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RUBIDIUM-STRONTIUM GEOCHRONOLOGY IN THE LYNN LAKE GREENSTONE BELT, NORTHWESTERN MANITOBA

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INTRODUCTION

The Lynn Lake Greenstone Belt occurs in northwestern Manitoba, extending approximately from the Saskatchewan border, east for about 150 km to the south end of Southern Indian Lake. The area included in the present study is shown in Figure 1. The belt occurs about 200 km north of the Flin Flon-Snow Lake Greenstone Belt, with an intervening region of predominantly high grade paragneisses currently referred to as the Kisseynew Sedimentary Gneiss Belt (McRitchie, 1974).

The oldest rocks in the Lynn Lake belt, the Wasekwan Group, are basic to acidic volcanic rocks, with sedimentary rocks subordinate. These rocks are overlain by the Sickle Group made up predominantly of metamorphosed basal conglomerate, arkose, greywacke and shale. Intrusive rocks in the area are predominantly granodioritic to tonalitic in composition, with some units being clearly pre-Sickle in age whereas others are intrusive into the Sickle Group (Milligan, 1960).

Because the lithologies and stratigraphy of the Wasekwan and Sickle Groups resemble those of the Amisk and Missi Groups, respectively, of the Flin Flon-Snow Lake Greenstone Belt, the rocks of the two volcanic belts have long been considered equivalent in age (McGlynn, 1970), although direct correlation is not possible due to their wide separation by the Kisseynew Sedimentary Gneiss Belt. Campbell et al. (1970) have also emphasized the similarities in the geology and mineral deposits in the two greenstone belts.

Although minerals separated from granitic intrusions and gneisses from the two greenstone belts yield late Aphebian K-Ar ages, the Wasekwan-Sickle and Amisk-Missi strata were considered, on the basis of lithological similarities, to be of possible Archean age and the 1700-1800 Ma ages a result of updating by the Hudsonian orogeny (McGlynn, 1970).

Subsequent ages by the Rb-Sr whole-rock method (Mukherjee et al., 1971; Josse et al., 1974; and Bell et al., 1975) and model lead ages from volcanogenic ore sulphides (Sangster, 1972; Stauffer, 1974) from the Flin Flon-Snow Lake Greenstone Belt, are all consistent with a late Aphebian (Hudsonian) age for the volcanic and associated granitic rocks in the belt. Moore (1977) has summarized the Rb-Sr isochron ages from the Flin Flon-Snow Lake belt and emphasizes the strong evidence in favour of a late Aphebian age for the region.

More recently, Sangster (1978) has compiled Rb-Sr whole-rock ages from the Flin Flon-Snow Lake belt and the Kisseynew Sedimentary Gneiss Belt and compared these to model lead ages from volcanogenic massive sulphide deposits situated north, west and south of the Kisseynew belt. Sangster also presents new model lead ages from the Fox Lake and Ruttan deposits in the Lynn Lake Greenstone Belt, from deposits to the west, in Saskatchewan, and the Sherridon deposit in the Kisseynew belt, in Manitoba. The isotopic evidence supports an Aphebian age for the sulphides, and the host volcanic rocks in this "circum-Kisseynew volcanic belt" (Sangster, 1978).

Before the present study began, only a small number of K-Ar mineral ages (including one biotite Rb-Sr age) were reported from the Lynn Lake Greenstone Belt (Lowden et al., 1963; Moore et al., 1960; and Turek, 1967). The dates range from about 1600 to 1750 Ma. More recent model lead ages (Sangster, 1978) from the Fox and Ruttan deposits are 1830 and 1770 Ma respectively (by the Cumming-Richards model) and 1980 and 1795 Ma (by the Stacey-Kramers model).

This study presents the first whole-rock Rb-Sr ages from the Lynn Lake belt. Samples were collected while detailed mapping was being completed by geologists of the Manitoba Mineral Resources Division. The ages from this study are consistent with the previously reported isotopic ages and will be discussed in relation to the geology of the Lynn Lake belt and the Flin Flon-Snow Lake greenstone and Kisseynew gneissic belts.

