Geophysical Research Abstracts
Vol. 20, EGU2018-14891, 2018
EGU General Assembly 2018

Major 17O and 18O depletions in Antarctic micrometeorites: a signature of isotopic interaction with Antarctic ice and snow?

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We report the discovery of 4 cosmic spherules (i.e. fully molten micrometeorites) exhibiting extreme 17O and 18O compositions (δ17O: -21.2‰ to -27.8‰ δ18O: -39.7‰ to -52.0‰ Δ17O: -0.6‰ to -0.8‰). These particles have been collected from sediment traps in the Sør Rondane Mountains (East-Antarctica) and range in size between 190-399 μm.

Petrographic analysis was conducted with a JEOL JSM-IT300 scanning electron microscope, connected to an energy dispersive spectrometer at the Department of Chemistry, Vrije Universiteit Brussel. Major and trace element concentrations of 3 cosmic spherules were previously analysed with a Teledyne Cetac Technologies Analyte G2 excimer-based laser ablation system coupled to a Thermo Scientific Element XR double-focusing sector field inductively coupled plasma mass spectrometer at the Department of Chemistry, Ghent University (Soens et al., 2017). Triple-oxygen isotope ratios were acquired for 2 cosmic spherules with an infrared-laser assisted fluorination system, coupled to a Thermo Scientific MAT 253 dual-inlet mass spectrometer at the Open University. Two additional spherules were previously analysed with a sensitive high-resolution ion-microprobe-stable isotope (SHRIMP-SI) system at the Australian National University (Van Ginneken et al., 2017).

Three of the characterized spherules display a barred olivine (BO) texture, while one spherule displays a porphyritic olivine (PO) texture. Based on the weathering scale by Van Ginneken et al. (2016), cosmic spherules are characterized by minor (1) to moderate (2) degrees of alteration of primary material, and lack a visible encrustation (A). Overall, major element contents confirm the chondritic nature of the particles. Trace element patterns are largely similar between the particles, but appear to be fractionated relative to CI chondrites (McDonough & Sun, 1995). This elemental pattern is also observed in several other cosmic spherules that do not exhibit extreme oxygen isotopic signatures. The oxygen isotopic signatures reported here plot close to local and regional Antarctic ice and snow (δ18O: -35.0‰ to -49.7‰ Zekkolari et al., submitted). These preliminary results suggest a contribution of Antarctic ice and/or snow to the oxygen isotope budget of a limited number of Antarctic micrometeorites, without an apparent modification of their chemical composition. We aim to study in greater detail the nature of the processes involved and compare this to the Antarctic weathering processes of larger meteorites (e.g., Brearly et al., 1989; Alexander et al., 2018).

References

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