UNIVERSITY OF MANITOBA

Thesis

THE GEOLOGY OF THE KENORA AIRPORT AREA

Submitted by

John Morris Hodgkinson

(B. Sc., London, 1957)

In Partial Fulfillment of the Requirement

for the Degree of

Master of Science

Winnipeg, Manitoba

1968

ABSTRACT

A geologic map of approximately 90 square miles of the Kenora Airport Area is presented, with a scale of one inch to one mile.

One area of greenstones and amphibolites, the Keewatin Metavolcanics, and two areas of granitic rocks, intrusives of the Dryberry Dome and the Melick Gneiss Group, are major rock type divisions.

A fault is proposed between the Melick Gneiss Group and the Keewatin Volcanics.

The petrography of these rocks is described, and the chemical composition of the Keewatin greenstones is discussed on a basis of nine rock analyses.

A study of the crystallographic structure of the potassium feldspars in the Dogtooth Leucoadamellite found little variation in obliquities (Δ= 0.85 to 1.00 $\pm$ 0.025). The area is not suitable for a statistical study of the relationship between obliquity and rock composition.

A geological history of the area is suggested, with one phase of regional metamorphism north and another south of the fault. It is not known if these two phases were contemporary.

TABLE OF CONTENTS

CHAPTER		PAGE
	ABSTRACT	ii
	TABLE OF CONTENTS	iii
	LIST OF TABLES	vi
	LIST OF FIGURES	vii
	LIST OF PLATES	viii
I.	INTRODUCTION	1
	Acknowledgements	1
	Location and Access	2
	Previous Work	2
II.	GENERAL GEOLOGY	6
	Introduction	6
	The Keewatin Volcanics	7
	Fine Grained Amphibolite	11
	Acid and Basic Schists	11
	Coarse Grained Amphibolite	12
	Granite Intrusives of the Dryberry Dome	14
	Western Extremity of the Dryberry Dome	14
	Longbow Granodiorite Gneiss	15
	Hilly Lake Biotite Granodiorite	16
	Quartz Diorite	17
	Dogtooth Granodiorite	17
	Dogtooth Leucoadamellite	18
	Porphyrytic Adamellite	18
	Other Intrusives of the Dryberry Dome	19
	The Fort Frances Road	19
	Dykes and Veins in the Dryberry Dome	19
	Melick Gneiss Group	19
	Melick Gneiss	20
	Melick Granodiorite	22
	Other Intrusive Rocks in the Melick Gneiss	22
	Dykes in the Melick Gneiss Group	23

TABLE OF CONTENTS CONTINUED

CHAPTER		PAGE
	Quaternary	23
	Pleistocene and Recent	23
	Structure	23
	Metamorphism	26
	Metamorphic Grade	26
	Metamorphic History	27
	Metasomatism	27
III.	CONCLUSIONS	28
	The Geologic History	28
	Recommendations for Future Work	30
	BIBLIOGRAPHY	32
APPENDIX		
A.	PETROGRAPHY	35
	Keewatin Volcanics	35
	Summary of the Mineralogy of the Keewatin Volcanics	37
	Granitic Intrusives of the Dryberry Dome.	41
	Longbow Granodiorite Gneiss	41
	Hilly Lake Biotite Granodiorite	42
	Quartz Diorite	44
	Dogtooth Granodiorite	44
	Dogtooth Leucoadamellite	45
	Porphyrytic Adamellite	47
	Pegmatite, Granite, and Aplite Dykes	48
	Melick Gneiss Group	49
	Melick Gneiss	49
	Leucocratic Gneiss	49
	Biotite Gneiss	50
	Amphibole Gneiss	50
	Melick Granodiorite	50
	Pegmatite, Granite, and Aplite Dykes	51

TABLE OF CONTENTS CONTINUED

APPENDIX		PAGE
B.	THE CHEMISTRY OF THE BASIC KEEWATIN VOLCANICS	52
	Carbonates in Keewatin Volcanics	53
C.	THE NATURE OF THE POTASSIUM FELDSPARS IN THE DOGTOOTH LEUCOADAMELLITE	58
	Introduction	58
	A Brief Statement of the Problem	58
	Experimental Methods	60
	Mineral Separation	60
	Determination of Obliquity	61
	Chemical Analysis	61
	Results	62
D.	PHOTOMICROGRAPHS OF ROCKS FROM THE KENORA AIRPORT AREA	69

