MINERALOGY AND PETROLOGY OF THE BUCK CLAIM LITHIUM PEGMATITE, BERNIC LAKE, SOUTHEASTERN MANITOBA

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PAUL G. LENTON

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ABSTRACT

A study of the mineralogy, textural zoning and geochemical characteristics of the Buck claim pegmatite dike in southeastern Manitoba was undertaken to obtain data to use in interpreting the petrological and geochemical evolution of the dike.

The dike is a sheet-like body of 1 to 10 m variable thickness and a known extent of 0.4 km north-south and 2.0 km east-west. It is intruded into metamorphosed rocks of upper greenschist to lower amphibolite facies, in the Bird River greenstone belt of the English River subprovince (westernSuperior Province). The dike forms a culmination at the point of the only known surface exposure, a small open-cut trench. The dike dips gently away from the surface exposure to the east and west.

Internal zonation is well developed in the dike, although zone distribution is assymetric. The sequence of zones downward in the pegmatite is: a thin border zone of saccharoidal albite ± quartz; a quartz-albite-muscovite-beryl-tourmaline wall zone; a cleavelandite-microcline perthite-quartz-muscovite-lithian muscovite-beryl-amblygonite intermediate zone; and a quartz-rich core zone containing microcline perthite, triphylite, amblygonite, petalite, pollucite and apatite. Similar zones exist below the core except for the absence of a lower border zone.

The Buck pegmatite belongs to the Bernic-Rush Lake cogenetic swarm of which the Tanco pegmatite is the most famous member. Based on geochemistry and mineralogy the Buck dike can be included in the

classification of pegmatites most enriched in Li, Rb and Cs. The dike shows a progressive inward enrichment in Li, Rb, Cs and Be, and decreasing concentrations of Ca and Fe. The dike is rich in volatile elements, particularly F and B. Rare element minerals found in the dike include tantalite-columbite, beryl, pollucite and cassiterite.

Based on mineralogical, chemical and textural studies it is evident that the dike crystallized totally from a supercritical aqueous fluid without the direct involvement of a silicate melt phase. Subsequent to formation most of the primary assemblage of the dike was altered during an extensive phase of albitization. Hydrothermal and supergene alteration and deposition are evident as late stage processes of limited extent.

A pressure of about 3.0 Kbars and a maximum temperature at the beginning of crystallization of about 650^{o}C are inferred from mineralogical evidence.

ACKNOWLEDGEMENTS

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Permission to enter the Buck claim and to sample the pegmatite was granted by International Mogul Mines Ltd. (Lithium Corporation of Canada). Permission was also given to use the diamond drilling records.

TABLE OF CONTENTS

TABLE OF CONTENTS (Contd.)

TABLE OF CONTENTS (Contd.)

LIST OF TABLES

LIST OF TABLES (Contd.)

LIST OF FIGURES

LIST OF FIGURES (Contd.)

LIST OF FIGURES (Contd.)

LIST OF FIGURES (Contd.)

LIST OF FIGURES (Contd.)

CHAPTER 1

INTRODUCTION

General statement

The Buck pegmatite dike, located in the Precambrian shield of southeastern Manitoba, is an excellent example of a layered differentiated pegmatite. It falls within the general classification as Li, Rb, Cs enriched pegmatite.

While the dike, averaging 6 to 10 m in thickness, is small compared to the nearby massive Tanco pegmatite, it still represents an excellent case for detailed study. Zoning is well developed in the body, although somewhat assymmetric.

The dike is well exposed in a 6 m by 25 m two level open cut trench. All zones of the dike are exposed in the trench which runs roughly parallel to the strike of the body. There is no exposure of the pegmatite away from the area of the trench, but extensive diamond drilling by the Lithium Corporation of Canada has outlined the shape and extend of the body.

