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Rum Jungle East (Area 44 Extended, Coomalie Gap West, and Woodcutters Areas) Geophysical Surveys,

Northern Territory 1967

by

J.E.F. Gardener

The information contained in this report has been obtained by the Department of National Development as part of the policy of the Commonwealth Government to assist in the exploration and development of mineral resources. It may not be published in any form or used in a company prospectus or statement without the permission in writing of the Director, Bureau of Mineral Resources, Geology & Geophysics.

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SUMMARY

In 1967 the Bureau of Mineral Resources made geophysical surveys using electromagnetic, self-potential, induced polarisation, and surface radiometric methods in three areas in the Rum Jungle East area. The localities are known as Area 44 Extended, Coomalie Gap West, and Woodcutters.

One radiometric anomaly requiring further investigation was found in Area 44 Extended and one in Coomalie Gap West.

Electromagnetic, self-potential, and induced polarisation anomalies found in Area 44 Extended and Coomalie Gap West and a self-potential anomaly in the Woodcutters L3 area are all ascribed to carbonaceous slate, but this requires testing by drilling.

Self-potential anomalies associated with a geochemical anomaly were found in the Woodcutters L5 area and are considered to be due to sulphides or graphite. However, a self-potential anomaly in the Woodcutters L1 area is unexplained and requires testing.

Results of diamond-drilling of geophysical anomalies in the Coomalie Gap West and Woodcutters L3 and L1 areas are included. Recommendations are made for rotary drilling to assist in the interpretation of several geophysical (particularly S-P) anomalies.

1. INTRODUCTION

Geophysical surveys were made in 1967 by the Bureau of Mineral Resources (BMR) in three areas within the Rum Jungle East area: Area 44 Extended, Coomalie Gap West, and Wooductters (Plate 1). These detailed surveys in areas where anomalies were known to exist from previous surveys are discussed below. A gravity survey made in 1967 in and to the west of the Rum Jungle East area is discussed separately by Williams (in preparation). The gravity survey was made to study the behaviour of the eastern boundary of the Rum Jungle Complex.

Results of diamond-drilling of geophysical anomalies in the Coomalie Gap West and Woodcutters areas in 1967 and 1968 are included in this report.

The Rum Jungle East area extends southwards for 12 miles from where the Giants Reef Fault crosses the Stuart Highway (about 45 miles from Darwin) and averages about two miles in width. The area was originally selected for a reconnaissance geochemical, radiometric, and geophysical survey in 1964 on the basis of geological environment. It contains rocks of the Golden Dyke Formation, Coomalie

Dolomite, and Crater Formation, and much of the known mineralisation in the Rum Jungle area occurs in the Golden Dyke Formation, especially near its boundary with the Coomalie Dolomite, and in the Crater Formation.

2. PREVIOUS WORK

In 1964 the BMR made reconnaissance geochemical, radiometric, and geophysical surveys in the Rum Jungle East area (Dodson and Shatwell, 1965; duckworth, 1966a). These surveys found a number of anomalies, which were the basis of detailed surveys in succeeding years. Previous to this survey a geophysical survey was made in 1962 in an area known as Area 44, where weak surface radioactivity occurs near the Coomalie Dolomite - Golden Dyke Formation boundary. No anomalies of interest were found (Douglas, 1963). In 1967 resurveying of the whole of Area 44 was included in the Area 44 Extended survey.

In 1964 two areas of strong electromagnetic anomalies found in the reconnaissance survey were surveyed in detail using Slingram, Turam, and surface radiometric methods (Duckworth, 1966a). These two areas were named Huandot North and Coomalie Gap West. All the Huandot North area except for a narrow strip along the eastern boundary was resurveyed in the 1967 Area 44 Extended survey. The northern part of the 1964 Coomalie Gap West area was surveyed with the self-potential method in 1967; the 1964 Slingram results for that part of the area are also included in this report.

In 1965 detailed geochemical, radiometric, and geophysical surveys were made in the Woodcutters area and part of the Coomalie Gap West area (Shatwell, 1966; Duckworth, 1966b).

In 1966 further geochemical and radiometric surveys were made in the Wooductters area (Semple, 1967) and some test geophysical work was done in the Wooducters, Coomalie Gap West, and Huandot North areas (Duckworth, Farrow, and Gardener, 1968). This included a detailed gravity survey in the Woodcutters L5 area.

Diamond-drilling, begun in 1966 in the Woodcutters L5 area located sulphide mineralisation, which was the source of the L5 geochemical anomaly. Other geochemical anomalies drilled were found to be due to sparse sulphide mineralisation, the best being associated with the Woodcutters L1 geochemical anomaly.

