

A Report on the Paleomagnetism of two cores of Pugwash Mud  
taken from the Northumberland Strait - Contract # 650718

PQ CORES

1976

TO: Dr. Charles Schafer  
FROM: Daniel Plasse  
RE: A Report on the Paleomagnetism of two cores of Pugwash Mud taken from the Northumberland Strait - Contract # 650718.  
DATE: November 23, 1976

OUTLINE:

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### I. Introduction

This is a summary report of the Paleomagnetic data obtained from two Pugwash Mud cores, one totally oriented and the other vertically oriented, taken from the Northumberland Strait, lat.  $45^{\circ}40.3'N$ , long.  $61^{\circ}45.4'00$ . The two cores were obtained from a water depth of 22 m, 1.5 meters apart. The purpose of the project was to establish a post glacial magnetic stratigraphy reference section for marine sediments in Eastern Canada, which could then be used as a dating tool for offshore sediments in conjunction with other techniques such as  $C_{14}$ , pollen, foraminifera,  $Pb_{210}$ . Details of the sampling procedure and methods of analysis are described elsewhere (Plasse, 1975) and will not be presented in this report. The paleomagnetic results are summarized below.

II. Brief description of Cores. PQ1 and PQ2 with lengths 98 cm and 64 cm respectively, appeared to consist of "Pugwash Mud" as described by Kranck (1974) (photos 1 and 2). One important feature in PQ1 was the presence of a shell horizon at a depth of 79 cm, which was extracted from both the working and archive halves for the purpose of  $C^{14}$  dating. X-ray photographs revealed an occasional ice rafted pebble and a great deal of bioturbation in the sedimentary column, indicated by the total absence of bedding. PQ1 was totally oriented whereas PQ2 was only vertically oriented.

### III. Paleomagnetic Results

The paleomagnetic data is presented in Figures 2-5 and the work-

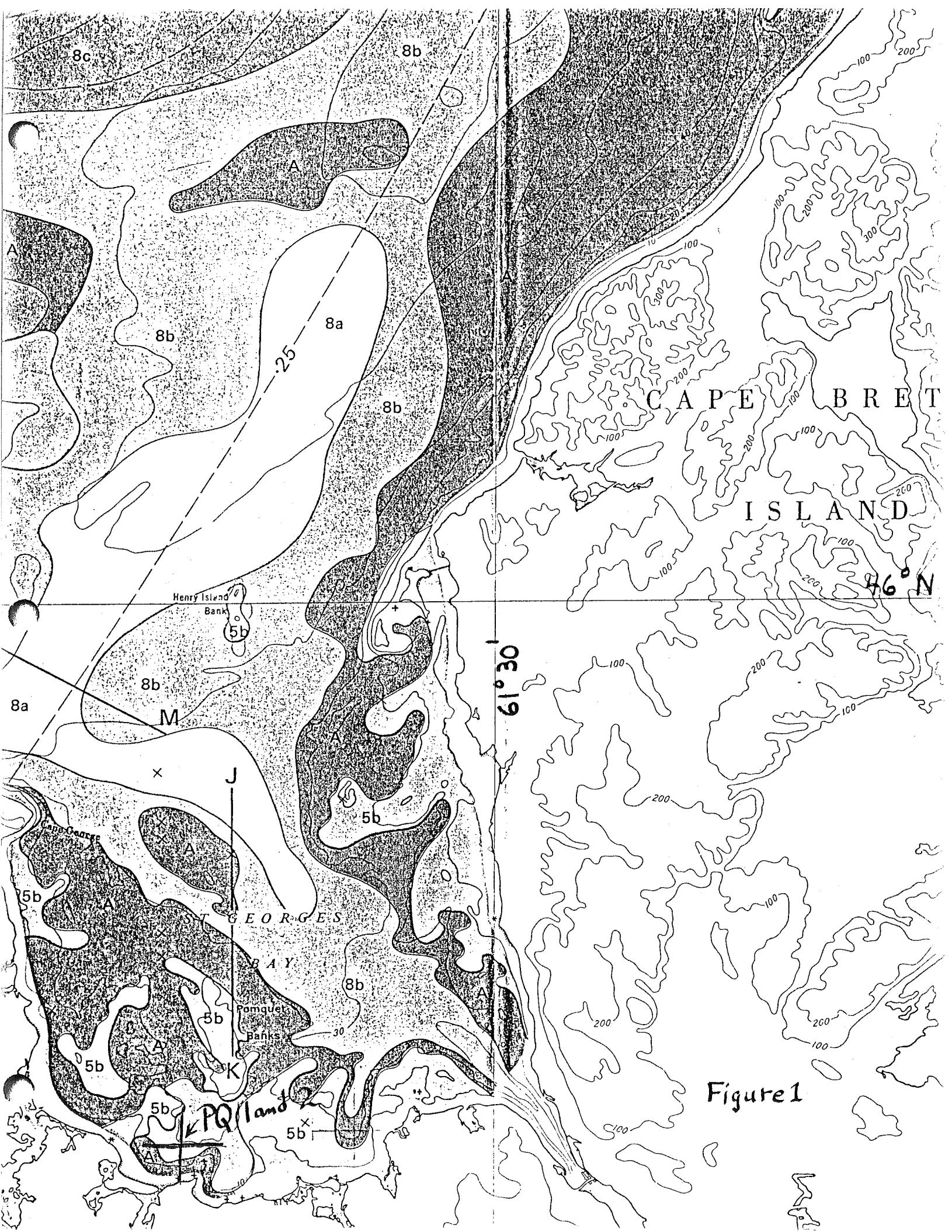
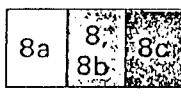


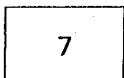
Figure 1

## LEGEND

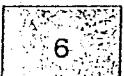
### QUATERNARY

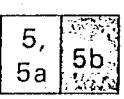
Northumberland Strait sediments deposited or transported at the present time

 Pugwash mud: 8a, silty mud with less than 5% sand; 8b, sandy mud with 5-50% sand; 8c, muddy sand with 50-95% sand; 8, undifferentiated (appears on cross-sections only)

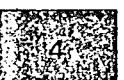
 Egmont sand: well-sorted medium-grained sand  
Note: positions of boundaries subject to change

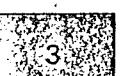
Goldthwait Sea sediments relict from former stands of Sea level

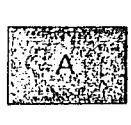
 Malagash mud: sandy mud with minor gravel

 Buctouche sand and gravel: 5a, mainly sand with less than 5% gravel; 5b, mainly sandy gravel with more than 5% gravel; 5, undifferentiated (appears on cross-sections only)

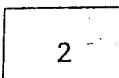
Glacial sediments deposited in association with Pleistocene glaciation

 Henry Island sediments: proglacial with well-developed bedding (appears on cross-sections only)

 Pómquet drift: glacial till surface modified

 Mixed bottom consisting of glacial sediments (3,4) or Buctouche sand and gravel (5) overlain by small irregular patches or a thin discontinuous layer of Pugwash mud (8)

### PENNSYLVANIAN TO PERMIAN

 Soft, well-stratified sandstone and shale, horizontal to gently folded (appears on cross-sections only)

PALeozoic

### ORDOVICIAN TO PENNSYLVANIAN

Figure 1  
From Kranch  
1971

sheets and data sheets attached to this report. Perhaps the most significant result was the hint of four cycles in the secular variation of declination in the upper 90 cm of PQ1.

A. Intensities. Both PQ1 and PQ2 cores exhibit a 3.5-fold decrease in natural remanent magnetization (NRM) from about  $7 \times 10^{-6}$  to  $2 \times 10^{-6}$  at a depth of about 12 cm (Figure 2). Below 12 cm the remanence varies from 1 to  $2.5 \times 10^{-6}$  emu's. Both cores contain a weakly magnetized layer at a depth of about 52 cm.

B. Directions. Present values  $I = 72.5^\circ$ ,  $D = -24^\circ$ , Expected Paleomagnetic  $I^* = 63.4^\circ$

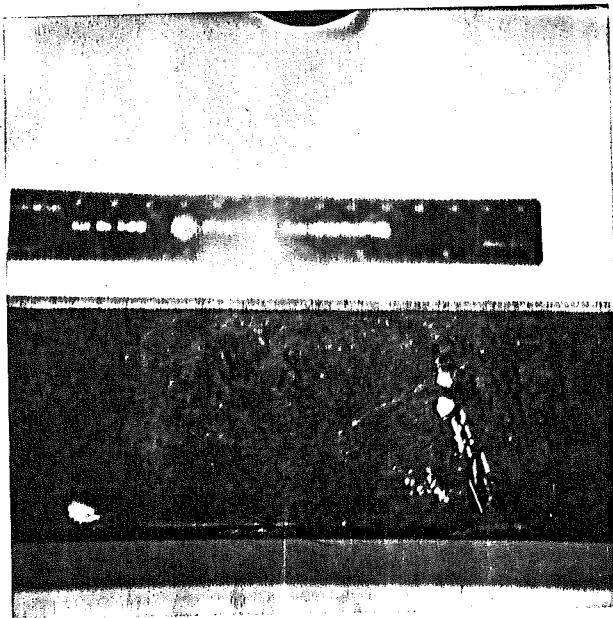
1. Inclinations. Cores PQ1 and PQ2 do not exhibit consistent patterns of inclination variation with increasing depth (Figure 5). However, the general trend of both cores is a shallowing of inclination values by about  $20^\circ$  from the tops of the cores to a depth of about 60 cm. The rather steep inclinations ( $\sim 70^\circ$ ) at the top of the cores is consistent with the present inclination value of  $\pm = 72.5$ .

2. Declinations. As stated earlier, it would appear that four secular variation oscillations in declination were recorded for PQ1 (Figure 3), at depths 0, 17, 41, 65 and 87 cm. If this cyclical pattern is indeed a secular variation feature, then assuming that the duration of

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\*  $I$  = inclination, for an axial geocentric dipole, at  $45^\circ$  N  
=  $\text{arc tan } 2 \cot P$  (where  $P$  = colatitude)

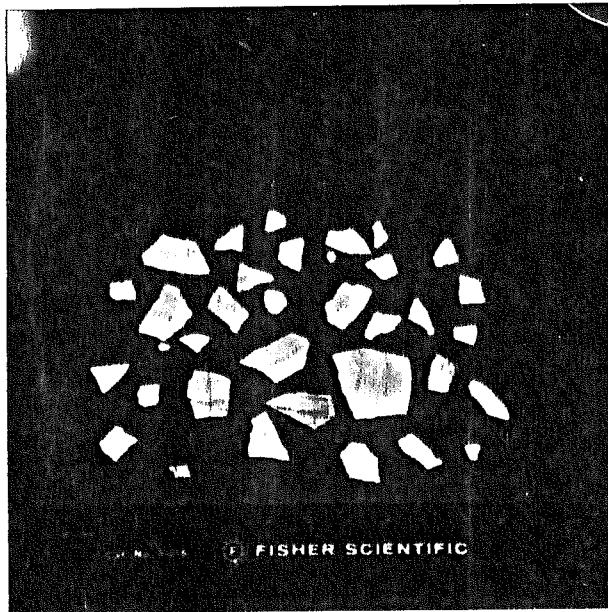
\* Krueger Enterprises, Inc.; Geochron Laboratories Division



SHELL HORIZON - PQ [REDACTED] 1

Z = 79 cm

1.



FISHER SCIENTIFIC

SHELL FRAGMENTS PQ-1

Z = 79 cm

2.

4.

