the Geological Survey of Canada. He described the sediments of the area as having a porphyritic appearance (i.e. fine grained matrix of quartz, epidote, zoisite, chlorite and biotite with large grains of feldspar).

J.S. DeLury in 1937 mapped the area on a scale of one half mile to the inch and described the volcanic and sedimentary belt as a belt of schists striking northeast to east across Star Lake and West Hawk Lake and continuing into Ontario. He believed that the hornblende schists in the belt were derived from ellipsoidal lavas. DeLury described the sediments as consisting of Lawson's types: graywackes, arkoses, siltstones and conglomerates with such minerals as biotite, garnet, sericite and some graphite. He apparently found a conglomerate west of Star Lake containing boulders and pebbles varying greatly in size and composition with a quartzitic matrix.

L. Greer in 1930 studied the Shoal Lake area of interbedded

sediments and lavas for the Ontario Department of Mines and found the ellipsoidal greenstone to be composed of plagioclase (andesine and oligoclase) and hornblende, with chlorite, epidote and sericite in the altered areas. He found a peculiar type of rock which he called "volcanic conglomerate" which is composed of well rounded fragments of felsitic material in a dark green fine grained matrix. These locally grade into granitic fragments and become pebble like and stratification is present. The pebbles are not uniformily distributed across the strike and the layers of pebbles pass gradually to cherty sediments in beds six inches thick. The volcanic material in this conglomerate prevails over the granitic. This deposit may be of Piedmont type.

G.E. Springer mapped the area for the Manitoba Geological Survey and found the Archaean belt in the West Hawk Lake area to be composed of siltstones, graywackes, argillites, and arkoses interbedded with ellipsoidal andesite and basalt. An area of agglomerate grading into conglomerate was found west of Star Lake.

## Summary of General Geology of the Area

The geology of this West Hawk Lake area comprises an Archaean belt of sediments and lavas which strikes eastward into Ontario and is partially intruded by granitic rocks and covered by glacial drift in the west. The lavas and the sediments have been metamorphosed into schists. The area was glaciated during the Pleistocene epoch leaving thin glacial deposits of sands and gravel. The relief is moderate with numerous lakes and swamps and outcrops are abundant.

The following table of formations was suggested by G.E. Springer;

## Table of Formations

| | | |
|---|---|---|
| Recent and Pleistocene Deposits | | Fine sandy loam, sand and gravel |
| Proterozoic or Archaean | Granitic intrusives | Pegmatites |
| | | Falcon Lake Stock Pink Porphyritic Granodiorite |
| | | Gray gneissic Granodiorite, quartz diorite and quartz feldspar dikes |
| Archaean | Sedimentary rocks | Graywackes, siltstones, argillites, arkoses and conglomerates |
| | Volcanic rocks | Andesite, basalts and agglomerates |

## Volcanics

The volcanics in this area consist of metamorphosed andesites, basalts and some agglomerates which are interbedded with the sediments. The basalts appear to be the commonest of the three. The agglomerates are found south west of Star Lake.

The andesites show evidence of having been ellipsoidal lavas and are composed of actinolite with a very fine grained andesine matrix. Tabular grains of epidote and some zoisite are present near the contacts of the andesites and the intrusives.

The basalts are dark greenish to black and are composed of tabular grains of hornblende in a very fine grained matrix of soda-lime feldspar.

The agglomerate appears to grade into a conglomerate with a basic matrix according to G.E. Springer who studied these rocks in detail.

## Sediments

The sediments of the West Hawk Lake area consist of graywackes, siltstones, arkoses, and argillites interbedded with the lavas and the conglomerate mentioned above southwest of Star Lake. The sediments all have a light to dark gray color, very fine grained texture, and have been metamorphosed to produce biotite-garnet schists, sericite schists and biotite-graphite schists.

The graywackes have a fine grained matrix with angular fragments of feldspar disseminated through it. The matrix is composed of quartz, biotite, some feldspar, sericite, calcite and locally epidote.

The biotite occurs as tiny blades well lineated along the schistosity.

The siltstones are very fine grained and occur in conjunction with the graywackes. They are composed of fine quartz with sericite, biotite, and locally, garnets.

The arkoses were found to be abundant in a sedimentary band at the northeast end of West Hawk Lake (see Plate VI). These rocks are predominantly feldspar with small lenses of quartz, some biotite and epidote.

The argillites are not common but occur locally as thin beds. They are dark gray to black and are composed of a fine grained matrix of quartz, some sericite and disseminated specks of graphite.

G.E. Springer found the conglomerate northwest of Star Lake and there appeared to be a gradation from the agglomerate to conglomerate. The conglomerate contains granitic and andesitic pebbles with a fine grained arkosic matrix.

