KREEP and Mg-suite investigations through Northwest Africa 6950

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Introduction: The Moon represents a convenient, relatively pristine source of information on planetary formation. The model of lunar formation is derived from the limited samples we have available, wherein the Moon accretes from the residue of an impact (or impacts) with the early Earth [1]. The formation of KREEP, the incompatible residue from the crystallizing Moon, provides a timeline for the ending of solidifaction. The KREEP-rich Apollo samples cluster in age around 3.8 ± 0.1 Ga, a potential consequence of the proximity of their sample sites.

Meteorites avoid this sampling bias. The Northwest Africa (NWA) 773 family of meteorites (which includes NWA 6950, 2977, 2700, 2727, and 3333) comprise rare lunar gabbros and bear geochemical signatures akin to KREEP but distinctly less trace element enriched at extremely low Ti contents. Of this family, NWA 6950 is a magnesian gabbro bearing veins of shock-induced melt [2].

This study: A sample of NWA 6950 was crushed, and minerals density separated and picked for purity, in order to avoid the shock melt. Samples were analyzed on the University of Cologne's Neptune plus. Creating a Lu-Hf isochron from the picked mineral separates, we find an age of 3.103 ± 0.039 Ga which significantly overlaps with the baddeleyite ^{207}Pb-^{206}Pb age of 3.108 ± 0.020 Ga for NWA 6950 reported by [2], from which we infer the Lu-Hf age to represent a pristine crystallization age. The initial εHf of NWA 6950 (-12.46 ± 0.64) can now greatly expand a perfectly defined array in εHf vs. age space of older KREEP-rich breccias [3] and KREEP-basalts [4] to much younger ages. In contrast, Mg-suite samples, i.e., some of the earliest magmatic lunar rocks, plot above this array. This implies that Mg-suite samples represent a different mantle source(s) than KREEP-dominated rocks, whose source gave rise to magmatism for well over 1 Gyr and which might have been established within the first 50 Myrs of the solar system, consistent with recent Hf-W evidence [5].

References: (1) Snyder *et al.* GCA 56, 3809-3823 (1992) (2) Shaulis *et al.* (2017) GCA 213, 435-456, (3) Sprung *et al*. (2013) EPSL 380, 77-87, (4) Gaffney and Borg (2014) GCA 140, 227-240, (5) Thiemens *et al*., under review