3. GEOLOGY

Dodson and Shatwell (1965) describe the geological succession in the Rum Jungle East area as:

Superficial deposits	Quaternary
Laterite	?Tertiary
Acacia Gap Tongue (Masson Formation)	Lower Proterozoic
Golden Dyke Formation	Lower Proterozoic
Coomalie Dolomite	Lower Proterozoic
Crater Formation	Lower Proterozoic

A transition zone separates the Golden Dyke Formation and the Coomalie Dolomite.

In Area 44 Extended, all the above units occur. In the north of the area a north-trending syncline occurs in the Acacia Gap Tongue and extends south into the Golden Dyke Formation.

In the Coomalie Gap West area only Coomalie Dolomite and Golden Dyke Formation occur. In the northern section the Golden Dyke Formation is tightly folded (Semple, 1968).

In the Wooductters area Golden Dyke Formation occurs, with a small area of Coomalie Dolomite in the nose of an anticline in the north of the area. This anticline extends southwards through the Wooductters area.

4. GEOPHYSICAL METHODS

Methods used in the 1967 Rum Jungle East geophysical survey were Slingram, Turam, self-potential (S-P), induced polarisation (IP), surface radiometric, and gravity. The gravity survey is described elsewhere (Williams, in preparation).

The Slingram (or EM Gun) method is a moving source, moving receiver, horizontal loop electromagnetic (or EM) method.

The Turam method is a fixed source, moving receiver, horizontal loop EM method. In the survey described here the primary field was produced using a large rectangular loop on the ground. Slingram, Turam, and S-P methods are described fully by Daly (1962).

The S-P surveys were made using fixed base stations; the base stations were tied to a common datum in each area surveyed.

Measurements were made in the frequency domain in the IP surveys, Dipole-dipole electrode geometry was used. Results plotted are apparent resistivity, frequency effect, and metal factor.

Surface radiometric readings were made with Harwell type 1368A ratemeters.

The electric and radiometric logs mentioned in this report were made with a Widco 1000-ft logger.

5. FIELD OPERATIONS

Geophysical work in Area 44 Extended in 1967 consisted of:

1. A Slingram survey
2. A surface radiometric survey
3. An S-P survey, excluding strips along the north, east, and west boundaries.
4. An IP survey over part of the area where strong S-P and EM anomalies occur. The survey was between 228S and 252S and between the baseline and 26W.

Geophysical work in the Coomalie Gap West area in 1967 consisted of:

1. In the northern section, a small extension to the north (324S to 312S) of the 1964 detailed Slingram survey.
2. The same extension of the 1964 surface radiometric survey.
3. An S-P survey in the northern section (from 356S to 312S).
4. An IP survey on one traverse (344S) near the centre of the S-P anomaly found in (3).
5. A Slingram survey in the southern section of the Coomalie Gap West area.
6. A surface radiometric survey as in (5).

Geophysical work in the Woodcutters area in 1967 consisted of:

1. An S-P survey in the areas of the L1, L2, L3, L5, and L6 geochemical anomalies.

2. A Turam survey in the L5 area.

3. An IP survey on traverse 130S over the centre of an S-P anomaly.

In the Slingram surveys, coil spacing was 200 ft, frequency used was 1760 Hz, stations were 50 ft apart except in the southern section of the Coomalie Gap West area, where they were 100 ft apart, and the transmitter was west of the receiver.

In the Turam survey, coil spacing was 50 ft and frequencies used were 220 and 660 Hz. In the Turam, S-P, and surface radiometric surveys, stations were 50 ft apart.

In the IP surveys, frequencies used were 0.3 and 5 Hz. Dipole length was 100 ft.

In all areas, traverse spacing was usually 400 ft.

Geochemical surveys were made in Area 44 Extended and Coomalie Gap West (Northern Section) concurrently with the geophysical surveys, and are described by Semple (1968).

6. RESULTS AND INTERPRETATION

Area 44 Extended

Slingram results. Slingram real component contours are shown in Plate 3. The imaginary component contours were not used in the interpretation and are not presented here; they present a confused picture of mainly low values, and are not contourable.

The Slingram results in the western part of the surveyed area are undisturbed over Crater Formation and Coomalie Dolomite. The western boundary of the contour map (Plate 3) is 68W; however, the area was surveyed to 89W but the contour map between 68W and 89W is featureless and has been omitted.

