

ABERFOYLE EXPLORATION

(Internal Report)

INTERPRETATION OF DOWNHOLE ELECTROMAGNETIC DATA
FROM THE HELLYER DEPOSIT - REPORT 2

DISTRIBUTION


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I INTRODUCTION

Nine holes have now been surveyed in the vicinity of the Hellyer ore deposit. Six of these were discussed in detail in an earlier report (Eadie, 1984). In the present report, the data from the last three drill holes will be interpreted. In addition, test work with different systems, including Sirotem, Crone Pulse EM, EM37 and the Newmont EMP will be reviewed.

The purpose of all of this work has been twofold. The first reason was to attempt to help to define the limits and geometry of the ore body, in order to save drilling meterage and to insure that no substantial ore blocks were missed. The second reason was to learn more about the conductivity properties of this type of ore body and to research into downhole electromagnetics in general, to help with further exploration, particularly in Tasmania, but also elsewhere in Australia.

II SUMMARY

As an aid to the drill geologist, the DHEM campaign was only a limited success. The reasons for this are as follows:

1. Because of the rapid pace of the drill programme, it was logistically impossible to always complete the DHEM field work and interpretation quickly enough in the few cases where it might have helped;
2. In general, the shape of the ore body needed to be known in greater detail than could have been interpreted from the DHEM - it is hard to beat a 50 x 50 metre drill pattern;
3. In most cases, the shape of the ore body on untested sections could be predicted by an astute interpretation of earlier geological data and so DHEM was not necessary.

However, there were a few minor successes, most of which have been mentioned in the earlier report, and a few interpretational observations that might help in the future drilling.

One of these is that the untested inferred resource to the north of the known ore deposit has a greater conductance than anywhere else in the ore body suggesting that it is either bigger or has different mineralogy than the rest of the deposit. A second point is that the DHEM interpretation suggests that the ore body from 11050-11000N may be slightly thicker and more flat lying near the top (RL350) and thinner near the bottom (RL200-250) than presently interpreted. It may also be positioned about 50 metres east, particularly at its northern limit, which may suggest that there is an undiscovered fault sliver in this area.

7
or is magnified by
effects of fault &
also fault conductance

The experimental and educational parts of the DHEM programme were an unqualified success. Because of the knowledge gained from this work, downhole EM has become a major exploration tool for Aberfoyle, particularly on the Mackintosh-Hatfield licences, enabling Aberfoyle to have a very potent and cost-effective exploration programme.

III GEOMETRICAL INTERPRETATION

The interpretation of drillholes HL45, 62 and 79 will be discussed in this section. A plan with the location of the drillholes and transmitter loops is shown in Figure 1. The EM data and relevant geological cross sections are also included with the report.

1. HL45 and 62

These two drillholes must be interpreted together to be able to understand the three dimensionality of the situation. Both holes were surveyed with Sirotem with the same five transmitter loops. In addition, HL45 was surveyed from another loop that was mentioned in the 1984 report, and HL62 was also surveyed from a sixth, more

westernly loop with the EM37 system. The location of these and other relevant holes in plan are shown in Figure 1 and in section in Figure 2. There was an attempt to case HL69 with PVC to enable logging with DHEM but the attempt failed. However, geological evidence from this hole is very important to the interpretation.

A summary of the important features of each traverse down the two drillholes is shown in Table 1, and all of the data sections are included as Figures 4-14. A quick examination shows that the conductor is much closer to HL45 than HL62, based on the amplitudes and the distance between crossover and trough maximum.

Figure 3 which shows the primary field directions for Loops 1,2,3, and 6 (Macnae, 1980) is necessary for a more detailed analysis. The location and geometry of the conductor shown in this diagram explains most of the features seen in the data, although it will be proven later that this conductor does not exist on section, but is actually to the south.

The lateral position has been chosen to have the bulk of the body closest to HL45, because of the amplitude and shape considerations mentioned above. The vertical position has been interpreted from the location of the various crossovers and peaks within the data sets. The interpreted flat dip at the top of the conductor is necessary to explain the fact that almost all of the anomalies in HL62 have a positive polarity. The exception is the data from Loop 6, which is null coupled with the top of the conductor, enabling a fairly accurate estimation of the dip.

The steep eastern dip near the bottom of the conductor is necessary to explain the polarity of the data near the bottom of HL45. Loop 1 shows a very high positive at the end of the hole, suggesting it is energized from above, while loop 3 shows a negative in the same location, suggesting that it is being energized from the other side. This indicates that the conductor near the bottom of HL45 must have a steep dip.

Although the shape of the body has been well constrained by the above arguments, there are several factors that prove that the conductor does not actually occur on this section, but is in fact offset to the south. The most obvious of these factors is the fact that a hole, HL69, has been drilled right through the interpreted body (prior to the EM work) without hitting any massive sulphides. However there are geophysical factors that would force the same interpretation. The strongest of these is the interpreted distance from HL45 and 62 to the conductor. From Figure 3, these distances would appear to be quite small, about 35 and 45 metres respectively. However, an interpretation based on the shape of the profiles from HL45 and 62, show that the distances are really about 70 and 100 metres respectively. Therefore the conductor must not exist on section, but be offset to the north or south.

A second geophysical observation that supports this conclusion, and in fact shows that the conductor is definitely off to the south, is the comparison of data from loop 4 (to the north) and loop 5 (to the south). The loop 5 anomaly for both HL45 and 62, is clearly much stronger.

In conclusion, the DHEM work in HL45 and 62 has outlined the shape and position of the Hellyer ore body at its extreme north end. A detailed interpretational section will be shown after the HL79 results are discussed.

There are a few other less important observations that should be made here to explain some of the other features in the data. The most obvious is a spike in most of the data at a depth of 450 metres. This is caused by a drill wedge.

Another feature seen particularly well in the EM37 data (Figure 14:HL62-loop 6) is a short time constant anomaly from 100 metres to 200 metres. This is caused by the black shale in the hole.

TABLE 1

SUMMARY OF IMPORTANT DHEM FEATURES - HL45 + 62

TRAVERSE - figure #	AMPLITUDE OF FIRST + (ch5) (volt/amp)	+ → - CROSSOVER PT. (metres)	-trough peak location (metres)	-trough peak amplitude (chs) (volt/amp)	Other features
HL45-LP1 Figure 4	+8	330	410	-8	End of hole high +
HL45-LP2 5	+14	350	420	-35	End of hole low +
HL45-LP3 6	+6	355	420	-12	End of hole high -
HL45-LP4 7	+10	355	425	-11	End of hole low +
HL45-LP5 8	negative	340 (scattered)	410	-30	End of hole moderate +; lots of shallow negatives to ch 6.
HL62-LP1 9	+0.2	280	410	-1.2	
HL62-LP2 10	+1.0	280	395	-5	
HL62-LP3 11	+4	310	400	+1	ch 5 stays +; absolute - is -1.0
HL62-LP4 12	noisy -5	300	400	-1	Profile goes - at beginning
HL62-LP5 13	+8	290	390	-4	
HL62-LP6 14	-	-	-	-	Null response

A third mildly interesting feature is the large negative anomaly that occurs quite shallow (200-300m) for loop 5-HL45. Loop 5 is positioned right over the main section of the Hellyer ore body, which is centred at about 10900N at a depth of about 250 metres. It is interpreted that the secondary field from this part of the deposit has caused the negatives shallow in this hole.

Linear scale format of the Sirotem data is also available as Plates XHELL 10B - 19B (not included with report).

2. HL79

HL79 was surveyed from 3 transmitter loop positions (1,2, and 6), shown in Figure 1. The EM37 system was used for this work. The results are shown in Figures 15-17. In addition, the results for the late time channels from loop 2 are shown in Figure 18 alongside the geological interpretation.

The primary field directions, with the geologically interpreted ore position, are shown in Figure 19. The geophysical data supports the interpreted geology in almost all respects. In particular, the data from loop 2 (Figures 16 and 18), confirms the following features:

- 1) from the position of the maximum of the negative trough that the thickest part of the lower part of the ore body is near to where it is interpreted.
- 2) from the position of the positive to negative crossover, that the centre of the body is near to where it is interpreted.
- 3) by the higher values of the positive peak uphole from the negative trough, rather than downhole from it, that the deeper portions of the body dips steeply to the east.
- 4) from the lack of response deep in the hole that the body terminates at about RL200.

The only disagreement from the interpretation of the data from loop 2 is that the geological interpretation located the body closer to the drill hole (40 metres) than is suggested by the geophysics (about 70 metres). Much of this disagreement can be explained by the fact that HL79 is 20 metres north of section at this point and HL40, upon which the geology is based, is about 20 metres south of section.

The data from loops 1 and 6 are more difficult to reconcile with the interpreted geology. The problem is illustrated by Figure 19, which suggest that with the body as now interpreted, we would have expected a null-coupled response (no anomaly) from loop 1, and a positive anomaly from loop 6. Instead we actually measured a negative from loop 1 and no response from loop 6. This indicates that the top part of the body must be more flat-lying than interpreted, probably about 20-30 degrees to the east.

3. Summary of the Geometrical Interpretation

On section 11050N, the EM and the geological interpretations agree except for some minor differences mentioned above. On 11150N, the ore body does not exist, at least in the vicinity of the drill holes. This may be explained by faulting, a termination of the ore because of depositional reasons, or a sudden drastic plunge of the ore body. In order to summarize the geophysical interpretation, a section of the ore body on 11100N is attempted in Figure 20. This combines all of the observations from HL45, 62 and 79, and at this stage ignores geological considerations.

There is only one major discrepancy between the geological and geophysical interpretations, and this is that the geophysics would locate the body further to the east, putting it far away from the position of the Jack Fault and apparently on the wrong side of the photo lineament fault. If this problem can not be explained by cross-faulting, or a bend in the faults, then a drastic change in geophysical interpretation is necessary. This is because it is

impossible to move the interpreted body any further away from HL45 or closer to HL62, without changing one assumption that has been strictly adhered to. This assumption is that the same body is being seen from all three holes. It follows that if Figure 20 is impossible based on geological arguments, then this assumption must be wrong. The alternate interpretation would be that the main Hellyer ore body is terminated by the convergence of the Jack and photo faults at about 11100N (this body is seen by HL62 and 79) and that there is another fault sliver of ore that continues to the north, coming very close to the west of HL45, and still terminating before section 11150N. One problem with this interpretation is that the response in HL45 appears to be from a very large body and not just a fault sliver with a strike length of about 100 metres. However this large response would be explained if the two bodies remained connected at some location along the fault. This will be discussed further in the next section.

IV DECAY CURVES AND CONDUCTANCE CONSIDERATIONS

An analysis of the decay curves at the location of the maximum anomalous value is very instructive for conductance (conductivity x size) calculations. These curves are plotted in Figures 21-23 for HL45, 62, and 79 respectively. As had been suggested by the original, single loop of HL45 data in the 1984 report, there is a marked increase in conductance in this northern, untested part of the ore body, compared to even the thickest, best part of the ore body on 10800N-10900N. This is illustrated by the fact that the time constant of the curves for HL45, 62, and 79 average 3.73 milliseconds while those for HL19, 21 and 31 average 3.03 milliseconds. This means that there is a 25% increase in conductivity in the northern part of the deposit, a 25% increase in cross sectional area or a combination of the two.

Any one of these possibilities is interesting; increased conductivity could relate to different mineralogy and metallurgy, and of course a bigger cross sectional area means more tonnage.

A close analysis of the decay curves for HL45 is particularly important. The current geological interpretation is that there is no significant ore in the vicinity of HL45. However, not only does the high time constant of the decay curve prove that there is a large body in the vicinity, but the high amplitude of the response, which is just as high as for HL31, loop 2, proves that this large ore block is relatively close, certainly within 70 metres. This is further evidence for the argument that if the interpretation shown in Figure 20 can not possibly be correct on geological grounds, then the assumption that only one body is being seen from HL45, 62 and 79 is definitely wrong. The alternate solution would then have to be that there is a northern faulted slice of ore that is being detected by HL45. The large time constant shows that the slice of ore must either be very large (not likely due to drill information) or else it is still partially connected through the fault to the known section of the Hellyer ore body.

V COMPARISON OF THE VARIOUS DHEM SYSTEMS

1. Introduction

As a research project, several different types of DHEM units were tested at the Hellyer deposit. The first was the Newmont system which was discussed in the 1984 report. For this study, the Geonics EM37, Crone Pulse EM and Sirotem were all compared by testing them from exactly the same loop positions in HL3, HL19 and HL62. A test of the UTEM downhole system was also planned but could not be completed due to equipment failure. This equipment has still not been operational in Australia.

The results of this experiment show clearly that when run by an experienced, conscientious operator, Sirotem is just as good, and in some instances better than any of the other systems tested, even for identifying weak conductors, now that the early time (ET) Sirotem has been introduced. The Sirotem and Newmont EMP proved to be more effective than the other systems when late time information

was helpful for totally defining the decay curve of the target body.

Another important observation is that most contractors must be watched very carefully, and checks must be done to ensure that they get the right polarity when measuring the response. A mistake at this point can destroy any interpretation.

A plan of the loop positions and drillholes used for this experiment is shown in Figure 24.

2. HL3

The geological cross section interpreted by Gary McArthur is shown in Figure 25, the Sirotem data in Figures 26 (standard times) and 27 (early times), the EM37 data in Figure 28 and the Crone PEM in Figures 29 and 30 (two ramp lengths). The transmitter loop position is shown in both Figures 24 and 25. The Newmont EMP data and loop position is included in Eadie (1984).

The wildly fluctuating data, as seen with all the systems used, is typical of an intersection response. The sharp crossover from negative to positive at early times suggests that at early times, a horizontal current is being induced in the ore body, exactly perpendicular to the vertical inducing field. This causes a negative until the body is intersected, when the response becomes positive and remains positive even after passing through the ore body.

At moderate times, to late times (1.5-7.0ms), the current flows in the largest possible cross section of the conductor which appears to dip at about 50-70 degrees to the east. This causes a positive as the conductor is approached, a positive right through the conductor (which suggests the body was intersected very close to its geometrical centre on this section) and a subtle negative on exiting the conductor.

At late times, as seen only by Sirotem and the EMP, current doesn't flow on this section at all, but only in the thicker areas of the ore body to the north, resulting in a classic off hole positive (Sirotem) or negative (EMP) trough anomalies. This is a very important point in that only these two systems are detecting the main Hellyer ore body; PEM and EM37 are only seeing the small offshoot from 10300N to 10500N. This is illustrated very clearly in the decay curves (Figure 32). All of the systems see a weak conductor with tau equalling 0.7 to 1.2 ms at early to moderate times. However, only the EMP and Sirotem see the strongly conductive ($\tau > 3.0$ ms) body to the north. This is an important factor to consider when planning which system to use in the future.

It should be noted here that the Sirotem late time response is positive because the transmitter loop is placed well south of the main ore body and is therefore energizing the body from below. The large EMP loop, on the other hand, is directly over the main ore body.

Another interesting feature of the decay curves is the relative amplitude. All data has been normalized to microvolts/ampere and thus the amplitude differences should reflect only effective receiver coil area and preamplifier gain (except for the Newmont EMP which has a larger transmitter loop). It is clear that in this case the EM37 amplitude is the largest followed by the Sirotem, EMP and then the PEM. This and other decay curve observations will be discussed after all three test drill holes have been reviewed.

3. HL19

HL19 shows a classic example of a very thick body causing totally different responses in the same drill hole due to varying the transmitter loop position. The geological interpretation is shown in Figure 33.

The Sirotem results for loop 1 and 2 are shown in Figures 34 and 35, the EM37 data in Figures 36 and 37, and the PEM data, which varied both ramp time from 0.5 to 1.5 ms and time base from 10 ms to 20 ms, in figures 38 to 43. In addition, there are two PEM plots (figures 44 and 45) displayed in Crone's standard units instead of the more widely accepted microvolts. The Newmont EMP was tested from only one loop and the data is included in the 1984 report.

In general, the same features can be seen by all of the systems. At early times, only the host rock response is apparent which consists of a gradual drop off of secondary field down the hole.

However at moderate times, it can be seen that loop 1, which is situated directly over the deposit (Figure 24) induces a horizontal current flow because of its vertical primary field at the deposit (primary field diagrams are shown in the 1984 report).

This causes a large negative trough anomaly centred at about 210 metres in all loop 1 data.

Loop 2, on the other hand, induces vertical current flow in the ore body, thereby causing a crossover at almost the same location as the centre of the trough for loop 1. It is interesting to observe that the crossover point migrates up the hole at later times, and almost approximates the loop 1 data at very late times. This is due to the principal that at the latest times, the currents try to rotate to flow in the largest possible dimension available to them, which is quite close to horizontal in this case. At earlier times they simply flow perpendicular to the inducing direction.

The data sets from the three well-tested systems are quite similar. All see the ore body through the host rock effects at 0.5-1.0 ms and from this time onwards until the last time measured. The body appears to be the most difficult to see on the Crone data, but this is just due to their plotting convention in Figures 37-42. Crone's

normal convention, which applies a heavier gain to the latest channels, is shown in Figures 43 and 44. The anomaly is very well measured. The only poor quality data set is from the EMP system which was having some equipment problems (1984 report).

To highlight any differences in the data, decay plots for the maximum negative anomaly from loop 1 are plotted for the systems in Figure 46. The relative amplitudes and decay patterns are the same here as for HL3. This will be discussed in detail in a later section.

4. HL62

The interpretation of the HL62 data has been thoroughly discussed earlier in this report. In this section, only the relative effectiveness of the various EM systems is addressed. The Sirotem data for loop 2 is shown in Figure 47, the EM37 data in Figure 48, and the PEM data in figures 49 and 50. In this case the PEM data is displayed in Crone units because no anomaly can be seen on the microvolts display. No Newmont EMP work was completed on this hole. The decay curves for the various systems are shown in Figure 51.

Looking at all of the data, it is obvious that all three systems see the ore body, which is a major accomplishment considering the deposit is interpreted to be well over 100 metres away. In addition, the EM37 and PEM clearly show the shale unit from 100-200 metres. The EM37 data even shows a positive (in hole) shale response changing to a negative (off hole) shale response (also see Figure 51). The time constant of the shale unit is very low, less than 0.4 ms.

It is unfair to suggest that Sirotem does not see the shale on the basis of this data because in this run the shale unit was not covered. However, in most surveys with the Sirotem, the shale went undetected as would be expected because of the lack of early time channels.

One important observation is that all three of the systems indicate that this undrilled portion of the ore body has a larger time constant and thus more conductance than anywhere else in the deposit.

5. Decay Curve Analysis

The decay curves have been presented on Figures 32, 46 and 51 and in summary on figure 52. In all cases an attempt has been made to normalize all of the data similarly to units of microvolts/ampere as measured at the receiver. Therefore, except for different receiver coil area and pre-amplifier gains, all of the data would be expected to have similar amplitudes, with the exception of the Newmont EMP data, which had a bigger transmitter loop.

However this is not the case as suggested by the following statistics. In HL3, the amplitude of the EM37 data was about 4.8 times as large as the Sirotem and 90 times as large as the PEM. In HL19, the figures are 6 times and 100 times and in HL62, they are 2.8 and 110 times. This shows clearly that there is something inconsistent about the coil and/or receiver gains of the Sirotem system used in these tests, or else some mistake has been made in post-processing. The EM37 and PEM appear to be mutually consistent.

Getting the correct amplitudes is obviously crucial for any interpretation exercise, particularly if computer modelling is contemplated.

Another interesting observation is that, within experimental error, the time constants measured with the Sirotem, EM37 and Newmont systems, are identical.

However, the PEM time constants are consistently, and significantly higher than these values. This is probably due to the fact that each channel in the PEM unit has a different gain to aid in data presentation. Although this gain has been corrected out by Crone in

a post-processing step, this test information indicates that it has not been done properly. To my knowledge, this is the first direct test of Crone's correction factors.

VI CONCLUSIONS

The downhole EM work has had some limited success in increasing the knowledge of the geometry and potential of the Hellyer ore deposit at its northern end. Certainly the fact that the body's conductance is unexpectedly large and that it appears to be further east than geologically interpreted at its extreme north end, should be taken into consideration in further planning.

The downhole EM tests at Hellyer have supplied a wealth of information on the potential of EM systems in general, and the relative capabilities of the various systems. All of this can be applied to Aberfoyle's base metal exploration programmes.

In general, Sirotem, which is the cheapest and most readily available of the downhole systems, performed just as well as the other systems tested. There is some indication that UTEM has the potential for outperforming all of the systems. The degree of this superiority should be tested if the downhole UTEM system is ever available in Australia.

References

Eadie, E.T. 1984: Interpretation of Downhole Electromagnetic Data from the Hellyer Deposit - Report 1; Internal Aberfoyle Report

Macnae, J.C. 1980: An Atlas of Primary Fields Due to Fixed Transmitter Loop EM Sources, Research in Applied Geophysics, No. 13, University of Toronto Press, Toronto

10200 N

10400 N

10600 N

10800 N

11000 N

11200 N

5500 E

5600 E

5700 E

5800 E

5900 E

6000 E

6100 E

6200 E

**TRANSMITTER
LOOP POSITION
HL 45, 62 & 79**

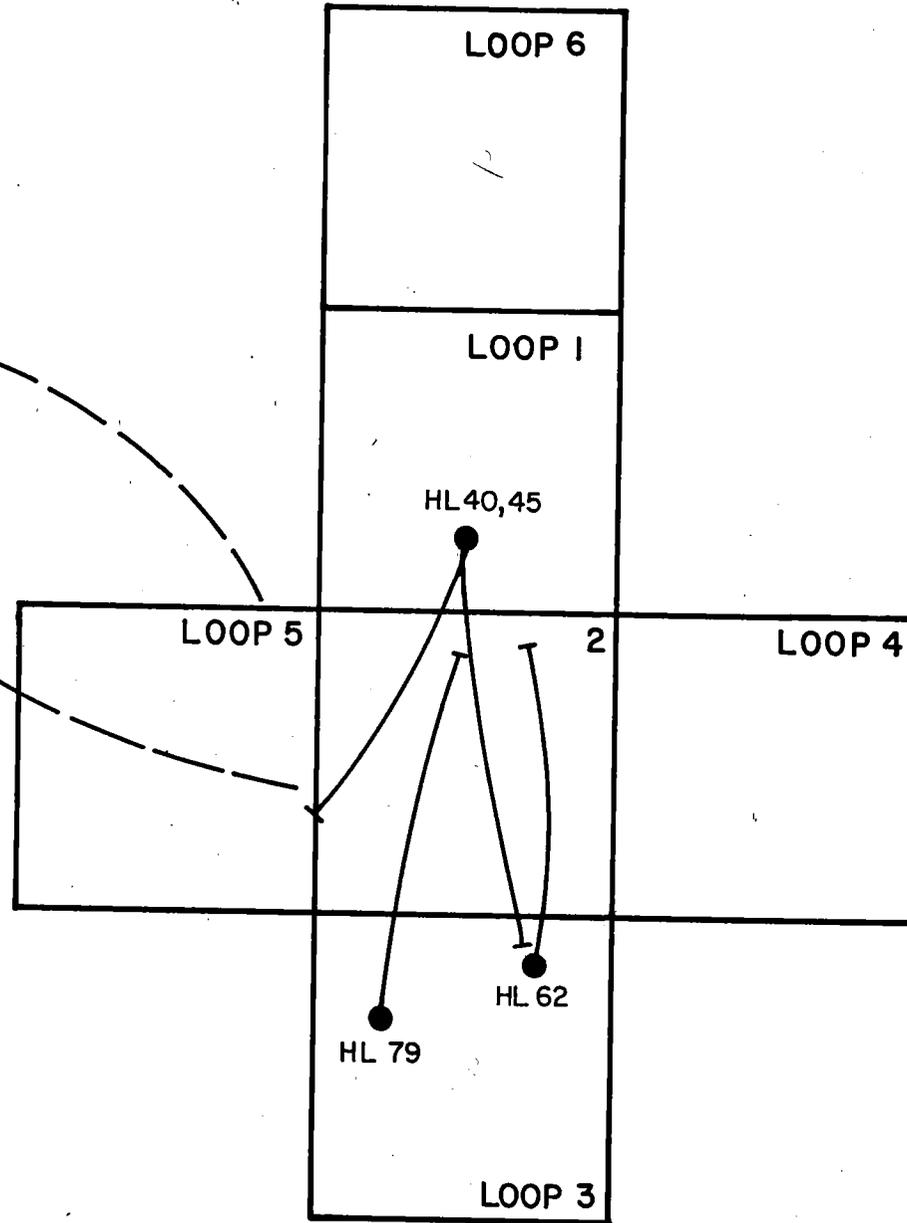
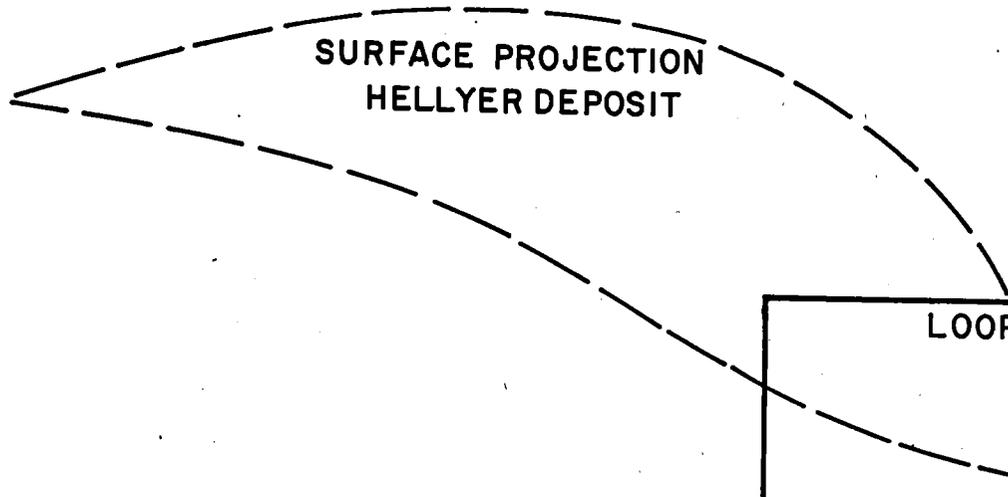


