IDENTIFICATION OF THE PARENT BODIES OF MICROMETEORITES: HIGH-PRECISION OXYGEN ISOTOPIC COMPOSITIONS WITH SHRIMP-SI.

M. Van Ginneken[1,2,*], S.J. Mckibbin[1], J.N. Ávila[3], T.R. Ireland[3], P. Holden[3], S. Goderis[1], B. Soens[1], P. Claeys[1], V. Debaille[2], L. Folco[4], P. Rochette[5], [1]AMGC, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussel, Belgium. (*e-mail: mvginnek@ulb.ac.be), [2]Laboratoire G-Time, Université Libre de Bruxelles, Franklin Rooseveltlaan 50, 1050 Brussel, Belgium, [3]Research School of Earth Sciences, The Australian National University, Canberra ACT 2601, Australia, [4]Università di Pisa, Pisa, Italy, [5]CNRS/Aix-Marseille Université, CEREGE UM34, Aix-en-Provence, France.

Introduction: Triple-oxygen isotope data are a powerful tool commonly used to identify the parent bodies of micrometeorites (MMs) [e.g., 1]. Secondary Ion Mass Spectrometry (SIMS) [2,3,4] and Laser Fluorination coupled with Isotope Ratio Mass Spectrometry (LF-IRMS) [1,5] are usually used. SIMS offers the advantage of being non-destructive and generally offers quick acquisition. However, it previously offered limited precision on the mass independent component $\Delta^{17}O$ (~0.5‰). Conversely, LF-IRMS provides high-precision $\Delta^{17}O$ data (~0.1‰), but is totally destructive and time consuming. Here, we return to SIMS oxygen isotope acquisition using the new Sensitive High Mass Resolution Ion Microprobe - Stable Isotopes (SHRIMP-SI) using previously described methods for olivine [6]. The SHRIMP-SI technique has the advantage of offering intermediate precision (~0.3‰ for $\Delta^{17}O$ on San Carlos olivine, 2 S.D.), fast acquisition time and is semi-destructive. Here we present a preliminary study of oxygen isotopes of micrometeorites using SHRIMP-SI.

Samples and methods: A set of 55 S-type cosmic spherules (CSs) from Miller Butte, Northern Victoria Land, Antarctica, were analysed and measurements on CSs from the Antarctic Sør Rondane Mountains, Queen Maud Land, are ongoing. SHRIMP-SI analyses were carried out at the Research School of Earth Sciences of the Australian National University.

Results and discussion: Preliminary results show that the precision of SHRIMP-SI analyses allows good discrimination between parent bodies for MMs. On a $\delta^{18}O$ vs $\Delta^{17}O$ diagram, about 50% of the MMs have oxygen signatures plotting below the Terrestrial Fractionation Line (TFL) and, thus, are likely related to carbonaceous chondrites. Other particles have oxygen isotope signatures plotting above the TFL and are likely related to ordinary chondrites (~25%), to a ^{16}O-poor unkown parent body (~5%) or show ambiguous oxygen isotope signatures (i.e. multiple potential parent bodies; ~20%). These results are broadly in agreement with those for other sets of MMs from the Transantartic Mountains, and of the Atacama Desert as well, which were determined using LF-IRMS [1,7]. Furthermore, results suggest that despite the analytical area being a mixture of olivine, glass, and rare magnetite, there is no significant bias on $\delta^{18}O$ induced by matrix effects. The non-destructive aspect of SIMS including SHRIMP-SI enables other geochemical techniques to be combined on the same sample and helps assess the processes affecting MMs during atmospheric entry. Thus, this technique will be an important addition to future studies focusing on the nature of the flux of extraterrestrial matter to Earth.

Conclusion: We have carried out oxygen isotope analyses on a set of micrometeorites from the Transantarctic Mountains. Preliminary results are consistent with previous studies of oxygen isotopes in MMs. SHRIMP is a highly efficient technique to acquire relatively high-precision oxygen isotope signatures of MMs, offering a compromise between high-precision LF-IRMS and non-destructive SIMS analytical techniques.

References: [1] Suavet C. et al. (2010) EPSL 293, 313-320. [2] Engrand C. et al. (2005) GCA 69, 5365-5385. [3] Taylor S. et al. (2005) GCA 69, 2647–2662. [4] Yada T. et al. (2005) GCA 69, 5789–5804. [5] Cordier C. et al. (2012) GCA 77, 515-529. [6] McKibbin S.J. et al. (2016) 79th An. Meet. MetSoc, Abstract #6519. [7] Van Ginneken et al. (2015) 78th An. Meet. MetSoc, Abstract #5116.