THE ALEY CARBONATITE COMPLEX

by

URS KARL MÄDER

Dipl. Natw. ETH, Zürich, Switzerland

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF

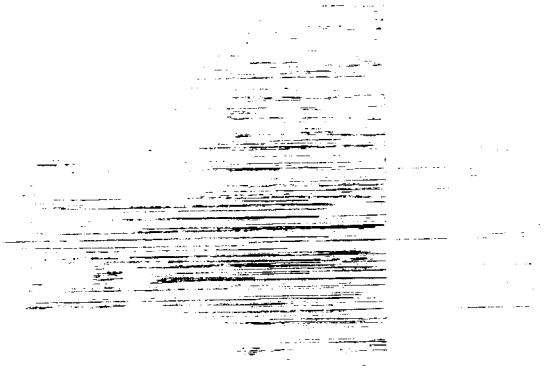
THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

in

THE FACULTY OF GRADUATE STUDIES

Department of Geological Sciencies



THE UNIVERSITY OF BRITISH COLUMBIA

October 1986

Abstract

The Aley carbonatite complex, a property belonging to Cominco Ltd., is 140 km north-northeast of Mackenzie, British Columbia at latitude 56°27′ N, longitude 123°45′ W. The complex intruded Cambrian rocks 345 ma ago near the shelf / off-shelf boundary of ancient North America and is now contained in an imbricate thrust sheet of the Northern Rocky Mountains. The circular complex is 3 km in diameter, cylindrical with respect to the third dimension and little affected by structures of the Rocky Mountains. The relationship of nearby lamprophyric dikes and the lamproitic Ospika diatreme, closely related in time, is unclear.

The Aley carbonatite complex consists of an older, outer "syenite" ring (33% of the area) and a younger dolomite carbonatite core with minor calcite carbonatite "sweats". Rare-earth rich ferro-carbonatite dikes intruded the contact aureole. The contact aureole is composed of recrystallized rocks characterized by brownish weathering, but is little affected by metasomatism and shows no indication of high temperature contact metamorphism.

The mineralogy and mineral chemistry were studied in detail. Over forty mineral species are described, including rare-earth carbonates (burbankite, ancylite, cordylite, huanghoite etc.), niobium oxides (pyrochlore, fersmite, columbite) and alkali-rich silicates (arfvedsonite, aegirine, richterite). Dolomite carbonatite contains apatite, pyrite and fersmite pseudomorphs after pyrochlore. Calcite carbonatite is composed of apatite, magnetite, biotite, pyrochlore, pyrite, ±richterite.

The inner part of the contact aureole forms an annular, cylindrical ductile shearzone suggesting that doming was the major mechanism of emplacement. This is consistent with the circular structural trends in the carbonatite core. Temperatures deduced from field observations and mineralogy (250°C-400°C) disagree with temperatures calculated for a cooling igneous body based on a simple heat conduction model (500°C-600°C) further supporting the view that the complex was

emplaced at subsolidus temperatures.

Oxygen and carbon isotope ratios ($\delta^{18}O$ = 7.7-15.4, $\delta^{13}C$ = -4.7 - -6.1) and some initial Sr isotope ratios ($^{87}Sr/^{86}Sr$ = 0.7034-0.7036) are indicative of a mantle source of carbonatite and syenite.

Geochemically, the carbonatites are enriched in the incompatible elements LREE, Th, U, Nb, Ta, Zr. The rare-earth carbonatite dikes represent a residual liquid extremely enriched in Fe, S, LREE, Sr and Ba. The "syenite" is not a typical alkali-syenite, bearing quartz instead of felspathoids. A strong metasomatic overprint is marked by secondary aegirine and metamorphic textures.

Processes by which the rocks of the Aley may be related genetically are discussed in the light of petrography, geochemistry and experimental studies.