Moment EMU  $\times 10^{-6}$

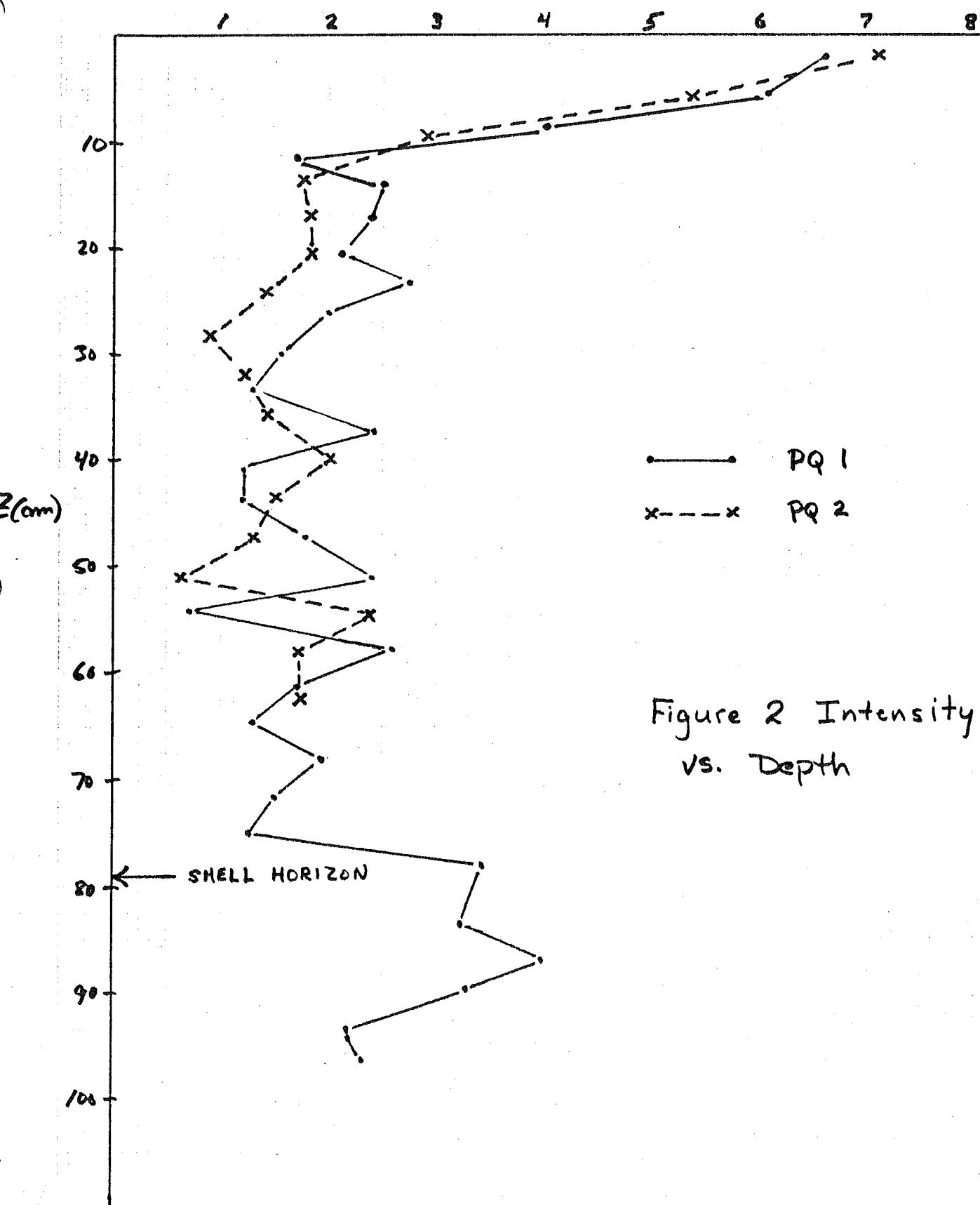


Figure 2 Intensity  
vs. Depth

### Declination<sup>o</sup> PQ 1

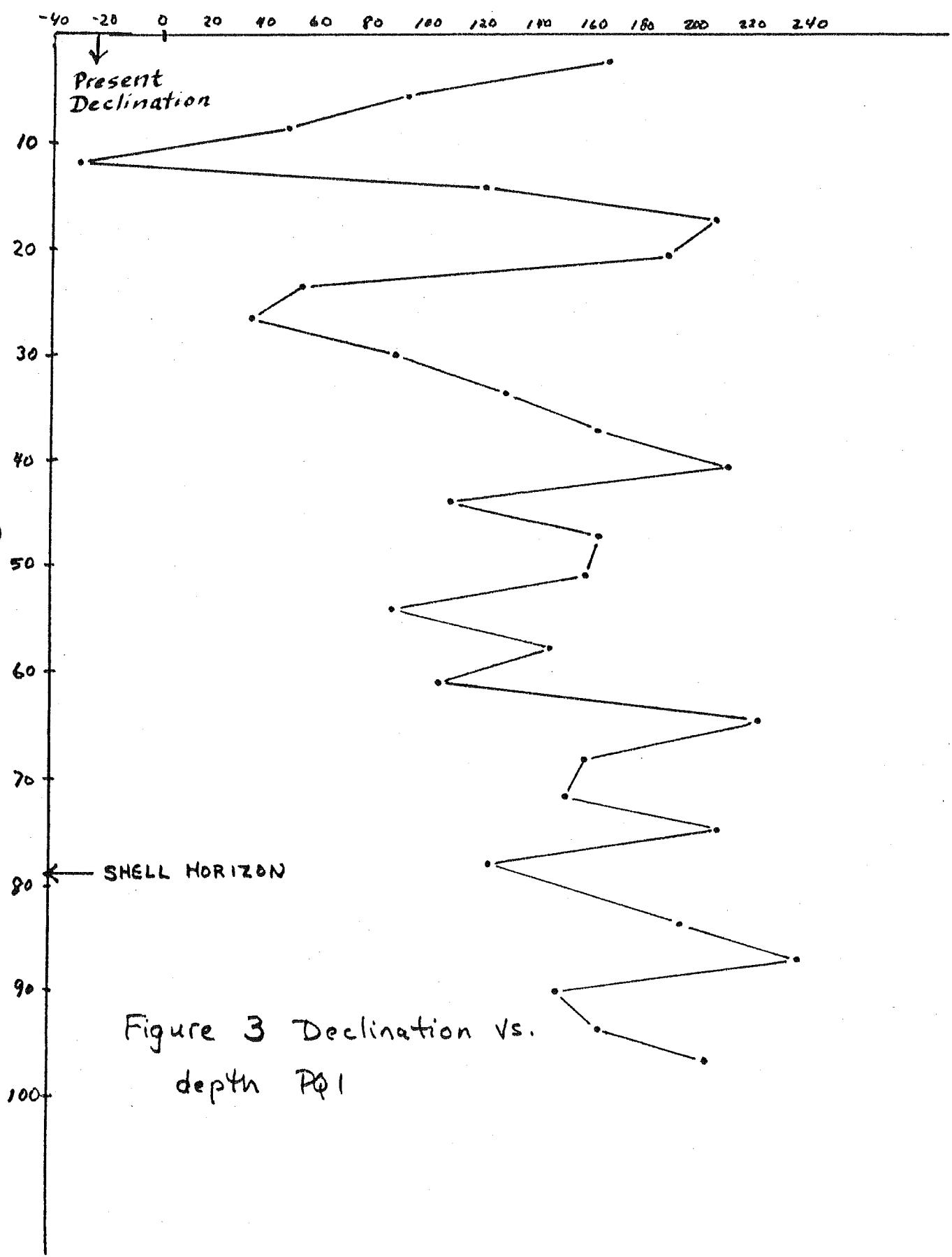


Figure 3 Declination vs.  
depth PQ 1

## Declination PQ 2 (Arbitrary Units)

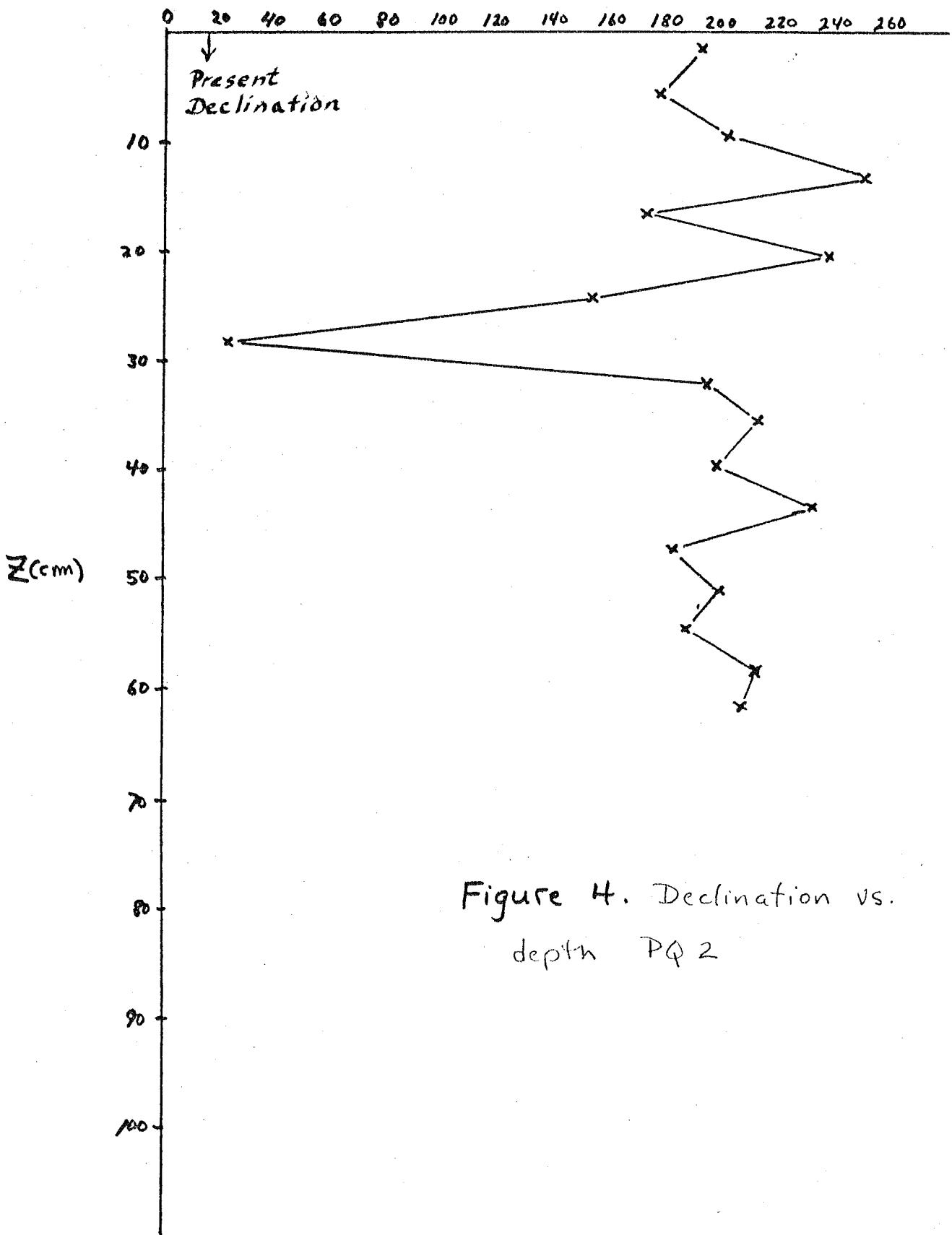
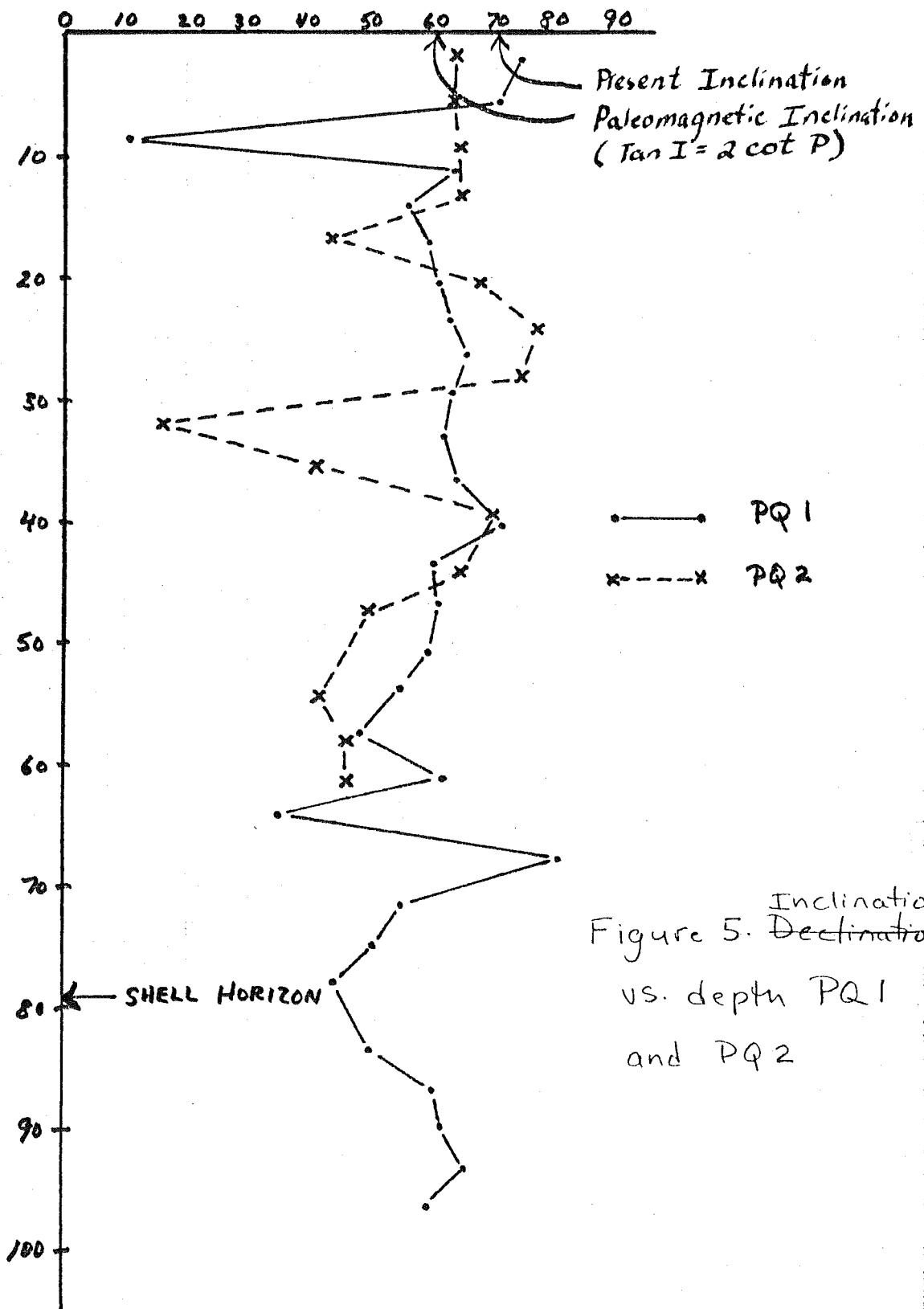
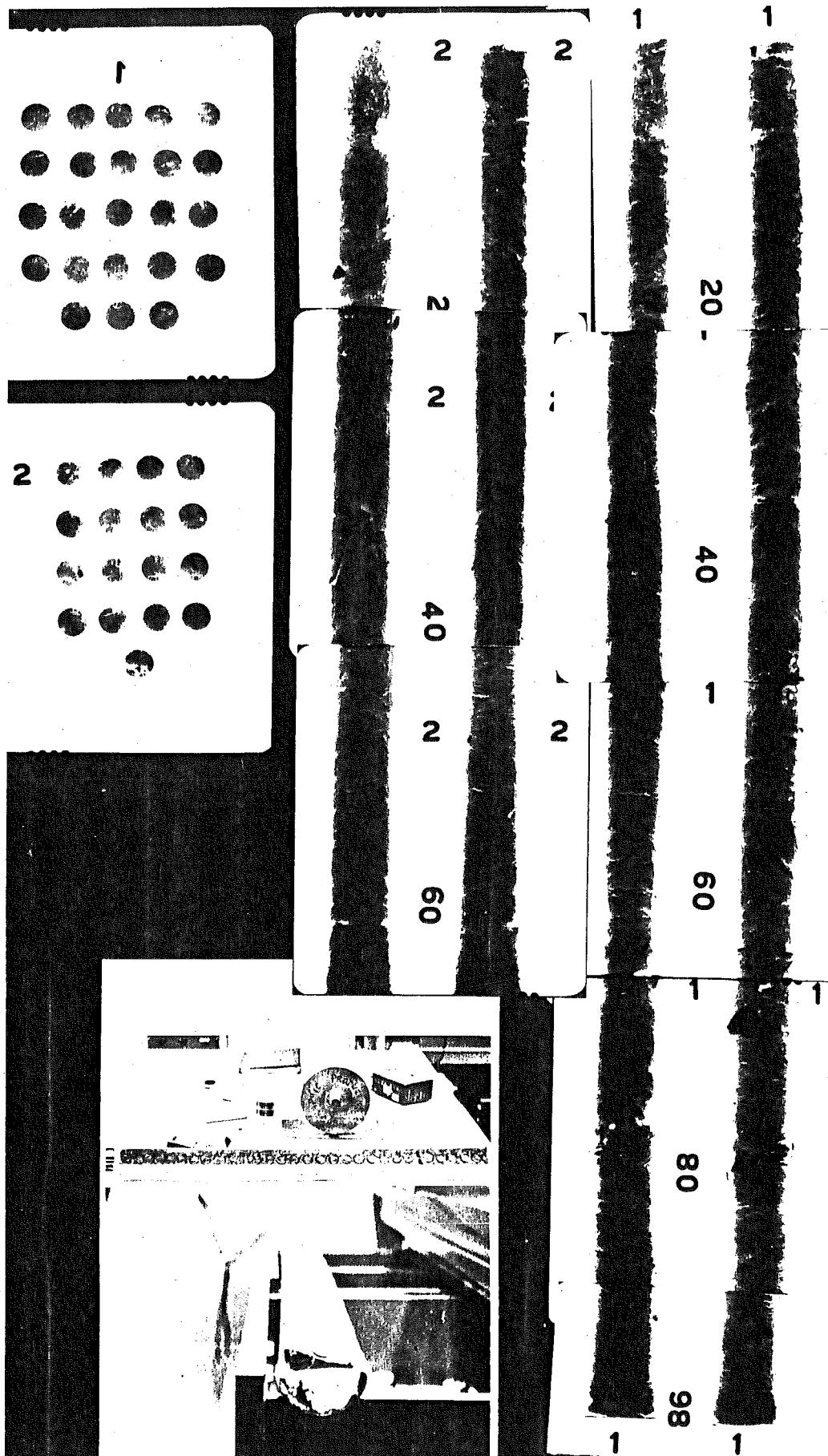


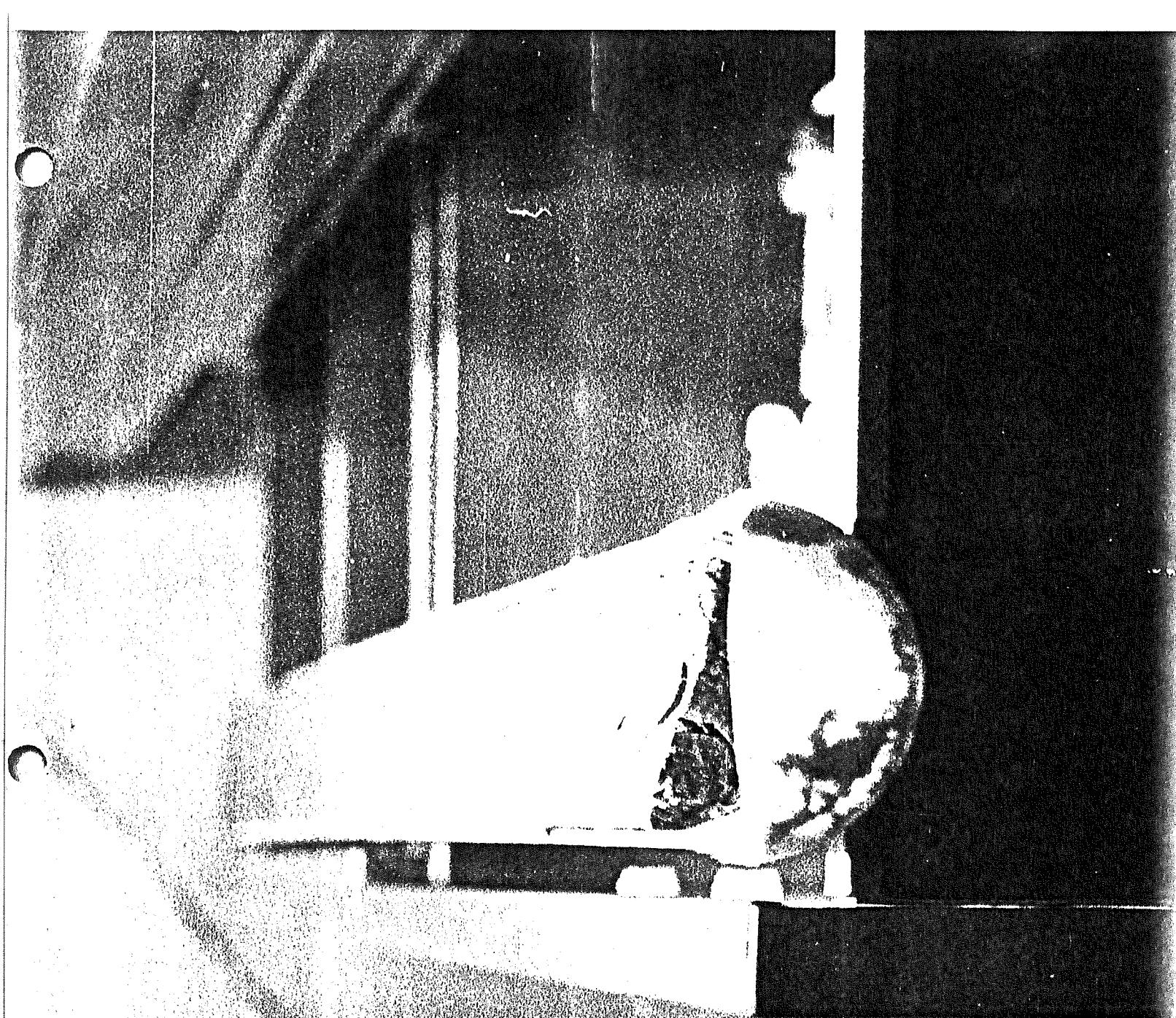
Figure 4. Declination vs.  
depth PQ 2

## INCLINATIONS

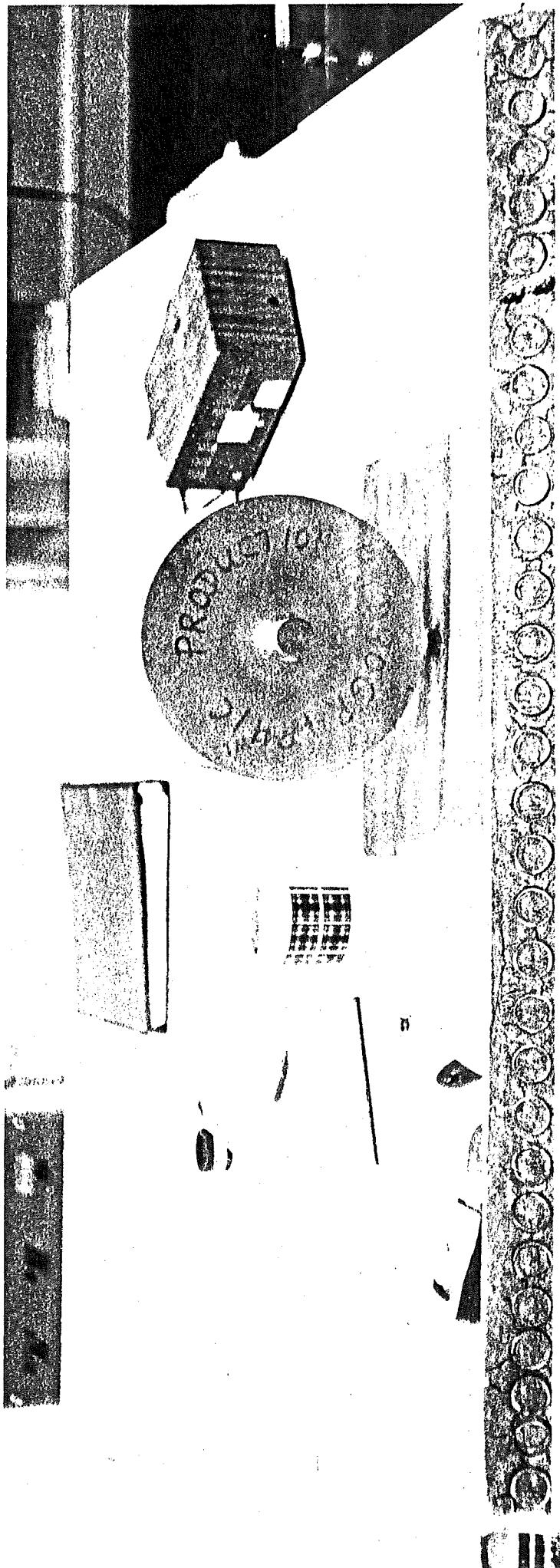


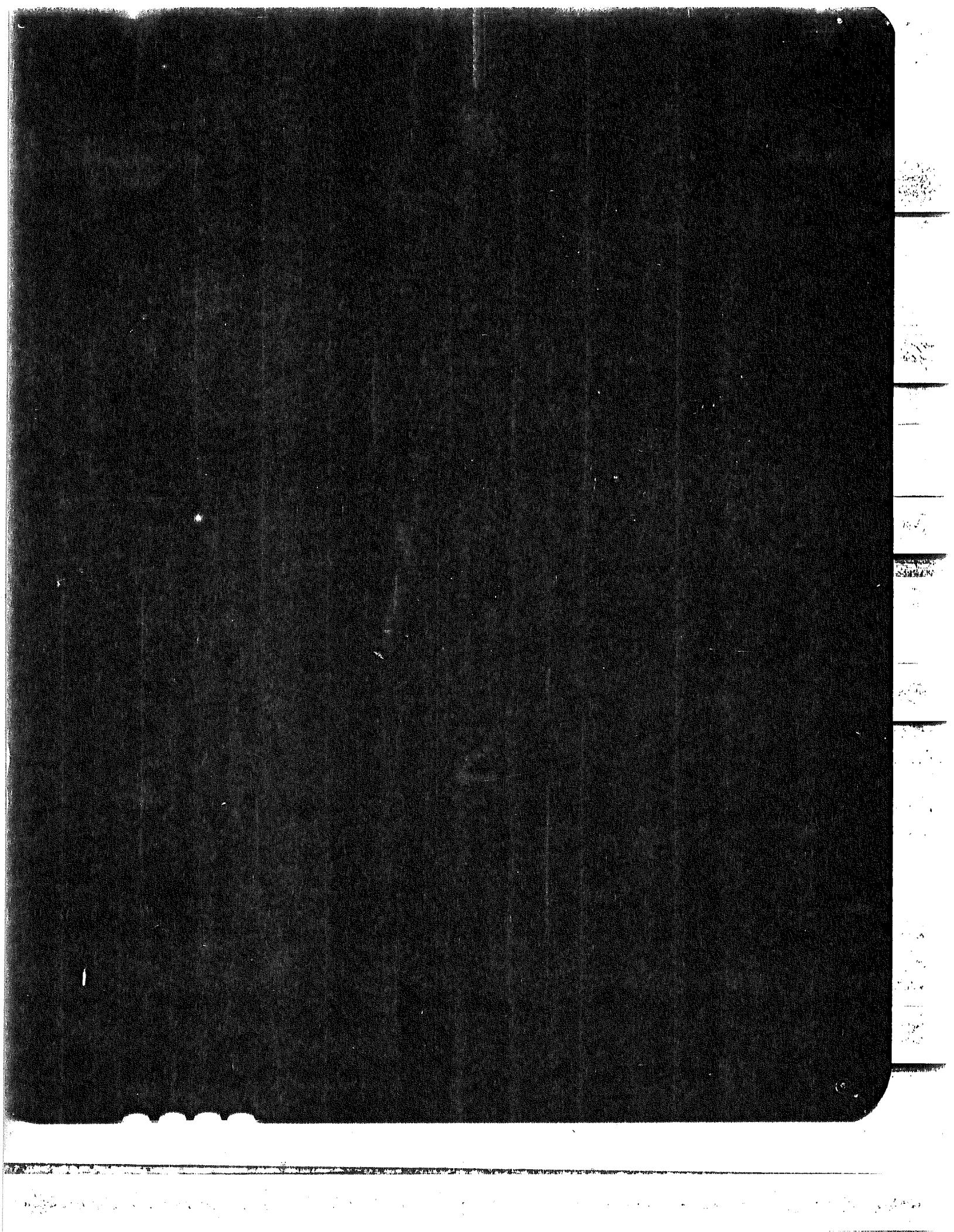
Inclination  
Figure 5. Declination  
vs. depth PQ1  
and PQ2





52





6:

