INFERENCES FROM COMPARATIVE MAGNETIC STUDIES OF SOME APOLLO 17 BASALTS, BRECCIAS AND SOILS. A. Brecher* and K.R. Morash†, *Dept. of Earth Planet. Sci. and †Dept. of Metal. and Materials Sci., M.I.T., Cambridge, Mass., 02139.

Introduction: Preliminary results of studies of the natural (NRM) and saturation (IRM_S) remanence in a number of interesting Apollo 17 samples are summarized in Table 1 and Figs. 1-4. Experiments on viscous(VRM) and thermo-remanence(TRM) acquisition are still in progress and the analysis of hysteresis behavior with temperature, is not yet completed. However, some links between the magnetic behavior and formation history for rocks and soils are already apparent. Results: The initial moments (NRM_O) of breccias and basalts are comparable, changing by <10% in up to a week of zero field storage. Considerable demagnetization was effected by repeated cooling, recovery and storage cycles in zero-field, simulating the lunar diurnal cycle. If the reduced moments (NRM*) represent the indigenous lunar remanence (Table 1), the viscosity coefficients implied by NRM_O decay range from a low .02 to .1, averaging .05 for most rock samples. The stability of NRM* to AF demagnetization in peak fields up to 500 oe (Fig.1) can be best compared to that of IRM_S acquired in 12 koe (Fig.2), by examining the normalized curves (Fig.3). All the (IRM_S/NRM*) ratios are typical of multidomain (MD) thermoremanence (TRM), as is the generally lower relative stability of NRM vs. IRM_S to AF cleaning. On these premises, lunar paleofields of ∿.01 oe can be estimated[2]. The shocked or fractured basalts (74275 and 77017) proved to possess the stablest NRM and IRM_S of all samples, suggesting that stable shock remanence (SRM) was introduced at impacts[3]. Also, cleaned directions of NRM clustered best for the shocked gabbro 77017. Both the shocked basalt 74275 and the green-gray (boulder) breccia 77135 are apparently inhomogeneous, attesting to complex history. Stability of NRM in both breccia types is similar, comparable to the coarse basalt 70017 and lower than the shocked basalts, but higher than that for the fine grained basalt, reflecting the size spectrum of grains. The trend of decreasing IRM_S stability reflects the competition between the hardening effect of shock and annealing and grain coarsening. Soils. Our earlier report[4] contrasted the magnetic properties of the orange and grey soils (Table 2, Fig. 4). A recent low temperature search for magnetite in the orange soil did not confirm its presence[5]. If the MD grains found to dominate the magnetic behavior[4] of 71220 were magnetite, a reversible loss of remanence (J_{rs}) would be seen at T_k∿140°K. Instead, a drastic reduction of J_{rs} (by x 5) and of coercivity, H_c (200 to 85 oe) occurred at 105°K only on the warming half cycle, (Fig. 5), indicating the presence of abundant fine grained (120 Å) iron. Titano-chromites and chromian ulvospinel phases present[6], whose transition points are seen on the J_S-T cooling curve (Fig. 5), could also contribute. The presence of abundant very fine-, in addition to the coarse-grained, iron inferred magnetically for the iron- poor orange soils, further corroborate their proposed formation by shock fusion of basalts in the Shorty impact[7].

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TABLE 1

SAMPLE (mass, g)	NRM_0	NRM*	NRM_{100}	IRMs	$\frac{NRM^*}{NRM_0}$	$\frac{NRM_{100}}{NRM^*}$	$\frac{IRMs}{NRM}$
	10^{-5}emu/g			10^{-3}emu/g			
BASALTS:							
70017,26(.362)	2.85	2.02	.71	1.18	.71	.35	41
71055,44(.812)	3.45	2.46	.148	.85	.71	.06	246
74275,65a(.617)	1.1	.97	.147	1.28	.87	.15	115
74275,65b(.295)	2.6	.82	.84	---	.31	1.02	---
77017,45(.812)	1.1	.68	.30	1.2	.61	.45	105
BRECCIAS:							
72275,67(.932)	6.1	4.75	.50	4.75	.61	.13	78
77135,36#1(.396)	3.5	2.56	.35	2.88	.73	.14	75
77135,36#2(.350)	1.98	1.75	.67	---	.88	.38	--
SOILS:							
74220,57(.2)	∿30	.70	--	11	∿ 40	---	30
74241,27(.2)	∿60	.65	--	74	∿100	---	120

Valley floor: 70017 coarse-grained vesicular , 71055 fine-grained vesicular. Shorty crater: 74275-dense aphanitic basalt; orange (74220) and gray (74241) soils. N. Massif: 77017-brecciated gabbro and 77135-green-gray vesicular matrix breccia from fractured St.7 boulder. S. Massif: light-gray matrix breccia (72275) from foliated boulder 1, St.2.

