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Experimental study of zircon solubility in silicate melts

Експериментално изследване на разстворимост на циркона в силикатните топилки

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Experimental method

The solubility of zircon in an aluminosilicate melt was experimentally investigated at T 1000 °C and P 2 kbar in a high gas pressure vessel. The temperature was controlled and monitored with Pt-PtRh10 thermocouples with an accuracy of ±2 °C, the pressure was measured with a spring pressure gauge with an error of ±1%. The gradient free zone is 50 mm, the working diameter of the furnace is 15 mm. The experiments were carried out in welded platinum ampoules, where the sample was placed and, if necessary, the initial solution was poured.

The solubility of zircon was studied in the presence of water or a solution of 1M KF. In the experiments, zircon synthesized under hydrothermal conditions and granite (Orlovka deposit, well 42) of the following composition were used (mas.%): SiO_2 72.10; TiO_2 0.01; Al_2O_3 16.14; Fe_2O_3 0.68; MnO 0.09; CaO 0.30; MgO 0.01; Na_2O 5.17; K_2O 4.28; P_2O_5 0.02; F 0.32; H_2O 0.18, which was previously melted at atmospheric pressure and a temperature of 980 °C. Also aluminosilicate granite glasses with different agpaitic coefficient K_{agp} = (Na+K)/Al (from 0.80 to 2.5) were previously prepared by melting. The experiments were carried out in 7x0.2x50 mm platinum ampoules, into which about 50 mg of granite glass, 5 mg of zircon crystals and about 15 mg of water or 1 M KF were loaded. Ampoules were hermetically sealed and placed in a “gas bomb” for the experiment. The duration of such experiments was 5 days, and then isobaric quenching procedure was made.

The compositions of all samples after experiments were determined by electron probe X-ray spectral analysis (EZRSA) using a Tescan Vega II XMU scanning electron microscope (Tescan, Czech Republic) equipped with the INCA Energy 450 X-ray microanalysis system with energy-dispersion (INCAx-sight) and crystal diffraction (INCA wave 700) X-ray spectrometers (Oxford Instruments, England) and software platform INCA Energy +.

Experimental data

To estimate the solubility of zircon in an aluminosilicate melt, we used the method of measuring the diffusion profile of the ZrO_2 content in quenching glass from the boundary of the zircon crystal. Fig. 1

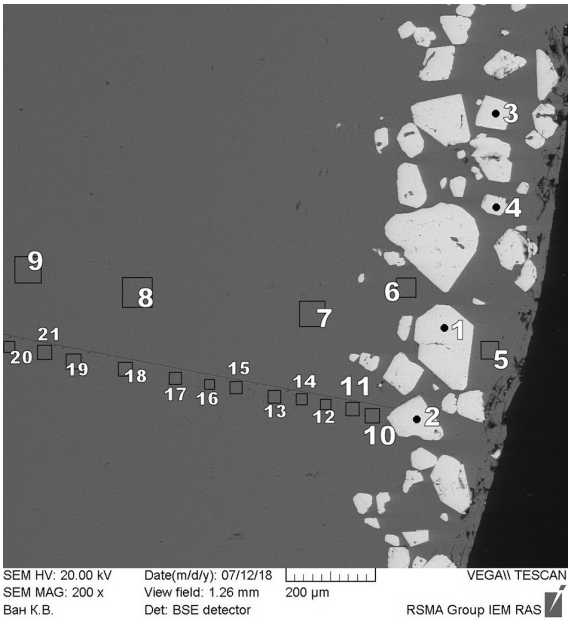

Fig. 1. Diffusion profile in the study of zircon solubility in an aluminosilicate melt in the presence of 1 M KF (T 1000 °C, P 2 kbar)

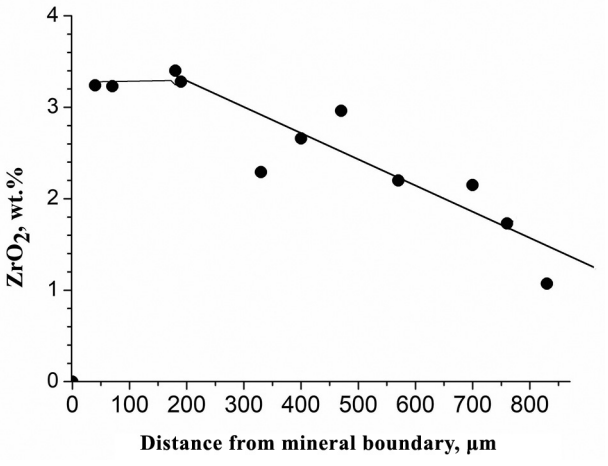

Fig. 2. An example of the measured profile of the diffusion ZrO_2 distribution upon dissolution of zircon in the granite melt with 1 M KF (K_{agp} = 0.80, T 1000 °C, P 2 kbar)

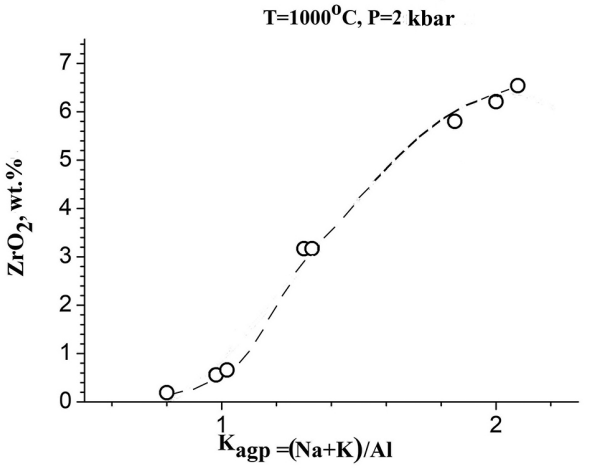

Fig. 3. Dependence of zircon solubility in an aluminosilicate melt in the presence of water on agpaiticity (K_{agp} = (Na+K)/Al)

shows the selected diffusion profile, and Fig. 2 shows an example of the measured diffusion distribution profile of ZrO_2 when zircon is dissolved in a granitic melt in the presence of 1 M KF. The figure clearly shows that at a distance of ~ 200 μm, the ZrO_2 content in the glass remains constant and then begins to decrease. This gives ground to take these maximum values as the solubility of ZrO_2 in the melt.

To determine the effect of alkalinity on the solubility of zircon in an aluminosilicate melt, experiments were carried out in systems with different K_{agp} = (Na+K)/Al: from 0.80 to 2.5 in the presence of water. The dependence of the solubility of ZrO_2 in the melt on K_{agp} was revealed: with an increase in K_{agp} from 0.8 to 2.08, the solubility of ZrO_2 in glass increases from 0.2 wt% to 6.54 wt% (Fig. 3).