A Petrological Study of REE-enriched Carbonatite Intrusions in the Lofdal Farm Area, Namibia

Alexander Kaul*
Department of Earth and Environmental Science, Acadia University, Wolfville, Nova Scotia, Canada B4P 2R6, 083535k@acadiau.ca

and

Sandra M. Barr
Department of Earth and Environmental Science, Acadia University, Wolfville, Nova Scotia Canada B4P 2R6

Abstract

Carbonatite dykes in the Lofdal Farm area near the town of Khorixas in Damaraland, Namibia, contain elevated concentrations of rare-earth elements (REE) and in some cases unusually high ratios of heavy REE to light REE. The dykes generally trend NE-SW, and occur in a zone at least 12 km in length and 6 km in width. Individual dykes are mostly between 0.5 cm and 5 m in width, but some are up to 25 m wide and extend over several kilometres. Carbonatite also occurs in plugs with diameters up to several hundred meters; the plugs appear to lack highly elevated REE values but are still of economic interest. The dykes and plugs occur in association with syenite and nepheline syenite intrusions that combined form an alkaline intrusive complex in an area of over 125 km^2. Previously reported U-Pb dating of xenotime in the carbonatite dykes indicated ages of 709± 9 Ma to 775±41 Ma. The complex is hosted by 1.7 Ga metasedimentary rocks, including gneiss and schist, of the Huab Basement Complex.

This study is based on 18 samples from 6 carbonatite dykes and their host rocks and two carbonatite plugs. The calcic carbonatite samples consist of equigranular twinned calcite with varying abundance of Fe-carbonate, Fe-oxide, and magnetite. Other minerals include biotite, K-feldspar, and very fine-grained apatite. Some samples are highly altered ferrocarbonatite and consist of a homogeneous mass of ankerite/siderite with inclusions of calcite, K-feldspar, and biotite. Based on electron microprobe analyses, the Fe-carbonate mineral is ankerite. Microprobe data also indicate that REE appear to occur in fine-grained opaque minerals as well as in REE-mineral inclusions in calcite. Analyses of eight whole-rock samples showed varying total REE abundances, with a high of 50 820 ppm. Four samples from one dyke show an increasing amount of silicon from the center of the dyke to the edge, accompanied by a decrease in total REE. Ratio of total light (La to Sm) to total heavy (Eu to Lu) REE in the analyzed samples ranges from less than 1 up to 60. The low light to heavy REE ratios occur in the highly altered ferrocarbonatite samples, whereas the high light to heavy REE ratios occur in the calcic carbonatite samples, suggesting a link between alteration and light REE depletion.

A regional geochemical database of 1400 REE analyses shows total REE concentrations up to 86 184 ppm in some dykes. According to this database, the light REE concentrations are highest in dykes located in a ‘halo’ around each of the two carbonatite plugs in the study area, whereas the dykes with high heavy REE are located outside the light REE-enriched “halo” NE of the Emanya plug, and outside the light REE-enriched “halo” both NE and NW of the main plug to the east. Yttrium shows a strong positive correlation with heavy REE concentration in the dykes, with Y values up to 20 600 ppm in the 1400-sample database. The correlation between light REE and Y is not as strong. The high concentration of total REE in these carbonatite dykes may be the result of a highly REE-enriched melt coupled with a high degree of crystal fractionation during melt evolution.