Marine reverse silicate weathering traced by silicon isotopes

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Reverse silicate weathering is controlled by biogenic silica ($bSiO_2$) dissolution and silicon (Si) re-precipitation as authigenic aluminosilicates, and thus exerts an important control on silicon cycling and the interlinked carbon cycle. However, the exact processes involved in preservation and recycling of $bSiO_2$ are still poorly constrained. In this study, reverse silicate weathering is investigated applying stable Si isotopes ($\delta^{30}Si$) in the Guaymas Basin, Gulf of California, which is characterized by high biological productivity, $bSiO_2$–rich sediments, and hydrothermal activity. Three fundamentally different environmental settings are investigated including the oxic deep basin, a hydrothermal site, and a site within the Oxygen Minimum Zone (OMZ) on the slope of the Guaymas Basin. The average pore fluid $\delta^{30}Si_{pf}$ signatures differ significantly between the three settings, with +1.20±0.14‰ (1SD, n=17) in the deep oxic basin, -0.14±0.29‰ (1SD, n=5) in the OMZ, and +1.99±0.18‰ (1SD, n=3) close to a hydrothermal vent field. Authigenic aluminosilicate precipitation dominates within the deep oxic basin and in the vicinity of a hydrothermal vent. In contrast, authigenic aluminosilicate precipitation is hindered in the OMZ, most likely due to high sedimentation rates and the coupling of Si to the Fe redox-cycle, which preferentially transfers the relative lighter ^{28}Si from the water column to the sediment. Additionally, light $\delta^{30}Si$ values in pore fluids and bottom waters confirm earlier studies suggesting an isotopically light benthic Si flux in upwelling regions. Ambient environmental conditions, especially the redox state and sedimentation rates, significantly influence reverse silicate weathering and thereby the Si isotopic composition of the benthic Si flux and consequently affect the entire Si (isotope) cycle.