CHAPTER 2

LOCATION AND GENERAL GEOLOGY

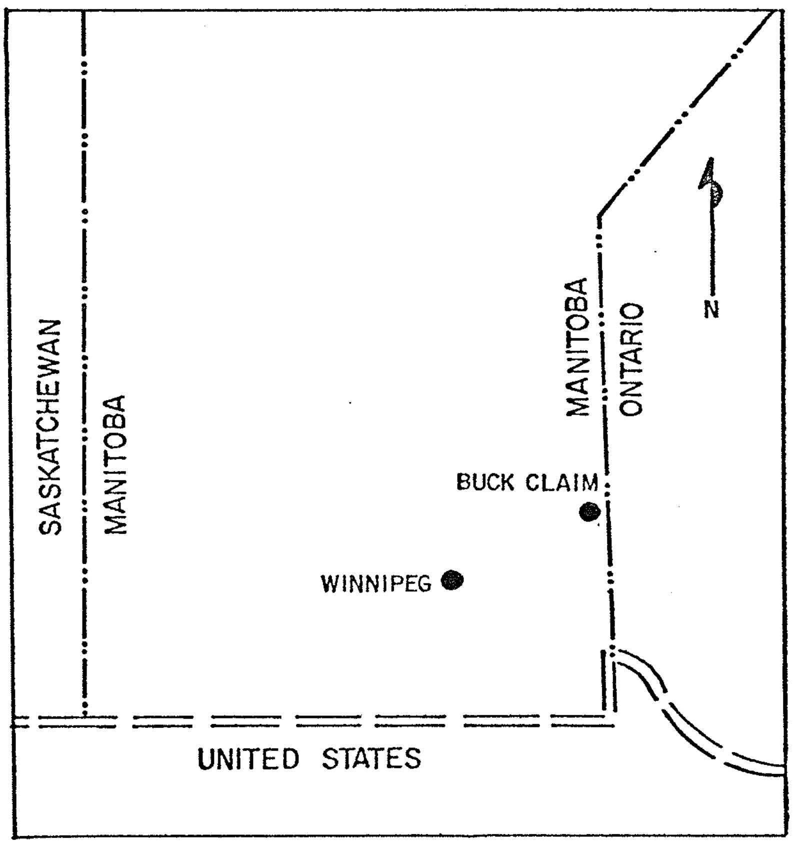
A Location and access

The Buck pegmatite is located about 190 km ENE of Winnipeg, close to the Manitoba-Ontario boundary (Fig. 2-1). The dike crops out 0.5 km east of the east end of Bernic Lake. The walk from Bernic Lake to the trench is easily accomplished over dry fairly flat ground. Bernic Lake is accessible by float plane or by road from Lac du Bonnet. The final section of road down to Bernic Lake is a private access road for the use of which permission must be obtained from the Tantalum Mining Corporation of Canada Limited. A boat is required for access from the Tanco mine, which is located on the northwestern shore of Bernic Lake. Lac du Bonnet has a float plane base and is accessible from Winnipeg by provincial highways and by rail connection.

B Previous work

The Buck pegmatite, located in the center of the Buck mining claim, has a varied history of exploration and development spanning 50 years of sporadic work. Exploration at the east end of Bernic Lake was confined to three adjacent mining claims, the Buck, Coe and Brilliant (now known as Pegli numbers 1 and 2). Work on the Buck claim is linked closely with the Coe and Brilliant claims. The first record of staking in the Buck claim area was in 1926 when Pegli number 2 was staked. Shortly after this in 1926 the Buck and Coe claims were staked. Initial

Fig. 2-1 Location map showing the position of the Buck pegmatite dike.



staking was by private individuals but the claims were signed over to the Lithium Corporation of Canada Ltd. in 1934. The three claims were leased by the Lithium Corporation of Canada Limited in 1947 and the lease was renewed in 1968.

From 1934 to 1955 work on the Buck claim consisted of about 600 feet of diamond drilling in 11 drill holes, surface mapping and the opening of a 2 level trench approximately 25 m long by 8 m wide in the exposed portion of the main Buck pegmatite. Approximately 150 tons of rock from the trench were hand sorted and stockpiled in bins at the south end of the quarry. Much of this material remains today at the locality.