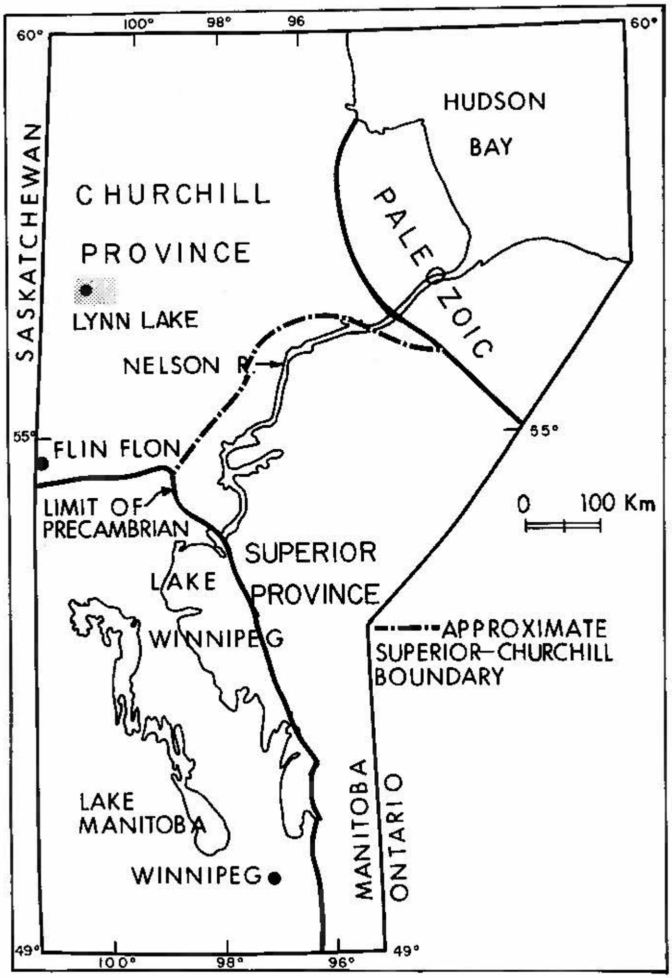

FIGURE 1. Location map showing Lynn Lake and area of Figure 2.

ACKNOWLEDGEMENTS

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GEOLOGICAL SETTING

Milligan (1960) published a very comprehensive report on the geology and mineral deposits of the Lynn Lake belt. This was based on a compilation of the work of others and his own extensive field work. Later, McGlynn (1970) summarized the geology of the belt. In 1976, an extensive remapping program was initiated in the Lynn Lake Greenstone Belt by the Manitoba Mineral Resources Division in an attempt to establish the stratigraphic and structural framework of the volcanic belt and associated intrusive rocks. The main thrust of the program was the study of the Wasekwan and Sickle Group rocks as well as their relationship to the Kisseynew paragneisses. The preliminary results of this work have been summarized in the Report of Field Activities (1976-1978) of the Manitoba Department of Mines, Resources and Environmental Management, Mineral Resources Division. A simplified geological map covering part of the greenstone belt included in the present study is shown in Figure 2. The map is modified after Gilbert et al., (1978) and is based on a regional correlation of the mapping program cited above (Zwanzig, 1978). The following is a brief summary of the geology of the Lynn Lake volcanic belt. A more detailed description of the lithological units investigated will follow.

WASEKWAN GROUP

The oldest rocks recognized in the belt consist of acidic to basic metavolcanic flows, tuffs, breccias and interlayered porphyritic and aphyric flows. Gilbert (1976) has subdivided the Wasekwan Group in the Lynn Lake area into two volcanic divisions (upper and lower) separated by sedimentary rocks consisting chiefly of greywacke and siltstone with minor flows and tuff. However, the sedimentary rocks lens out in the northeastern part of the belt, and the distinction can no longer be made, although the subdivision is recognized in the southern and western part of the Lynn Lake belt (Zwanzig, 1978). In the Laurie Lake area, near the Saskatchewan border, metasedimentary and metavolcanic rocks of Wasekwan age are recognized (Zwanzig, 1976) which have been traced throughout the Kisseynew Sedimentary Gneiss Belt. The lower greywackes were included in the Burntwood River Supergroup (McRitchie, 1974), and are now referred to as the Burntwood River Metamorphic Suite (Zwanzig, 1979, personal communication).

SICKLE GROUP

The sedimentary Sickle Group unconformably overlies the Wasekwan Group, and intrusive rocks, and conformably overlies the Burntwood River Metamorphic Suite. The Sickle Group consists of a basal polymictic conglomerate commonly overlain by arkosic rocks, although locally, the arkose forms the base of the succession. Greywacke and siltstone are also found within the group. In the Kisseynew Belt, the rocks occur as muscovite and sillimanite schist and gneiss, biotite gneiss and hornblende-biotite gneiss.

The Sickle Group rests unconformably on Wasekwan strata near Gemmell Lake (Gilbert, 1977) and basal conglomerate is observed overlying mafic volcanics and a pre-Sickle quartz diorite. Also, at Sickle Lake and Hughes Lake the Sickle conglomerate overlies tonalitic rocks, gabbro, and Wasekwan strata. In this area, the base of the Sickle Group contains up to 540 m of polymictic pebble and cobble conglomerate (Syme, 1977) containing a wide variety of clasts that include Wasekwan volcanic and sedimentary rocks as well as granodiorite and tonalite.

PRE-SICKLE INTRUSIVE ROCKS

Much of the detailed information available on the intrusive rocks in the Lynn Lake Greenstone Belt has been reviewed by Milligan (1960). The most abundant pre-Sickle intrusive rocks are granitic in composition, but include granodiorite, diorite, quartz diorite and tonalite. Gabbro, pyroxenite and peridotite are much less extensive,