20

NOT

09 00

40

60



СБОМЕХ

ВБ

80

98

20

2

2

6C

40

2

2

CRONG

MOB 928

1910

60

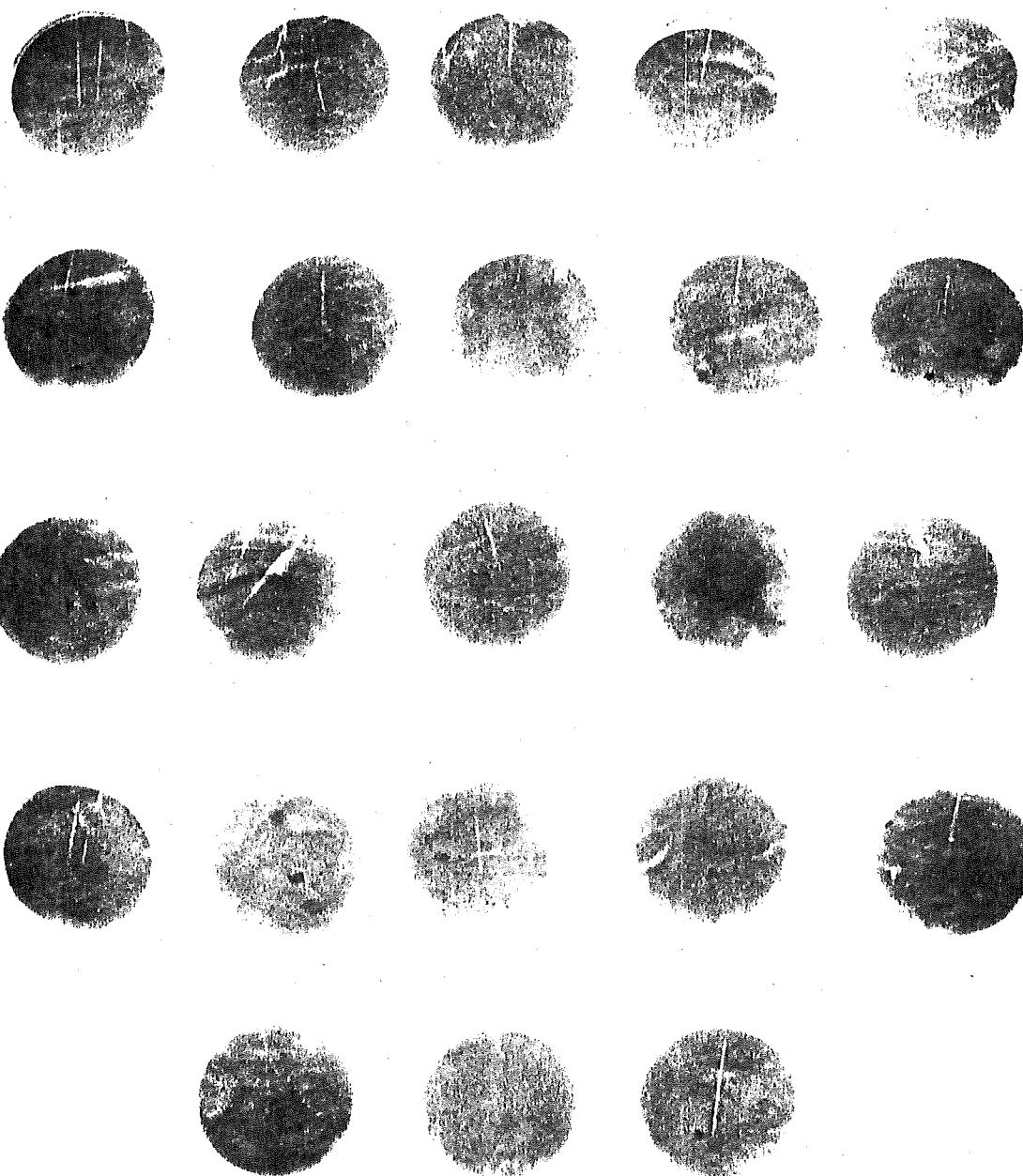
2

2

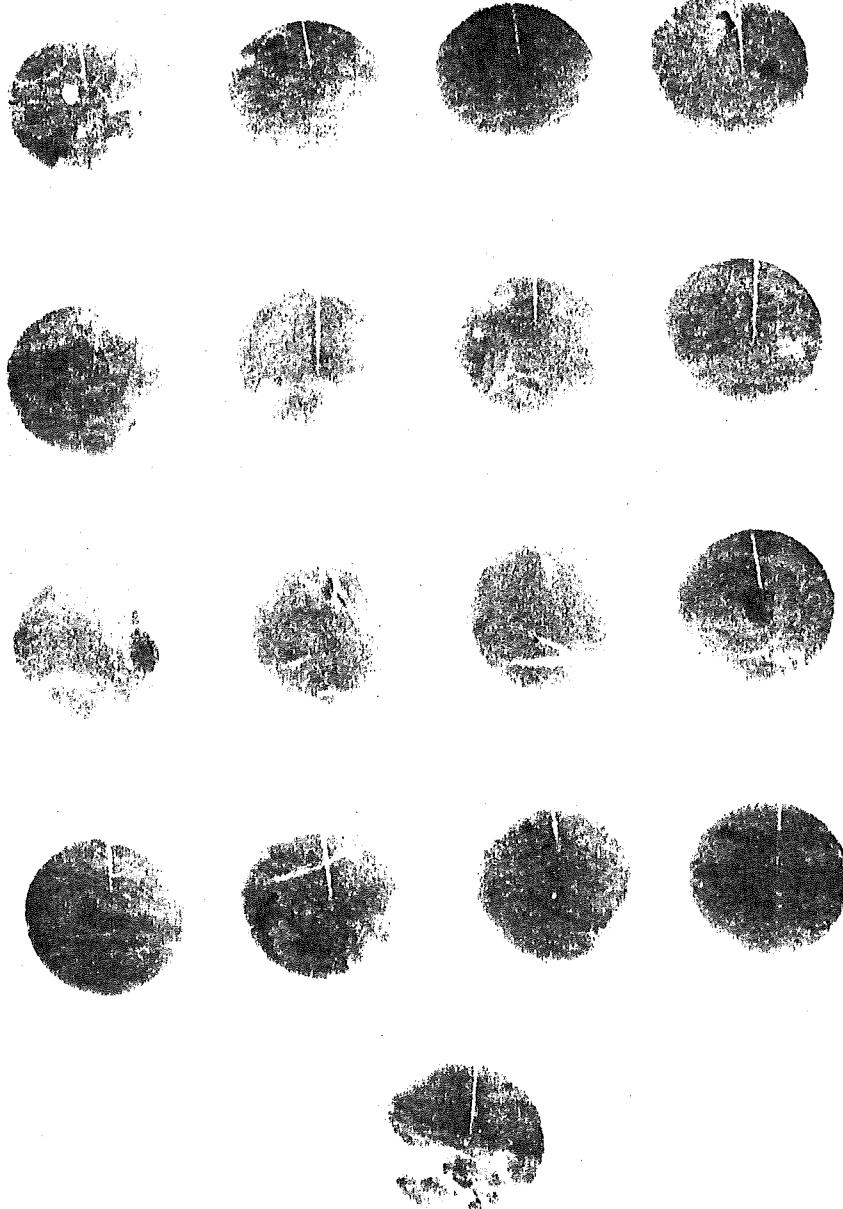
60 874

6

1



2



the cycles is comparable (at about 2,500 yrs/cycle) to those determined by Creer et al. (1976), then the age of the shell horizon at 79 cm should be near  $8,500 \text{ yrs} \pm 2,000 \text{ yrs}$ . This age differs from that obtained by  $C_{14}$  which dated the shell horizon at  $2230 \pm 165$  years.\* Recognition of the S.V. cycle at intervals of 17, 24, 24, 22 cm also implies a rather constant sedimentation rate at .01 cm/yr. Over the past 10,000 yrs (allowing for some sediment disturbance at the top of the core) the general trend of declination in PQ1 after averaging out secular variation, is one of increasing declination with increasing depth.

There are ambiguities regarding the above interpretation of declination variation with depth. One major problem is the lack of reproducibility between PQ1 and PQ2, especially in the upper 10 cm (Figures 3 and 4). C. Schafer has suggested that the discrepancy might be explained, in part, by the hasty manner in which PQ2 was obtained by a scuba diver on his last breath of compressed air. However, this explanation is not particularly satisfying, and more sampling will be necessary to verify the presence of secular variation cycles.

#### IV. Comparison with other secular variation studies.

A number of investigations have been carried out on s.v. recently (Johnson et al., 1948, the closest geographic s.v. study to the Maritimes, Creer et al., 1971, MacKereth 1971; Thompson, 1973; Plasse, 1975; Creer et al., 1976). In these studies it is generally concluded that cyclical patterns of declination are potentially useful as a means of dating sediments.

The declination variation observed in this study is anomalous in several respects. First, in a preliminary study of what turned out to be about 20 cm of "Pugwash Mud", Plasse (1975) did not observe a cyclical pattern of secular variation. Second, the amplitude of the declination swings is in the order of  $100^\circ$  in the top of core PQ1, nearly five times that observed by Creer *et al.* (1976) and three times that noted by Mackereth (1971). In a study of varved clays throughout New England by Johnson *et al.* (1948) only a  $50^\circ$  variation in declination amplitude was observed for material ranging from 10,000 to 15,000 yrs. in age. Thus, it appears that the amplitude of s.v. swings is unusually large in this investigation.

Perhaps this large amplitude variation in declination is an artifact of the convention used for separating a magnetic remanence into declination and inclination components. Declination variations are particularly exaggerated when inclination values are steep. Notice in Fig. 3 that the declination oscillations appear to be attenuated with increasing depth, and in Fig. 2 the general trend of inclination values gets shallower with increasing depth. Also, the declination at the top of the core is well away from the value of  $-25^\circ$ . Creer *et al.* (1976) observed a similar ( $60^\circ$ ) deviation from the present value at the top of Lake Michigan cores. Creer *et al.* (1976) claimed that the declination at the top of the core represented a record of a shorter period swing in the s.v. It is also possible that sediment disturbance at the top of the core and low precision of core orientation effected the observed declination values.

#### Inclinations

As a general rule, inclination as a function of depth does not exhibit

a cyclical pattern (Johnson *et al.*, 1948; MacKareth, 1971; Creer, *et al.*, 1971, Plasse, 1976). Nevertheless the fact that the pattern of inclination variation is generally reproducible in different cores indicates that inclination variation may be a useful paleomagnetic measurement. However, laboratory studies and field investigations (Johnson, *et al.*, 1946; Creer *et al.*, 1972) show that shallowing of inclination with depth might be due to a flattening of the long axes of nonspherical magnetic grains due to compaction in the sedimentary column, and may not represent variations in the ancient geomagnetic field. Thus, caution should be extended when relating inclination patterns of different cores of Pugwash Mud.

Intensities. The results of this investigation figure and Plasse (1975) suggest that a rapid decrease in the intensity of remanence in the top 10 cm of Pugwash Mud might be a common occurrence in the Northumberland Strait. Whether the decrease in intensity with depth represents a variation in type of abundance of magnetic minerals, or a decrease in total field intensity has not been investigated. Creer (1976) suggests that fluctuations in total field intensities can be demonstrated by plotting Q ratios (where  $Q = \frac{J_{NRM}}{J_{induced}}$ ) v.s. depth. Induced magnetization of Pugwash Mud would have to be measured before such a curve can be constructed. In summary, plots of intensity vs. depth may be useful when relating cores taken from the Northumberland Strait, however, more work should be done to determine whether or not the decrease in intensity with depth is a function of the properties of the recording medium, or a decrease in total field intensity.

## V. Summary

Measurements of the magnetic intensity and direction within marine sediment cores may eventually prove to be a useful dating technique for examining sea level changes in Eastern Canada. In at least one core, PQ1, there appeared to be a periodicity to the SV declination which implied that the age of sediments at a depth of 80 cm. was in the range of 8,500  $\pm$  2,000 yrs, and the sedimentation rate has been a rather constant at about .01 cy/yr. The age based on paleomagnetics is considerably older than that obtained by C<sub>14</sub> dating (2230  $\pm$  165 year). Inclination and intensities do not exhibit periodic cycles, but are repeated in different cores, and may serve as useful criteria to correlate any future cores to a reference section. Should other techniques such as C<sub>14</sub>, pollen, Ce<sub>137</sub>, Pb<sub>210</sub>, or examination of foraminifera, provide reasonably consistent age dates, for the shell horizon at 79 cm, core PQ1 may eventually serve as a reference section for marine sediments in the Maritimes.

Suggestions for future work. Marine sediments from the Northumberland Strait are not the most suitable material for establishing a magnetic stratigraphy reference section for Eastern Canada. In particular, variations in sedimentation rate could make correlation to a reference section difficult if not impossible. The Northumberland Strait must contain a tidal nodal point whose position must oscillate according to the dynamics of the Strait. In addition, the dynamics of Canso Strait must play an important role in the sediment transport in that area. Therefore, it is doubtful that these marine sediments are suitable material for establishing a paleomagnetic reference section. A lacustrine paleomagnetic reference

section with more control on sedimentation rates and less bioturbation, would probably be more suitable.

Also, the cores should be obtained and oriented with more precision. Scuba divers pounding core barrels into the mud and then orienting them with respect to magnetic north with a divers compass, hacking a v-shaped notch on the north side of the tube with a knife, then yanking the core to and fro to retrieve it from the mud, to me, seems hardly the method to obtain precisely oriented cores. A Bronton compass, inclinometer type pod should be constructed to fit on top of a carefully sharpened core tube. The whole assembly can then free-fall into the mud and oriented in situ by a scuba diver who can then carefully dig the mud away from the tube before removal.

### References

Creer, K. M., R. Thompson, L. Molyneux, and F.J.H. Mackereth (1972).

Geomagnetic Secular Variation Recorded in the Stable Magnetic Remanence of Recent Sediments. *Earth Planet. Sci. Letters* 14, 115-127.

Creer, K. M., D. L. Gross, and J. E. Lineback (1976). Origin of regional geomagnetic variations recorded by Wisconsinian and Holocene sediments from Lake Michigan, U.S.A., and Lake Windermere, England. *G.S.A. Bull.* 87, 531-540.

Johnson, E. A., T. Murphy, and O. W. Torreson (1948). Pre-history of the Earth's Magnetic Field. *Terrest. Magn. Atmosph. Elect.* 53, 349-73.

Kranck, K. (1971). Surficial Geology of the Northumberland Strait. Marine Science Paper 5. *Geol. Survey Canada paper* 71-53.

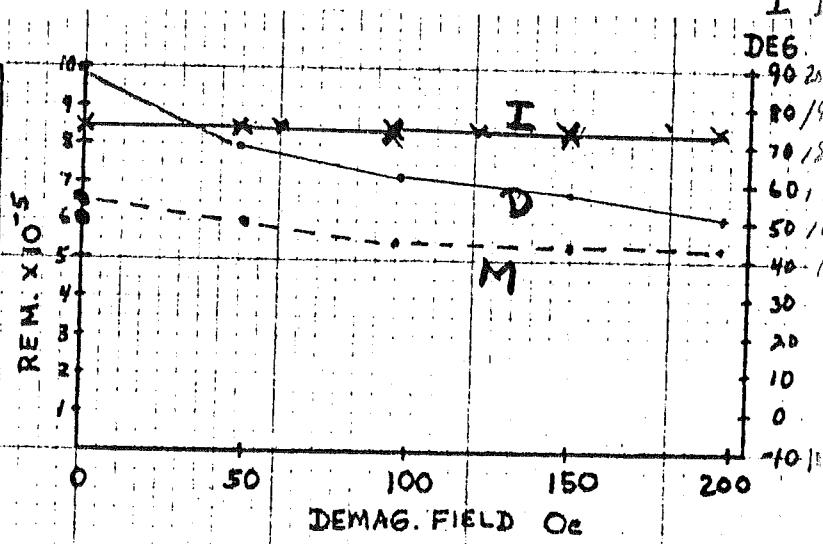
Mackereth, F.J.H. (1971). On the variation in Direction of the Horizontal Component of Remanent Magnetization in Lake Sediments. *Earth Planet. Sci. Letters* 12, 332-338.

Thompson, R. (1973). Paleolimnology and Paleomagnetism. *Nature*, 242, 182-184.

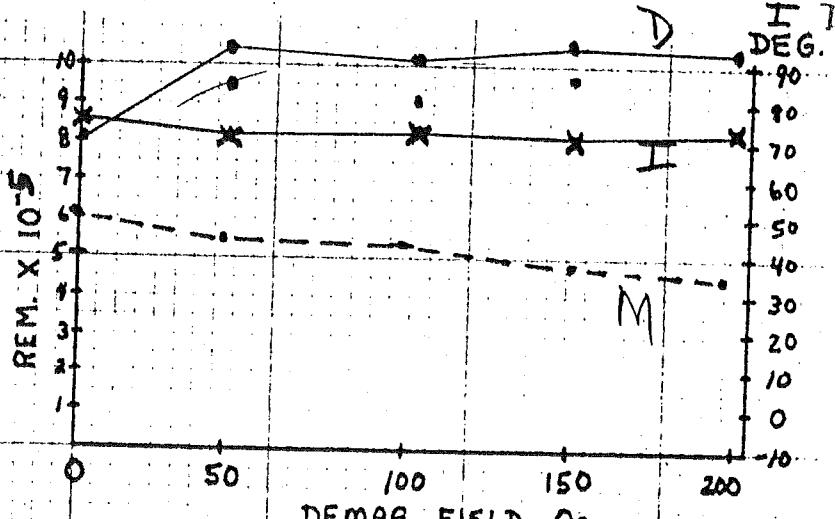
SAMPLE # PQ 1-1, 1-2# PQ 1-1Z = 2.3 C.P.   

## MAGNETIC PARAMETERS

A.F. DEMAG.	DEC.	INC.	$\Sigma$ MOM. $\times 10^{-6}$
0	201.3	75.0	6.60
50	182.3	76.0	6.08
100	174.1	75.6	5.52
150	164.0	76.7	5.37
200	159.4	76.9	5.20
$\frac{x_{100} + x_{150}}{2}$		-	
$\frac{x_{100} + x_{150} + x_{200}}{3}$	168	74	-

# 1-2 Z = 5.3 C.P.   

A.F. DEMAG.	DEC.	INC.	$\Sigma$ MOM. $\times 10^{-6}$
0	81.3	76.9	6.11
50	95.1	73.6	5.59
100	91.7	74.4	5.36
150	96.4	71.5	4.76
200	93.5	74.0	4.46
$\frac{x_{100} + x_{150}}{2}$		-	
$\frac{x_{100} + x_{150} + x_{200}}{3}$	94	72	-



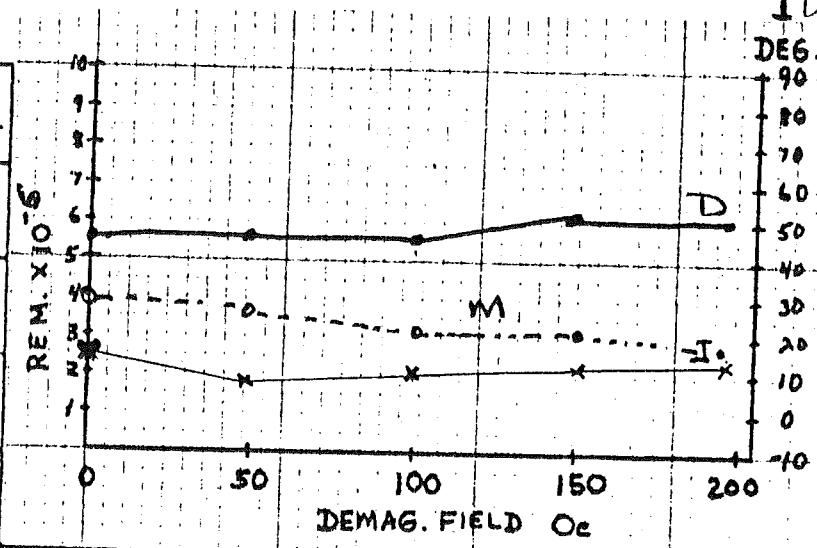
COMMENTS
X-ray
MAGNETICS

SAMPLE # PQ 1-3,4

# 1-3  
Z = 8.4 C.P.

## MAGNETIC PARAMETERS

A.F. DEMAG.	DEC.	INC.	$\Sigma \text{MOM.}$
0	46.4	15.0	4.05
50	48.3	9.6	3.70
100	46.5	10.6	3.30
150	52.3	11.6	3.13
200	50.9	13.2	2.75
$\frac{x_{100} + x_{150}}{2}$			-
$\frac{x_{100} + x_{150} + x_{200}}{3}$	48.0	10.5	-



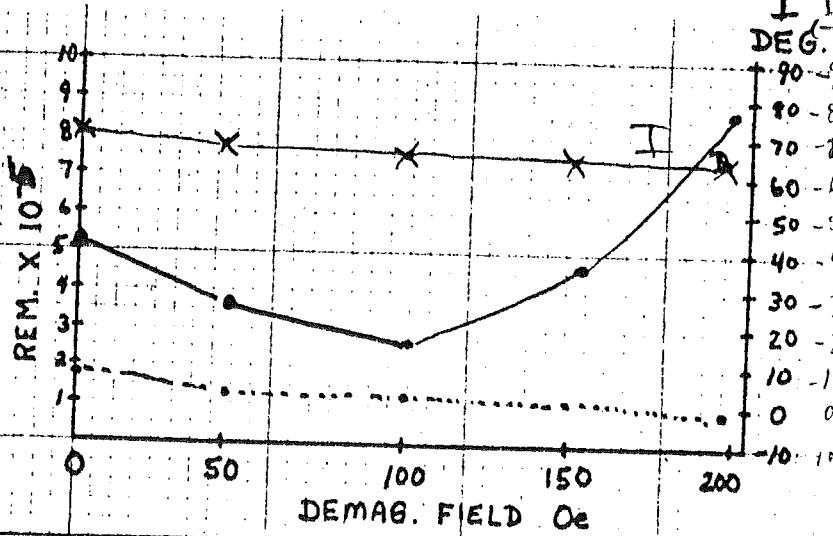
## COMMENTS

x-ray

## MAGNETICS

# 1-4 Z = 11.4 C.P.

A.F. DEMAG.	DEC.	INC.	$\Sigma \text{MOM.}$
0	-42.0	70.8	1.72
50	-25.7	69.8	1.45
100	-16.3	65.7	1.22
150	-32.9	74.1	1.10
200	-77.8	63.9	.846
$\frac{x_{100} + x_{150}}{2}$			-
$\frac{x_{100} + x_{150} + x_{200}}{3}$	-30(?)	64.5	-



## COMMENTS

x-ray

MAGNETICS Anomalous behavior  
in declination washing

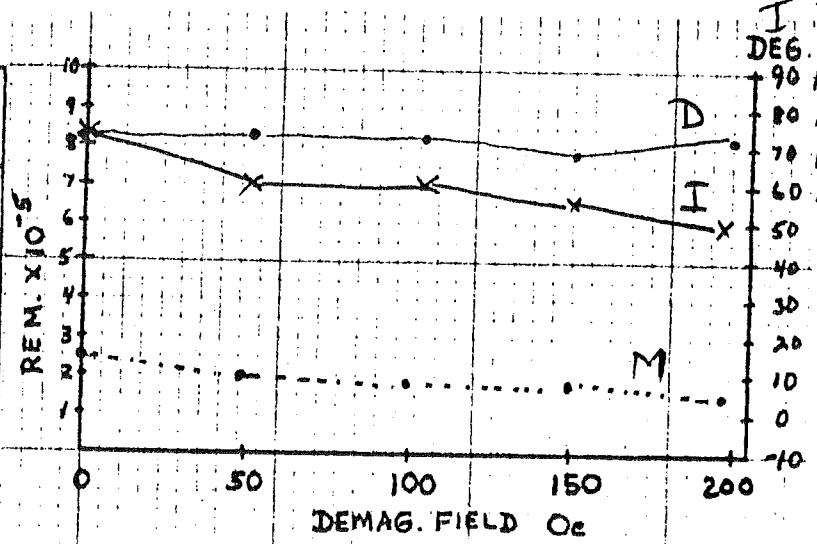
SAMPLE # PQ 1-5,6

# PQ 1-5,6

Z = 14.0 C.P.