LIST OF TABLES

TABLE		PAGE
1.	Table of formations.....	8
2.	Mineral descriptions of the nine Keewatin Volcanic rocks for which chemical analyses are available.....	36
3.	Composition of Plagioclase in the rocks of the Kenora Airport Area.....	39
4.	Modal percentage of Hornblende and Microcline in Longbow Granodiorite Gneiss.....	42
5.	Modal percentage of Porphyrytic Adamellite from location 6.....	48
6.	Chemical analyses of nine basic Keewatin Volcanics.....	54
7.	Niggli molecular equivalent normative minerals.....	55
8.	The Obliquities and partial chemical analyses for six samples of the Dogtooth Leuco-adamellite.....	63
9.	The Obliquities of eight samples of Potassium Feldspar.....	64
10.	Modal percentage for the Dogtooth Leucoadamel-lite.....	65

LIST OF FIGURES

FIGURE		PAGE
1.	Geology of the Kenora Airport Area.....	80
2.	Geology of the Kenora Airport Area-Location of Specimens.....	81
3.	Plot of chemical analyses by Larsen's method for six specimens of Keewatin Volcanics.	56
4.	CaO weight percentage against CO_2 weight percentage for nine basic Keewatin Volcanics(see Table 6, p.54).....	57
5.	Map of Longbow Leucoadamellite: shows Potassium Feldspar locations and Obliquities (to nearest $\pm$0.025). Scale 4 inches to 1 mile.....	66
6.	Obliquity of Dogtooth Leucoadamellite compared with K_2O, Na_2O and CaO composition of whole rock.....	67
7.	Mode percentage of Potassium Feldspar and Plagioclase and Obliquity of Potassium Feldspar vs. mode percentage of Quartz..	68

LIST OF PLATES

PLATE		PAGE
1a.	Fine Grained Amphibolite, Keewatin Volcanics. Contains essential hornblende, plagioclase, and epidote. (Specimen Number 14, ordinary light). Also see Table 2).....	70
1b.	Fine Grained Amphibolite, Keewatin Volcanics. Laths of plagioclase with hornblende. (Specimen Number 15, cross-nicols).....	70
2a.	Fine Grained Amphibolite, Keewatin Volcanics. Hornblende more prismatic than above. (Specimen Number 17a, ordinary light). Also see Table 2).....	71
2b.	Fine Grained Amphibilite, Keewatin Volcanics. Monomineralic zoning of epidote, carbonate, and garnet, filling cavity between pillows in pillow lava. (Specimen Number 6b, ordinary light).....	71
3a.	Basic Schist, Keewatin Volcanics. Very fine grained, banded biotite schist, with biotite, plagioclase, magnetite, and carbonate.(Specimen Number 16, ordinary light). Also see Table 2).....	72
3b.	Sedimentary, Keewatin Volcanics. Fine grained, banded biotite schist with porphyroblasts of plagioclase. (Specimen Number 8, ordinary light).....	72
4a.	Coarse Grained Amphibolite, Keewatin Group. With more intense colour around crystal margins; laths of amphibole are also present in the plagioclase matrix. (Specimen Number 11, ordinary light).....	73
4b.	Coarse Grained Amphibolite, Keewatin Volcanics. With very pale fibrous amphibolite, probably tremolite; associated with a matrix of serpentine. (Specimen Number 12, ordinary light).....	73

