REVISED TRAPPED MELT MODEL FOR IRON METEORITES.

Nancy L. Chabot[1], [1]Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Rd, Laurel, MD, 20723, USA. Nancy.Chabot@jhuapl.edu

Introduction: The IIIAB group is the largest magmatic iron meteorite group, making it well-suited to investigate the process of core crystallization in the early Solar System. Previous studies have described strong evidence that the IIIAB core solidified by fractional crystallization but that the manner of crystallization also trapped pockets of metallic melt during that process [1–3]. This trapped melt model (Fig. 1a) resulted in the composition of IIIAB irons falling between the solid metal and liquid metal tracks from fractional crystallization of the core, due to different amounts of trapped melt during the formation of each individual iron meteorite specimen, providing an elegant conceptual model to explain the inherent spread in IIIAB irons about the fractional crystallization trend.

However, a major issue with the IIIAB trapped melt model calculations [1–3] is that the values of the solid metal/liquid metal partition coefficient (D) of Ir used in the models differ considerably from the experimental data [4] (Fig. 1b). In any model, the expression of D(Ir) is just a means to mathematically represent the partitioning behavior; however, having that expression be consistent with the experimental determinations of D(Ir) would be more physically plausible. Using a parameterization for D(Ir) derived from the latest experimental data [4], the IIIAB irons do not fall between the solid metal and liquid metal tracks (Fig. 1c).

Revised Trapped Melt Model: To date, trapped melt models have not included any effects on the element chemistry due to the formation of troilite and have mathematically just used mixtures between solid metal and liquid metal to model trapped melt. In the revised trapped melt model in this work, an effect on the element chemistry due to the formation of troilite from the trapped melt is included. In particular, the revised trapped melt model assumes a simple system where any trapped melt will solidify into troilite and solid metal. Given that S is nearly insoluble in Fe-Ni solid metal, the fraction of trapped liquid that solidifies to troilite rather than solid metal can be calculated by mass balance. Many siderophile elements are not expected to partition heavily into troilite in comparison to Fe-Ni metal, and thus, their concentrations in the troilite can be approximated as zero, resulting in a simplified equation:

$$C_{TrapSolidMetal} = C_{TrapLiq}/(1-x)$$

where $C_{TrapLiq}$ and $C_{TrapSolidMetal}$ are the concentrations of an element in the trapped liquid and resulting solid metal respectively, and x is the fraction of the trapped liquid that solidifies to troilite rather than solid metal. In this revised trapped melt model (Fig. 1c), the IIIAB irons largely fall between the tracks of solid metal formed from fractional crystallization and solid metal formed from trapped liquid. Conceptually, this is as envisioned by previous trapped melt models, but mathematically, this model is different in that 1) it uses parameterizations for D(Ir) and D(Au) derived from the experimental data and 2) it includes an effect on the element chemistry due to the formation of troilite from the trapped melt. This simple model shows great potential to resolve existing issues with previous models and to provide a consistent approach to model trapped melt in all magmatic iron meteorite groups.

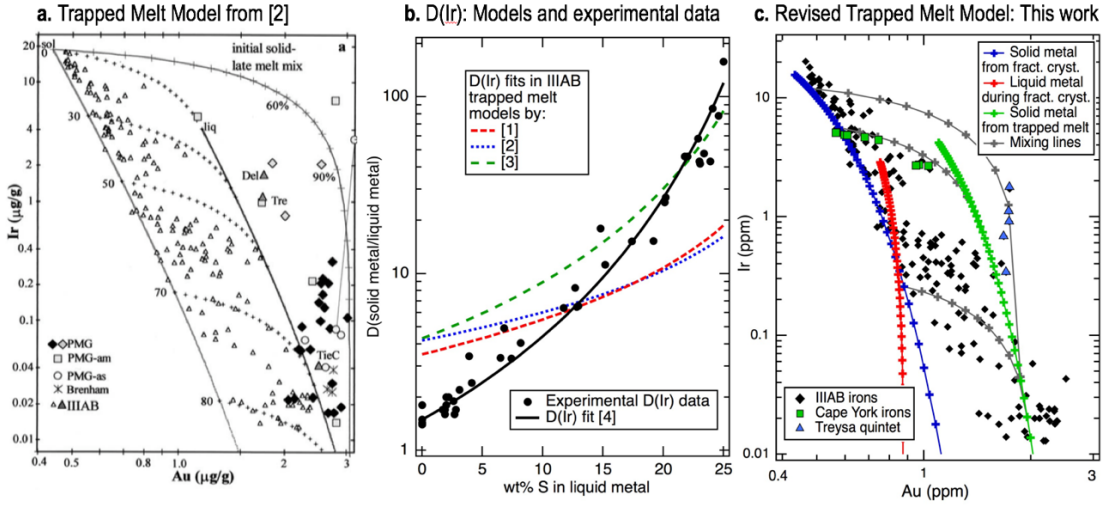

Fig. 1. Original (**a., b.**) and revised (**b., c.**) trapped melt models with D(Ir) fits applied to the IIIAB group.

References: [1] Wasson, J. T. (1999) *GCA* 63: 287–2889. [2] Wasson, J. T. & Choi, B.-G. (2003) *GCA* 67: 3079–3096. [3] Wasson, J. T. (2016) *MAPS* 51: 773–784. [4] Chabot, N. L. et al. (2017) *MAPS* 52: 1133–1145.

Acknowledgement: NASA grant NNX15AJ27G.