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Application of the ^{182}Hf-^{182}W chronometer to eucrite zircon and initial solar ^{182}Hf abundance – a multicollector SIMS approach

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The decay of ^{182}Hf to ^{182}W ($t_{1/2}$ = 9 Ma) is a very useful relative chronometer for time scales of core formation and silicate differentiation on planetary bodies. With high Hf (1-2%) and exceedingly low W ($<$ 1ppm), zircon is ideally suited to determination of the ^{182}Hf abundance at the time of its formation. Previous attempts to investigate the Hf-W systematics of eucrite zircon using SIMS have suffered either from loss of signal in energy filtering, or inefficient peak-hopping monocollection. We report a novel analytical routine developed on the Cameca IMS 1270 using four ion counting electron multipliers (EMs) positioned to measure simultaneously the species ^{178}Hf$^+$, ^{182}W$^+$, ^{183}W$^+$ and ^{186}W$^+$. A mass resolution in excess of the highest nominally achievable (MRP = 8000) was used to eliminate REE oxide interferences. Calibration of Hf/W ratios followed a previously described method (Ireland et al., 2003) using Yb as a proxy for W in relative sensitivity factor calibration, with NIST SRM 610 and Geostandards 91500 zircon as reference materials.

Applying our method, we show that zircon in eucrites A881467 and A881388 formed 5.4$\pm$5.2 Ma and 3.8$\pm$3.5 million years respectively after metal-silicate differentiation on the eucrite parent body (4 Vesta). These relative ages suggest that zircons formed $<$ 14.5 million years after the formation of CAIs and that primary igneous activity lasted for at least this long. Our estimated $[^{182}\mathrm{Hf}/^{180}\mathrm{Hf}]_{SSI}$ of (2.2$\pm$1.2) $\times 10^{-4}$ agrees at the lower limit of uncertainty with values inferred from chondrites. Zircon from a third eucrite, EET90020, have extremely low ^{182}Hf abundance suggesting partial melting (impact induced?) and crystallization when ^{182}Hf had decayed significantly and ^{26}Al and ^{60}Fe had ceased to be effective heat sources.