ROCK MAGNETIC PROPERTIES OF THE GRASSTREE DYKE, GERMAN CREEK

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Summary

The rock magnetic properties of six (6) samples of dolerite from the Grasstree Dyke, German Creek have been determined. Four (4) samples were from the central part (core) of the dyke while two (2) were from the chilled margin. The samples were supplied and oriented by McElroy Bryan Geological Services Pty Ltd.

Properties measured include low-field magnetic susceptibility, anisotropy of magnetic susceptibility, natural remanent magnetisation and cleaned remanent magnetisation. The chilled margin samples were more strongly magnetised than were those from the core of the dyke, although the much greater volume of the core relative to the chilled margin suggests that the overall dyke properties will reflect those of the core samples. The anisotropy of remanent magnetisation is very low (1%-3%) and this may be ignored for the purposes of magnetic modelling. The mean susceptibility of the core samples is 687 μG/Oe (0.000687 cgs or 0.0863 SI) while the best estimate of the remanent magnetisation has a declination of 299°, an inclination of -82° and an intensity of 1900 μG (0.00190 emu/cc (cgs) or 1.90 Am^{-1} (SI)). The remanence is of normal polarity. A Koenigsberger ratio of 5.5 indicates the relative greater importance of the remanence, rather than the induced magnetisation, in contributing to the magnetic expression of the dyke.

Introduction

Dolerite of the Grasstree Dyke occurs in the German Creek Mine, Queensland. A rock magnetic study was instigated by Capricorn Coal Management Pty Ltd to determine the magnetic properties of the dyke. Three (3) samples were collected from the fine grained margin and five (5) samples were collected from the coarse grained centre (core) by McElroy Bryan Gelogical Services. After consultation with Mr Rowan Johnson on the orientation technique used two (2) samples were rejected. The provision of two (2) replacement samples was agreed upon but to date they have not been delivered and this report is therefore on the remaining six (6).

Methods

The laboratory methods used are routine and are described in a number of general texts (Irving, 1964, McElhinny, 1973; Collinson, 1982). The magnetometer used was a CTF three-axis cryogenic, while the AF demagnetiser was a Schonstedt GSD-1 model. Each sample was drilled and sliced in the laboratory to provide duplicate (or more) specimens, each nominally 2.5cm diameter and 2.2cm height, this being the best cylindrical approximation to a sphere.

Results

Natural Remanent Magnetization

The samples possessed moderately strong natural remanent magnetizations (NRMs) with the chilled margins being more strongly magnetised than the core samples. NRM directions are plotted in Fig. 1 while the vector means for specimens from each sample are listed in Table 1. From the palaeomagnetic cleaning the remanence of the core samples is composed of a single palaeomagnetic component and although the chilled margin samples change direction slightly on magnetic cleaning their remanences are dominated by a single component. This indicates that the dyke has not been overprinted and the remanence was acquired on cooling after intrusion.

Susceptibility and Anisotropy

The magnetic susceptibility and anisotropy of magnetic susceptibility (AMS) of the specimens were measured to determine the bulk susceptibility and the magnetic fabric which might have to be considered in magnetic modelling. The tensor means for specimens from each sample are listed in Table 2. Bulk susceptibilities of the core samples are less than 1000 μG/Oe (0.013 SI) while those of the chilled margin samples are about an order of magnitude higher. Anisotropies are weak (1%-3%) and will not deflect the induced magnetisation significantly.

Representative Properties (cgs and SI)

The behaviour of the samples on magnetic cleaning is displayed as orthogonal projections in Fig. 2. The vector mean NRM has a declination of 108° and an inclination of -55°, being dominated by the properties of the chilled margin samples. In view of the volumetrically less importance of the chilled margin, and the fact that their directions change with magnetic cleaning, it is considered best to use the direction and intensity of magnetisation of the core samples as representative properties. These give a vector mean direction after cleaning at 200 Oe AF with a declination of 299° and an inclination of -82°. The directions are more scattered than is usual for dolerite dyke samples with an α_{95} (Fisher, 1953) of 45° suggesting that the method used to orient the samples was not accurate.

The NRM intensity is approximately 1900 μG (1900x10^{-6} emu/cc, 1.9 Am^{-1}, 190 "gamma"), and an induced magnetization (kH), of about 687μG/Oe x 0.5 Oe (863x10^{-5} SI x 50,000 nT / μ_o = 863x10^{-5} SI x 50,000 / (4πx10^{-7}) nAm^{-1}) which equals 344 μG (344x10^{-6} emu/cc, 344 mAm^{-1}, 34.4 "gamma") in the direction of the geomagnetic field. These values correspond to an overall Koenigsberger ratio of 5.5.

References

Collinson, D.W., 1982. *Methods in Rock Magnetism and Palaeomagnetism*. Chapman and Hall, London, pp. 503.

Fisher, R.A., 1953. Dispersion on a sphere. Proc. R. Soc. Lond. A217: 295-305.