LIST OF PLATES CONTINUED

PLATE		PAGE
5a.	Porphyrytic Adamellite. Quartz clear, plagioclase cloudy microcline cross-hatched interstitial. (Specimen Number 6a, ordinary light).....	74
5b.	Same as 5a under cross-nicols.....	74
6a.	Dogtooth Leucoadamellite. Quartz, plagioclase and microcline. (Specimen Number 9, cross-nicols).....	75
6b.	Plagioclase crystal from Dogtooth Leucoadamellite, shows white mica with preferred orientation, with epidote.(Specimen Number 10, cross-nicols).....	75
7a.	Longbow Foliated Granodiorite. Saussuritized plagioclase, clear quartz biotite flakes. (Specimen Number 7, ordinary light).....	76
7b.	Hornblende Gneiss, Melick Gneiss. Contains plagioclase hornblende and epidote. (Specimen Number 1, ordinary light).....	76
8a.	Melick Gneiss. Biotite Gneiss with plagioclase augen.(Specimen Number 5, ordinary light).....	77
8b.	Same as 8a under cross-nicols.....	77
9a.	Melick Gneiss, Leucocratic Gneiss. Typical texture of Melick Gneiss. (Specimen Number 3, cross-nicols).....	78
9b.	Melick Gneiss, Leucocratic Gneiss, With euhedral porphyroblasts of feldspar in fine grained quartz-feldspathic mosaic.(Specimen Number 4, cross-nicols).....	78
10.	Contact between Leucocratic Gneiss and Biotite Gneiss, Melick Gneiss. (Specimen Number 2, cross-nicols).....	79

CHAPTER I

INTRODUCTION TO THE KENORA AIRPORT AREA

The mapping and study of the petrology of the rocks in the area north and east of Kenora, Ontario, was undertaken in 1960 and 1961, to correlate with a gravity survey which was made by Colin Riley, of the Department of Geology, University of Manitoba.

Colin Riley's work, which is now completed (Riley,1965), was concerned with the area of the contact between the Keewatin Volcanics and the "Laurentian Granites". The most up-to-date map of this area prior to the completion of the one presented with this thesis was that of A. C. Lawson (1885) with minor alterations by A. L. Parsons (1913). Davies and Pryslak (1967) have published a map which includes this area, since the thesis mapping was completed. The chief purpose of this thesis is to provide an improved map of the area to aid the geophysical interpretation.

ACKNOWLEDGEMENTS

My gratitude is due to Dr. A. Turnock for both his help and encouragement.

Mr. Ken Ramlal, Department Analyst, provided the chemical analyses of nine samples of Keewatin Volcanics, also the Na_2O, K_2O and CaO composition of six granitic rock specimens which were necessary for the study of the structure of potassium feldspars of the Dogtooth Leucoadamellite.

Dr. J. C. Davies, Resident Geologist at Kenora, also provided generous help, and Prof. R. B. Ferguson advised with the X-ray Crystallographic work.

LOCATION AND ACCESS

The area comprises about ninety square miles north and east of Kenora, Ontario, close to the north shore of the Lake of the Woods.

The paved highways in the area are: the Trans-Canada Highway, the Fort Frances Road, and the Redditt Road. In addition to the paved roads there are several gravelled and dirt roads, and the well graded Jones' road, which is a private road. The Trans-Canada Highway has been in places re-routed subsequent to the field work.

In most parts of the area the roads were sufficiently close together to provide adequate traverses for the scale of mapping needed.

PREVIOUS WORK

Robert Bell (1883) published a reconnaisance map and a brief report of the Lake of the Woods area. A. C. Lawson spent two summers and part of a third working in the Lake of the Woods area from 1883 to 1885, and he published a detailed report and map in 1885. Both Bell and Lawson had to survey topography, as well as geology, as no base maps were available. Lawson's topographic map was more accurate than Bell's.

Lawson gave the name Keewatin to the greenstones (altered volcanic and sedimentary rocks) in the Lake of the Woods region. He introduced this new term because he thought they were older than the typical "Huronian" as described in Geology of Canada, written by Sir William Logan in 1863 (Lawson, 1885, p.10). This term has since been applied to the oldest metavolcanic rock in the regions throughout the Superior Province of the Canadian Shield. It has thus become a semi-lithological term rather than a stratigraphic term. If the term has any validity as a stratigraphic term, it is in the Lake of the Woods region, which is the type locality, although a type section has never been described. In 1905 a report from a Special International Geological Committee confirmed Lawson's main findings (Van Hise (1905)).

