The Petrogenesis and Geochemistry of the Zandkopsdrift Carbonatite Complex, Namaqualand, South Africa

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INTRODUCTION

Carbonatites are igneous rocks composed mostly of carbonate minerals and are typically associated with alkaline magmatic activity. They may be intrusive or extrusive, with or without associated alkaline rock sets (e.g., Wooley & Kjarsgaard, 2008). Carbonatites are generally formed by alkaline magmas and are not likely simple mantle melts. Carbonatites are separated from enriched carbonate silicate magma with further fractional crystallization. Carbonatites vary in composition and have relatively low SiO2 (25 – 31 wt.%) and Al2O3 (5.3 – 6.1 wt.%), high K2O (6 – 6.3 wt.%) and TiO2 (5.6 – 9.5 wt.%), and moderate Mg numbers (51 – 58). Carbonatites have primary mantle carbon isotope signatures but heavy oxygen isotope signatures. The high oxygen isotope signature of carbonatites is most likely attributed to secondary alteration for groundwater.

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Carbonatites are variably evolved. Phase diagram (Cafemics-silicate rocks (e.g. Woolley & Kjarsgaard, 2008). Carbonatite varieties are named on the basis of the dominant carbonate minerals present: Calcicarbonate (CaCO3, calcite), Magnesiocarbonate (MgCO3, dolomite), Ferrocarbonate ((Fe,Mg,Mn)2(CO3)2) and Natrocarbonate (Na,K(CO3)2).

GEOCHEMISTRY

Major elements (+Ni) variation diagrams for carbonatites, olivine melilitites and aillikites have relatively low SiO2 (25 – 31 wt.%) and Al2O3 (5.3 – 6.1 wt.%), high K2O (6 – 6.3 wt.%) and TiO2 (5.6 – 9.5 wt.%), and moderate Mg numbers (51 – 58).

CLASSIFICATION OF CARBONATITES


References


SAMPLE COLLECTION

The freshest available samples were used. Most are core samples from >100 m below the altered cap zone at 2 km diameter. Coke core and blast samples contain rare earth element signature and olivine melilitite. These samples were collected from the Zandkopsdrift carbonatite complex. Aillikite was collected from Zandkopsdrift. Samples were collected from the Zandkopsdrift carbonatite complex. Aillikite was collected from Zandkopsdrift.

PETROGRAPHY

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Acknowledgements

Many thanks to Dr. Stuart Smith and Frontier Rare Earths, Ltd for samples and access to the site.

Conclusions

• MgO contents, Mg numbers and Ni & Cr contents are variably evolved. Phase diagram (Cafemics-silicate rocks (e.g. Woolley & Kjarsgaard, 2008). Carbonatite varieties are named on the basis of the dominant carbonate minerals present: Calcicarbonate (CaCO3, calcite), Magnesiocarbonate (MgCO3, dolomite), Ferrocarbonate ((Fe,Mg,Mn)2(CO3)2) and Natrocarbonate (Na,K(CO3)2). Carbonatite separated out immiscibly from a enriched carbonate silicate magma with further fractional crystallization. Carbonatites have primary mantle carbon isotope signatures but heavy oxygen isotope signatures. The high oxygen isotope signature of carbonatites is most likely attributed to secondary alteration for groundwater.

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• Liquid immiscibility is a common feature of carbonatite magmas. It is thought to occur in the presence of a carbonate-rich silicate parental magma, followed by further fractional crystallization.