Determining Rates and Mechanisms of Geologic Respiration at Watershed Scales

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Geologic respiration, or the mineralization of rock organic carbon during chemical weathering, is a source of CO_2 to the atmosphere. Global geologic carbon and oxygen models suggest that the release of CO_2 from geologic respiration is similar in magnitude (but opposite in direction) to the carbonic-acid-driven silicate weathering sink of atmospheric CO_2, and also comparable in magnitude to the burial flux of organic carbon in marine sediments. While extensive studies have investigated controls on silicate weathering fluxes and organic carbon burial, little work has been done to directly quantify the geologic respiration fluxes and their controls. Further investigation of the magnitude and controls on georespiration fluxes is needed in order to understand the relationship between climate, rates of chemical weathering, and variations in atmospheric CO_2 over time.

Here we present results of a field study investigating the relationship between geologic respiration and physical erosion rates. The study sites are small mountainous river systems on the West Coast of the US: the Eel River catchment in Northern California (which is also a Critical Zone observatory), and the Umpqua River catchment in Oregon. These two catchments have strongly contrasting tectonic uplift and sediment yields, but similar size (~10,000 km^2), climate, runoff, and vegetation. Using measurements at the catchment, subcatchment, and weathering profile scale, we test the utility of dissolved rhenium (Re) as a quantitative tracer of geologic respiration, and the importance of riverine particulate Re for accurate estimation of geologic respiration rates. Measurements isotopic tracers, biomarker analyses of organic carbon, and other geochemical tracers are combined and analyzed in order to characterize the sources, flowpaths, and processes that deliver Re and rock-derived organic carbon from upland landscapes to rivers. We use these data to evaluate overall georespiration fluxes, and also to put this CO_2 flux in the context of those associated with present day organic carbon burial and silicate weathering fluxes in these systems.