

Assessing the stardust inventory of comet 81P/Wild 2 by NanoSIMS

J. LEITNER^{1*}, P. HOPPE¹, P.R. HECK² AND J. HUTH¹

¹Max-Planck-Institute for Chemistry, 55020 Mainz, Germany
(*correspondence: leitner@mpch-mainz.mpg.de)

²University of Chicago, Chicago, IL 60637, USA

Introduction

Comets most likely have formed in the cold, outer regions of the protosolar cloud, representing the most primitive matter in the solar system. NASA's Stardust mission collected dust from the coma of comet 81P/Wild 2 and returned it to Earth in 2006 [1]. Besides low-density aerogel, aluminum foil provided a second valuable capture medium for cometary dust [1, 2]. Impactor residues were found inside crater cavities or on crater rims. Preliminary examination revealed the dust to be an unequilibrated mixture of heterogeneous material of mainly solar system isotopic composition [2, 3]. To date, only three ¹⁷O-rich presolar grains and one presolar SiC grain were found [4, 5].

Results and Discussion

We investigated the O isotopic composition of impact residues in small craters (\varnothing 0.25–4.4 μm) on Stardust Al foils by NanoSIMS. 120 craters have been analyzed so far, with a total area of 135 μm^2 . None of the residues show isotope signatures characteristic of presolar grains. $\delta^{17}\text{O}$ and $\delta^{18}\text{O}$ are between -223 ± 64 and $+202\pm 138$ ‰ and between -52 ± 6 to $+111\pm 48$ ‰, respectively. Together with results for two large craters (C2013N & C2086N), we obtain an upper limit of ~ 30 ppm for the presolar silicate/oxide abundance in Wild 2. With the results from [4], this yields an abundance of 11 ppm, significantly lower than for other primitive solar system materials. This value may be biased in the investigated samples: Presolar grains that melted during foil impact may have been mixed with matter of solar system composition. Thus, isotopic anomalies might have been lost by dilution in large impact craters ($\varnothing > 20$ μm), which make up more than 90 % of the investigated material. Isotopic anomalies are much easier preserved in small craters ($\varnothing < 2$ μm), even for complete melting. Thus, small impact craters are the most promising objects to infer the abundance of presolar grains within Wild 2 matter. Based on our investigation of small craters, we obtain a preliminary upper limit of 8000 ppm for presolar grains.

[1] Brownlee *et al.* (2006) *Science* **314**, 1711–1716. [2] Hörz *et al.* (2006) *Science* **314**, 1716–1719. [3] McKeegan *et al.* (2006) *Science* **314**, 1720–1724. [4] Stadermann & Floss (2008) *LPS* **39**, #1889. [5] Messenger *et al.* (2009) *LPS* **40**, #1790.

Li isotope fractionation in surface waters of an alpine granitic catchment

E. LEMARCHAND^{1,2*}, E.T. TIPPER¹, R. HINDSHAW^{1,2}, J.G. WIEDERHOLD^{1,2}, B.C. REYNOLDS¹, B. BOURDON¹ AND R. KRETZSCHMAR²

¹Institute of Isotope Geochemistry and Mineral Resources, ETH Zurich, Switzerland

²Institute of Biogeochemistry and Pollutant Dynamics, ETH Zurich, Switzerland (*lemarchand@env.ethz.ch)

The study of silicate weathering is fundamental to understanding global biogeochemical cycles, the evolution of atmospheric pCO₂, soil formation and nutrient availability. Physical and chemical denudation in mountainous areas has a strong impact on continental weathering fluxes due to high mechanical erosion rates and exposure of fresh rocks. In this context, the multi-disciplinary BigLink Project aims at a detailed understanding of incipient weathering and soil formation in an alpine granitic catchment (the Damma glacial forefield, Switzerland). Furthermore, the retreat of the glacier offers unique opportunities to investigate isotopic tracers of chemical weathering within a chronosequence of initial soil development.

Li is particularly useful as a tracer of chemical weathering because it is concentrated in silicate rocks (10-100 ppm in granite) and its two isotopes are known to fractionate during water-rock interactions. We have previously determined that the ⁷Li/⁶Li ratio decreases along the chronosequence with increasing age of the soil, implying a preferential release of the heavy Li isotope into surface waters [1]. In this study, we analyzed dissolved Li concentrations and isotopic compositions in the catchment. Stream waters were sampled fortnightly from May to October 2008 at 5 different sites. 2 groundwater and 8 soil solutions were also collected at the end of the summer.

The Li concentrations in stream waters were between 0.05 and 0.35 ppb and increased up to 2 ppb in soil solutions and groundwaters. Dissolved Li isotopes were strongly fractionated relative to the rocks and soils, with $\delta^7\text{Li}$ ranging from +14 to +31‰ in the streams and from +7 to +10‰ in the soil solutions (compared to 0 to +4‰ in rocks and soils). In streams, seasonal trends were observed for Li concentrations and isotopic compositions. As Li is poorly influenced by biological cycles, we explain those variations by mixing between different pools of water and isotope fractionation processes within the streams.

[1] Lemarchand *et al.* (2008) *Geochim. Cosmochim. Acta*, **72** (12 Suppl.1) A533.