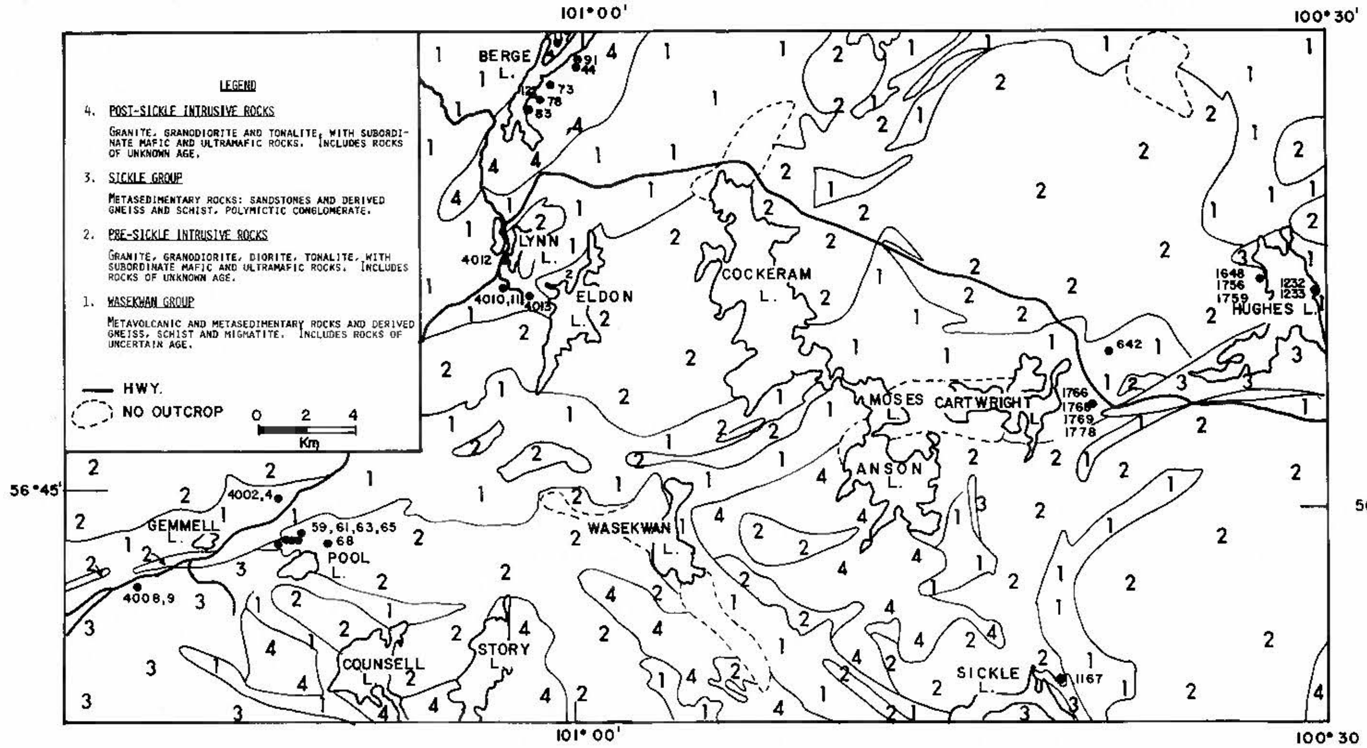

FIGURE 2. Simplified geological map for part of the Lynn Lake volcanic belt showing sample locations (geology modified from Gilbert et. al., 1978).

with gabbro and norite having a greater distribution than the ultrabasic rocks. Although several intrusions are inferred to belong to the pre-Sickle Group, there are a number of localities where the age relations can be observed, for example, at Hughes Lake, Sickle Lake and Pool Lake, where basal Sickle conglomerate overlies the intrusive rocks (Milligan, 1960). Syme (1977) describes the contact relationships at Hughes and Sickle Lakes whereas Gilbert (1977) gives a more recent description of the age relations at Pool Lake. Milligan (1960) describes several localities where the post-Wasekwan age of the pre-Sickle intrusive rocks has been established. More recent mapping has established that the pre-Sickle intrusion at Hughes Lake is clearly post-Wasekwan in age (Syme and Gilbert, 1977). Here, the pluton truncates stratigraphic units and folds within the Wasekwan Group and mafic xenoliths occur in the quartz diorite beneath the exposed unconformity at Hughes Lake.

POST-SICKLE INTRUSIVE ROCKS

The rocks belonging to this intrusive group can be identified in some localities directly, where exposures reveal intrusive contacts with rocks of the Sickle Group. In other areas, the age is inferred on the basis of composition and deformational history. The intrusions range in composition from granite to gabbro, with minor ultramafic rocks. Granodioritic to tonalitic rocks are the most prevalent throughout the volcanic belt.

METAMORPHISM

In the eastern part of the area shown in Figure 2, the rocks are metamorphosed to the middle greenschist facies (Syme, 1976) and the metamorphic grade increases to the west where the rocks reach the lower amphibolite facies. This applies to the southern volcanic belt extending from Hughes Lake to the vicinity of Gemmel Lake. The main structure in this southern belt is an east-west trending anticline. In the northern belt, Gilbert (1976) reports an upper greenschist to lower amphibolite grade of metamorphism.

In the southwestern extension of the Lynn Lake Greenstone Belt, and beyond the area shown in Figure 2, the metamorphic grade is highest, reaching the upper amphibolite facies, and migmatites and sillimanite-bearing gneisses are common as the rocks grade into the Kisseynew Sedimentary Gneiss Belt (Zwanzig, 1976, 1977).

PRESENT INVESTIGATION

ANALYTICAL PROCEDURE

Details of the chemistry and mass spectrometry procedures followed in this laboratory have been described elsewhere (Cheung, 1978). All isotopic measurements were made on whole-rock samples using a triple filament, thermal ionization, solid source assembly, single focusing mass spectrometer having a 25 centimeter radius of curvature and a 90 degree deflection.

