

Sound velocities of aluminosilicate glasses at high pressure

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The sound velocities (compressional wave velocity [V_p] and shear wave velocity [V_s]) of four types of aluminosilicate glasses, with the compositions of $Mg_3Al_2Si_6O_{18}$ (MAS), $Ca_3Al_2Si_6O_{18}$ (CAS), $Na_3AlSi_3O_9$ (NAS), and $K_3AlSi_3O_9$ (KAS), were measured using an ultrasonic technique at high pressures up to 7.8 GPa. The V_p and V_s of the MAS glass exhibited anomalous changes with pressure; both velocities decreased up to 2 GPa then started to increase with increasing pressure. The CAS glass velocities exhibited a change in pressure dependence; V_p was almost constant with pressures up to 2 GPa then increased above 2 GPa, and the V_s had a minimum around 2 GPa, in common with the MAS glass. The sound velocities of the NAS and KAS glasses showed a monotonous increase with pressure. Increments in V_p and V_s of the KAS glass showed less sensitivity than that of the NAS glass within the pressure range of our experiments. Bulk sound velocity calculated from V_p and V_s exhibited similar pressure behavior to that of V_p . Differences in the properties of modifying cations in the glasses, such as size ($^{[5]}Mg^{2+} < [^{6-7}]Ca^{2+} \approx [^{6-7}]Na^+ < [^{9-11}]K^+$) and field strength (ratio of the charge to the radius), accounted for each sound velocity trend. The effects of cation field strength on the structure and elasticity of aluminosilicate glasses could govern the pressure-induced change in sound velocities. Results indicate that the kind and amount of alkali and alkaline-Earth metals control the elastic behavior of silicate glass under high pressure.

Keywords: aluminosilicate glass, network modifier cation, sound velocity, high pressure