TABLE 2

A17 Soils	T (°K)	$J_{s/m}$ (emu/g)	m^{ferro} (wt.%)	$J_{rs/m}$ (emu/g)	J_{rs}/J_s	H_c (oe)	$\chi_p \times 10^6$ (gauss/oe·g)	$\chi_i \times 10^4$ (gauss/oe·g)	f^{para} (wt.%)
Orange	175	.145	.065	∿.011	.078	∿94	58.5	.86	17.5
74220	300	.125	.057	∿.009	.075	∿85	38	.54	15.5
Grey	175	15.15	6.90	.95	.062	30	114	140	∿30
74241	300	4.36	1.97	.074	.017	8	250	35	$\lesssim$100

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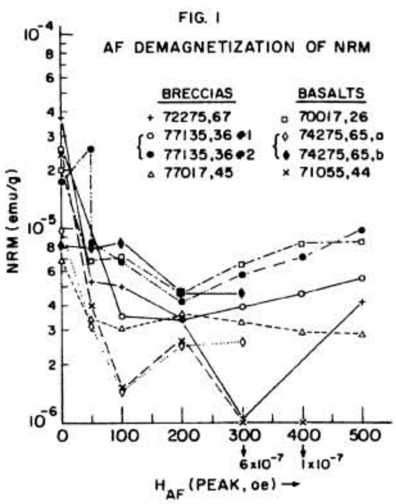

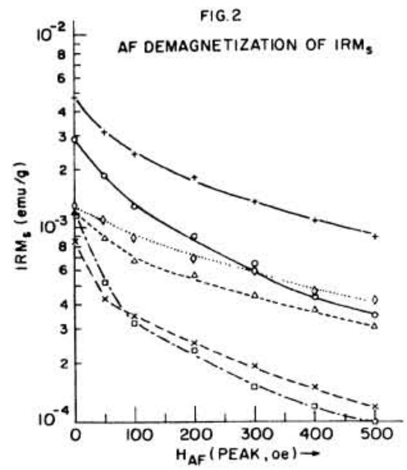

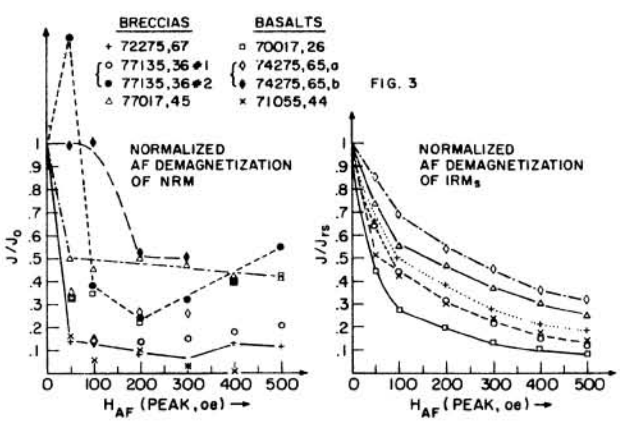

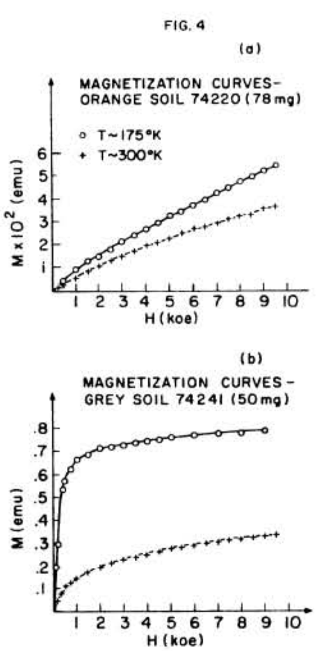

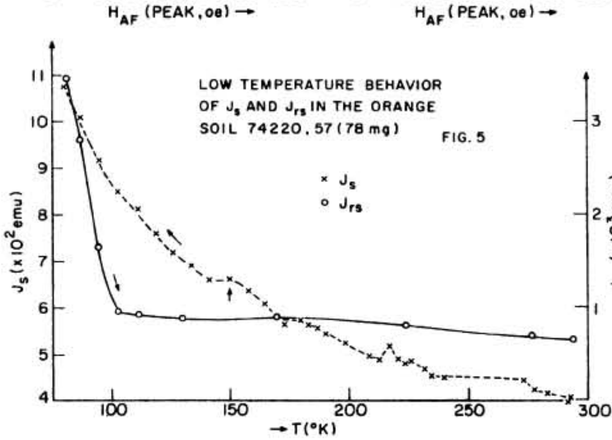

Fig. 4 - courtesy American Geophysical Union, *EOS*.