Irving, E., 1964. *Palaeomagnetism and its Application to Geological and Geophysical Problems*. John Wiley, New York, pp. 399.

McElhinny, M.W., 1973. *Palaeomagnetism and Plate Tectonics*. Cambridge University press, Cambridge, pp. 358.

Table 1 Vector Mean Natural Remanent Magnetization

Site	n	Dec(°)	Inc(°)	Int(μG)	σ(μG)
01	2	318.8	-58.0	819	110
02	2	138.5	-41.3	753	137
03	3	31.5	-69.8	518	61
04	2	306.8	-39.6	242	70
05	2	96.2	-42.1	6513	167
06	2	135.4	-54.8	4555	1787
Vector mean		107.7	-55.2	1904	

Int - intensity, σ - standard deviation

Table 2 Tensor Mean Anisotropy of Magnetic Susceptibility

Site	n	Dec(°)	Inc(°)	Int(μG/Oe)	A	bulk
01						
Max	2	198	31	717	1.02	709
Int	2	300	18	707		
Min	2	56	51	702		
02						
Max	2	127	10	958	1.02	947
Int	2	230	51	943		
Min	2	29	36	941		
03						
Max	3	249	11	687	1.03	682
Int	3	79	77	683		
Min	3	339	2	675		
04						
Max	2	172	4	412	1.03	408
Int	2	267	50	409		
Min	2	79	38	405		
05						
Max	2	277	52	5170	1.01	5133
Int	2	32	18	5134		
Min	2	134	31	5095		
06						
Max	2	319	63	3702	1.03	3636
Int	2	161	24	3615		
Min	2	67	8	3590		

Figure 1. Stereographic projections of natural remanent magnetization (nrm) directions. Full (open) symbols plot on the lower (upper) hemisphere.

Figure 2a. Orthogonal projections of demagnetization vector for sample 1. Full (open) symbols plot on the horizontal (vertical) plane.

Figure 2b. Orthogonal projections of demagnetization vector for sample 2. Full (open) symbols plot on the horizontal (vertical) plane.

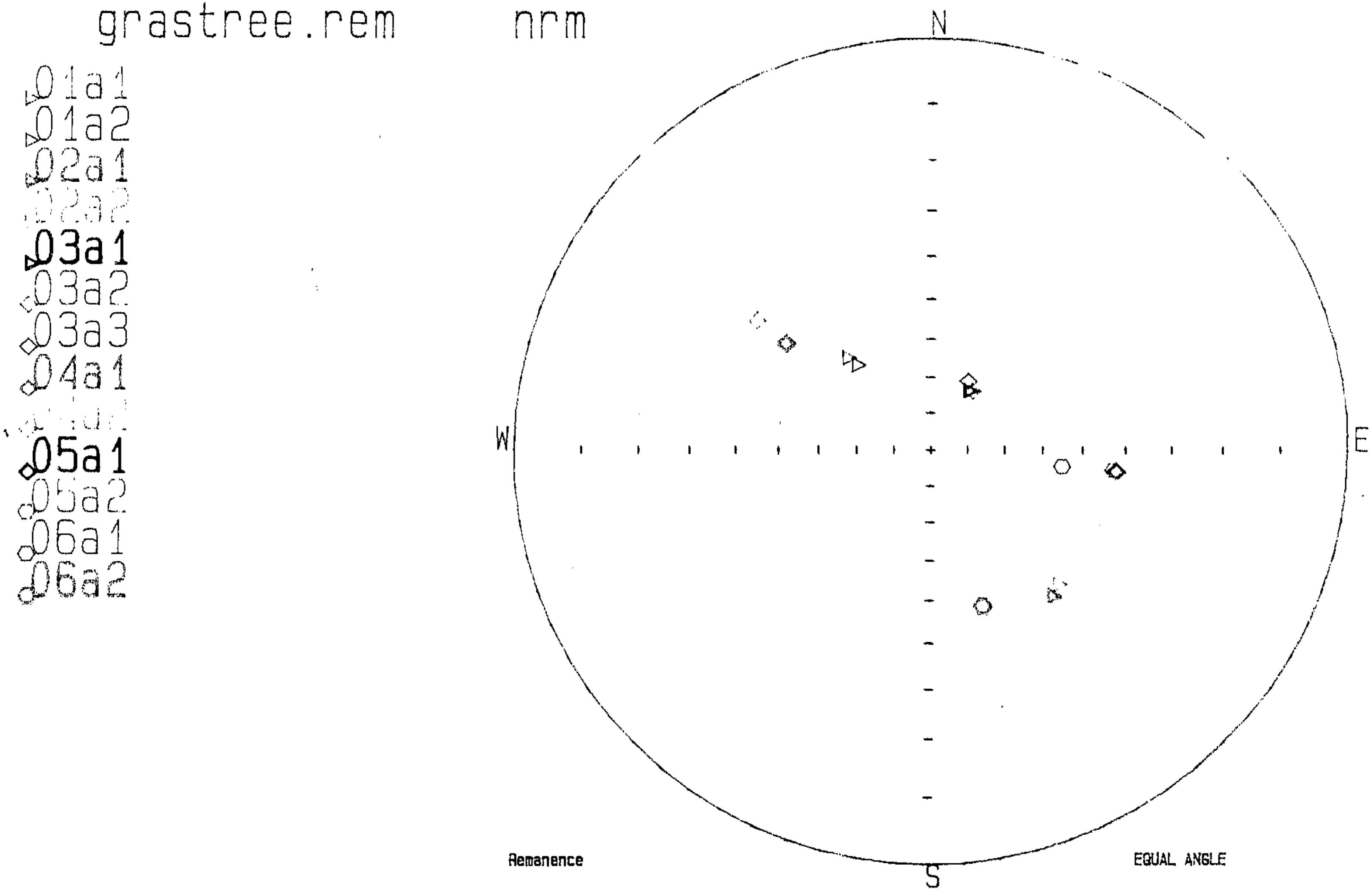
Figure 2c. Orthogonal projections of demagnetization vector for sample 3. Full (open) symbols plot on the horizontal (vertical) plane.

