PARENT BODIES OF DIFFERENTIATED METEORITES: IMPACT HISTORIES AND RELATIONSHIPS WITH CHONDRITES. Edward R. D. Scott1[1] and Joseph I. Goldstein[2] [1] Hawai'i Institute of Geophysics and Planetology, University of Hawai'i, Honolulu, Hawai'i, 96822, USA. Email: escott@hawaii.edu [2] University of Massachusetts, 160 Governors Dr, Amherst, MA, 01003, USA. Email: jig0@ecs.umass.edu.

Introduction: Although Vesta is well established as the parent body of the largest group of differentiated meteorites (the HEDs), our understanding of the other ~100 parent bodies of differentiated meteorites is much more limited. Where are the asteroids and meteorites from the olivine-rich mantles of the bodies that provided us with ~80 grouped and ungrouped iron meteorites? What happened to the parent asteroids of the ungrouped eucrites like NWA 011 and Ibitira? How could numerous differentiated bodies have been disrupted while Vesta's basaltic crust was preserved? Why are meteorites derived from far more differentiated parent bodies than chondritic parent bodies, yet the asteroid belt is dominated by C and S class chondritic asteroids?

Two very different explanations have been proposed to account for the paucity of differentiated asteroids. Weiss and Elkins-Tanton [1] have proposed that many partially differentiated planetsimals formed in the asteroid belt but are camouflaged with unmelted chondritic crusts. Bottke et al. [2] proposed instead that differentiated asteroids formed and were disrupted inside 2 AU. This is consistent with Hf-W isotopic evidence that iron meteorite parent bodies accreted before chondrites, as accretion times at 1-2 AU would have been shorter and initial ^{26}Al concentrations higher (see [3]). Hit-and-run glancing collsions with larger protoplanets during accretion at 1-2 AU could have disemboweled differentiated asteroids by shear and tidal forces much more effectively than hypervelocity impacts [4]. Collisional fragments from numerous bodies could then have been tossed into the asteroid belt [5].

Our review of differentiated meteorites strongly argues against the first model and favors early destruction of numerous differentiated planetesimals.

Angrites: These basaltic achondrites are unbrecciated and largely unshocked, unlike eucrites, even though they formed on a large Vesta-like body. Related chondrites or other differentiated meteorites are not known. The absence of impact damage suggests they were extracted early from their parent asteroid, possibly 4558 Myr ago [6]. Asteroids that match the angrites spectrally are rare and tiny: <10 km in diameter.

Ureilites: The second largest group of achondrites are coarse-grained, ultramafic rocks derived from a large partially melted C-rich body that was unrelated to carbonaceous or other known chondrites [7]. Most ureilites cooled rapidly from ~1100°C to 650°C at 0.05-10°C/hr following catastrophic disruption and gas-assisted fragmentation into meter-sized pieces [8]. Many ureilites were probably shocked in this impact which probably occurred 5-10 Myr after CAI formed [9].

Aubrites: Aubrites consist largely of almost FeO-free enstatite. Their isotopic composition suggests formation near ~1 AU like other enstatite meteorites, but they are not derived from known E chondrites [10]. They are mostly fragmental and regolith breccias and some were shocked. Spectrally they match a few small E type asteroids, which are rare. The unique Shallowater aubrite formed on a separate body around 4 Myr after CAIs when a largely molten body was broken up by a low-velocity impact with a largely solid body [11].

Mesosiderites: Mesosiderites formed by impact mixing of molten metallic Fe,Ni with fragments of basalt, gabbro and dunite. Evidence that IVA irons come from an impact generated, molten metallic Fe-Ni body with little or no mantle (see [3]) suggests that mesosiderite metal may have come from a similar body. Mesosiderites were then buried so deeply under well insulating regolith that they cooled exceptionally slowly for >600 Myr and did not retain Ar until 3.8-4.0 Gyr ago [12] or sustain impact deformation during the LHB. The absence of a suitably large Vesta-like source for the mesosiderites suggests that a Vestan origin for the mesosiderites should be reconsidered.

Relationship with chondrites: Polymict fragmental breccias from the ureilite, aubrite, and eucrite parent bodies contain assorted chondrite fragments, but they are samples of projectiles, not endogenous chondritic crust. The preservation of foreign chondritic clasts and the absence of chondritic clasts or chondrites that could represent the unmelted precursor materials strongly argue against the concept of asteroids with differentiated interiors and chondritic crusts [1].

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