GROUP IIE IRON METEORITES; METAL COMPOSITION, FORMATION, RELATIONSHIP TO ORDINARY CHONDRITES. J. T. Wasson[1],and E. R. D. Scott[2], [1]IGPP, University of California, Los Angeles, CA 90095-1567, USA; [2]HIGP, University of Hawaii, Honolulu, HI 96822, USA. Email: jtwasson@ucla.edu

Introduction. Wasson and Wang (1986) [1] reported instrumental neutron-activation-analysis (INAA) data for 12 IIE irons and concluded that IIE irons, like IAB irons, were produced by impacts onto a chondritic asteroid. We now have INAA metal compositions for 20 IIE irons. Nine have differentiated silicates; in 8 silicates have not been recognized. Three IIE irons (Netschaevo, Techado and Mont Dieu) have chondritic inclusions including one with chondrules; Watson and Garhi Yasin have silicates with chondritic compositions [see 2]. O-isotope and chemical compositions of the silicates indicate that IIEs are closely related to ordinary chondrites (OC). Although IIE irons formed at 4.5 Ga, some impact-altered members record Ar-Ar ages as young as 3.8 Ga [3].

Bild and Wasson [4] argued from chemical data for Netschaevo silicates and metal that IIE silicates were derived from ordinary chondrites—specifically from a group they called HH that lay on an extension of the LL-L-H sequence to more reduced and metal-rich material. Clayton and coworkers [5.6] reported that the IIE $\Delta^{17}O$ was 0.59‰, 0.14‰ lower than that in H chondrites. In contrast, McDermott et al. [7] obtained laser-fluorination data implying that O isotopic compositions of the two groups were unresolvable.

Abundant silicate inclusions (some of which are chondritic) in IIE irons, their narrow range of Ir concentrations, and diverse structures and troilite contents preclude formation in an asteroidal core. Proposed origins include impact melting of solid chondritic material [1] or by impact mixing of materials from a partly molten and partly differentiated body [e.g., 3,8].

Questions: Our new INAA data for IIE irons plus Portales Valley H chondrite metal [Rubin et al., 2001] are used to address the following questions. a) What geochemical processes generated the wide and correlated variations in Au, As, and Ni, and the relatively narrow range in Ir? b) Were IIE irons produced on the H-chondrite asteroid, on a more reduced and metal-rich asteroid, or perhaps both? c) What was the S content and thus the liquidus temperature and viscosity of the metal at the time FeS-rich liquid and silicates were trapped? d) What was the length scale of the region or regions where the IIE iron masses were produced. e) Was the IIE parent body melted by impact(s) or ^{26}Al, or both?

Results: INAA data were obtained for 15 elements in IIE metal using techniques described in Wasson et al. (1989) [9]. Compositional boundaries of IIE are essentially those of [1]. Fig. 1 shows data for 6 elements plotted against Au on log-log diagrams.

Au and Ni concentrations in IIE metal are highly correlated as well as As and Au (not shown). Weak correlations are visible on Co-Au (positive) and Ga-Au (negative) plots. Four samples with high FeS contents (open triangles) have distinctive metal compositions on most plots. IIEs with chondritic silicates or young ages lack distinctive metal compositions. Compositions of metal samples from the large veins in the Portales Valley H chondrite [10] are well resolved from IIE trends on Co-Au and Ga-Au plots. By comparison with fractionally crystallized groups, IIE shows a remarkably small Ir range: a factor of 3, excluding Miles.

Discussion:

a) Fractionation within group IIE: Chemical trends within group IIE metal compositions probably reflect crystal-liquid fractionation during melting and/or solidification but cooling was too rapid to permit continuous melt homogenization. The As-Au-Ni fractionation might reflect impact-generated batch melting if melts formed at diverse temperatures and were segregated. Alternatively, Au and As may have been vaporized. Impact-generated metallic nodules in H chondrites [11] have strongly depleted Ir contents; the authors suggested that they formed via fractional condensation of a cooling stream of vapor.

b) Relation with H chondrites: The distinctive compositions of metal in IIE irons and H chondrites on Ga-and Co-Au plots, and of olivine in the three IIEs with chondritic silicates (Fa14-17 vs. Fa17-20 in H chondrites; Fs14-15.3 vs. Fs16-18 in H chondrites) favors derivation from separate bodies. IIE irons probably formed on a sister asteroid that was slightly more reduced and metal rich, i.e., an HH asteroid [4]. It is plausible that the terrestrial set of OC materials reflects stochastic sampling of a large set of OC asteroids [12].

c) Diverse FeS contents: The high troilite contents of four IIEs and the small size of metal dendrites require rapid cooling (in one day) for HOW 88403 [13]. Either these melts quenched by heat exchange with cool chondritic material near the surface or by ejection from a crater and incorporation into a regolith.

d) Length scales for molten Fe-Ni-S melts: Trapping of silicates in molten metal requires short periods of melting and rapid solidification. The mean recovered size of iron meteorites offers constraints on the sizes of molten metal pools. We suspect that IIE irons are smaller than that of the IAB-MG irons but similar in size to members of IAB subgroups. The largest IIE is 360-kg Mont Dieu, the second largest 134 kg Colomera. Two have masses <100 g.

e) Role of impact melting: Because the heat is released so slowly by ^{26}Al decay it is difficult to imagine plausible models for forming nonmagmatic meteorites with this heat source. Impact melting requires large energetic collisions with more heat generated in porous targets. The IIE precursor may have included uncompacted primitive chondritic materials.

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