FIGURE 1
ETE/acd November '85

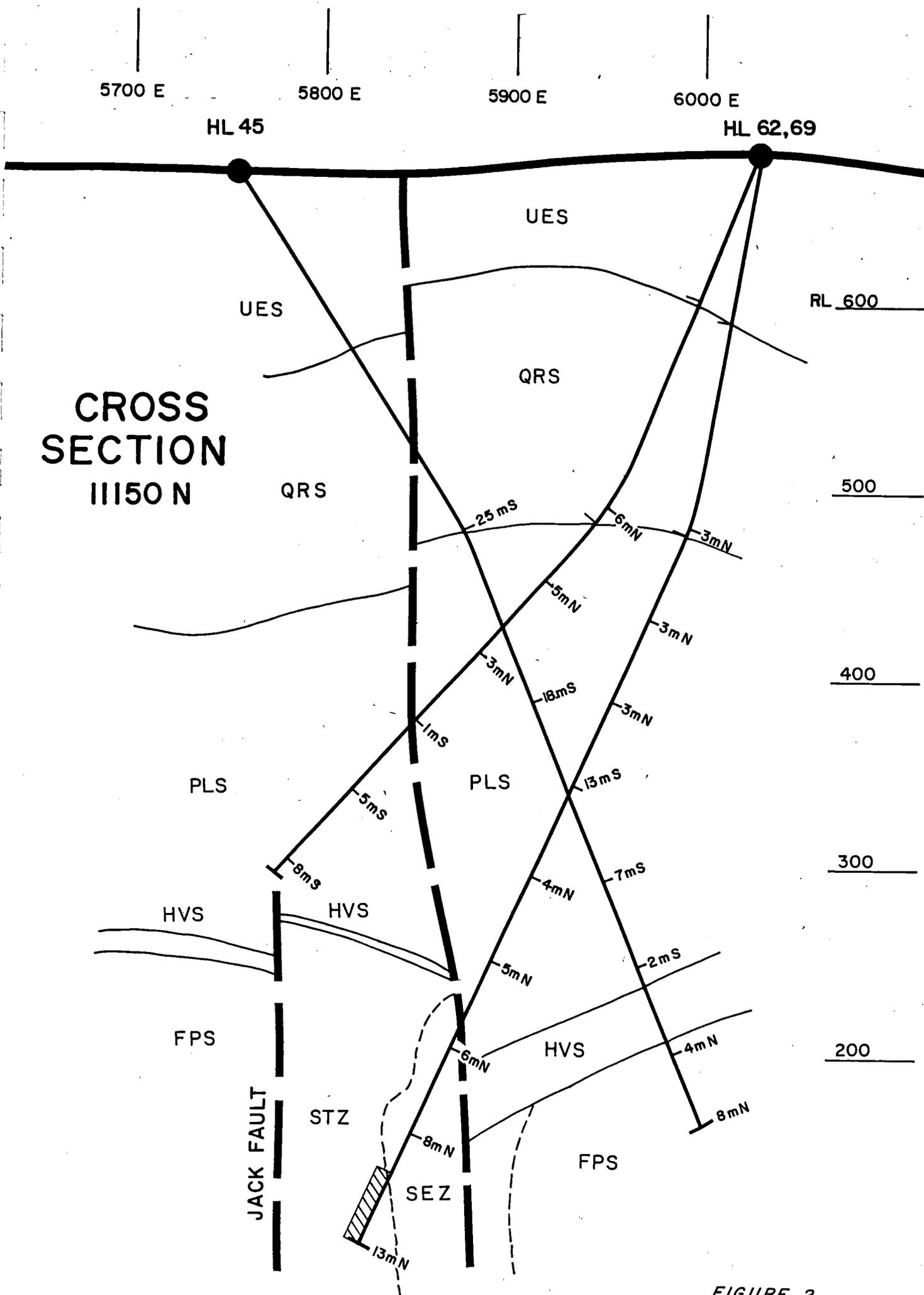
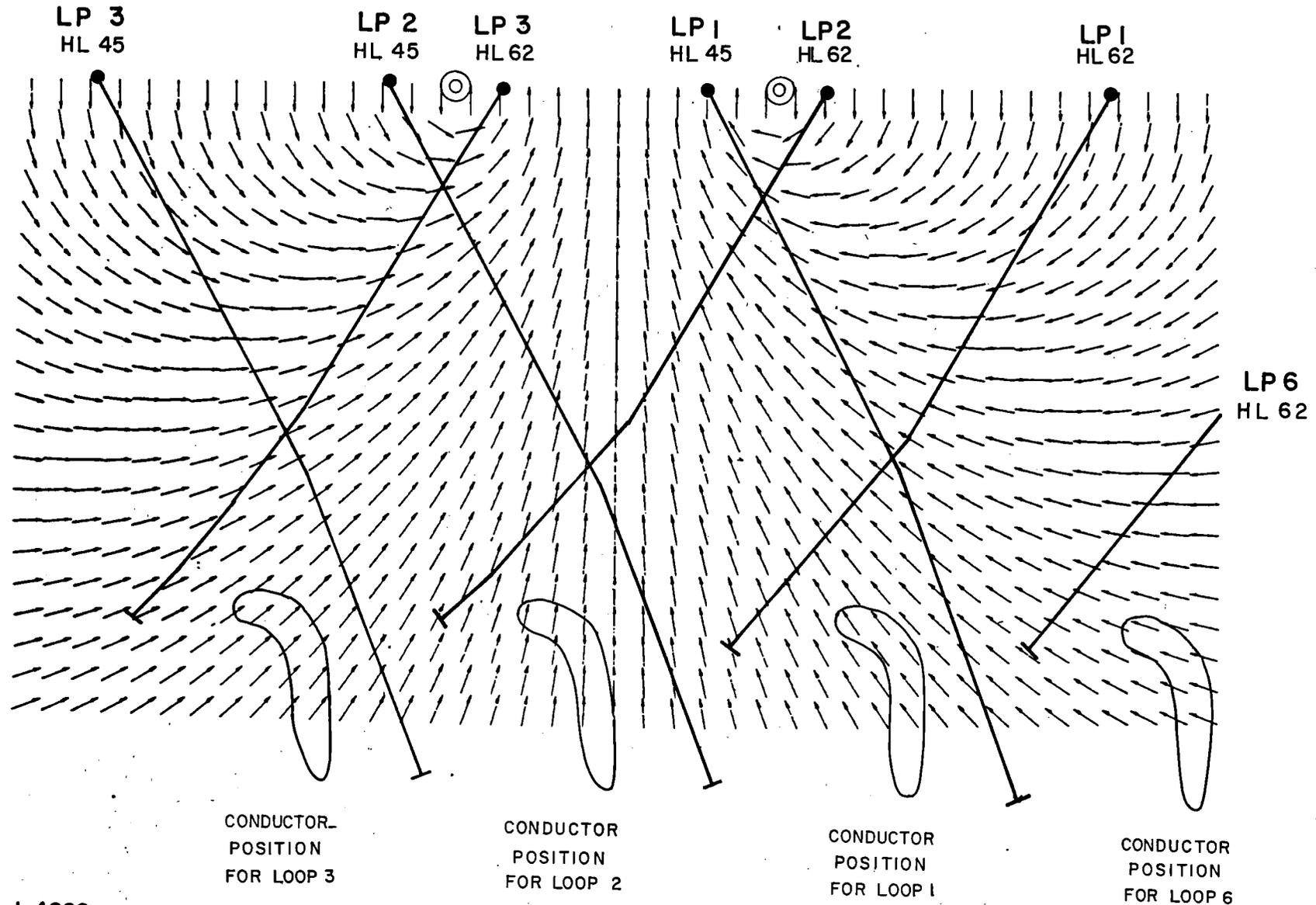


FIGURE 2
ETE/acd November 1985

PRIMARY FIELD DIRECTIONS

LINE 11150N



SCALE 1:4000

FIGURE 3
ETE/acd November '85

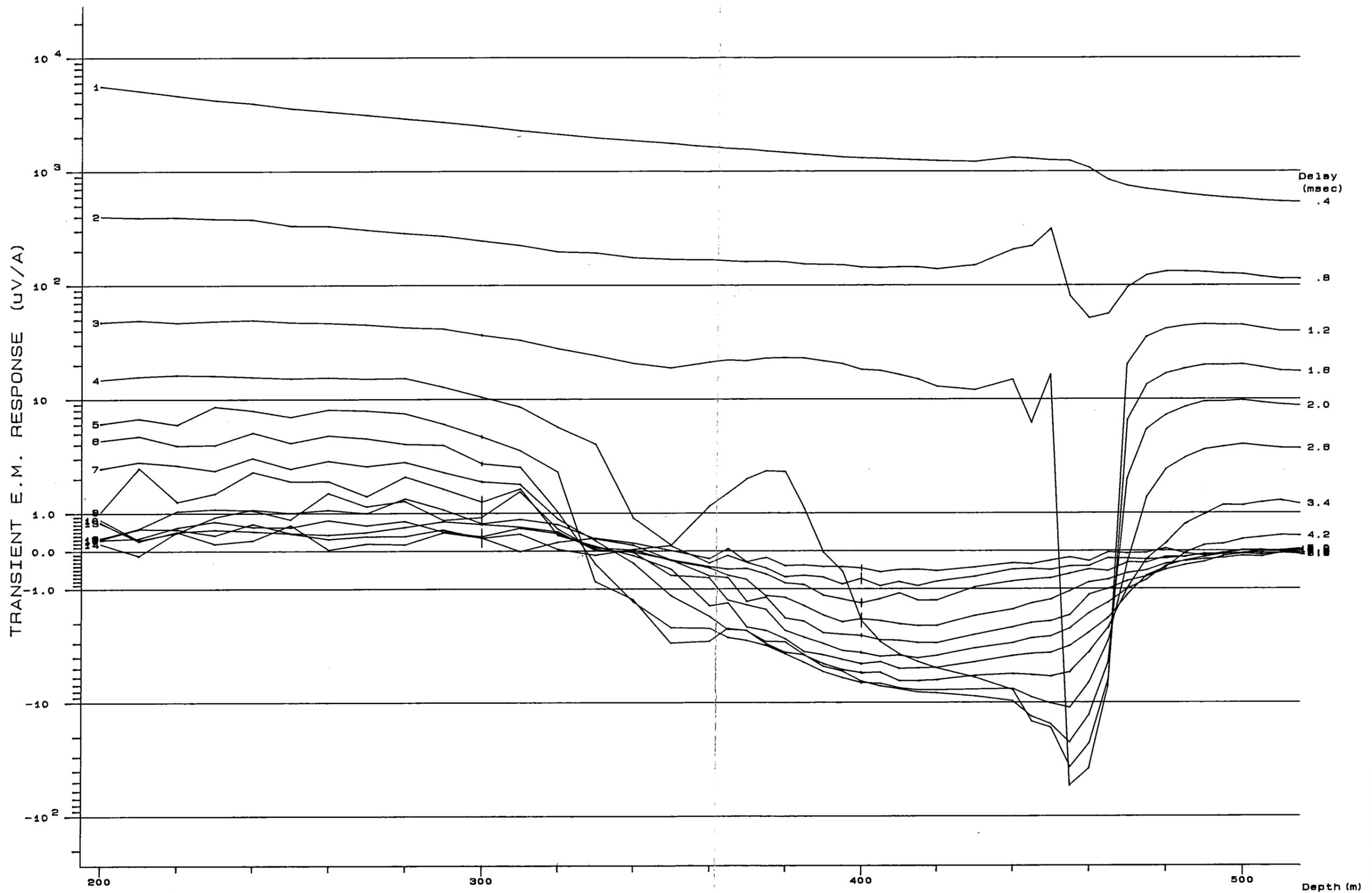
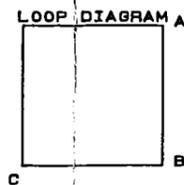


FIGURE 4

ABERFOYLE EXPLORATION PTY. LTD.
 QUE RIVER AREA TASMANIA
 HELLYER PROSPECT, JOB NO.566
 HL 45 LOOP NO 1
 SIROTEM Survey by SOLO Geophysics & Co. 23/ 1/85
 SOLO hole ref.210 Reading interval 5.0 m
 SCALE 1 : 1000 Loop size : 200 m
 LOOP configuration : Drill hole
 Plotted : 5:21 PM 22/ 2/85



A = (11200N, 5800E)
 B = (11000N, 5800E)
 C = (11000N, 5800E)
 DH = (5747N, 11100E)



DH

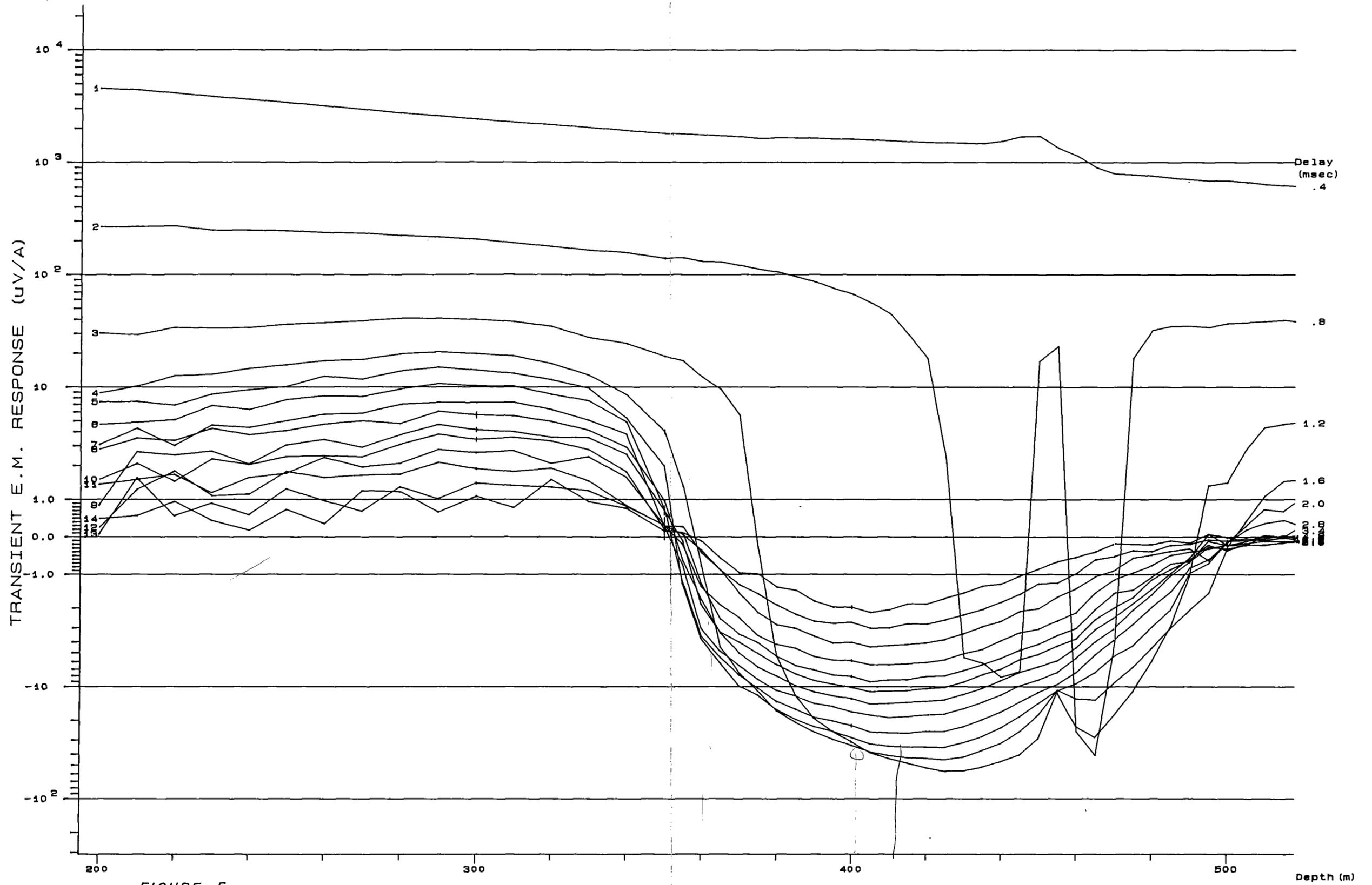
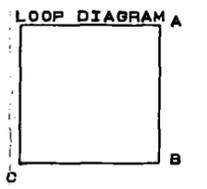


FIGURE 5
 ABERFOYLE EXPLORATION PTY. LTD.
 QUE RIVER AREA TASMANIA
 HELLYER PROSPECT JOB NO.
 HL 45 LOOP NO 2
 SIROTEM Survey by SOLO Geophysics & Co. 22/ 1/85
 SOLO hole ref.206 Reading interval 3.0 m
 SCALE 1 : 1000 Loop size : 200 m
 LOOP configuration : Drill hole
 Plotted : 4:59 PM 22/ 2/85



- A - (11200N, 8000E)
- B - (11000N, 8000E)
- C - (11000N, 5800E)
- DH - (5747N, 11100E)

SOLO

OR

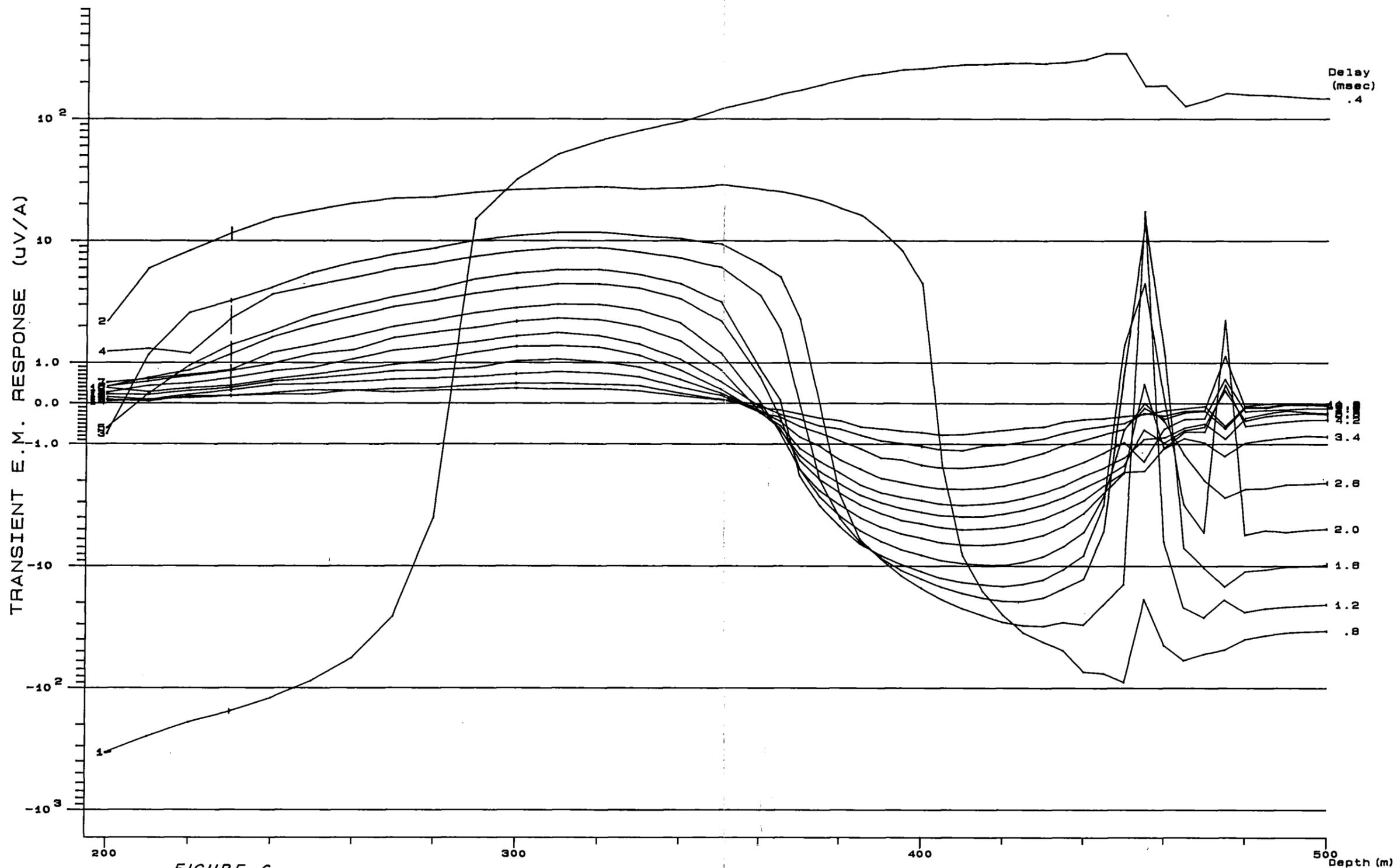
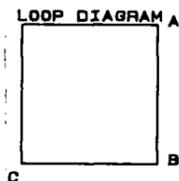


FIGURE 6

ABERFOYLE EXPLORATION PTY.LTD.
 QUE RIVER AREA, TASMANIA
 HELLYER PROSPECT (JOB NO. 570A)
 HL 45 LOOP #3
 SIROTEM Survey by SOLO Geophysics S Co. 27/ 2/85
 SOLO hole ref.213 Reading interval 5.0 m
 SCALE 1 : 1000 Loop size : 200 m
 LOOP configuration : Drill hole
 Plotted : 11:31 AM 12/ 3/85

DH



A - (11200N, 8800E)
 B - (11000N, 0200E)
 C - (11000N, 8000E)
 DH - (11100N, 0750E)

SOLO

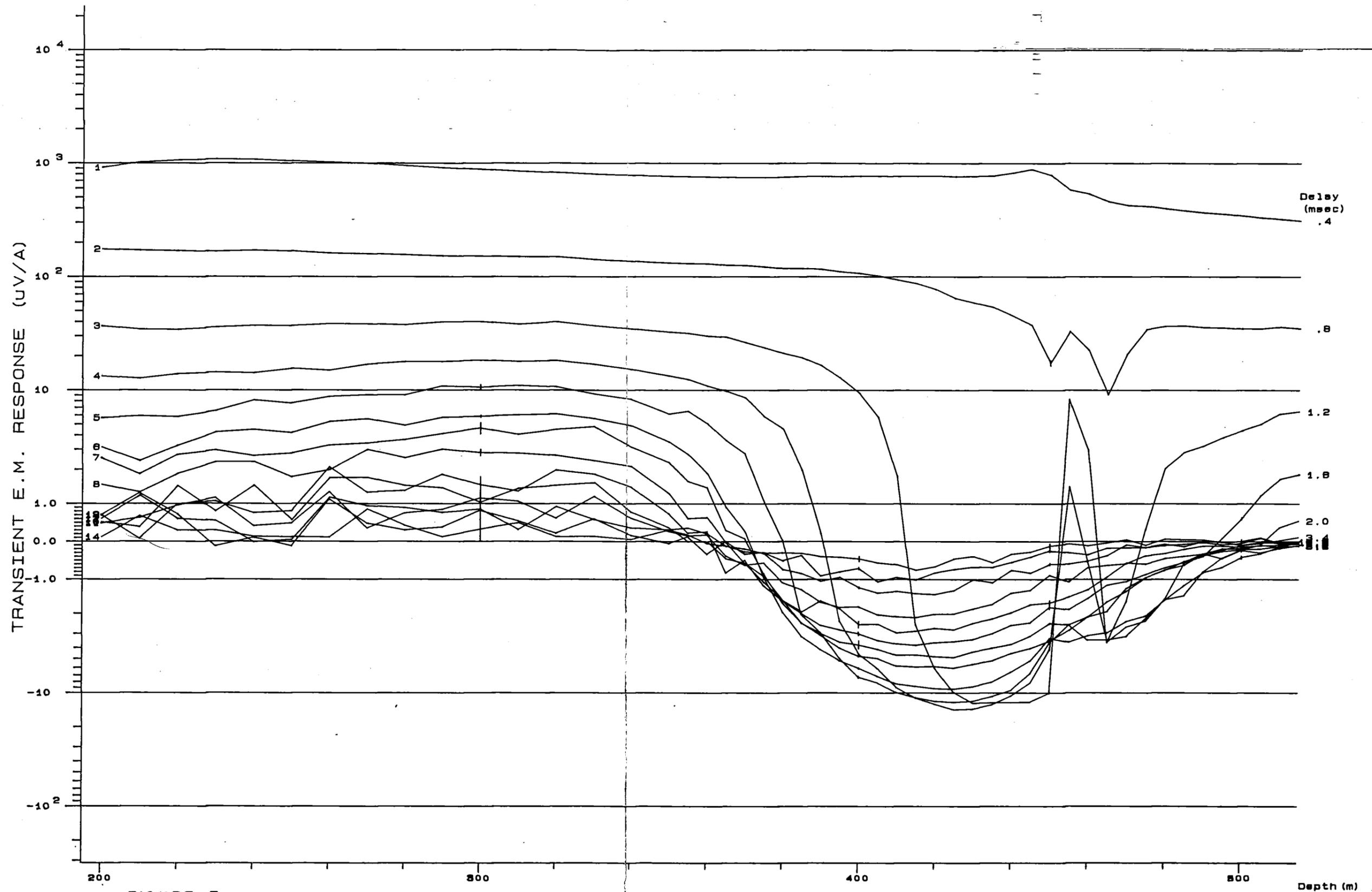
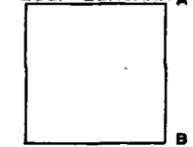


FIGURE 7
 ABERFOYLE EXPLORATION PTY. LTD.
 QUE RIVER AREA TASMANIA
 HELLYER PROSPECT, JOB NO.568
 HL 45 LOOP NO 4
 SIROTEM Survey by SOLD Geophysics & Co. 22/ 1/85
 SOLO hole ref.207 Reading interval 5.0 m
 SCALE 1 : 1000 Loop size : 200 m
 LOOP configuration : Drill hole
 Plotted : 5:08 PM 22/ 2/85

LOOP DIAGRAM A



- A - (8000N, 11400E)
- B - (8800N, 11400E)
- C - (8800N, 11200E)
- DH - (8747N, 11100E)



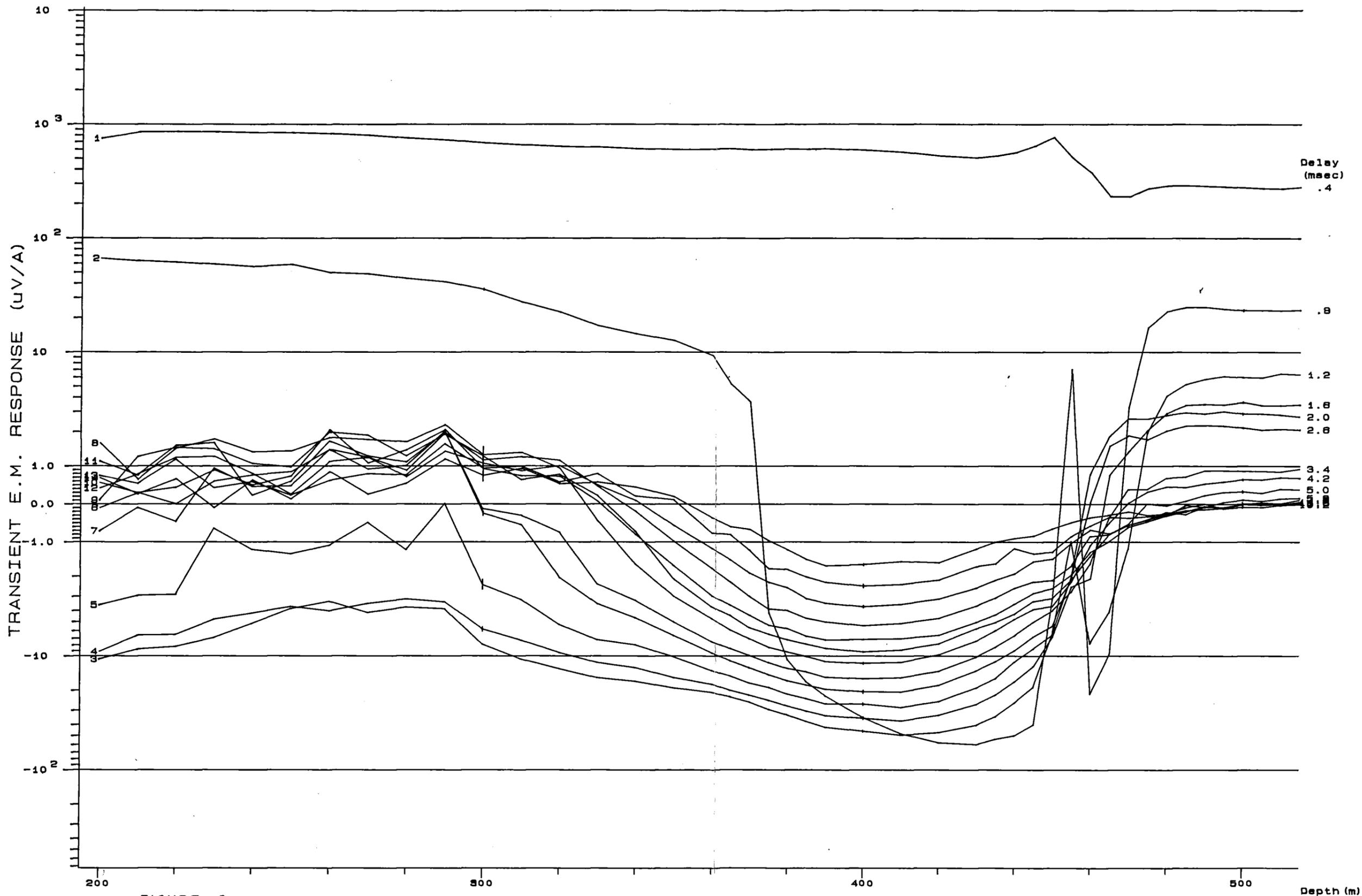


FIGURE 8

ABERFOYLE EXPLORATION PTY. LTD.

