

19. STRONG FIELD MAGNETIC PROPERTIES OF BASALTS FROM DSDP LEG 26

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INTRODUCTION

Measurement of the strong field magnetic properties of basalts often yields a quick indication of their alteration history, alteration having taken place either during initial cooling or during later hydrothermal alteration following burial by younger rocks (Ade-Hall et al., 1971). The main indicator of alteration history is the Curie temperature, but the shape of magnetic moment-temperature profiles and the magnetic changes that take place during thermal cycling may also yield useful information.

METHOD

Approximately 10-mg chips of basalt were heated in a small furnace situated between the Faraday pole pieces of a 7.5-kg electromagnet. Heating rates, in air, were in excess of 200°C/min. These high rates were used in order to reach initial Curie temperatures before alteration could take place in the many magnetically highly metastable samples. Changes in magnetic moment were recorded using a Cahn R100 electrobalance. The output from the electrobalance was fed to the Y scale of a BBN 815M X-Y recorder, with temperature recorded on the X scale.

RESULTS

The results are summarized in Table 1 and illustrated in Figure 1. The salient features of the results are the wide range of Curie temperatures and types of thermomagnetic curves, both between and within sites. A number of simple reversible curves with low ($\leq 240^\circ\text{C}$) Curie temperatures (e.g., Hole 250A, Curves 1 and 2 and Site 256, Curves 2 to 5) indicate that a single phase, little altered titanomagnetite is the magnetic phase of the samples. Curves showing intermediate Curie points ($240^\circ < T_c < 500^\circ\text{C}$) probably represent titanomagnetite that have experienced various degrees of hydrothermal alteration leading to cation deficient forms (Readman and O'Reilly, 1970). An interesting class of curves for

samples in this state show an initial rise in moment on heating (Site 251, Curves 1 and 4; Site 256, Curve 1). This is the most thermally unstable state known for basalts. Phase splitting always takes place very rapidly during heating, and it is often difficult to determine the initial Curie temperature. Phase splitting produces nearly pure magnetites and ilmenites, with a dramatic rise in Curie point and saturation moment.

Curie temperatures of greater than 500°C represent low titanium titanomagnetite produced by the subsolidus exsolution of ilmenite following high-temperature oxidation during initial cooling (e.g., Site 254, Curve 3 and the high Curie points of Site 254, Curves 1 and 2). With this interpretation of thermal curves in mind, we see that partial alteration of the magnetites, and thus probably of samples in general, is widespread. All the samples from Hole 251A and Site 253 and some from Sites 256 and 257 have probably experienced low-temperature hydrothermal alteration, while the samples from Site 254 have experienced different degrees of deuteric oxidation. The particular points are of interest. The mean Curie temperatures for sites do not relate simply to geographic location, and in particular to the nearest spreading ridge, as is the case in the Atlantic at 45°N (Schaeffer and Schwartz, 1970). Again, there is no clear systematic variation of Curie temperature with depth at Site 257, from which 11 samples were available. However, there is a clear inverse relationship between Curie temperature and the presence of secondary hematite at this (Figure 2) and other sites.

REFERENCES

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- Readman, P. W. and O'Reilly, W., 1970. The synthesis and inversion of non-stoichiometric titanomagnetites: *Phys. Earth Planet. Int.*, v. 4, p. 121.
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TABLE 1
Strong Field Magnetic Properties of Basement Rocks
(See also Figures 1 and 2)

Sample (Interval in cm)	Saturation Magnetization at 21°C (Arbitrary Units)	Curie Temperature During Heating Cycle (°C)	Significant Features of J_{S-T} Curves
250A-26-2, 140	0.731	238	
250A-26-6, 58	0.537	224	
251A-31-2, 84	not available	298	Nearly reversible.
251A-31-3, 50	2.08	528	Double Curie point could arise from alteration during heating cycle. 2% initial rise in moment on heating. Great increase in moment from 522°C Curie point during cooling cycle.
251A-31-4, 48	1.12	394, 482	
251A-31-5, 105	0.972	460	3% initial rise in moment on heating. Steep rise in moment from 548°C Curie point during cooling cycle.
253-58, CC	1.45	536	Reversible curve.
254-31-1, 111	0.512	274, 514	Clear double Curie point. Lower Curie point absent in cooling cycle.
254-35-1, 107	0.334	332, 534	(as for Sample 254-31-1, 111 cm).
254-36-3, 105	0.857	564, (650)	Reversible. Possible small hematite component.
256-9-2, 12 (green igneous rock)	1.18	334	2% increase in moment on heating. Moment reduced by 60% on cooling to room temperature. 2% increase in moment on heating.
256-9-2, 12 (green igneous rock plus brown vein interval)	0.370	302, 610	
256-10-2, 68	2.43	224	
256-10-3, 85	1.80	210	
256-11-1, 15	1.37	198	
256-11-3, 15	2.11	240	
257-11-2, 074	0.420	354	Considerable loss of moment and mass after thermal cycling.
257-11-3, 130	0.237	384	
257-12-1, 130	0.313	382	1.5% increase in moment on heating. Great increase in moment from 536°C Curie point on cooling.
257-12-3, 085	0.890	366	Reversible.
257-13-3, 015	0.440	348	
257-14-2, 095	0.678	392	
257-14-4, 111	1.27	278	
257-15-1, 133	1.02	280	
257-16-2, 145	0.677	302	
257-17-1, 086	1.00	400, 496	Clear double Curie point. Lower Curie point absent on cooling cycle.
257-17-5, 130	0.938	328	

