

Calibrating the Hafnium-Tungsten and Aluminium-Magnesium Clocks

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Short-lived nuclides such as ²⁶Al and ¹⁸²Hf are among the most important chronometers for constraining the duration of processes in the early solar system but their use as chronometers is highly dependent on the assumption that they were homogeneously distributed in the early solar system. Here we present internal ¹⁸²Hf-¹⁸²W isochrons for angrites and CAIs and use these data, in combination with previously published results for the ²⁶Al-²⁶Mg system, to assess the initial distribution of ²⁶Al and ¹⁸²Hf in the early solar system. We obtained precise ¹⁸²Hf-¹⁸²W isochrons for several angrites, whose ²⁰⁷Pb-²⁰⁶Pb ages range from ca. 4558 Ma to ca. 4565 Ma (Amelin 2008). The Hf-W results for angrites and CAIs are consistent with the ²⁶Al-²⁶Mg results for these samples (Bivak-Spirndorf et al. 2005), indicating that both ²⁶Al and ¹⁸²Hf were homogeneously distributed in the early solar system. Consequently, relative ages obtained from the ²⁶Al-²⁶Mg and ¹⁸²Hf-¹⁸²W systems have chronological significance. The ¹⁸²Hf-¹⁸²W results are also consistent with the ²⁰⁷Pb-²⁰⁶Pb ages for angrites: the ¹⁸²Hf decay constant determined from the regression of $\log(^{182}\text{Hf}/^{180}\text{Hf})$ vs. ²⁰⁷Pb-²⁰⁶Pb age is identical to the experimentally determined value of the ¹⁸²Hf decay constant (Vockenhuber et al. 2004). This provides evidence that absolute ¹⁸²Hf-¹⁸²W ages calculated relative to any of these angrites are robust and accurate. The absolute ¹⁸²Hf-¹⁸²W age for CAIs relative to the angrites D'Orbigny and Sahara 99555 is 4568.6 ± 0.5 Ma, which is significantly older than the most precise ²⁰⁷Pb-²⁰⁶Pb age for CAIs (Amelin et al. 2002). This probably reflects disturbance of the ²⁰⁷Pb-²⁰⁶Pb systematics in CAIs. ²⁰⁷Pb-²⁰⁶Pb ages for Allende chondrules (Connelly et al. 2008; Bouvier et al. 2008) are 1-3 Ma younger than 4568.6 ± 0.5 Ma, consistent with the ²⁶Al-²⁶Mg age difference between CAIs and chondrules from CV-like chondrites (Hutcheon et al. 2000).

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