QUE RIVER AREA TASMANIA

HELLYER PROSPECT, JOB NO.566

HL 45 LOOP NO 5

SIROTEM Survey by SOLO Geophysics & Co. 24/ 1/85

SOLO hole ref.211 Reading interval 5.0 m

SCALE 1 : 1000 Loop size : 200 m

LOOP configuration : Drill hole

Plotted : 5:27 PM 22/ 2/85

LOOP DIAGRAM A



A = (11000N, 8000E)

B = (10800N, 8000E)

C = (10800N, 5800E)

DH = (8747N, 11100E)

SOLO

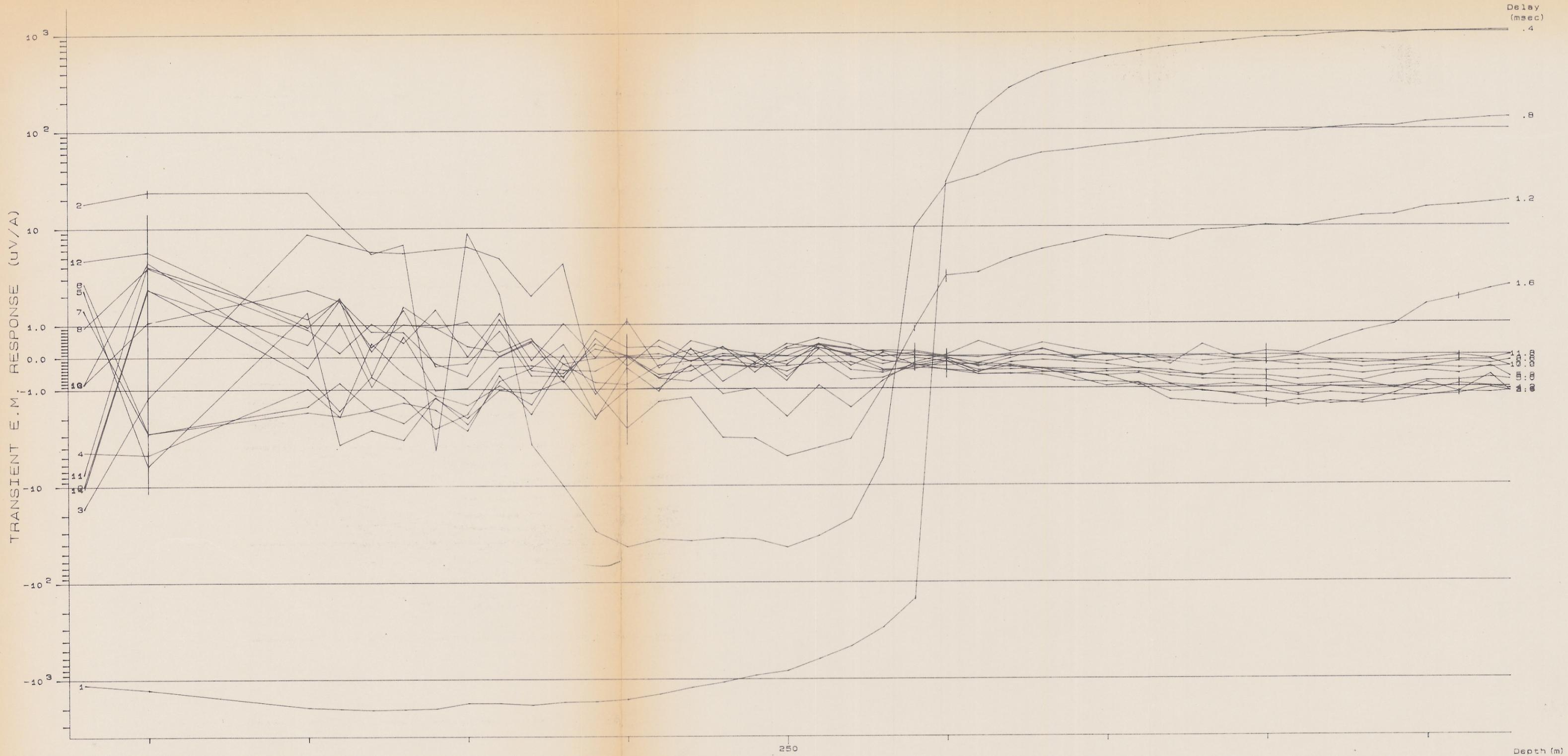


FIGURE 9

ABERFOYLE EXPLORATION PTY. LTD.

QUE RIVER AREA TASMANIA

HELLYER PROSPECT, JOB NO.568

DH HL82 LOOP #1

SIROTEM Survey by SOLO Geophysics & Co. 18/ 1/85

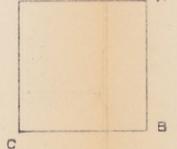
SOLO hole ref.201 Reading interval 6.0 m

SCALE 1 : 1000 Loop size : 200 m

LOOP configuration : Drill hole

Plotted : 5:51 PM 22/ 2/85

LOOP DIAGRAM A



OR

A = (11200N, 5800E)

B = (11000N, 5800E)

C = (11000N, 5600E)

DH = (6032N, 11148E)

SOLO

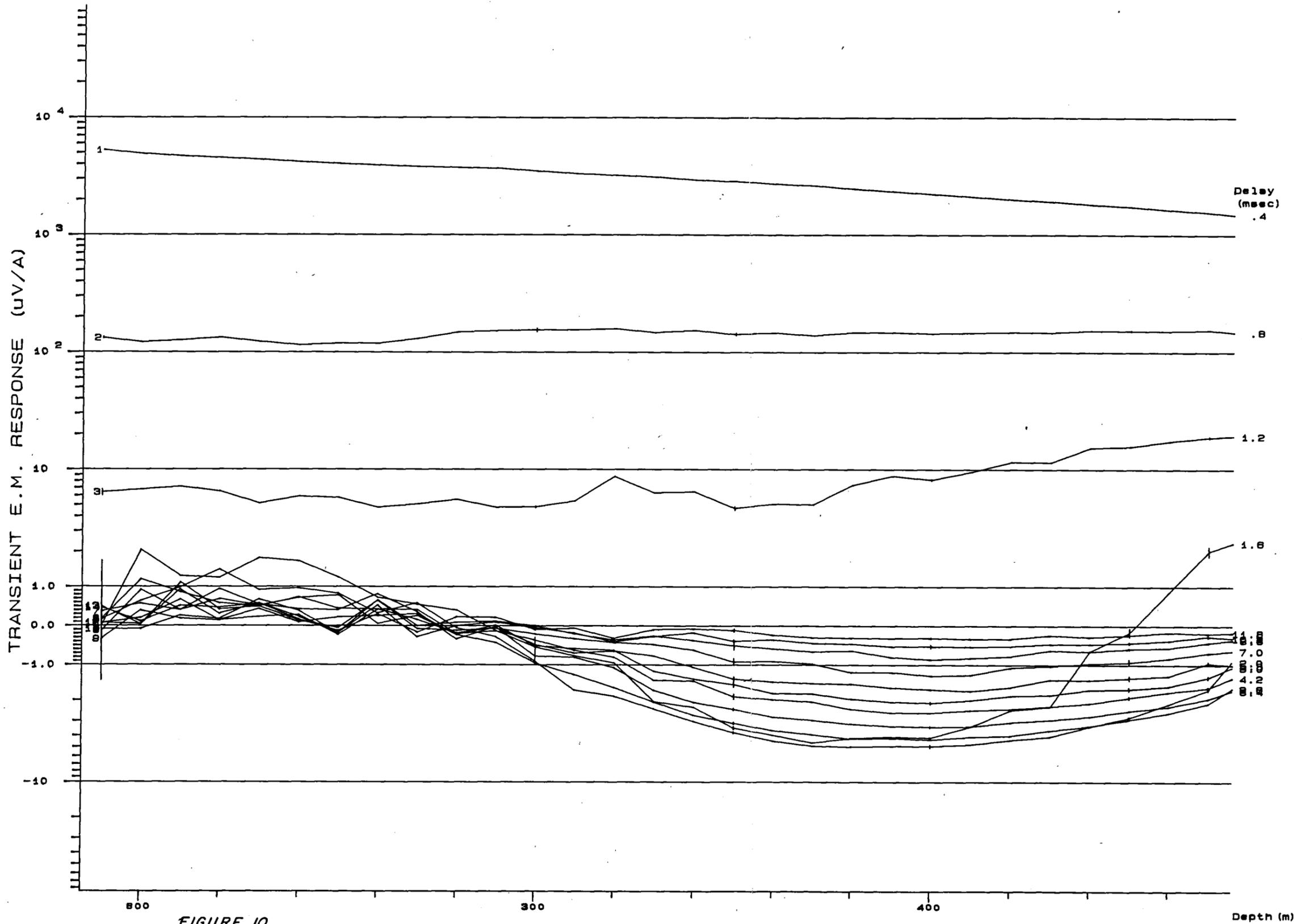


FIGURE 10

ABERFOYLE EXPLORATION PTY. LTD.

QUE RIVER AREA TASMANIA

HELLYER PROSPECT, JOB NO.588

DH HLB2 LOOP #2

SIROTEM Survey by SOLO Geophysics & Co. 21/ 1/85

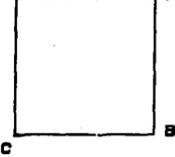
SOLO hole ref.204 Reading interval 8.0 m

SCALE 1 : 1000 Loop size : 200 m

LOOP configuration : Drill hole

Plotted : 8:18 PM 22/ 2/85

LOOP DIAGRAM A



A - (11200N, 8000E)

B - (11000N, 8000E)

C - (11000N, 5800E)

DH - (0032N, 11140E)

SOLO

CF

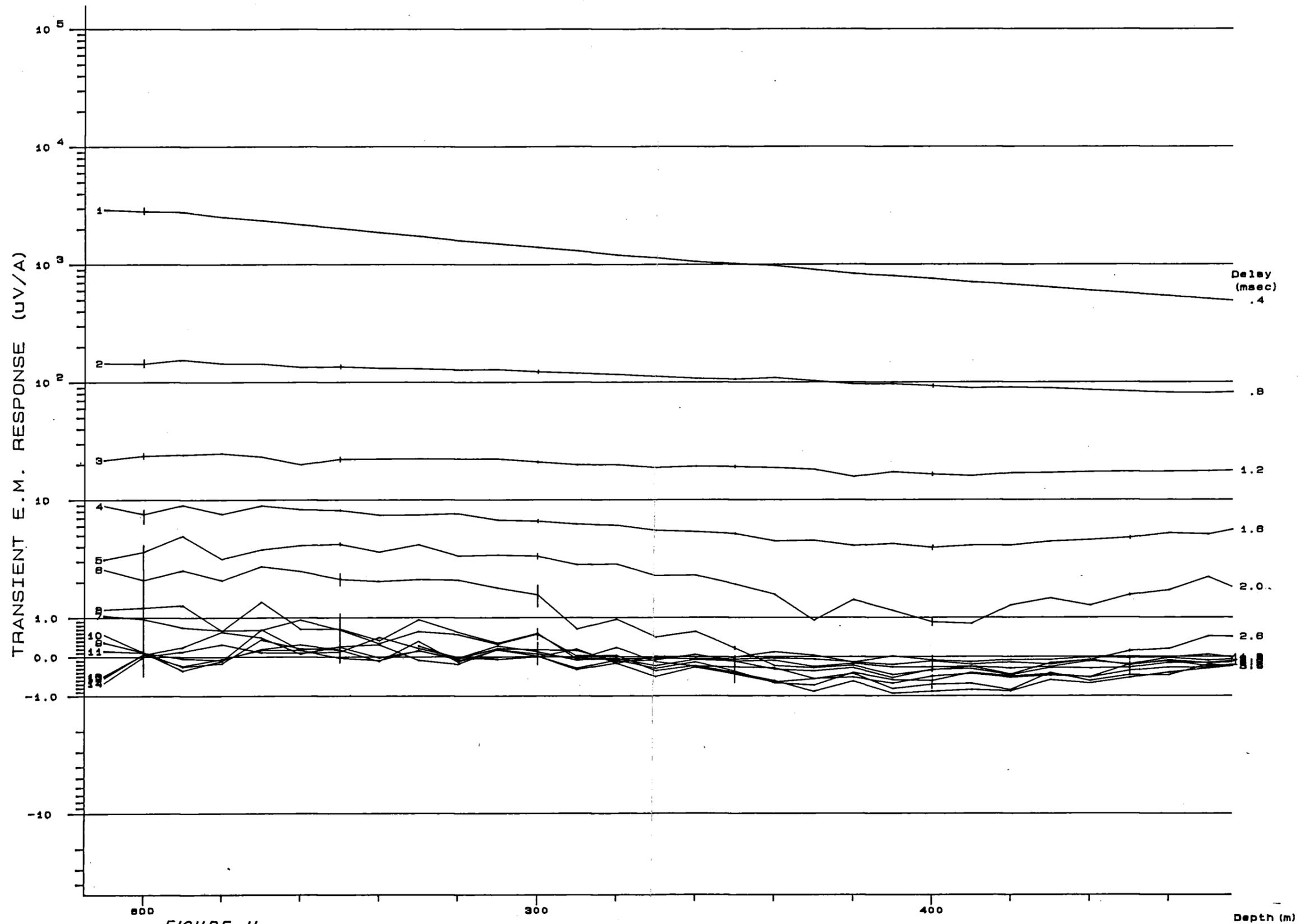


FIGURE 11

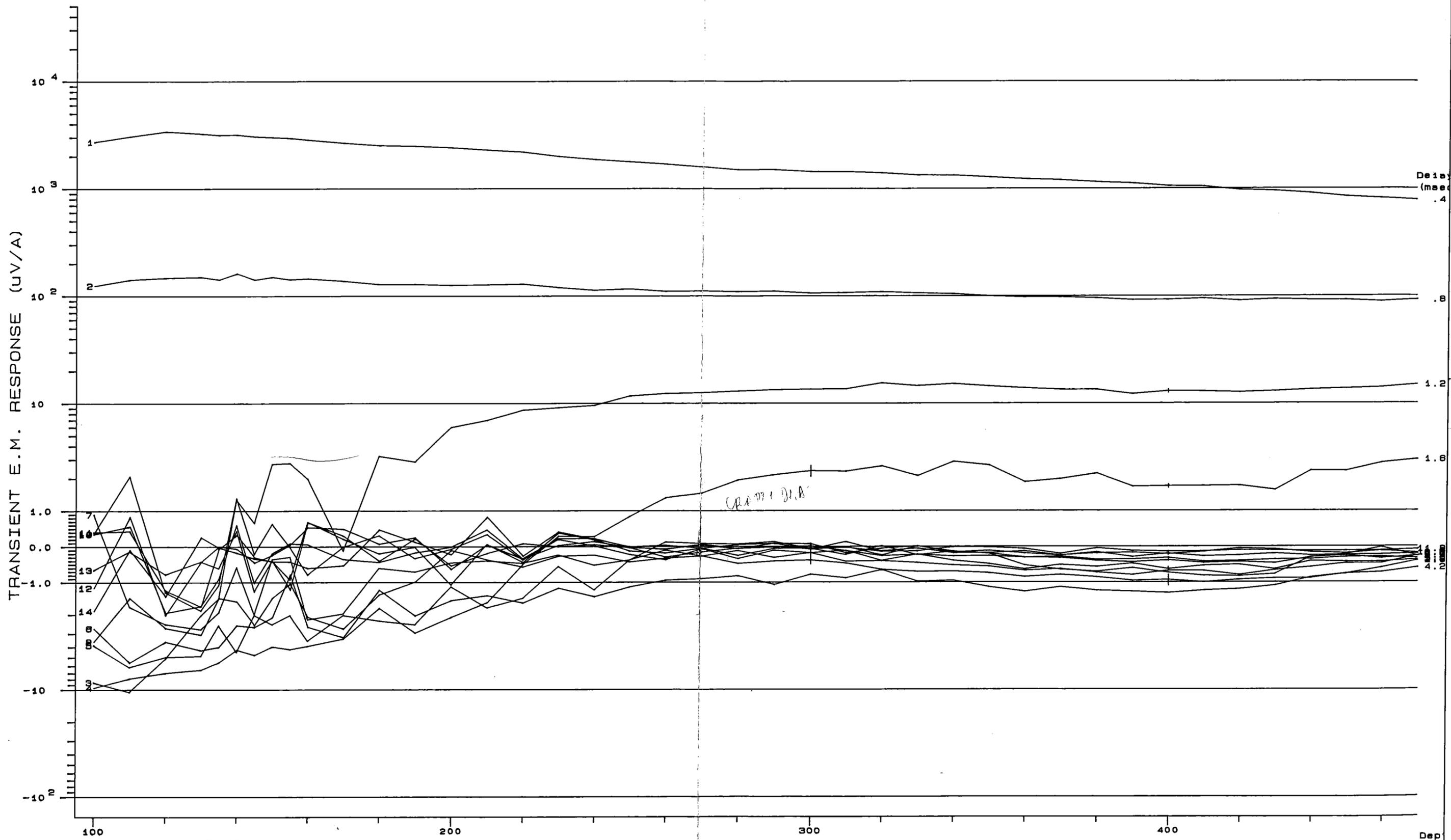
ABERFOYLE EXPLORATION PTY. LTD.
 QUE RIVER AREA TASMANIA
 HELLYER PROSPECT JOB NO.
 DH HLB2 LOOP #3
 SIROTEM Survey by SOLO Geophysics & Co. 21/ 1/85
 SOLO hole ref.205 Reading interval 6.0 m
 SCALE 1 : 1000 Loop size : 200 m
 LOOP configuration : Drill hole
 Plotted : 4:54 PM 22/ 2/85

LOOP DIAGRAM A



A = (11200N, 8200E)
 B = (11000N, 8200E)
 C = (11000N, 8000E)
 DH = (8032N, 11148E)

SOLO



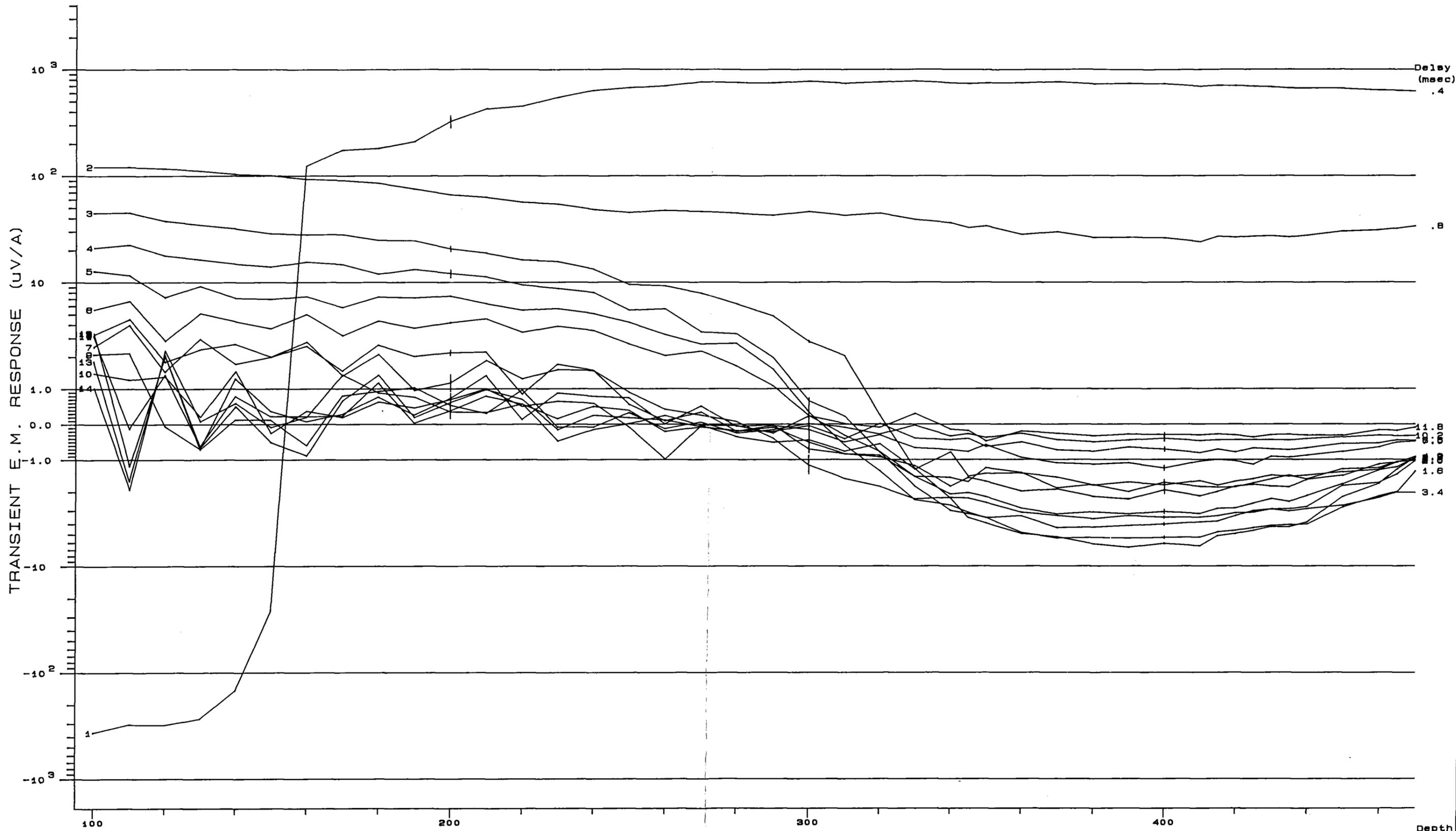


FIGURE 13

ABERFOYLE EXPLORATION PTY. LTD.
 QUE RIVER AREA TASMANIA
 HELLYER PROSPECT, JOB NO.566
 HL 62 LOOP NO 5

SIROTEM Survey by SOLO Geophysics & Co. 24/ 1/85

SOLO hole ref.212 Reading interval 5.0 m

SCALE 1 : 1000 Loop size : 200 m

LOOP configuration : Drill hole

Plotted : 5:45 PM 22/ 2/85

LOOP DIAGRAM A

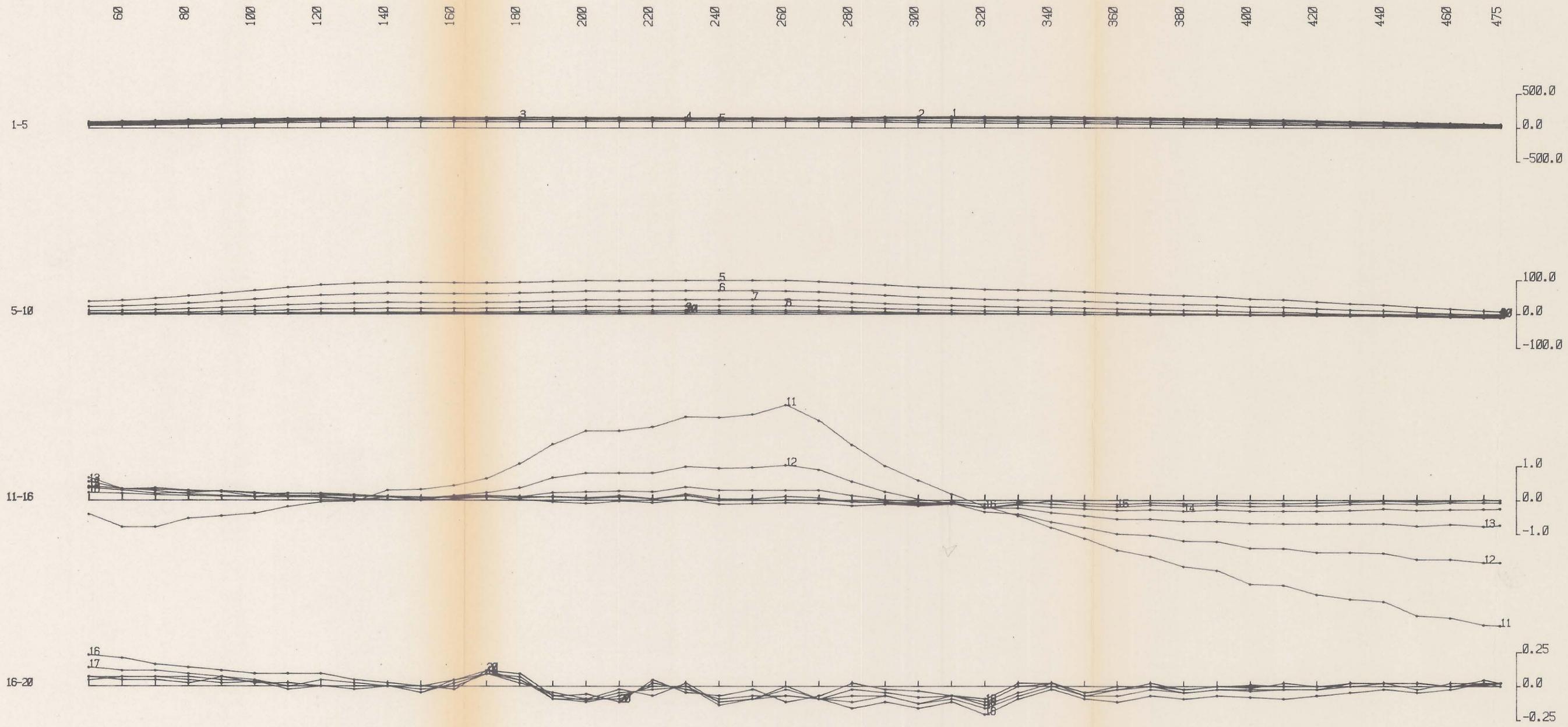


A - (1100N, 0000E)
 B - (10800N, 8000E)
 C - (10800N, 5800E)
 DH= (0032N, 11148E)

SOLO

CH

AXIAL COMPONENT B (A)



EM-37
BOREHOLE
SURVEY

ELECTROMOTIVE FORCE INDUCED BY
SECONDARY FIELD
TIME DERIVATIVE OF FLUX DENSITY (B)

nano volts per amp. metre squared

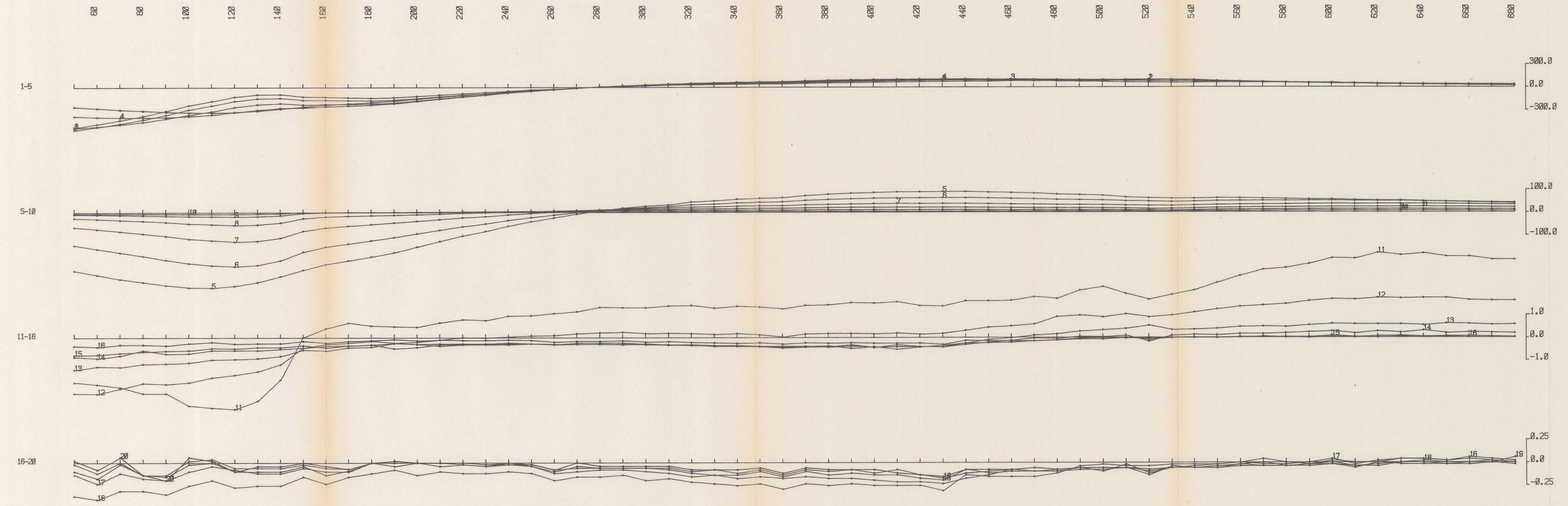
TX LOOP SIDES : 11200N 5400E
 : 11200N 5600E
TX LOOP SIZE : 200m X 200m
TX TURN OFF TIME : 195 microseconds
CURRENT : 13.0 ampe
FREQUENCY : 25
INTEGRATION TIME : 1024 cycles
SYNC MODE : CRYSTAL
HORIZONTAL SCALE : 1:1000
SURVEYED BY : PECH
DATE : 06-JUN-1965

	SURVEYED AND COMPILED BY GEOTREX PTY. LTD.	PROJECT NO. 65-1862
--	---	------------------------

CLIENT : Aberfoyle Ltd.
PROJECT : Hellyer
AREA : Waratah Tasmania
BOREHOLE : HL62
TX LOOP : 6