The Slingram anomaly at 41.5W/288S and its northward continuation is due to conducting carbonaceous slate at the boundary of the Golden Dyke Formation and Coomalie Dolomite. This boundary anomaly trends NNW from here and follows the geological boundary. The anomaly at 41.5W/288S is much weaker than the corresponding boundary anomaly half a mile away in the Coomalie Gap West area, indicating an increase in depth to the conductor due to an increase in depth of weathering. The anomaly becomes even weaker north of 288S, indicating increasing depth of weathering to the north. In DDH 67/14 (50W/196S) the completely weathered zone is 130 ft thick.

North of 55W/228S the boundary anomalies are too indistinct to define the geological boundary. The boundary anomalies and the boundary of the Golden Dyke Formation as shown on the geological map (Plate 2) are in good agreement.

East of the Coomalie Dolomite boundary the Slingram real component values are above 100% and indicate conductors at depth. Variations in the results are due to variations in depth of weathering and to interbedded poor conductors. In the centre of the area is a zone of strong Slingram anomalies. This is the area of the IP survey discussed later. The anomalies are due to near-surface (within 50 ft), steeply-dipping, strong conductors such as beds of carbonaceous slate;either with interbedded poorly conducting zones or to massive slate with prominences on it. The IP results suggest the second alternative.

North and south of the area of strong Slingram anomalies the real component values are mostly over 100% and indicate the presence of conductors at depth (over 80 ft).

In the north of the surveyed area the conductors and Slingram contours are influenced by a south-plunging syncline. The strong anomalies discussed above in the centre of the surveyed area are in line with the axis of this syncline and may be due to a local change in the plunge of the syncline that brings the conductors closer to the surface. The conductors plunge to the south again south of the area of strong anomalies.

Near-surface conductors are indicated on the eastern edge of the area.

No major geochemical anomalies were found in the area of the strong Slingram anomalies. Geochemical anomalies were found in those areas where the Slingram results indicate conductors at depth i.e., in areas of deep (over 80 ft) weathering.

<u>Self-potential results</u>. The S-P survey did not cover the north and west edges of Area 44 Extended. S-P contours of the area surveyed are shown in Plate 4. In the western half of the area the +200-mV contour follows very roughly the western boundary of the Golden Dyke Formation as mapped by Semple (1968). In the north, the contours are influenced by the syncline, as are the Slingram contours.

In the centre of the area, strong S-P anomalies are associated with the strong Slingram anomalies. The conductors causing the Slingram anomalies cause S-P anomalies of varying intensities.

Except in the centre of the area there is no general correlation between the Slingram and S-P results, and some of the S-P anomalies, especially in the western half of the area, are in areas where drilling indicates conductors at depth.

The S-P anomalies between 224S and 232S and 40W and 56W have a loose association with geochemical anomalies (especially Zn1) (Semple 1968), but in general there is no strict correlation between the S-P and geochemical results.

There is a general S-P 'low' in the area mapped as Golden Dyke Formation in Plate 3, with intense localised anomalies within the Golden Dyke Formation. The Coomalie Dolomite and Crater Formation produce high regional S-P effects. High S-P effects also occur on the eastern edge of the surveyed area, and may be related to amphibolite mapped there (Plate 2).

<u>Surface radiometric results</u>. The results are shown as profiles in Plate 5. A weak anomaly occurs in and around the area of the 1962 Area 44 survey (roughly 220S to 260S and 25W to 55W) where the radioactivity was not considered significant (Douglas, 1963).

An anomaly around 85W/216S is in the Crater Formation and is the only significant surface radiometric anomaly found in the area. This anomaly coincides with Semple's R1 radiometric anomaly. Semple (1968) states that the R1 anomaly overlies areas of outcrop and no deep auger holes were drilled. This anomaly should be tested further. There is no correlation between the surface radiometric results and the Slingram and S-P results.

Induced polarisation results. An IP survey was made in the area of strong Slingram and S-P anomalies between 228S and 252S and 0 and 26W. The results, together with Slingram and S-P profiles, are shown in Plates 6 to 12.

Slingram, resistivity, frequency effect, and metal factor anomaly axes can be followed south through Plates 6 to 12 from 1.5W/228S, 1.5W/232S, 4.5W/236S, 6W/240S, about 7W/244S, and 10.5W/248S to about 13W/252S (the anomalies at 10W/252S are a branch axis). These anomaly axes are accompanied by an S-P anomaly from 236S to 252S (only those parts of the Slingram and S-P anomaly axes which were covered by the IP survey are considered here). The Slingram and resistivity (n = 2) anomalies are strongest on traverses 240S, 248S, and 252S and these are the positions of the strongest S-P anomalies. The resistivity results indicate that the conductor is nearest the surface where the S-P anomalies are strongest. Thus the variation in intensity of the S-P anomaly along the axis of the conductor appears to be related to the depth of the conductor in this case.

