

Presolar organic globules in astromaterials

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Presolar grains were identified in meteorite residues 20 years ago based on their exotic isotopic compositions [1]. Their study has provide new insights into stellar evolution and the first view of the original building blocks of the solar system. Organic matter in meteorites and IDPs is highly enriched in D/H and ¹⁵N/¹⁴N at μm scales, possibly due to presolar organic grains [2-4]. These anomalies are ascribed to the partial preservation of presolar cold molecular cloud material. Identifying the carriers of these anomalies and elucidating their physical and chemical properties may give new views of interstellar chemistry and better understanding of the original components of the protosolar disk. However, identifying the carriers has been hampered by their small size and the inability to chemically isolate them.

Thanks to major advances in nano-scale analytical techniques and advanced sample preparation, we were able to show that in the Tagish Lake meteorite, the principle carriers of these isotopic anomalies are sub- μm , hollow organic globules [5]. The organic globules likely formed by photochemical processing of organic ices in a cold molecular cloud or the outermost regions of the protosolar disk [5].

Organic globules with similar physical, chemical, and isotopic properties are also recently found from Bells CM2 carbonaceous chondrite, in IDPs [6] and in the comet Wild-2 samples returned by Stardust [7]. These results support the view that microscopic organic grains were widespread constituents of the protoplanetary disk. Their exotic isotopic compositions trace their origins to the outermost portions of the protosolar disk or a presolar cold molecular cloud.

[1] Zinner in *Treatise on Geochemistry* (2004) pp. 17-39.

[2] Messenger (2000) *Nature* **404**, 968. [3] Busemann *et al.*

(2006) *Science* **312**, 727 [4] Floss *et al.* (2004) *Science* **303**,

1355. [5] Nakamura-Messenger *et al.* (2006) *Science* **314**,

1439. [6] Messenger *et al.* (2008) *LPSC XXXIX*, #2391

[7] Matrajt *et al.* (2007) *MAPS* **42**, 5138.

Multiple Sulfur isotope fractionation of SO₂ by UV radiation with narrowly-defined wavelengths

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Mass-independent fractionation of sulfur (MIF-S) isotopes in Archean sedimentary rocks has been used to indicate a very low O₂ pressure in the Earth's early atmosphere, as large MIF-S can be experimentally produced by UV photolysis of SO₂ in an atmosphere free of O₂ and O₃ [1]. In this study, we have measured the UV absorption spectra of the four pure sulfur isotopomers of SO₂ (³²SO₂, ³³SO₂, ³⁴SO₂, and ³⁶SO₂) to reveal an isotope-dependent spectral shift at UV wavelengths.

In order to investigate the interaction between UV photolysis of SO₂ and the spectral shift, we have studied SO₂ photolysis by 193 nm and 213 nm lasers. Degradation of SO₂ is a first-order reaction, such that $-d[\text{SO}_2]/dt=k[\text{SO}_2]$, where k is the rate constant. It is likely that k is proportional to the absorption cross section of SO₂. At 193 nm, the cross sections are quite different for the four sulfur isotopomers. Using the spectral data, $\delta^{33}\text{S}$, $\delta^{34}\text{S}$ and $\delta^{36}\text{S}$ values of residual SO₂ after UV photolysis can be calculated, and these values show good agreement with the measured values [1]. In contrast, at 213 nm there is little difference in the cross sections of the sulfur isotopomers, which is consistent with essentially zero MIF-S produced by 213 nm photolysis. Hence, the large MIF-S produced by SO₂ photolysis using UV lasers or resonance lamps is a result of the interaction of the narrowly-defined UV wavelengths emitted by these light sources with the isotope-dependent UV absorbance of the SO₂ isotopomers. In turn, this suggests that Archean MIF-S signatures may not necessarily indicate low O₂ concentrations in the Archean atmosphere.

[1] Farquhar *et al.* (2001) *JGR* **106**, 32829.