THE VOLCANIC STRATIGRAPHY AND PETROCHEMISTRY OF THE GODS LAKE SUBGROUP KNEE LAKE, MANITOBA

and

THE DIAGRAM MgO/Al_2O_3 VERSUS $(Na_2O + K_2O)/(\text{Total } FeO + TiO_2)$: A DISTINCT SEPARATION OF THE CALC-ALKALINE AND THOLEIITIC ROCK SERIES

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Nathan Louis Green

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ABSTRACT

The predominantly volcanic-volcaniclastic Hayes River Group of Archean age outcrops within a northeasterly trending synclinorium on Knee Lake in northern Manitoba. The greenstone belt was mapped on a scale of 1 inch to 2640 feet; three acid volcanic sections were mapped on a scale of 1 inch to 500 feet. All inland and shoreline outcrops were sampled where feasible. Seventy-six chemical analyses of Hayes River Group volcanic and pyroclastic rocks are presented in graphical and composite form.

Stratigraphic and petrochemical studies (in Part I) indicate that the Hayes River Group can be compared with the upper volcanic and sedimentary sequences of the Barberton model for Archean evolution.

The Hayes River Group is subdivided into the Gods Lake, Knee Lake and Oxford Lake Subgroups (Campbell et al., 1972). The basal Gods Lake Subgroup consists of at least three superimposed cycles of mafic to acid sub-alkaline volcanism. The Gods Lake Subgroup basalts are comparable to modern oceanic tholeiites, but their acid differentiates possess strong calc-alkaline affinities. Chemical data defines two sequences within each volcanic cycle: (1) a thick basal low-alumina tholeiite succession; (2) an upper high-alumina (porphyritic) tholeiite - calc-alkaline succession. The differentiation trend of each volcanic

cycle shifts from tholeiitic to calc-alkaline affinity with increasing stratigraphic height. High-alumina (porphyritic) tholeiites mark the transition from a tholeiitic to calc-alkaline line of descent. The accumulation and later resorption of plagioclase phenocrysts within a tholeiitic magma, during a process of near-surface fractionation concurrent with increasing oxygen fugacity, may have produced the evolution of calc-alkaline differentiates from a low-alumina quartz-normative tholeiitic parental magma.

The Knee Lake Subgroup, which comprises agglomerates, tuffs, trachyandesites and minor sediments, unconformably overlies the Gods Lake Subgroup, and is in fault contact with the overlying Oxford Lake Subgroup.

A new method of petrochemical representation is presented in Part II which discriminates plots of calc-alkaline versus tholeiitic rocks and their differentiation trends, and which: (1) is applicable to a majority of sub-alkaline igneous provinces, (2) minimizes the effect of alteration, and (3) provides a 95 percent effective separation of the two sub-alkaline rock series. In application, the new diagram successfully distinguishes between high-alumina olivine tholeiites and high-alumina calc-alkaline basalts. The diagram was devised to overcome inconsistent results obtained from the conventional methods of plotting chemical data.

TABLE OF CONTENTS

LIST OF FIGURES

Page

I. The Volcanic Stratigraphy and Petrochemistry of the Gods Lake Subgroup, Knee Lake, Manitoba

LIST OF TABLES

LIST OF MAPS

I. THE VOLCANIC STRATIGRAPHY AND PETROCHEMISTRY OF THE GODS LAKE SUBGROUP, KNEE LAKE, MANITOBA

INTRODUCTION

General Statement

Predominantly volcanic-volcaniclastic rocks outcrop within a northeasterly trending belt on Knee Lake, Manitoba. The study area is approximately 145 miles southeast of Thompson, Manitoba within the Superior Province of the Canadian Shield (Figure 1); it was mapped systematically in conjunction with the Greenstone Project of the Manitoba Mines Branch. The purpose of this study is to define the stratigraphy of the Gods Lake Subgroup within the Knee Lake greenstone belt, and to correlate the petrochemistry of the Gods Lake Subgroup volcanic rocks with the stratigraphy.

Method

An area of approximately 150 square miles was mapped at a scale of 1:31,680 during two field seasons. All shoreline outcrops on Knee Lake, Seller Lake, Magill Lake, and Cinder Lake were examined. Pace and compass, and heliocopter-supported traverses covered all inland outcrops where feasible. The final geological interpretation of the Knee Lake greenstone belt was reduced to a scale of

