MAGNETIC PROPERTIES OF APOLLO 16 ROCKS.

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The main purpose of the investigation of magnetic properties of lunar rocks continues to be the search for further evidence of an ancient lunar magnetic field, and to estimate the intensity of any such field. Samples from previous missions have provided evidence of a field which existed between 3900 and 3200 my ago, but several puzzling features of the remanent magnetism of the rocks has been noted. Among these is the behaviour of intensity and direction of the NRM during alternating field (A.F.) demagnetization (1),(2). Apart from the testing of the stability of remanence, the above aspect of the NRM of Apollo 16 rocks is currently being investigated, and some of the results are described in this abstract.

1. Sample 66055,10. This is a coarse breccia with a whitish matrix and dark grey clasts typically several millimetres in size. It was divided into 4 chips, 66055,10A, B, F and R in order to examine the homogeneity of the NRM of the original piece and to compare the behaviour of the chips during A.F. demagnetization. The intensity of NRM of the original piece (0) was 18.1 x 10^{-6} emu/g and that of the chips was 30.0, 7.9, 7.3 and 15.6 x 10^{-6} emu/g respectively. Fig.1 shows the direction of NRM of the original and the chips (referred to a common arbitrary direction); they appear to be in reasonable agreement considering the difficulty of preserving a common orientation in each chip after division from the original. There is no obvious correlation between NRM intensity and the proportion of dark clasts in the chips.

Chips A, F and R all show the presence of a dominant, soft component of NRM; chip A became to weak to reveal a hard component, but F and R possessed a hard component of NRM of about 1.0 and 2.0 x 10^{-6} emu/g respectively, persisting up to 300 Oe. The changes in direction of the NRM of the three chips during demagnetization are also shown in Fig.1, and these changes are seen to be significantly different in the chips.

An explanation of these results is that the breccia was not heated above the iron Curie point ($\sim 780^{\circ}$C) during formation, and the constituent rock fragments were not completely remagnetized in any field then present. The different behaviour of the chips can then be explained by the residual hard magnetization of the rock fragments being randomly oriented in the breccia, and by the presence of one or more components of magnetization of differing hardness

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within each of the chips. Sometime between the formation of the breccia and the present it acquired a soft, relatively strong remanence, thus providing the directionally homogeneous NRM observed in the original rock. The variation in intensity is presumably due to variation in the content of iron of appropiate grain size.

2. Sample 62235,53. This is a rather fine-grained rock and is classed as a recrystallised breccia (3). It was divided into 5 chips, A,B,C,D and R, in which the initial NRM intensity was 169, 188, 107, 137 and 133 x 10^{-6}emu/g. The directions of NRM in the chips were close to the direction shown by the original rock. On A.F. demagnetization the direction in chip D remained nearly constant up to 400 Oe, its intensity decreasing to 20 x 10^{-6} emu/g; between 400 and 1200 Oe its direction changed through about 30, with an intensity of about 15 x 10^{-6} emu/g remaining at 1200 Oe.
This suggests a component of very high stability in the rock, and this is confirmed by thermal demagnetization of chip A, in which the direction of NRM remained almost constant up to 600°C and then moved through nearly 100° on further heating to 750°C. The relative change in NRM direction was the same as in chip D. Thus there appear to be two stable components of magnetization in this sample.

There was no evidence of chemical change on repeated heating to 810°C in vacuum. An artificial TRM was given to chip A between 810°C and 20°C in fields of 0.050 and 0.47 Oe; The acquired TRM

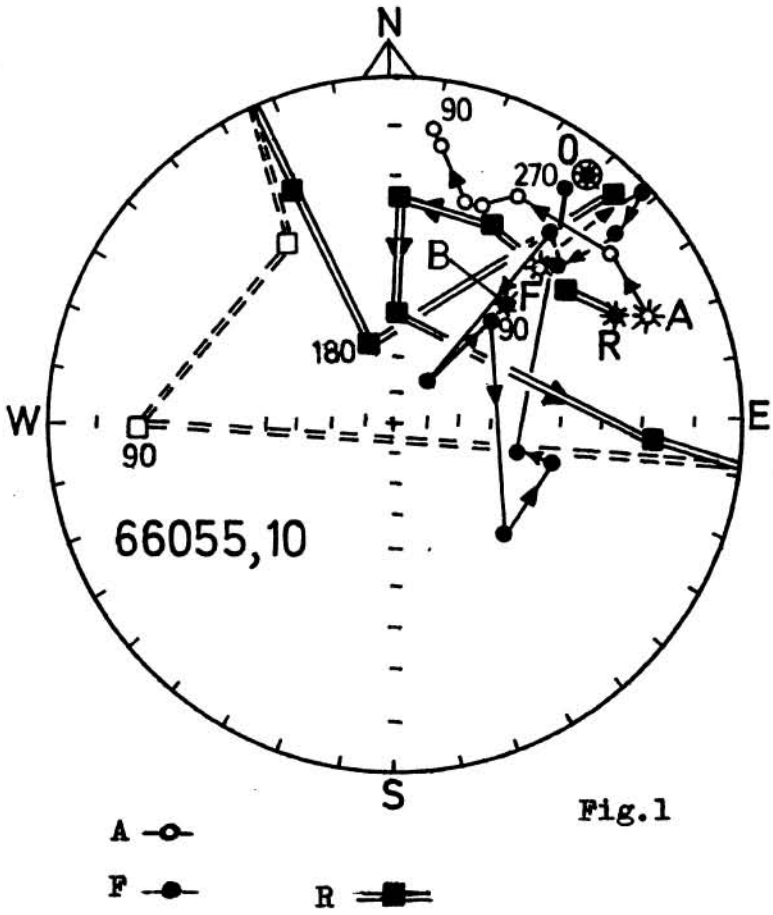

Fig.1

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was approximately proportional to field and comparison of the intensity of natural and artificial TRM in the demagnetization range 600 - 1200 Oe suggests an ancient lunar field intensity of about 0.5 Oe. This is a higher field than has generally been found by similar methods previously, but not too much weight should be given to it because of the lack of the full ancient field intensity technique (4), which in any case is of doubtful use in this sample because of the presence of more than one component of magnetization.

3. Sample 68416,23. Preliminary examination of this sample, a gabbroic anorthosite (3), shows only a weak soft component of magnetization, and a hard one of about 3×10^{-6} emu/g persisting to above 300 Oe.

4. Fines. Experiments on a sample of Apollo 16 fines (60601,21) indicate that, like the fines returned from previous missions, they contain the size distribution of single domain iron grains found in the Apollo 11 fines (5), most of which are superparamagnetic at room temperature. The fines have an initial susceptibility of 1.8×10^{-3} emu/g/Oe and a saturated remanence of 0.065 emu/g which exhibits a logarithmic decrease with time. This decrease is similar to that of previous fines samples, and is about 3% per decade.

The Apollo 16 samples provide further evidence of stable components of magnetization in lunar rocks, in both breccias and crystalline types. Evidence is also accumulating that the thermal history of breccias may be further understood through a study of the remanent magnetizations they contain.

5. References.

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