In situ Magnesium Isotopes and Trace Elements in Ungrouped Achondrite Northwest Africa 7325

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Northwest Africa 7325/8014 is a highly-shocked, Mg-rich cumulate olivine gabbro, composed of calcic plagioclase, diopside, forsterite, and minor Cr-troilite and kamacite [1]. Distinctive O and Cr isotopic compositions [1,2], extreme depletion in highly-siderophile elements, magnetic paleo-intensities [3], and chemical similarities to surface rocks on Mercury suggest that this achondrite may be Hermean in origin [1]. Both the Pb-Pb [4] and Al-Mg [5] isotope systems yield an ancient formation age of 4562.8 Ma. The whole rock Sm-Nd and Lu-Hf systems have been disturbed by terrestrial weathering, yielding young model ages.

A total of fifty-six 20-25 μm spots in six olivines were analysed for their Mg isotope compositions relative to San Carlos olivine. The Mg isotopic composition of the unfractured cores of the olivines in NWA 7325 are heavy, with an average δ^{25}Mg value of 0.39±0.17‰ (2σ) relative to the San Carlos olivine. Olivine has δ^{26}Mg* values of 0.01±0.10‰ (2σ) and ^{27}Al/^{24}Mg ratios of (3.8±1.1)x10^{-4}. These data neither confirm nor refute the excess $\delta^{26}Mg^{0}$* seen in [5].

NWA 7325 is depleted in lithophile trace elements, with a gently sloping subchondritic whole rock REE pattern (Nd_{CN}=0.35, Sm_{CN}=0.27, Lu_{CN}=0.13 ID). All silicate phases are LREE depleted. Diopside has La_{CN}=0.02, Nd_{CN}=0.08, and Sm_{CN}=0.18 (LA). Plagioclase and diopside show large positive Eu anomalies, with Eu/Eu* values of ~33 and ~10, respectively. All silicate phases are highly depleted in Sm/Nd,with ^{147}Sm/^{144}Nd ~0.4. If this reflects the melt that NWA 7325 crystallized from, it indicates extreme depletion and fractionation of LREE. The age of NWA 7325 seems to preclude the existence of a trace element-rich crust on the parent body. Rather, its reduced nature suggests efficient core formation, which sequestered trivalent REE. Similar processes in the reduced early Earth may have sequestered a fraction of terrestrial LREE in such a hidden reservoir.

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