The measurements were taken with a Cary model 401 vibrating reed electrometer and recorded with a Hewlett-Packard model 5326B timer-counter DVM. The Sr concentrations and $^{87}Sr/^{86}Sr$ ratios were determined on single, spiked aliquots using a ^{84}Sr-enriched spike. Several $^{87}Sr/^{86}Sr$ ratios were repeated on unspiked samples. The Rb concentrations were determined on separate sample aliquots by isotope dilution. During the time of this study several analyses of the E and A $SrCO_3$ standard (lot 492327) gave an average value of 0.7083 $\pm$ 0.0003 (1σ). Precision and accuracy for the Rb and Sr concentrations were checked using the NBS K-feldspar standard and the results were consistent with those of other laboratories.

GEOLOGICAL UNITS INVESTIGATED

The Rb-Sr isotopic results presented in this report were obtained from six major rock units representing a broad range in geological age from lower Wasekwan volcanics to post-Sickle intrusions. The rock units are described briefly below and the sample locations are shown in Figure 2.

Quartz-Plagioclase Porphyry. This unit was sampled in two areas separated by a distance of about 14 km. One area is located 3 km northeast of Gemmell Lake. Here, the outcrop area is of rather small extent and the samples were collected over a distance of about 15 m. In this locality, the porphyry appears as a sill or flow within mafic tuff of the Wasekwan Group. Most of the samples of quartz-plagioclase porphyry were collected near Lynn Lake (see Gilbert, 1977, p. 38) where the unit is up to 2400 m thick. The stratigraphic age of this unit within the Wasekwan Group is uncertain but at least, in part, it is correlative with the lower section of the group (Gilbert, 1977).

Rhyolite-andesite. All samples of the felsic volcanic rocks were obtained from a single outcrop area about 1 km east of Cartwright Lake. One sample of andesite was collected about 2 km north of the felsic samples and from within the same folded succession consisting chiefly of Wasekwan intermediate volcanic and sedimentary rocks.

Granodiorite-Tonalite (Pre-Sickle). Most of the samples analyzed from this unit were collected from below exposed unconformities where conglomerate of the Sickle Group is observed overlying the intrusive rocks along the shore of Hughes Lake. One sample was collected about 1 km northeast of Sickle Lake, again, from below an exposed unconformity. The rocks are chiefly tonalite and quartz diorite but two samples from Hughes Lake were collected from a granodiorite dyke cutting quartz diorite. The dyke is truncated at the exposed unconformity.

Pool Lake Quartz Diorite (Pre-Sickle). The area near Pool Lake is another locality where the age relations of the pre-Sickle intrusions can be demonstrated. Milligan (1960) states; "At Pool Lake, the conglomerate at the base of the Sickle series is unconformable upon a rock which is considered a phase of tonalite." The unit is largely a biotite-hornblende quartz diorite, and near the northern contact with the Wasekwan rocks, shows evidence of assimilation of the mafic flows (Milligan, 1960).

Arkose. The samples of arkose were collected from two outcrop areas along provincial road 396, about 3 km southwest of Gemmell Lake. The sample localities are separated by a distance of about 0.4 km. In the area sampled, the arkose is dense, medium- to fine-grained and locally grades into greywacke. Pink feldspar grains are conspicuous in most of the samples. In this area, the maximum width of the arkose-greywacke section is about 4200 m.

Berge Lake Granodiorite. The samples from this unit were collected from the main body near Berge Lake. Sample 94 is not shown on Figure 2 since the precise location is not known. However, it was collected from the same area as the others (P. Gilbert, 1978, personal communication).

This intrusion was included with the pre-Sickle intrusive group (Milligan, 1960) with some reservation, and was considered to be the youngest of the pre-Sickle intrusive rocks. It was assigned to this group since similar rocks were seen to occur at the base of the Sickle Group at Hughes Lake. However, information from more recent detailed mapping favours a post-Sickle age for this unit (P. Gilbert, 1978, personal communication).

ANALYTICAL RESULTS

Total-rock Rb-Sr isochrons were obtained from the six units briefly described above. The analytical results are listed in Table 1

TABLE 1. Rb-Sr ANALYTICAL RESULTS[1]

Sample	Rb(ppm)	Sr(ppm)	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$ [2]
Intrusive Rocks				
Berge Lake granodiorite (4)				
78	59.58	690.0	0.2495	0.7091
44	82.06	395.0	0.6008	0.7178
12	32.01	927.9	0.09964	0.7051
94	34.96	422.5	0.2391	0.7083
73	53.85	621.3	0.2506	0.7092
117	29.21	1052.5	0.0802	0.7049
83	41.75	745.7	0.1618	0.7064
91	48.97	813.8	0.1739	0.7065
Pool Lake quartz diorite (2)				
68	19.16	248.6	0.2228	0.7078
59	24.96	151.3	0.4772	0.7151
65	7.177	200.4	0.1035	0.7053
63	17.70	148.1	0.3456	0.7110
61	23.25	235.3	0.2857	0.7102
Granodiorite-tonalite (Hughes Lake-Sickle Lake) (2)				
1648-4	18.76	129.6	0.4184	0.7143
1759	28.50	485.8	0.1695	0.7073
1648-5	31.70	228.2	0.4020	0.7137
1756	39.48	378.3	0.3002	0.7108
1167	38.22	316.9	0.3487	0.7121
1648-3	45.14	447.3	0.2917	0.7109
1233	33.34	280.1	0.3443	0.7123
1232	41.32	240.0	0.4978	0.7165
Metavolcanic Rocks				
Quartz-plagioclase porphyry (1)				
4002	18.35	111.2	0.4774	0.7154
4004	44.16	86.81	1.474	0.7421
4010	57.57	76.18	2.195	0.7613
4011	125.5	100.3	3.649	0.7966
4012-3	116.5	77.70	4.379	0.8165
4012-8	35.71	178.3	0.5790	0.7193
4013	46.66	232.0	0.5818	0.7182
Rhyolite-andesite (Cartwright Lake) (1)				
1778	39.15	71.45	1.589	0.7460
1766	61.21	62.30	2.859	0.7777
1769	75.72	65.93	3.346	0.7892
1768	42.26	57.52	2.135	0.7605
642	16.51	453.5	0.1051	0.7048

