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Formation of an Al-rich niccolite-type silica in subducted oceanic crust: implications for water transport to the deep lower mantle

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Basaltic oceanic crust in subducted slabs can contain free silica up to ~20 wt.% in the lower mantle [1]. As one of the silica polymorphs at lower-mantle pressures, niccolite-type phase (Nt-phase) has not been found in multicomponent metabasaltic or metasediment compositions relevant to subducting oceanic crust. Here we reported the formation of an Al-rich Nt-phase, coexisting with Al-depleted bridgmanite, $CaCl_2$-type hydrous δ-phase, and an iron-rich phase in model hydrated basalt in the pressure-temperature range of 84–113 GPa and 1800–2200 K. A compared experiment showed that in the starting material with lower water content there is coexistence of both $CaCl_2$-type and Nt-type phases, indicating that hydrogen incorporation stabilizes the Al-rich Nt-phase. Considering the water storage potential of stishovite and $CaCl_2$-type silica up to weight percentage level at low mantle pressures [2,3], the Al-rich Nt-phase could likely also contain substantial water. Along with the previously identified water carriers including Al-bearing stishovite,$CaCl_2$-type SiO_2 and hydrous Al-rich phase D in the subducting crust at the shallow lower mantle [4], Al-rich Nt-phase can be formed at greater depths, accommodating considerable amount of water in the deep lower mantle.

Reference

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