EXPERIMENTAL STUDY OF INTERACTION BETWEEN REDUCED GASES AND XENOLITHS OF LHERZOLITES FROM KIMBERLITES

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The interaction between the reduced fluid flows and depleted ultrabasites plays the key role in the appearance of ore-magma systems and basic magmas formation. The aim of our experiments was to study the interaction of reduced gas flows and real mantle rocks, when the gas initial composition is similar to mantle fluids. Xenoliths of lherzolites from kimberlits of the undestroyed structure and compositions were taken as such rocks.

The experiments were carried out in flow reactor containing subsequent windows for thermocouples and sample probing for gas composition analysis (fig. 1).

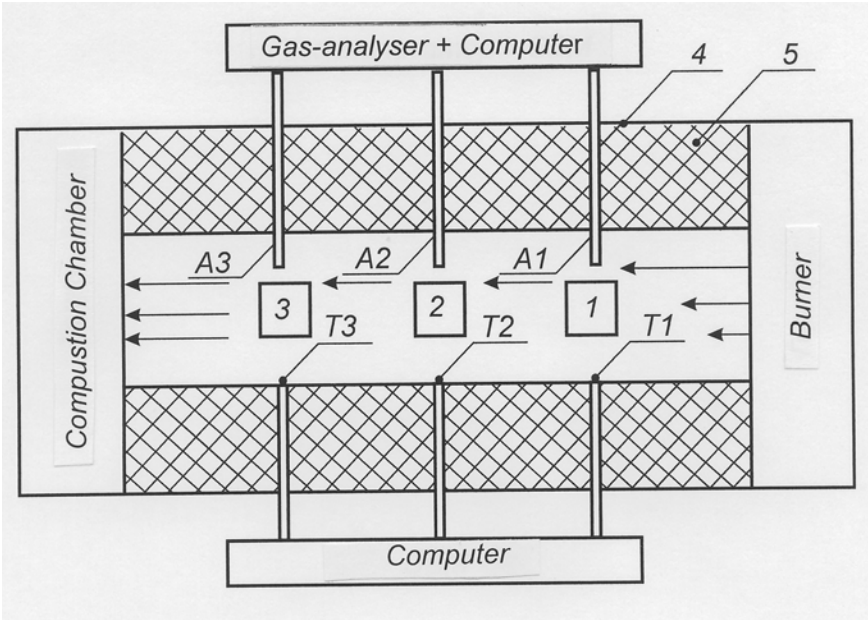

Fig.1. The scheme of the experimental chamber. 1,2,3 – rock samples: the arrows show the gas flow direction, $T_{1,2,3}$ – thermocouple, $A_{1,2,3}$ – gas-analyzers

The rock cubes of 2×2×2 cm were placed on the porcelain thermocouple parts with their soldered joints at the sample bounders; in this way the temperature of the coming gas flow was measured. The temperature interval and pressure were 1200-800ºC and 1 bar respectively. The gas composition mixture was $H_2 \approx$ 8-13%, $CO \approx$ 9-11%, $CO_2 \approx$ 17-18%, $N_2 \approx$ 58-66%. The experiment parameters were the following: the initial heating stage > 700ºC was about 3 minutes, the non-stationary heating - 5-7 minutes, the stationary heating - 15-17 minutes, then the reducer was switched off and the samples were quenched in the open air.

As the result of the experiment we planned: 1) to obtain the products of hetero-phase reactions and to determine the character of changes at the mineral surfaces and boundaries, while these minerals were subjected to hot gas flows; 2) to estimate the composition of interstitial and liquating melts; 3) to trace the transfer of components from interstitial zones, secondary gas-liquid inclusions and from the sections of dehydration.

The experiments we carried out before showed that the main structural transformations were vent formation, output of the gas from the sample depth, the deposition of bubbled drops, aluminosilicate glass films, spinellide dendtites, troilite, wustite and nikel-iron spots at the samples surfaces [1,2].

New experiments with garnet lherzolites and anorthosites showed that the processes of sublimation and melting took place. We found that the main export of water fluid happened within the temperature interval 600-700ºC. The most reduced fluids were separated under the temperature interval 800-1000ºC. When the temperature was more than 800ºC melt films appeared at the contacts of olivine, orthopyroxene and clinopyroxene grains, while garnet crystals melted completely when the temperature was more than 1000ºC. Quenched glasses happened to be inhomogeneous in composition, both in various rocks, an in a separate rock when the melting temperatures were different - 1000ºC и 1200ºC. In each case there were from 3 to 6 clusters of melt composition of characteristic difference in SiO_2, Al_2O_3, and other components.

Specific features of garnet volume transformation, its amorphism and dispersion are shown in fig. 2.