In 1956 assessment reports were filed under claims grouping certificates for the Buck-Coe-Pegli Group for 45 drill holes with a total footage of 14,578 feet (445m). Extensive assays for lithia content were done on the split core. At a later date the remaining core was quartered and assayed for tantalum content (personal communication, B. Bannatyne).

The Buck claim was still valid in 1976 and was held by the Lithium Corporation of Canada Limited.

The Buck claim pegmatite was noted by Springer (1950) and Davies (1957) during regional mapping programs but no specific work was done on the pegmatite.

Some surface mapping and sampling was done on the Buck pegmatite in 1972 by the Manitoba Mineral Resources Division (Bannatyne, 1972).

C General geology of the surrounding rocks

The Buck pegmatite occurs in the Archean Bird River greenstone belt in the Western Superior geological province of the Canadian Shield. The Bird River greenstone belt separates the Manigotagan-Ear Falls gneiss belt and the Winnipeg River batholithic belt (Beakhouse, 1976). Together these belts form the English River subprovince (the mobile zone of Wilson, 1976) (Fig. 2-2).

Bird River greenstone belt

The Bird River greenstone belt is an east-west trending belt of metamorphosed volcanic and sedimentary rocks. The belt is bounded by the Maskwa Lake, Marijane Lake and Lac du Bonnet batholiths. The belt has been subdivided by Crouse, Černý, Trueman and Burt (1972), into five subareas (Fig. 2-3).

Subarea 1 consists of mafic lavas and volcanoclastic sediments. It has undergone polydeformation and metamorphism to greenschist facies grade.

Subarea 2 consists of metamorphosed basalt, tuffs and Algoman type iron formations. It has been intruded by gabbro, the ultramafic-gabbroic Bird River sill (Trueman and Macek, 1971), quartz-feldspar porphyry dikes and pegmatite dikes. The rocks form a simple east-trending synclinorium and are metamorphosed to greenschist facies grade.

Subarea 3 is comprised of layers of felsic volcanic and volcanoclastic rocks and metaconglomerate interlayered with felsic to mafic metavolcanic rocks overlain unconformably by metaconglomerate

Fig. 2-2 The western Superior geologic province showing the subdivision into subprovinces. The location of the Buck pegmatite is shown in the English River mobile zone. The subprovince boundaries used are taken from Černý and Trueman (1978).

