Application of atom probe microscopy to nanoscale Os isotopic studies

TESSALINA S.[1], DALY L.[2], BLAND P.A.[2], SAXEY D.W.[1], REDDY S.M.[2,1] , FOUGEROUSE D.[2,1], AND RICKARD W.D.A. [1]

[1]John de Laeter Centre, Curtin University, Perth WA, Australia; svetlana.tessalina@curtin.edu.au
[2]Department of Applied Geology, Curtin University, Perth, WA, Australia

Atom probe microscopy (APM) has the potential to extract three-dimensional isotopic information at sub-nanometer spatial resolution, inaccessible by other techniques [1]. We assess the capability of APM for the determination of isotopic ratios and abundances, for pure Os metal and complex synthetic alloys, by comparison to Thermal Ionisation Mass Spectrometry (TIMS).

APM uses time-of-flight mass spectrometry to identify isotopes with a mass resolving power ~1000. The isotopic composition of the Os metal, calculated from the APM mass spectra ($^{187}Os/^{188}Os$ = 0.142±0.003, 2 SD), is within 2 SD of the TIMS analysis (0.1417±0.0002), indicating an accuracy of 2% for this isotopic ratio using APM. This analysis is based on APM dataset sizes between 5 and 40 million atoms. For natural samples, APM isotopic analyses may be limited by isobaric interferences. To asses this, we analysed two complex synthetic alloys (HSE and SYN) composed of several highly siderophile elements (Os-Ir-Fe-Pt-Ni-Ru-Re-Mo-W-Re-Os). HSE and SYN are the initial alloy and subsequent run products (heated to 1600 °C) used in the experiments of Schwander et al. [2], respectively. These alloys have similar elemental abundances to refractory metal nuggets (RMNs) found in meteorites [2,3]. In these samples, the seven Os isotopes may overlap with isotopes of W, Pt, Re, Ru_2 and Mo_2. Evaluation of several APM data reduction approaches, and deconvolution of peak overlaps using other stable isotopes of these elements, allowed us to approach the accuracy of the TIMS data within 1% for SYN (2 samples). However, there is a 7% discrepancy in the isotopic composition of the HSE alloy, between APM and TIMS. This may reflect isotopic heterogeneities within the sample, or indicate a higher uncertainty in deconvolution of isobaric interferences. This approach was applied by Daly et al [3] to RMNs from meteorites to assess their Os isotope systematics.

[1] Peterman E.M. et al. (2016) *Sci Advances* [2] Schwander et al. (2015) *Met Planet Sci* [3] Daly L., *et al.*, (this meeting) *Goldschmidt 2017*.