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The role of green clay authigenesis in marine trace element cycling

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The extent to which marine authigenic clay formation (i.e. reverse weathering) impacts trace element cycling has hardly been examined to date. The scarcity of reported authigenic clay trace element data can be attributed to the typically µm size of authigenic clays and their co-occurrence with detrital clays and other sediment components so that isolating a 'pure' authigenic clay is challenging. This has largely prevented elemental and isotopic characterization of authigenic clays.

Here, we used a refined separation technique to isolate authigenic green clays (Fe smectite and glauconite) from their host sediment. These green clays are amongst the most common authigenic clays in the ocean, both now and throughout Earth's history. Their tendency to form large pellets with specific magnetic properties aid in their purification. Taking advantage of these characteristics, we were able to isolate authigenic green clays from ~20 samples across 5 locations. These were digested using standard methods prior to compositional characterization by ICP-MS. Samples come from Scientific Ocean Drilling as well as field outcrops. We validate the effectiveness of the authigenic clay purification method and add context to the elemental trends using high-resolution SEM imaging.

The chemical constituents required for clay authigenesis are sourced from i) the dissolution of mineral or biogenic components present within the host sediment (e.g. detrital or volcanogenic aluminosilicates and oxides provide Al, Fe, Si, etc) or ii) primarily from seawater (e.g. K, Mg, Sr). Comparison of immobile-element (e.g. Zr) normalized compositions of host sediment precursor material versus authigenic clay allows for the quantitative assessment of elemental enrichment and depletion patterns associated with reverse weathering. Since our samples represent diverse ages and depositional environments, we can make preliminary assessments of whether these patterns are robust or dependent on local factors. Trace elemental characterization of the authigenic clay separates improve quantification of reverse weathering and its implication on global climate through time and into the future as well as our understanding of the role of a benthic flux to major and trace element cycling in the ocean.