Another Slingram and IP axis can be followed from 11.5W/228S, about 10W/232S, 10W/236S, about 11W/240S, 13W/244S, and 15W/248S to 18W/252S. The resistivity anomaly for n = 2 is strongest at 236S and likewise the S-P anomaly is also strongest there. It can be inferred again that the S-P anomaly is strongest where this conductor is closest to the surface. The S-P anomaly axis terminates at about 244S. The resistivity results indicate that the conductor is deeper south from traverse 244S.

At 16W/232S, a weak S-P anomaly has no Slingram or resistivity anomaly associated with it, but there is a frequency effect anomaly. These anomalies may have a different source from the other anomalies in this area.

A Slingram and IP anomaly axis extends from about 22W/232S, about 24W/236S, 22W/240S, 23W/244S, and 23.5W/248S to 23.5/252S. The resistivity results indicate the conductor is closest to the surface at 240S and 252S. The S-P anomaly is strongest at 240S.

The very low resistivities and the generally high frequency effects in this area indicate that the geophysical anomalies are due to steeply dipping highly conducting bodies (such as carbonaceous slate) separated by non-conducting zones. The area is probably underlain by conducting slate with prominences of slate coming nearer to the surface and causing the anomalies.

The results indicate that the depth of conductors has a definite relationship to the intensity of the S-P anomalies in this area. The localisation of S-P anomalies along beds of carbonaceous slate is caused by local high spots in the slate. However, not all the Slingram or IP anomalies interpreted as due to near-surface carbonaceous slate beds produce S-P anomalies either in Area 44 Extended or in the Coomalie Gap West Area. Becker and Telford (1965) have shown that the depth of the source of an S-P anomaly has a large influence on the size of the anomaly, and that if the top of the source is deeper than 100 ft no S-P anomaly would be detected at all. They also show that if a body is totally beneath the water table, the S-P anomaly is attenuated and, most important, that certain types of overburden especially clays can attenuate and even prevent S-P anomalies. Thus the absence of S-P anomalies in an area is not necessarily significant unless a number of associated facts concerning the area are known. Also, of course, the presence of S-P anomalies is not necessarily significant unless it can be established that they are not merely a function of weathering.

Coomalie Gap West area (North Section)

Slingram. Strong Slingram real component anomalies occur throughout the area accompanied by medium strength imaginary component anomalies (Plates 14 and 15) indicating strong near-surface conductors in the area. The conductors show a general northerly trend, which agrees with the geological strike.

There are no Slingram contours in the extreme western edge of the area owing to the non-conducting Coomalie Dolomite.

The real component contours (Plate 14) show strong narrow anomalies near the western boundary of the area, then a central zone of low values, then further east a zone consisting of a single 'low' with peaks on either side and finally on the eastern side a broad zone of low values.

The strong narrow anomalies near the western boundary of the area are due to highly conducting beds of carbonaceous slate of the Golden Dyke Formation with interbedded poorly conducting calcilutite. The boundary anomaly on the Golden Dyke Formation agrees well in position with the boundary of the Golden Dyke Formation mapped by Semple (1968) and shown in Plate 13.

Diamond-drilling in 1968 on traverse 344S (DDH 68/1 and DDH 68/2) showed that the boundary anomaly at 20.5E and the anomaly at 23.5E on this traverse are due to carbonaceous slate within 40 ft of the surface. The drilling results and geophysical anomalies are shown in Plate 16 and the geophysical logs and their correlation in Plate 17. The geology and correlation between holes are by A. Taube of the BMR Darwin Uranium Group. The relationship of the bedding and cleavage in the holes suggests a somewhat more complicated structure than is shown in the section in Plate 16 (A. Taube, pers. comm.).

The anomalies at 20.5E and 23.5E on traverse 344S are due to steeply-dipping highly-conducting bodies narrower than the carbonaceous slate intersections in DDH 68/1 and DDH 68/2. The anomaly at 20.5E is near the eastern edge of the carbonaceous slate and the S-P anomaly is on the centre of the slate (Plate 16). These Slingram and drilling results require reconciling and this can be done by assuming an uneven weathering pattern. If the eastern edge of the slate has been sheltered by the dololutite east of it, it could have weathered more slowly than the western edge of the slate, and this would cause a prominence on the eastern end of the slate. This possibility requires testing by a shallow rotary drilling programme.

