Linking Jurassic plutonism and ignimbrite volcanism in California

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Is large-volume ignimbrite volcanism associated with plutonism, or are these processes largely distinct in time, and hence in tectonic significance? Volcanism was broadly associated with Mesozoic plutonism in the U.S. Cordillera, but the precise relationships between volcanic rocks and adjacent zoned plutons are not known. We examined igneous rocks in a tilted crustal section in California, where Jurassic Sidewinder Volcanic Series is comprised of four principal, laterally extensive ash flow tuffs from 550 to >1100 m thick, and is underlain at deeper structural levels by Jurassic plutons. Zircon geochronology confirms previous correlations of individual tuffs, suggesting ignimbrites with eruptive volumes up to 800 km^3 were deposited both during the apparent Early Jurassic plutonic lull and contemporaneous with solidification of regionally widespread and voluminous Middle and Late Jurassic plutons. The tuffs are weakly to strongly porphyritic (5 to 55% phenocrysts) monotonous intermediate porphyritic dacite to low silica rhyolite. The tuffs show strong bulk rock chemical affinity to contemporaneous plutons, and record consistent secular compositional variation. Trace element compositions of zircons from the tuffs and contemporaneous granites record large and consistent differences in Hf/Zr and REE over similar ranges in Ti abundances, supporting bulk compositional similarities and illuminating variations in thermal histories despite the effects of hydrothermal alteration. Premagmatic zircon analyses are in progress to determine if these differences were related to the age and/or composition of magma sources.

Recovery from acidification: Sulfur cycling and dissolved organic carbon dynamics

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Organic soils represent an important store of carbon; recent work suggests these stores may be destabilising, with an increase in dissolved organic carbon (DOC) in (European) surface waters over the last few decades. While there have been many hypotheses as to the cause of this phenomenon, little attention has been given to the coincident decline in acid sulfate deposition, despite apparent inverse trends in sulfate and DOC concentrations in some organic soil systems. Here, we describe laboratory experiments, which use $^{34}SO_4$ tracer techniques to better understand sulfur biogeochemistry and constrain the relationship between sulfur and DOC cycles in organic soils.

Long-term laboratory mesocosms are ongoing; living peat and organic podsol cores from Plynlimon, Wales, have been kept under controlled conditions (10ºC, 12 hour artificial sunlight) and treated with artificial rainwater solutions for 18 months. Triplicate cores were treated with (1) control rainwater (based on modern deposition data); (2) high acid sulfate rainwater (based on peak acid sulfate deposition, 1989); (3) high acidity rainwater (as for 2, additional sulfate omitted). All rainwaters contained a 99.9% pure $^{34}SO_4$ tracer as part of the basic chemistry. Regular sampling of peat and podsol soil waters allows a comparison of the soil biogeochemistry under varying acid and acid sulfate loadings.

Initial data suggest that acid deposition does affect the release of DOC to soil water, with higher acid loadings inhibiting DOC release; but that this effect is moderated by the activity of sulfate reducing bacteria. Reduction of sulfate to sulfide attenuates acidity, provided that sulfur can be permanently stored in reduced form (e.g. FeS). Continuing analysis of the physical and geochemical fate of the ^{34}S tracer in the solid phase will establish an estimate of acid attenuation due to storage of reduced sulfur. Together with the soil water data, this will determine the balance between the sulfur and carbon cycles, and resolve the mechanism by which DOC release is controlled under changing atmospheric deposition.