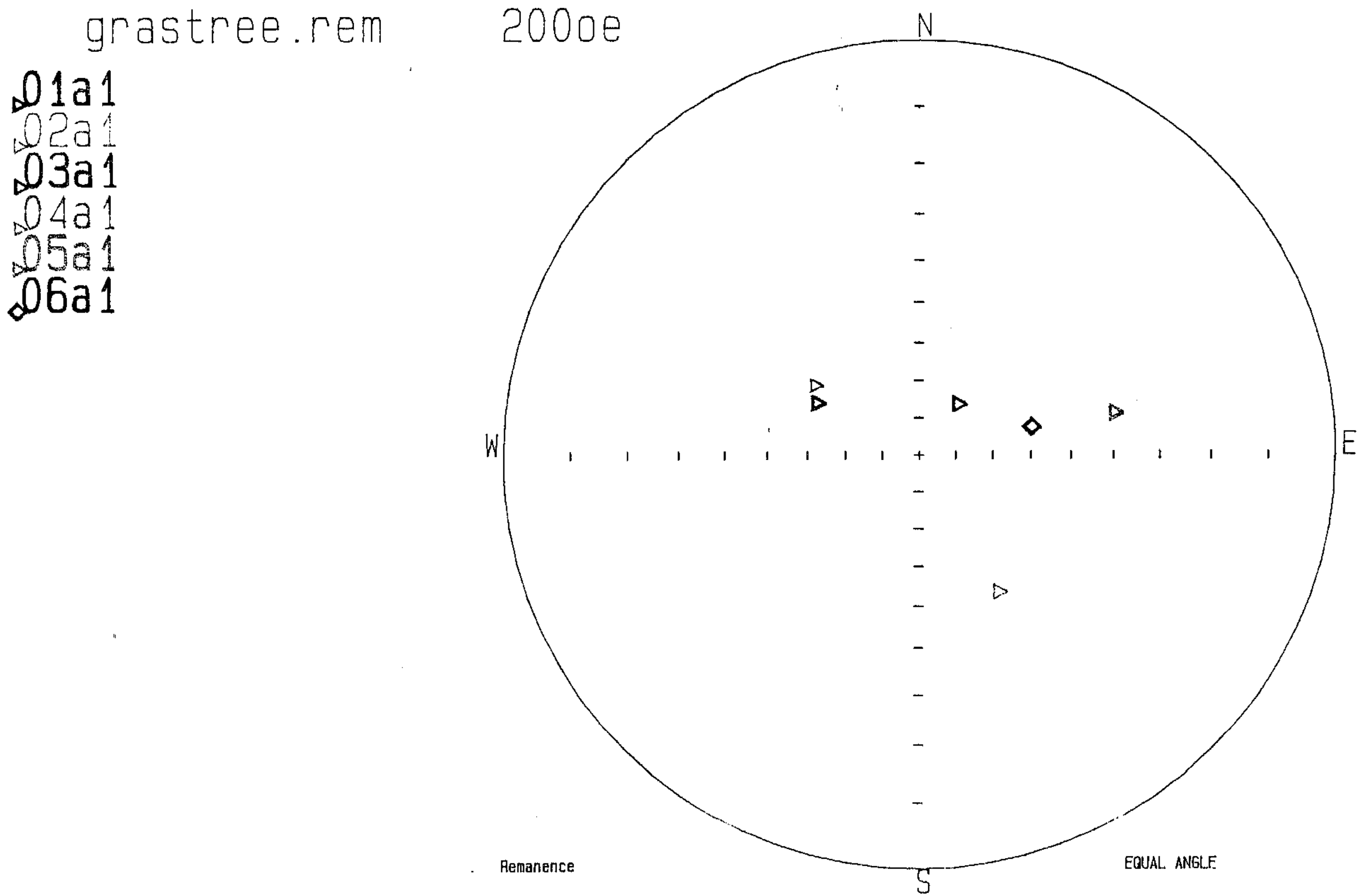
Figure 2d. Orthogonal projections of demagnetization vector for sample 4. Full (open) symbols plot on the horizontal (vertical) plane.