MAGNETIC PARAMETERS

A.F. DEMAG.	DEC.	INC.	$\Sigma$ MOM. $\times 10^{-6}$
0	123.7	75.5	2.5
50	124.4	61.8	2.02
100	123.1	61.1	1.82
150	117.4	56.1	1.68
200	121.7	50.0	1.51
$\frac{X_{100} + X_{150}}{2}$			-
$\frac{X_{100} + X_{150} + X_{200}}{3}$	122	57	-



COMMENTS

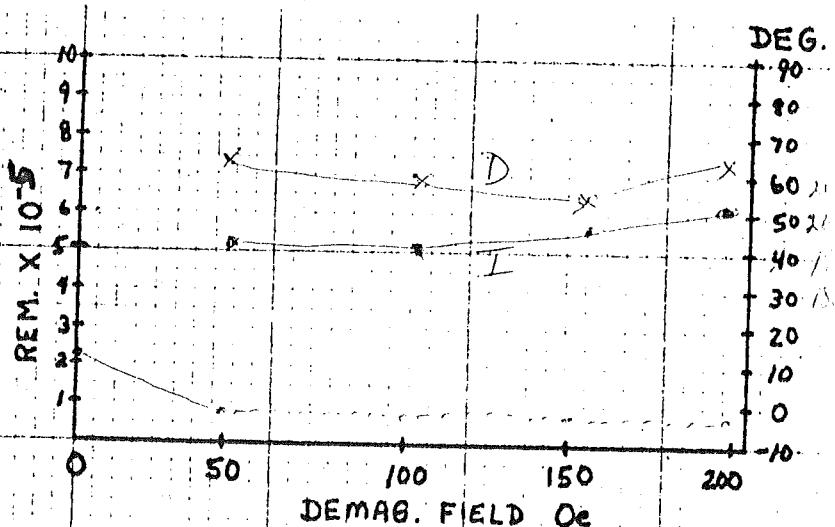
X-ray

MAGNETICS OK

# PQ 1-6 Z = 17.2 C.P.

Archive

A.F. DEMAG.	DEC.	INC.	$\Sigma$ MOM.
0	-	-	2.35
50	191.6	65.8	1.9
100	201.8	59.9	.78
150	208.1	52.8	.80
200	210.9	64.1	.65
$\frac{X_{100} + X_{150}}{2}$			-
$\frac{X_{100} + X_{150} + X_{200}}{3}$	208	59	-



COMMENTS

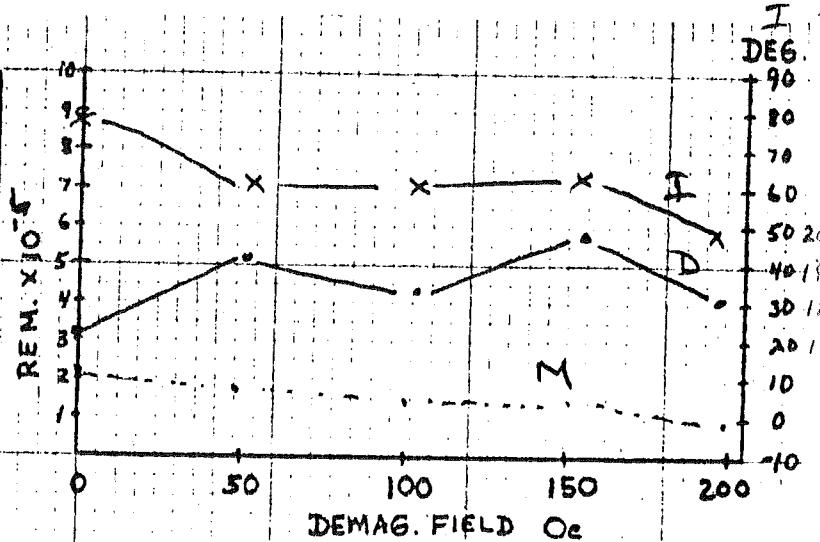
X-ray

MAGNETICS

SAMPLE # TG 1-7,8# 7  
Z = 20.4 C.P. = 

## MAGNETIC PARAMETERS

A.F. DEmag.	DEC.	INC.	$\Sigma M_{OM} \times 10^{-6}$
0	172.6	79.5	2.24
50	191.1	62.5	1.75
100	154.8	62.6	1.53
150	199.1	64.2	1.49
200	177.9	49.6	1.04
$\frac{X_0 + X_{150}}{2}$		-	
$\frac{X_{100} + X_{150} + X_{200}}{3}$	190	61	-



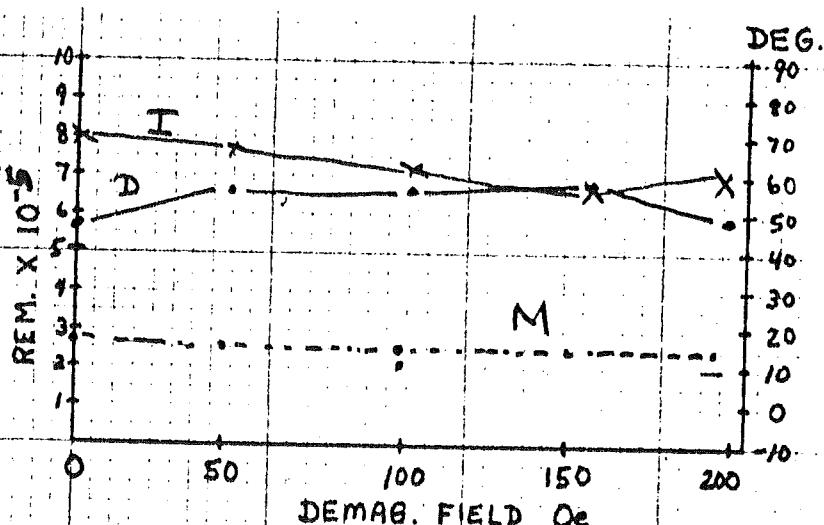
## COMMENTS

x-ray

mAGNETICS Shakey

# 8 Z = 23.4 C.P. = 

A.F. DEmag.	DEC.	INC.	$\Sigma M_{OM}$
0	46.9	70.4	2.77
50	56.1	66.5	2.64
100	56.4	62.3	2.49
150	58.6	57.3	2.49
200	49.3	60.2	2.55
$\frac{X_{100} + X_{150}}{2}$		-	
$\frac{X_{100} + X_{150} + X_{200}}{3}$	54	63	-



## COMMENTS

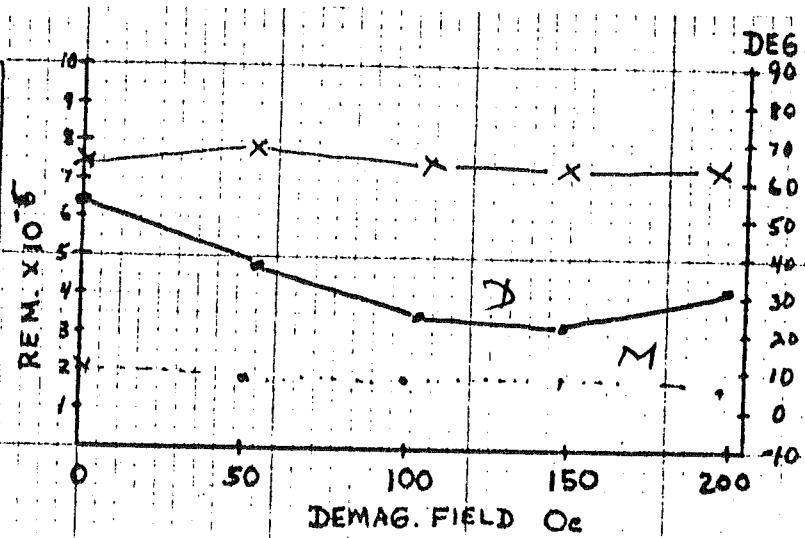
x-ray

mAGNETICS

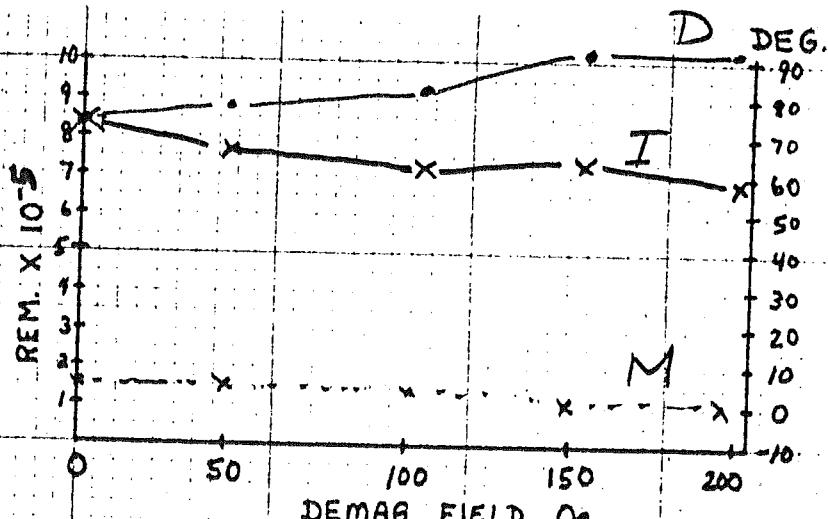
SAMPLE # PQ1-9,10# 9  
Z = 26.4 C.P.

## MAGNETIC PARAMETERS

A.F. DEMAg.	DEC.	INC.	$\Sigma$ MOM.
0	53.9	64.8	2.02
50	37.0	69.2	1.72
100	24.5	65.1	1.77
150	21.0	64.2	1.81
200	32.3	64.2	1.63
$\frac{x_{100} + x_{150}}{2}$			-
$\frac{x_{100} + x_{150} + x_{200}}{3}$	28	66	-

# 10 Z = 29.8 C.P.

A.F. DEMAg.	DEC.	INC.	$\Sigma$ MOM.
0	73.4	73.8	1.64
50	79.0	68.5	1.47
100	83.2	62.7	1.38
150	102.9	63.9	1.07
200	101.8	58.0	1.04
$\frac{x_{100} + x_{150}}{2}$			-
$\frac{x_{100} + x_{150} + x_{200}}{3}$	88	63	-



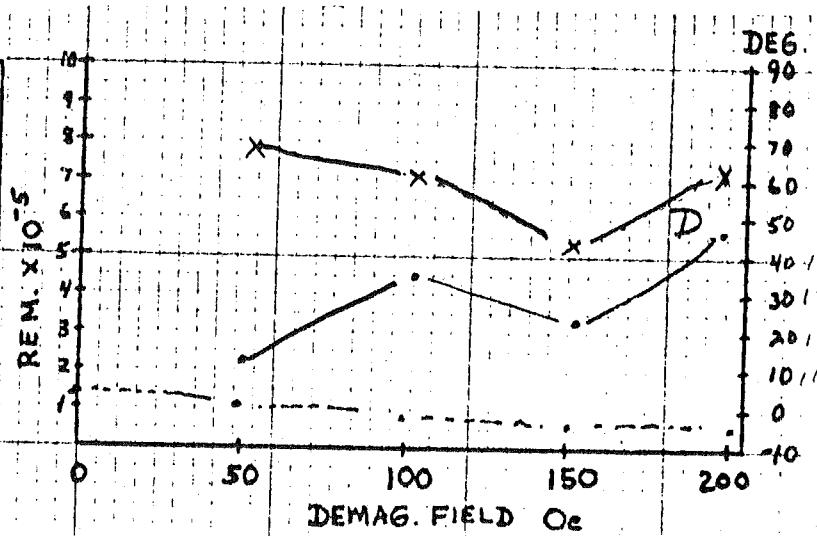
Comments	MAGNETICS
x-ray	

SAMPLE # PQ1-11,12

# 11  
Z = 33.2 C.P.

## MAGNETIC PARAMETERS

A.F. DEmag.	DEC.	INC.	$\Sigma$ MOM.
0	120.3		1.33
50	119.1	69.7	1.08
100	135.9	61.8	.855
150	123.9	43.6	.540
200	147.8	63.9	.534
$\frac{X_{100} + X_{150}}{2}$			-
$\frac{X_{100} + X_{150} + X_{200}}{3}$	130	62	-



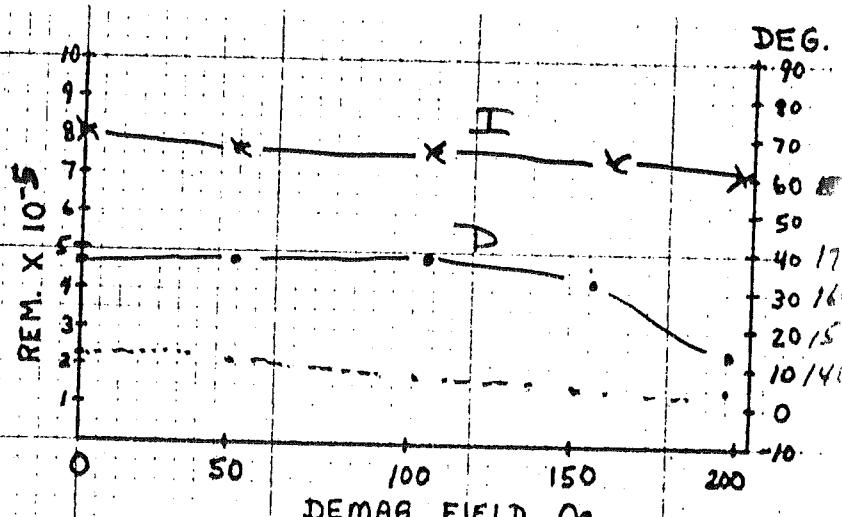
## COMMENTS

x-ray

## MAGNETICS

# 12 Z = 36.8 C.P.

A.F. DEmag.	DEC.	INC.	$\Sigma$ MOM.
0	168.5	71.5	2.38
50	168.6	67.4	2.16
100	169.4	68.3	1.59
150	161.5	65.3	1.48
200	141.5	62.7	1.51
$\frac{X_{100} + X_{150}}{2}$			-
$\frac{X_{100} + X_{150} + X_{200}}{3}$	164	64	-



## COMMENTS

x-ray

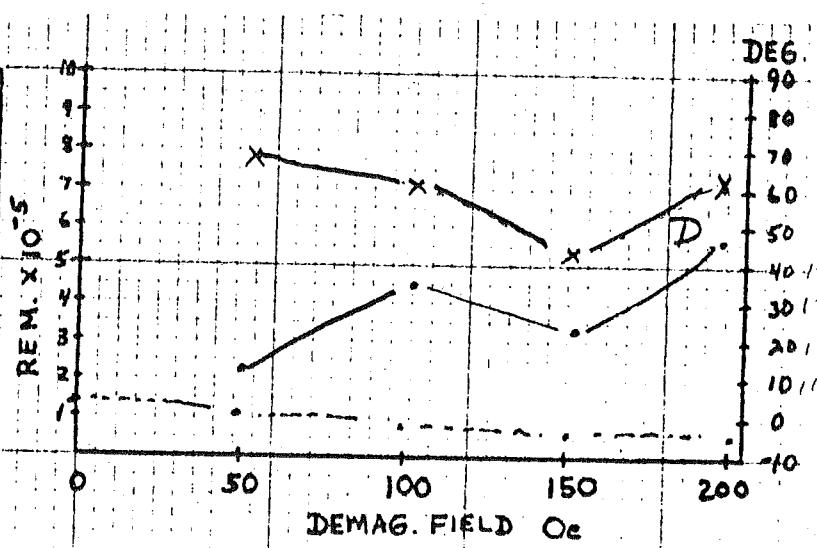
## MAGNETICS

SAMPLE # PQ1-11,12

# 11  
Z = 33.2 C.P.

## MAGNETIC PARAMETERS

A.F. DEMAG.	DEC.	INC.	$\Sigma$ MOM.
0	120.3		1.33
50	119.1	69.7	1.08
100	135.9	61.8	.855
150	123.9	43.6	.540
200	147.8	63.9	.534
$\frac{X_{100} + X_{150}}{2}$			-
$\frac{X_{100} + X_{150} + X_{200}}{3}$	130	62	-



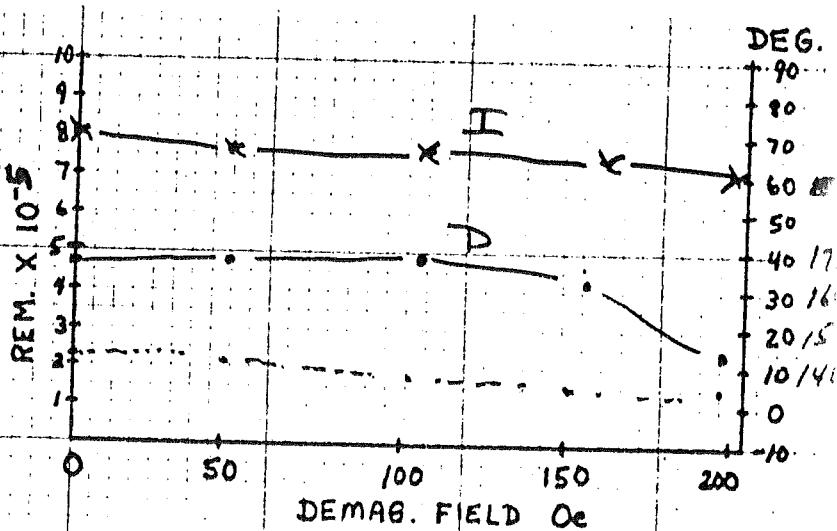
## COMMENTS

x-ray

## MAGNETICS

# 12 Z = 36.8 C.P.

A.F. DEMAG.	DEC.	INC.	$\Sigma$ MOM.
0	168.5	71.5	2.38
50	168.6	67.4	2.16
100	169.4	68.3	1.59
150	161.5	65.3	1.48
200	141.5	62.7	1.51
$\frac{X_{100} + X_{150}}{2}$			-
$\frac{X_{100} + X_{150} + X_{200}}{3}$	164	64	-



## COMMENTS

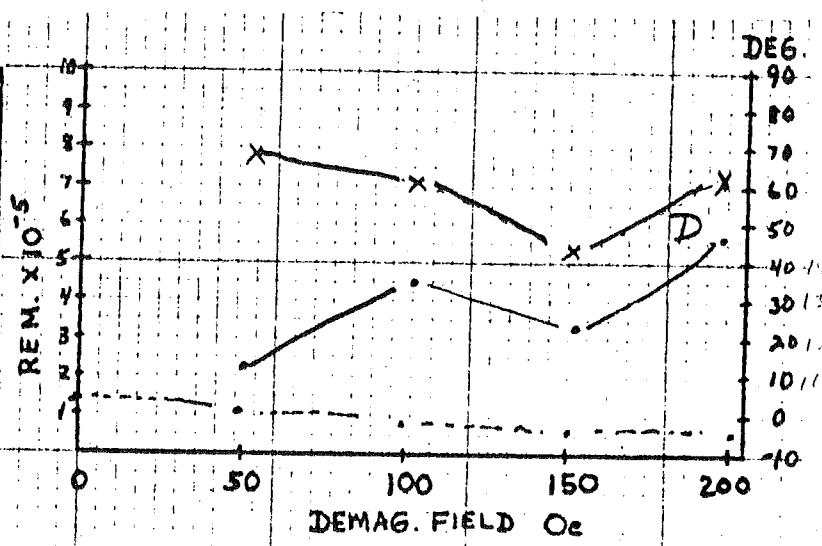
x-ray

## MAGNETICS

SAMPLE # PQ1-11,12# 11  
Z = 33.2 C.P.