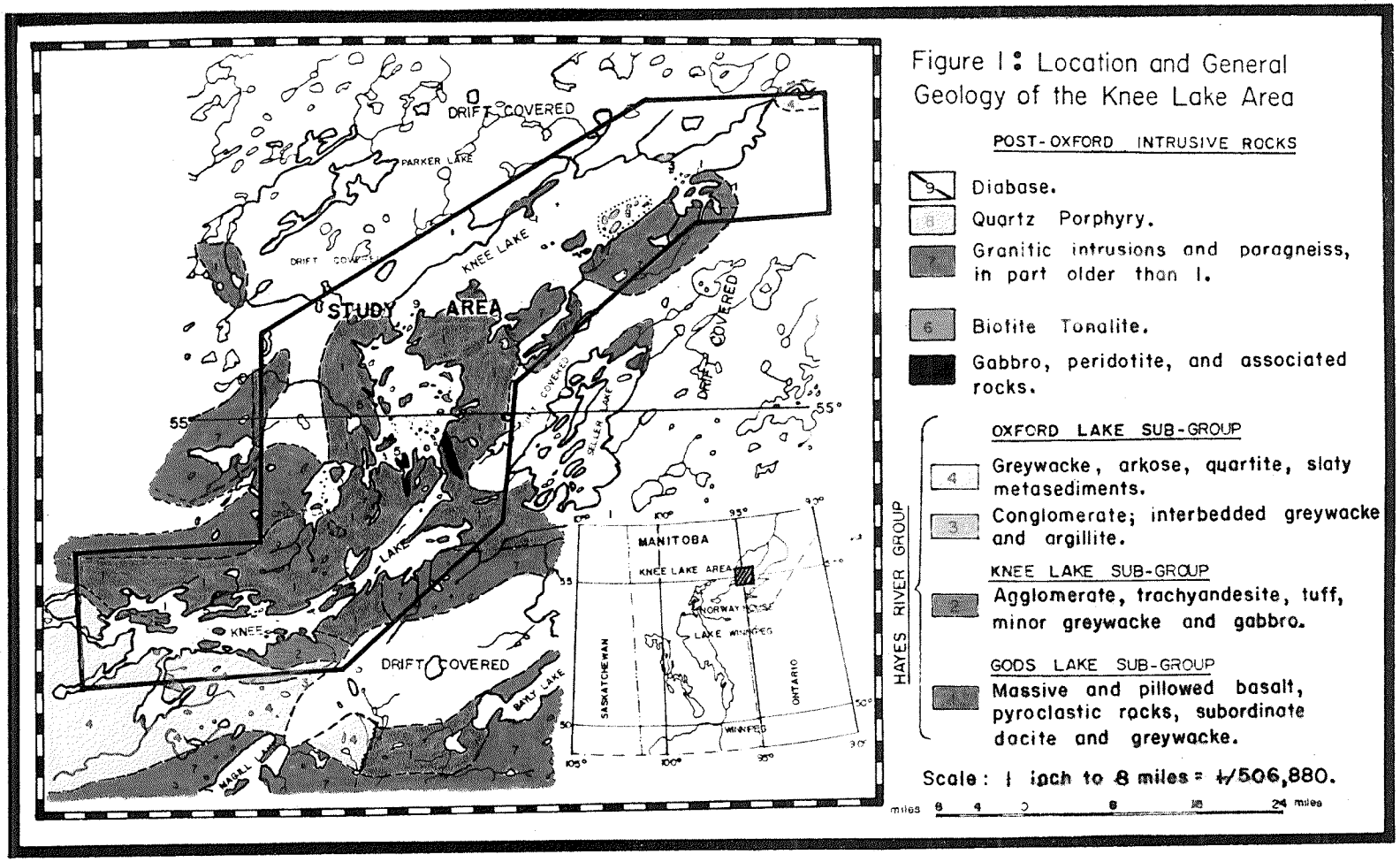

Figure 1 : Location and General Geology of the Knee Lake Area

Figure 1

1:63,360 (Map 1, in pocket).

One hundred and forty samples were examined in thin section (Appendix 1), and seventy-six rocks, which appeared to have suffered a minimum of alteration, were chosen for chemical analysis. Sixty-five chemical analyses were carried out at the Manitoba Mines Branch analytical laboratory using wet chemical methods under the auspices of F.J. Elbers and H.P. Gilbert. Twelve additional chemical analyses were carried out in the Department of Earth Sciences laboratory, University of Manitoba by K. Ramlal using the analytical procedures described by Wilson et al. (1969). Six previously unpublished analyses of a syenite - pegmatite complex on Cinder Lake (Donofrio, 1972) are also included. Niggli molecular-equivalent normative minerals and various variation diagram ratios and indices were calculated utilizing a computer program written by Andrews (1964). This program was adapted for the 360 I.B.M. computer at the University of Manitoba.

Previous Work

The Knee Lake greenstone belt, of Archean age, is approximately 50 miles long and 30 miles wide. Bruce (1919) first mapped the area and established the presence of this easterly trending belt. Wright (1931) proposed the name "Hayes River Group" for the volcanic flows, tuffs, and