Figure 2e. Orthogonal projections of demagnetization vector for sample 5. Full (open) symbols plot on the horizontal (vertical) plane.

Figure 2f. Orthogonal projections of demagnetization vector for sample 6. Full (open) symbols plot on the horizontal (vertical) plane.

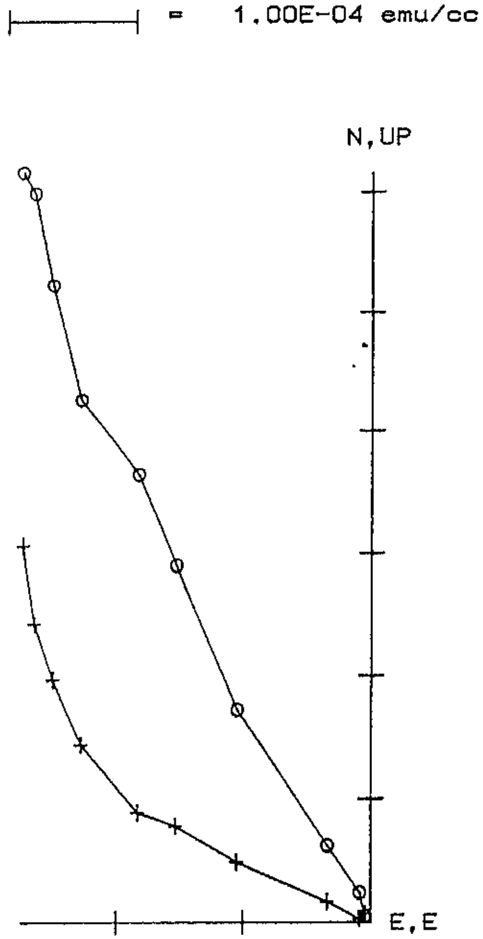
grastree.rem nrm

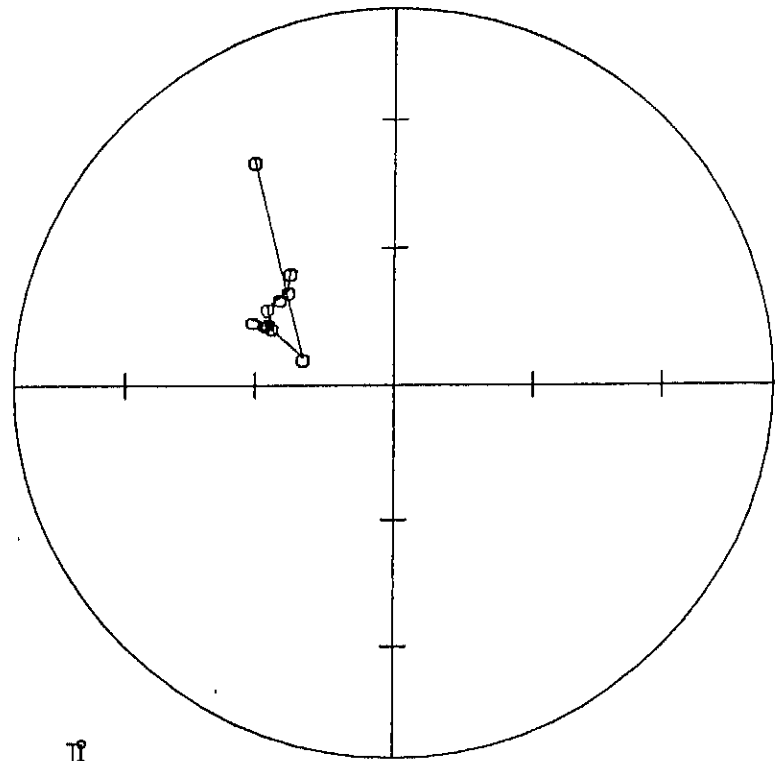



grastree.rem
200oe
01a1
02a1
03a1
04a1
05a1
06a1
N
W
E
S
Remanence
EQUAL ANGLE

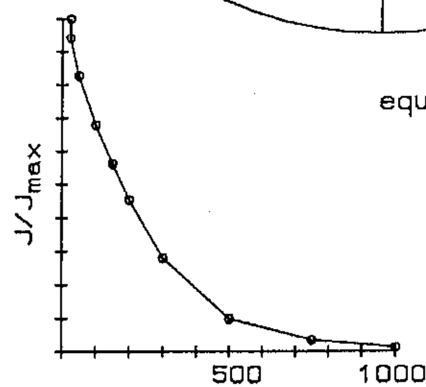
gd   01a   NRM to 10000   geog coords   file: grastree.rec