[1] Numbers in parentheses correspond to numbers in legend of Fig. 2.
[2] normalized to a $^{87}Sr/^{86}Sr$ value of 0.1194.

TABLE 1. Rb-Sr ANALYTICAL RESULTS[1] (Cont'd)

Sample	Rb(ppm)	Sr(ppm)	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$ [2]
		Metasedimentary Rocks		
Arkose (3)				
4008-1	88.18	113.7	2.253	0.7609
4008-3	79.64	104.4	2.215	0.7598
4009-7	58.99	178.0	0.9600	0.7283
4009-5	68.61	94.56	2.108	0.7592
4009-12	59.18	272.3	0.6291	0.7205
4009-9	54.63	96.85	1.636	0.7444

[1]Numbers in parentheses correspond to numbers in legend of Fig. 2.
[2]normalized to a $^{87}Sr/^{86}Sr$ value of 0.1194.

and the isochrons are presented in Figures 3 - 8. The errors used in the age calculations are 1.5% for the $^{87}Rb/^{86}Sr$ ratios and 0.15% for the $^{87}Sr/^{86}Sr$ ratios. These are 2σ errors based on replicate determinations for samples and standards. The $^{87}Sr/^{86}Sr$ error used for the pre-Sickle intrusive unit at Hughes and Sickle Lakes is 0.1% since several more replicates were determined for that suite.

The ages are calculated using the least squares regression method of York (1966) and the ^{87}Rb decay constant of 1.42 x 10 $^{-11}yr^{-1}$. The errors in the ages and initial $^{87}Sr/^{86}Sr$ ratios are at the 2σ and 1σ level respectively.

DISCUSSION OF RESULTS

INTRUSIVE ROCKS

The isochrons for the pre-Sickle intrusive units at Hughes and Sickle Lakes and Pool Lake are shown in Figures 3 and 4, respectively. The granodiorite-tonalite body at Hughes and Sickle Lakes gave the highest age of all the units dated. The age is 1940 ± 74 Ma with an initial $^{87}Sr/^{86}Sr$ ratio (I) of 0.7026 ± 0.0002. Since the spread of Rb/Sr ratios for this unit is rather low, and a large extrapolation to the $^{87}Sr/^{86}Sr$ axis is necessary, 8 samples were used in the isochron construction to reduce the error. The data points all fit the regression well within the limits of analytical uncertainty. This intrusion is considered to be one of the older phases of the pre-Sickle intrusive group and therefore, the 1940 Ma age can be considered a minimum age for the Wasekwan Group volcanic and sedimentary rocks (within the error quoted). The age of this body, as well as the ages of the other intrusive rocks, are interpreted as intrusive ages (rather than "reset" ages) since there appears to be little scatter of the data points other than that which can be explained by the analytical errors. The Rb/Sr ratios for the three intrusive units dated are quite similar, with only one sample (sample 44 from the Berge Lake granodiorite) having a value exceeding 0.2.

The five-point isochron for the Pool Lake quartz diorite gives an age of 1825 ± 210 Ma (I = 0.7023 ± 0.0005). Although the error is quite large, the points all fall on the line within the error limits and the age is consistent with the age of the granodiorite-tonalite unit from Hughes and Sickle Lakes. The major gabbroic intrusions in the Lynn Lake belt are clearly post-Wasekwan in age (Milligan, 1960 and Pinsent, 1977), and there is evidence in several localities that the pre-Sickle granitic intrusions post-date the gabbro bodies (Pinsent, 1977), including the mineralized Lynn Lake bodies. The ages reported here for the pre-Sickle intrusions therefore, places a lower limit on the age of the gabbroic rocks and hence their associated mineralization.

The Berge Lake granodiorite is considered, on geological grounds, to represent the latest igneous intrusive activity in the Lynn Lake volcanic belt. The age of 1765 ± 100 Ma (I = 0.7025 ± 0.0002) supports this interpretation, and is the youngest age obtained for granitic intrusive rocks in the area. Again, because of the unfavourable range in the Rb/Sr ratios, eight points were used to construct the isochron. Seven of the points fall within a narrow, low Rb/Sr range of about 0.03 to 0.09 (Fig. 5). The other sample (44) has a ratio of about 0.2 and largely controls the slope of the isochron. Omitting sample 44 results in no significant change in the slope, however, and the seven points give an age of 1745 Ma, but with a much larger error (270 Ma).