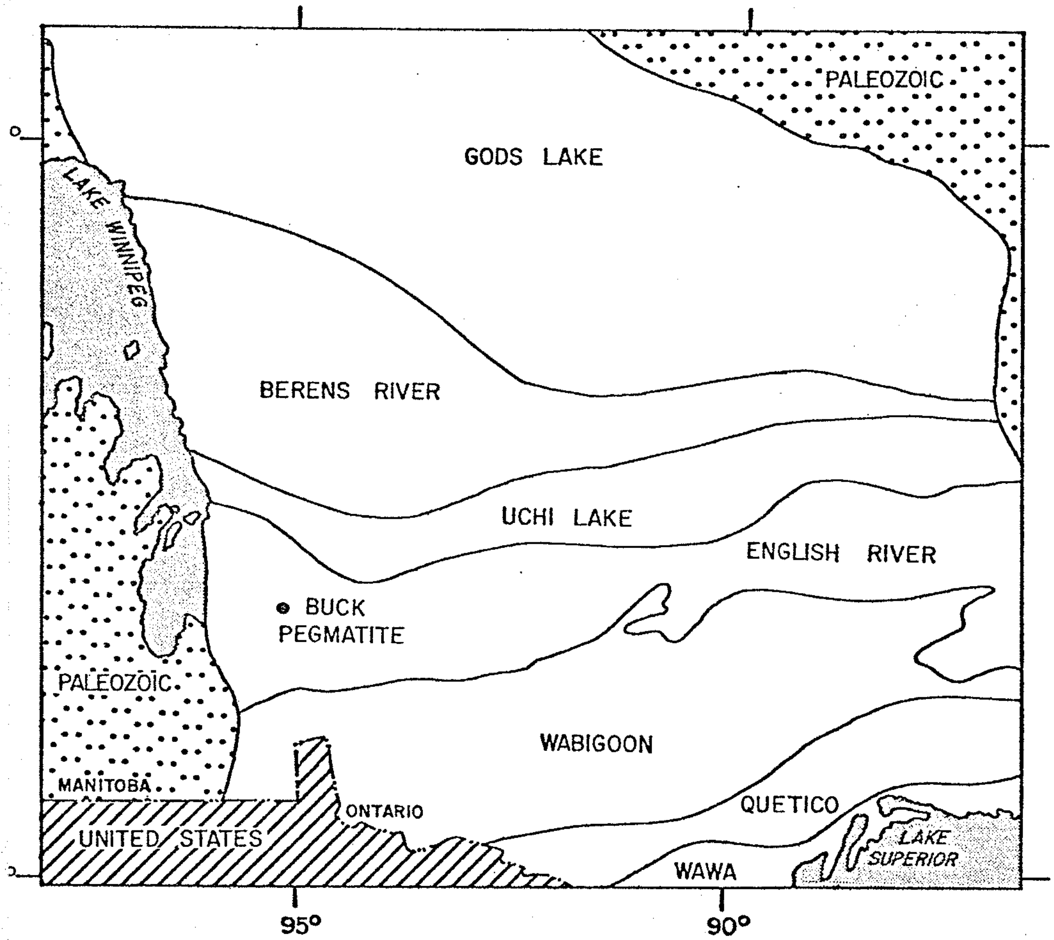
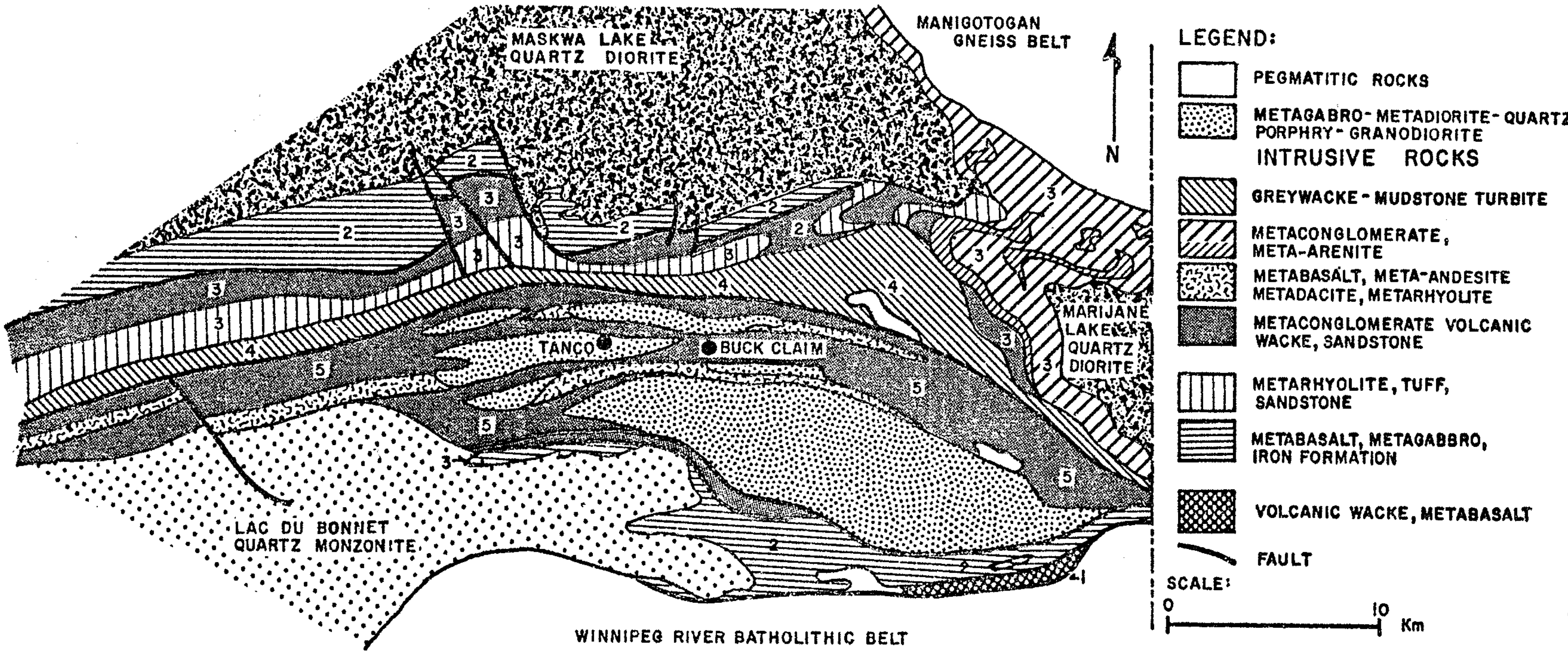