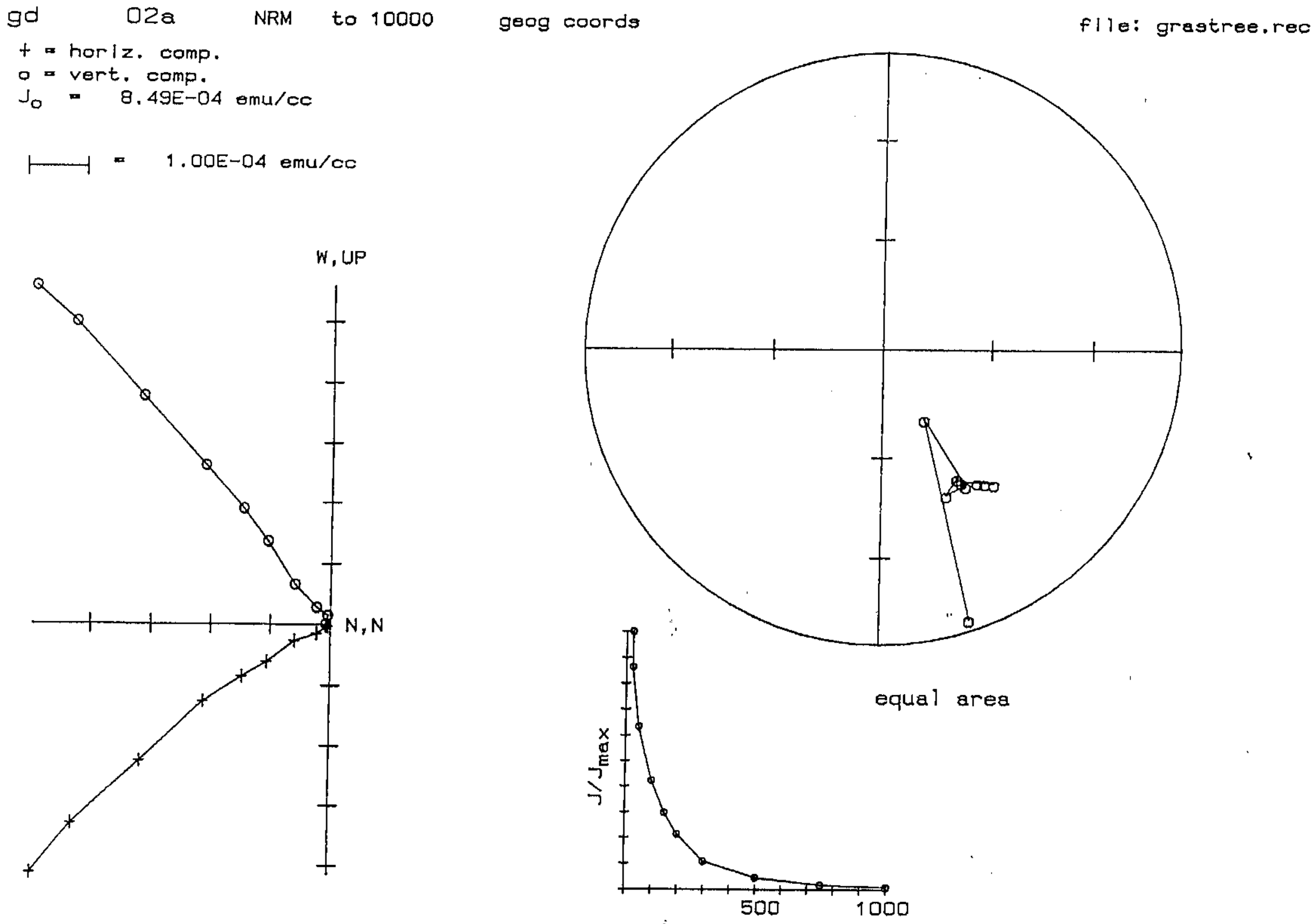
+ = horiz. comp.
o = vert. comp.
J_o = 7.42E-04 emu/cc