WASEKWAN GROUP METAVOLCANIC ROCKS

Two isochrons were obtained from volcanic rocks of the Wasekwan Group. These represent two lithologically distinct units; a coarser-grained quartz-plagioclase porphyry and a rhyolite-andesite suite. The isotopic results from the porphyry are plotted in Figure 6. All the samples fall on the isochron and give an age of 1790 ± 35 Ma (I = 0.7037 ± 0.0004). Two of the samples, 4002 and 4004, were collected from an exposure of rather small extent occurring near Gemmell Lake while the other five samples were collected from a more extensive outcrop area near Lynn Lake. The isotopic data from the two sampling areas is indistinguishable, suggesting a common age and genesis for the porphyry from the two areas.

Five samples of the metavolcanic (rhyolite-andesite) suite collected just east of Cartwright Lake gave an age of 1835 ± 75 Ma and an I of 0.7027 ± 0.0011 (Fig. 7). This age agrees with that of the quartz-plagioclase porphyry which could represent recrystallization ages related to post-Wasekwan intrusive activity. However, the ages and initial ratios are consistent with a late Aphebian age for Wasekwan volcanism. Other evidence suggesting that these are metamorphic ages is the apparently older age for the post-Wasekwan intrusive unit at Hughes Lake.

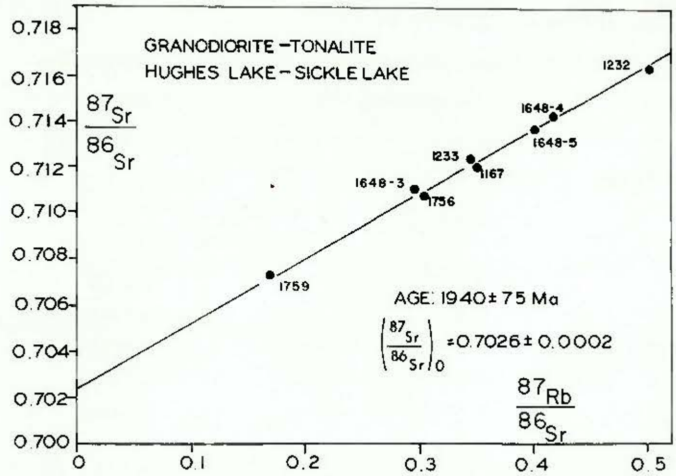

FIGURE 3. *Rb-Sr isochron, pre-Sickle tonalitic rocks from Hughes and Sickle Lakes.*

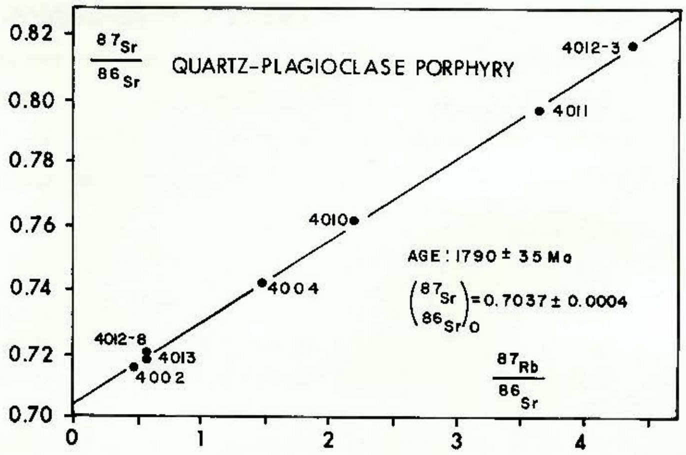

FIGURE 6. *Rb-Sr isochron, quartz-plagioclase porphyry, Wasekwan Group. Samples 4002 and 4004 are from the vicinity of Gemmell Lake and the others are from Lynn Lake.*

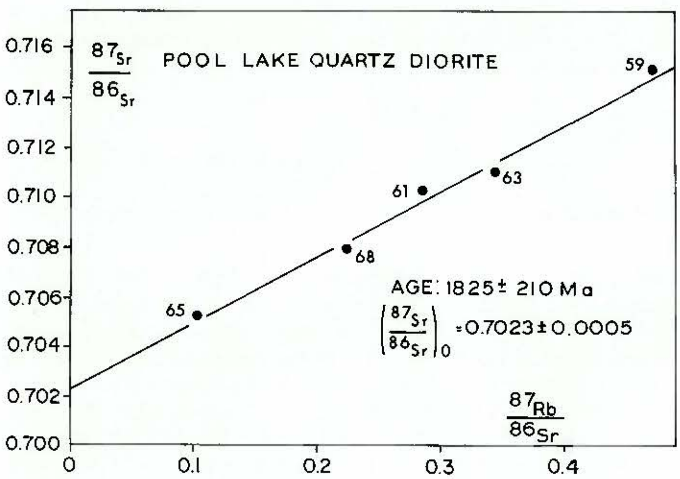

FIGURE 4. *Rb-Sr isochron, pre-Sickle quartz diorite at Pool Lake.*

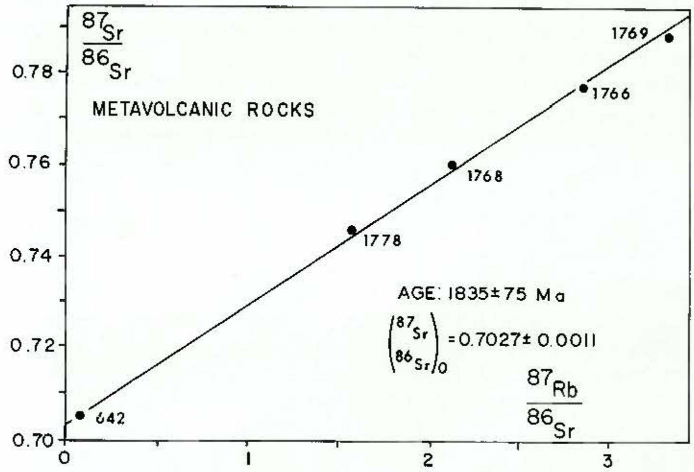

FIGURE 7. *Rb-Sr isochron, volcanic rocks from the Wasekwan Group. Sample 642 is andesite and the other samples are rhyolite collected east of Cartwright Lake.*

