High resolution S-XRF study of stardust impact tracks

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Introduction

Stardust was the first sample return mission which captured extraterrestrial solid particles on a flight-by through the coma of a comet (Wild 2) which enables the investigation of cometary dust in its direct contextual setting [1] with the best available analytical system available in any laboratory on Earth. The nature of cometary material is of great importance for the understanding of the history of the early solar nebula and the protoplanetary disk.

Data processing

Several keystones, each including an impact track with a terminal particle (TP) at its end, were studied [2]. Track No. C2044, 37 was investigated with high resolution synchrotron XRF and XRD (S-XRF/XRD) techniques at beamline ID13 at the ESRF (Grenoble, France) with 13 keV to determine the elemental abundances from Ca to Se. The focus spot size was 200 nm enabling an investigation with very high spatial resolution of grains having sub micron size.

Results

The evaluation of the diffraction pattern obtained from the TP yield a mixture of olivine and pentlandite and/or phyrrotite [3].

S-XRF data reveal several chemical hot spots along the track with most of these fragments having sizes of only several 100 nm. Some have Fe concentrations of more than 20 wt. % indicating Fe–Sulphide as possible phases along the track. These fragments are also high in Mn and Cr in comparison to the other hotspots. Fe-Ni sulphide or - metal is also assumed for a fragment containing up to 2.5 wt. % Ni.

For the TP, S-XRF reveals a complex chemical structure showing band like Fe- and Cr-features inside the particle. Fe- and C1 normalized abundances for the TP show relative enrichments for Cr and Mn, depletions for Ni and CI abundance for Ca, Ti, Cu and Zn.

References

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A potential site for long-term *in situ* cosmogenic ^{3}He and ^{21}Ne production rate calibration on Fuerteventura, Canary Islands

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The use of terrestrial cosmogenic nuclides (TCN) as a tool for quantitative geomorphology has rapidly increased over the last decade or so. Production rates are poorly understood and are perhaps the biggest constraint on their use as absolute chronometers.

The CRONUS-EU network aims to improve TCN production rates. In this particular study we are focusing on potential calibration sites on Fuerteventura in the Canary Islands (29°N) because sets of scaling factors used for determining production rates so far diverge most prominently in at latitudes below 40° (Dunai, 2000). Furthermore most reported production rates are of late Pleistocene or even Holocene age making them susceptible to the influence of short term variations in the Earth's magnetic field. The production rate of cosmogenic ^{3}He can be determined from the analysis of olivine and pyroxene phenocrysts from well-preserved flow tops of independently-dated basaltic lavas. We have identified several suitable flows from the most recent Series IV volcanic units from the north side of Fuerteventura (Coello *et al*., 1992). ^{40}Ar/^{39}Ar incremental heating experiments of 9 flows yield eruption ages of 50 - 400 ka with total uncertainties of 5 % and less. Analysis of ^{3}He in pyroxene and olivine phenocrysts from sea-level samples have potential as calibration for short- to mid-term production rates at low latitude, as well as allow a comparison of elemental control on cosmogenic ^{3}He production. Cosmogenic ^{21}Ne accumulation in 400 ka flows should be high enough to measure with reasonable accuracy. We aim to present new cosmogenic ^{21}Ne production rate estimates from the oldest flows.

References

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