Fig. 2-3 Geologic map of the Bird River greenstone belt showing the subdivision of the belt. The numbers refer to the subareas defined by Trueman as described in the text. The figure is from Černý, 1976.



and lithic arenite. The rocks have undergone polydeformation and metamorphism to upper amphibolite facies grade.

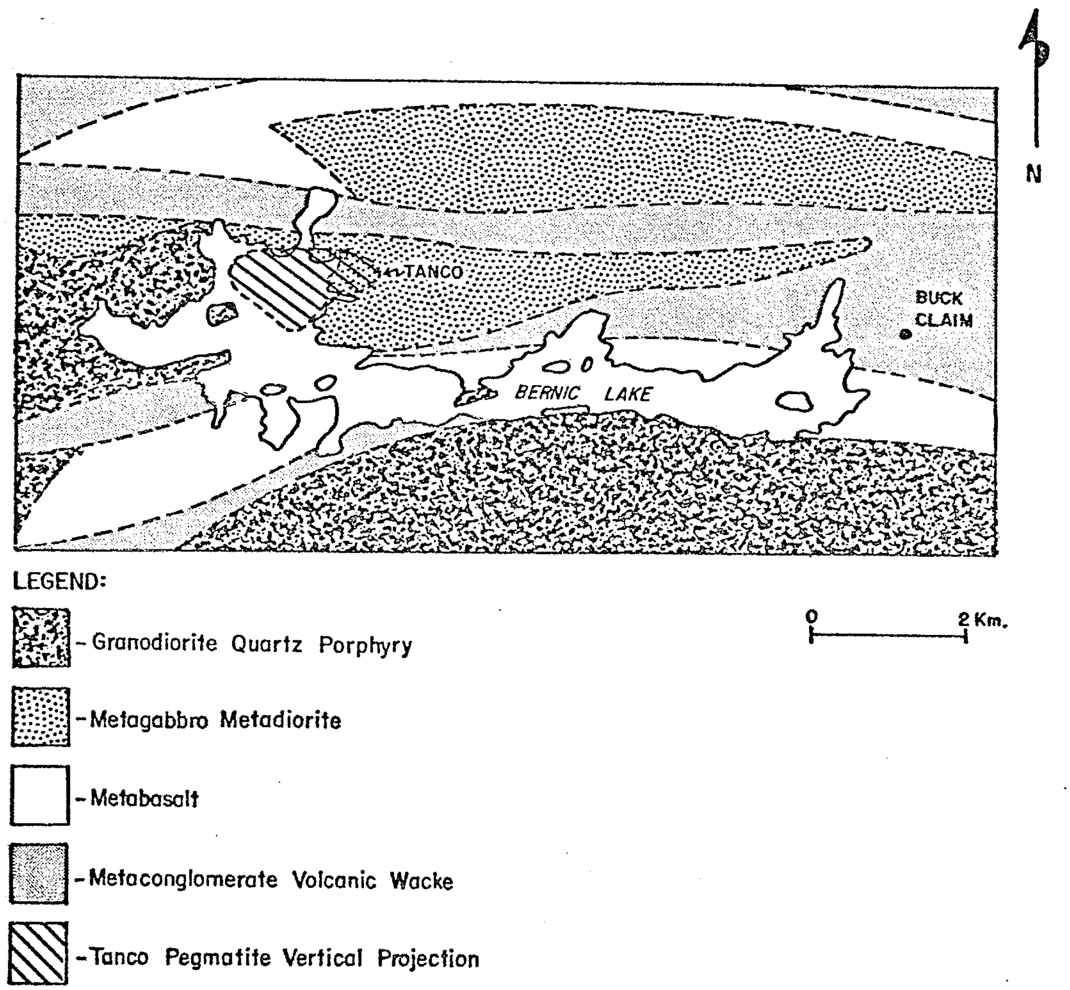
Subarea 4 consists of greywacke-mudstone turbidites with interbedded iron formation. These are the youngest rocks in the belt and rest unconformably on the rocks of subareas 1,2,3 and 5. Subarea 4 has undergone little deformation. The rocks were metamorphosed to lower amphibolite facies grade and subsequently retrogressed.