## MAGNETIC PARAMETERS

A.F. DEMA6	DEC.	INC.	$\Sigma$ MOM.
0	120.3		1.33
50	119.1	69.7	1.08
100	135.9	61.8	.855
150	123.9	43.6	.540
200	147.8	63.9	.534
$\frac{x_{10} + x_{150}}{2}$			-
$\frac{x_{100} + x_{150} + x_{200}}{3}$	130	62	-



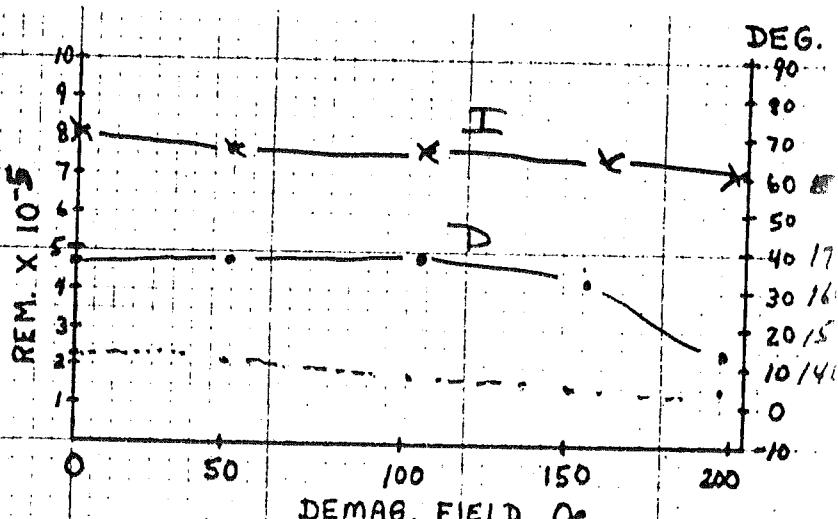
## COMMENTS

x-ray

## MAGNETICS

# 12 Z = 36.8 C.P.

A.F. DEMA6	DEC.	INC.	$\Sigma$ MOM.
0	168.5	71.5	2.38
50	168.6	67.4	2.16
100	169.4	68.3	1.59
150	161.5	65.3	1.48
200	141.5	62.7	1.51
$\frac{x_{100} + x_{150}}{2}$			-
$\frac{x_{100} + x_{150} + x_{200}}{3}$	164	64	-



## COMMENTS

x-ray

## MAGNETICS

SAMPLE # P01-11,12

# 11  
Z = 33.2 C.P.

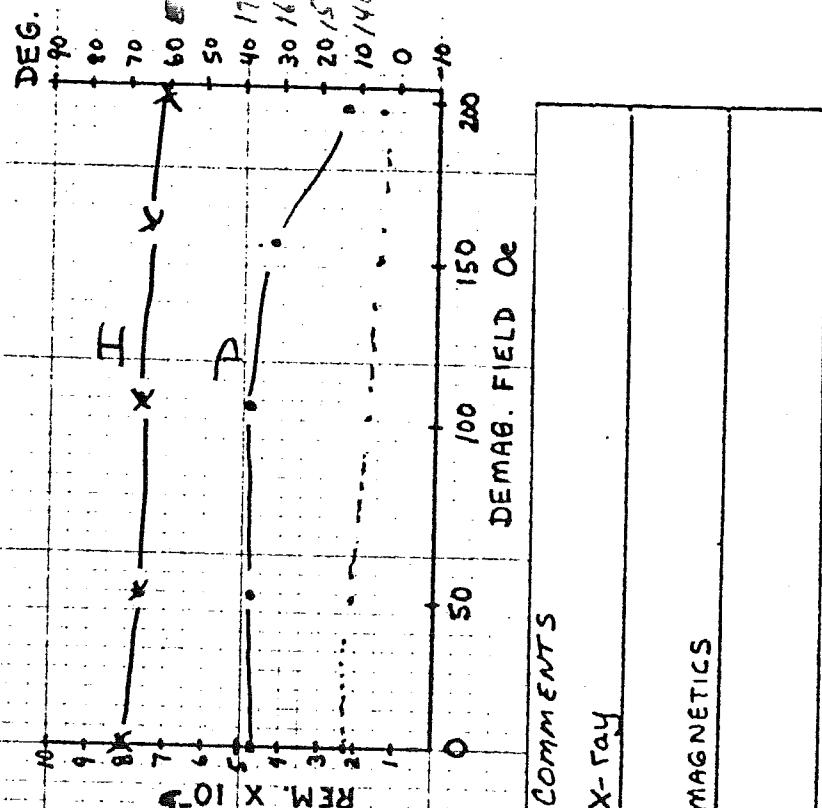
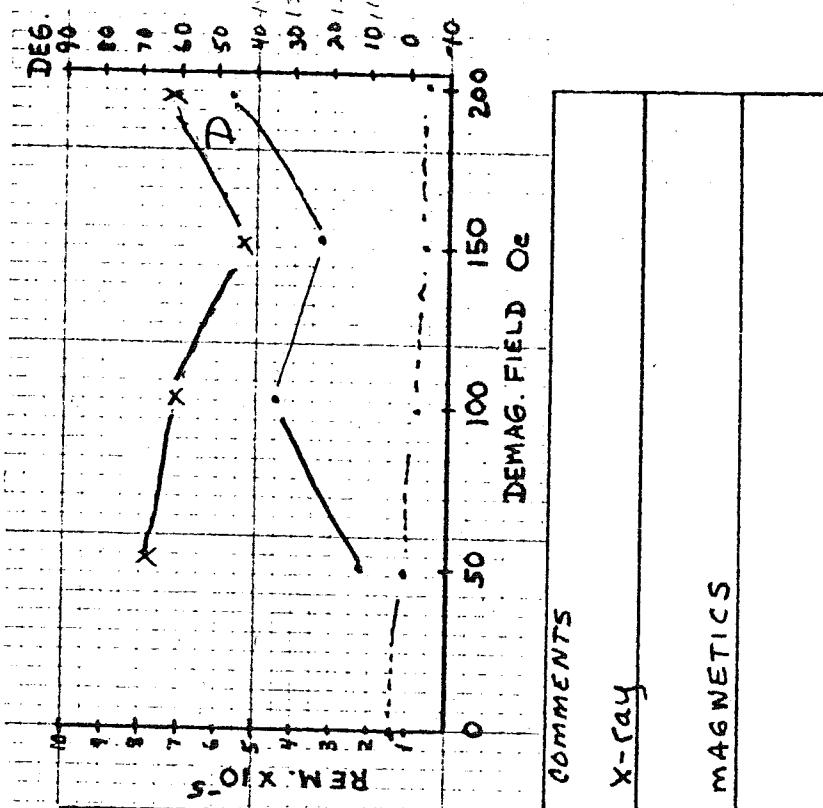
MAGNETIC PARAMETERS

A.F. DEMAG.	DEC.	INC.	$\Sigma$ MOM.
0	140.3	1.33	RE.M. X <sub>50</sub>
50	119.1	69.7	1.08
100	135.9	61.8	0.855
150	123.5	43.6	0.540
200	147.8	63.9	0.534
$\frac{x_{100} + x_{150}}{2}$	-	-	X-ray
$\frac{x_{100} + x_{150} + x_{200}}{3}$	130	62	-

# 12 Z = 36.8 C.P. =

COMMENTS

MAGNETICS



SAMPLE # P11-13,14

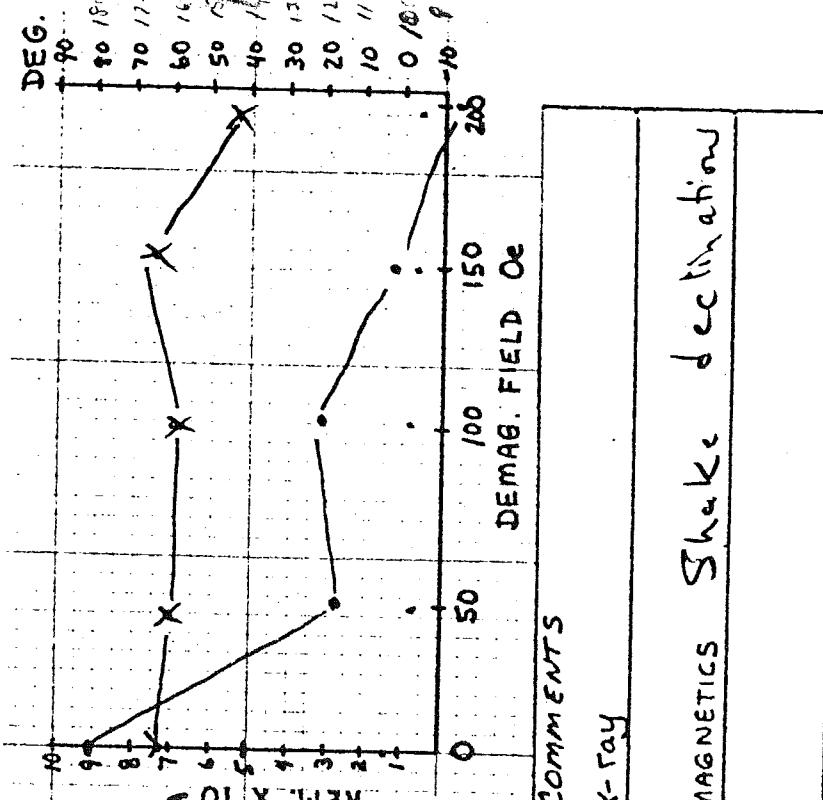
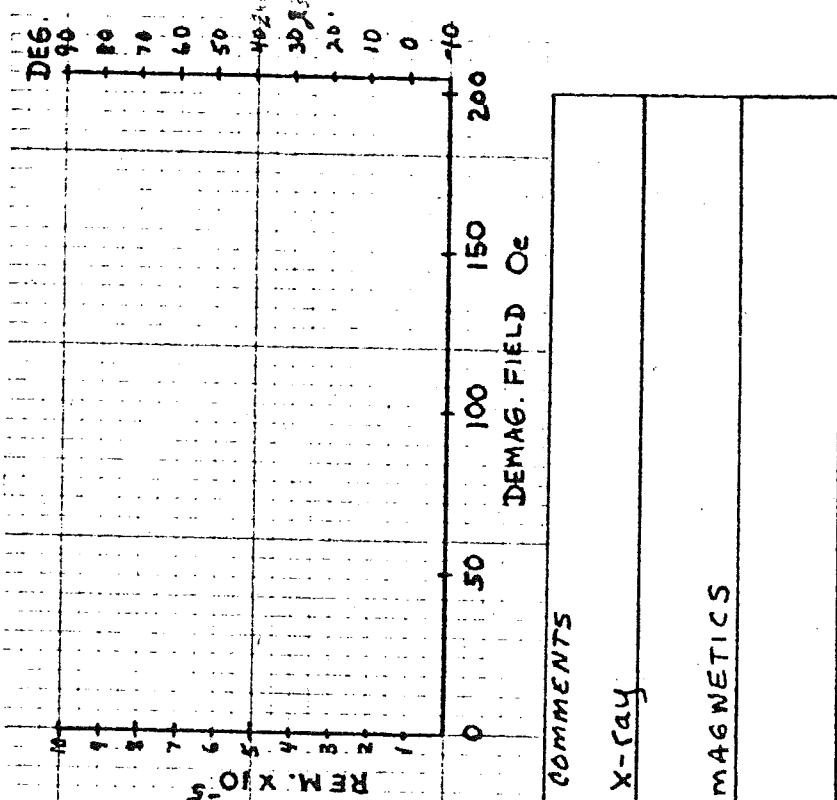
# 13  
Z = 40.2 C.P. =       

MAGNETIC PARAMETERS

A.F. DEMAG.	DEC.	INC.	$\Sigma$ mom.
0	255.8	74.7	1.49
50	198.1	69.3	1.28
100			
150			
$\frac{X_{10} + X_{150}}{2}$		-	
$\frac{X_{100} + X_{150} + X_{200}}{3}$	215	72	-

# 14  
Z = 43.5 C.P. =       

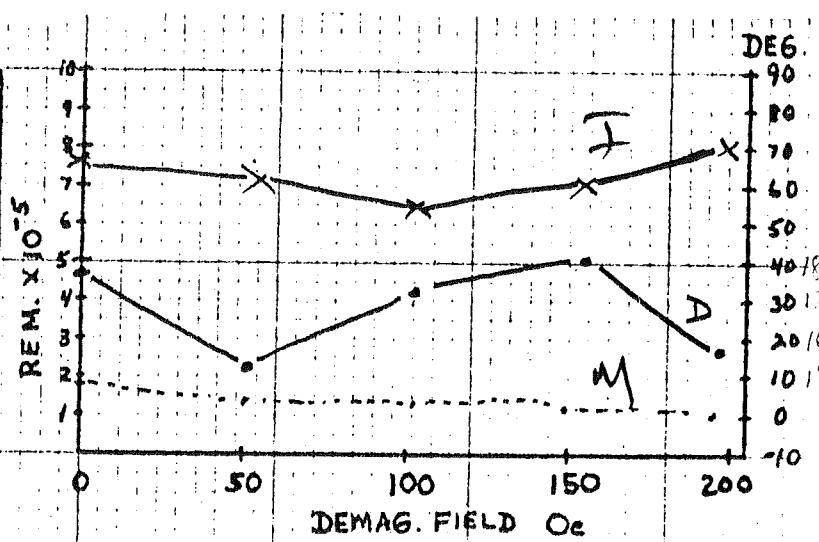
A.F. DEMAG.	DEC.	INC.	$\Sigma$ mom.
0	180.9	64.0	1.24
50	119.2	61.8	.86
100	122.0	57.5	.82
150	102.5	66.5	.77
200	85.9	43.0	.59
$\frac{X_{100} + X_{150}}{2}$		-	
$\frac{X_{100} + X_{150} + X_{200}}{3}$	110	60	-



SAMPLE # PPI-15,16# 15  
Z = 47.0 C.P.

## MAGNETIC PARAMETERS

A.F. DEMA6.	DEC.	INC.	$\Sigma$ MOM.
0	178.9	68.7	1.75
50	152.5	61.3	1.53
100	172.7	54.9	1.38
150	180.2	61.6	1.28
200	157.5	72.1	1.04
$\frac{X_0 + X_{150}}{2}$		-	
$\frac{X_{100} + X_{150} + X_{200}}{3}$	165	61	-



## COMMENTS

x-ray

## MAGNETICS

A.F. DEMA6.	DEC.	INC.	$\Sigma$ MOM.
0	119.1	59.4	2.36
50	189.6	~	Sample Coercive
100	~	~	Coercive
150	~	~	~
200	~	~	~
$\frac{X_{100} + X_{150}}{2}$		-	
$\frac{X_{100} + X_{150} + X_{200}}{3}$	160	59.4	-

Demag. Field (Oe)	Remanence (F) (M)	Coercivity (D) (M)
0	8.5	4.5
50	7.5	2.5
100	6.5	4.0
150	7.0	5.5
200	7.5	7.0

COMMENTS

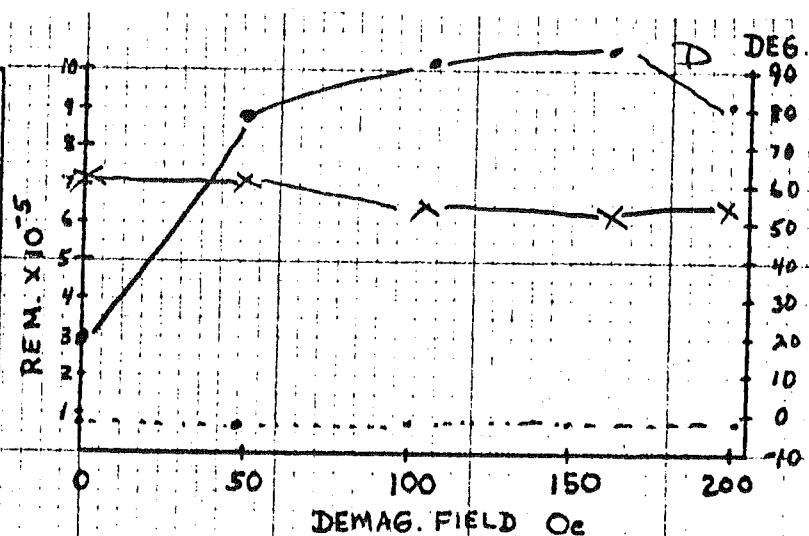
x-ray

MAGNETICS

SAMPLE # PPI-1718# 17  
Z = 54.0 C.P.

## MAGNETIC PARAMETERS

A.F. DEMAg.	DEC.	INC.	$\Sigma$ MOM. $\times 10^{-6}$
0	19.1	60.8	.790
50	77.0	61.4	.754
100	92.2	53.8	.705
150	96.0	52.4	.712
200	81.2	54.4	.953
$\frac{x_{10} + x_{150}}{2}$			-
$\frac{x_{100} + x_{150} + x_{200}}{3}$	88	55	-



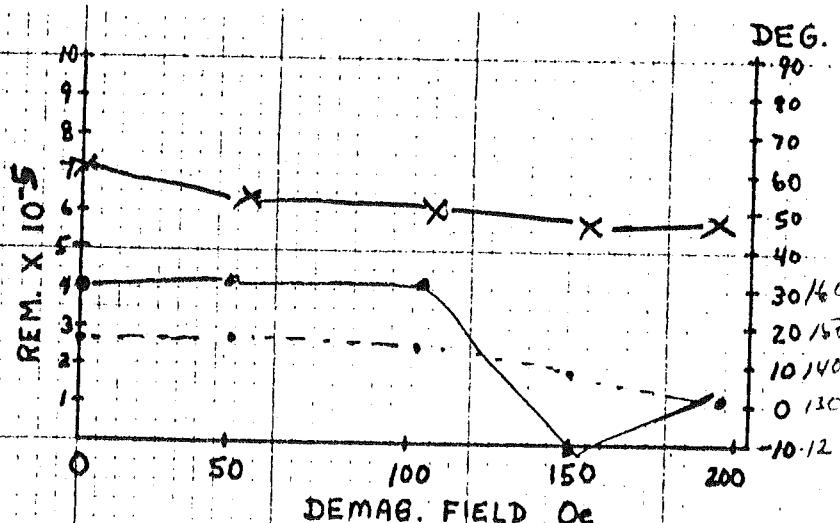
## COMMENTS

x-ray

## MAGNETICS

# 18 Z = 57.5 C.P.

A.F. DEMAg.	DEC.	INC.	$\Sigma$ MOM.
0	160.4	63.1	2.66
50	163.2	53.4	2.69
100	162.6	51.0	2.56
150	119.9	47.9	1.82
200	130.6	47.3	1.26
$\frac{x_{100} + x_{150}}{2}$			-
$\frac{x_{100} + x_{150} + x_{200}}{3}$	145	48	-



## COMMENTS

x-ray

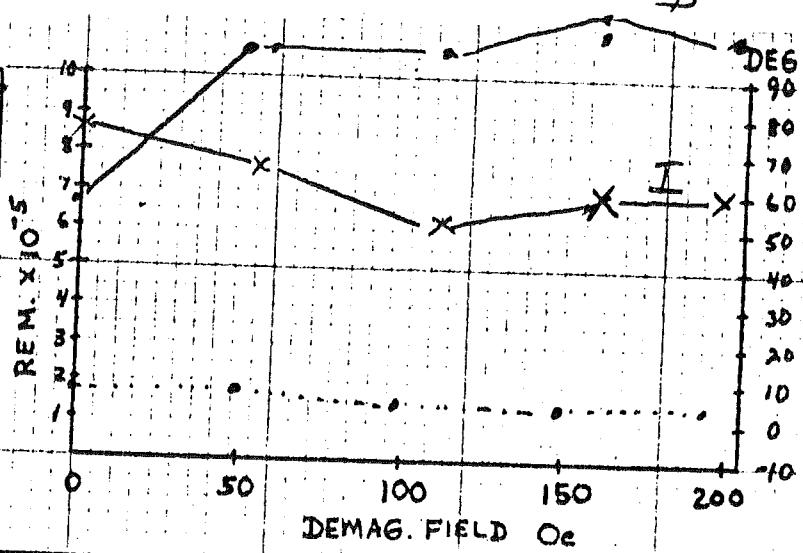
## MAGNETICS

SAMPLE # PQ1-19,20

# 19  
Z = 64.0 C.P.

## MAGNETIC PARAMETERS

A.F. DEMAg.	DEC.	INC.	$\Sigma$ MOM. $\times 10^{-6}$
0	58.9	76.3	1.74
50	98.6	67.1	1.76
100	98.0	51.0	1.53
150	107.3	59.6	1.51
200	103.9	60.3	1.50
$\frac{X_{100} + X_{150}}{2}$		-	
$\frac{X_{100} + X_{150} + X_{200}}{3}$	105	62	-



