A modern view of the sulfur isotopes mass-independent fractionations: The lesson from the ice cores

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Introduction

Ice cores are well-kown recorders of past volcanic euptions [1]. They provide a means to access past stratospheric sulphate aerosols (SSA) [2] allowing tests of ideas proposed to explain the mass-independent sulphur isotope fractionation (S-MIF) [3, 4].

In 2010-2011, five 100m-long ice cores from Dome C, Antarctica, were collected with the goal of producing the most extensive database of S-MIF on SSA.

Results and Discussion

We use the isotopic signature ($\Delta^{33}S$) of volcanic sulfate to identify stratospheric volcanic eruptions over the last 2600 years and compare our composite record with the latest database based on bipolar identification [5]. There is excellent consistency between the two methods; however, the $\Delta^{33}S$ record reveals the presence of few high-latitude stratospheric events that were misidentified as tropospheric events by the bipolar method.

The new isotopic data provides improved constraints on the $\Delta^{33}S$ vs. $\Delta^{36}S$ and $\Delta^{33}S$ vs. $\delta^{34}S$ slopes (-1.5 and 0.09, respectively), the $\Delta^{33}S$ vs. $\Delta^{36}S$ differs from an earlier determination from a smaller dataset [3]. These slopes, and the duration of the anomalies, carry information relevant to understanding the production of S-MIF in the stratosphere. Using a basic model implemented with fractionation factors available in the literature to account for the isotopic pattern observed on volcanic sulfate deposition, we will discuss the significance of the S-MIF production mechanisms and its links to the oxidation process (mass-dependent vs. mass-independent processes, self-shielding vs. spectra isotopic shift).

Oxygen isotopic ($\Delta^{17}O$) data for the largest peaks recorded in our cores, confirm that large volcanic eruptions can be associated with significant changes in the oxygen isotopic composition, probably in relation with the altitude of injection.

[1] Hammer (1977) *Nature* **270**, 482-486. [2] Savarino *et al*. (2003) *J Geophys Res*, **108**(D21), 4671, doi: 10.1029/2003jd003737. [3] Baroni *et al*. (2008) *J Geophys Res*, **113**(D20), D20112, doi: 10.1029/2008jd010185. [4] Baroni *et al*. (2007) *Science*, **315**(5808), 84-87, doi: 10.1126/science.1131754. [5] Sigl *et al*. (2015) *Nature* **523**(7562), 10.1038/nature14565, 2015.