

I-type micrometeorites as probes for the isotopic composition of upper atmospheric oxygen and their use as a CO₂-barometer

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The so-called I-type micrometeorites [1] have formed by atmospheric oxidation of extraterrestrial Fe,Ni alloys during atmospheric deceleration and heating. The I-type micrometeorites are highly enriched in the heavy isotopes of O, Fe, Ni, and Cr [e.g., 2,3]. For the transition metals, evaporative enrichment explains the isotope enrichments. In contrast to the transition metals, oxygen in the I-type micrometeorites is not of extraterrestrial, but terrestrial atmospheric origin. The oxygen isotope composition of I-type micrometeorites, however, is enriched in ¹⁷O and ¹⁸O relative to atmospheric O₂. The oxygen isotope composition of I-type micrometeorites is controlled by i) fractionation during the Fe,Ni metal oxidation, ii) exchange/equilibration with ambient oxygen, iii) fractionation during evaporation.

Atmospheric oxygen carries an isotope anomaly from mass-independent fractionation. The anomaly is a function of the atmospheric CO₂ mixing ratio [4]. The oxidation in the atmosphere and the exchange/equilibration with ambient oxygen, hence, transfers an anomaly to the micrometeorites. Fractionation associated with the oxidation and evaporative isotope enrichment is, in contrast, a strictly mass-dependent process.

We report new laser fluorination $\delta^{17}\text{O}$ and $\delta^{18}\text{O}$ and MC-ICPMS Fe isotope data on I-type micrometeorites. Results are compared to data obtained on air O₂ that we measured in the same laboratory. The isotope fractionation associated with atmospheric oxidation of Fe,Ni alloys was studied in high-T experiments.

The results are used for the reconstruction of the O isotope composition of upper atmospheric oxygen and to explore the useability of I-type micrometeorites as paleo-CO₂ proxy.

[1]Genge et al. (2008) *Meteor. Planet. Sci.* **35**: 807-816. [2]Clayton et al. (1986) *Earth Planet. Sci. Lett.* **79**: 235-240. [3] Engrand et al. (2005) *Geochim. Cosmochim. Acta* **39**: 569-584. [4] Bao et al. (2008) *Nature* **54**: 349-392.