## Intrusives

Two large intrusives, the gray gneissic granodiorite and the pink porphyritic granodiorite, and the smaller Falcon Lake stock occur in the area studied. Other intrusives in the area are the feldspar porphyry dikes near the north shore of Falcon Lake and the pegmatite, aplite dikes present near the large intrusives. The table of formations (Page 6) shows the probable relative ages of these intrusives. There are some "quartz veins" present in the area which appear to be younger in age than the above mentioned intrusives.

## Feldspar Porphyry Dikes

The feldspar porphyry dikes (or sills) are thirty feet wide and are composed of large zoned phenocrysts of feldspar in a fine grained matrix of quartz, feldspar and biotite. These dikes are concordant with the lavas and might be easily mistaken for sediments in the field, because they have the same color and texture.

## Gray Gneissic Granodiorite

The gray gneissic granodiorite is present in the northeast and southeast parts of the area (Plate VI). The granodiorite is a medium grained rock composed of oligoclase, quartz, and biotite, zircons and apatite as accessory minerals. Schlieren are abundant near the contact of the granodiorite and the Archaean rocks (sediments and lavas) but decrease in number from the margin of the intrusive.

## Pink Porphyritic Granodiorite

The pink porphyritic granodiorite is the largest intrusive in the West Hawk Lake area and occurs south of Falcon Lake and west of Star Lake. This granodiorite is composed of large phenocrysts of orthoclase and microcline in a medium grained groundmass of oligoclase, quartz, microperthite, biotite and locally garnets.

## Falcon Lake Stock

The Falcon Lake stock is an irregular body four miles long and as much as six thousand feet wide. The stock is situated between Star Lake

and Falcon Lake (Plate VI). Dr. G.M. Brownell made a detailed study of this stock and divided it into three zones: the central core of quartz monzonite, the intermediate zone of granodiorite and the outer rim consisting of quartz diorite, diorite and gabbro. The central core and the intermediate zone are separated by a contact breccia consisting of granodiorite fragments in the quartz monzonite. The other contacts are predominantly gradational. Some mineralization consisting of pyrite with a little copper and gold occurs in the central core. Two exploratory shafts; the Goldbeam and the Sunbeam-Kirkland were sunk into the stock, but the gold mineralization was not rich enough for production.

## Dikes

The pegmatite and aplite dikes are found near the periphery of the two large granitic intrusives and intrude the sediments parallel to their schistosity. The pegmatites are typically coarse grained and are composed of orthoclase, quartz and a small amount of rare minerals such as spodumene, scheelite and molybdenite. The aplites are narrow and equigranular and contain no rare minerals.

## Veins

The "quartz veins" are irregular bodies of pure quartz which occur in the sedimentary schists, but do not necessarily strike along the schistosity. The pyrrhotite and pyrite occurrences appear to be associated with these veins.

## Structure of the Area

The Archaean belt of sediments and lavas in the West Hawk Lake area appears to be the north limb of an anticline whose axis was obliterated by the intrusion of the porphyritic granodiorite south of Falcon Lake. The volcanic belt north of Indian Bay of the Lake of the Woods in the Shoal Lake area may possibly be the southern limb of the anticline.

# CHAPTER III

## METHODS OF RESEARCH

### Field

The material for this study was gathered during a five day field trip in West Hawk Lake with the assistance of W.J. Koop. Representative samples of the sediments, greenstones and intrusives were taken in the four traverses across the Archaean belt of rocks and along the shores of Star Lake (Plate VII). Large outcrops of sediments were sampled at shorter intervals in order to obtain a better picture of the texture and composition of these rocks.

### Laboratory

The laboratory study consisted of the examination of thin sections, separation and identification of minerals by refractive index liquids and X-rays, and the preparation of two tables; one on Regional Metamorphism, the other on Thermal Metamorphism.

### Petrographic Study

Thin sections of the sediments, greenstones and intrusives were studied under the petrographic microscope to determine the composition of the rocks and the abundance of each mineral. The first examination of the thin section was of the reconnaissance type to determine the general texture and composition of the sediments, lavas and intrusives. The rocks were then examined in a detailed manner to identify all the minerals and

and estimate their abundance. The minerals were identified by their optical properties and the estimate of content was calculated visually on a basis of the grains of a mineral filling the whole eye-piece being 100% of the rock, $\frac{1}{2}$ eye-piece 50%, $\frac{1}{4}$ eye-piece 25%. Several estimates were taken across a thin section to determine the overall composition.

The grain size of the sediments was measured by using a micrometer eye-piece in the petrographic microscope. The average grain size was determined by taking twenty readings of the grains across each thin section. Two separate readings were taken for the graywackes; one on the fine grain matrix, the other on the feldspar fragments. A table showing the grain size of the rocks was drawn up.