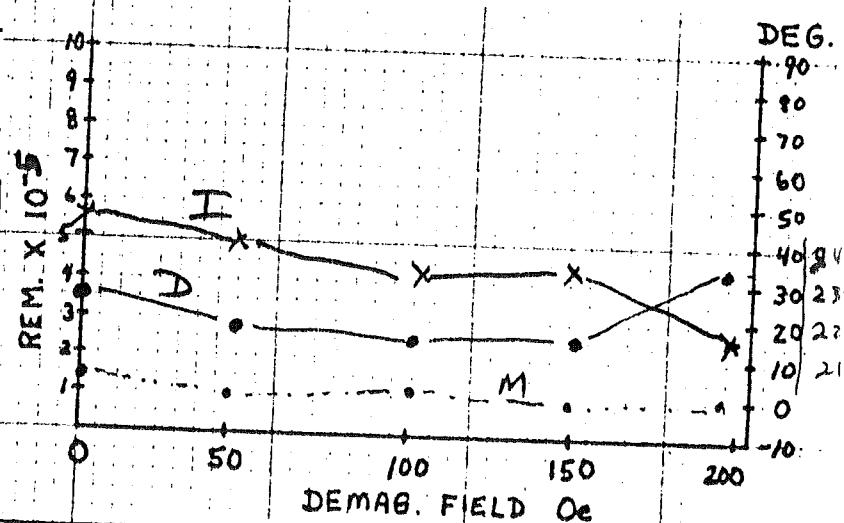
## COMMENTS

x-ray

## MAGNETICS

# 20 Z = 64.4 C.P.

A.F. DEMAg.	DEC.	INC.	$\Sigma$ mom.
0	225.3	46.7	1.31
50	217.9	40.5	1.09
100	213.0	33.7	1.17
150	215.4	34.1	0.926
200	235.3	16.0	1.07
$\frac{X_{100} + X_{150}}{2}$		-	
$\frac{X_{100} + X_{150} + X_{200}}{3}$	226	34	-



## COMMENTS

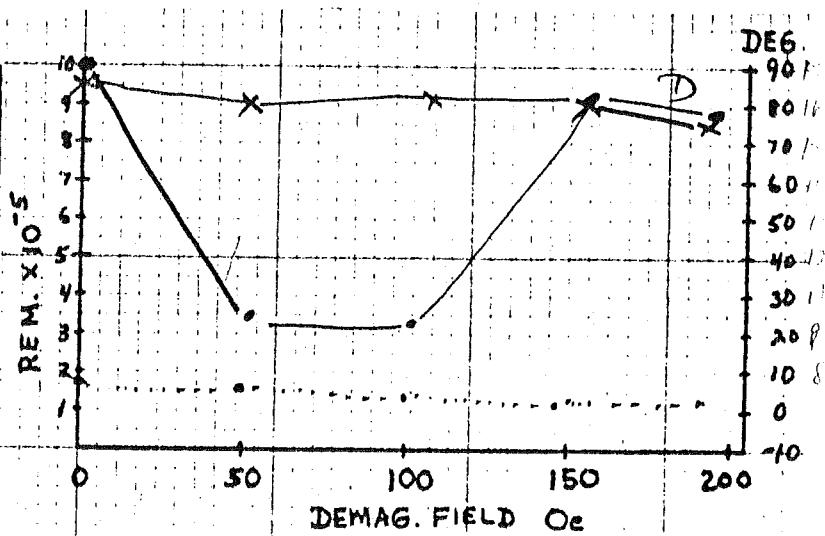
x-ray

## MAGNETICS

SAMPLE # PQ1-21,22# 21  
Z = 67.9 C.P.

## MAGNETIC PARAMETERS

A.F. DEMAG.	DEC.	INC.	$\Sigma$ MOM.
0	169.9	86.9	1.86
50	95.7	78.2	1.62
100	89.0	84.2	1.43
150	163.9	79.8	1.12
200	157.8	78.0	1.19
$\frac{X_{100} + X_{150}}{2}$			-
$\frac{X_{100} + X_{150} + X_{200}}{3}$	160	81	-



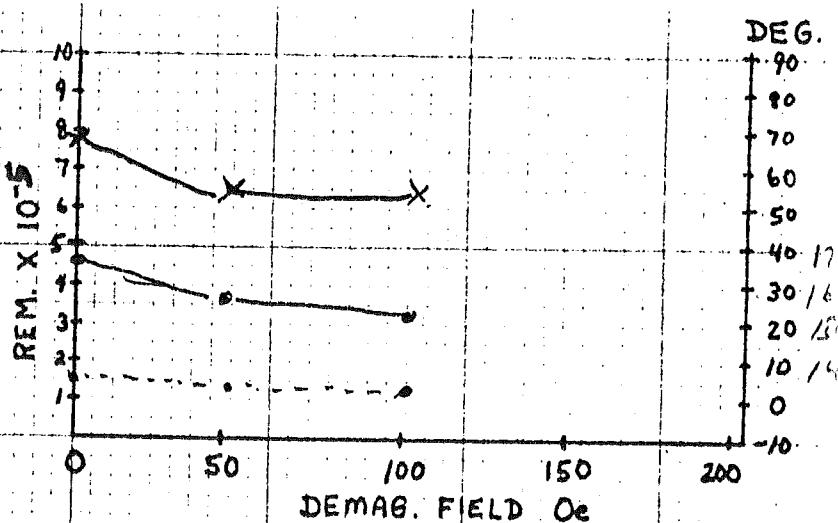
## COMMENTS

x-ray

## MAGNETICS

# 22 Z = 71.4 C.P.

A.F. DEMAG.	DEC.	INC.	$\Sigma$ MOM.
0	167.3	69.0	1.54
50	156.8	54.9	1.40
100	154.7	56.4	1.43
150			
200			
$\frac{X_{100} + X_{150}}{2}$			-
$\frac{X_{100} + X_{150} + X_{200}}{3}$	155	55	-



## COMMENTS

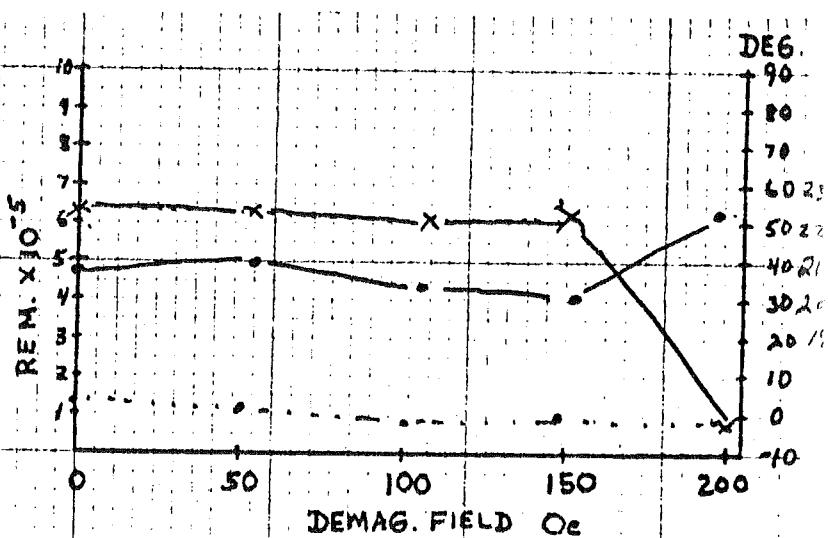
x-ray

## MAGNETICS

SAMPLE # PQ 1-23,24# 23Z = 74.7 C.P.

## MAGNETIC PARAMETERS

A.F. DEMA6	DEC.	INC.	$\Sigma$ MOM.
0	209.4	54.4	1.25
50	210.6	54.9	1.08
100	204.7	49.0	.98
150	201.8	52.6	1.05
200	224.	-1.7	1.06
$\frac{x_{10} + x_{150}}{2}$	.	-	-
$\frac{x_{100} + x_{150} + x_{200}}{3}$	210	51	-



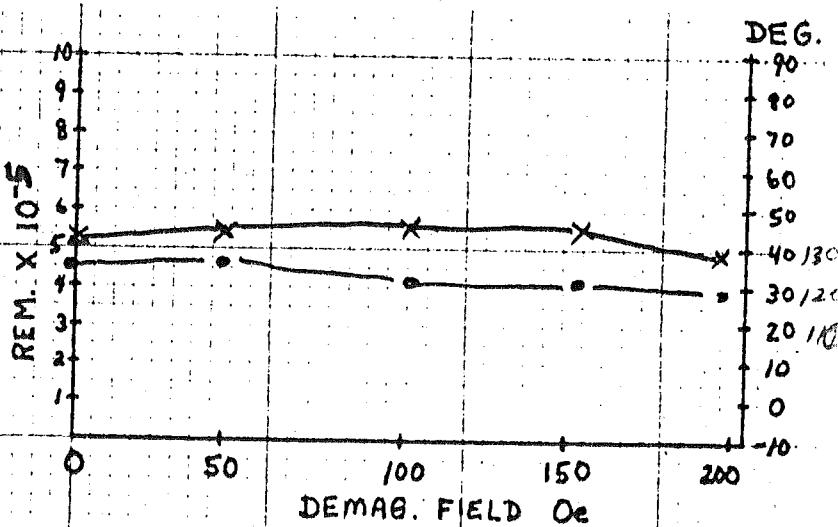
## COMMENTS

x-ray

## MAGNETICS

# 24 Z = 77.8 C.P.

A.F. DEMA6	DEC.	INC.	$\Sigma$ MOM.
0	126.6	41.2	3.46
50	127.3	44.4	3.09
100	121.3	45.0	2.64
150	122.1	45.1	2.50
200	118.5	39.9	2.16
$\frac{x_{100} + x_{150}}{2}$	.	-	-
$\frac{x_{100} + x_{150} + x_{200}}{3}$	124	44	-



## COMMENTS

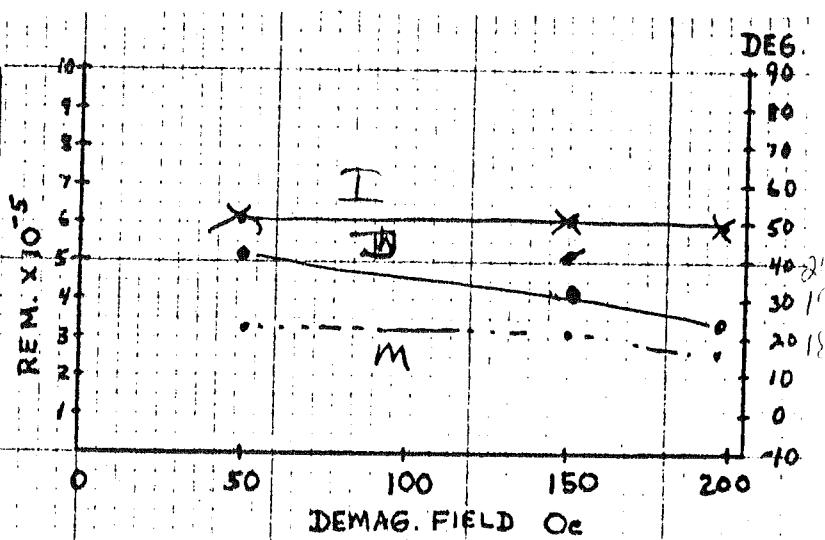
x-ray

## MAGNETICS

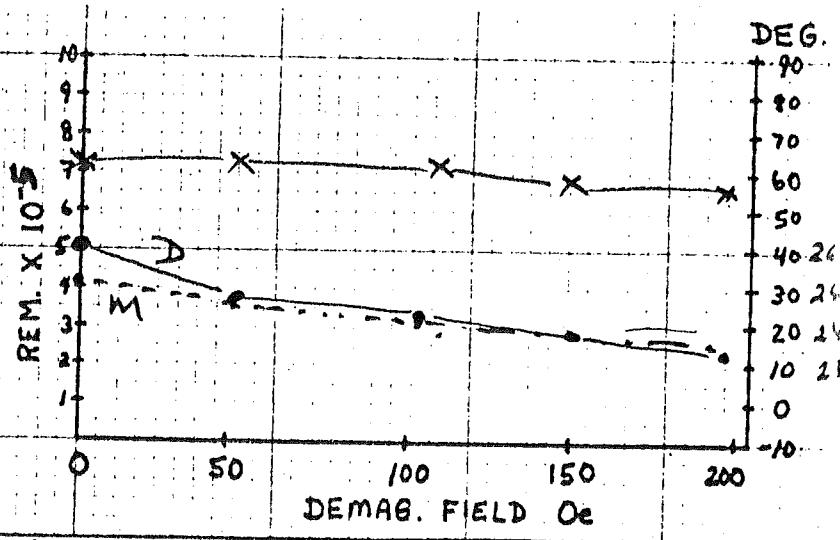
SAMPLE # PQ1-26, 26# 25  
Z = 82.4 C.P.

## MAGNETIC PARAMETERS

A.F. DEMAG.	DEC.	INC.	$\Sigma$ MOM.
0	<del>217.2</del>		3.53
50	204.2	51.4	3.21
100	191.0	51.9	2.83
150	↓	↓	↓
200	184.7	49.8	2.65
$\frac{x_{10} + x_{150}}{2}$			-
$\frac{x_{100} + x_{150} + x_{200}}{3}$	195	50	-

# 26 Z = 86.8 C.P.

A.F. DEMAG.	DEC.	INC.	$\Sigma$ MOM.
0	258.0	64.2	4.08
50	247.6	64.1	3.61
100	243.5	63.4	3.17
150	239.6	59.2	2.84
200	234.1	56.8	2.63
$\frac{x_{100} + x_{150}}{2}$			-
$\frac{x_{100} + x_{150} + x_{200}}{3}$	240	59	-

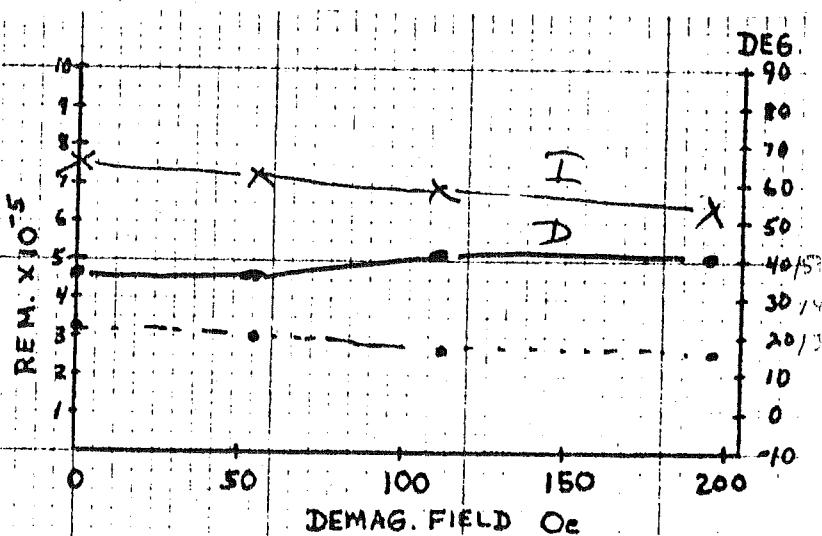
COMMENTS  
X-ray

MAGNETICS

SAMPLE # PQ1-27,28# 27Z = 89.9 C.P.

## MAGNETIC PARAMETERS

A.F. DEMAg.	DEC.	INC.	$\Sigma$ MOM.
0	148.5	65.7	3.34
50	147.5	61.6	2.91
100	152.3	58.4	2.73
150	-	-	-
200	150.1	53.6	2.66
$\frac{x_{100}+x_{150}}{2}$		-	
$\frac{x_{100}+x_{150}+x_{200}}{3}$	150	61	-



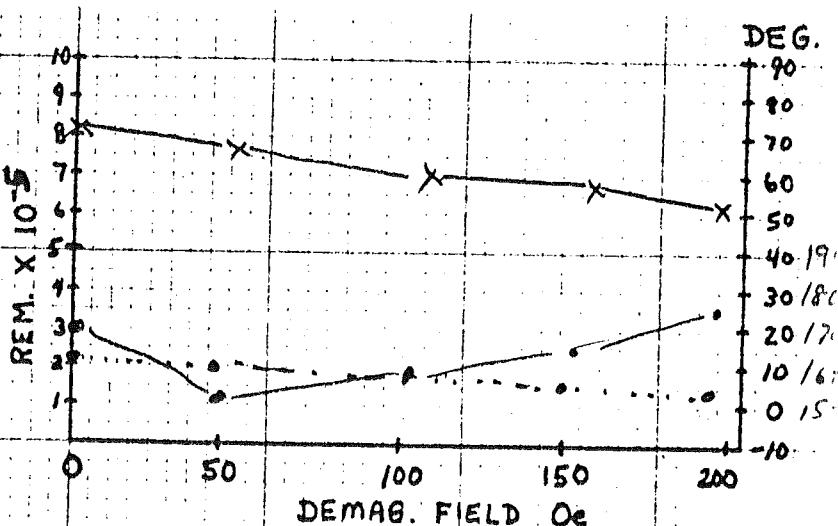
## COMMENTS

x-ray

## MAGNETICS

# 28 Z = 93.2 C.P.

A.F. DEMAg.	DEC.	INC.	$\Sigma$ MOM.
0	170.7	72.4	2.21
50	153.7	66.8	2.02
100	157.9	59.7	1.78
150	165.7	58.0	1.56
200	175.6	52.5	1.52
$\frac{x_{100}+x_{150}}{2}$		-	
$\frac{x_{100}+x_{150}+x_{200}}{3}$	165	64	-



## COMMENTS

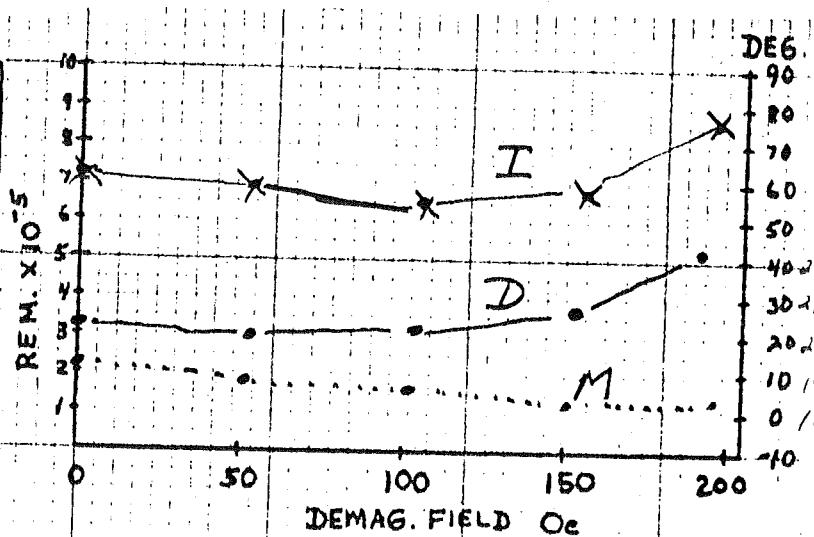
x-ray

## MAGNETICS

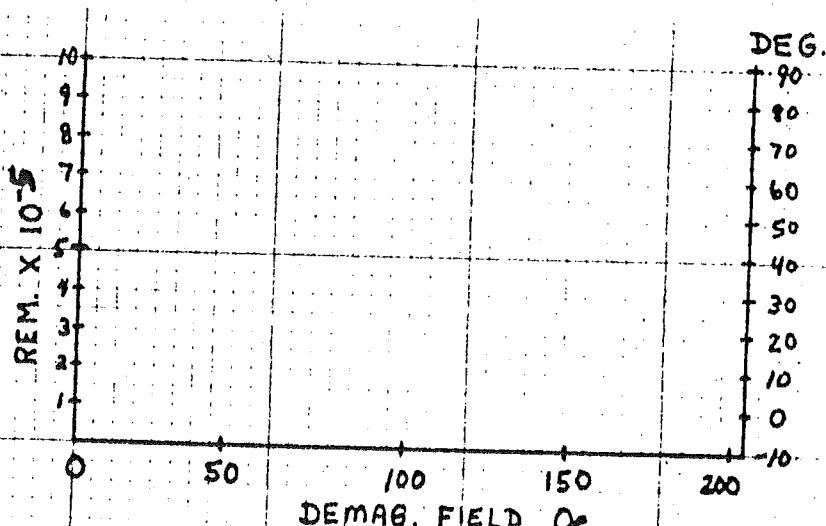
SAMPLE # PQ 1 - 29# 29  
Z = 96.5 C.P.

