Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.27970

Mineralogical and Si isotopic indications of reverse-weathering in the Changjiang Estuary and East China Sea shelf

XINNING XU[1,2], SHOUYE YANG[3], DR. ANDRE BALDERMANN[4], XUECHAO WU[1,5], JUNJIE GUO[3] AND DI CAI[1]

[1]State Key Laboratory of Marine Geology, Tongji University
[2]Graz University of Technology
[3]State Key Laboratory of Marine Geology, Tongji University, Shanghai, China
[4]Institute of Applied Geosciences, Graz University of Technology
[5]GEOMAR Helmholtz Centre for Ocean Research Kiel

Reverse-weathering, a geological process characterized by the consumption of alkalinity, cations and dissolved silica in marine porewater alongside authigenic clay mineral formation in sediments, plays a critical role in regulating global carbon-silica cycling and Earth's climate feedback mechanisms. While authigenic clays were historically thought to form exclusively over long-term timescales in sediment-stable marine environments, recent studies hypothesize that this process may occur rapidly in dynamic estuarine settings.

This study uses mineralogical and silicon isotopic ($\delta^{30}Si$) signatures combined with some sequential extraction experiments to identify reverse-weathering process in the Changjiang Estuary and adjacent East China Sea (ECS) shelf—a region influenced by massive terrestrial sediment inputs and extensive development of mobile mud. Samples include surface sediments, multi-core sediments, and porewater collected across the Changjiang-ECS continuum, capturing gradients in seawater salinity, temperature, pH, and dissolved oxygen.

Porewater geochemical profiles demonstrate a progressive depletion of potassium (K) concentrations with depth from the sediment-water interface, indicative of K mobilization during early diagenesis. However, X-ray diffraction (XRD) analyses of shallow sediments (<20 cm) do not substantiate macroscopic enrichment of authigenic clay minerals, while exchangeable cation datasets from multi-core sediments reveal negligible K sequestration, effectively excluding ion exchange as a predominant mechanism. These observations collectively imply that reverse-weathering processes in the Changjiang-ECS system surpass the thermodynamic thresholds of cation exchange or adsorption yet fall short of achieving stable phyllosilicate crystallization, likely stabilizing as metastable, poorly ordered clay precursors. Scanning electron microscopy (SEM) analyses corroborate this transitional state: chemically purified diatom frustules exhibit pristine biosilica surfaces, whereas untreated counterparts from offshelf locales display microcrystalline coatings (<2 μm) morphologically consistent with incipient authigenic clay precipitates. Subsequent silicon isotope analyses will be employed to quantitatively constrain the reverse-weathering flux and elucidate its spatiotemporal dynamics, thereby bridging micro-scale mineralogical signatures with regional silica mass balances.