

Identifying water availability in the Atacama Desert (Chile) by triple oxygen isotope analyses of sulfate

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Sulfate sources in the Atacama Desert include sea spray, terrestrial weathering, and deposition of sulfate formed in the atmosphere (secondary atmospheric sulfate = SAS).

- Sea spray is restricted to < 1200 m by a temperature inversion layer.
- The proportion of terrestrial weathering is limited by hyper aridity, which is decreasing at higher elevations.
- SAS is the only source with a positive triple oxygen isotope signature ($\Delta^{17}\text{O}_{\text{SO}_4}$) originating from atmospheric SO_2 oxidation by ozone or hydrogen peroxide.

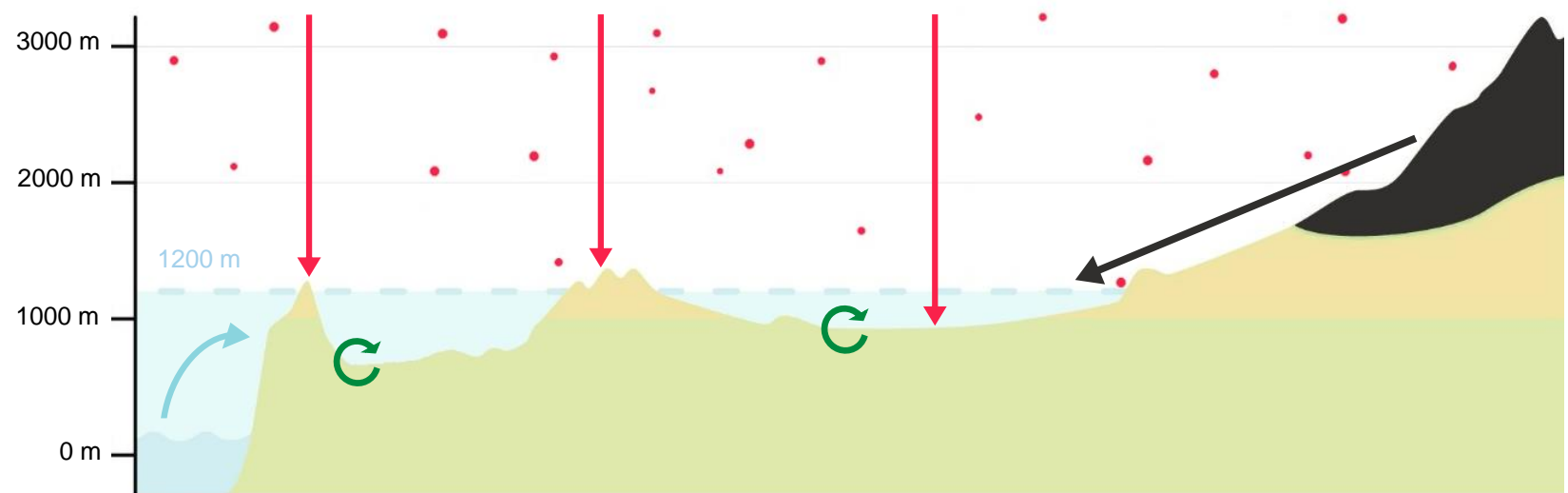
The $\Delta^{17}\text{O}_{\text{SO}_4}$ value of a sulfate sample depends on