The Slingram anomaly at 23.5E is due to a narrower body than intersected in DDH 68/2. A fault as shown in Plate 16 has been inferred in the section to cut off the top western edge of the slate. The fault has been inferred from the resistance and geological logs. In DDH 68/2 the pattern shown in the resistance log of DDH 68/1 (Plate 17) is cut off sharply half way up the hole and a fault is inferred at this cut off. The geological log of DDH 68/2 between 385 ft and 405 ft shows a broken, veined, and brecciated core (Taube, pers. comm.), which is evidence of a fault. The Slingram real component contours show that this inferred fault extends from about 356S to 328S, which is the extent of the conductor intersected in DDH 68/2.

The survey from 324S northwards was not extended far enough west to map the continuation of the anomaly on the Golden Dyke Formation boundary; this is programmed for the 1968 field season. However, the 1964 reconnaissance survey located an anomaly at 5E on traverse 312S and this is probably the northern continuation of the boundary anomaly.

The abrupt termination between 22E/332S and 20E/328S of the strong Slingram anomaly is due to faulting. The zone of low conductivity between traverses 328S and 312S may be Coomalie Dolomite displaced eastwards, or upwards, by faulting.

The zone of low Slingram real component values in the central portion of the Coomalie Gap West area is due to a wide zone of carbonaceous slate of the Golden Dyke Formation. A diamond-drill hole (DDH 65/1) in this zone on traverse 412S shows the presence of this slate (Plate 18) and the resistance log (Plate 19) shows the high conductivity of the slate. The slate is near the surface (within 50 ft). This slate and the Slingram contours trend north towards the Woodcutters area. Diamond-drilling in the Woodcutters L5 area has revealed an area of highly conducting carbonaceous slate (Crohn, Langron, and Prichard, 1967), and the two areas may be related.

Plate 18 shows calcilutite in the last few feet of DDH 65/1. This calcilutite is related to the high Slingram real component values shown in Plate 18. The contour map (Duckworth, 1966b) shows that this 'high' has a considerable north-south extent and indicates that considerable beds of calcilutite occur in the area. The 'highs' in the contours in Plate 14 can thus be related to interbedded calcilutite.

The zone to the east of the broad zone of low real component values already described and consisting of a single 'low' with 'highs' on either side was surveyed (from 328S southwards) in 1964 with the Turam method; the results showed two anomalies in place of one as in the Slingram results (Duckworth, 1966a). The Turam and Slingram results can be reconciled by assuming two conductors each having a width of the order of the coil spacing used in the Slingram survey (200 ft) and separated by an insulator. The 1966 IP results on traverse 348S show reasonable agreement with an insulator on the Slingram 'low'.

The broad zone of low Slingram values on the eastern edge of the area is probably due to more beds of conducting carbonaceous slate.

Discontinuities and changes of strike throughout the Slingram contour maps are probably due to faulting. All the anomalies in the Coomalie Gap West area are due to beds of highly conducting slate of the Golden Dyke Formation. Coomalie Dolomite is on the western edge of the area, and beds of poorly conducting calcilutite separate some of the carbonaceous slate beds. In the north of the area surveyed faulting is indicated by the disturbed contours.

No geochemical anomalies are associated with the Slingram anomalies.

Self-potential results. The S-P contours (Plate 20) show a general 'low' near the Coomalie Dolomite - Golden Dyke Formation boundary on the western side of the surveyed area, with a major negative centre at about 20E between 344S and 340S.

The 100-mV contour line changes position abruptly between 324S and 328S and supports the Slingram evidence of a fault here.

The S-P anomaly is due to the same bed of carbonaceous slate that caused the western Slingram anomaly. Diamond-drilling of the S-P anomaly (DDH 68/1; Plates 16 and 17) was inconclusive because the hole could not be logged in the oxidised zone. The S-P anomaly is slightly west of the Slingram anomalies on traverses 340S and 344S; the negative centre itself is between these two traverses. The S-P anomaly occurs in the centre of the carbonaceous slate bed whereas the Slingram anomalies are near the eastern edge. This requires investigation by shallow rotary drilling.

The reason for the absence of S-P anomalies on the numerous other conducting slates in the Coomalie Gap West area is not known.

Induced polarisation results. An IP survey was made on traverse 344S from 16E to 26E over Slingram and S-P anomalies and DDH 68/1 and DDH 68/2. The results are shown in Plate 16 and are similar to the results obtained on traverse 348S in 1966 (Duckworth, Farrow, and Gardener, 1968).

