HF-W THERMOCHRONOMETRY OF THE ACAPULCOITE-LODRANITE PARENT BODY

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Key issues in the formation and early evolution of meteorite parent bodies are the timescales of accretion, differentiation and cooling. The ^{182}Hf-^{182}W system is a powerful tool to obtain such age constraints and has been used to date the differentiation of iron meteorite parent bodies [1] and to constrain the thermal evolution of the H chondrite parent body [2]. Whereas heating of the iron meteorite parent bodies was sufficient to cause global differentiation, ordinary chondrite parent bodies did not ever melt. In contrast, acapulcoites and lodranites were partly melted, yet their parent body did not differentiate. To constrain the parameters that control the thermal evolution of the acapulcoite-lodranite parent body, we applied the Hf-W chronometer to several acapulcoites and lodranites.

Metal and silicate fractions from acapulcoites define an isochron, whose slope corresponds to an age of 5.1±0.8 Ma after CAI formation. Likewise, a metal-silicate isochron for lodranites corresponds to an age of 5.7±1.0 Ma. Relative to the Pb-Pb ages for angrites D'Orbigny and Sahara 99555 [3], these relative ages correspond to 'absolute' Hf-W ages of 4563.5±0.7 Ma for acapulcoites and 4563.0±0.9 Ma for lodranites. These ages are older than Pb-Pb ages for Acapulco phosphates [4], which reflects the relatively high closure temperature of the Hf-W system. The Hf-W closure temperatures were estimated from numerical simulations of W diffusion in high-Ca pyroxenes (the major host of radiogenic ^{182}W) [2] and are ~975°C for acapulcoites and ~1050°C for lodranites, significantly higher than the Pb-Pb closure temperature of ~550°C for Acapulco phosphates [5]. The Hf-W and Pb-Pb constraints correspond to a cooling rate of ~65°C/Ma and indicate that acapulcoites/lodranites, in spite of higher peak temperatures, cooled much faster than H6 chondrites. Thermal modelling of spherical asteroids heated by ^{26}Al decay indicate that the thermal history of acapulcoites/lodranites appears most consistent with a parent body of 30-40 km radius that accreted instantaneously at ~2 Ma after CAI formation. Compared to a thermal model for the H chondrite parent body [2], the acapulcoite/lodranite parent body accreted earlier (which is consistent with its higher peak temperature) and is smaller (which is consistent with the faster cooling of its interior).

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