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High time resolution study of the mass-independent sulfur isotopic composition in the Pinatubo and Agung volcanic eruptions as recorded in Dome C (Antarctic) snow.

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Plinian volcanic eruptions can modify the terrestrial atmospheric system by injecting directly into the stratosphere large amount of dusts and gases such as sulfur dioxide which will further be oxidized to sulfuric acid. In order to study the impact of such brutal events on the atmosphere, we used the mass-independent sulfur isotopic composition of volcanic sulfates. A sulfur isotopic composition which deviates from the two mass-dependent relationships ($\delta^{33}S \approx 0{,}515\ \delta^{34}S$ and $\delta^{36}S \approx 1{,}91\ \delta^{34}S$) is termed mass-independent and is quantified by the relations : $\Delta^{33}S = \delta^{33}S - 1000*[(1+\delta^{34}S/1000)^{0,515}-1]$ and $\Delta^{36}S = \delta^{36}S - 1000*[(1+\delta^{34}S/1000)^{1,91}-1]$. The sulfur isotopic anomaly is photochemically produced and is highly wavelength dependent. It appears in the stratosphere where UV light shorter than 310 nm is available and can dissociate SO_2.

We studied the two most important stratospheric events of the last 50 years, the Agung (8˚S, 115˚E, March 1963) and the Pinatubo (15˚N, 120˚E, June 1991) eruptions which perturbed the atmospheric system for several years by injecting into the stratosphere more than 10 Tg of SO_2. The volcanic sulfate recorded in a Dome C (75˚S, 123˚E) snow pit allowed a high time resolution study of the sulfur isotopic anomaly signal with approximatively one measurement every 6 months subsequent to the eruptions.

The results show that for both events, the sulfur mass-independent fractionation

changes in sign with time, starting with a positive phase. Our observations confirm Pavlov et al. (2005) model proposition. The sulfur isotopic composition is enriched in heavy isotopes at the beginning of the eruption and depleted with time. The maximum isotopic anomaly precedes the maximum sulfates concentration in both cases.

As a result of the study of sulfur mass-independent fractionation in volcanic sulfates recorded in snow, we confirm the presence of a sulfur isotopic anomaly for only stratospheric-produced sulfate, we show for the first time the time-dependency of such anomaly and demonstrate the reproducibility of such isotopic anomaly signatures. Coupled with lab experiments, such observations are intended to serve as basis for the understanding of the origin of the mass-independent sulfur isotopic effect observed in nature.

References :

A.A. Pavlov, M.J. Mills, O.B. Toon, Mystery of the volcanic mass-independent sulfur isotope fractionation signature in the Antarctic ice core, *Geophys. Res. Lett.*, 32, 12816, (2005)