Geochemistry of alkaline silicate-carbonatite rock associations within the intrusive complexes of Brava Island, Cape Verde

Daniel Weidendorfer, Hannes B Mattsson, Max W Schmidt

Swiss Federal Institute of Technology Zurich (ETH Zurich), Switzerland

E-mail: daniel.weidendorfer@erdw.ethz.ch

Intrusive carbonatites often occur in intimate association with various silicate rocks such as phonolite, nephelinite, syenite and melilitite. Compared to the alkali-rich composition of the world's only existing carbonatite volcano Oldoinyo Lengai (Tanzania), the absence of alkalis in most calcitic carbonatites around the world may be a direct consequence of fluid-release (rich in alkalis) to the surrounding wall-rocks during crystallization (i.e., fenitization). This study focuses on physico-chemical interaction between carbonatite and silicate magmas, as well as on late stage fenitization processes in alkaline silicate-carbonatite complexes within the intrusive unit of Brava Island (Cape Verde).

Alkaline silicate rocks from Brava range in composition from phonolites, tephriphonolites, phonotephrites, basanites to nephelinites and melilitites. Compared to previous studies our new whole rock data (80 bulk rock samples) show that the previously inferred compositional gap between calico/magnesiocarbonatites and nephelinite/melilitite rocks is, in fact, chemically linked via a set of highly SiO2-undersaturated (<30 wt%) alkaline rocks. Trace element chemistry of magnesio- and calciocarbonatite dikes crosscutting the alkaline silicate complexes suggests a direct petrogenetic link to their associated silicate rocks. Trace element plots show that calciocarbonatites are characterized by a positive correlation of REE (e.g., La vs. Sm) and are unequivocally more enriched in REE than magnesiocarbonatites which are defined by positive curvilinear trends. Interestingly, the associated alkaline silicate intrusives closely follow either the calico- or the magnesiocarbonatite REE trends, possibly indicating a common petrogenetic origin.

Some of the intermediate alkaline rocks display mingling textures consisting of carbonatite globules within a silicate matrix, whereas the exact transition between the two rock types is rather diffuse. Coulometric analyses show a bimodal variation in CO2 within the carbonatite and alkaline silicate rock suites. Fenitized silicate rocks and mingled silicate/carbonatite rock associations define, together with the CO2-rich carbonatite endmembers, a negative linear trend when the total alkalinity is plotted against CO2 (ranging from 5-43 wt%). In contrast, nephelinites, melilitites and phonolites which are hardly affected by an overprint of fenitizing fluids display CO2 concentrations less than 5 wt%. Within the carbonatites an internal variation in CO2 concentration is observed, whereas a significant drop of CO2 (from 40 to 20 wt%) is recorded in mingled rock samples displaying the effect of the increasing carbonatite fraction within silicate magmas. Thus, mixing proportions between these rheologically and chemically contrasting magmas may affect significantly the eruption dynamics within silicate-carbonatite volcanic provinces such as the Island of Brava.