

TOF-SIMS STUDIES OF LIGHT ELEMENTS IN AXTELL AND ALLENDE MATRIX AND CAIs

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Introduction: Matrix varies greatly between meteorite types but in the least altered meteorites is usually made up of micron scale mineral grains of very heterogeneous composition. The very fine scale and diverse nature of this material has meant that there have been very few detailed studies of matrix, for whilst SEM and TEM analyses have studied the chemical composition of matrix, isotopic measurements have been extremely difficult to obtain. The very light elements are also difficult or impossible to detect using electron beam techniques. TOF-SIMS (Time-of-Flight Secondary Ion Mass Spectrometry) offers high spatial resolution (~100nm) and complete and simultaneous coverage of the whole periodic table. It is therefore a useful tool for studying meteorite matrix. This work describes a preliminary study of Axtell and Allende (CV3) matrix and CAIs using a new TOF-SIMS instrument described in a companion abstract [1]

TOF-SIMS of light elements:

One of the traditional drawbacks of TOF-SIMS has been relatively poor mass resolving power and therefore inability to resolve isobars, a requirement for acquisition of accurate isotope ratios. Whilst this limitation is no longer true [e.g.1, 2], in fact for the lighter elements, Li, B, Be, only relatively low resolving powers (~600) are required to resolve isobars which is well within the capabilities of high transmission TOF-SIMS instruments. Furthermore, Li, like Na and K, does not form a hydride in SIMS so making measurements of ${}^7\text{Li}/{}^6\text{Li}$ relatively straightforward. TOF-SIMS instruments also have the capability of forming images of the sample under study in which-ever mass range is desired so allowing isotope ratio maps of areas to be acquired. The ionization efficiency for the light elements is also fairly high [2], lithium in particular being over an order of magnitude more easily ionized than Si [2]. Mass resolved images of Axtell and Allende matrix were obtained at places on a thin section of each where the matrix looked fresh and unaltered. The surface was coated with carbon but then areas of upto several $100\mu\text{m}^2$ were rastered clean with the Ga primary beam. No charge compensation was required to obtain stable secondary ion beams. At several places Li rich areas were found up to a few microns in diameter. The nature of these Li rich grains is as yet uncertain but the fact that the Li signal was clearly defined in an area of only a few microns, only appeared after the surface was cleaned, were relatively rare (only 3 discovered so far in a total area that sampled up to thousands of grains) and the lack of a large Li signal from elsewhere within the matrix argue that the Li rich areas are not terrestrial contamination but inherent within the meteorite. ${}^7\text{Li}/{}^6\text{Li}=11.7\pm 0.3$ for these areas which agrees with measurements from terrestrial lithium = 11.92 ± 0.13 (mean of 17 measurements). Both are the same as the standard $\text{Li}_{\text{NBSLSVEL}}$ [3] within error. [3] suggested that micron scale heterogeneity in Li isotopes in meteorites cannot be ruled out and the apparent presence of Li 'hot-spots' within the matrix clearly has implications for the mass balance of Li within the meteorite. This preliminary study will seek further evidence to validate these observations and the nature, isotopic composition and distribution of light element hot-spots.

References:

[1] Tizard et al., this volume, [2] Stephan T. (2001), Planetary and Space Science, **49**, (2001), 859-906, [3] Chaussidon and Robert, (1998) EPSL **164**, 577-589