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Final Technical Report for NASA Cosmochemistry Grant (J.T. Wasson, P.I.)

Much of our research involves the chemical characterization of iron meteorites, and discussion of their origins. Wasson (1999a) used an extensive set of data on irons from the magmatic group IIIAB (including planimetric determinations of S in 23 irons) to show that the irons in this group can be modeled as mixtures of equilibrium solid and melt, and that the inferred fraction of trapped melt varies widely, from a few per cent to >80 per cent. The main group pallasites are closely related to the IIIAB irons. Wasson et al. (1999) described massive chromite in the Brenham pallasite and discussed possible formation mechanisms and implications for D_{Cr}. Sugiura et al. (2000) reported concentration and isotopic data for N and C in IIIE irons, and also showed that these are resolved from IIIAB irons on Ga-Au and Co-Au diagrams.

Wasson and Richardson (2001) analyzed 45 irons from group IVA, also a magmatic group, and demonstrated that important insights are gained by comparisons with the IIIAB data set; the initial D_{Ir}, D_{Au} and D_{As} values were all substantially lower in IVA than in IIIAB, apparently because the initial S (and P) contents were much (≈6x) lower in the IVA magma than in the IIIAB magma.

Wasson and Kallemeyn (2001) carried out a new, comprehensive evaluation of IAB and closely related irons including those formerly called IIICD; they found that there are five "satellite" subgroups showing compositional trends parallel to those in IAB. The Birch et al. (2001) paper describes Willow Grove, a new volatile-poor, Ni-rich ungrouped iron that is closely related to Tishomingo, and possibly, as suggested for the IAB irons, the product of impact melting.

Wasson (1999b) demonstrated that, among iron meteorites from Antarctica,. about 40% are ungrouped. This is in contrast to non-Antarctic irons which contain about 15% ungrouped members. Wasson proposed that this difference is due to the small size of the Antarctic specimens which may mean that they have suffered more interplanetary collisions and were derived from parent rocks launched from their parent bodies in the more distant past.

A careful evaluation by Wasson et al. (2000) of a set of neutron-activation data for chondrules physically separated from the ungrouped carbonaceous chondrite LEW85332 revealed striking differences in the siderophile and chalcophile abundance patterns between low-FeO and high-FeO chondrules, the former being relatively unfractionated, the latter showing large fractionations between refractory Ir (highly depleted) and the common siderophiles Ni, Co and Fe (moderately depleted). Rubin et al. (1999) reported the abundance and petrographic setting of FeS in 226 chondrules from highly unequilibrated ordinary chondrites, (68 of them are from LL3.0 Semarkona) and showed that primary troilite occurs in chondrules of all textual types, although in fewer low-FeO than high-FeO chondrules. Nelson and Rubin (2001) quantified the size distributions and the degree of fragmentation in chondrules from unequilibrated ordinary chondrites.

Chizmadia et al. (2001) showed that the systematic changes in the properties of AOI in CO3 chondrites can be used to improve the assignment of these meteorites to petrologic subtypes.

Rubin et al. (2000) studied the new Los Angeles martian meteorite and showed that it is the most differentiated basalt known from Mars.

Bell et al. (2000) discussed how FU Orionis outbursts could have heated solar-nebula material numerous times. Such heating mechanisms are possibly responsible for forming chondrules, recrystallizing matrix material and causing heating of asteroid-size bodies.

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