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A high-temperature Brillouin scattering study on four compositions of haplogranitic glasses and melts: High-frequency elastic behavior through the glass transition

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Abstract

The sound velocities (nv_p, v_p, v_s) and refractive index n of four haplogranitic glasses and melts have been measured as a function of temperature by Brillouin scattering spectroscopy. The measurements were conducted at GHz frequency, through the glass transition temperature (T_g), using both platelet and backscattering geometries. The compositions of the four haplogranites are based on the addition of ~5 wt% each of the components Li_2O, F_2O_{-1}, Na_2O, and K_2O to a haplogranitic (HPG8) composition. Marked changes in slope and sign are observed in the temperature dependences of sound velocities (nv_p, v_p, v_s) as a function of composition. The glass transition temperatures T_g of the haplogranite samples are determined from distinct slope changes of sound velocities (v_p and v_s) vs. temperature. The lithium-enriched glass has the lowest glass transition temperature (466 °C), while the potassic glass has the highest glass transition temperature (575 °C). The unrelaxed bulk moduli vary markedly with composition below the glass transition, as do their temperature dependencies: the bulk moduli of the F- and Na-rich glasses have positive shifts with temperature. For comparison, the shear moduli have relatively similar temperature dependences below T_g for different alkali contents. At temperatures above the glass transition, the temperature derivatives of the bulk moduli, which for these frequencies reflect the vibrational compressibilities of the liquids, shift to more negative values. However, the compositional range over which the bulk moduli undergo positive or small negative temperature shifts of the vibrational compressibility appears to extend to NBO/T ratios near 0.3–0.4, or spanning most haplogranite compositions.

Keywords: High temperature, elasticity, Brillouin scattering, haplogranites