CARBON IN PLESSITE AND TAENITE IN IRON AND STONY-IRON METEORITES.

Edward R. D. Scott[1], Gary R. Huss[1], and Joseph I. Goldstein[2]. [1]Hawaiʻi Institute of Geophysics and Planetology, University of Hawaiʻi at Mānoa, Honolulu, HI, 96822, USA. E-mail: escott@hawaii.edu [2]Dept. of Mech. and Industrial Engineering, University of Massachusetts, Amherst, MA 01003, USA.

Introduction: We have determined C concentrations in kamacite, taenite, and fine-grained plessite (kamacite-taenite intergrowths) in 18 iron meteorites and 2 mesosiderites using the Cameca ims 1280 ion microprobe at the University of Hawaiʻi [1] to help understand the diverse chemical compositions and thermal histories of these meteorites. Here we focus on insights from C analyses of plessite, cloudy taenite and tetrataenite into their origin.

Results: After discarding analyses that drilled into μm-sized carbides or phosphides or across taenite-kamacite borders, we obtained 180 analyses of 5-7 μm spots in plessite, cloudy taenite, tetrataenite, and taenite [1]. Carbide-rich irons—main group IAB, sLL subgroup of the IAB complex, and IIICD irons—show the highest C concentrations in taenite and fine-grained plessite: mostly 200-900 ppm by wt. Irons in groups IVA and IVB, which lack carbides and graphite [2], contain only 2-6 ppm C in taenite and plessite. Although taenite in all carbide-bearing irons has high C levels of 150-600 ppm, plessite fields in three cohenite-rich sLL irons contain only 10-30 ppm C. Low-C plessite generally has a pearlitic texture—a symplectite mineral intergrowth of kamacite and tetrataenite with lamellar spacing of ≤1-2 μm [2, 3], whereas high-C plessite has a martensitic texture. Cloudy taenite in carbide-rich IAB irons contains ~200 ppm C or more, about half the C in associated martensitic plessite. Tetrataenite, ordered FeNi, could only be analyzed cleanly in mesosiderites which lack carbides. Here it contains ~12 ppm C, 3-9 × less than nearby cloudy taenite. Kamacite grains in all meteorites contain 2-15 ppm C.

Discussion: Very low C in pearlitic plessite was unexpected as it only forms in carbide-rich irons, it is found near large grains of cohenite Fe_3C in IAB irons [3], and it is a favored site for formation of haxonite, $Fe_{23}C_6$. We propose that the very different C contents of pearlitic and martensitic plessite in IAB irons reflect diverse formation temperatures on cooling. Taenite with ~25% Ni probably decomposed to pearlitic plessite at ~400-450°C [3]. Taenite with 20% Ni probably decomposed at somewhat higher temperatures of ~450-500°C. At 350°C, pearlitic plessite would already have consisted of Fe,Ni and kamacite, and since mm-sized haxonite grains form in pearlitic plessite fields, pearlitic plessite would have contained much less C than untransformed taenite. Our mesosiderite analyses suggest that subsequent ordering at 320°C would also lower the C content of FeNi. By contrast, taenite with 20 and 25% Ni starts to transform to martensite at ~230 and ~130°C, respectively [4]. We infer that when martensite decomposed to tetrataenite and kamacite [4], effective loss of carbon by diffusion to distant growing carbides had already ceased. Thus martensitic plessite retained high C levels from the parent taenite whereas pearlitic plessite did not. This scenario also explains why pearlitic plessite, unlike martensitic plessite, was partly spheroidized on cooling. Cloudy taenite which formed by spinodal decomposition of taenite at ~250-300°C has somewhat lower C than nearby martensitic plessite, consistent with their formation temperatures.

References: [1] Goldstein J. I. et al. 2012. *Lunar Planet. Sci*. 43:1339. [2] Buchwald V. F. 1975. *Handbook of Iron Meteorites*. University of California Press. [3] Kowalik J. A. et al. 1988. *Proc. 18th LPSC* 493-501. [4] Goldstein J. I. and Michael J. R. 2006. *Meteorit. Planet. Sci.* 41:553–570.