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Just how reactive is the reactive Si cycle?

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Reactive silica is mobilized on the surface of our planet by chemical weathering of silicate rocks, reactions which consume atmospheric CO_2 and release dissolved Si (dSi) plus alkalinity to rivers, groundwater, and the ocean. Ultimately, reactive silica is buried in the ocean as a biomineral, biogenic Si (bSi), or an amorphous alumino-silicate phase that forms via reverse weathering (RW) reactions, reactions that consume ocean alkalinity and produce CO_2. Through these linkages, reverse weathering (RW) reactions may also control atmospheric CO_2 over geological timescales by altering the pH of the ocean, which in turn influences diffusion of atmospheric CO_2 into the ocean. For decades RW was thought to play a negligible role in controlling atmospheric CO_2 because it was assumed to happen too slowly (i.e., $>10^5$ years) or in insignificant quantities. Several lines of evidence point to rapid (<6 months) RW formation rates and a RW flux that rivals biogenic Si burial. At the same time, field studies indicate that Si is both rapidly released through weathering and captured through secondary phase formation *in situ* in end-member cold environments in Iceland. The relative importance of RW versus forward silicate mineral weathering in partitioning of C between atmosphere-ocean-geologic reservoirs is controversial. Several recent papers suggest that low-temperature silicate weathering in the ocean is underestimated 4-fold [1] and that RW sinks are underestimated 2-fold [2], a major departure from recent marine Si summaries [3]. Yet inverse modeling of Si isotopes suggests the prior marine Si budget is accurate [4], though a higher forward silicate mineral weathering flux is needed to achieve mass balance. Verifying or refuting these additional sources and sinks will have major consequences for the residence time of dSi (i.e., reactivity), ocean chemistry, and how Si is coupled to C in climate evolution models.

[1] Aparicio et al. (2025), *Nature Geoscience* 18(2),154-159. [2] Trapp-Müller, G. (2024), Ph.D. Thesis, Utrecht University. [3] Tréguer et al. (2021), Biogeosciences 18(4), 1269-1289. [4] Rahman & Trower (2023), Science Advances 9(49), eadi2440.