MAGNETIC PROPERTIES OF ORDERING ALLOYS IN METEORITES, P. J. Wasilewski and Chhaya Saralkar, NASA/Goddard Space Flight Center, Astrochemistry Branch, Greenbelt, MD 20771

Tetrataenite (ordered taenite with composition near FeNi) and awaruite (composition near $FeNi_3$) are being studied to determine the magnetic effects of ordering in the natural FeNi alloys. It is well established that alloys with compositions from ~50 wt % to ~90 wt % Ni are ordering alloys. $FeNi_3$ has an ordering temperature near 500°C (below the ~600°C Curie temperature) while FeNi has an ordering temperature near 300°C (below the 525°C Curie point). K_1 (magnetocrystalline anisotropy constant) and λ_s (magnetostriction constant) figure significantly in determining the magnetic domain wall configuration and stability and the pressure sensitivity, respectively, and these parameters change with the degree of ordering.

Shown in Figure 1a is a thermomagnetic curve for a sphere of composition 51Ni 49Fe similar to the tetrataenite compositions (1). This sphere is disordered and exhibits a typical convex curve, which is essentially reversible. The thermomagnetic behavior of Appley Bridge which contains tetrataenite as the dominant ferromagnetic phase is shown in Figure 1b. The change from the square type heating curve with the very sharp drop to the Curie point (over ~50°C) to the more typical convex curve characteristically shown by the cooling curve is considered to be associated with the change from the ordered to disordered state. Points A and B on the thermomagnetic curves in Figure 1b correspond to the ordered and disordered states respectively and the corresponding magnetic hysteresis loops associated with these states are shown in Figure 1c and d. The coercive force (H_c) changes from 135 to 15 Oe and remanent coercive force from 320 to 115 Oe on disordering the Appley Bridge meteorite.

A magnetic anisotropy can be introduced by annealing below the Curie point in a field as weak as the earth's field. Whether annealing takes place in the presence or absence of an external field determines if a squarish or constricted hysteresis loop respectively is produced. The FeNi tetrataenite compositions are expected to have extremely large values of anisotropy ($K \sim 10^6$ ergs/cm^3) as a result of shape anisotropy of the ordered particles. This anisotropy has been observed optically by Clarke and Scott.(1)

If the alloys are ordered isotropically, e.g., in the presence of zero field, plastic deformation will convert the structure to a directionally ordered structure. This plastic deformation induced anisotropy is large and generally the greater the degree of atomic order prior to deformation, the larger the anisotropy developed by deformation. Ordering takes place below the Curie point, after the material becomes ferromagnetic. The degree of order is related to the cooling rate, and the magnitude of the induced anisotropy depends on the degree of order. Ordering in a magnetic field can produce magnetic anisotropy, and shock in ordered FeNi alloys is expected to have significant magnetic effects. These magnetic contrasts between ordered and disordered FeNi alloys will be reviewed and new experimental results discussed.

Clarke, R. S. and Scott, E. R. D. 1980: Amer. Min., V65, p. 624-630.

FIGURE 1