## Mineral Determination

The minerals that could not be identified by their optical properties were separated from the main rock mass by crushing, sieving and separating in heavy liquids. The samples which contained the unknown minerals were crushed in a steel mortar and sieved. The (-100 +200) sieve sample was quartered with a spatula and one quarter was used for separation in Bromoform or Clerici solution. The heavy fraction containing the unknown mineral (e.g. epidote) was dried and identified by obtaining its index of refraction with standard index oils. The unknown minerals were confirmed by X-ray analyses. Hand picking of the heavy minerals had to be done in samples where the matrix of the rock was so fine grained that some of the light fraction came down with the heavy fraction in the heavy liquid separations. This hand picking was

done by means of a sharpened tooth pick or a needle.

## Preparation of Tables

Two tables; one on Regional Metamorphism, the other on Thermal Metamorphism were compiled to be used in conjunction with the study of the sediments of this area. The table on Thermal Metamorphism is divided into three grades: low, medium and high, whereas the Regional one is divided into five zones: chlorite, biotite, garnet, kyanite and sillimanite. A system of arrows was used to show the changes of all the possible minerals in the most common rock types with increasing metamorphism (see Plate VIII in pocket.

# CHAPTER IV

## PETROGRAPHIC DESCRIPTION OF THE ROCKS

The petrographic study of the Archaean rocks of this area was confined chiefly to the sediments, although some samples of the lavas and intrusives were examined. This study revealed that the sediments could be divided into five common types: graywackes, siltstones, arkoses, argillites and "other sediments". The "other sediments" represent those sediments which are near the "quartz-pyrrhotite dikes". The "quartz-pyrrhotite dikes" represent those areas which have pyrrhotite and sugary textured quartz occurring usually near the contacts of the sediments with the lavas. These sediments differ from the common sediments due to the introduced quartz, feldspar, and pyrrhotite, and have different metamorphic minerals (tremolite, cordierite). Such occurrences can be found at Merritt Road on Manitoba Highway No.1 and at the south end of Star Lake Island (Plate VII).

### The Sediments

The dark gray color, fine grained texture and large feldspar fragments are the striking features of the sediments. There are variations to these typical features such as the absence of large feldspar fragments in the siltstones, argillites and arkoses.

The three tables compiled below show the grain size of the sediments as taken across the strike north to south at three different locations. Table 1 represents a traverse across the sedimentary band

near shaft No.2 east of West Hawk Lake. Table II represents a traverse across the sediments along Manitoba Highway No.1 west of Sam's Corner. Table III represents a traverse across the sediments of Star Lake (see Plate VII).

Table I

| Sample No. | Rock Type | Grain Size in Millimeters |
|---|---|---|
| -87 | Arkose | .05 to .5 |
| -88 | " | .05 to .2 |
| -89 | " | .02 - .1 |
| -90 | " | .05 -..2 |
| -91 | " | .05 - .3 |
| -92 | " | .02 - .2 |

Table II

| Sample No. | Rock Type | Grain Size in Millimeters | |
|---|---|---|---|
| | | Matrix | Feldspar Fragments |
| - 78 b | Graywacke | .003 - .005 | .01 - .02 |
| - 78 c | " | .002 - .005 | .02 - .03 |
| - 78 d | " | .001 - .004 | .02 - .04 |
| - 79 | Siltstone | .01 - .02 | |
| - 80 | Graywacke | .02 - .05 | .1 - .4 |
| - 81 - (1) | Argillite | .001 - .002 | |
| - 81 - (2) | Graywacke | .01 - .02 | .05 - .08 |
| - 82 | " | .002 - .03 | .05 - .1 |
| - 83 | Siltstone | .01 - .03 | |
| Merritt Road Sample | Graywacke | .02 - .05 | .08 - .25 |
| - 84 | Siltstone | .001 - .002 | |
| - 86 | Graywacke | .05 - .1 | .15 - .3 |

Table III

| Sample No. | Rock Type | Grain Size in Millimeters | |
|---|---|---|---|
| | | Matrix | Feldspar Fragments |
| - 23 | Graywacke | .01 - .05 | .08 - .4 |
| - 25 A | Argillite | .001 - .003 | |
| - C | Siltstone | .003 - .006 | |
| - D | Graywacke | .003 - .005 | .05 - .1 |
| - E | Siltstone | .002 - .005 | |
| - F | " | .001 - .002 | |
| - G | " | .002 - .005 | |
| - 50 | Graywacke | .01 - .08 | .1 - .3 |
| - 48 | Siltstone | .01 - .05 | |
| - 47 | Graywacke | .01 - .06 | .1 - .2 |