## MAGNETIC PARAMETERS

A.F. DEmag.	DEC.	INC.	$\Sigma$ MOM.
0	203.0	62.1	2.31
50	199.9	59.8	1.87
100	203.1	55.3	1.70
150	209.8	58.3	1.42
200	223.0	76.3	1.42
$\frac{x_{100} + x_{150}}{2}$			-
$\frac{x_{100} + x_{150} + x_{200}}{3}$	204	58	-

#            Z =            C.P. =           

A.F. DEmag.	DEC.	INC.	$\Sigma$ MOM.
0			
50			
100			
150			
200			
$\frac{x_{100} + x_{150}}{2}$			-
$\frac{x_{100} + x_{150} + x_{200}}{3}$			-

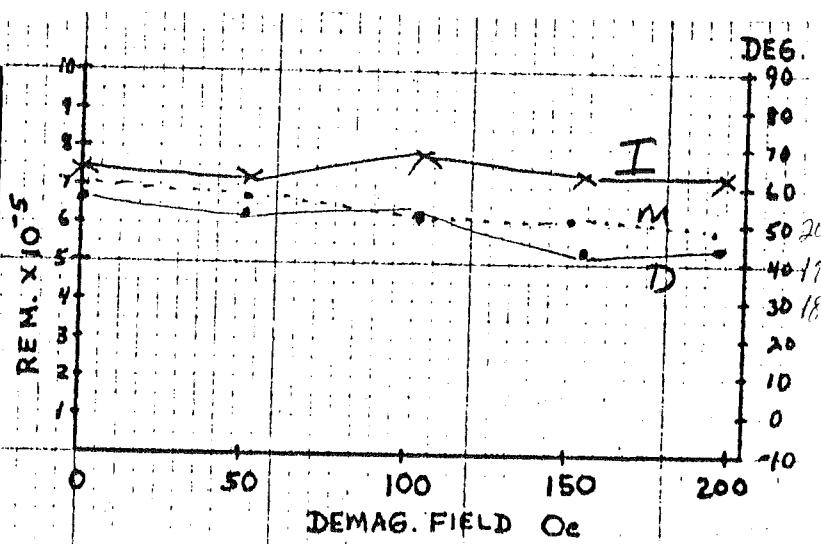


Comments
X-ray
MAGNETICS

SAMPLE # PQ 2-1,2# PQ 2-1Z = 1.8 cm C.P.

## MAGNETIC PARAMETERS

A.F. DEMAG.	DEC.	INC.	$\Sigma$ MOM.
0	207.7	64.8	$\times 10^4$ 7.1
50	198.1	63.4	6.8
100	197.2	68.7	6.4
150	193.8	63.2	6.2
200	194.1	61.9	5.8
$\frac{x_0 + x_{150}}{2}$			-
$\frac{x_{100} + x_{150} + x_{200}}{3}$	195	64	-



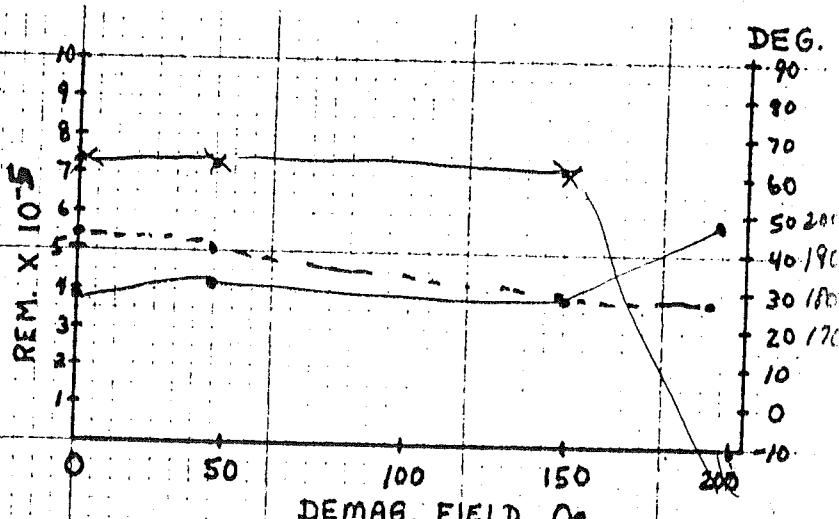
## COMMENTS

x-ray OK

## MAGNETICS

# 2-2 Z = 5.6 C.P.

A.F. DEMAG.	DEC.	INC.	$\Sigma$ MOM.
0	179.9	64.1	$\times 10^4$ 5.4
50	182.9	62.3	5.1
100			
150	174.1	62.8	4.2
200	199.9	-18.8	4.1
$\frac{x_{100} + x_{150}}{2}$			-
$\frac{x_{100} + x_{150} + x_{200}}{3}$	180	63	-



## COMMENTS

x-ray

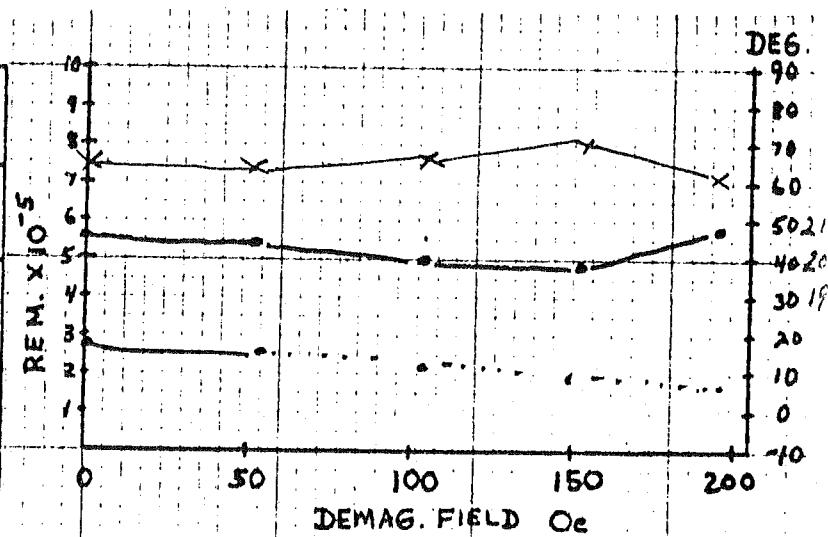
## MAGNETICS

SAMPLE # PQ 2-3, 4

# 2-3  
Z = 9.4 C.P.

MAGNETIC PARAMETERS

A.F. DEMAG.	DEC.	INC.	$\Sigma$ MOM.
0	206.5	65.4	2.9
50	204.0	64.0	2.6
100	200.0	66.4	2.3
150	197.2	70.0	1.9
200	209.7	62.2	1.8
$\frac{x_{10} + x_{150}}{2}$			-
$\frac{x_{100} + x_{150} + x_{200}}{3}$	204	65	-



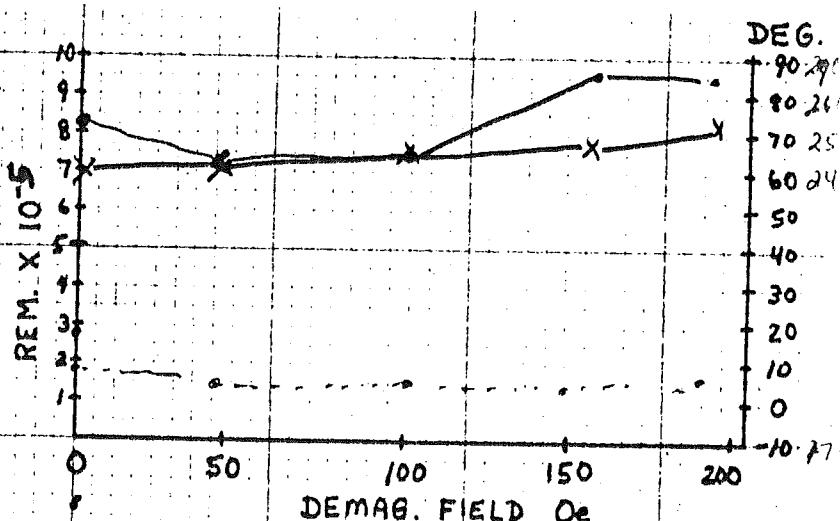
COMMENTS

X-ray

MAGNETICS

# 2-4 Z = 13.2 C.P.

A.F. DEMAG.	DEC.	INC.	$\Sigma$ MOM.
0	254.1	60.7	1.80
50	244.4	62.5	1.5
100	244.8	66.2	1.5
150	266.1	68.9	1.3
200	265.1	74.0	1.5
$\frac{x_{100} + x_{150}}{2}$			-
$\frac{x_{100} + x_{150} + x_{200}}{3}$	255	65	-



COMMENTS

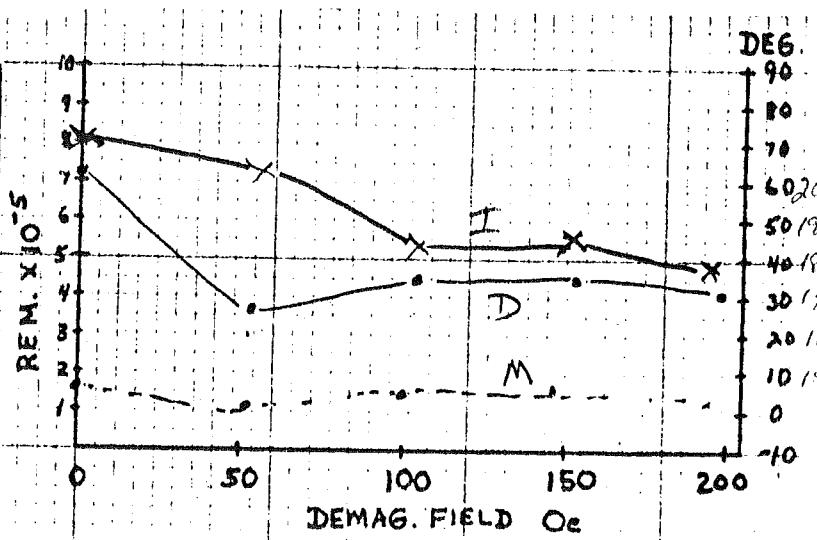
X-ray

MAGNETICS

SAMPLE # Pp 2-5,6# 2-5Z = 16.8 C.P. =

## MAGNETIC PARAMETERS

A.F. DEMAG.	DEC.	INC.	$\Sigma$ MOM. $X_{100} + X_{150}$
0	203.1	70.5	1.8
50	166.8	64.6	1.4
100	175.0	43.1	1.6
150	174.0	45.2	1.6
200	171.2	39.2	1.3
$\frac{X_{100} + X_{150}}{2}$			-
$\frac{X_{100} + X_{150} + X_{200}}{3}$	173	44	-



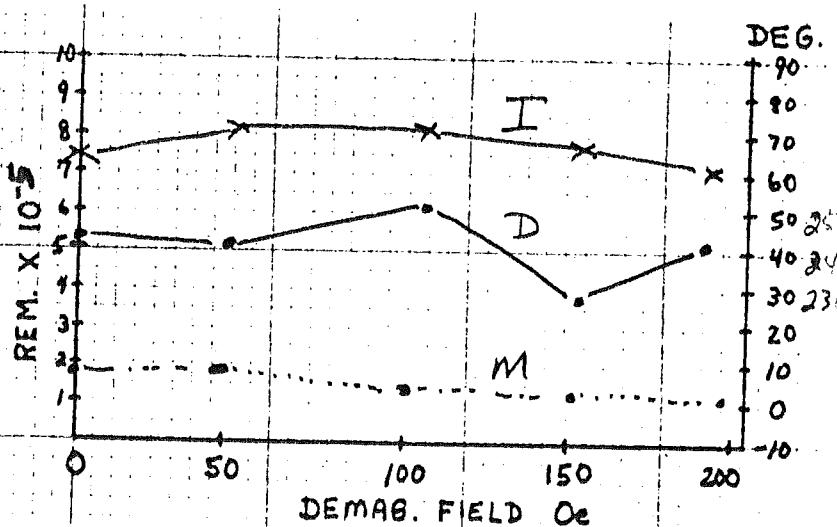
## COMMENTS

x-ray

## MAGNETICS

# 2-6 Z = 20.4 C.P. =

A.F. DEMAG.	DEC.	INC.	$\Sigma$ MOM. $X_{100} + X_{150}$
0	243.9	64.7	1.8
50	242.3	72.0	1.8
100	252.1	71.7	1.5
150	228.4	68.5	1.3
200	241.8	62.7	1.3
$\frac{X_{100} + X_{150}}{2}$			-
$\frac{X_{100} + X_{150} + X_{200}}{3}$	240	68	-



## COMMENTS

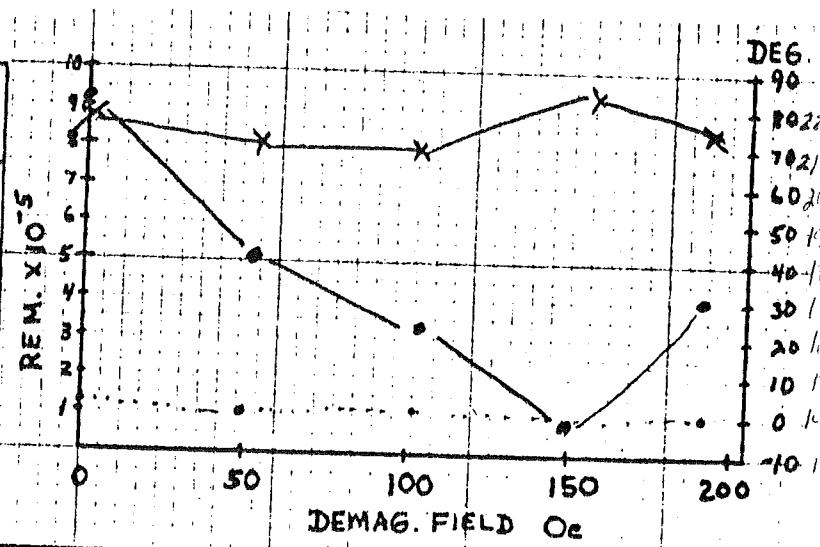
x-ray

## MAGNETICS

SAMPLE # PQ 2-7,8# 2-7  
Z = 24.3 C.P.

## MAGNETIC PARAMETERS

A.F. DEMAG.	DEC.	INC.	$\Sigma$ MOM.
0	226.0	78.4	1.4
50	181.0	71.5	1.1
100	165.9	70.5	1.1
150	133.8	85.2	.9
200	171.6	74.3	1.0
$\frac{x_{100} + x_{150}}{2}$		-	
$\frac{x_{100} + x_{150} + x_{200}}{3}$	155(1)	76	-



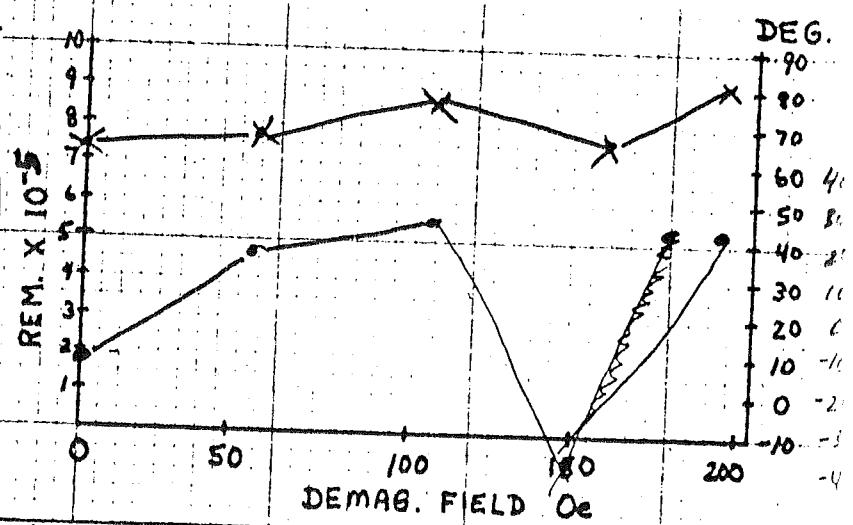
## COMMENTS

X-ray

## MAGNETICS

# 2-8 Z = 28.2 C.P.

A.F. DEMAG.	DEC.	INC.	$\Sigma$ MOM.
0	-11.7	63.9	.84
50	17.5	67.7	.7
100	25.6	75.9	.7
150	-37.4	67.6	.74
200	23.1	81.1	.74
$\frac{x_{100} + x_{150}}{2}$		-	
$\frac{x_{100} + x_{150} + x_{200}}{3}$	22	74	-



## COMMENTS

X-ray

## MAGNETICS

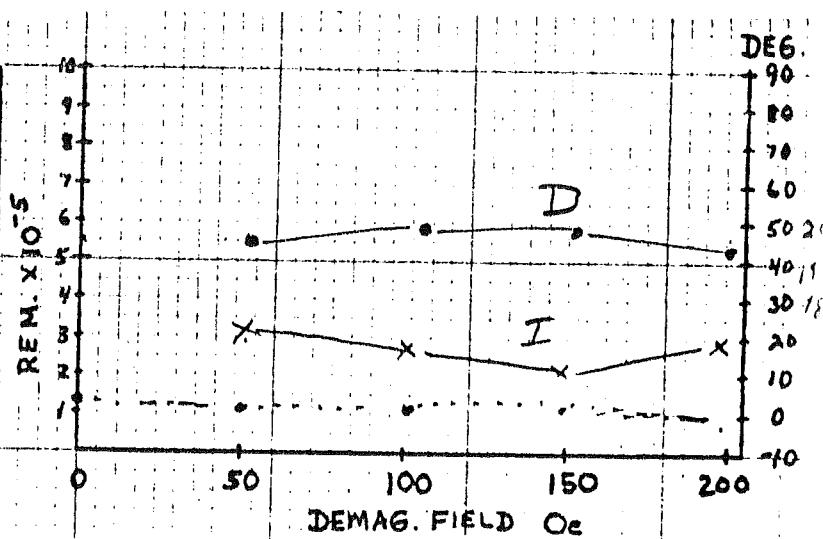
SAMPLE # PQ 2-9, 10

# 2-9

Z = 31.9 C.P.

## MAGNETIC PARAMETERS

A.F. DEmag.	DEC.	INC.	$\Sigma$ MOM.
0	2 -	-	1.2
50	195.4	20.7	1.2
100	198.8	16.9	1.1
150	197.9	12.2	1.2
200	194.1	18.5	D.8
$\frac{X_{100} + X_{150}}{2}$			-
$\frac{X_{100} + X_{150} + X_{200}}{3}$	195	16	-



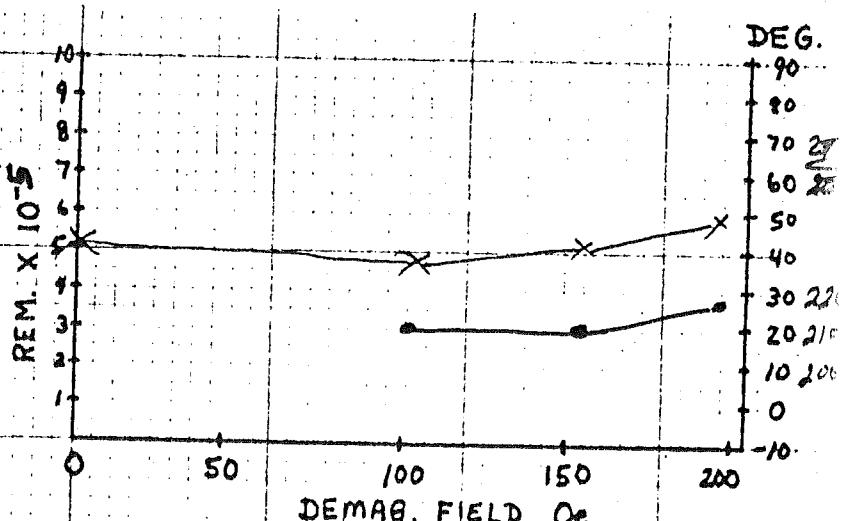
## COMMENTS

x-ray

## MAGNETICS

# 2-10 Z = 35.4 C.P.

A.F. DEmag.	DEC.	INC.	$\Sigma$ MOM.
0	-80.9	41.0	1.4
50	-	-	-
100	211.6	37.4	1.2
150	210.1	42.1	1.1
200	218.3	29.3	1.1
$\frac{X_{100} + X_{150}}{2}$			-
$\frac{X_{100} + X_{150} + X_{200}}{3}$	214	41	-



## COMMENTS

x-ray

## MAGNETICS

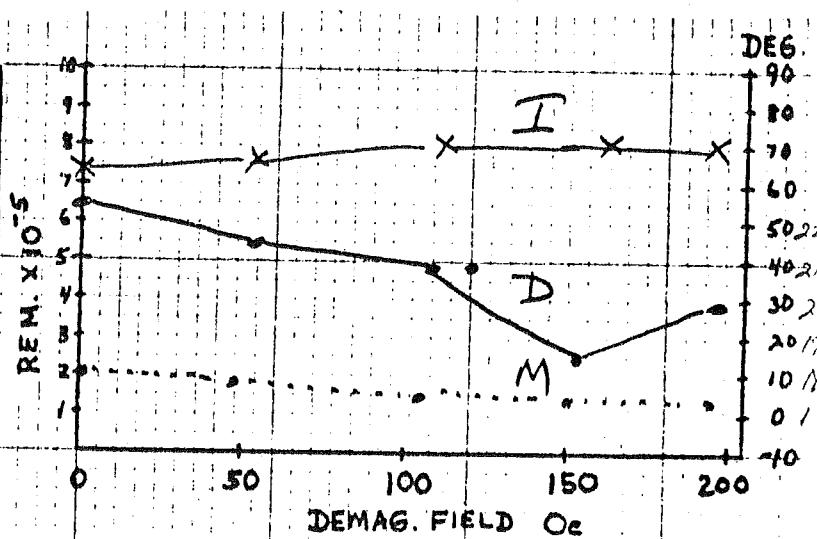
SAMPLE # Pp 2-11, 12

# 2-11

Z = 39.6 C.P.

