IMPACT MELTING AND ^{182}W ANOMALIES IN MAGMATIC IRON METEORITES.

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Introduction: Asteroidal impact processes produced large-scale metallic melts that migrated from the original formation site and engulfed relatively unaltered silicates. The classic example is the Portales Valley meteorite in which melt sheets having thicknesses of several cm are in contact with silicates that have retained metal and troilite (some S also seems to have moved through the gas phase). The very limited ranges in Ir fractionation observed in main-group IAB irons seems best explained by "crystal-settling" (from a large, >1 km^3 melt) rather than by fractional crystallization responsible for large ranges in the magmatic groups (IIAB, IIIAB, IVA). The metal in IABs engulfed silicates some of which retained chondritic compositions including FeS and planetary rare gas. Slow heating by an internal heat source such as ^{26}Al would have caused early loss of FeS-rich and albite-rich melts and major outgassing of rare-gas hosts. Wasson et al. [1] argued that if, as indicated by the O-isotopic composition, the IVA irons formed from an L-LL chondritic precursor, impact melting offered a plausible mechanism to explain both the loss of the volatile metals Ga and Ge and the reduction of FeO to lower the Ni content of the metal. Although some researchers doubt that asteroidal impacts (mean impact velocity 5 km/s, 20% >7 km/s) can produce large-scale (kilometer-scale) melts, the high porosity inherited from the first planetesimals would have greatly increased the efficiency of melt production.

Impact-shock versus ^{26}Al heating. Internal heating by ^{26}Al decay is temporally and spatially very different form impact heating. Heating by ^{26}Al is a very slow process producing the highest temperatures at the center of the asteroid; about 10^6 years are necessary to provide enough sensible and latent heat to increase the temperature from 1400 K where silicate melting begins to 1600 K, when large-scale melting leads to phase separation (core formation and/or basalt extrusion). A problem with an ^{26}Al model specific to the IVA iron meteorites is that separation of a basaltic magma would occur long before low-S metal melted at ~1770 K.

^{182}W in an impact-heated asteroid. A recent study by Burkhardt et al. [2] revealed ε^{182}W values (with no cosmogenic contribution) in magmatic iron meteorites (IVA Gibeon and IIAB Negrillos) that are marginally lower than the initial solar-system value obtained by analyzing refractory inclusions from CV3 chondrite Allende. Because nebular Hf is expected to be concentrated in chondrule mesostasis and clinopyroxene, much of the radiogenic ^{182}W was probably inside chondrules at the time of impact heating of the IVA asteroid. Rapid formation of a metallic melt and migration to the center of the asteroid can thus account for low amounts of radiogenic ^{182}W in the metal. The W isotopic composition then provides only a lower limit for the time of the impact. Because one would expect minor contamination by radiogenic W, the solar-system initial ε^{182}W was somewhat lower than that measured by [2] in these two irons.

References: 1] Wasson J. T., Matsunami Y. and Rubin A. E. (2006) Geochim. Cosmochim. Acta 70, 3149; [2] Burkhardt C, Kleine T., Bourdon B., Palme H., Zipfel J., Friedrich J., Ebel D. (2008) Geochim. Cosmochim. Acta, submitted.