Glass and ceramics properties, applied mineralogy

[#]Kuryaeva R.G., Kirkinskii V.A. Refractive index and density of obsidian at pressures to 5.0 GPa from the measurement data in a diamond anvil apparatus.

key words [*obsidian refractive index contractability of obsidian high pressure diamond anvils*]

Silicate glasses are used as structural models of magmatic melts, and a high pressure study of their behaviour gives an insight into particular properties of deep-seated magmas, important for petrography, geochemistry, and geodynamics. We have shown earlier [1-4] that silicate glasses with silica content $\geq$50 wt% are characterized by a nonlinear increase of the refractive index and density with growing pressure, the pressure coefficient of these quantities initially increase, goes through the maximum and then slowly decreases herewith.

In order to have a more complete pattern of a change in the properties of glasses under pressure as a function of silica content in them, we have studied in this work rhyolite obsidian glass containing ~75% silica of density ρ=2.340$\pm$0.005 g/cm^3 (the density was measured by a hydrostatic weighing method). As suggested by the RSMA Camebax-micro data, the chemical composition of the glass in question (wt%) was as follows: SiO_2 75.32, K_2O 4.13, CaO 0.941, Na2O 3.43, MgO 0.182, Al_2O_3 14.16, FeO 0.719, MnO 0.08, TiO_2 0.173, Cr_2O_3 0.006.

The measurement of the refractive index under high hydrostatic pressures was carried out by our technique [5] using a polarizing interference microscope and an apparatus with diamond anvils. The sample was pressurized in a stainless steel gasket. The diameter of the working area of the anvils was 800 mkm, the sealing gasket opening diameter was ~300 mkm. The pressure transmitting liquid being, simultaneously, optical medium was a standard alcohol mixture: methanol-ethanol (4:1). The pressure in the range of 0-2.0 GPa was determined by the technique of [6] using a polarizing interference microscope, and in the range of 2.0-5.0 GPa by the shift of the R_1-line of ruby luminescence. The luminescence was excited by a helium-neon laser radiation LG-79-1 (λ=630 nm). The pressure uncertainty was σP=$\pm$0.05 GPa.

The pressure dependence of the refractive index (fig.1) and the density of obsidian (fig.2) calculated from the obtained experimental data and photoelasticity theory [7], grow nonlinearly with increasing pressure with an inflection in the region of 2.5-3 GPa.

Such anomalous behaviour is analogous to the behaviour of silica [1] tholeiite basalt [2], and diopside [3] glasses (see fig.2) and is indicative of structural reorganizations under high pressures. The contractability of silicate glasses grows with silica concentration in the glass and the corresponding increase of the degree of binding of the silicooxygen carcass.

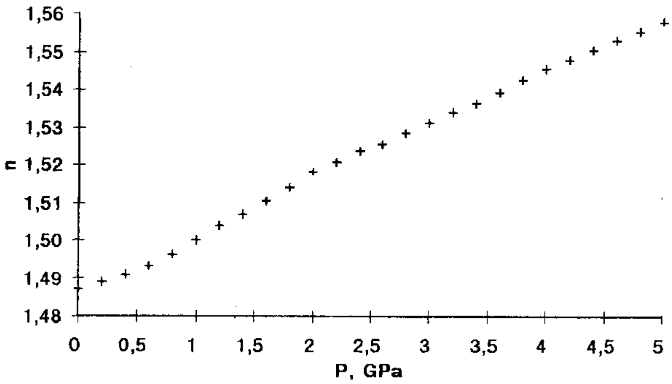

Fig.1. Refractive index n of rhyolite obsidian glass as a function of the pressure P.

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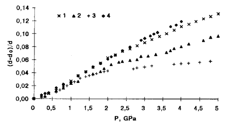

Fig.2. Relative density changes (d-d$_o$)d vs the pressure P for silicate glasses. 1- obsidian, 2 -tholeiite basalt glass, 3 - diopside glass, 4 - silica glass.

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