MAGNETIC PARAMETERS

A.F. DEMAG.	DEC.	INC.	$\Sigma$ MOM.
0	225.1	64.3	2.0
50	214.9	67.5	1.8
100	209.8	71.2	1.5
150	184.8 <del>184.1</del>	71.1	1.3
200	198.4	70.9	1.3
$\frac{X_{100} + X_{150}}{2}$		-	
$\frac{X_{100} + X_{150} + X_{200}}{3}$	198	70	-



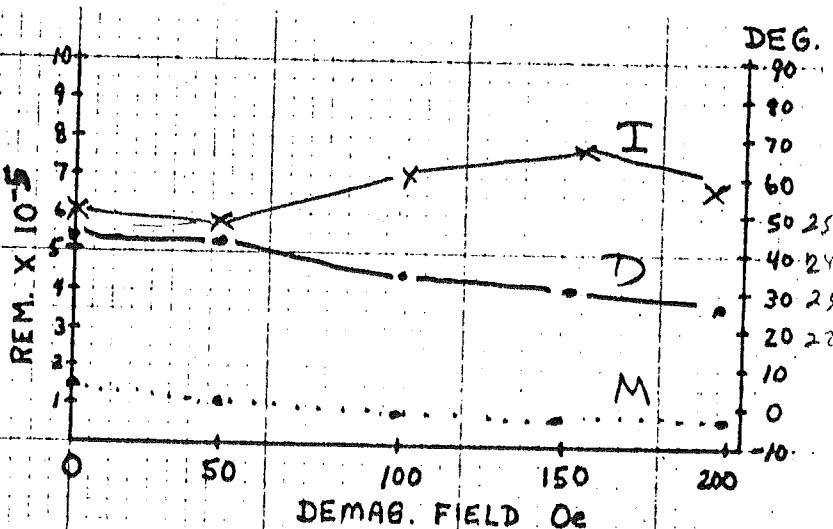
COMMENTS

x-ray

MAGNETICS

# 2-12 Z = 43.4 C.P.

A.F. DEMAG.	DEC.	INC.	$\Sigma$ MOM.
0	244.1	50.3	1.5
50	244.5	57.7	1.0
100	235.0	60.3	0.9
150	231.3	67.5	0.7
200	226.4	57.2	0.8
$\frac{X_{100} + X_{150}}{2}$		-	
$\frac{X_{100} + X_{150} + X_{200}}{3}$	234	64	-



COMMENTS

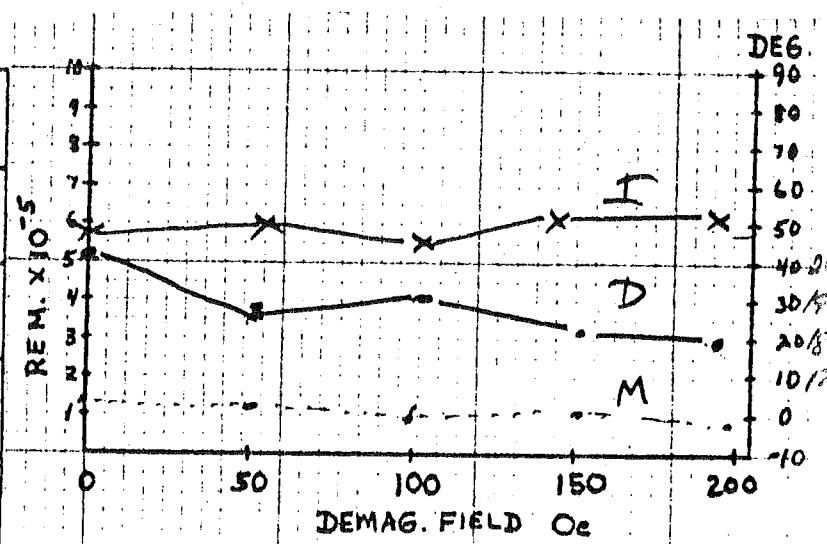
x-ray

MAGNETICS

SAMPLE # P02-13, 14# 2-13Z = 47.1 C.P. =

## MAGNETIC PARAMETERS

A.F. DEMAg.	DEC.	INC.	$\Sigma$ MOM.
0	201.6	49.5	1.31
50	189.8	49.9	1.2
100	190.9	46.7	1.0
150	183.9	53.2	1.1
200	179.8	53.4	0.8
$\frac{x_0 + x_{150}}{2}$			-
$\frac{x_{100} + x_{150} + x_{200}}{3}$	184	49	-



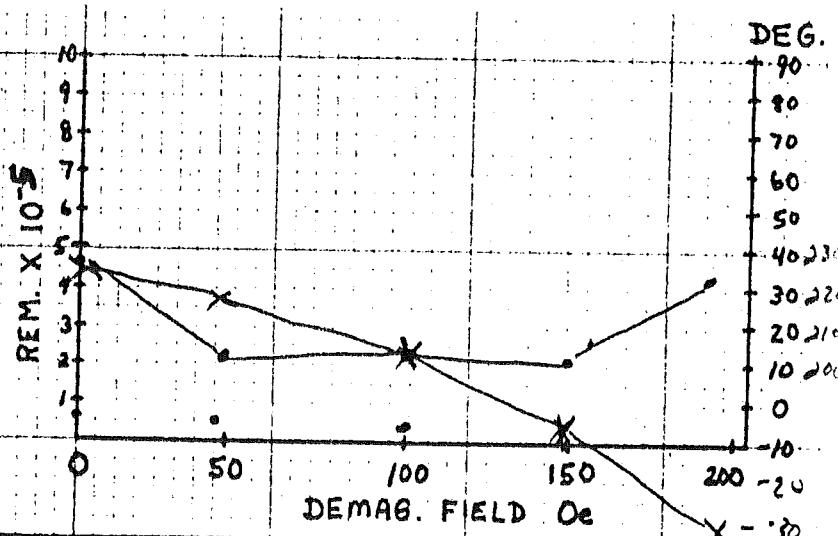
## COMMENTS

x-ray

## MAGNETICS

# 2-14 Z = 50.7 C.P. =

A.F. DEMAg.	DEC.	INC.	$\Sigma$ MOM.
0	228.2	35.1	.6
50	202.2	27.8	.55
100	204.4	10.6	.4
150	203.6	-8.4	.43
200	224.4	-30.7	.57
$\frac{x_{100} + x_{150}}{2}$			-
$\frac{x_{100} + x_{150} + x_{200}}{3}$	205		-



## COMMENTS

x-ray

## MAGNETICS

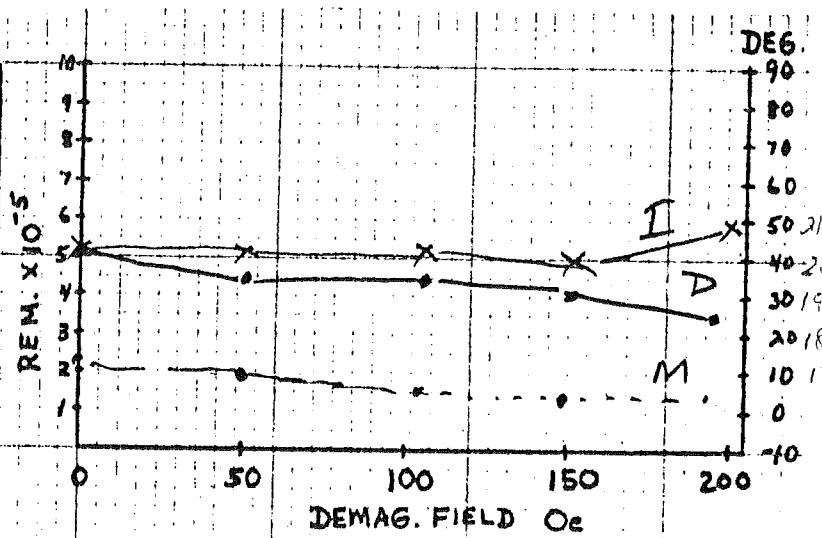
SAMPLE # PQ 15/6

# 2-15

Z = 54.5 C.P.

MAGNETIC PARAMETERS

A.F. DEMA6	DEC.	INC.	$\Sigma$ MOM.
0	203.2	43.2	2.4
50	195.0	42.5	2.0
100	195.9	41.6	1.8
150	192.0	40.1	1.7
200	185.4	49.9	1.6
$\frac{x_{10} + x_{150}}{2}$		-	
$\frac{x_{100} + x_{150} + x_{200}}{3}$	188	42	-



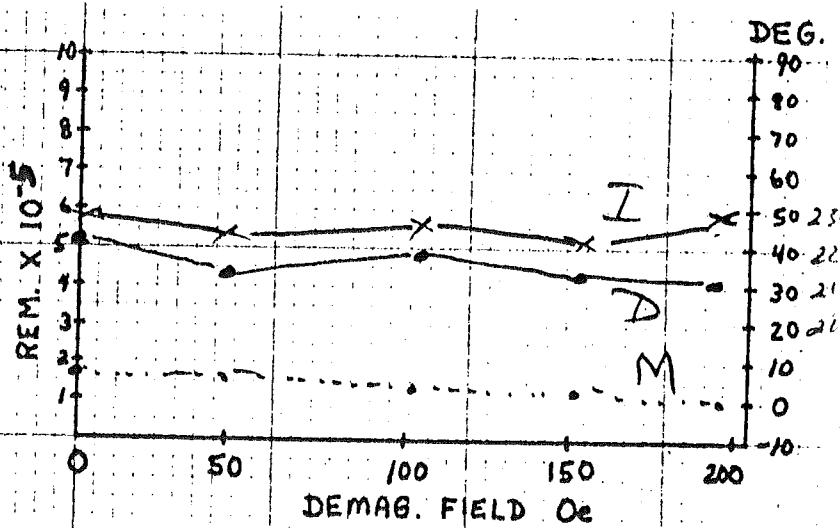
COMMENTS

x-ray

MAGNETICS

# 2-16 Z = 58.1 C.P.

A.F. DEMA6	DEC.	INC.	$\Sigma$ mom.
0	222.4	49.6	1.7
50	244.5	44.0	1.6
100	218.9	46.9	1.4
150	214.4	42.0	1.4
200	210.7	49.3	1.2
$\frac{x_{100} + x_{150}}{2}$		-	
$\frac{x_{100} + x_{150} + x_{200}}{3}$	214	46	-



COMMENTS

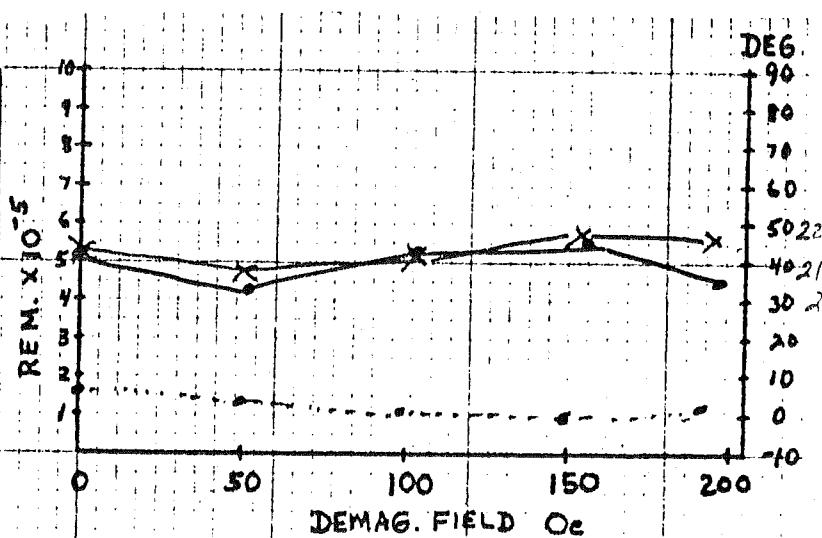
x-ray

MAGNETICS

SAMPLE # Po 2-17# 2-17Z = 61.8 C.P.

## MAGNETIC PARAMETERS

A.F. DEMAG.	DEC.	INC.	$\Sigma$ MOM.
0	212.6	41.1	1.67
50	205.3	38.4	1.37
100	213.2	43.6	1.11
150	215.7	47.4	0.99
200	205.8	47.0	0.11
$\frac{x_{10} + x_{150}}{2}$			-
$\frac{x_{100} + x_{150} + x_{200}}{3}$	209	.46	-



## COMMENTS

x-ray

## MAGNETICS

A.F. DEMAG.	DEC.	INC.	$\Sigma$ MOM.	
0				
50				
100				
150				
200				
$\frac{x_{100} + x_{150}}{2}$			-	
$\frac{x_{100} + x_{150} + x_{200}}{3}$			-	

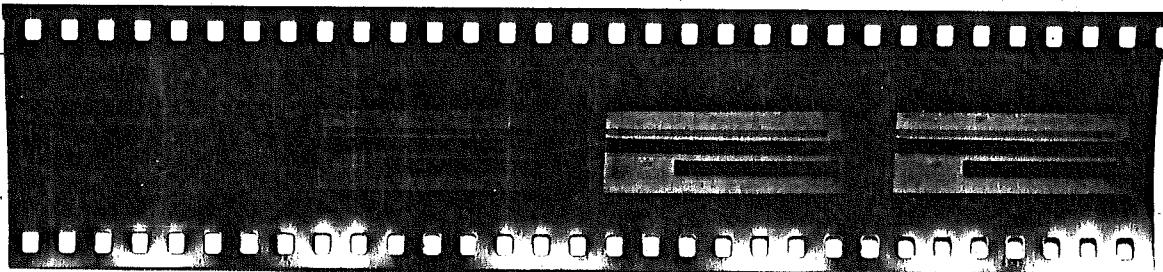
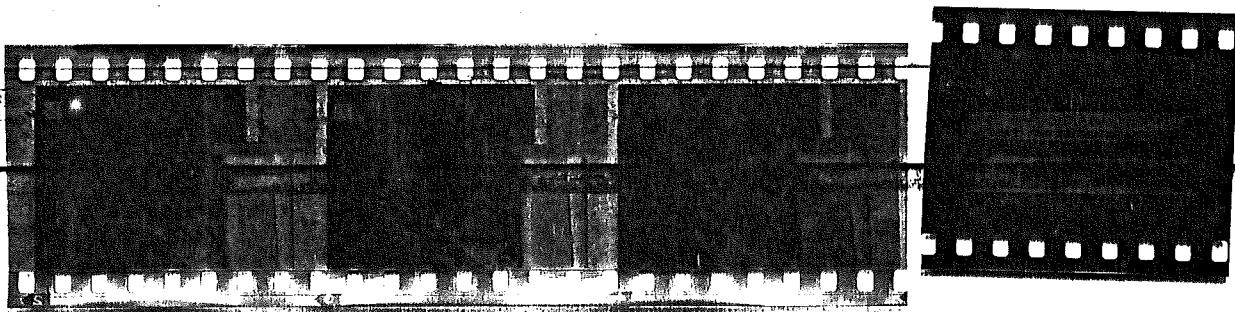
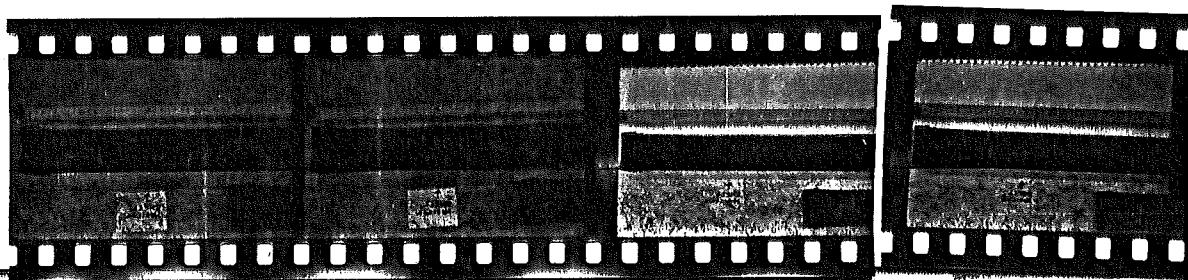
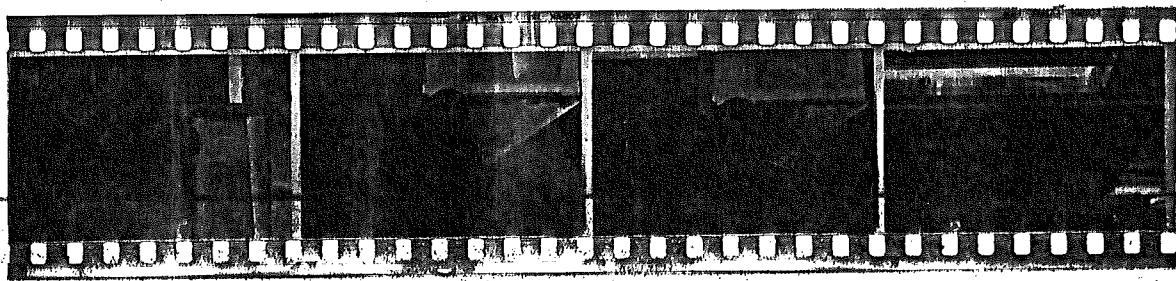
A graph showing Remanence ( $x_{10} \times 10^{-5}$ ) on the y-axis (0 to 10) versus Demagnetizing Field (Oe) on the x-axis (0 to 200). The curve shows a slight decrease from approximately 5.2 at 0 Oe to about 4.5 at 50 Oe, followed by a gradual increase to about 5.0 at 200 Oe. A dashed horizontal line is drawn at  $x_{10} \approx 1.1$ .

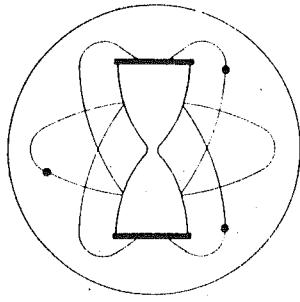
Demag. Field (Oe)	Remanence ( $x_{10} \times 10^{-5}$ )
0	5.2
50	4.5
100	4.8
150	5.0
200	5.0

COMMENTS

x-ray

MAGNETICS





# KRUEGER ENTERPRISES, INC.

## GEOCHRON LABORATORIES DIVISION

24 BLACKSTONE STREET • CAMBRIDGE, MA. 02139 • (617) - 876 - 3691

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### RADIOCARBON AGE DETERMINATION

### REPORT OF ANALYTICAL WORK

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Our Sample No. GX-4539

Date Received: 21 September 1976

Your Reference: Sample PQ 1

Date Reported: 29 September 1976

Submitted by: K. R. Robertson  
Atlantic Geoscience Center  
Bedford Institute of Oceanography  
Box 1006  
Dartmouth, Nova Scotia  
CANADA

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Sample Name: Shell sample (Mya fragments), sample PQ-1.

AGE = 2230 ± 165 C-14 years B.P.

79 CM INT/

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Description: Small sample of shell fragments.

Pretreatment: The shell fragments were cleaned and washed with HCl in an ultrasonic cleaner to remove surficial carbonate. They were then hydrolyzed with dilute HCl, under vacuum, to recover carbon dioxide for analysis.

Comment:

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Notes: This date is based upon the Libby half life (5570 years) for C<sup>14</sup>. The error stated is ±1 σ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid.

The age is referenced to the year A.D. 1950.



# TRANSMITTAL NOTE AND RECEIPT NOTE D'ENVOI ET REÇU

GOVERNMENT OF CANADA — GOUVERNEMENT DU CANADA

TO →  
À

Mr. Dan Plaice,  
Dept. of Geology,  
Life Sciences Building,  
Dalhousie University,  
Halifax, N.S.

SECURITY CLASSIFICATION  
CLASSIFICATION DE SÉCURITÉ  
WITH ENCLOSURE(S) — AVEC ANNEXE(S)

WITHOUT ENCLOSURE(S) — SANS ANNEXE(S)

FILE OR SERIAL NO. — N° DE DOSSIER OU DE SÉRIE

QUANTITY QUANTITÉ	REFERENCE/COPY NO. N° DE RÉFÉRENCE	DESCRIPTION
1	PQ-1	CORES: released for X-ray and paleomagnetic analyses by contract
1	PQ-2	ORIGINATING SCIENTIST: Dr. C.T. Schafer

CORES PICKED UP 30 AUGUST 1976

SENT BY — TRANSMIS PAR

Signature

RECEIVED BY — REÇU PAR

Signature

Date

Sept  
1976

Mr. A.G. Sherin,  
Atlantic Geoscience Center,  
P.O. Box 1006,  
Dartmouth, N.S.

PLEASE SIGN AND  
RETURN TO ORIGINATOR  
PRIÈRE DE SIGNER ET DE RETOURNER  
AU SIGNATAIRE

RECEIPT NOT REQUIRED  
REÇU NON REQUIS

ORIGINATOR'S ADDRESS — ADRESSE DU SIGNATAIRE

CGSB STANDARD FORM 44

7540-21-860-7610

FORMULE NORMALISÉE 44 DE L'ONGC