

Aluminous silica under the hydrated lower mantle conditions

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Silica is thought to be a potential water carrier in the basaltic layer of subducting slabs. Recent studies suggest that the water storage capacity of stishovite might be at weight percentage level under the lower mantle conditions,^{1,2} and this water content is much higher than the previously reported value of 15-72 weight ppm in stishovite based on the analysis of the quenched sample.³ It is generally accepted that silica follows the structural transition sequence of stishovite to CaCl₂-type to α -PbO₂-type phase with depth in the lower mantle.⁴ As important components in the subducting slabs, incorporation of alumina and hydrogen (water) into silica can have significant effects on the pressure-temperature (*P-T*) conditions of the post-stishovite transition.⁵ Here we investigated the phase relations of aluminous silica in model hydrated SiO₂-Al₂O₃-enriched multicomponent compositions using X-ray diffraction in a laser-heated diamond anvil cell under *P-T* conditions corresponding to the deep lower mantle. We found that (i) the Al-rich niccolite-type silica with Al₂O₃ content up to 32.4 wt.% was synthesized in a wide *P-T* stability field along a warm geotherm; (ii) there is a sharp increase of Al₂O₃ content in the CaCl₂-type silica from ~7 to ~17.5 wt.% at 84-88 GPa along a hot geotherm; (iii) both of the niccolite-type and CaCl₂-type silica contain some amounts of water. Our results suggest that the aluminous silica polymorphs could serve as water carriers throughout the lower mantle. With the implications for global hydrogen cycle and deep Earth's mineralogy, we expect future research works dedicating to the effects of pressure, temperature, mantle composition and water content on the phase transitions in aluminous silica and its crystal chemistry.

Reference

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