equal area

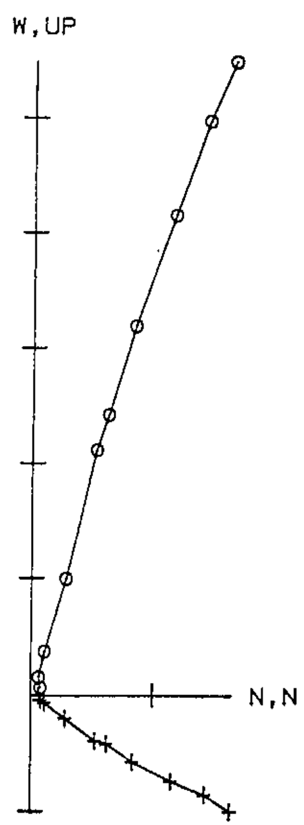


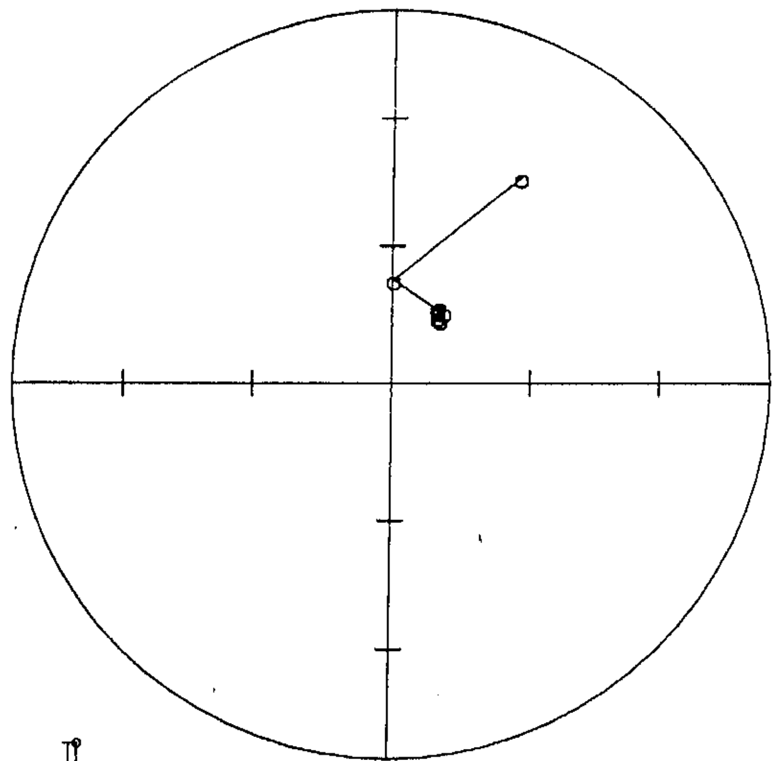

gd 02a NRM to 10000 geog coords
file: grastree.rec
+ = horiz. comp.
o = vert. comp.
J_o = 8.49E-04 emu/cc
= 1.00E-04 emu/cc
W,UP
N,N
equal area
J/J_{max}
500
1000

gd   03a   NRM   to 10000   geog coords   file: grastree.rec

+ = horiz. comp.
o = vert. comp.
J_o = 5.80E-04 emu/cc

|——| = 1.00E-04 emu/cc





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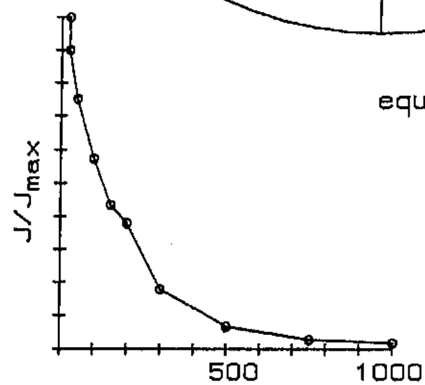

