MAGNETIC CHARACTERIZATION OF TETRATAENITE AND ITS ROLE IN THE MAGNETIZATION OF METEORITES, P. J. Wasilewski, NASA/GSFC, Laboratory for Extraterrestrial Physics, Greenbelt, MD 20771.

Tetrataenite, containing between 48 and 57% Ni, is an optically anisotropic metal phase which has recently been designated as a new meteoritic mineral. Clarke and Scott (1980) indicate that tetrataenite is widely distributed in H, L, and LL chondrites of all metamorphic types, and is present in mesosiderites. Tetrataenite develops during formation of the Widmanstatten pattern or by decomposition of martensite, and there is evidence for a broad range of tetrataenite crystallite size and orientation distributions in meteorites. Neel et al. (1964) concluded that ordered FeNi has characteristics of a uniaxial substance and therefore the magnetic properties should be significantly different from the taenite phase of similar composition. The Curie points for the taenite in the composition range 48 to 57% Ni range from 530°C to 575°C and there does not appear to be any significant difference in the Curie temperature for taenite produced by disordering the tetrataenite. The disordering of tetrataenite takes place on reaching the Curie point.

Most of the natural remanence (NRM) in chondrites containing tetrataenite is thermally demagnetized when the Curie temperature of tetrataenite is reached. In Estherville (mesosiderite) and in the Bjurbole (L4) chondrules, even though > 50% of the metal is kamacite there does not appear to be any significant natural remanence associated with the kamacite, or if kamacite does carry remanence it was acquired below 600°C.

Magnetic hysteresis loops were measured between room temperature and the Curie point, and on return to room temperature. We therefore have a record of the structure and composition sensitive magnetic parameters for the ordered and disordered compositional equivalents, as well as a record of the nature of the disordering process. The shape of the tetrataenite thermomagnetic curve is essentially flat out to 500°C, and then drops abruptly to the Curie point, while the cooling curve is convex and resembles the thermomagnetic curve for ordinary ferromagnetic minerals. The dramatic differences between tetrataenite and taenite magnetic hysteresis loops (see Figure 1), i.e., the slope of the initial part of the loop and the shape of the loop (field dependence) explains in a quantitative way the differences between the heating and cooling curves. Thermomagnetic curves for taenite, tetrataenite, cloudy taenite, and kamacite are distinctive and easily recognized. The magnetic characteristics of the different magnetic phases in chondrite meteorites will be summarized in order to provide a comparison with the tetrataenite. Magnetic characteristics of tetrataenite and disordered taenite are summarized in Figure 1. Magnetic hysteresis loops labeled A, B, A', B' correspond to measurements taken at points on the coercivity-temperature curves and the corresponding thermomagnetic curve. Hysteresis loops are made to coincide at an applied field (H_a) of 15K oe in order to emphasize the differences in initial slope and overall shape.

REFERENCES

Clarke, R. S., Jr. and E. R. D. Scott, 1980, Amer. Min. V5. p. 624-630.

Neel, L., J. Paulene, R. Pauthenet, J. Laugier, and D. Dautreppe, 1964, J. Appl. Phys., V35, p. 873-876.

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