THE USE OF ANHYSTERETIC AND ROTATIONAL REMANENT MAGNETIZATIONS IN DETECTING FINE IRON PARTICLES;
D. K. Potter* and A. Stephenson, Department of Geophysics and Planetary Physics, University of Newcastle upon Tyne, NE1 7RU, United Kingdom.
(*Present address: Seismological Laboratory, California Institute of Technology, Pasadena, CA 91125).

Previous experiments (1) have shown that rotational remanent magnetizations (RRM) and anhysteretic remanent magnetizations (ARM) can be used to detect fine particles of magnetite (which exhibit high RRM/ARM ratios). The present study describes the dependence of RRM and ARM on particle size in iron by investigating these effects in iron powders, metallic recording tape and Alnico alloys. The samples were rotated in an alternating field (AF) of peak value 80 mT, applied normal to the rotation axis, both (i) in the absence of a direct field (<50 nT) so as to produce an RRM along the rotation axis and (ii) with a direct field of 44 µT applied along the rotation axis thus producing an RRM plus a rotational ARM. Negligible RRM was produced in either coarse iron grains or, more significantly, in spherical iron grains 1-9 µm in diameter. All these samples, however, exhibited large values of ARM. The metallic tape and Alnico alloys (Alcomax and Hycomax III), all of which consist of elongate single-domain particles, showed definite RRM effects. The maximum RRM for these samples occurred at a rotation rate of about twice the AF frequency and ranged from about 0.6 to 2.4 times the ARM acquired under the above conditions.

The results indicate that a determination of the RRM/ARM ratio could be a potential non-destructive tool for rapidly detecting the presence of (elongate) single-domain iron particles in lunar samples. RRM has been detected in a lunar breccia (15015, 9019), and had a maximum value almost equal in magnitude to the corresponding ARM acquired in a direct field of 44 µT.

The results are also consistent with Stephenson’s hypothesis (2) that RRM is due to the irreversible flip of the moments of single-domain particles. If further measurements on appropriate samples confirm that RRM in iron is only produced in elongate single-domain particles, then this may add weight to previous suggestions by Butler and Banerjee (3) and Wasilewski (4) that there is no stable single-domain size range for spherical iron grains.

The metallic tape and anisotropic samples of the Alnico alloys (where the anisotropy was given by an ellipsoid of revolution about the easy, x, axis) also acquired a gyroremanent magnetization (GRM) when an AF was applied to the static samples. When the AF was applied at an angle $\theta_{xy}$ in the x-y plane, the GRM produced along the z axis exhibited a $\sin 2\theta_{xy}$ dependence in line with theory (5). In addition, a GRM of the type described by Edwards (6), was produced in isotropic samples of the Alnico alloys by subjecting them to successive applications of an AF. Therefore errors will result if any GRM produced during static single-axis or multiaxis AF-demagnetization of samples containing fine particles of iron or iron alloys is not accounted for.

REFERENCES:

