THE UNIVERSITY OF MANITOBA

RUBIDIUM-STRONTIUM AGE DETERMINATIONS FROM THE FILE-MORTON-WOOSEY LAKES AREA OF THE FLIN FLON VOLCANIC BELT, WEST CENTRAL MANITOBA

BY

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ABSTRACT

Rubidium-strontium whole rock isochron ages have been determined on rock units from the File-Morton-Woosey Lakes area of the Flin Flon volcanic belt. A minimum age of emplacement is given by the radiometric age of 1860 ± 112 m.y. and an $^{87}Sr/^{86}Sr$ initial ratio of 0.7019 ± 0.0005 for the Ham pluton, a syn- to late kinematic 'granitic' intrusion (^{87}Rb decay constant of $1.39 \times 10^{-11} yr^{-1}$). This age also provides a minimum age for the Amisk Group volcanic strata, the Missi Group sedimentary strata, and all other rocks, such as the Morton porphyry, and early deformation that predate the Ham pluton in the study area. The approximate age of 1737 ± 257 m.y. and an initial ratio of 0.7020 ± 0.0002 obtained for the Elmes Island Formation dacite flows, (an Amisk Group felsic volcanic), and the radiometric age of 1715 ± 83 m.y. and an initial ratio of 0.7027 ± 0.0001 for the Morton porphyry, (a pre- to early kinematic hypabyssal intrusion), are considered to be metamorphic ages and not emplacement ages, and that these units were updated during regional metamorphism.

The age of the regional metamorphism that affected the study area is given by the radiometric age of 1760 ± 43 m.y. obtained for the File gneiss dome, a granitoid paragneiss complex from the Kisseynew sedimentary gneiss belt.

The $^{87}Sr/^{86}Sr$ initial ratio for this unit is 0.7038 ± 0.0008.

The late pegmatite dykes are post-kinematic intrusions that postdate all other rocks in the study area. The calculated mineral ages of 1741 ± 55 m.y. and 1763 ± 55 m.y. (assumed initial ratio of 0.710), give the best approximation of the age of the youngest intrusive event in the study area.

The late Aphebian age of emplacement for the Ham pluton is consistent with the interpretation of Mukherjee (1971) and Sangster (1972) that the Flin Flon volcanic belt is late Aphebian. The area was subjected to regional metamorphism approximately 1760 m.y. ago, a late Aphebian event that may be representative of the Hudsonian orogeny.

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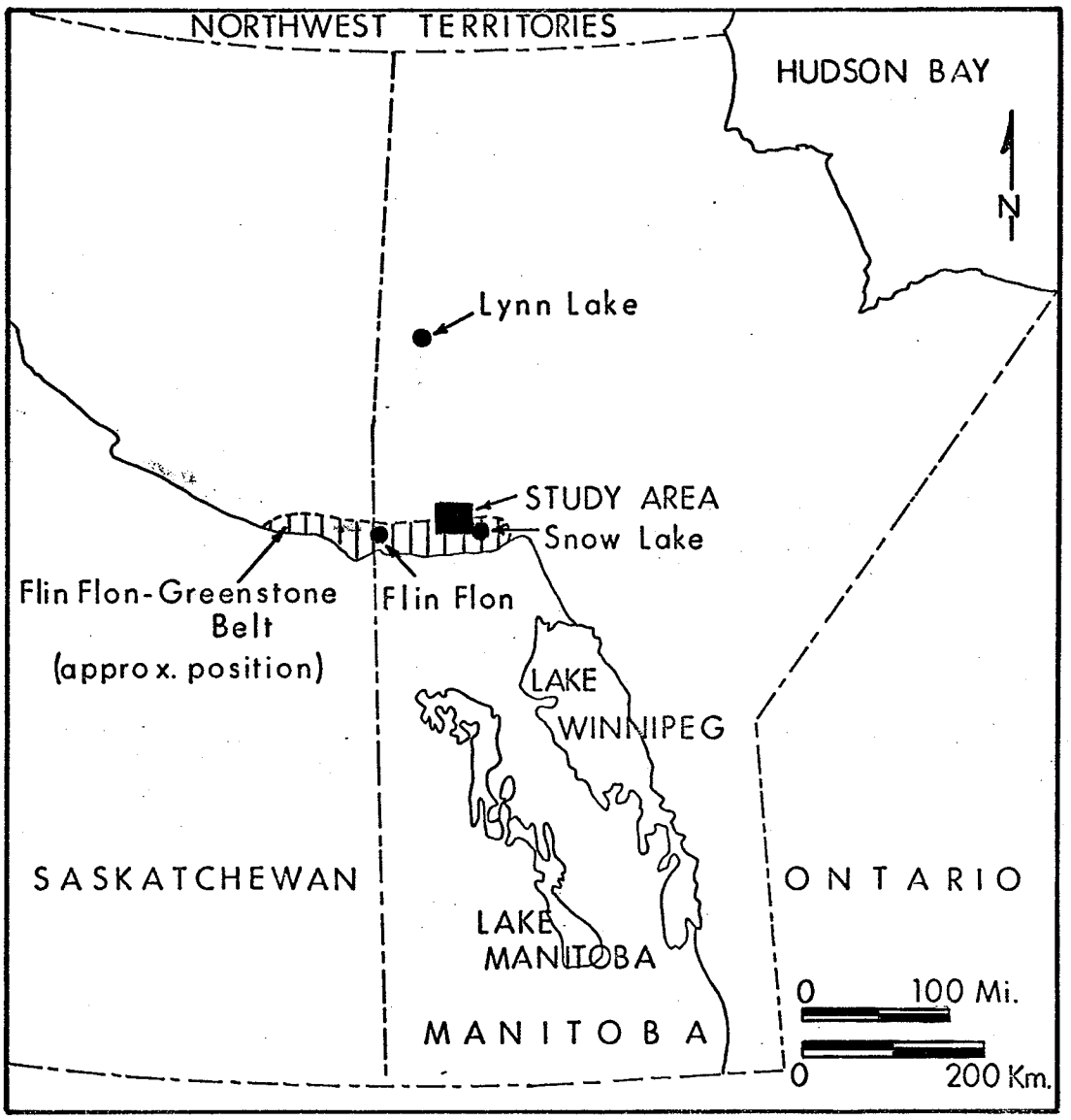
CHAPTER 1. INTRODUCTION