A. L. Parsons made additions to Lawson's map of the Lake of the Woods area following field work in the summer of 1912. (Parsons, 1913).

The map presented with this thesis (Figure 1, p.80) is the first new geological map of the Kenora Airport Area to be published since 1913.

From 1913 until 1931, the additions to the literature of the area were brief descriptions of mining properties: Hopkins (1921) and Bruce (1925).

In 1931 G. G. Suffel described the geology of the Bigstone Bay Area, which is south of the area described in this thesis. Suffel divided the Precambrian rocks into three systems: Keewatin, Laurentian, and Keweenawan. Suffel (p.68) described east-west folds in the greenstone at Bigstone Bay which are consistent with more extensive emplacement of the Laurentian granites along the anticlines than along the synclines.

J. E. Thomson (1937) described the geology of the north central part of the Lake of the Woods, an area south-west of the thesis area. It is west of, and adjoins the Bigstone Bay Area, mapped by Suffel. This area is important to the present study because the Keewatin rocks described therein appear to be along the strike from the Keewatin of the map area.

Thomson divided the Precambrian of the area into four systems: Keewatin, Timiskaming, Algoman, and Keweenawan. The Keewatin is by far the most widespread. The Timiskaming is restricted to a small outcrop area seven miles long in the centre of his map area, which is about eight miles from the thesis area. The Algoman rocks occur "(1) as the border phases of the large granite batholiths lying north and south of the greenstone belt on the Lake of the Woods, and (2) as small intrusive stocks within the boundaries of the older lava-sedimentary complex". (Thomson, 1956, pp.18-19).

Thomson notes considerable variation in the texture, composition, and colour of these Algoman rocks, but no evidence was found of more than one period of plutonic invasion. Much more recently, J. C. Davies (1965) has described the geology of the Ewart and Forgie Townships, which are thirty miles west of Kenora. He reports acid plutonic rocks of two distinct periods of emplacement.

Thomson (1937, pp.20-21) describes a quartz diabase which forms northwest-southeast trending dykes up to 300 feet wide. These dykes are "...presumably part of the Keweenawan basic intrusives so commonly found in the Lake Superior region." (Thomson, 1937, p.20).

Goodwin (1965) has compiled a map of the Lake of the Woods area, and has divided the Keewatin into two complete volcanic sequences. His map did not extend north of the Trans-Canada Highway, into the thesis area, but the compilation of Davies (O.D.M. Map 2115, 1967) does.

CHAPTER II

GENERAL GEOLOGY

INTRODUCTION

Figure 1 (p.80) is a geological map of the Kenora Airport Area, on a scale of one inch to one mile. The base map were compiled from air photographs. The geologic data was obtained by: traverses along the roads; shoreline mapping; and traverses through the bush at key locations. Most of the fieldwork was done in the autumn of 1960. Figure 2 (p.81) shows all sample locations by numbers on the map. Where two or more samples are taken from one outcrop they are identified by a small-case letter.

The area is roughly rectangular, six miles by eighteen, and its long dimension trends north-west. Precambrian and Pleistocene rocks are exposed. About 18 square miles (15%) of the bedrock area is occupied by greenstone, the remainder (85%) by granite rocks. The unconsolidated Pleistocene and Recent rocks have not been mapped. They are noted, only where their thickness precludes the study of the Precambrian.

The Keewatin Volcanics strike north 40° east across the map area, thereby separating the granitic rocks into two distinct areas.

Northwest of the Keewatin Volcanics, in and around Melick Township, the granites are further divided into two

types. Adjacent to the volcanics the rocks are strongly banded. Farther north there is no banding.

Southeast of the Keewatin Volcanics six intrusive plutonic rock types are distinguished in the "Dryberry Dome" granitic complex. Four are gneissic and two are massive. All have acid composition. Pegmatitie, granite, and aplite dykes and quartz veins cut all the earlier rocks.

No Keweenawan dykes were encountered, although quartz diorite dykes have been mapped in the adjoining areas to the south (Suffel, 1931, p.67) and to the south-west (Thomson, 1937, pp.20-21) of the Kenora Airport Area. Davies and Pryslak (1967) have since reported diabase in the western part of Dogtooth Lake.