Subarea 5 is equivalent to subarea 3 in age but has been separated because of the presence of synvolcanic stocks of gabbro, diorite, quartz-feldspar porphyry and granodiorite.

Of the batholiths that bound the Bird River greenstone belt, the Maskwa Lake and Marijane Lake quartz diorite-granodiorite plutons appear to have been emplaced synchronously with the development of the tectonic foliation of the layered rocks of the greenstone belt (McRitchie, 1971). The Lac du Bonnet quartz monzonite has been shown to be younger than the other botholiths (McRitchie 1971, Penner and Clark 1971, Farquharson 1975). Farquharson's Rb/Sr age for the Lac du Bonnet intrusive is 2680± 91 m.y.

The Buck pegmatite lies within a sequence of mafic metasedimentary rocks of subarea 5 (Fig. 2-4) with minor mafic metavolcanic rocks. The rocks in contact with the dike are homogeneous hornblende-plagioclase (quartz) amphibolites. The amphibolite is well foliated in the vicinity of the open trench but layering is generally not apparent.

Fig. 2-4 Geologic map of the Bernic Lake area. The positions of the Tanco pegmatite and Buck pegmatites are indicated. The map was adapted from Crouse et al., 1979.



Genetic affiliation of the Buck pegmatite dike

Pegmatite bodies are rarely isolated features, but generally occur in swarms within a geologic district. Černý and Turnock (1971) have classified the various pegmatites of Southeastern Manitoba into cogenetic swarms on the basis of mineralogy and petrochemical similarities. Under this classification the Buck dike is included in the Bernic-Rush Lake Group, of which the Tanco Pegmatite is the largest and best known member.

The source of the fluids from which the pegmatites crystallized is uncertain. The whole process is currently under study as a part of a Department of Regional Economic Expansion subsidiary agreement between the Government of Canada and the Province of Manitoba. Under this program Černý and Trueman (1978) used, as a working hypothesis, the differentiation of the Lac du Bonnet batholith into adjacent bodies of pegmatitic granite. The residual fluids left from the crystallization of the pegmatitic granites formed the pegmatite aureoles. More recently geochemistry suggests partial melting of rare-element-enriched sediments as the process generating pegmatitic granites directly, with the pegmatite aureoles fractionating from them (Černý, Goad and Trueman, 1978).

CHAPTER 3

EXPERIMENTAL METHODS

A Selection and Preparation of Samples

A systematic collection of samples was gathered during a series of short field trips during 1972 and 1973.

These samples fall roughly in two groups; systematically collected suites of minerals that commonly occur either throughout the pegmatite body, or within specific zones, and minerals that had rare occurrences or could not be identified in the field. In the first group would fall the feldspars, beryl, micas, tourmalines, lithium phosphates and apatites. The second group consists of oxides, alteration products, saccharoidal albite samples and unusual occurrences of the major minerals.

In addition to the mineralogical samples taken from the pegmatite body, there was systematic sampling of the country rock at the contacts and at various intervals away from the pegmatite. These samples were thin sectioned to check for contact metasomatic features in the country rock.

Mineral samples that were collected systematically were referenced to their physical location within the open trench and to their position with respect to the mineralogical zoning of the entire pegmatite body. Because both the hanging wall and the footwall of the pegmatite are exposed it was possible to take a reasonably complete cross section of samples.

