PREDICTING THE COMPOSITIONS OF IRON METEORITES FORMED AT THE EUTECTIC IN THE FE-NI-S SYSTEM

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Introduction: Two outstanding problems related to iron meteorites are the rarity of S-rich specimens and the large number of ungrouped samples. Proposed explanations for these two problems include a sampling bias in our meteorite collections due to weak S-rich meteorites not surviving to Earth [1] and iron meteorites being samples of more than 50 different parent bodies [2]. Another possibility is that our meteorite collections contain irons that formed in S-rich conditions but that have not been recognized as such, and that these irons are actually members of existing groups rather than representing distinct parent bodies [3]. Most previous work on the crystallization of iron meteorites has focused on the fractional crystallization of a molten metallic liquid up to the eutectic composition. In this work, I calculate the predicted compositions of iron meteorites that crystallized at the eutectic in the Fe-Ni-S system. These predictions can be compared to iron meteorites in our collections to search for ungrouped irons that may be linked to existing groups and may represent samples with a S-rich crystallization history.

Method: At the eutectic composition, both FeNi solid metal and FeS troilite crystallize. For my calculations, which are similar to the approach of [3], I assumed that the troilite would be pure FeS and that all Ni and siderophile trace elements would partition completely into the crystallizing solid metal. The eutectic composition of the Fe-Ni-S system was expressed mathematically as a function of the Ni and S contents. Published parameterizations of the solid metal/liquid metal partition coefficients as a function of the liquid S content were used for 17 siderophile elements. The composition of the solid metal formed at the eutectic relative to the last solid metal to fractionally crystallize prior to reaching the eutectic was calculated. By assuming that the highest Ni member of a group represents the solid metal that crystallized just prior to reaching the eutectic, the composition of the eutectic FeNi metal was predicted.

Results: FeNi metal formed at the eutectic had Ni enrichment levels that ranged from a factor of 2.5-3 relative to the solid metal formed prior to reaching the eutectic. Predicted eutectic solid FeNi metals were also characterized by depletions of Ga and Ge (factors of 0.1-0.3), similar levels of Au (factors of 1.1-1.4), and large depletions of Ir (factors of <0.01). The predictions for Ir and other highly siderophile elements are known to be problematic however, as these elements have not been successfully modeled for late crystallizing irons of magmatic groups with the parameterizations of the partition coefficients used in this study. The calculations also revealed that the element Sb is highly diagnostic for determining FeNi solids formed at the eutectic; the enrichment of Sb in the FeNi solid metal formed at the eutectic was >10 times that of the solid metal formed just prior to reaching the eutectic composition. Thus, I have begun to search for iron meteorites with high Sb contents to locate potential eutectic solid metals that may be related to existing iron meteorite groups.

References: [1] Kracher A. and Wasson J. T. 1982. *Geochimica et Cosmochimica Acta* 46, 2419-2426. [2] Wasson J. T. 1990. *Science* 249, 900-902. [3] Kracher A. 2002. *LPSC* XXXIII, 1421.