Calibrating the Hafnium-Tungsten and Aluminium-Magnesium Clocks

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

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