

Origin of Sulfate in Post-Snowball-Earth Oceans: River Inputs vs. Shelf-Derived H₂

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A synthesis of global barite sulfur and triple-oxygen isotope data from approximately 635 million years ago, at the end of a global glaciation, undermines the hypothesis that river sulfate was the primary carrier of the distinctive ¹⁷O-depleted atmospheric O₂ signature of the period. The compiled data has exposed that the $\delta^{34}\text{S}$ and $\delta^{18}\text{O}$ values are too high and their ranges too narrow comparing to those of the modern river sulfate worldwide. Solving this puzzle could potentially transform our understanding of paleo-ocean redox chemistry. Here, we propose that the ¹⁷O-depleted SO₄²⁻ came predominantly from H₂S oxidation at the oxic-sulfidic redoxcline in shallow oceans (i.e., the shelf H₂S model), not from the river input. Due to the low seawater SO₄²⁻ concentration, the fluctuating redoxcline brought Ba²⁺ and the newly produced SO₄²⁻ to precipitate ¹⁷O-depleted barite which may survive dissolution on shallower, oxidized water while re-dissolve in deeper, reduced water. A water mass of this nature, along with its associated bacterial sulfur metabolism that produced the rather positive $\delta^{18}\text{O}$ value, could be prevalent in the Ediacaran continental shelf. Although compelling, the H₂S model demands extensive validation across multiple fronts by the scientific community.