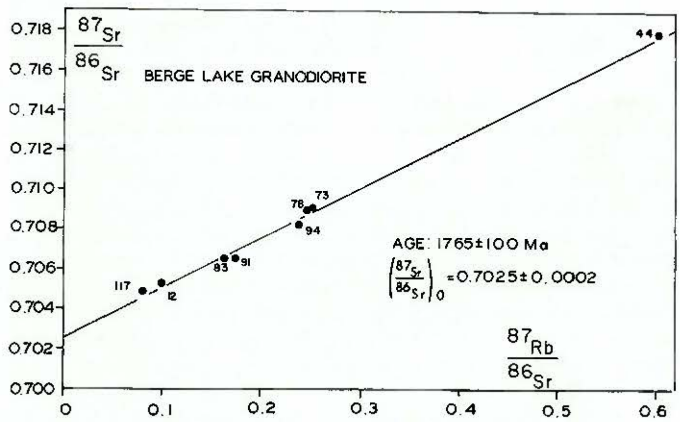

FIGURE 5. *Rb-Sr isochron, Berge Lake granodiorite post-Sickle intrusion.*

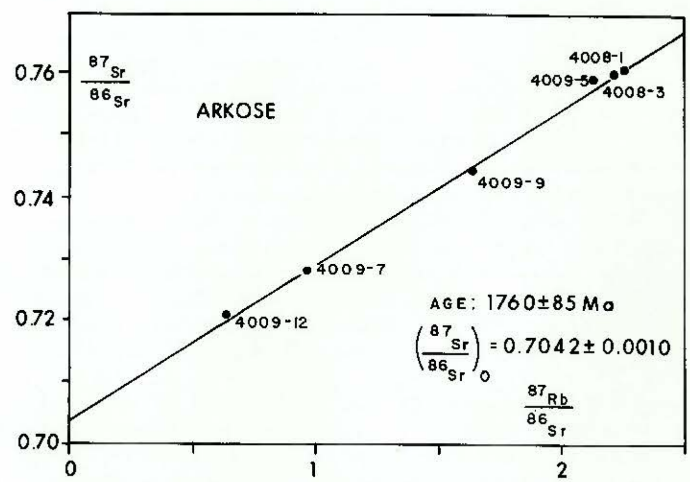

FIGURE 8. *Rb-Sr isochron, arkose and arkosic greywacke of the Sickle Group.*

SICKLE GROUP ARKOSE

Samples of this rock unit, described above, were collected over a small area between Gemmell and Wilmot Lakes where extensive deposits of arkose and greywacke have been mapped overlying basal Sickle conglomerate (Gilbert, 1977). The conglomerate contains pebbles of quartz-plagioclase porphyry similar to that discussed above. Six samples of the arkose-arkosic greywacke give an isochron age of 1760 ± 85 Ma (I = 0.7042 ± 0.0010). This age is one of the youngest obtained from the area, and probably represents a metamorphic age, corresponding to the culmination of post-Sickle igneous intrusive activity in the Lynn Lake greenstone belt. The isochron is shown in Figure 8. The age of 1760 Ma can be interpreted as a minimum age for the deposition of Sickle Group sedimentation and corresponds to the time of post-Sickle plutonism as indicated by the 1765 Ma age of the Berge Lake granodiorite. The relatively low I suggests a derivation of the sediment from a source area of an age consistent with the ages obtained from the Wasekwan volcanic rocks and pre-Sickle intrusive rocks. This is consistent with the geological interpretation based on clasts found in the underlying conglomerate.

COMPARISON WITH ISOTOPIC AGES FROM THE FLIN FLON-SNOW LAKE GREENSTONE BELT AND KISSEYNEW SEDIMENTARY GNEISS BELT

The similarities in the geology and mineral deposits of the Flin Flon-Snow Lake and Lynn Lake greenstone belts, and their possible time equivalence has been referred to in the introduction of this report. Sangster (1978) has given the most recent summary of the isotopic ages in the two volcanic belts so only a brief comparison is warranted here in relation to the Rb-Sr ages from this study.

