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**LETTER**

# Aluminum coordination and the densification of high-pressure aluminosilicate glasses

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## ABSTRACT

To better understand the relationship between atomic-scale structures and densities of aluminosilicate glasses and liquids, we used $^{27}$Al MAS NMR to determine the speciation of aluminum ions in $K_3AlSi_3O_9$, $Na_3AlSi_3O_9$, and $Ca_3Al_2Si_6O_{18}$ glasses quenched from melts at 3 to 10 GPa. These data are a first approximation of high-pressure melt structure and illustrate the effects of the type of modifier cation. High field strength modifier cations (e.g., Ca) clearly induce more high-coordinated Al than lower field strength cations (e.g., Na and K). Measured glass densities show that, especially with rapid decompression, a significant portion of the total densification observed in-situ in melts is retained on return to ambient temperature and pressure. Observed increases in Al coordination are well correlated with decreased volume, which suggests that this structural change is a major part of the mechanism for recovered densification of high-pressure melts. Additionally, $^{23}$Na MAS NMR, combined with the $^{27}$Al MAS spectra and density determinations, reveal that other changes, such as the compression of modifier cation sites and/or decreased network bond angles, must also be significant, especially at low pressure.