1.1. General Statement

The File-Morton-Woosey Lakes area is located within the southeastern portion of the Churchill geological province of the Canadian Shield in west central Manitoba. The area includes portions of two major easterly trending lithological belts: the Flin Flon volcanic belt to the south, and the Kisseynew metasedimentary gneiss belt to the north (Bailes, 1971b). The study area is located 20 kilometers (12 miles) west of the town of Snow Lake, and is bounded by latitudes $54^{o}45'$ and $55^{o}00'$ north, and longitudes $100^{o}10'$ and $100^{o}30'$ west (see Figure 1).

Traditionally, the Flin Flon volcanic belt (also called the Flin Flon-Snow Lake greenstone belt) has been considered Archean in age (e.g. Stockwell, 1963, 1964; McGlynn, 1970; Bailes, 1971b; Tectonic Map of Canada, G.S.C. Map 1251A). K-Ar age determinations of micas from rocks of this belt by the Geological Survey of Canada gave Hudsonian ages (e.g. Lowdon, 1961; Lowdon *et al.*, 1963; Wanless *et al.*, 1965, 1967). These ages generally have been attributed to updating of Archean rocks by the Hudsonian orogeny (e.g. Stockwell, 1963, 1964). Archean Rb-Sr whole rock isochron ages obtained by Coleman (1970)

Figure 1. Location map of the File-Morton-Woosey Lakes study area.


NORTHWEST TERRITORIES
HUDSON BAY
N
Lynn Lake
STUDY AREA
Snow Lake
Flin Flon-Greenstone Belt (approx. position)
Flin Flon
LAKE WINNIPEG
SASKATCHEWAN
ONTARIO
LAKE MANITOBA
MANITOBA
0 100 Mi.
0 200 Km.

on volcanic and plutonic rocks at Hanson Lake, an area that may be the western extension of the Flin Flon volcanic belt, appear to support this Archean premise. However, more recently, Aphebian Rb-Sr whole rock isochron ages have been obtained by Mukherjee et al. (1971) on volcanic and plutonic rocks near Flin Flon, and Aphebian common lead isotope ages have been obtained by Sangster (1972) on galena from sulfide deposits that are considered by him to be coeval with volcanism and to consist of single stage leads. Both authors have interpreted these Aphebian dates as the age of the Flin Flon volcanic belt. However, Slawson and Russell (1973) have questioned the validity of Sangster's lead ages, suggesting that they are multistaged leads and that the secondary U/Pb system formed at least 2450 m.y. (million years) ago.

