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The investigation of argon diffusion in phlogopite under high pressure conditions

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The present study deals with assessment of pressure effect on the mechanism of bleeding an argon from mica at high temperatures and pressures. The influence of pressure on the diffusion of argon in crustal conditions is not significant (Harrison et al., 2009), while in the mantle conditions, should be significant. The authors suggest that the findings will help to better understand the behavior of K/Ar isotopic system in mica under the lower crust and mantle, including xenoliths transport by kimberlite melt. The experiment was made by using high-pressure spacer "split-sphere" (BARS - 300). Phlogopite from veins cutting metamorphic rocks from the Sludyanka number 2 quarry was used as a testing material.
Inclusions of other minerals were not found in the original phlogopite crystal. Chemical composition of phlogopite is homogeneous. 8 experiments was made at a constant pressure of 30 kbar and different temperature and duration: 20 degrees Celsius, 20 minutes; 700 degrees Celsius, 20 minutes; 800 degrees Celsius, 10 minutes; 800 degrees Celsius, 20 minutes; 800 degrees Celsius, 30 minutes; 900 degrees Celsius, 20 minutes; 1000 degrees Celsius, 20 minutes; 1100 degrees Celsius, 20 minutes. According the results of SEM-observation, there is no signs of recrystallization and solid state transformations and melting of phlogopite. It's chemical composition is identical to that of the original phlogopite. Diffractograms of phlogopites after the experiments are similar to the diffractograms of the original phlogopites. Research results of IR spectroscopy, together with the results of SEM and microprobe analysis suggest that phlogopite dehydroxylation in the temperature range T = 700-900 degrees Celsius was negligible.
Numerical simulation of the behavior of radiogenic argon in phlogopite at high temperatures and pressure was performed using «Diffarg» software finite differences algorithm, based on the mechanism of bulk thermally activated diffusion (Wheeler, 1996). The size of the effective diffusion domain of mica was considered to be 100-150 microns, when modeling (Baxter, 2010). Comparison of results of simulations and experiments suggests that the mobility of argon isotopes in phlogopite at high temperatures and pressure is well described by the mechanism of thermally activated volume diffusion.
Stepwise release of argon in a vacuum experiment was also conducted. The activation energy of 207,714 J/mol was calculated from the slope of the line on the Arrhenius chart. This value is consistent with data obtained by other authors in hydrothermal experiments (Baxter, 2010).

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