The selection of samples for analysis was based on attaining the maximum of chemical and physical data possible in a cross section of the pegmatite body. Because the purpose of this study was to derive a petrologic interpretation of the pegmatite, the type of analysis used for each mineral group was chosen on the basis of the type of data concerning the chemistry and physical characteristics of the pegmatite body as a whole that each mineral was capable of yielding.

Sample preparation was done manually. Samples were chosen for their purity and lack of alteration. After hand crushing the mineral concentrates were made by hand picking under a binocular microscope. Final comminution for chemical analysis and x-ray study was done in an agate mortar and pestle.

B Chemical Analysis

Chemical analysis was done in the Rock Analysis Laboratory of the University of Manitoba by K. Ramlal, R. M. Hill and R. J. Chapman.

Samples analysed for alkakies, alkali earths, iron and lead were totally dissolved in acid and the determinations made on a Perkin-Elmer Atomic Absorption unit. Absorption curves were made using prepared standards on each determination. Alumina content was determined using a Philips X-ray Fluorescense Unit.

C X-ray Diffraction Studies

All x-ray diffraction work was done using a Philips X-ray diffractometer, Philips X-ray powder cameras and a Philips Gandolfi camera. The diffractometer was not monochromated and used an analog output. Where accurate absolute values were necessary the powder mounts included an internal standard of either annealed fluorite or quartz.

The type of x-ray analysis used varied with the mineral species involved.

(1) Feldspars

Three types of feldspars were examined by x-ray methods; plagioclase, mainly cleavelandite, perthitic microcline, and small crystals of adularia taken from fissures in the core zone. Each plagioclase was x-rayed twice. The first pattern was used to determine the obliquity by the method described by Bambauer et al. (1967) based on the position of the (131) and ($1\bar{3}1$) reflections. The second sample was mixed with $KBrO_3$ and x-rayed according to the method of P. M. Orville (1967) using the plagioclase ($\bar{2}01$) and the $KBrO_3$ (101) reflections to determine the amount of orthoclase in solid solution.

Similarly the potassium feldspar was x-rayed to determine obliquity according to the method of Goldsmith and Laves as described by Orville (1967) based on d(131) and d($1\bar{3}1$) and the amount of albite in solid solution in the potassium feldspar phase as described by Orville (1967).

The adularia was x-rayed according to the methods of Wright and Stewart (1968) in order to refine the unit cell parameters. Powder smear mounts were made containing 1 part in 4 of synthetic annealed fluorite (a_0= 5.4620 at 25°C) as an internal standard. This sample was run on a diffractometer with CuK_{α_1} radiation from 57° to 10° 2Θ. Two separate trials, each consisting of three runs on the diffractometer were made. The data of three runs was averaged giving two independent sets of accurate 2Θ values for the adularia. Unit cell parameters, based on the two independent sets of 2Θ values, were refined using the computer program developed by Evans, Appleman and Handwerker (1963). The results with the lower standard errors were chosen as representative.

A preliminary attempt to study the adularia using Buerger precession photographs indicated complex zoning and twinning in the crystals, as was confirmed optically. Because of the complexity of the problem compared to the amount of useable data to be derived, single crystal x-ray investigations were abandoned.

(2) Micas

A selection of samples representing all the morphological types of micas in the pegmatite were x-rayed using a 114.6 mm Debye-Scherrer/Straumanis Camera. Careful measurements were made on the resulting films to determine the structural polytypes present. All powder samples were prepared by filing the sample to avoid distortion or destruction of the structure.

(3) Tourmalines

A total of 11 samples of tourmaline, representing a cross section of the occurrences in the pegmatite, were x-rayed to determine precise unit cell parameters.

Powder smear mounts of tourmaline containing 1 part in 6 of annealed fluorite (a_0= 5.4620 at 25°C) as an internal standard were x-rayed on a diffractometer. The samples were run from 12° to 70° 2Θ CuK_{α_1} twice. The samples were then reground and remounted and run