1.2. Object of Study

The object of this study was to test the validity of Mukherjee's and Sangster's conclusion that the Flin Flon volcanic belt is Aphebian in age by preparing rubidium-strontium whole rock isochron ages on rock samples from the eastern portion of the belt. A paragneiss unit from the Kisseynew sedimentary gneiss belt, located in the north of the study area, was dated to obtain the age of regional metamorphism. K-feldspar mineral concentrates from late pegmatite dykes, that postdate the regional metamorphic event, were dated to obtain the youngest intrusive

event(s) in the study area. $^{87}Sr/^{86}Sr$ initial ratios obtained for igneous rocks have been interpreted to indicate the petrogenesis of the igneous rocks, and by inference, the petrogenesis of the rest of the Flin Flon volcanic belt.

CHAPTER 2. GEOLOGY OF THE FILE-MORTON-WOOSEY LAKES AREA

2.1. Regional Setting

The Precambrian rocks of the File-Morton-Woosey Lakes area comprise rocks of two broad easterly trending belts of differing lithology, degree of deformation and grade of metamorphism: the Flin Flon volcanic belt to the south and the Kisseynew metasedimentary belt to the north (Bailes, 1971b). The geology of the File-Morton-Woosey Lakes area is shown in Figure 2, and the corresponding Table of Formations is given in Table 1.

The following discussion of the regional geology of the Flin Flon volcanic belt and Kisseynew metasedimentary gneiss belt is based on a regional compilation prepared by Bailes (1971b). Other reports of related interest are: Davies *et al.* (1962), Harrison (1949, 1951), McGlynn (1959, 1970), Robertson (1953), Williams (1966), Russell (1957), Kalliokoski (1952, 1953), Kornik (1968), Hunt (1970), Roussell (1970), Mukherjee (1971), Byers *et al.* (1954, 1965), and Moore and Froese (1971, 1972).

2.1.1. Flin Flon Volcanic Belt

The Flin Flon volcanic belt comprises Amisk Group volcanic and sedimentary rocks, Missi Group sedimentary rocks, and intrusive rocks that outcrop over a distance of

240 km (150 miles), extending from 32 km (20 miles) east of Snow Lake to 48 km (30 miles) west of Flin Flon. The average exposed width of the Flin Flon volcanic belt is 48 km (30 miles). The volcanic belt is bounded to the north by the Kisseynew sedimentary gneiss belt and is overlain to the south by flat-lying Paleozoic sedimentary rocks.

In the study area, Bailes (in preparation) has subdivided the Amisk Group into Lower Amisk and Upper Amisk Subgroups, consisting of volcanic and sedimentary strata, respectively (see Table 1).

2.1.2. Kisseynew Metasedimentary Gneiss Belt

The Kisseynew sedimentary gneiss belt consists of two major metasedimentary sequences: a lower meta-greywacke unit and an upper unit of meta-arkose. Robertson (1953) termed these units the Nokomis Group and the Sherridon Group, respectively. In the study area, Bailes (in preparation) has termed these units the Upper Amisk Subgroup and the Missi Group, respectively, due to the probable equivalence of these strata to those of the Flin Flon volcanic belt. The dimensions of the Kisseynew gneiss belt are approximately 200 km (120 miles) in width and 500 km (300 miles) in length.

2.1.3. Metamorphism

The major metamorphic and tectonic event(s) postdate deposition of all volcanic and sedimentary strata. The

Figure 2. Generalized geological map of the File-Morton-Woosey Lakes area, with sample stations (after Bailes, 1971a).