High resistivities on the western part of the traverse are due to Coomalie Dolomite. The resistivity 'lows' are due to highly conducting carbonaceous slate of the Golden Dyke Formation.

The local resistivity 'highs' at 20.5E and 24.5E on the first line of readings (n = 2) are due to poorly conducting interbedded calcilutite. Below n = 2, the resistivity readings are influenced more by the conducting slate than the calcilutite. Comparison of the IP survey results with the drilling results and published theroetical results indicates that the depth penetration was very limited and in fact the current paths are probably confined almost entirely to the surfaces of the conductor, in particular the top surface. The depth penetration of the survey was probably no more than the upper surface of the unweathered slate.

The frequency effects are due to the carbonaceous slate, with lower readings associated with the Coomalie Dolomite. The metal factor 'highs' are also due to carbonaceous slate.

Surface radiometric results. The surface radiometric results (Plate 21) show two zones of anomalous radioactivity. The eastern zone is in an area of gravel commonly associated with superficial laterite in the Rum Jungle area. The western zone is on the central broad zone of Slingram 'lows' discussed above. The auger hole radiometric results are included in Plate 21 for comparison with the surface results It can be seen that both the surface anomalies have no depth extent, and are restricted to the A/B soil horizon; the C horizon seldom exceeded background value (Semple, 1968).

The A horizon is the top soil horizon, usually less than one foot thick in the Rum Jungle East area. The C horizon is composed of leached clays and fragments of weathered rock. The intermediate B horizon varies from zero to more than 50 ft in the Rum Jungle East area, but is generally no more than 20 ft.

The western anomaly has a maximum value in a costean near traverse 312S and the anomaly appears to extend north of the area surveyed; this northern extension is to be investigated in the 1968 field season. This anomaly could be a suitable target for analysis with a gamma ray spectrometer.

Coomalie Gap West area (Southern Section)

Slingram results. The results are shown as profiles in Plates 22 and 23. Contouring was not attempted because of the paucity of details to correlate from traverse to traverse, and because the oblique angle which the geological strike makes with the traverses in the southern part of the area would make correlation between traverses very doubtful. The real component results are uncorrected for terrain effects; these terrain effects account for the apparent but false northerly trends between traverses 460S and 480S; the trends are due to northerly trending ridges. Terrain effects also occur on 444S (20W to 8W), 440S (12W to 0), and 432S (4W).

The boundary inferred from the real component results between the Coomalie Dolomite and the Golden Dyke Formation is shown in Plates 22 and 23. Within the area shown as Golden Dyke Formation (i.e., east of the boundary shown) the real component is in general elevated indicating conductors at depth. Variations in the profiles indicate changes in depth to the conductors and changes in conductivity. In the Coomalie Dolomite, some raised real component values may indicate the presence of weak conductors within the Dolomite. A geochemical survey of this area is programmed for the 1968 field season.

Surface radiometric results. No surface radiometric anomalies were found in the area surveyed and the results are not shown.

Wooductters area

L3 area. An S-P survey was made on the local L3 grid and an anomaly was found as shown in Plate 24. This anomaly is associated with Turam and IP anomalies found in 1966 (Duckworth, Farrow, and Gardener, 1968). The Turam axes and geology are also shown in Plate 24. The anomalies are in the Golden Dyke Formation near its boundary with Coomalie Dolomite and on the nose of an anticline. The 1966 IP survey was confined to traverses 46E and 58E over maxima of Turam ratio anomalies. A check geochemical survey made in 1966 showed that the L3 geochemical anomaly does not exist (Semple, 1967).

In 1967 the anomalies on traverse 46E were drilled (DDH 67/11 and DDH 67/15). Drilling results and geophysical profiles are shown in Plate 25 and the logs in Plate 26. The geology and correlation between holes in these plates is by A. Taube. Bedding and cleavage in the holes are not in the same plane and the structure is somewhat more complicated than the section shown in Plate 25 (A. Taube, pers. comm.).

Drilling results and the resistance logs of the holes show that the Turam and IP anomalies on traverse 46E are due to beds of highly conducting carbonaceous slate. Comparison of the drilling results with the IP and Turam results indicates that depth penetration was very limited and was probably only to the top surface of the conductors. The drilling did not provide any information on the source of the S-P anomaly. The anomaly is associated with part of one of the carbonaceous slate beds; this may be due to a localised decrease of depth of the conductor. The Turam results were originally interpreted as being due to conductors at depth. However, the shallow dips in the area would cause this misinterpretation if not taken into account; the Turam anomalies are due to shallow dipping bodies within 100 ft of the surface.