FIGURE 14

AXIAL COMPONENT B (A)



EM-37
BOREHOLE
SURVEY

ELECTROMOTIVE FORCE INDUCED BY
SECONDARY FIELD
TIME DERIVATIVE OF FLUX DENSITY (B)

nanovolts per amp. metre squared

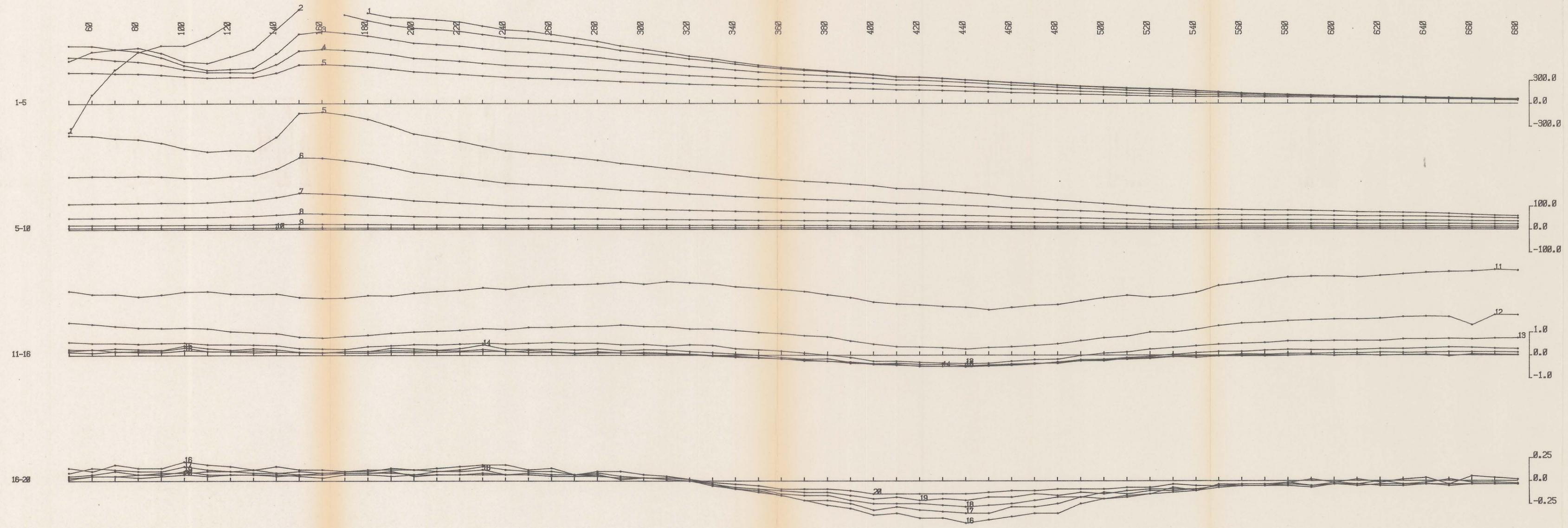
TX LOOP SIDES : 11000N 5600E
 : 11200N 5600E
TX LOOP SIZE : 200m X 200m
TX TURN OFF TIME : 160 microseconds
CURRENT : 15.5 amps
FREQUENCY : 25
INTEGRATION TIME : 1024 cycles
SYNC MODE : CRYSTAL
HORIZONTAL SCALE : 1:10000
SURVEYED BY : PECH
DATE : 22-APR-1965

SURVEYED AND COMPILED BY : GEDTERREX PTY. LTD. PROJECT NO. : 65-1662

CLIENT : Aberfoyle Ltd.
PROJECT : Halliher
AREA : Waratah Tasmania
BOREHOLE : HL79
TX LOOP : 1

FIGURE 15

AXIAL COMPONENT B (A)



EM-37
BOREHOLE
SURVEY

ELECTROMOTIVE FORCE INDUCED BY
SECONDARY FIELD
TIME DERIVATIVE OF FLUX DENSITY (B)

nanovolts per amp-metre squared

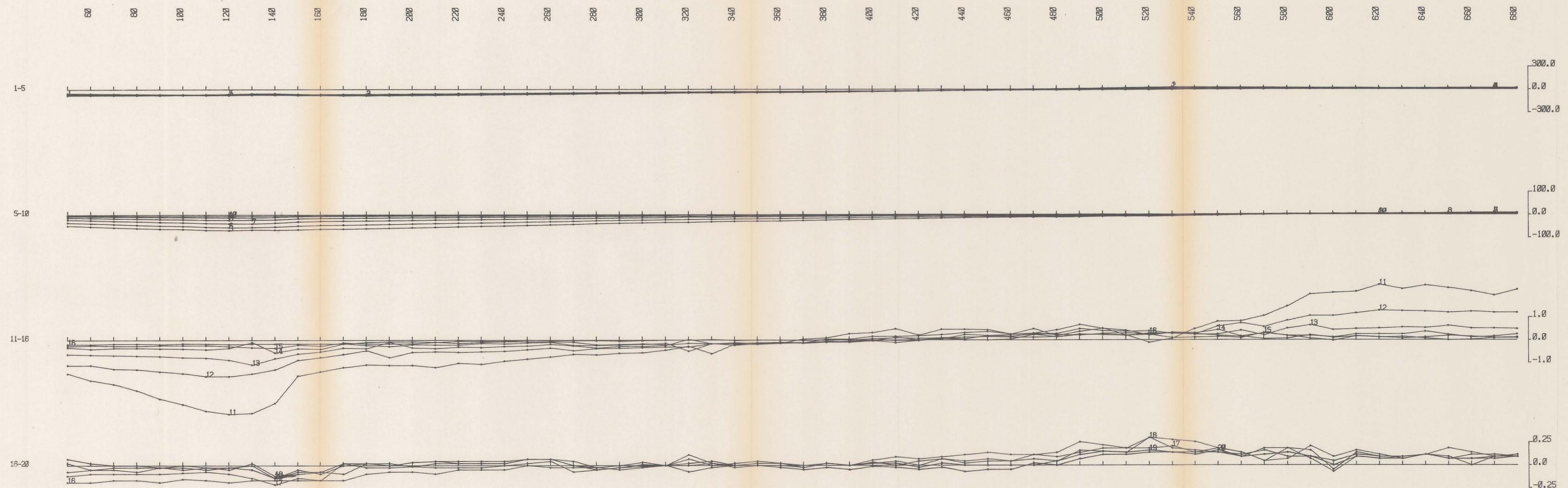
TX LOOP SIDES : 11000N 6000E
 : 11200N 5800E
TX LOOP SIZE : 200m X 200m
TX TURN OFF TIME : 150 microseconds
CURRENT : 17.0 amps
FREQUENCY : 25
INTEGRATION TIME : 1024 cycles
SYNC MODE : CRYSTAL
HORIZONTAL SCALE : 1:1000
SURVEYED BY : PECH
DATE : 23-APR-1965

	SURVEYED AND COMPILED BY	PROJECT NO.
	GEOTREX PTY. LTD.	65-1862

CLIENT : Aberfoyle Ltd.
PROJECT : Hellyer
AREA : Waratah Tasmania
BOREHOLE : HL79
TX LOOP : 2

FIGURE 16

AXIAL COMPONENT B (A)



EM-37
BOREHOLE
SURVEY

ELECTROMOTIVE FORCE INDUCED BY
SECONDARY FIELD
TIME DERIVATIVE OF FLUX DENSITY (B)

nanotesla per amp. metre squared

TX LOOP SIDES : 11000N 5600E
 : 11200N 5400E
TX LOOP SIZE : 200m X 200m
TX TURN OFF TIME : 195 microseconds
CURRENT : 13.0 ampe
FREQUENCY : 25
INTEGRATION TIME : 1024 cycles
SYNC MODE : CRYSTAL
HORIZONTAL SCALE : 1:1000
SURVEYED BY : FECH
DATE : 06-JUN-1985

	SURVEYED AND COMPILED BY GEOTREX PTY. LTD.	PROJECT NO. 65-1662
	CLIENT : Aberfoyle Ltd. PROJECT : Hellyer AREA : Waratah Tasmania BOREHOLE : HL79 TX LOOP : 6	

FIGURE 17

PRIMARY FIELD DIRECTIONS

LINE 11050 N

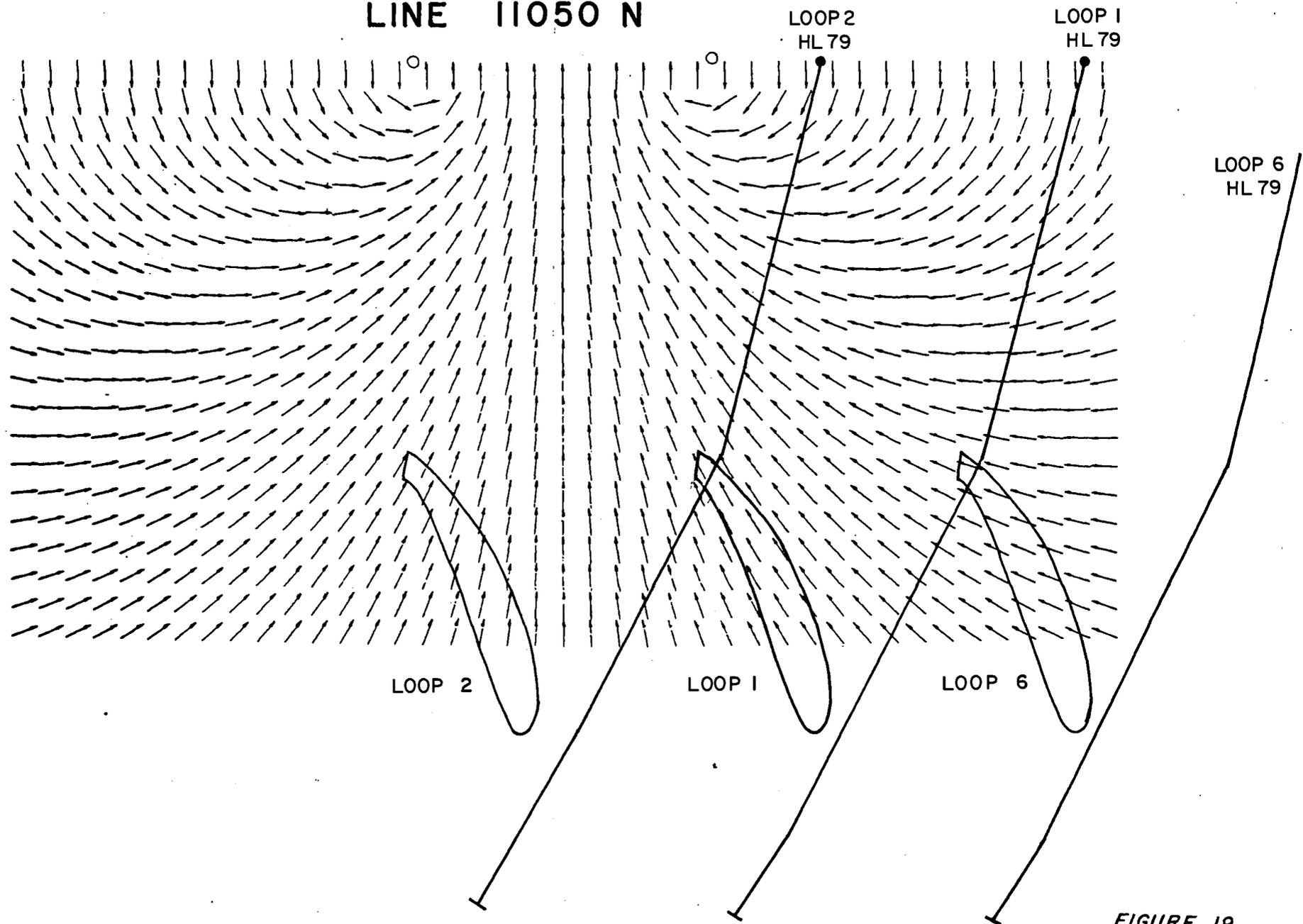


FIGURE 19

ETE/acd November '85

DOWNHOLE EM INTERPRETATION

LINE 11100 N

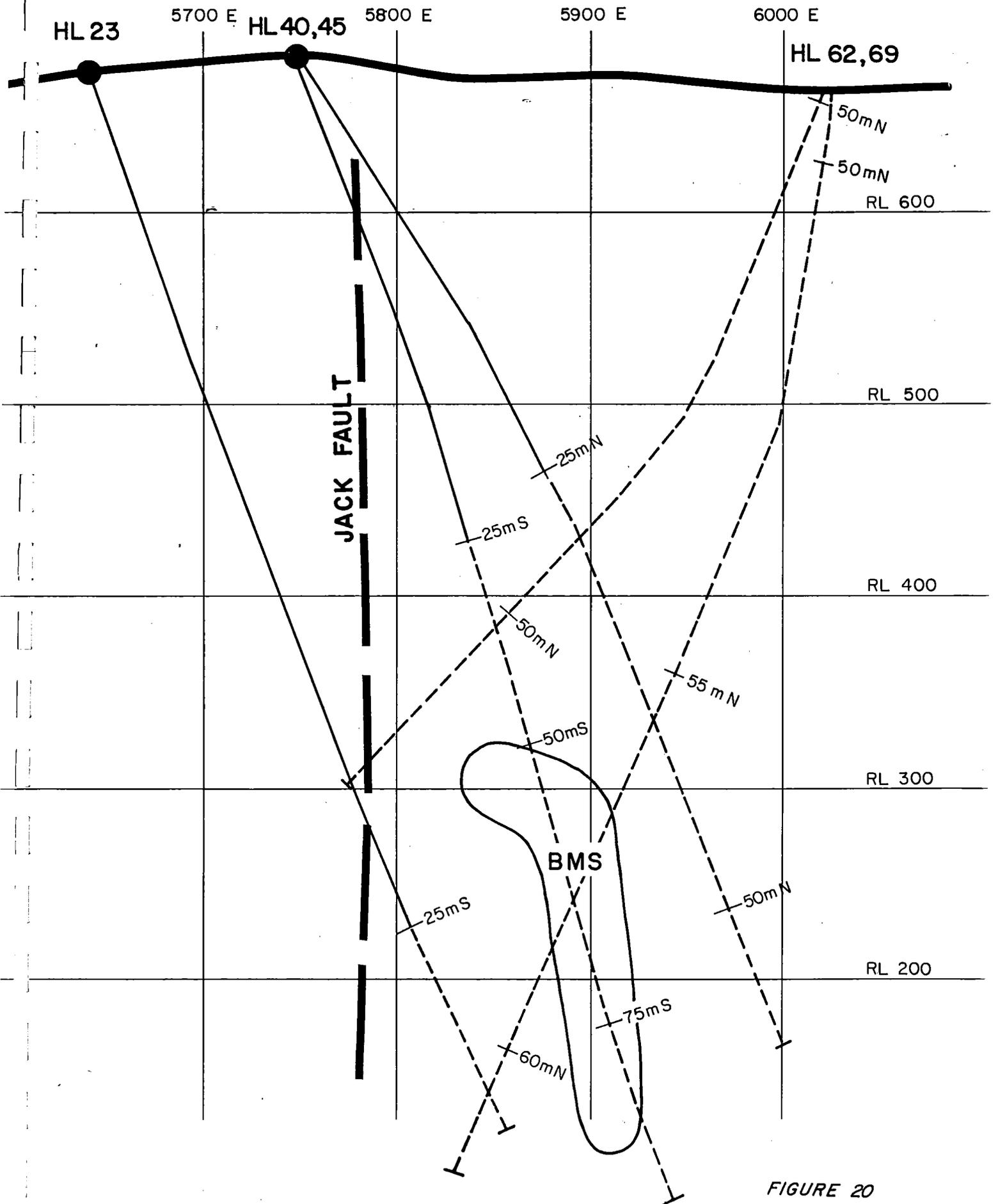


FIGURE 20
ETE/acd November '85

HL 45 SIROTEM DECAY CURVES

ANOMALY AMPLITUDE
MICROVOLTS/AMP

10.0

1.0

1

2

3

4

5

6

7

8

9

10

11

12

TIME (ms)

HL 45 LP2 400-425 $\tau = 3.95$
HL 45 LP5 390-420 $\tau = 3.85$

HL 45 LP4 405-435 $\tau = 3.57$

HL 45 LP3 405-425 $\tau = 3.9$

HL 45 LP1 400-420 $\tau = 3.333$

FIGURE 21

HL 62 SIROTEM DECAY CURVES

ANOMALY AMPLITUDE
MICROVOLTS/AMP

10.0

0

0.1

0

HL 62 LP 2
390-440 averaged $\tau = 3.7$

HL 62 LP 4
390-410 averaged $\tau = 4.17-3.0$

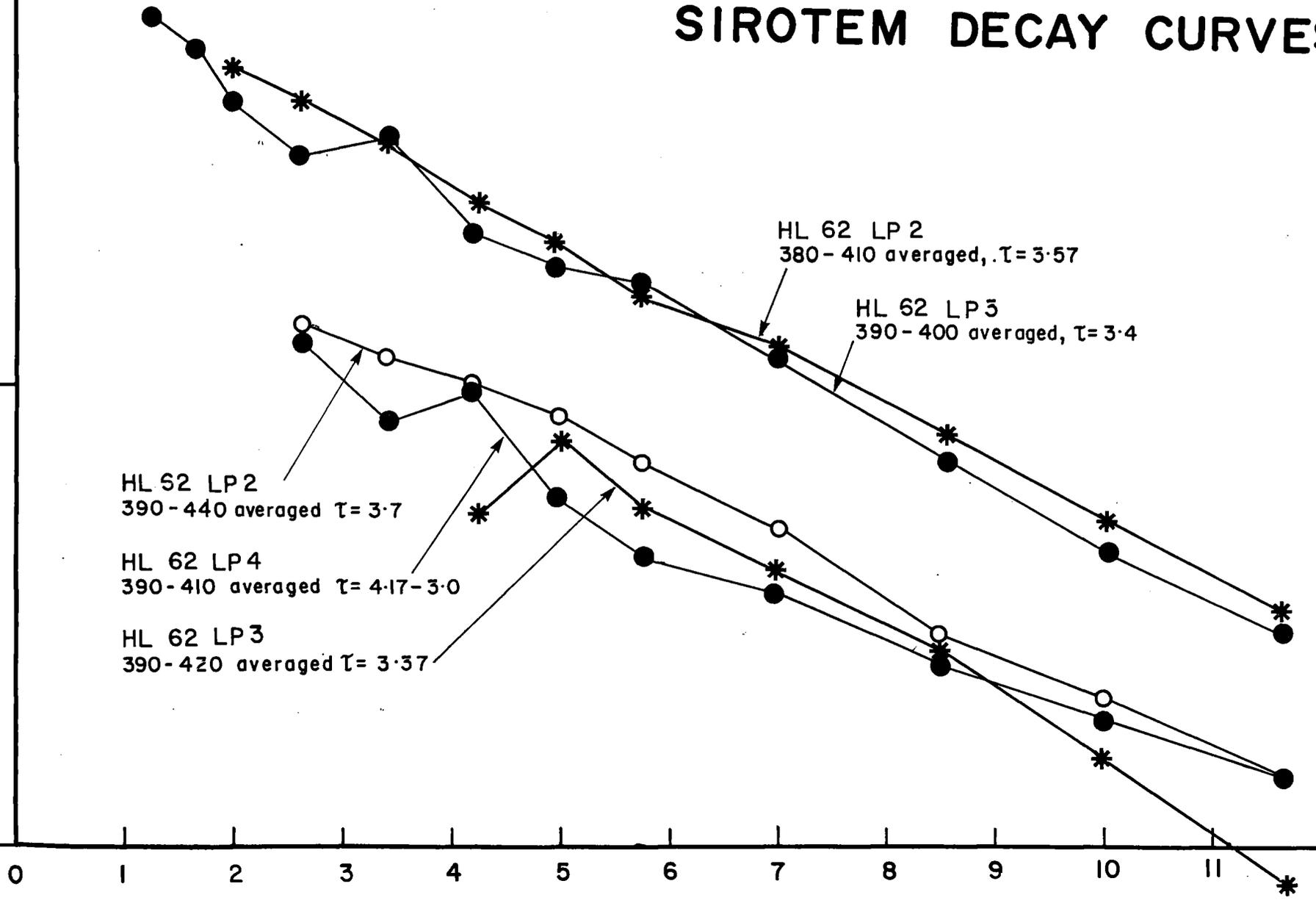
HL 62 LP 3
390-420 averaged $\tau = 3.37$

HL 62 LP 2
380-410 averaged, $\tau = 3.57$

HL 62 LP 3
390-400 averaged, $\tau = 3.4$

TIME (ms)

