Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.17527

Tracing sulfate sources in an Antarctic Ross Sea coastal glacier using sulfur isotope signatures

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Sulfur isotopes are increasingly used as tracers of sulfate sources, particularly for studying volcanic records in ice cores. Accurately identifying sulfate sources is crucial for interpreting sulfur isotope signatures, especially in coastal regions where sea salt and biogenic sulfate from seawater are major contributors. In this study, we collected snow samples from the coastal Styx Glacier located approximately 60 km inland from the Ross Sea, Antarctica. We collected the samples at 5 cm intervals down to a depth of 1.15 m (n = 23) and used multi-collector inductively coupled plasma mass spectrometry (Nu-plasma 3) to determine the ^{34}S and $\Delta^{33}S$ values. Our results showed that the ^{34}S values ranged from 15.1 to 21.4‰ with $\Delta^{33}S$ = -0.1 (± 0.3, 1sd). In the top layers of the snow samples, the ^{34}S value was close to seawater (~21‰), indicating the influence of sea salt transported to the area by a low-pressure system that had expanded just before sampling. We identified marine biogenic sulfate with ^{34}S of ~18‰, which was pronounced in late summer with increases in the concentrations of methanesulfonic acid (MSA). We also found samples with ^{34}S ~ 15‰, which suggests another major sulfate source with lower ^{34}S. The trace element compositions of the snow samples suggest that terrestrial dusts with ^{34}S < 10‰ are more likely than anthropogenic sources, and exposed surfaces of the Transantarctic Mountains may be potential sources. Our findings provide important information for discriminating the contribution of different sources of sulfates from ice cores obtained from this area in future studies.