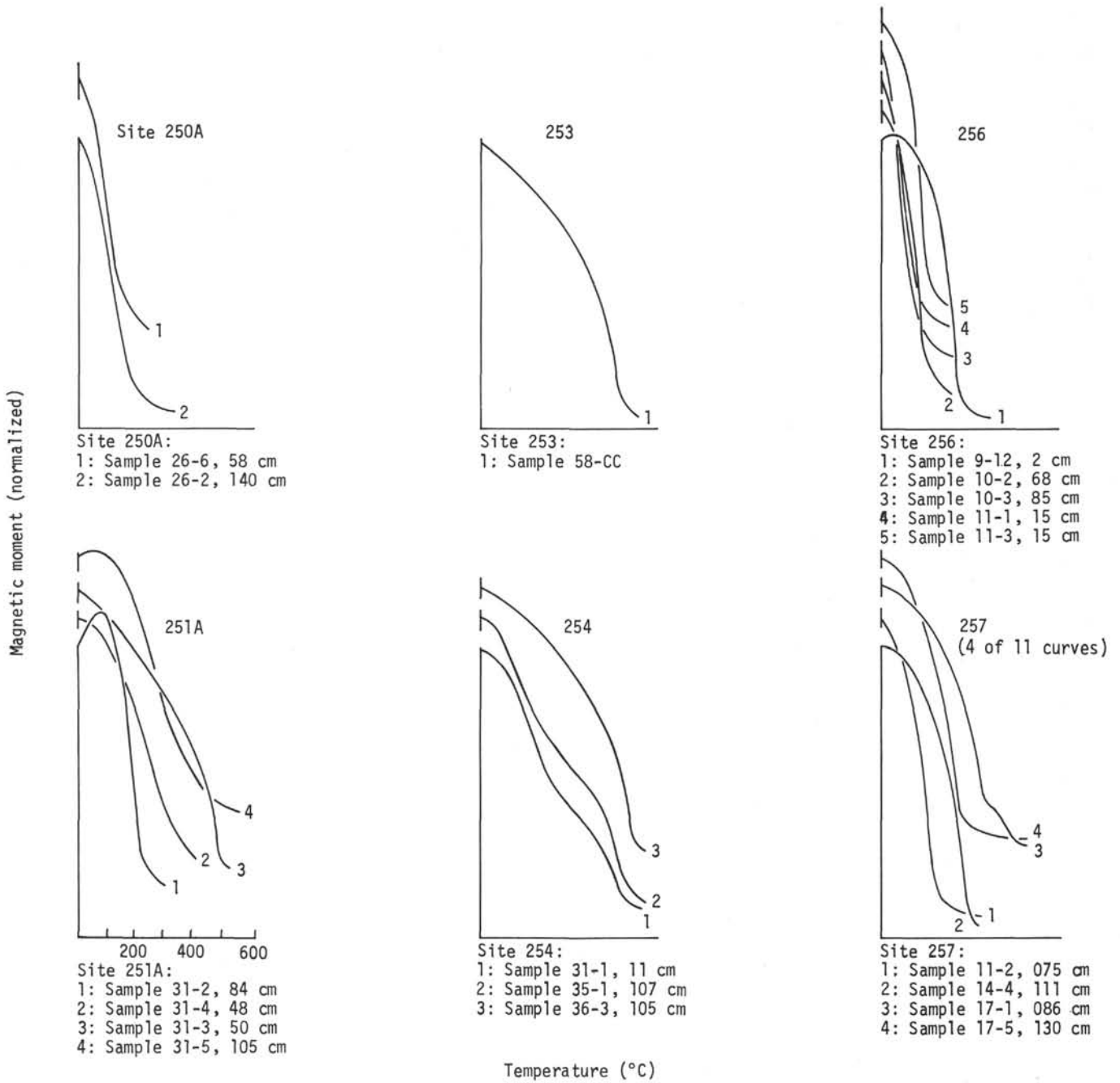


Figure 1. Curves of thermal decay of saturation magnetics for Leg 26 basement samples. Note the general within-site and between-site variability in behavior.

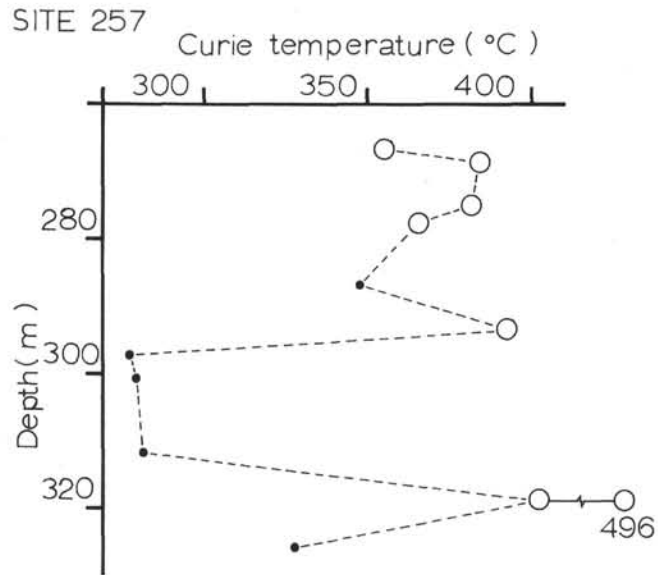


Figure 2. Curie temperature profile for Site 257. Large open circles are Curie temperatures for samples containing one or more forms of secondary hematite. Small closed circles are for secondary hematite-free samples.