Volcanic controls on seawater sulfate over the past 120 million years

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In its role as an electron acceptor and a contributor to ocean alkalinity, the sulfate ion is central to the oxygen, carbon, and iron cycles on Earth's surface. The sulfur isotopic composition of seawater, recorded in marine barites, suggests large and abrupt changes in the sulfur cycle took place during the Cenozoic and late Mesozoic. In particular, this data has been interpreted as evidence of stepwise changes in sulfur cycling at ~50 and ~100 million years ago. These apparent changes have been attributed to shifts in sulfur biogeochemistry or tectonic forcing, but the mechanisms remain debated. Using a simple model of the sulfur cycle, we demonstrate that long-term changes in burial processes, punctuated by sulfur outgassing associated with emplacement of large igneous provinces, can explain much of the structure in late Mesozoic/Cenozoic records of marine sulfate concentration and isotopic composition.