L2 area. The L2 area is between 72S and 96S. No S-P anomaly was found in this area (Plate 27). Diamond-drilling to date has not located a sulphide zone and has shown that the source of the geochemical anomaly may be in the weathered zone. A lead anomaly found in 1966 immediately south-east of the L2 anomaly, and called L7 (Semple, 1967) also has no S-P anomaly associated with it.

<u>L1 area</u>. The L1 area is between 108S and 126S. An S-P anomaly was found centred at about 36E/130S (Plate 27), which is about 1000 ft south of the centre of the L1 geochemical anomaly.

Diamond-drilling has found no sulphides to account for the geochemical anomaly. A vertical hole (DDH 67/7) was drilled at 36E/130S into the S-P anomaly; the drilling results are shown in Plate 28 and the logs in Plate 29. The S-P log shows that there is a large potential difference between the completely weathered zone and the partially weathered zone, and that the potential within the completely weathered zone is fairly uniform. Thus the anomaly appears to occur at the interface between the zones of oxidation and reduction. The geological log shows carbonaceous slate throughout the hole but the resistance log shows a definite band of poorly conducting rocks in the middle of the hole.

The S-P anomaly is in an area of carbonaceous slate; no source for the anomaly was found by the drilling.

An IP survey on traverse 130S was made after DDH 67/7 had been completed, in an effort to obtain information on the origin of the S-P anomaly. The results (Plate 28) are typical of carbonaceous slate at depth and no useful information was obtained.

<u>L6 area</u>. Minor S-P anomalies were found between 140S and 176S in the area of the L6 and other minor geochemical anomalies (Plate 27). Diamond-drilling in this area did not reveal sulphides to account for the geochemical anomalies. The S-P anomalies are unexplained.

<u>L5 area</u>. A Turam survey was made from 192S to 228S over the main part of the L5 geochemical anomaly. The primary field was produced by a loop east of the area surveyed. Results using 220 Hz together with diamond-drill hole major sulphide intersections are shown in Plate 30, There is no correlation between the Turam results and the sulphides. The results are related to the highly conducting carbonaceous slate underlying the area as found in the drilling (Crohn, Langron, and Prichard, 1967). Resistance logs of the drill holes have shown that the carbonaceous slate is at least as conducting as the sulphides and the drilling has shown that the volume of sulphides in the L5 area is insignificant compared with the volume of carbonaceous slate. Thus electromagnetic and IP methods cannot be expected to give useful results in the area. Variations in the Turam profiles are related to variations in depth of weathering of the slate; the drilling has shown that such variations do occur in the area.

S-P anomalies were found between 180S and 228S (Plate 27) in roughly the same position as the L5 geochemical anomaly. From 208S northwards the S-P anomalies are east of the sulphides intersected by drilling; south of 208S the S-P anomalies are west of the sulphide intersections.

The S-P survey was made in two stages. First the pegged traverses were surveyed; later in the year a detailed survey was made from 204S to 220S as shown in Plate 27. These later results fitted in well with the original results. In the detailed survey the observation points were every 50 ft east-west and north-south except on the eastern edge of the area surveyed, where they were every 100 ft.

The S-P results show that the major sulphides intersected in the drill holes are not the direct origin of the S-P anomalies. However, a definite correlation exists between the trends of the lead and S-P anomalies, including the south-west trend of the anomalies south of traverse 224S.

The gossan shown in Plate 27 is on part of the L5 orebody and extends along 40E with an average width of 50 ft from 205.75S to 209.25S. If the sulphides associated with this gossan (and found in DDH 66/1, DDH 66/2 and DDH 67/8) were the origin of an S-P anomaly the S-P contours would be symmetrical around the gossan. However, the S-P anomaly is east of the gossan. The S-P contours between 208S and 212S show a series of north striking anomalies, the series itself having a south-west trend. This south-west trend may be evidence of a stuctural change around 212S; the abrupt gradient of the S-P 'high' at 212S is also evidence of a structural change, perhaps a fault.

The drilling was no help in the interpretation of the S-P results because, of necessity, the holes were cased in the zone in which the main S-P effects arise (the oxidation-reduction interface) and no S-P logs could be obtained in the parts of interest.