FIGURE 22
ETE/acd, November '85



ANOMALY AMPLITUDE
MICROVOLTS/ AMP

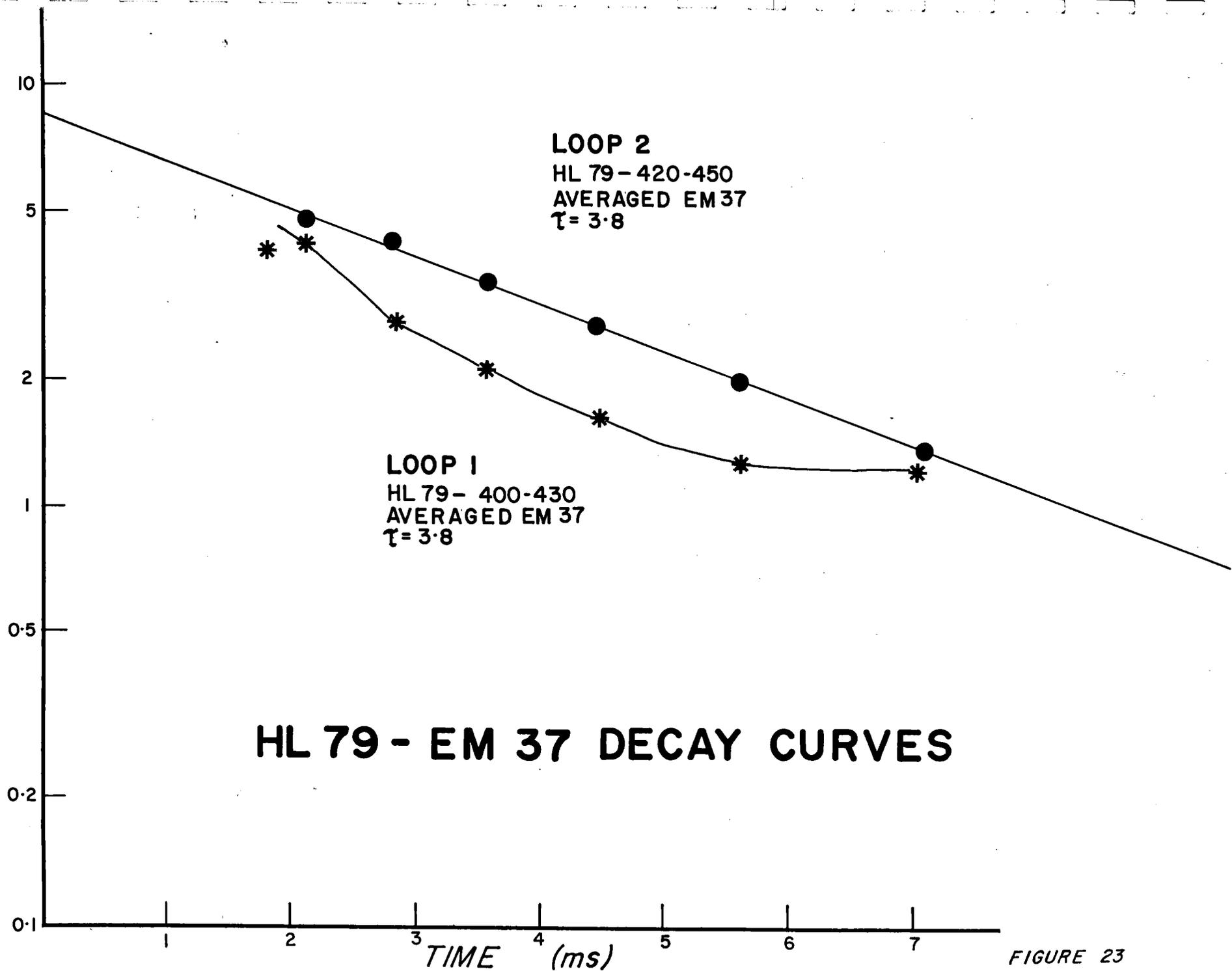


FIGURE 23

10200 N

10400 N

10600 N

10800 N

11000 N

11200 N

5500 E

5600 E

5700 E

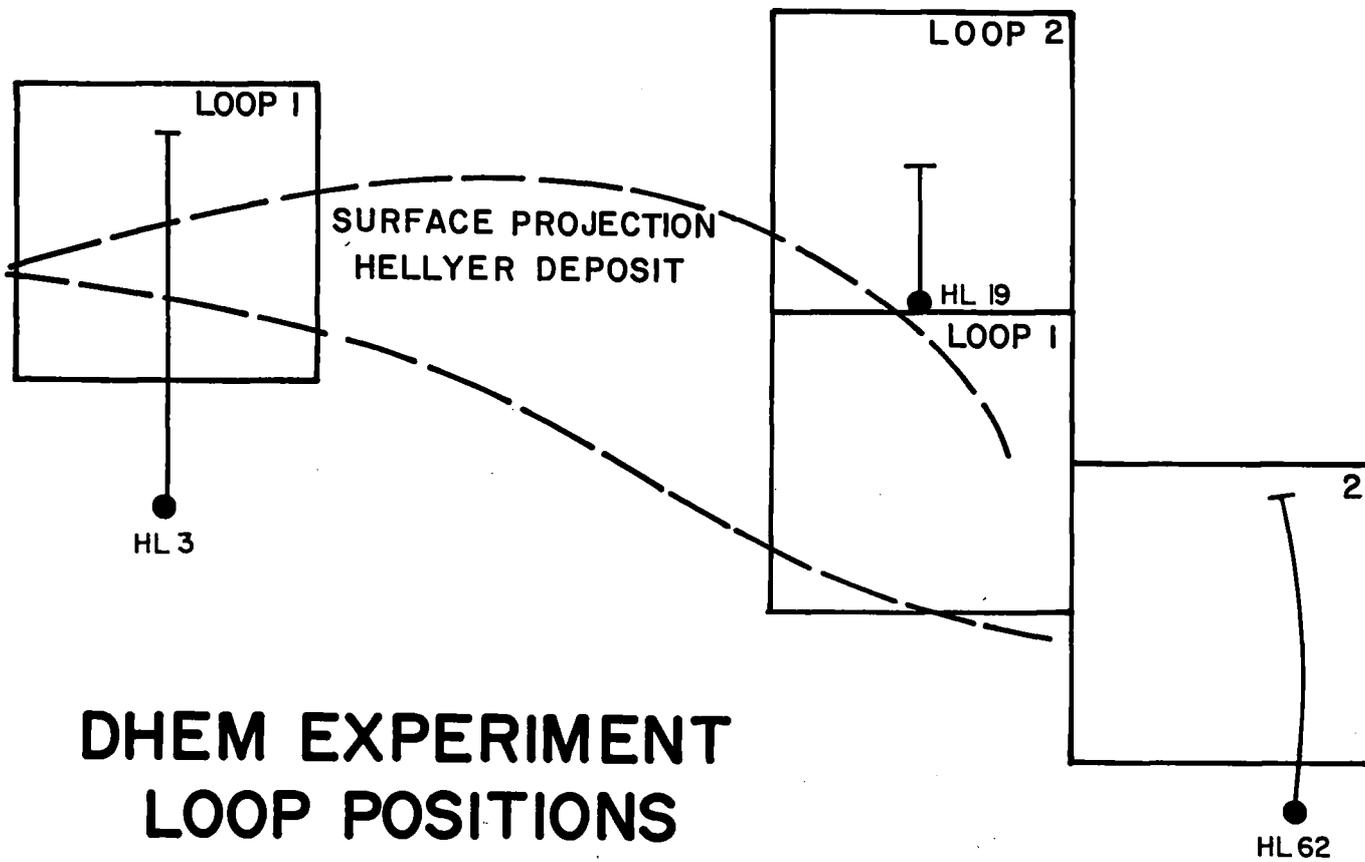
5800 E

5900 E

6000 E

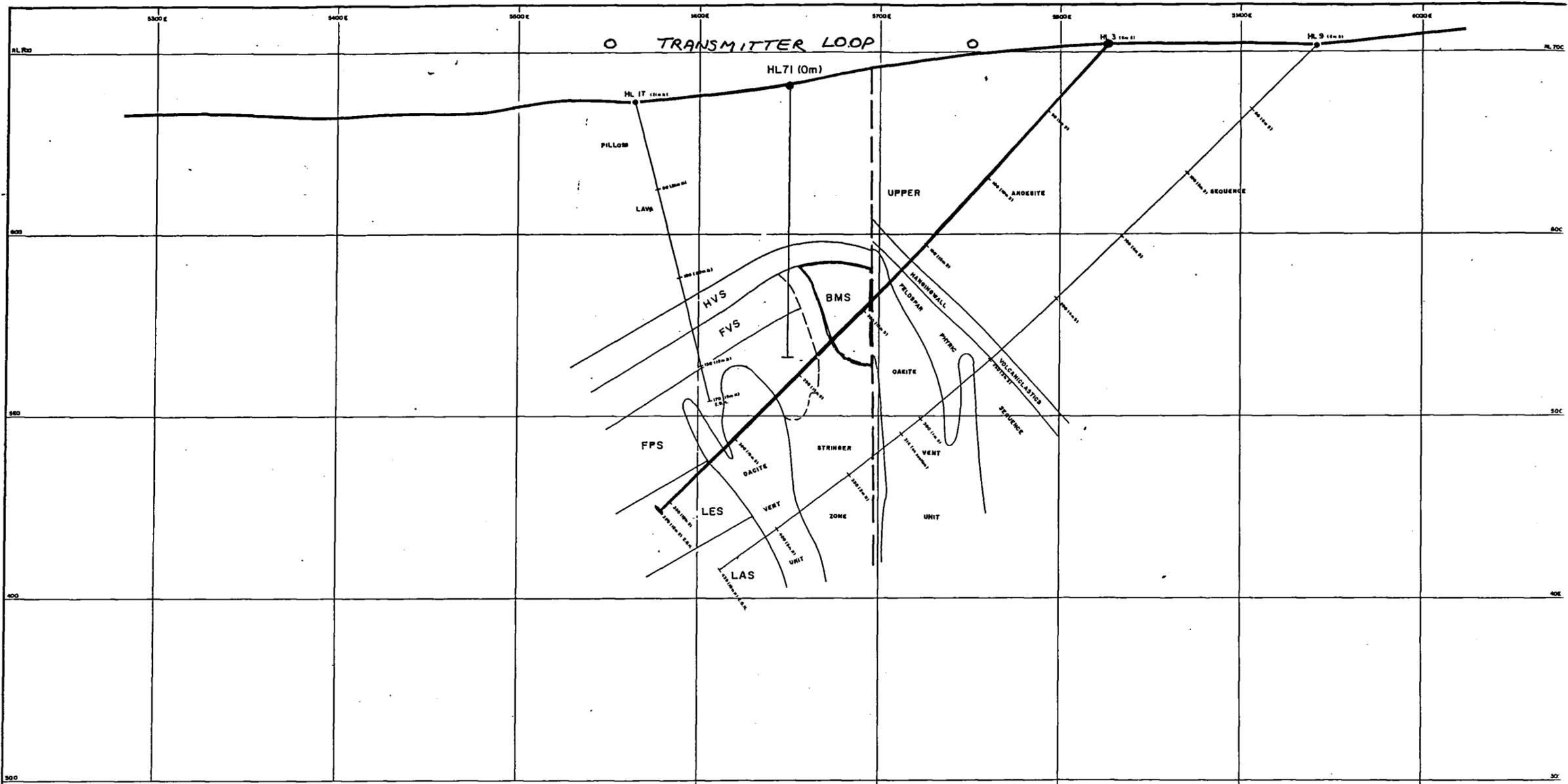
6100 E

6200 E



DHEM EXPERIMENT LOOP POSITIONS

FIGURE 24
ETE/acd November '85

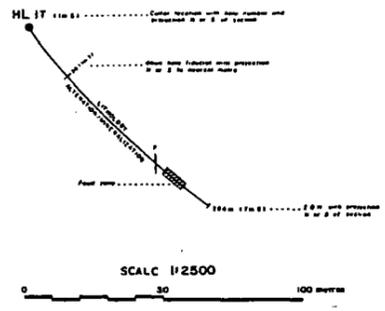


LEGEND

LITHOLOGY

- 55 [Symbol] Shale
- 56 [Symbol] Sandstone, siliceous
- 57 [Symbol] Pillow lava
- 58 [Symbol] Andesite lava
- 59 [Symbol] Andesite breccia
- 60 [Symbol] Andesite scoria tuff
- 61 [Symbol] Breccia composed of andesite scoria tuff
- 62 [Symbol] Felsic dyke zone
- 63 [Symbol] Felsic breccia
- 64 [Symbol] Felsic scoria tuff
- 65 [Symbol] Felsic sandstone
- 66 [Symbol] Porphyritic granite
- 67 [Symbol] Porphyritic diorite
- 68 [Symbol] Highly altered rock

- 69 [Symbol] Dark mudstone
 - 70 [Symbol] Dark grey sandstone
 - 71 [Symbol] Thin dark sandstone
 - 72 [Symbol] Shale with pyrite
 - 73 [Symbol] Shale with chert
- ALTERATION**
- 74 [Symbol] Shale
 - 75 [Symbol] Shale / S. / Quartz
 - 76 [Symbol] Shale / Pyrite
 - 77 [Symbol] Chlorite
 - 78 [Symbol] Chlorite / Epidote
 - 79 [Symbol] Epidote



Aberfoyle Exploration Pty Ltd

NORTH WEST TASMANIA			Geologist: G. M. A.
MACKINTOSH E.L. 2/70			Drawn: ABTEC
HELLYER PROSPECT			Traced: G.L.C.
CROSS SECTION 10400N			Checked:
Survey Code: 2000/700	Scale: 1:2500	Date: 16 June 1984	Plot No:

HEL 22/10400N
FIGURE 25

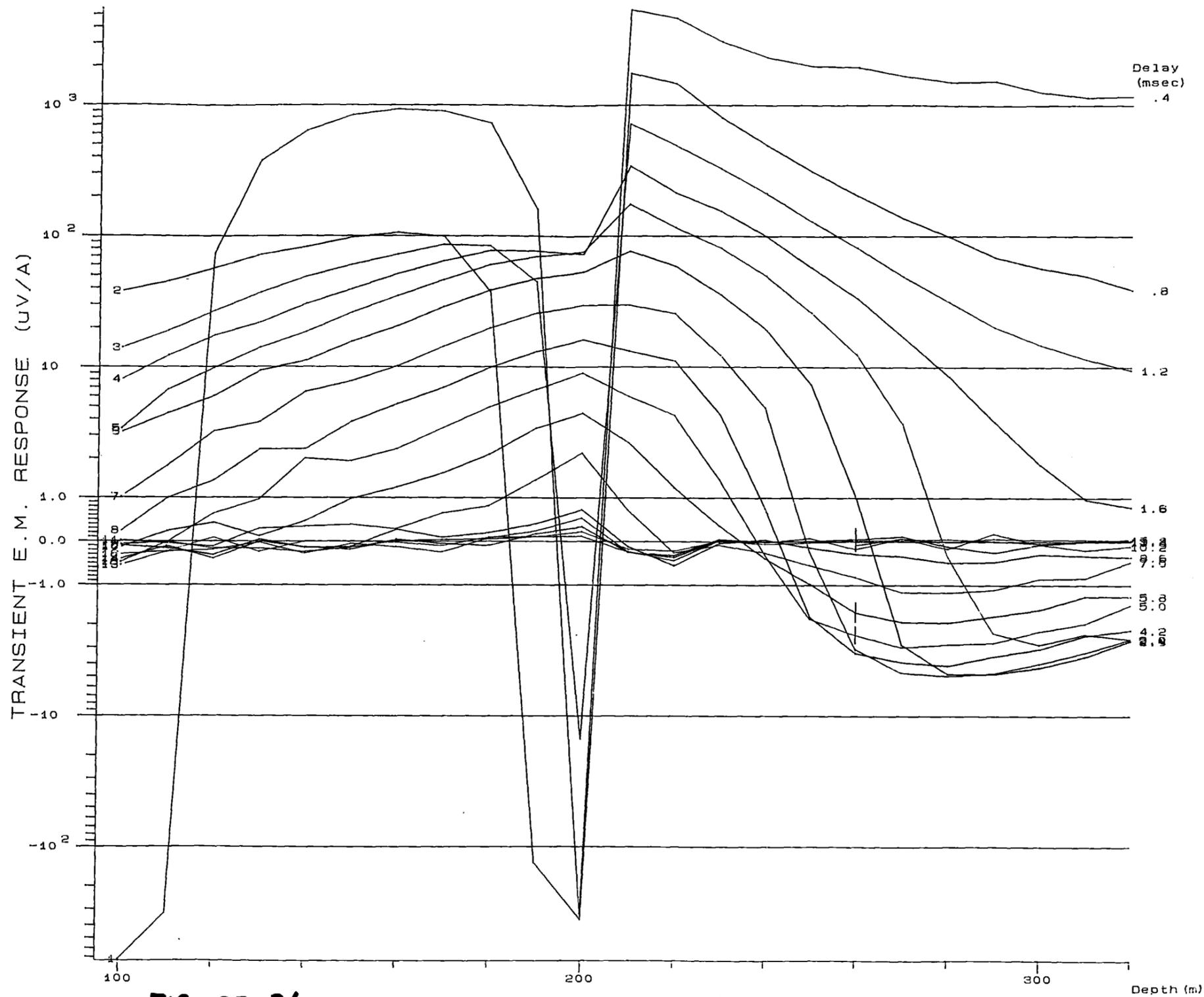
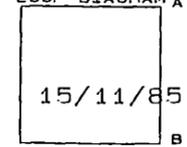


FIGURE 26

ABERFOYLE EXPLORATION PTY. LTD.
 HELLYER
 HELLYER, TASMANIA 607A
 HL-3 (STANDARD TIMES)

SOLO hole ref.536 Reading interval 10.0 m
 SCALE 1 : 1000 Loop size : 200 m
 LOOP configuration : Drill hole
 Plotted : 5:55 PM 22/11/85

LOOP DIAGRAM A



A = (10500N, 5750E)
 B = (10300N, 5750E)
 C = (10300N, 5550E)



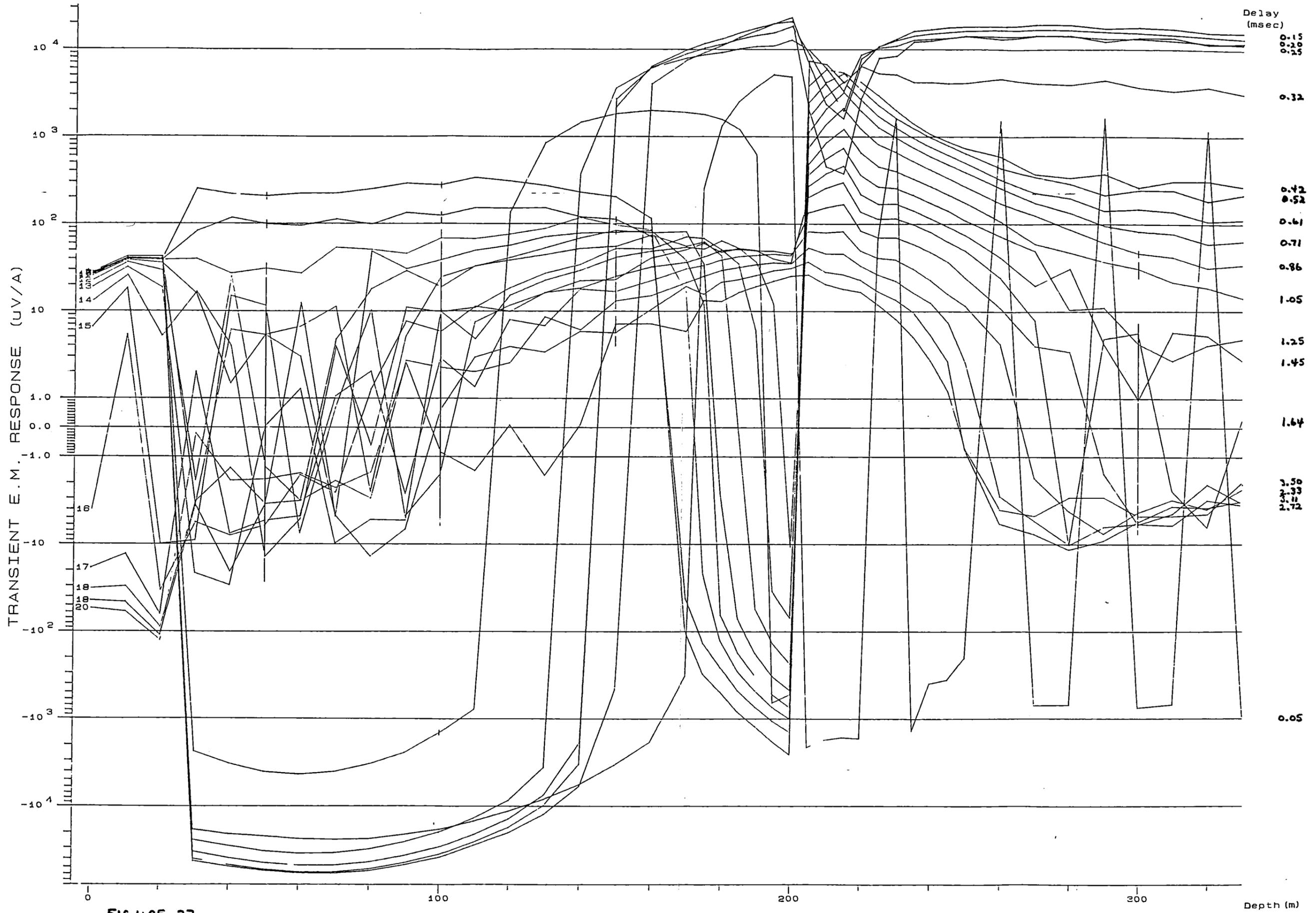
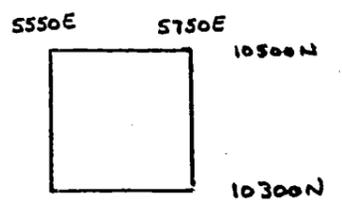
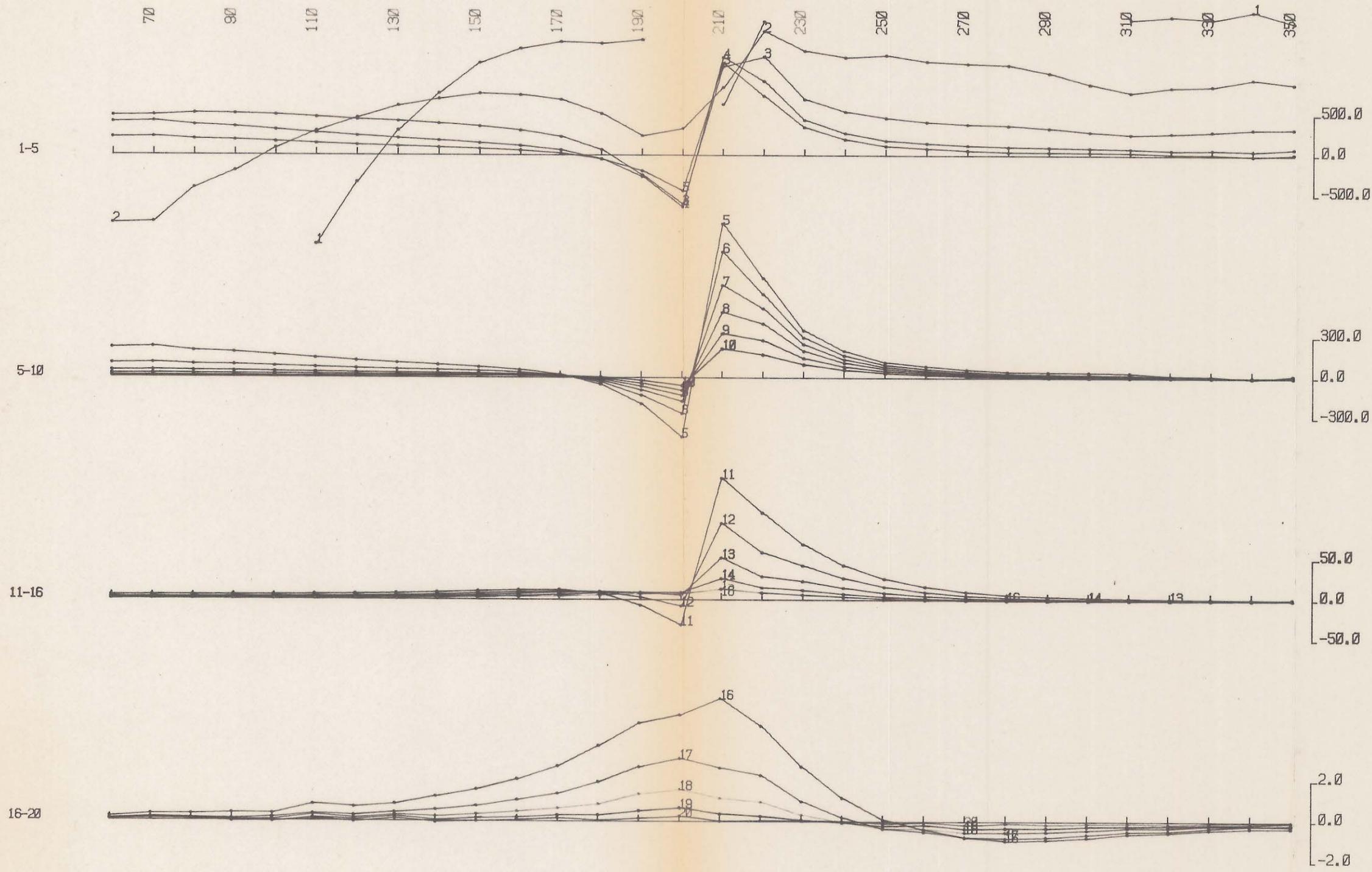


FIGURE 27

ABERFOYLE EXPLORATION PTY. LTD.
 C-ZONE (JOB NO.6066)
 HELLYER, TASMANIA
 DRILL HOLE HL-3 EARLY TIMES
 SIROTEM Survey by SOLO Geophysics & Co. 1/10/85



AXIAL COMPONENT B (A)



nanovolts per amp.metre squared

EM-37
BOREHOLE
SURVEY

ELECTROMOTIVE FORCE INDUCED BY
SECONDARY FIELD
TIME DERIVATIVE OF FLUX DENSITY (B)

TX LOOP SIDES : 10500N 5700E
 : 10300N 5500E
TX LOOP SIZE : 200m X 200m
TX TURN OFF TIME : 132 microseconds
CURRENT : 11.5 amps
FREQUENCY : 25
INTEGRATION TIME : 1024 cycles
SYNC MODE : CRYSTAL
HORIZONTAL SCALE : 1:1000
SURVEYED BY : PEJP
DATE : 20-APR-1985

	SURVEYED AND COMPILED BY GEOTREX PTY. LTD.	PROJECT NO. 85-1862
	CLIENT : Aberfoyle Ltd.	

PROJECT : Hellyer
AREA : Waratah Tasmania
BOREHOLE : HL3
TX LOOP : 1

A
FIGURE 28

CRONE GEOPHYSICS Limited
BOREHOLE PEM

Client
ABERFOYLE

File
A:HL305

Grid
HELLYER

Hole
HL3

Tx Loop
1

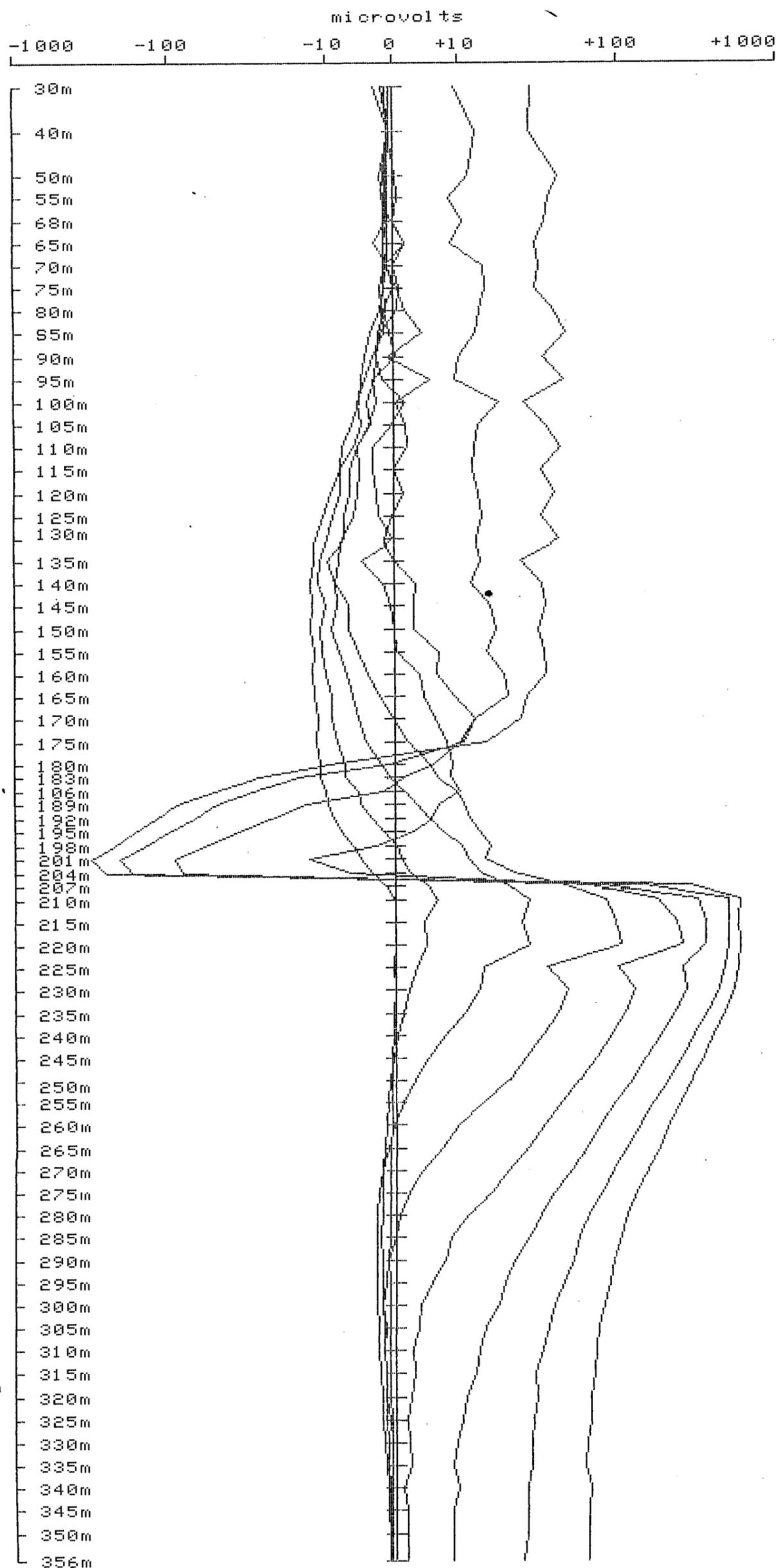
Time base: 10ms
Ramp time: 0.5ms

ZTS: 145
Gain: 500

Date: 26/03/85

Scale: 1:1000

FIGURE 29



CRONE GEOPHYSICS Limited
BOREHOLE PEM

Client
Aberfoyle

File
A: HL315

Grid
Hellyer

Hole
HL3

Tx Loop
1

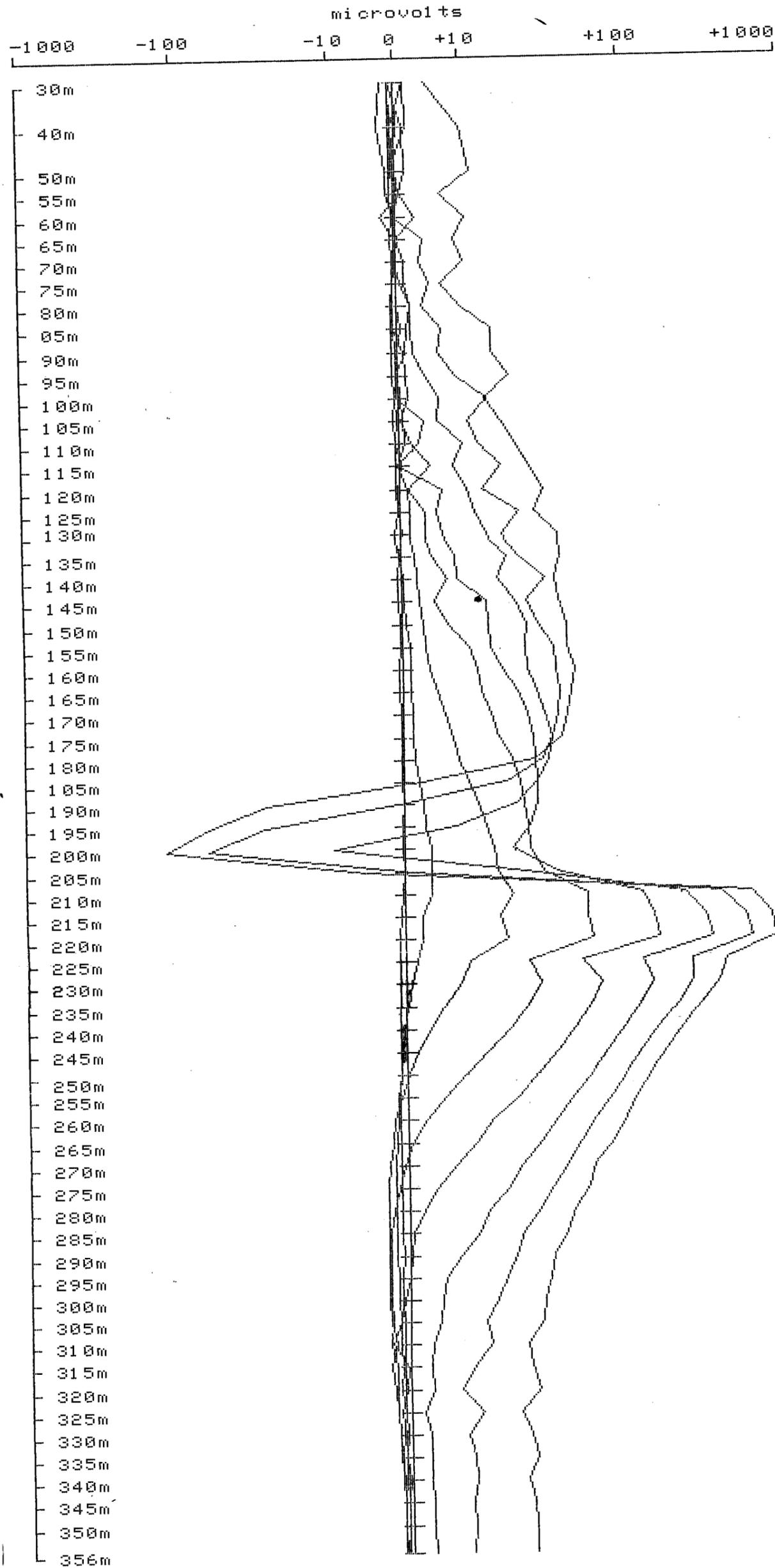
Time base: 10ms
Ramp time: 1.5ms

ZTS: 650
Gain: 200

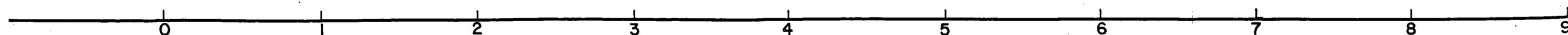
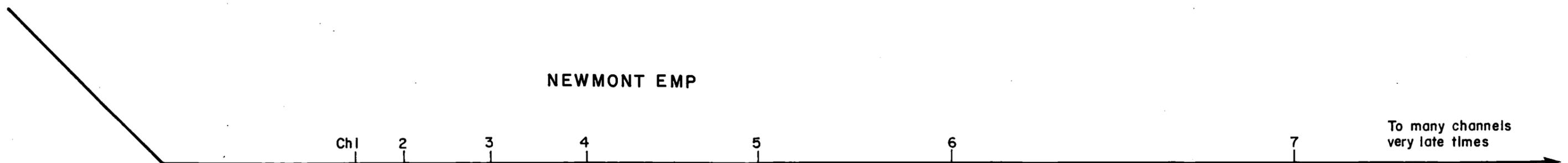
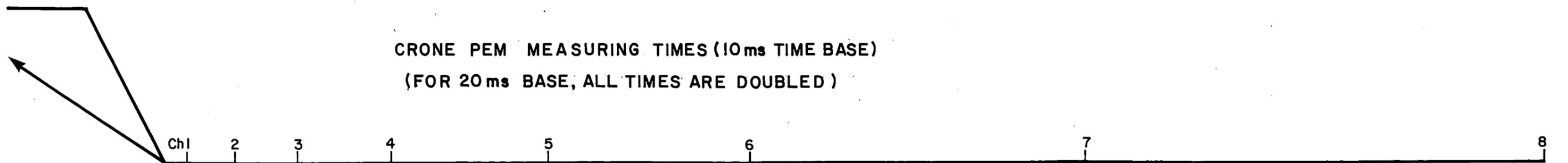
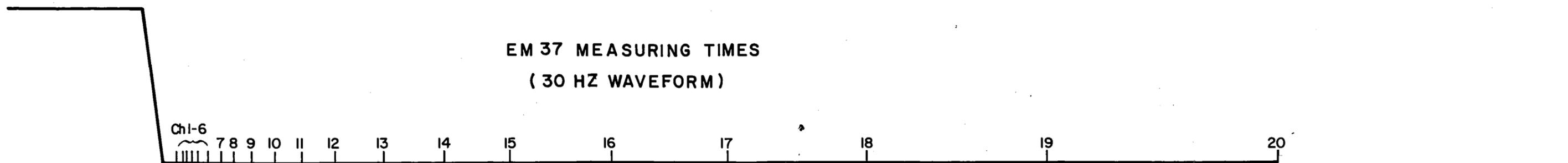
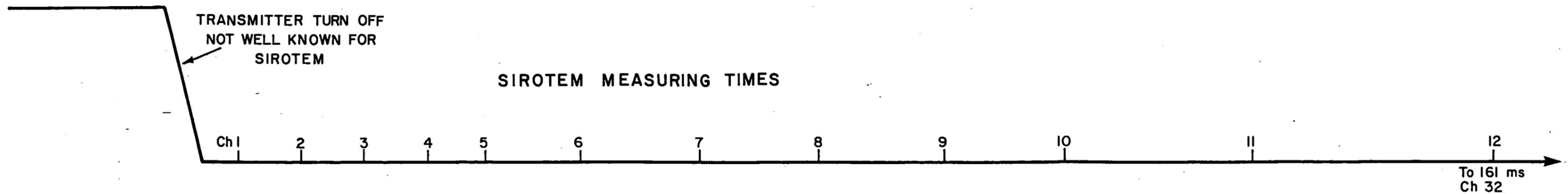
Date: 01/04/85