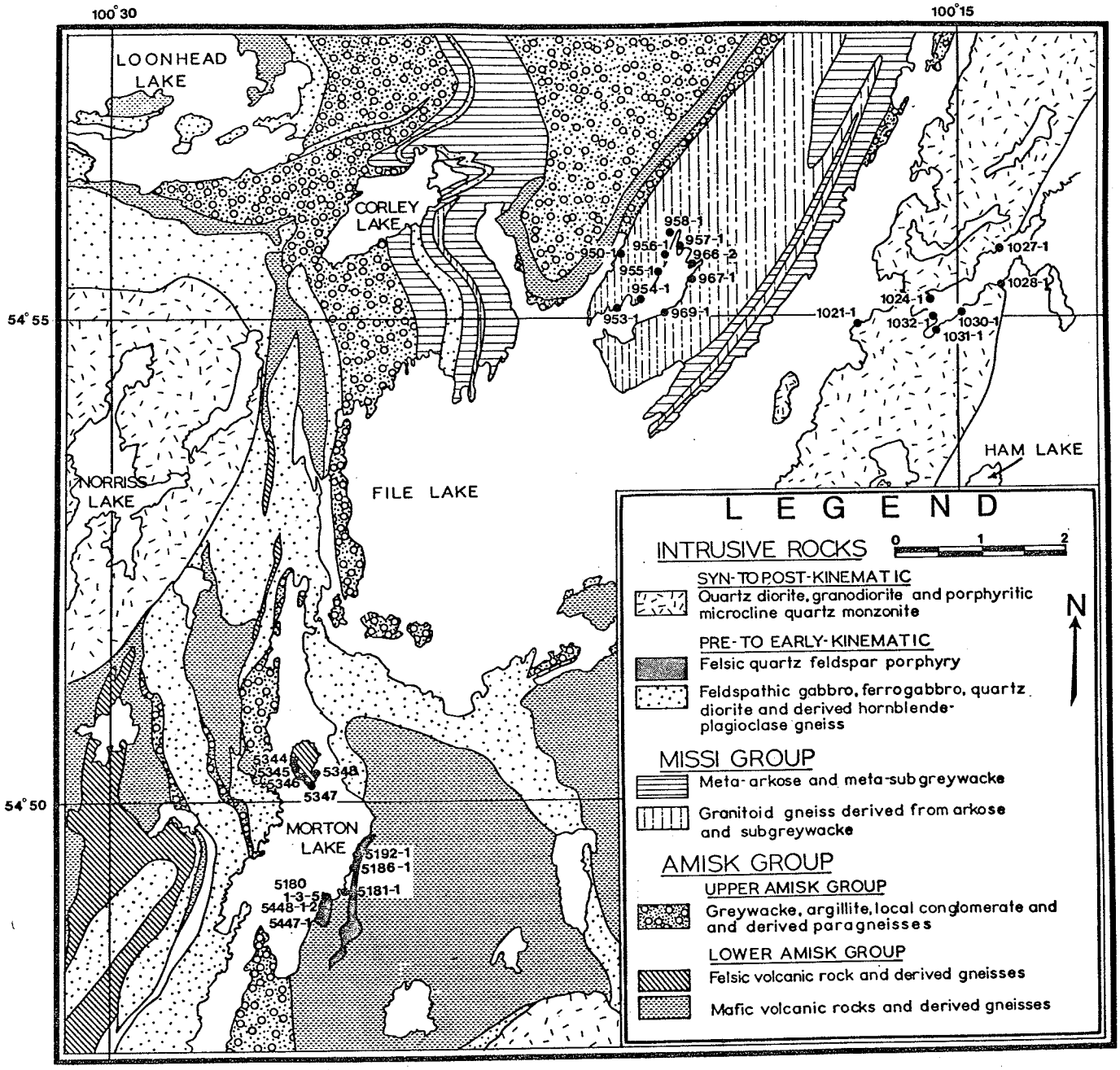

100°30
100°15
54°55
54°50
LOONHEAD LAKE
CORLEY LAKE
NORRISS LAKE
FILE LAKE
HAM LAKE
MORTON LAKE
958-1
957-1
956-1
966-2
950-1
955-1
967-1
954-1
953-1
969-1
1021-1
1027-1
1028-1
1024-1
1032-1
1030-1
1031-1
5344
5345
5346
5348
5347
5192-1
5186-1
5180
1-3-5
5181-1
5448-1-2
5447-1
LEGEND
INTRUSIVE ROCKS
0 1 2
SYN-TO POST-KINEMATIC
Quartz diorite, granodiorite and porphyritic microcline quartz monzonite
PRE-TO EARLY-KINEMATIC
Felsic quartz feldspar porphyry
Feldspathic gabbro, ferrogabbro, quartz diorite and derived hornblende-plagioclase gneiss
MISSI GROUP
Meta-arkose and meta-subgreywacke
Granitoid gneiss derived from arkose and subgreywacke
AMISK GROUP
UPPER AMISK GROUP
Greywacke, argillite, local conglomerate and and derived paragneisses
LOWER AMISK GROUP
Felsic volcanic rock and derived gneisses
Mafic volcanic rocks and derived gneisses
N

TABLE 1. TABLE OF FORMATIONS [after Bailes (in preparation)]

