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Ongoing biogenic silica diagenesis — Interstitial-water chemical signals

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Biogenic silica diagenesis leads to abrupt changes in the physical properties of host sediment across the depth of an opal-A to opal-CT transition zone. Predicting the present-day diagenetic state of this reaction boundary, i.e., active versus arrested opal-A to opal-CT transition zones, is imperative to constraining the diagenetic factors that impact dramatic variations in the physical state of sediment. This study assesses whether there are present-day signatures of active silica diagenesis in the interstitial water, and corroborates the potential for pore-water chemistry for distinguishing between ongoing precipitation of diagenetic opal and arrested reaction fronts. Interstitial-water chemistry, mineralogy, and thermodynamic analyses of the Ocean Drilling Program Sites 794 and 795 demonstrate that solubility equilibrium is reached with respect to opal-CT in the transition zones accommodated by the Neogene biosiliceous sediments in the Sea of Japan. Even though the dissolution of biogenic opal is triggering reverse-weathering processes, the equilibrium reached with respect to diagenetic opal strongly suggests that the dissolved silica depression across the transition zones is essentially influenced by ongoing transformation of opal-A to opal-CT. Owing to abrupt petrophysical variations linked to opal-CT precipitation, the interstitial profiles of major ions and primary parameters have also been impacted by silica diagenesis. The extremely low dissolved-silica diffusion fluxes in the sediment, the very low permeability of the sediment capturing silica diagenetic transformations, and the marked pore-water loss at the depth of the transition zone all support the fact that the dissolved species have not been diffused in the sediment at rates comparable to those by pore-water advection due to sediment porosity drop. Advective and diffusive mechanisms, however, appear to have ceased recently because they have failed to smooth out the traces of ongoing biogenic silica diagenesis.