Scale: 1:1000

FIGURE 30



EM SYSTEMS WAVEFORMS AND MEASURING TIMES



HELLYER HL3 DECAY CURVES

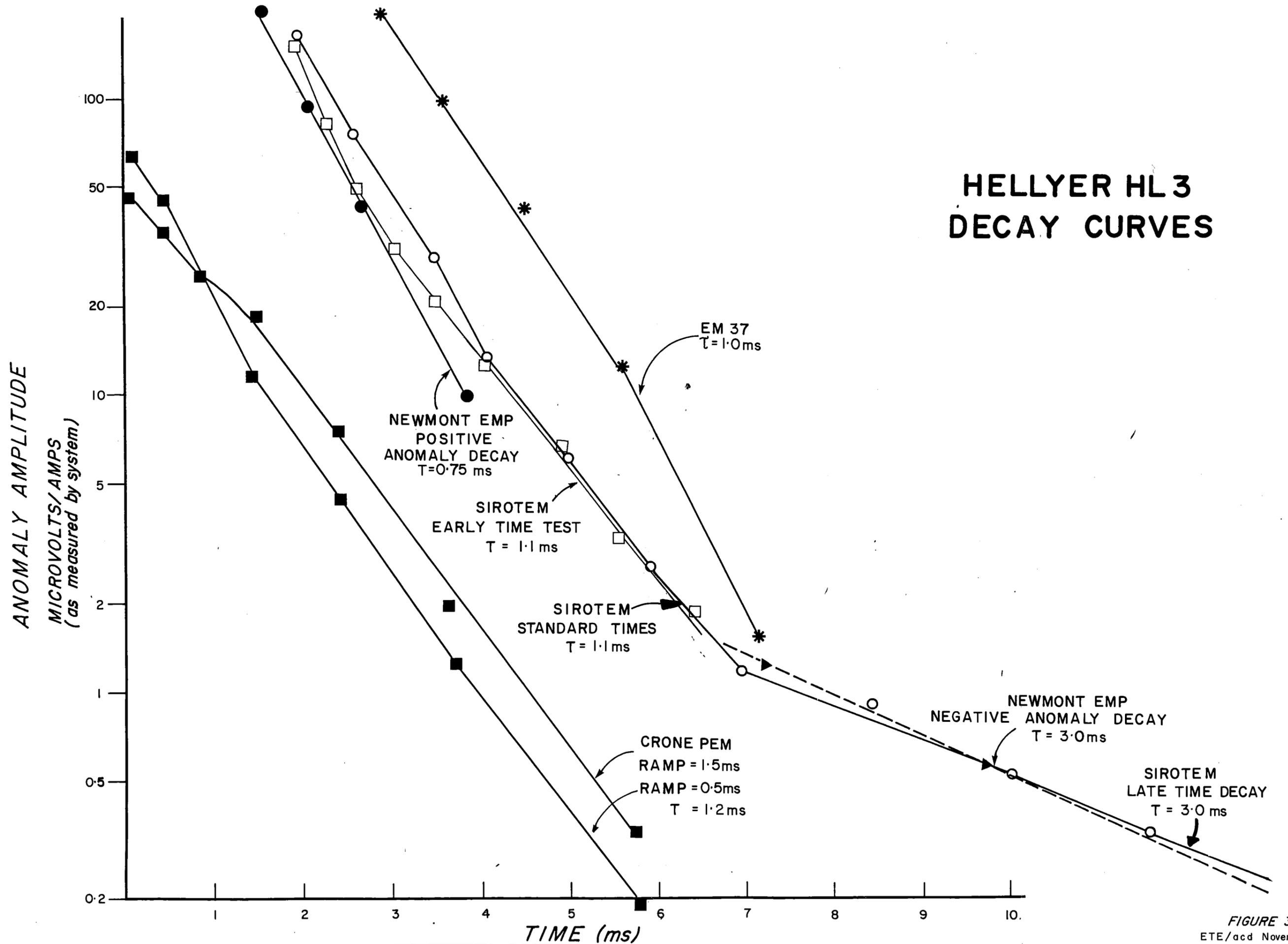


FIGURE 32
ETE/acd November '85

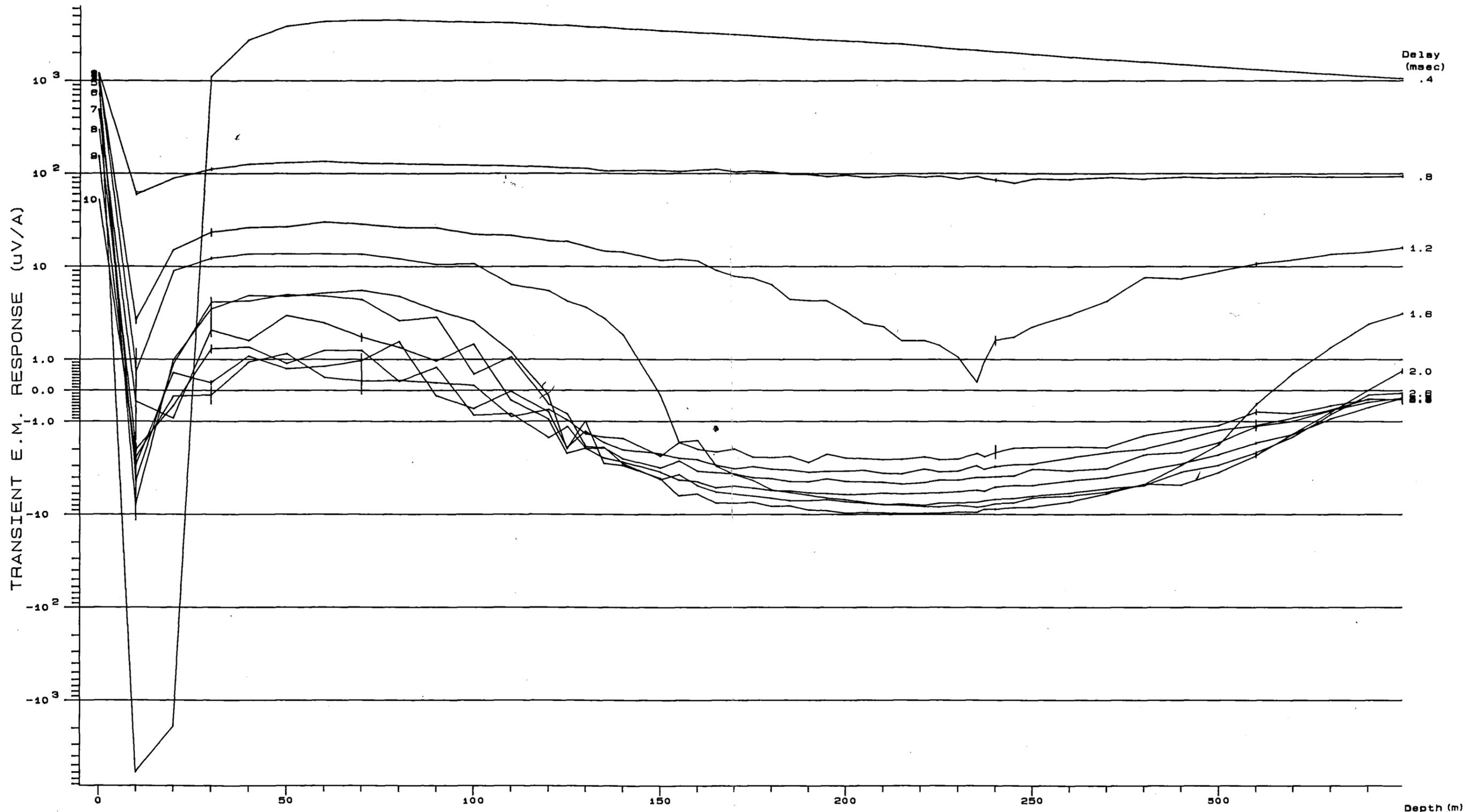


FIGURE 34

ABERFOYLE EXPLORATION PTY. LTD.

QUE RIVER TASMANIA

HELLYER (Job No. 518)

DRILL HOLE HL1S 1st loop

SIROTEM Survey by SOLO Geophysics & Co. 7/ 5/84

SOLO hole ref.218 Reading interval 2.0 m

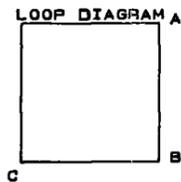
SCALE 1 : 1000 Loop size : 200 x 200 m

LOOP configuration : Drill hole

Plotted : 4:17 PM 8/ 8/84

Plate No: X HELL 5A

DH



A = (1100N, 8800E)
 B = (10800N, 8800E)
 C = (10800N, 5700E)
 DH = (10800N, 5680E)

SOLO

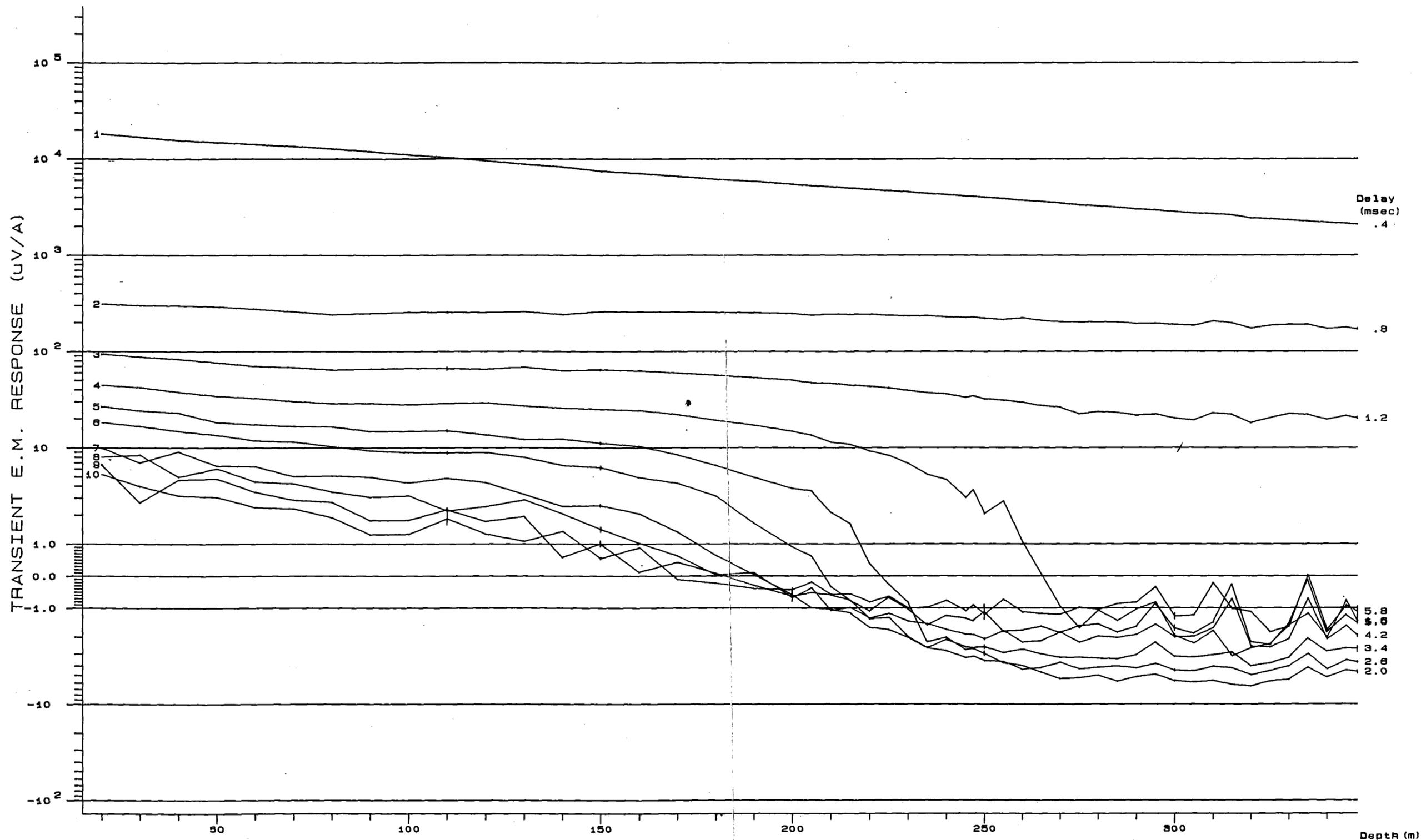


FIGURE 35

ABERFOYLE EXPLORATION PTY. LTD.

QUE RIVER TASMANIA

HELLYER (Job No. 518)

DRILL HOLE HL19 2nd loop

SIROTEM Survey by SOLO Geophysics & Co. 8/ 5/84

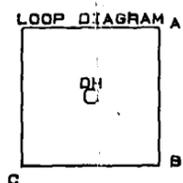
SOLO hole ref.220 Reading interval 2.0 m

SCALE 1 : 1000 Loop size : 200 x 200 m

LOOP configuration : Drill hole

Plotted : 4:24 PM 8/ 6/84

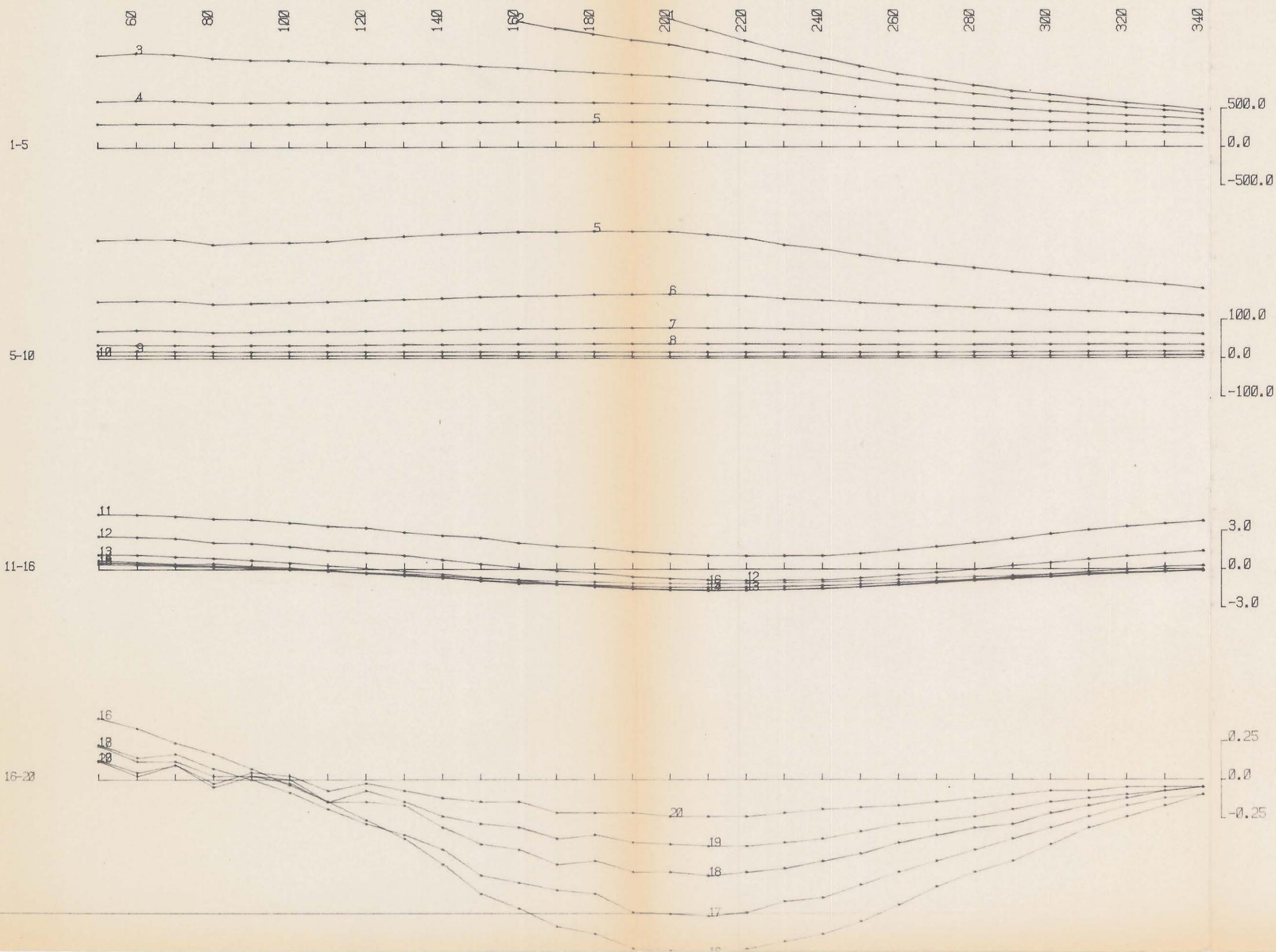
Plate No: X HELL 5B



A = (1100N, 8700E)
 B = (10800N, 8700E)
 C = (10800N, 5500E)
 DH = (10800N, 8650E)

SOLO

AXIAL COMPONENT B (A)



nanovolts per amp.metre squared

EM-37
BOREHOLE SURVEY

ELECTROMOTIVE FORCE INDUCED BY
SECONDARY FIELD
TIME DERIVATIVE OF FLUX DENSITY (B)

TX LOOP SIDES : 11000N 5700E
 : 10800N 5900E
TX LOOP SIZE : 200m X 200m
TX TURN OFF TIME : 145 microseconds
CURRENT : 12.5 amps
FREQUENCY : 25
INTEGRATION TIME : 1024 cycles
SYNC MODE : CRYSTAL
HORIZONTAL SCALE : 1:1000
SURVEYED BY : PEJP
DATE : 21-APR-1985

	SURVEYED AND COMPILED BY GEOTREX PTY. LTD.	PROJECT NO. 85-1862

CLIENT : Aberfoyle Ltd.
PROJECT : Hellyer
AREA : Waratah Tasmania
BOREHOLE : HL19
TX LOOP : 1

AXIAL COMPONENT B (A)

EM-37

BOREHOLE SURVEY

ELECTROMOTIVE FORCE INDUCED BY
SECONDARY FIELD
TIME DERIVATIVE OF FLUX DENSITY (B)

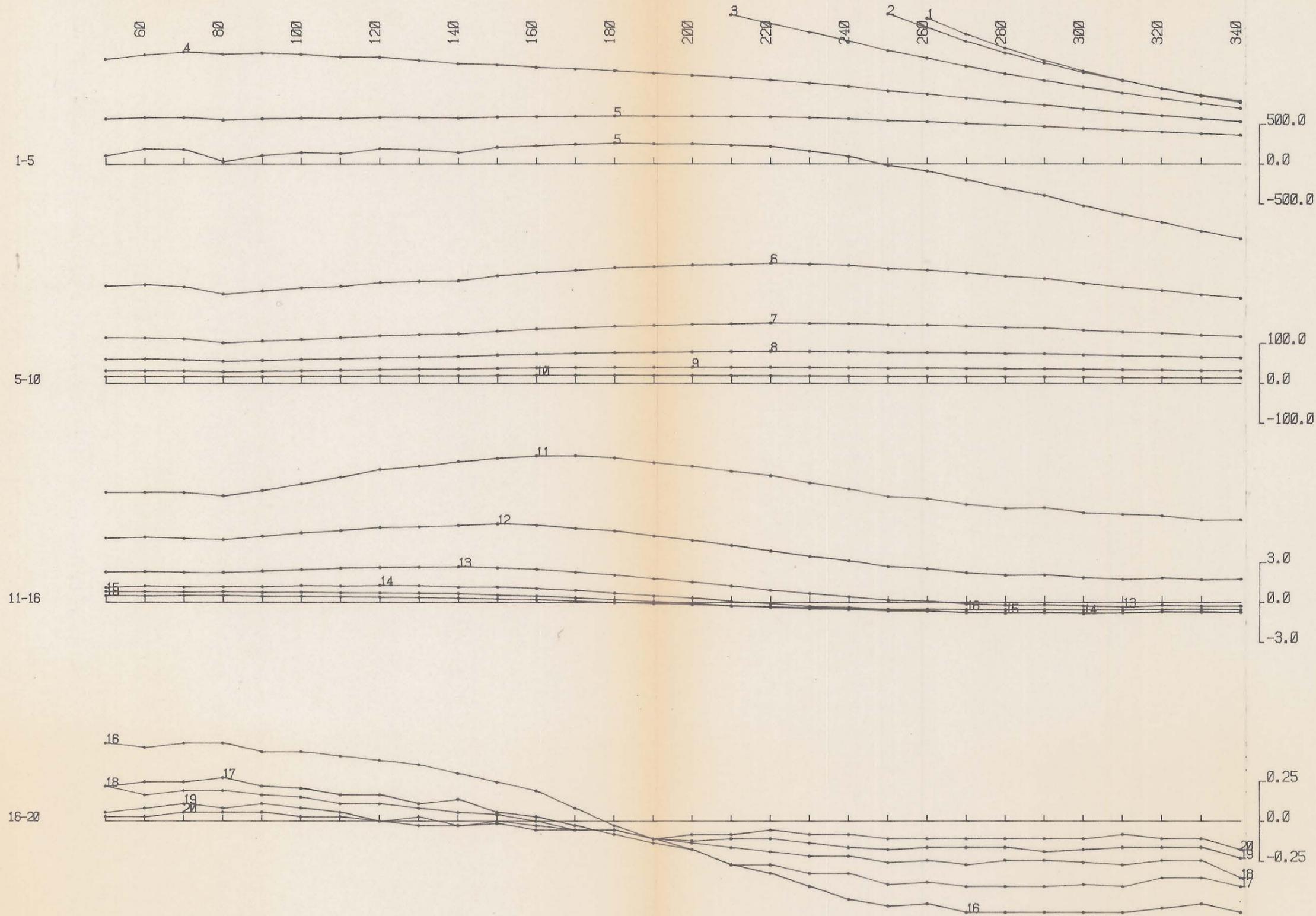
nanovolts per amp.metre squared

TX LOOP SIDES : 11000N 5500E
: 10600N 5700E
TX LOOP SIZE : 200m X 200m
TX TURN OFF TIME : 110 microseconds
CURRENT : 11.0 amps
FREQUENCY : 25
INTEGRATION TIME : 1024 cycles
SYNC MODE : CRYSTAL
HORIZONTAL SCALE : 1:1000
SURVEYED BY : PEJP
DATE : 21-APR, 1965

	SURVEYED AND COMPILED BY	PROJECT NO.
	GEOTREX PTY. LTD.	65-1662

CLIENT : Aberfoyle Ltd.
PROJECT : Hellyer
AREA : Waratah Tasmania
BOREHOLE : HL19
TX LOOP : 2