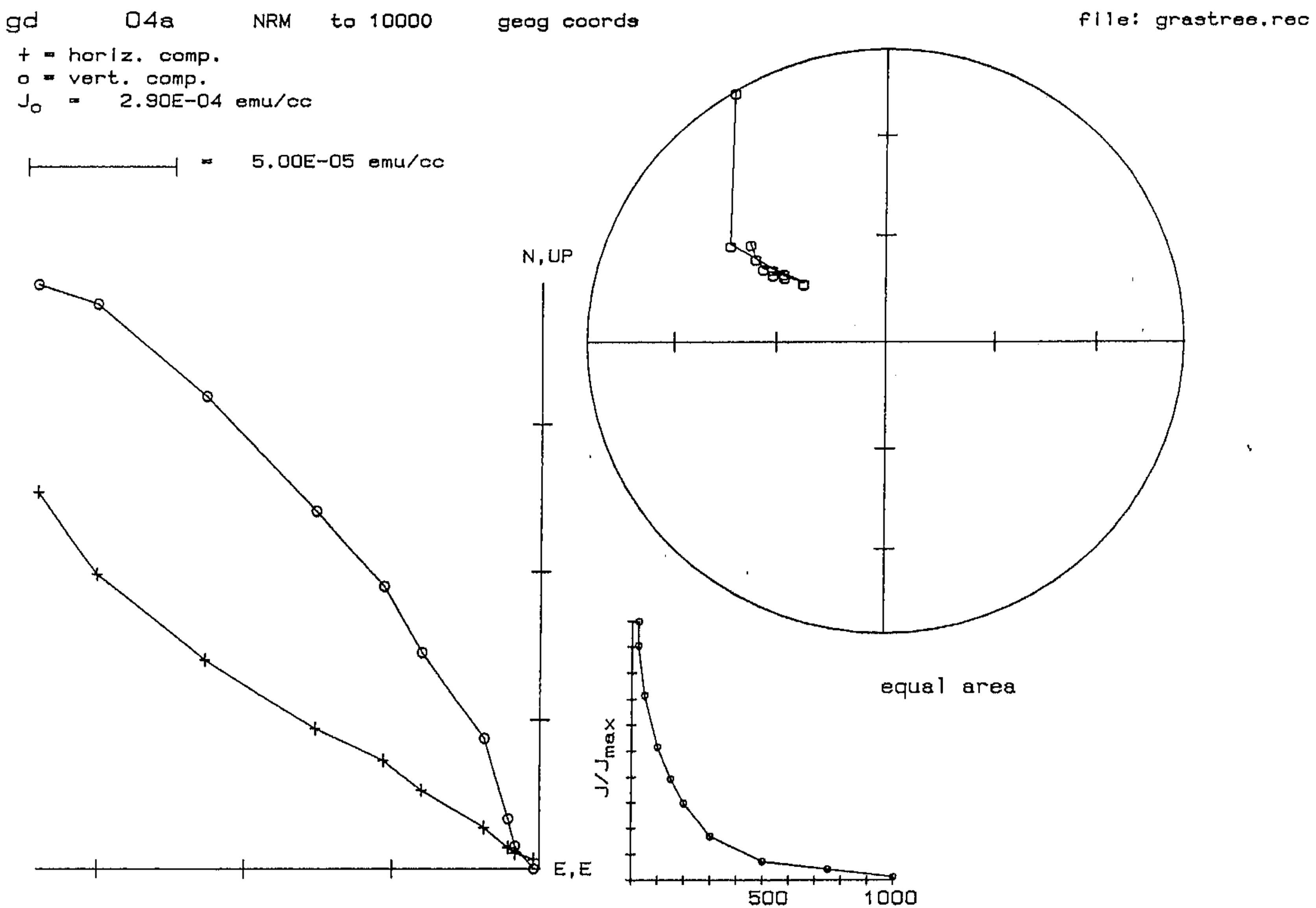
gd 04a NRM to 10000 geog coords
file: grastree.rec
+ = horiz. comp.
o = vert. comp.
J_o = 2.90E-04 emu/cc
= 5.00E-05 emu/cc
N,UP
E,E
J/J_{max}
500
1000
equal area

gd 05a NRM to 10000 geog coords file: grastree.rec

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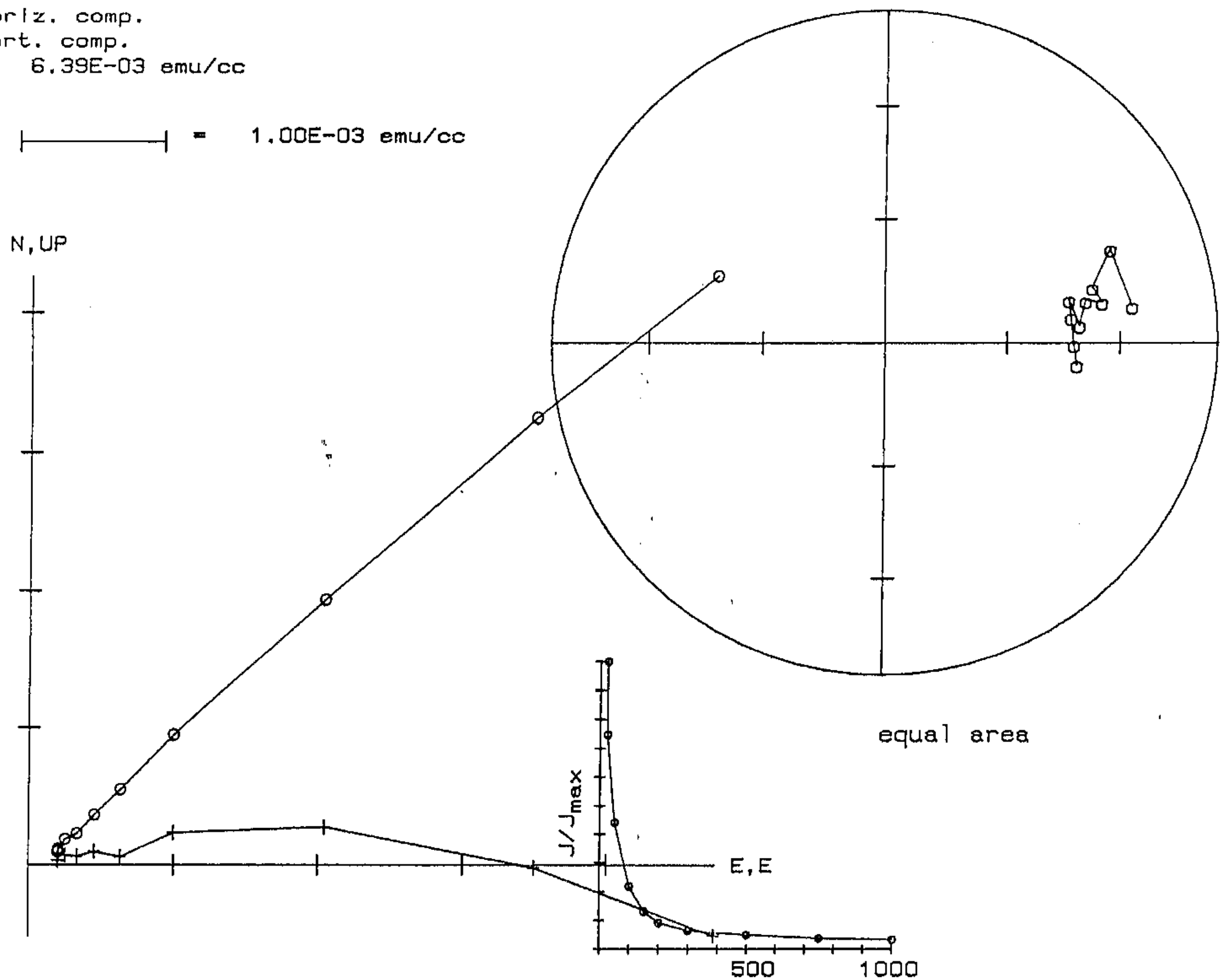
o = vert. comp.
J_o = 6.39E-03 emu/cc