METASEDIMENTARY ROCKS

Rubidium-strontium isochron ages for metasedimentary rocks have been previously reported by Josse (1974) from the Flin Flon-Snow Lake belt and Clark et al. (1974) from the Burntwood River Supergroup (Kisseynew belt). The ages obtained are 1725 ± 45 Ma (I = 0.7038 ± 0.0008) and 1775 ± 115 (I = 0.7035 ± 0.0012) respectively. The paragneiss from the Flin Flon-Snow Lake belt, the Nelson Bay Gneiss Dome (Bailes, 1978, personal communication), represents the metamorphosed equivalent of the Missi Group and extends into the southern area of the Kisseynew Sedimentary Gneiss Belt. The age reported by Clark et al. (1974) is from a metagreywacke of the gneissic belt and may represent metamorphosed Wasekwan sedimentary rocks. The 1760 ± 85 Ma age of the arkose reported here is the same as the other two ages even though the arkose unit exhibits a much lower metamorphism and preserves some primary features. The I of 0.7042 for the arkose is also consistent with that of the other paragneisses suggesting the age of the source rocks are similar and probably late Aphebian. It is also significant to compare these ages and initial ratios with a "Kisseynew-type gneiss" (Weber and Scoates, 1978) flanking the northern boundary of the Fox River belt and the Churchill-Superior boundary. A Rb-Sr age of 1740 ± 50 Ma has been obtained (G. Clark, unpublished information) with an I of 0.7038 ± 0.0005. Again, these data show very similar characteristics for the Rb-Sr systematics of these Churchill Province metasedimentary rocks.

The Rb-Sr ages of the metasedimentary rocks, as stated above, are interpreted as indicating the culmination of the Hudsonian orogeny in the Lynn Lake and Flin Flon-Snow Lake volcanic belts and the Kisseynew sedimentary gneissic belt.

Sangster (1978) recently reported new lead isotope data from the Sherridon massive sulphide deposit as well as the Ruttan deposit. These occur largely in metasedimentary rocks and, as Sangster states, may represent distal equivalents in, or associated with, volcaniclastic rocks and greywackes. These deposits are considered coeval with their host rocks (Sangster, 1978). Model lead ages (single-stage) for the Sherridon and Ruttan deposits are 1785 and 1795 Ma respectively, based on the Stacey-Kramers model. As Sangster points out, it is unlikely that the similar model lead ages of the sulphides of the volcanic rocks within the "circum-Kisseynew volcanic belt" could be updated Archean deposits and maintain such uniformity in the lead isotope compositions, as is found to exist. The same statement could be made for the uniform Rb-Sr ages and initial ratios for the metasedimentary rocks presented above.

IGNEOUS ROCKS

The ages of 1835 and 1790 Ma reported here for the Wasekwan volcanic rocks compare remarkably with Rb-Sr ages from the Flin Flon-Snow Lake belt. Mukherjee et al. (1971) obtained ages of 1765 and 1735 for Amisk volcanic rocks at Flin Flon. Bell et al. (1975) reported an age of 1790 Ma for Amisk volcanics at Snow Lake. A U-Pb age reported by MacQuarrie (1977) indicates an age of 1875 Ma for the Amisk Group at Flin Flon.

The ages reported here for the post-Wasekwan and pre-Sickle intrusive rocks (1940 and 1825 Ma) are slightly older than Rb-Sr ages from post-Amisk plutons from the Flin Flon-Snow Lake belt. Mukherjee (1971) obtained an age of 1765 Ma for the Annabel Lake pluton near Flin Flon, Josse et al. (1974) 1820 Ma for the Ham pluton at File Lake and Bell et al. (1975) reported ages of 1810 and 1749 Ma for the Triangle and Squall Domes in the Snow Lake area. The ages of the plutons are consistent from the two volcanic belts and, for the most part, agree within the quoted errors.

SUMMARY

The Rb-Sr whole-rock ages from intrusive, metavolcanic and metasedimentary rocks of the Lynn Lake volcanic belt are listed in Table 2.

TABLE 2. SUMMARY OF Rb-Sr AGES FROM THE LYNN LAKE GREENSTONE BELT

Rock Unit	Age (Ma)	Initial ratio
Intrusive Rocks		
Berge Lake granodiorite, post-Sickle	1765 ± 100	0.7025 ± 0.0002
Pool Lake quartz diorite, pre-Sickle	1825 ± 210	0.7023 ± 0.0005
Granodiorite-tonalite (Hughes-Sickle Lakes), pre-Sickle	1940 ± 75	0.7026 ± 0.0002
Metavolcanic Rocks (Wasekwan Group)		
Quartz-plagioclase porphyry	1790 ± 35	0.7037 ± 0.0004
Rhyolite-andesite (Cartwright Lake)	1835 ± 75	0.7027 ± 0.0011
Metasedimentary Rocks (Sickle Group)		
Arkose	1760 ± 85	0.7042 ± 0.0010

The ages range from 1940 to 1760 Ma and indicate a late Aphebian age for the evolution of the volcanic belt. Rb-Sr isotopic evidence does not support a derivation of any of the lithological units from pre-existing Archean rocks. The results are consistent with the Rb-Sr ages reported from the Flin Flon-Snow Lake volcanic and Kisseynew Sedimentary Gneiss Belts, supporting the geological and isotopic evidence that the two volcanic belts evolved simultaneously. The Rb-Sr and model lead ages from metasedimentary rocks and volcanogenic massive sulphide deposits, respectively, support the conclusion (for example, McRitchie, 1974 and Sangster, 1978) that the metasedimentary rocks of the two volcanic belts are correlative with the paragneisses of the Kisseynew Sedimentary Gneiss Belt.

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ADDENDUM

The current interpretation of the rocks of the Nelson Bay Gneiss Dome (Bailes, pers. comm. 1980) is that they are orthogneisses derived from Missi Group felsic metavolcanic rocks rather than paragneisses as indicated on Page 7 of this report.