A list of the formations in the Kenora Airport Area is given in Table 1. Petrographic descriptions of the rock types are contained in Appendix A.

THE KEEWATIN VOLCANICS

The Keewatin Volcanics occupy the central part of the Kenora Airport Area, between the Melick Gneiss, to the northwest and the plutonic intrusives of the Dryberry Dome, to the east. These Keewatin Volcanics are part of a "belt of schistose rocks" which A. C. Lawson (1885, p.10) named the Keewatin rocks, after the town of Keewatin which is 3 miles west of Kenora. Lawson rejected the name "Huronian" which had previously been used by Bell (1873, p.102) for this belt of schistose rock because he did not consider

TABLE I

TABLE OF FORMATIONS

CENOZOIC	
Pleistocene and Recent	Sand, Gravel and Boulder Clay
PRE-CAMBRIAN	
Melick Gneiss Group	Minor Intrusions:Pegmatite, granite, and aplite
	Melick Granodiorite
	Melick Gneiss
Granite Intrusives of the Dryberry Dome	Porphyrytic Adamellite
	Dogtooth Leucoadamellite
	Dogtooth Granodiorite
	Hilly Lake Biotite Granodiorite
	Longbow Granodiorite Gneiss
Keewatin Volcanics	Amphibolite-Medium Grained
	Acid Schist and Basic Schist
	Amphibolites-Fine Grained including pillow structures, Agglomerates, and sediment.

them equivalent to the "typical Huronian of Sir William Logan, as described in the Geology of Canada (1863)" (Lawson, 1885, p.10). Since Lawson used the term Keewatin, it has been applied to the oldest basic volcanic rocks exposed in localities throughout the Superior Province of the Canadian Shield. This has led to a loss of precision that the term might have had when applied solely to the rocks in the type locality. Horwood, in the Geology and Mineral Deposits of the Red Lake Area (1945, p.17), says "No attempt has been made to prove the ages of the various formations and the names Keewatin, Timiskaming, and Algomian have been used simply to show that these formations are similar to formations that bear the same name in other sections of the Pre-cambrian Shield." MacDonald describes the Geology of Gorham Township and Vicinity in which the volcanics "...are classed as Keewatin because of their lithological similarity to the type Keewatin Rocks." (1941,p.4).

J. M. Harrison (1957, p.29) states that, presumably, the term "Keewatin" now means the oldest volcanic rocks of any area in the Pre-cambrian of Ontario and Quebec. In the Burchell Lake Area, which is 65 miles east of Port Arthur, Ontario, P. E. Giblin (1964, p.6) has used "Metavolcanics" to refer to rocks which had been termed "Keewatin" by T. L. Tanton (1938). He thereby has refused to perpetuate use of the term "Keewatin" as a lithological term.

Thomson (1937) has separated part of the sedimentary rocks from the Keewatin and named them Timiskaming. Goodwin (1965) has subdivided the Keewatin into Upper and Lower parts, each of which is represented by the sequence: basic volcanics, acid volcanics, and sediments. However, until definitive mapping can provide evidence on which the subdivision of the Keewatin rocks can be made, consistent with the rules of the Code of Stratigraphic Nomenclature (American Commission on Stratigraphic Nomenclature, 1961) the term "Keewatin" should be used, as it was by Thomson, for the rocks of the schist belt of the Lake of the Woods Area, which includes both meta-volcanic and meta-sedimentary rocks.

The volcanic rocks in the Kenora Airport Area are part of what A. C. Lawson mapped as Keewatin rocks. They are herein named the Keewatin Volcanics.

The largest part of the outcrop area of the Keewatin Volcanics is occupied by basic volcanics. Within the area of the basic volcanics a roughly triangular area of acid and basic schists occurs. A zone of coarsely crystalline amphibolite cuts the other two parts of the Keewatin Volcanics. The rock types within the three zones of the Keewatin Volcanics are: (a) fine grained amphibolite, which is, in part, pillow lava and agglomerate, and sedimentary rocks; (b) basic schist, sericite schist, and "porphyrytic" sericite schist; and (c) coarse grained amphibolite. The petro-