FIGURE 37



CRONE GEOPHYSICS Limited
BOREHOLE PEM

Client
Aberfoyle

File
A: HL19E05

Grid
Hellyer

Hole
HL19

Tx Loop
1

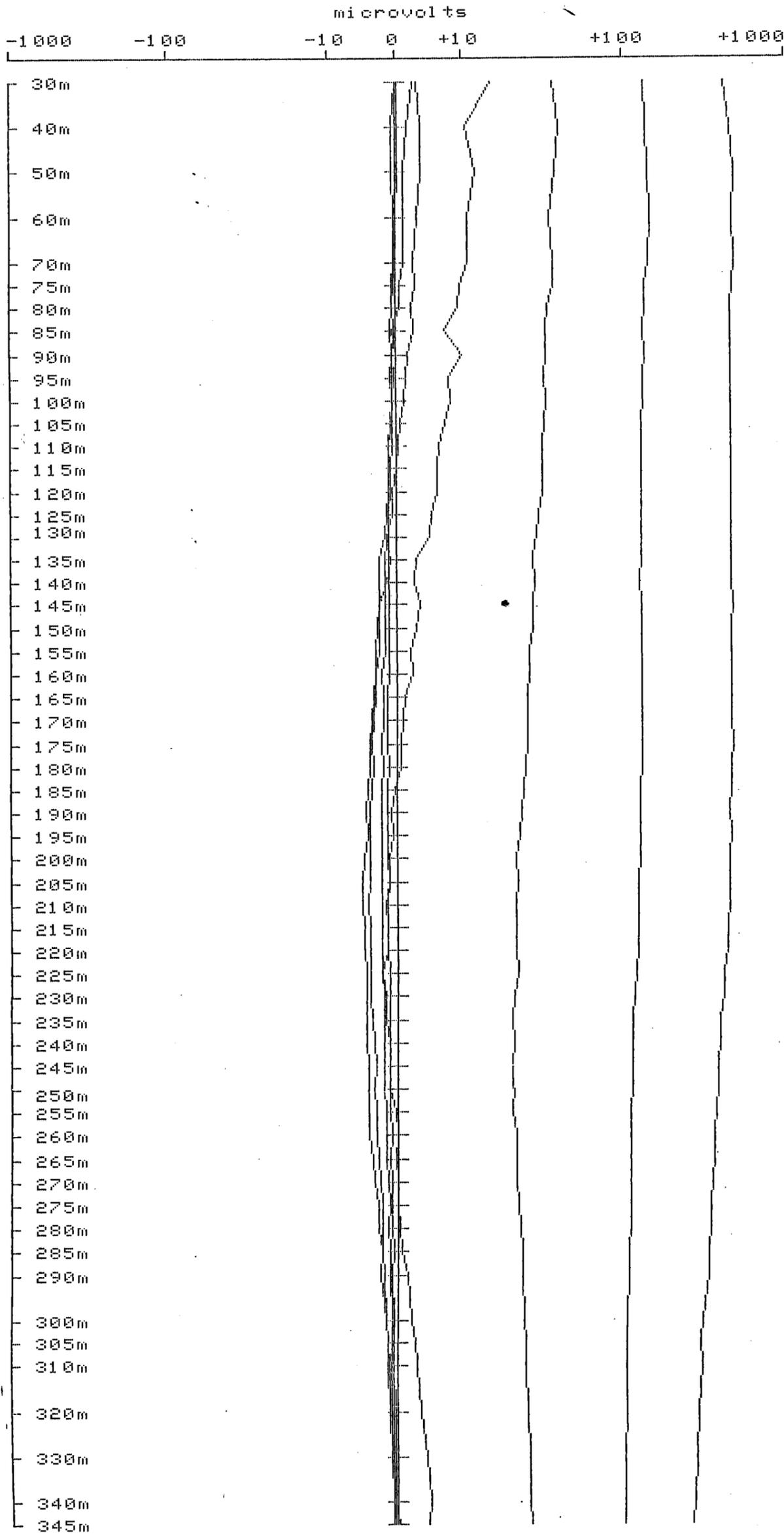
Time base: 10ms
Ramp time: 0.5ms

ZTS: 150
Gain: 250

Date: 27/03/85

Scale: 1:1000

FIGURE 38



CRONE GEOPHYSICS Limited
BOREHOLE PEM

Client
Aberfoyle

File
A:HL19E15

Grid
Hellyer

Hoie
HL19

Tx Loop

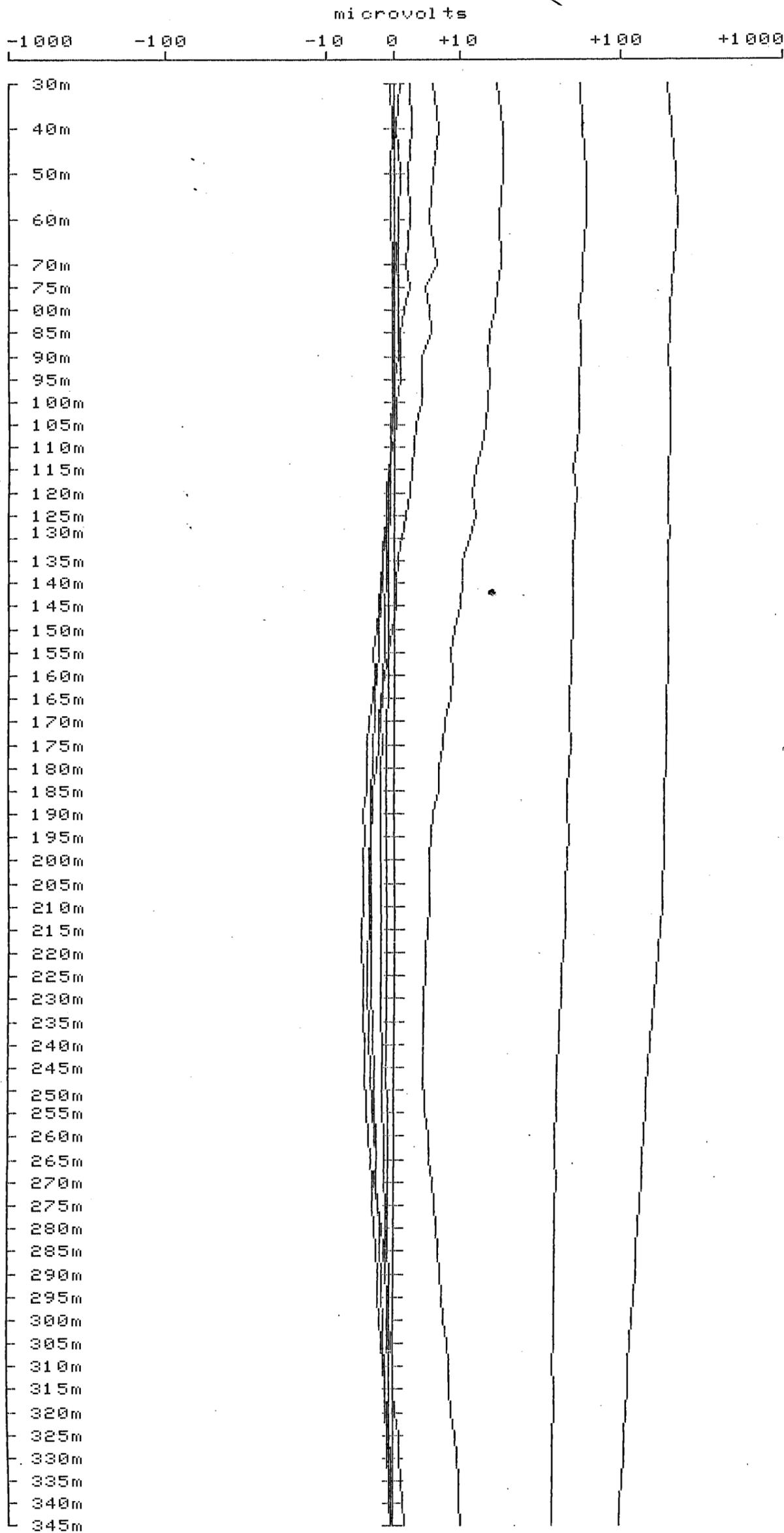
Time base: 10ms
Ramp time: 1.5ms

ZTS: 650
Gain: 250

Date: 02/04/85

Scale: 1:1000

FIGURE 39



CRONE GEOPHYSICS Limited
BOREHOLE PEM

Client
Aberfoyle

File
A:HL19E20

Grid
Hellyer

Hoie
HL19

Tx Loop

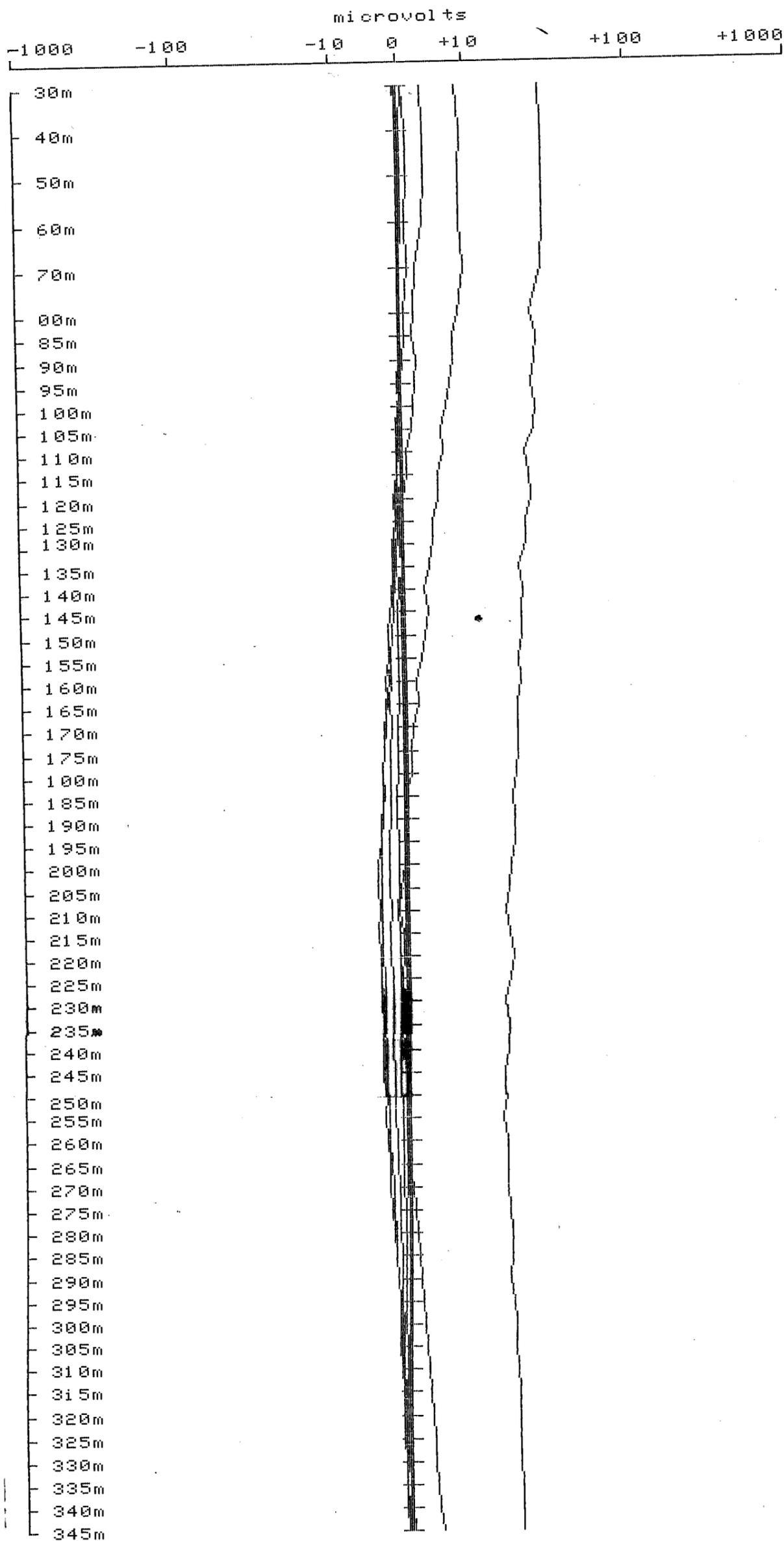
Time base: 20ms
Ramp time: 1.5ms

ZTS: 650
Gain: 500

Date: 02/04/85

Scale: 1:1000

FIGURE 40



BOREHOLE PEM

Client
Aberfoyle

File
A: HL19W05

Grid
Hellyer

Hole
HL19

Tx Loop
W

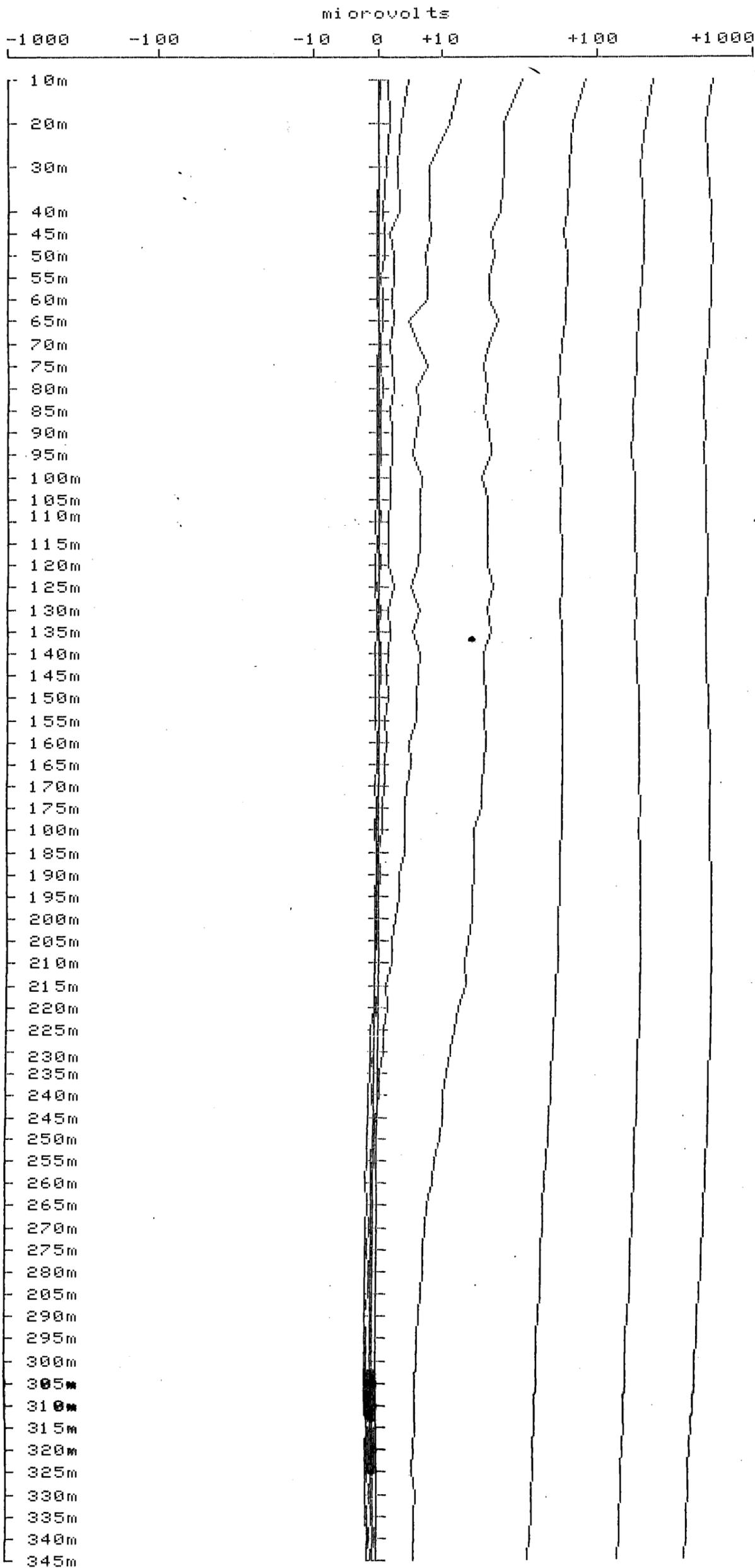
Time base: 10ms
Ramp time: 0.5ms

ZTS: 150
Gain: 250

Date: 27/03/85

Scale: 1:1000

FIGURE 41



Client
Aberfoyle

File
A: HL19W15

Grid
Hel1yer

Hoie
HL19

Tx Loop
W

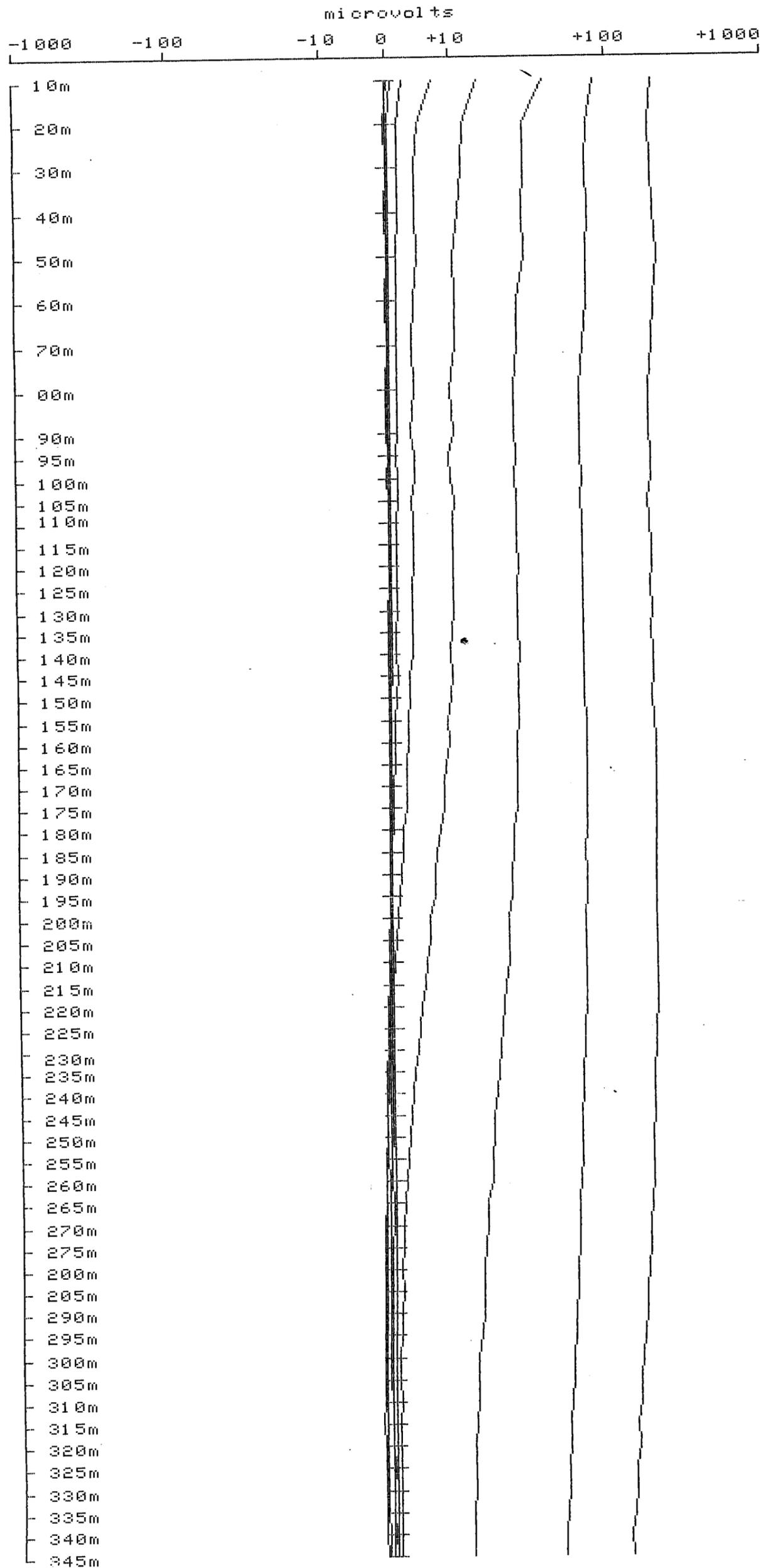
Time base: 10ms
Ramp time: 1.5ms

ZTS: 650
Gain: 500

Date: 02/04/85

Scale: 1:1000

FIGURE 42



CRONE GEOPHYSIOS Limited
BOREHOLE PEM

Client
Aberfoyle

File
A:HL19W20

Grid
Ne11yer

Hole
HL19

Tx Loop

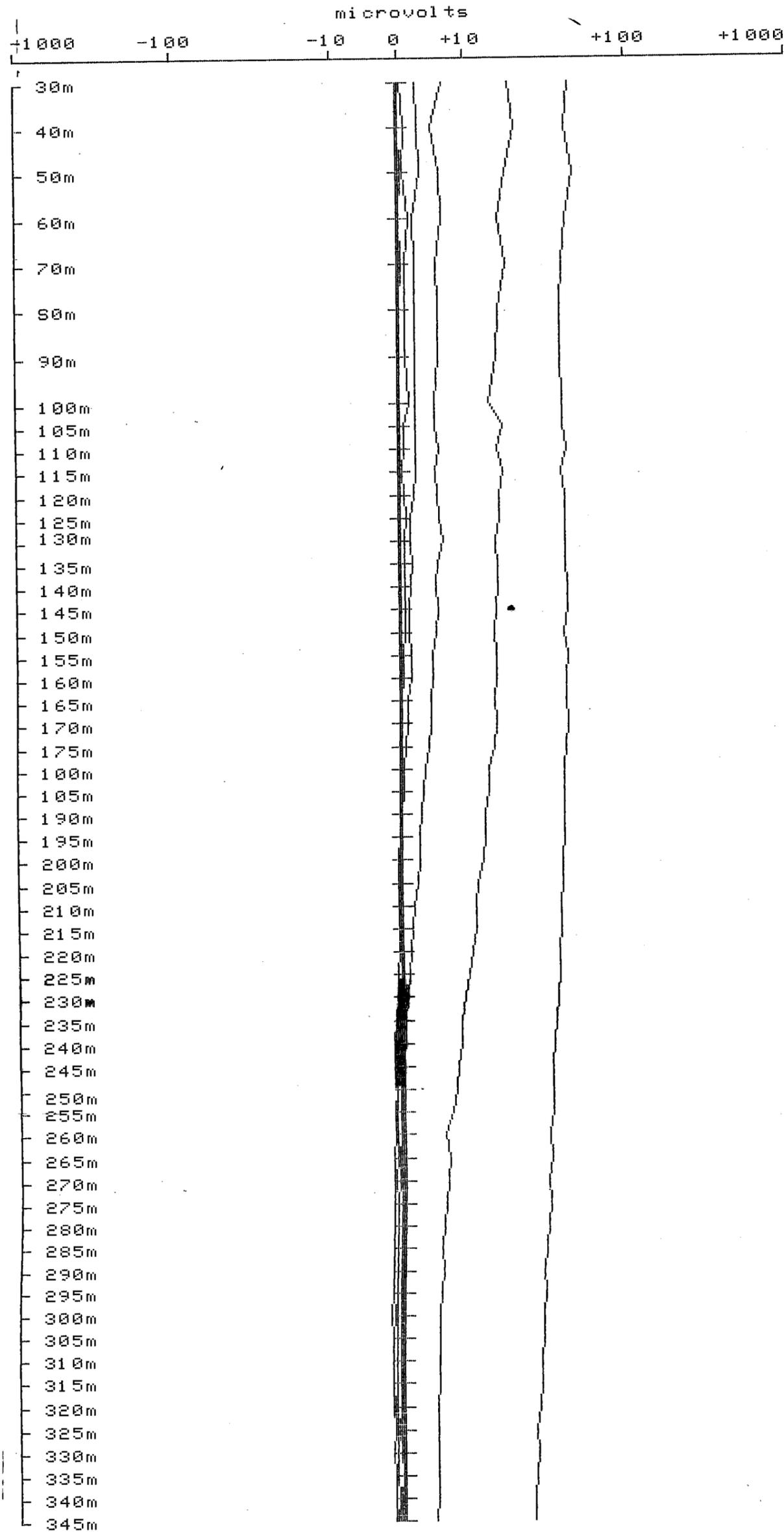
Time base: 20ms
Ramp time: 1.5ms

ZTS: 650
Gain: 500

Date: 02/04/85

Scale: 1:1000

FIGURE 43



CRONE GEOPHYSICS Limited
BOREHOLE PEM

Client
Aberfoyle

File
A:HL19E20

Grid
Hellyer

Hoie
HL19

Tx Loop
1

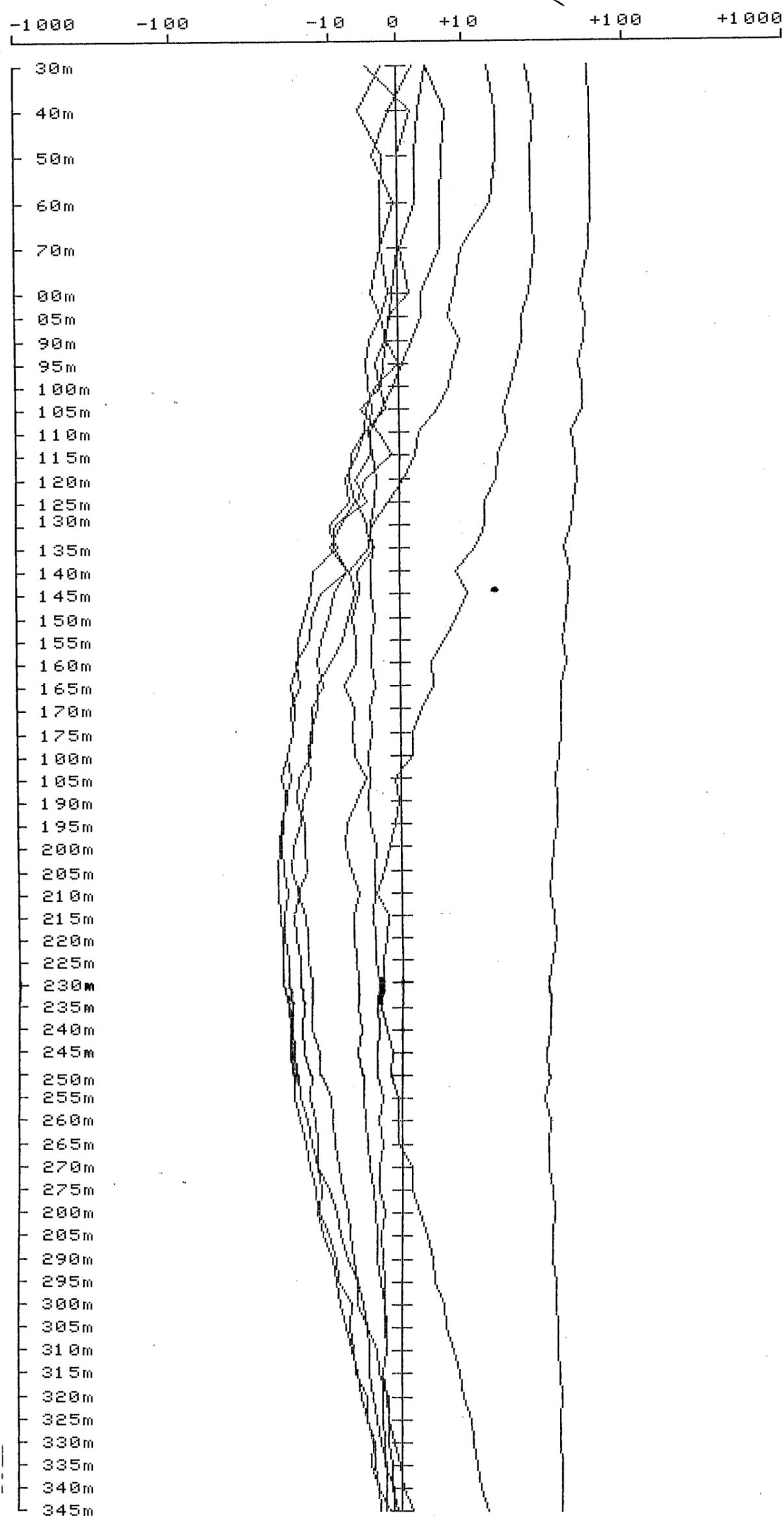
Time base: 20ms
Ramp time: 1.5ms

ZTS: 650
Gain: 500

Date: 02/04/85

Scale: 1:1000

FIGURE 11



CRONE GEOPHYSICS Limited
BOREHOLE PEM

Client
Aberfoyle

File
A: HL19W20

Grid
Hellyer

Hoie
HL19

Tx Loop
2

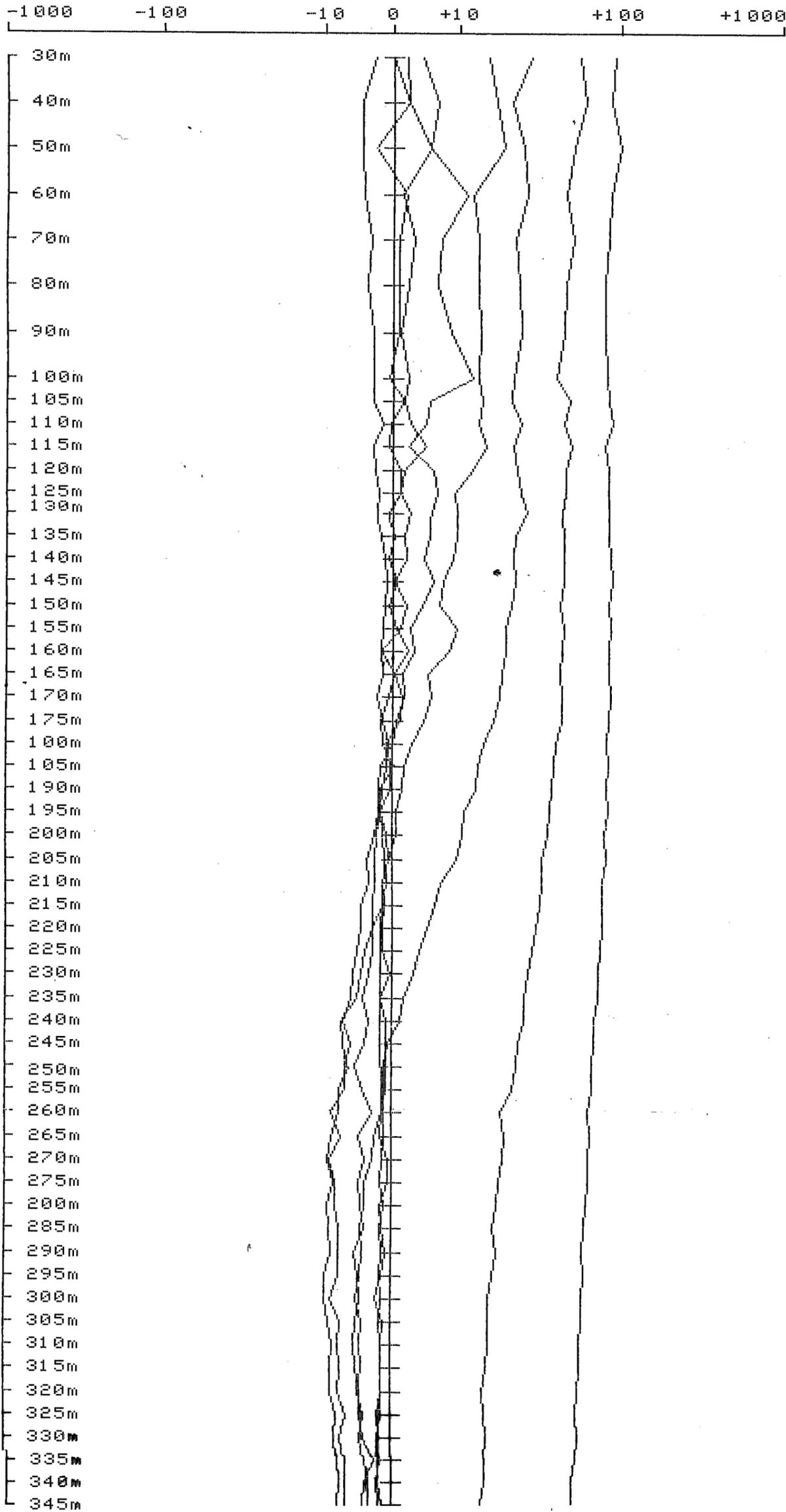
Time base: 20ms
Ramp time: 1.5ms

ZTS: 650
Gain: 500

Date: 02/04/85

Scale: 1:1000

