VOLATILE DEPLETION: CONSTRAINTS FROM DIFFERENTIATED METEORITES.

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Recent Hf-W and Al-Mg ages for irons and achondrites (e.g. [1-3]) constrain the timing of other processes in addition to differentiation. ^{16}O-depletion in angrites, IIIAB and IVA inclusions [4] suggests rapid modification of Solar System oxygen. In addition, most irons show volatile-depletion, plausibly inherited from precursor materials (e.g.[5]), to levels not seen in chondrites.

The principal theories that have sought to explain volatile depletion are incomplete condensation (e.g.[6,7]), and the two-component model (e.g.[8,9]), where bulk depletion is related to chondrule depletion. A problem for the latter model is that many differentiated objects (e.g. Earth [10]) are more volatile depleted than chondrules. But the Hf-W data raises another issue. Initial W isotopic compositions for magmatic irons are indistinguishable from CAI [2]. Chondrule formation ~2 Ma after CAI (e.g.[11]) therefore postdates core formation in planetesimals. If chondrites are not the precursor for differentiated asteroids [1], then chondrule formation is not responsible for volatile depletion.

A problem for incomplete condensation is that depletion does not clearly correlate with heliocentric distance [12]. The main belt contains (4) Vesta (similar depletion to the Moon), and probably the parent bodies of highly depleted irons. A possible solution comes from a recent model which suggests that differentiation occurred in the terrestrial planet region [13]. Differentiated planetesimals evolved collisionally, with some survivors scattering into the main belt: (4) Vesta may be an interloper [13].

The Bottke model [13] is a partial solution to the depletion-gradient problem. Further modelling is required to assess whether extreme depletion is possible at small heliocentric distances, but we might also consider another mechanism. Impact-generated vapour of ~solar composition would allow for local incomplete condensation. A variety of evidence supports an origin for highly depleted CB chondrites as condensates from an impact-generated vapour plume (e.g.[14-16]). Giant impacts should be common in the early Solar System [17]. Given short accretion times (e.g.[18]), and plausible impact velocities (Bottke *pers. comm.*), high energy impacts may have occurred within 1Ma of CAI. Although degassing might chemically fractionate elements, incomplete condensation of impact-generated vapour would produce a volatility-controlled depletion, and should be considered as a general mechanism for extreme volatile depletion.

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