Pleistocene & Recent				
	Great Unconformity			
PROTEROZOIC APHEBIAN	Intrusive Rocks	Post kinematic	‡Pegmatite Dykes	
		Intrusive Contact		
		Syn- to late kinematic	Porphyritic microcline granite ●Granodiorite, tonalite, quartz diorite	Meta-Complexes: Anatectic Complex: Pegmatitic granodiorite and granite File Gneiss Dome Complex: ■Granitoid gneiss derived from the Missi Group
		Intrusive Contact		
		Pre-to early kinematic	+Felsic quartz feldspar porphyry Josland Formation: Differentiated gabbro sills	
		Intrusive Contact		
	Missi Group		Meta-arkose	
		?Disconformity?		
	Amisk Group	Upper Amisk Sub-Group	▲File Lake Formations: Interbedded greywacke and shale and derived paragneisses. Yakimiw Formation: Interbedded greywacke and shale.	
		Lower Amisk Subgroup	Elmes Island Formation: Dacite Flows. Storozuk Formation: Basalt and andesite flows.) "2nd" volcanic cycle Dickstone Formation: Rhyolite and dacite flows and tuff Preaston Formation: Basalt and andesite flows) "1st" volcanic cycle Undifferentiated basalt and andesite flows	

Units dated: ▲Elmes Island Formation of dacite flows. +Morton porphyry. ●Ham pluton. ■File gneiss dome. ‡Late pegmatite dykes.

intensity of deformation and grade of metamorphism is highest in the Kisseynew sedimentary gneiss belt and decreases into the volcanic belt. Middle to upper almandine-amphibolite facies assemblages and widespread migmatization and granitization, dominate the Kisseynew belt. It is highly deformed.

The Flin Flon volcanic belt is less deformed and metamorphosed than the Kisseynew belt. It is composed of rocks metamorphosed under greenschist to lower almandine-amphibolite facies conditions. The metamorphic grade increases northward towards the boundary contact zone with the Kisseynew belt. Much of the deformation in the volcanic belt was caused by emplacement of large granitic plutons. The plutons have thermal aureoles in which hornblende hornfels assemblages have been developed.

2.1.4. Stratigraphic Correlation

The Amisk and Missi sedimentary rocks have been correlated with rocks of the Kisseynew sedimentary gneiss belt by Bailes (1971b, p.13-14) north of Wekusko Lake, Manitoba, and by Byers and Dahlstrom (1954, p.50) north of Amisk Lake, Saskatchewan. In the study area, Bailes (in preparation) has shown that rocks of both belts are part of the same stratigraphic succession. The Nokomis Group is considered equivalent to the "flyschoid" greywacke-shale sequences of the Upper Amisk Subgroup, and the Sherridon Group to the arkosic rocks of the Missi Group.

2.2. Geology of the Study Area

The File-Morton-Woosey Lakes area straddles the boundary zone of the Flin Flon volcanic belt and the Kisseynew sedimentary gneiss belt. This boundary is considered to follow the south shore-line of File Lake in the study area (Figure 2). Geological mapping by Bailes (in preparation) has shown that rock units of both belts are part of the same stratigraphic succession. In the accompanying table of formations (Table 1), rocks belonging to the Nokomis and Sherridon Groups of the Kisseynew belt have been included by him with the Upper Amisk Subgroup and Missi Group of the Flin Flon belt, respectively. The rocks of the study area have been subdivided into three main groups (from oldest to youngest): the Amisk Group, the Missi Group, and the Intrusive Rocks.

The following description of the geology for the study area is based on information provided by Bailes from a geological report in preparation by him for the Manitoba Mines Branch.

2.2.1. The Amisk Group

The oldest rocks of the study area are the Amisk Group, which consist of volcanic strata (Lower Amisk Subgroup) and overlying sedimentary strata (Upper Amisk Subgroup). There are believed to be at least two mafic to felsic volcanic cycles in the Lower Amisk Subgroup. The volcanic

rocks comprise primarily subaqueous flows of calc-alkaline composition. Mafic volcanism consists largely of flows, whereas felsic volcanism is a mixture of flows and pyroclastic material.

Sedimentary rocks of the Upper Amisk Subgroup comprise immature deposits of interbedded greywacke and shale. The deposits consist of the Yakimiw and File Lake formations, which are composed primarily of volcanic detritus and likely were derived by erosion of loose debris from contemporaneous volcanic deposits. The formations were deposited rapidly in deep water by turbidity currents. The rocks north of File Lake have been regionally metamorphosed to garnet-staurolite-sillimanite bearing paragneisses (i.e., lower to middle almandine-amphibolite facies). The rocks south of File Lake have been regionally metamorphosed to greenschist facies mineral assemblages.

2.2.2. The Missi Group

The Upper Amisk metasedimentary rocks are overlain conformably by a meta-arkose sequence known as the Missi Group. The rocks are commonly crossbedded and are likely shallow-water deposits. They consist of arkose and subgreywacke deposits that have been metamorphosed to middle and upper almandine-amphibolite facies. North of File Lake, portions have been intensely recrystallized and homogenized to produce granitoid rocks, including the rocks of the File gneiss dome. The rocks of this domal complex are believed