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file: grastree.rec

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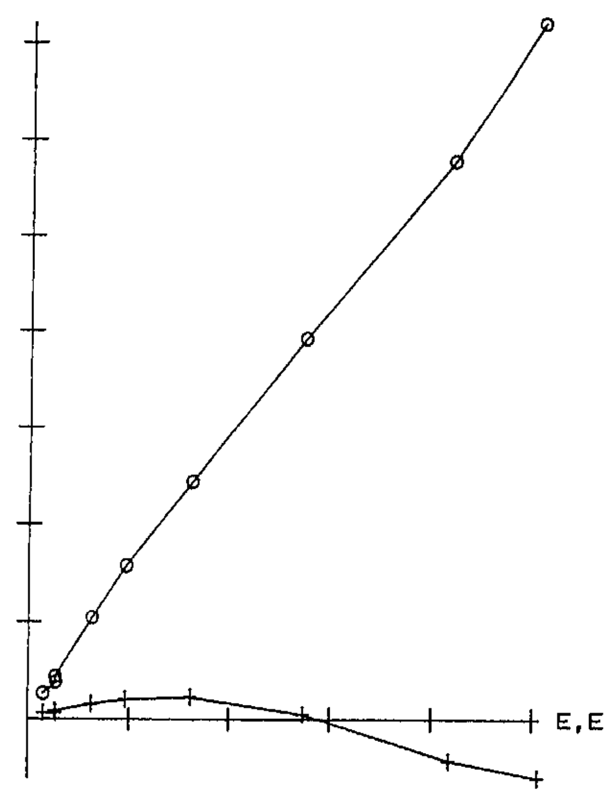
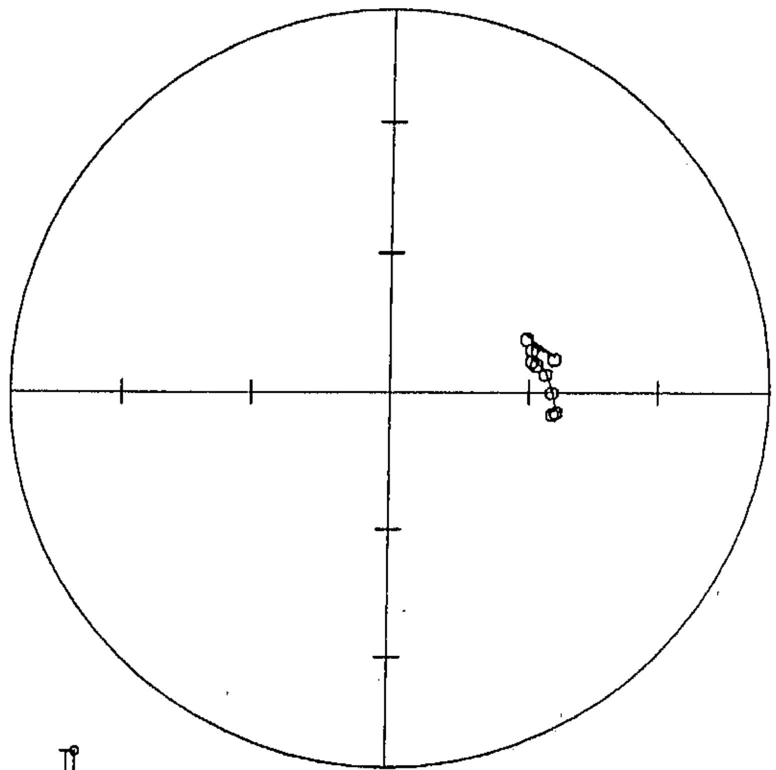
|—| = 5.00E-04 emu/cc





equal area