MAGNETIC AND NONMAGNETIC DIFFERENTIATED PLANETESIMALS. B. P. Weiss[1], R. Fu[1], D. L. Shuster[2], J. Gattacceca[3], C. R. Suavet[1], A. J. Irving[4], [1]Department of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, 54-814, 77 Massachusetts Avenue, Cambridge, MA 02139, USA, [2]University of California, Berkeley, Berkeley, CA 94720, USA, [3]CEREGE, CNRS/Université Aix-Marseille 3, France, [4]Department of Earth and Space Sciences, University of Washington, Seattle, WA, USA.

Introduction: The diversity of achondrite groups indicates that many early planetary bodies experienced large-scale differentiation and formed metallic cores. These cores would have been initially molten and may have convected and generated dynamo magnetic fields [1]. Modern paleomagnetic studies of achondrites have in fact indicated that at least four planetesimals (the angrite parent body, Vesta, the main group pallasite body and possibly also the CV chondrite parent body) generated dynamos with inferred surface magnetic fields ranging from tens to hundreds of µT (for comparison, Earth's field is 50 µT). In fact, an achondrite without evidence for paleomagnetic fields has yet to be confidently identified, hinting that the dynamo process may have been common among early planetary bodies (although the sample size is currently small). Here we present paleomagnetic measurements from two achondrite groups which reveal contrasting magnetic histories: eucrites (thought to be samples of asteroid 4 Vesta) and a newly discovered ungrouped basaltic achondrite (variably proposed to be a sample of an unusually reduced differentiated planetesimal or possibly even planet Mercury).

Eucrites: Vesta is the largest known differentiated asteroid and is thought to be the source of the howardite-eucrite-diogenite (HED) clan of meteorites. Recent olume and mass constraints from the Dawn mission provide evidence of a metallic core between 107 and 113 km in radius [2]. The 3.69 billion year old eucrite ALHA81001 provides evidence of strong (perhaps ~12 µT) crustal fields on the surface of its parent asteroid [3]. This makes Vesta the first asteroid identified to have formed a core dynamo. Although there are no unambiguous direct records of the early Vestan dynamo field yet identified because of the paucity of main-group HEDs with ancient (> 4.5 Ga) cooling ages (as indicated by $^{40}Ar/^{39}Ar$ thermochronometry), remanent magnetization has recently identified in the eucrite Millbillillie [4] and in the diogenite NWA 5480 [5] acquired in fields ranging from several to several tens of µT). This indicates that Vestan magnetization fromed on the planetary-scale. Furthermore, remanent magnetization has been identified in the anomalous eucrite PCA 82502 [6], which has an $^{40}Ar/^{39}Ar$ age within the range of planetesimal dynamos as predicted by some thermal models [7] (but see also [8]).

NWA 7325: In stark comparison to the HEDs, we find the newly discovered ungrouped achondrite NWA 7325 [9] provides no clear evidence for any magnetic fields > 1 µT at the time of cooling (to be constrained by our $^{40}Ar/^{39}Ar$ thermochronometry currently in progress). Bulk elemental and rock magnetic analyses nevertheless demonstrate that the meteorite is highly depleted in siderophile elements, consistent with core formation. This makes NWA 7325 the first example of an essentially unmagnetized igneous rock from a differentiated body in the early solar system. We discuss the implications of this for early planetary thermal histories and the hypothesis that NWA 7325 may have originated from Mercury.

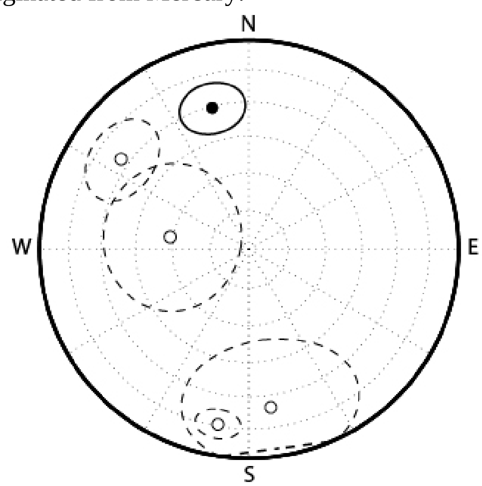

Figure 1: Magnetization directions of 5 mutually oriented subsamples of the ungrouped achondrite NWA 7325 after removal of lower coercivity (<190-520 mT) and lower blocking temperature (<380-400°C) magnetization overprints. The scattered distribution provides evidence of very weak to null fields during the last major cooling event.

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