FIGURE 45



HL 19 - LOOP 1 DECAYS

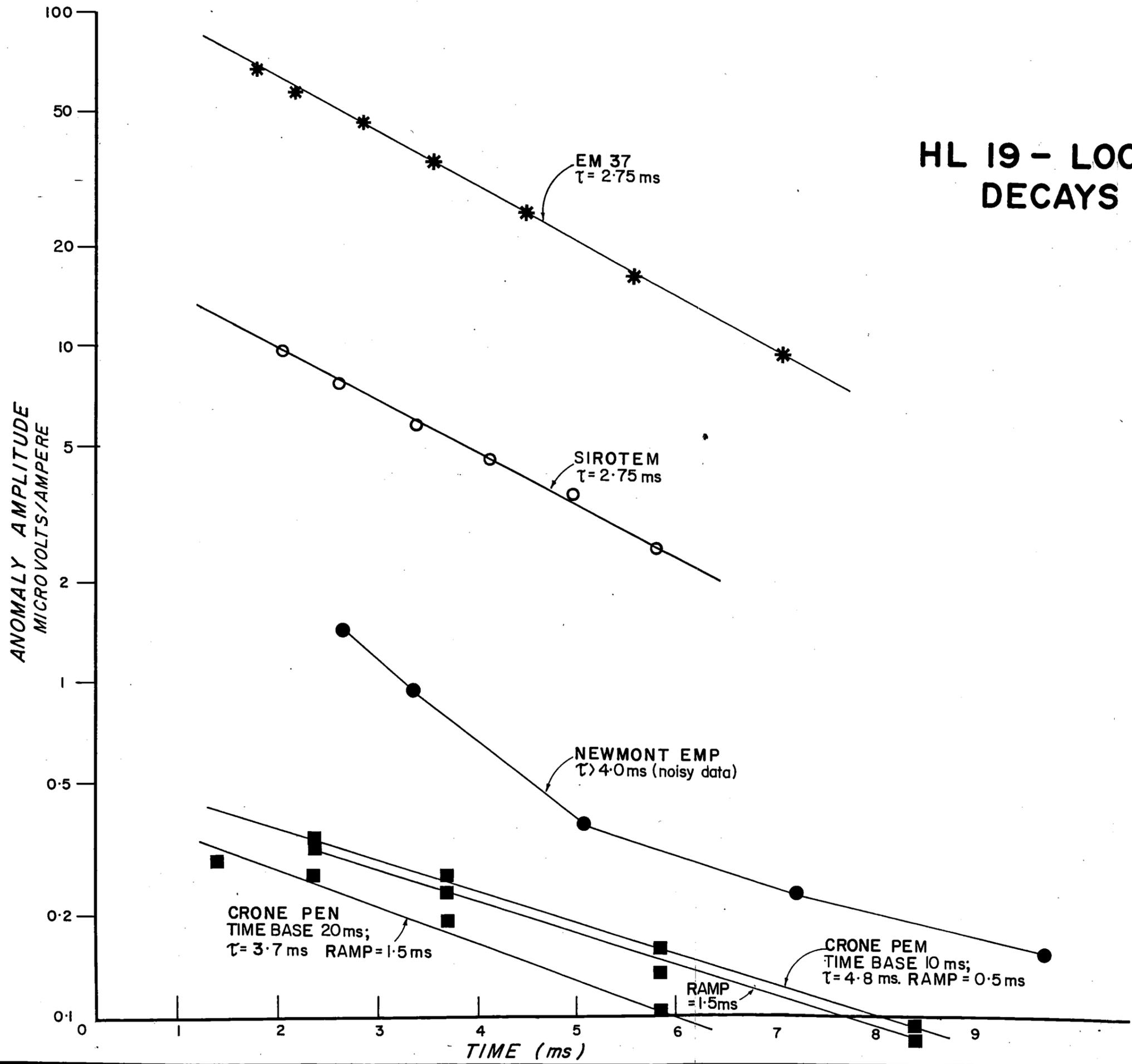


FIGURE 46
ETE/acd November '85

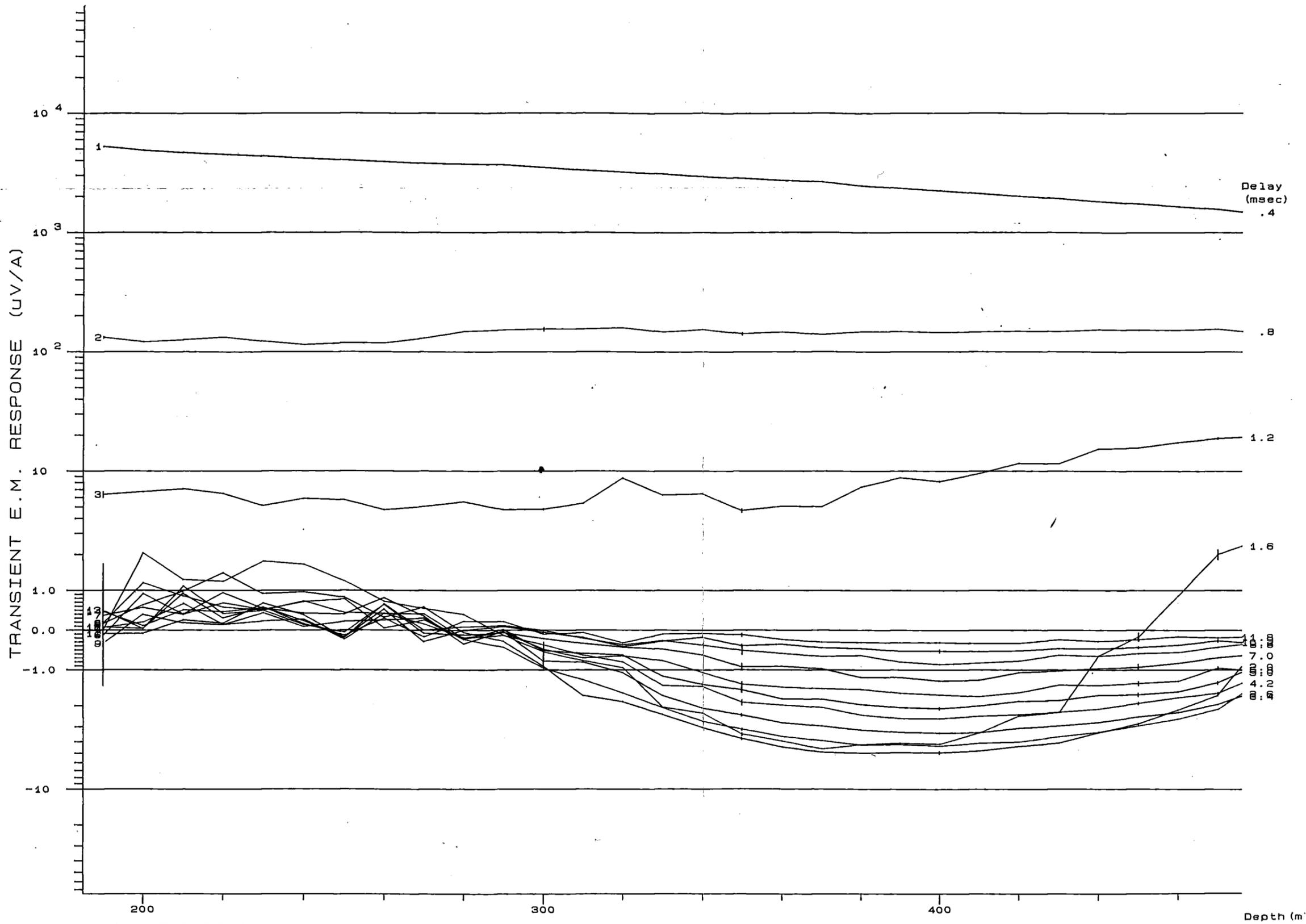
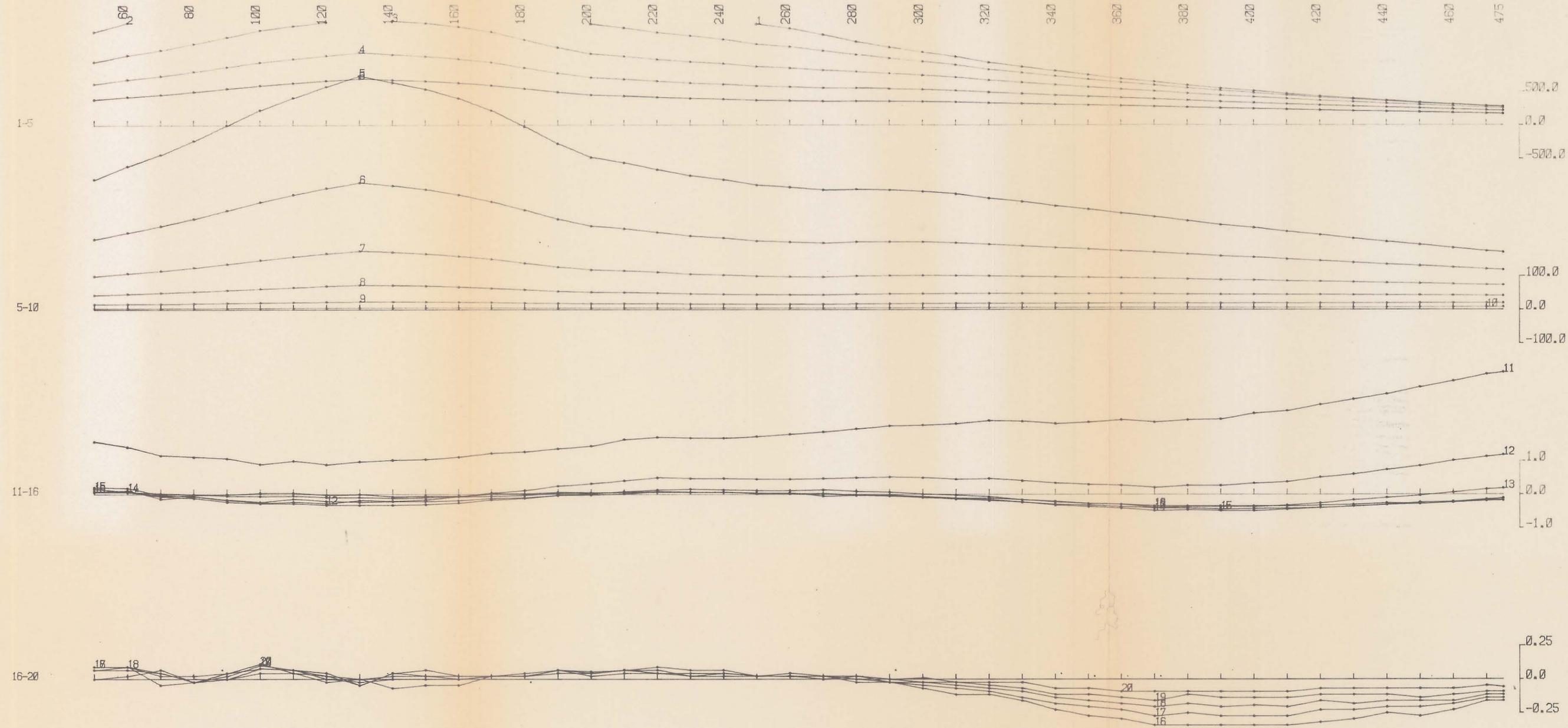


FIGURE 47
 ABERFOYLE EXPLORATION PTY. LTD.
 QUE RIVER AREA TASMANIA
 HELLYER PROSPECT JOB NO.
 DH HL62 LOOP #2
 SIROTEM Survey by SOLO Geophysics & Co.
 SOLO hole ref.204 Reading interval 6.0 m
 SCALE 1 : 1000 Loop size : 200 m
 LOOP configuration : Drill hole
 Plotted : 9:01 AM 1/12/81



AXIAL COMPONENT B (A)



nanovolts per amp. metre squared

EM-37
BOREHOLE
SURVEY

ELECTROMOTIVE FORCE INDUCED BY
SECONDARY FIELD
TIME DERIVATIVE OF FLUX DENSITY (B)

TX LOOP SIDES : 11000N 6000E
 : 11200N 5800E
TX LOOP SIZE : 200m X 200m
TX TURN OFF TIME : 144 microseconds
CURRENT : 13.2 ampe
FREQUENCY : 25
INTEGRATION TIME : 1024 cycles
SYNC MODE : CRYSTAL
HORIZONTAL SCALE : 1:1000
SURVEYED BY : PEJP
DATE : 11-JUN, 1985

	SURVEYED AND COMPILED BY GEOTREX PTY. LTD.	PROJECT NO. 85-1862
---	---	------------------------

CLIENT : Aberfoyle Ltd.
PROJECT : Hellyer
AREA : Maratah Tasmania
BOREHOLE : HL62
TX LOOP : 2

CRONE GEOPHYSICS Limited
BOREHOLE PEM

Client
Aberfoyle

File
A: HL62-05

Grid
Hellier

Hole
HL62

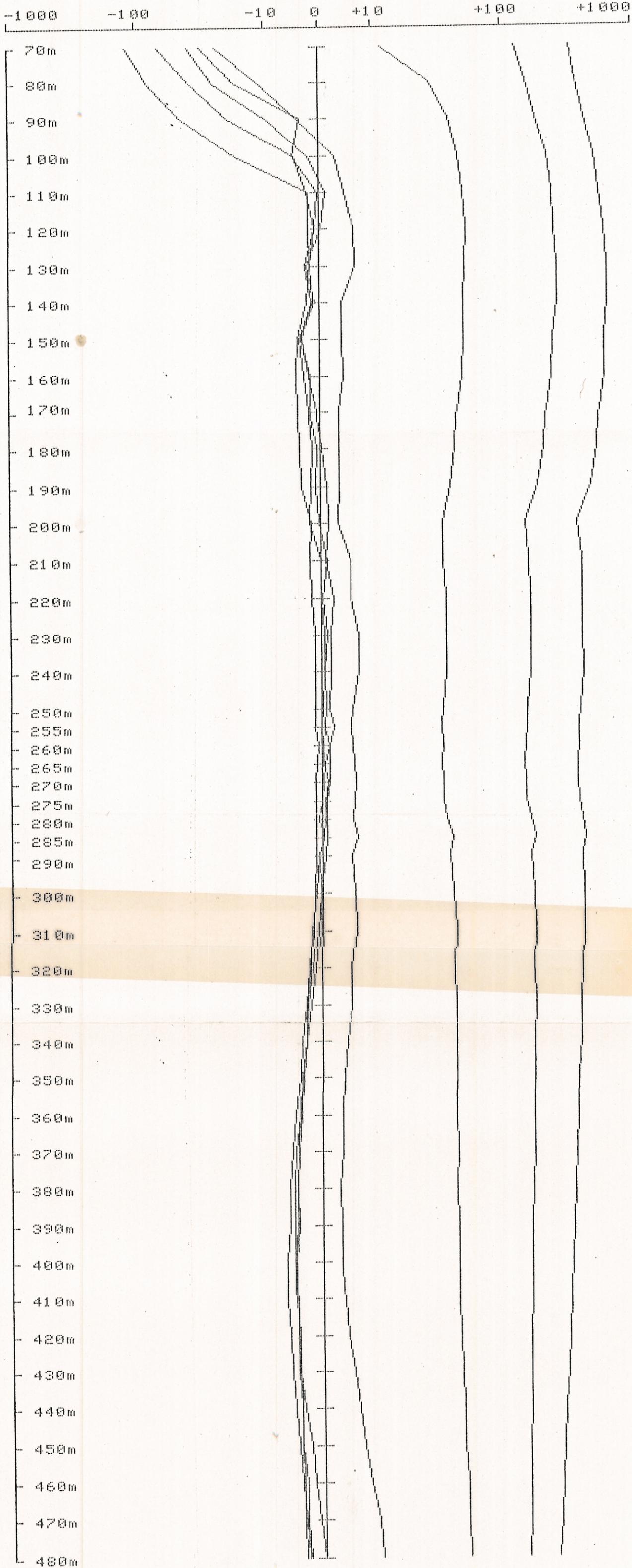
Tx Loop
2

Time base: 10ms
Ramp time: 0.5ms

ZTS: 150
Gain: 250

Date: 27/03/85

FIGURE 49



CRONE GEOPHYSICS Limited
BOREHOLE PEM

Client
Aberfoyle

File
A:HL62-15

Grid
Hel1yer

Hole
HL62

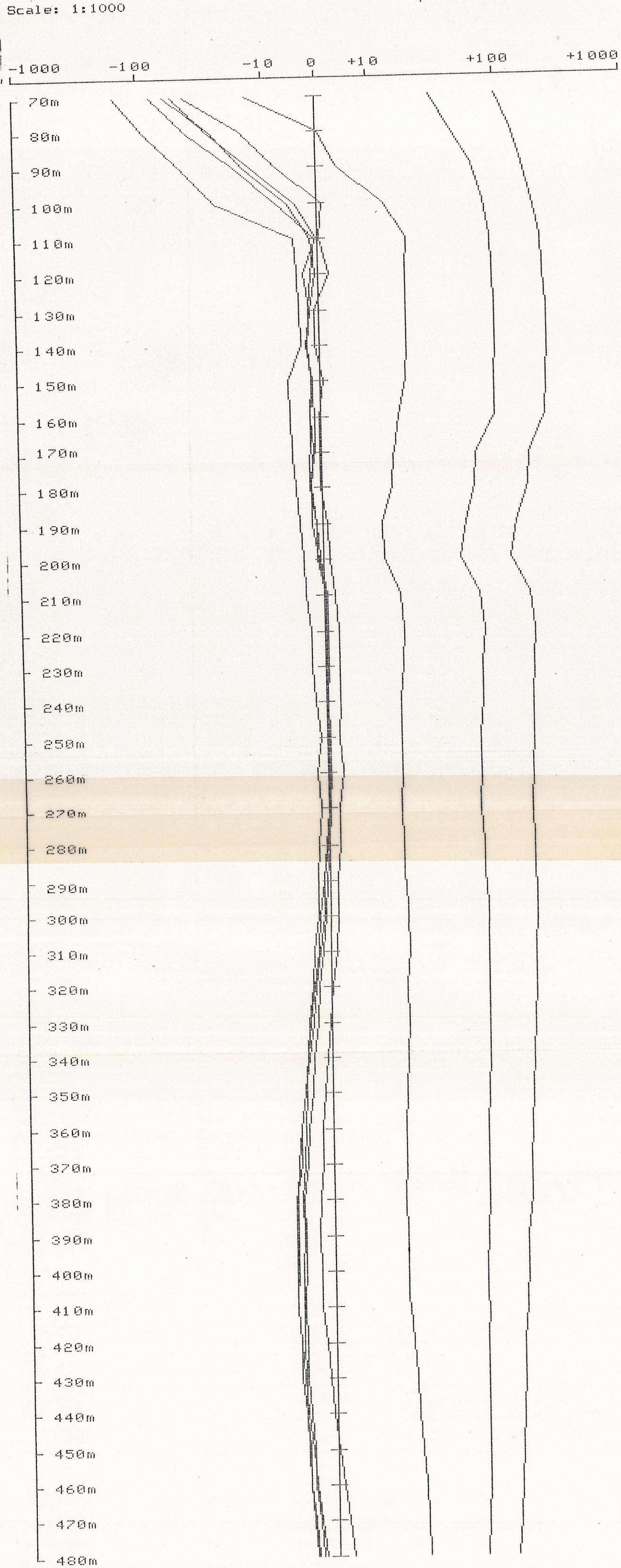
Tx Loop
2

Time base: 10ms
Ramp time: 1.5ms

ZTS: 645
Gain: 250

Date: 01/04/85

FIGURE 50



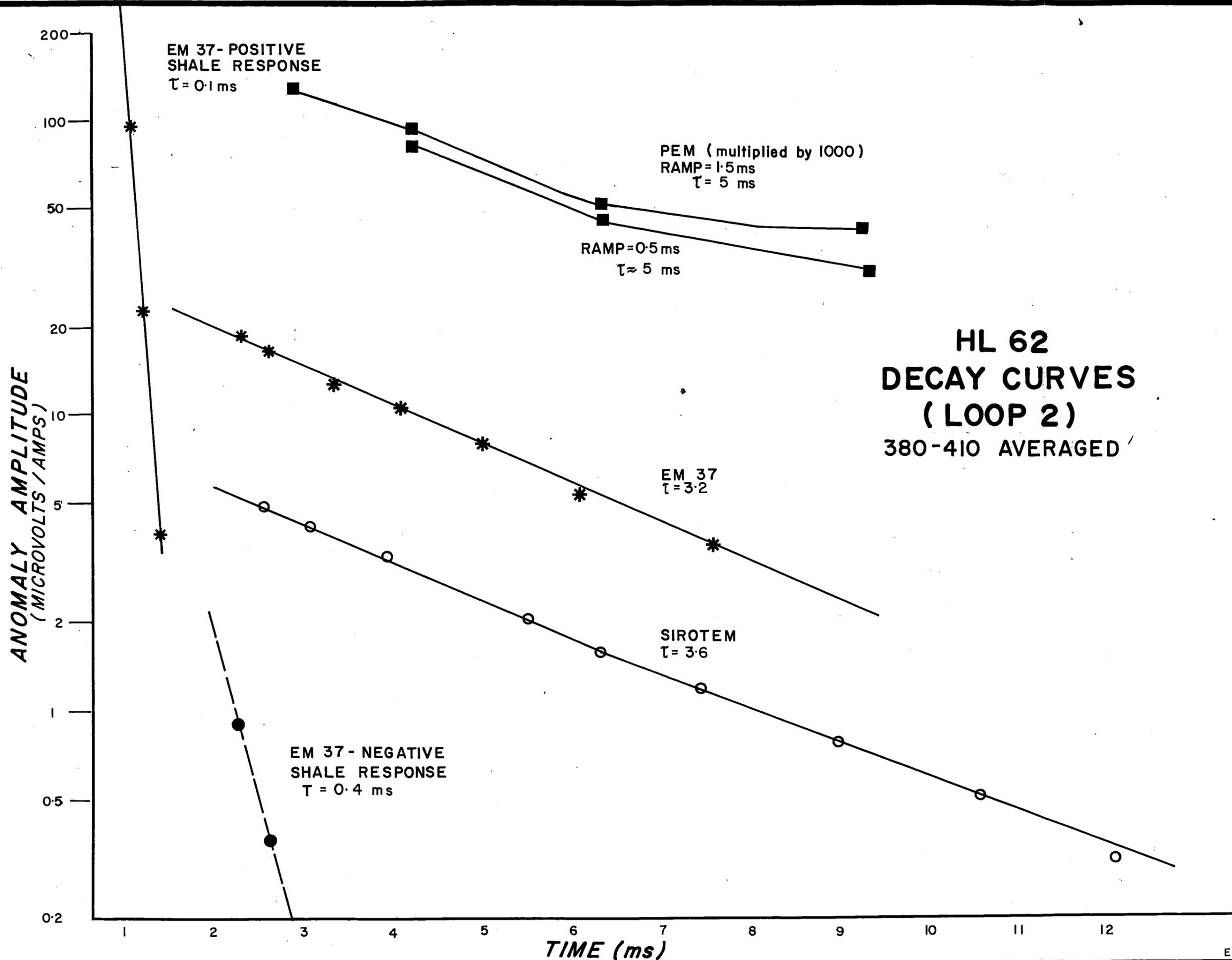


FIGURE 51
 ETE/acd November '85

SYSTEM RESPONSE COMPARISON

HL 3 - EM 37 = 4.8 x SIROTEM
 = 90 x CRONE
 HL 19 - EM 37 = 6.0 x SIROTEM
 = 100 x CRONE
 HL 62 - EM 37 = 2.8 x SIROTEM
 = 110 x CRONE

ANOMALY AMPLITUDE
MICROVOLTS / AMP

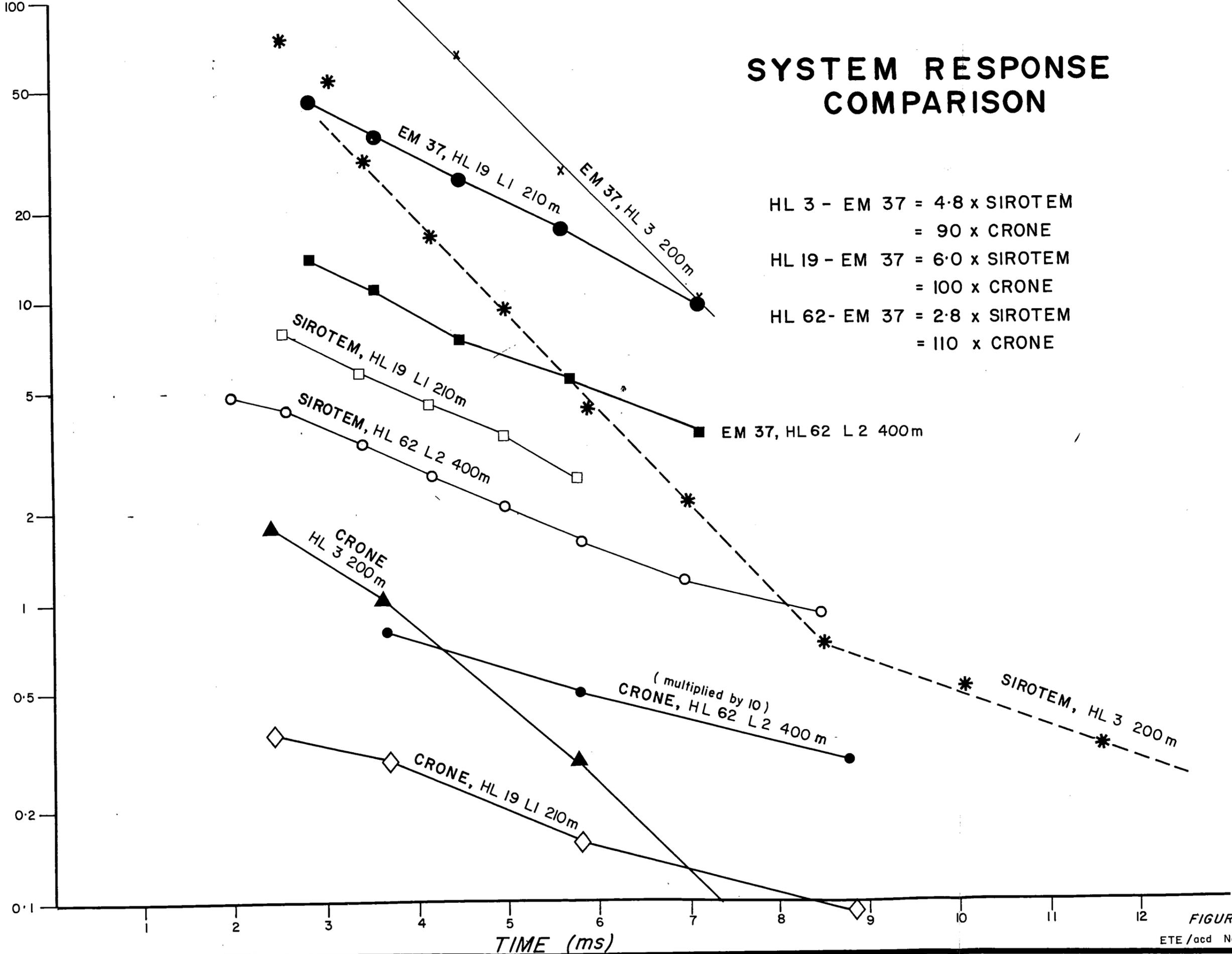


FIGURE 52
ETE/acd November '85