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Living up to the Hype(-rion)! – observations on ion microprobe geochronology using a high-brightness oxygen plasma source.

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The recent introduction of a high-brightness RF plasma oxygen ion source (Hyperion H201, Oregon Physics) to large geometry secondary ion mass spectrometers (e.g. CAMECA IMS1280/1300) has increased the range of available primary beam options compared to the several decades old technology of the duoplasmatron it replaces. Notably, the new source provides considerably higher beam density (ca. 10x and 3x for O^- and O_2^- respectively), which in principle allows for higher spatial resolution and/or shorter analysis times, coupled with unprecedented long-term beam stability.

Incorporating the RF plasma into both conventional spot analysis and ion-imaging geochronology routines has, however, revealed that the source upgrade has consequences for data-acquisition and data reduction strategies, which need to be modified in order to maintain precision. The most significant difference using the new source for spot analyses is the significant change in aspect ratio (width/depth) of the analysed volume. During a comparable length analysis, a three times brighter O_2^- (still favoured for U-Th-Pb geochronology) primary beam will sputter a three times deeper crater that is half the width of a comparable intensity duoplasmatron beam, an effective aspect ratio change of six times, introducing “down-hole” inter-element and, to a lesser degree, isotope fractionation effects that SIMS has largely been free of. Strategies developed to mitigate potential precision degradation and take full advantage of the new RF source include: 1) rastering of critically focused primary beams to retain high aspect ratio (at the expense of improved spatial resolution unless field of view restriction is employed); 2) use of a defocussed aperture-projected (Köhler-mode) primary beam (effectively lower beam density); 3) modelling of within-run ratio evolution based on standard analyses in a manner similar to that employed by laser ablation methods [1]; and/or 4) introduction of multicollection capabilities [2] to increase duty cycle efficiency in a shorter analysis. Ultimately, the choice of which method(s) to use will depend upon the goal of a specific project.

References: [1] Paton, C. et al., Geochem. Geophys. Geosyst., 2010, 11, Q0AA06]; [2] Li et al., J. Anal. At. Spectrom., 2015, 30, 979-985