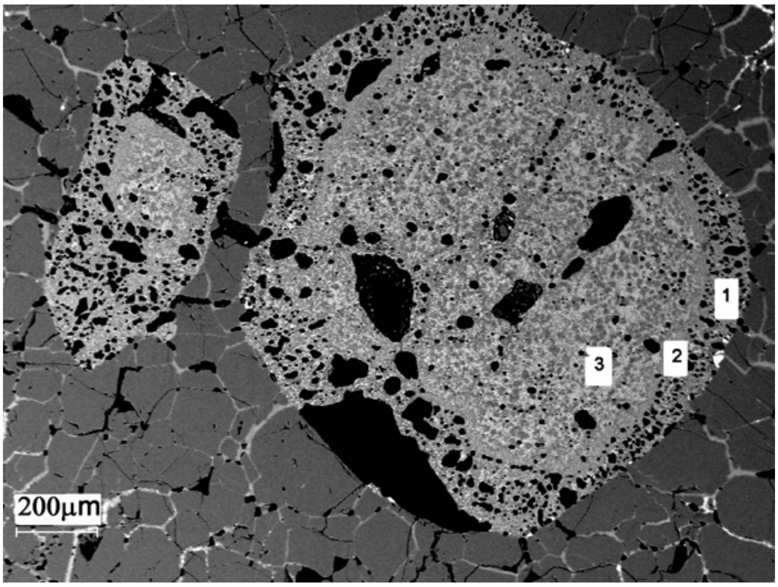

Fig.2. The structure of transformed garnet lherzolite. Interstitions of forsterite are composed of melt films (light color). Garnet rounded zones are zonal. The outer zone (1) is saturated with gas pores and amorphous; the next zone (2) is represented by thin-grained amorphous mass, and the inner (3) zone is of inhomogeneous structure. The latter contains the blocks close in composition to primary garnet, particles of hercynite in magnesium-silica glass; the rest is composed of aluminosilicate glass

The largest parts of interstitial glasses are different in composition from contact minerals. Within the samples parts remote from surface influenced by hot gases, nests and veins of hardened inter-grained melts are often seen among monomineral forsterite aggregates (fig. 3). Grains of magnesium olivine (4) are grown over with subsequently more ferruginous olivine (3,1), while in the central part skeleton grains of ferruginous olivine (2) are found in aluminosilicate glass having inclusions of isometric parts of monosulfide (2) and oxide solid solutions (white color).

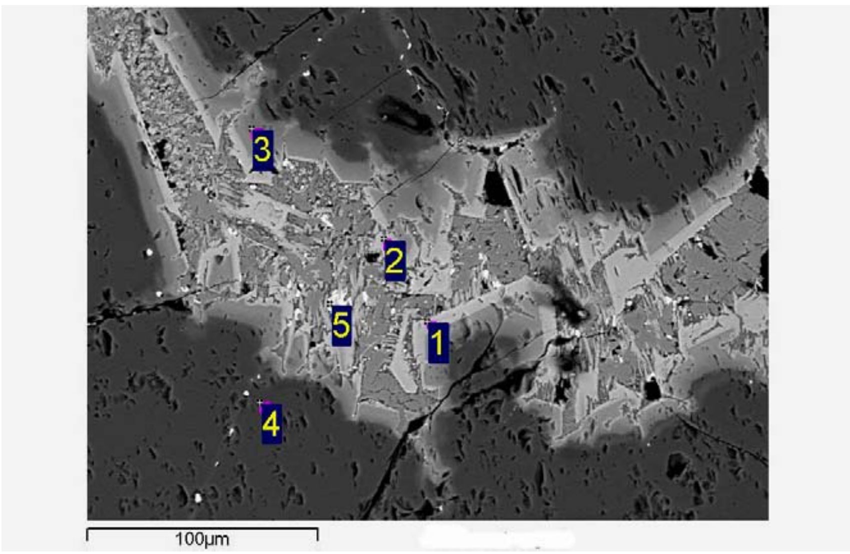

Fig.3. Zonal structure of inter-grain melting products

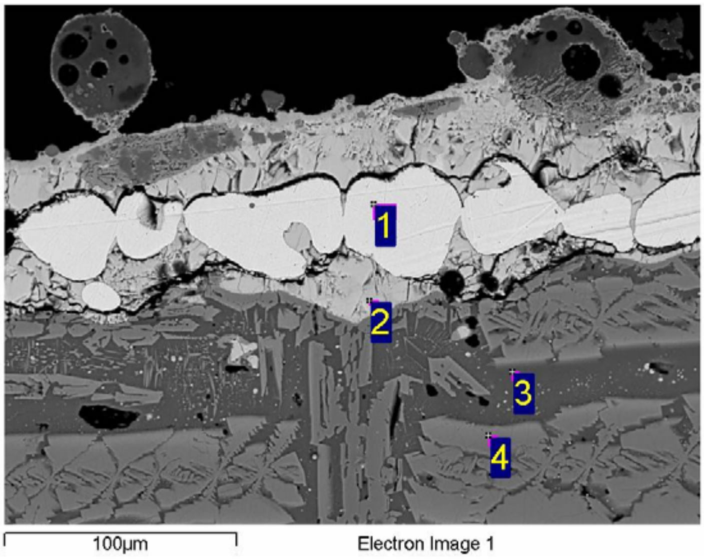

Fig.4. The structure of the quenched melt surface film

Melt films located at the surface and in rough fractures of the broken samples have their own zoning shown partly in fig. 4. The contact between the melt and the rock is not diffusive, as in the above-mentioned case, but sharp. The rock matrix is glassy, has aluminosilicate composition with dotted inclusions of sulfide particles and skeleton olivine grains. Close to the periphery larger olivine crystals (4) appear together with olivine submicron grains. Then we can see an inequigranular texture, where wustite-troilite matrix (2) contains rounded grains of nikel-iron (1). The outer border contains glassy of partly devitrified silicate spheres having gas bubbles.

The volume of contact melting and melt extraction at the surface for the studied samples under the temperature 1200ºC and heating time 20 minutes is about 10%. The experiments with various rocks showed that native iron, copper, lead, rutile, perovskite, spinellides, carbon, sulfides and rare elements silicates together with ore-forming minerals appear in new products. This process can be regarded as the main factor of metallogene properties of basic melts from lithosphere substrates of various compositions, when they are influenced by over-asthenosphere reduced fluids.

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