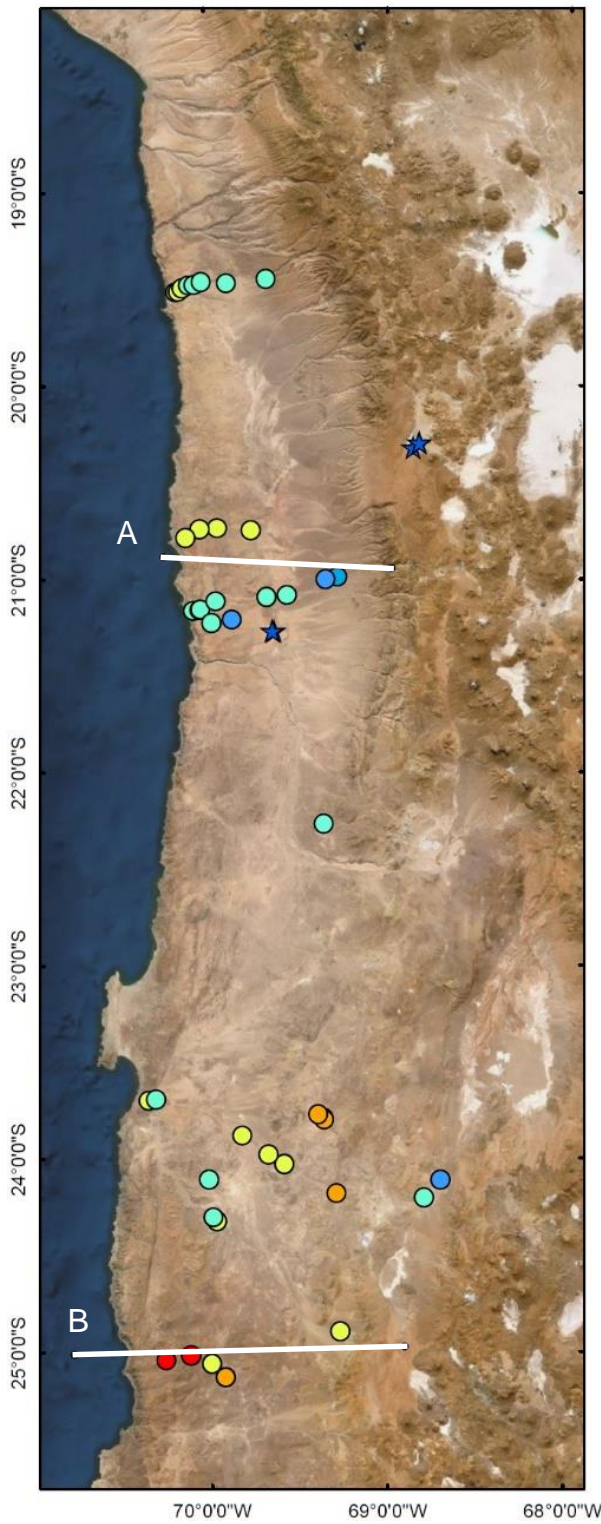
- 1) its source contribution and
- 2) microbial activity due to water availability, which influences the $\Delta^{17}\text{O}_{\text{SO}_4}$ value towards 0 ‰ (e.g. in salt lakes / salars).

Hence, the less water is available for microbial activity the better the positive $\Delta^{17}\text{O}_{\text{SO}_4}$ anomaly from SAS is preserved. Under the assumption of a homogeneous atmospheric chemistry throughout the studied area, the observed N-S gradient in $\Delta^{17}\text{O}_{\text{SO}_4}$ may be related to water availability.

Sulfate sources in the Atacama Desert





	SAS	$\Delta^{17}\text{O}_{\text{SO}_4} \approx 0.9 - 4 \text{ ‰}$
	Terrestrial weathering	$\Delta^{17}\text{O}_{\text{SO}_4} \leq 0 \text{ ‰}$
	Fog / sea spray	$\Delta^{17}\text{O}_{\text{SO}_4} \leq 0 \text{ ‰}$
	Microbial activity	$\Delta^{17}\text{O}_{\text{SO}_4} \rightarrow 0 \text{ ‰}$





- ★ $\Delta^{17}\text{O}_{\text{SO}_4} = 0.1 - 0.2 \text{ ‰}$ (salar sulfate)
- $\Delta^{17}\text{O}_{\text{SO}_4} = 0.2 - 0.4 \text{ ‰}$
- $\Delta^{17}\text{O}_{\text{SO}_4} = 0.4 - 0.6 \text{ ‰}$
- $\Delta^{17}\text{O}_{\text{SO}_4} = 0.6 - 0.8 \text{ ‰}$
- $\Delta^{17}\text{O}_{\text{SO}_4} = 0.8 - 1.0 \text{ ‰}$
- $\Delta^{17}\text{O}_{\text{SO}_4} = 1.0 - 1.1 \text{ ‰}$

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