INTENSE CARBONATE METASOMATISM OF OCEANIC MANTLE BENEATH THE FERNANDO DE NORONHA ISLAND

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Petrologic and geochemical study of lherzolitic and harzburgitic xenoliths from basanites of the Fernando de Noronha Island revealed that oceanic mantle of this region has been affected by very strong carbonate metasomatism. The metasomatism led to a wehrlitization of the primary harzburgitic mineral assemblage (Ol, Opx, Sp) and to an increase in Mg/Fe ratios of the minerals. The wehrlitization was a result of interaction between a possibly ephemeral sodic dolomitic melt or fluid with the harzburgitic rock according to the reactions:

$$2\ MgSiO_3 + CaMg(CO_3)_2 = 2\ Mg_2SiO_4 + CaMgSi_2O_6 + 2\ CO_2, \text{ and}$$

$$3\ CaMg(CO_3)_2 + CaMgSi_2O_6 = 4\ CaCO_3 + 2\ Mg_2SiO_4 + CO_2.$$

This model is in agreement with experimental results of Dalton and Wood (1994). Olivine encloses abundant polyphase, glass-rich inclusions consisting of trachytic glass, monosulphide of Fe, Ni, and Cu, Ca-rich carbonate and dense CO_2. All major silicate phases of the rocks are rich in CO_2 inclusions. The relationships between glass, sulphide and carbonate inclusions permit to speculate that silicate and sulphide in the Ca-rich carbonatite melts were in equilibrium with each other and originated by partial melting of metasomatized and wehrlitized mantle of the Fernando de Noronha Island.

We have experimentally investigated, with a piston-cylinder apparatus, the immiscibility relationships in the system Ca-rich carbonate – Fe, Ni sulphide – F-bearing silicate melt of phonolitic composition. Experiments were conducted at 1250 ^oC and 4–15 kbar. The double-Pt capsule method has been employed in order to control the oxygen fugacity. Immiscibility has been observed in the investigated system as a complete separation of carbonate and silicate liquids, with sulphide melt present in the form of small globules in both liquids.

The sulphur solubility in the silicate melt varies from 0.15 to 0.35 % and in carbonate liquid from 0.02 to 3.7 % depending on the total alkali content.

The results permit to develop a two-stage model of Ca-rich carbonatite formation:

1st stage – metasomatic wehrlitization and carbonatisation of mantle rocks;

2nd stage – partial melting of the wehrlitic substrate containing carbonates, resulting in two liquids and the generation of calciocarbonatites.

Comparison of these data with our observations on Montana Clara xenoliths (Kogarko et al., 1995) demonstrates that the carbonatization processes are widespread in the oceanic mantle and partial melting of wehrlitized mantle, containing carbonate, could result in generation of Ca-rich carbonatitic melts.

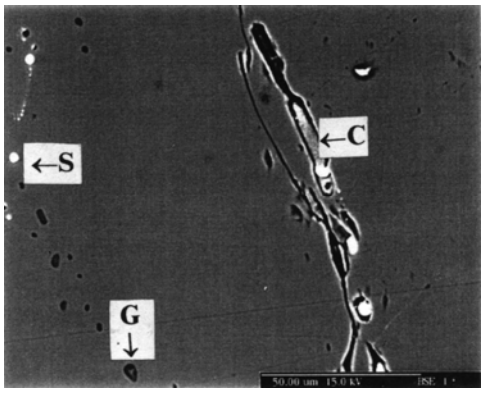

Fig. 1 Back-scattered electron image of secondary melt inclusions in olivine - I generation. Bright white – sulphide melt inclusions (S). White – carbonate inclusion, containing sulphide globule (C), inclusion is partly leached. Grey – inclusions, containing trachyte-phonolite melt (G)

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