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EP51A-03 Maturation of Silicate Weathering Pathways in the Landscape Evolution Observatory Revealed by Germanium-Silicon Ratios

   Friday, 13 December 2024

 09:00 - 09:12

 146 C (Convention Center)

Abstract

Germanium-silicon (Ge/Si) ratios offer a tracer for incongruent silicate weathering and secondary mineral formation from fluids in the Critical Zone. Across a range of upland watersheds, Ge has been shown to preferentially incorporate into secondary aluminosilicate phases, leaving stream water depleted in Ge/Si relative to bedrock. However, silica minerals precipitated in hydrothermal systems and under controlled laboratory conditions have been shown to exclude Ge, leaving the fluid enriched in Ge/Si as quartz and amorphous silica (opal) are formed from solution. The Landscape Evolution Observatory (LEO) in Tucson, Arizona, offers a unique opportunity to study an "intermediary" silicate weathering environment in that the artificially constructed hillslopes are composed of fresh basalt and have only been subject to a decade of Earth surface weathering conditions. In this sense, LEO offers a rare bridge between silicate weathering conditions found in natural systems and those that can be produced in the laboratory. Here we report fluid Ge/Si ratios from two LEO irrigation experiments which both produce enriched values relative to the basalt. These $(\text{Ge/Si})_{\text{aq}}$ signatures lie between depleted values observed in field data and the strongly enriched values reported in laboratory opal precipitation experiments. Discharge samples collected during a 2019 irrigation show slight, but systematically higher fluid Ge/Si ratios than those collected during a 2022-2023 irrigation, suggesting maturation of the porous media covering these hillslopes through time. Fluid $(\text{Ge/Si})_{\text{aq}}$ in ultrafiltered samples from 2019 are higher than those filtered at 0.45 mm, suggesting that a substantial fraction of the colloidal phase is composed of a silica-rich phase that excludes Ge. We suggest that measurable evolution in fluid Ge/Si signatures between 2019 and 2022 reflects the rapid pace of fresh basalt weathering. These data fill a gap in our understanding of $(\text{Ge/Si})_{\text{aq}}$ ratios between laboratory experiments and field data, suggesting that the capacity for natural systems to form alumina-silicate secondary phases is important for the retention of Ge during incipient basalt weathering.

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