The diamond-drilling has shown that the area is underlain by carbonaceous slate with relatively narrow interbedded dolomite zones. An anticline runs through the centre of the area. Sulphides, associated in part of the area with a crush zone and a gossan, occur under the geochemical anomaly. There is no evidence that the S-P anomalies are due to structure (the anticline or the crush zone); it is more likely that they are due to sulphides (including pyrite) or graphite. The weathering is very deep (200 ft) and variations in weathering are an unlikely source for the anomalies.

Besides the S-P and Turam surveys in the L5 area in 1967, a Slingram depth probing survey was made on 220S. This is a method of determining the depth of conductors using a modification of the Slingram method. The method was developed by K. Duckworth in the Darwin Office of the Bureau of Mineral Resources, and its use and the interpretation of results are described by Duckworth (in preparation).

Duckworth states that, to the east of 36E/220S, the behaviour of the depth probe profiles is as expected over a wide horizontal conductor (the top of the known massive sequence of very conductive carbonaceous slate). To the west of 36E, a feature appears which probably represents an elevation of the unweathered surface.

A profile of the surface of the unweathered slate was constructed by Duckworth using the methods he developed and is shown in Plate 31. (The vertical scale is exaggerated four times with respect to the horizontal scale). The depths of this surface are not absolute for reasons given by Duckworth, but it is reasonable to say that there is a decrease in the depth of weathering to the west of 36E, the minimum depth being at about 30E. This feature is shown by Duckworth to have a northerly strike.

The position of this elevated unweathered feature corresponds to gravity anomaly B (Plate 31) described by Duckworth, Farrow, and Gardener (1968) and Crohn, Langron, and Prichard (1967). It is probably therefore that the gravity anomaly is due to a change in depth of weathering. Other anomalies found in the 1966 gravity survey must be interpreted with caution as they too may be associated with the weathering profile.

Soil pH tests

The pH values of soil samples from the areas of the Woodcutters L5 and the Coomalie Gap West S-P anomalies were determined. The soil samples were taken from a depth of three feet on traverses 208S, 220S, and 344S at the positions shown in Plate 32. The S-P readings were repeated at the time of taking the samples and are also shown in Plate 32. The pH was determined using a kit borrowed from the Agriculture Section of the Agriculture and Animal Industry Branch, Northern Territory Administration, Darwin. The method is a colourimetric one accurate to half a pH unit. All the samples tested had a uniform pH of 6, which is normal for the acid soils found in the northern part of the Northern Territory. No detectable variation in pH was found with the S-P anomalies. The variations may be smaller than half a unit, or there may be no variation.

7. CONCLUSIONS AND RECOMMENDATIONS

The S-P anomalies in the Wooductters L5 area are considered to be due to sulphides or graphite, mainly on the grounds that they are not due to structure or weathering. The southern part of the anomalies (south of 224S) have not been tested. The anomalies are associated with a geochemical lead anomaly.

The S-P anomaly south of the Wooductters L1 anomaly is unexplained.

The rest of the S-P, IP, and EM anomalies in the areas surveyed are generally interpreted as due to carbonaceous slate, but this interpretation requires testing in many cases. This interpretation has already been shown to be correct in the Wooductters L3 area and in the Coomalie Gap West area, though further work is required to reconcile the drilling and survey results in the Coomalie Gap West area. Variations in weathering depth appears to vary the EM and S-P response of the conducting slates in Area 44 Extended.

In the Woodcutters L5 area, gravity anomaly B of the 1966 gravity survey is due to an elevation in the unweathered rock. Gravity anomalies in the Rum Jungle East area need to be interpreted with caution as any of them might also be due to changes in weathering.

Two radiometric anomalies require testing: these are at 85W/216S in Area 44 Extended in Crater Formation; and the western anomaly in Coomalie Gap West (Northern Section). These are suitable targets for investigation with a gamma ray spectrometer to determine the distribution of uranium and thorium daughter products and the source of the radioactivity.

Diamond-drill holes are normally designed to hit their targets at 300 ft or more down hole, but this is not much use in investigating geophysical anomalies that arise from the top surfaces of conductors. Geophysical targets (EM, S-P, and IP) in the Rum Jungle area require a type of drilling programme basically different from diamond drilling because geophysical anomalies generally originate from above a depth of 250 ft. In fact in much of the area surveyed in 1967 the anomalies originate within 70 ft or less of the surface. Further, single holes are almost valueless and intensive drilling of any promising target is essential. Thus, vertical rotary drill holes would be far more use to geophysical interpretation than diamond-drill holes, and are recommended to test anomalies in the Rum Jungle East area. The holes should be to reasonably fresh rock and preferably should be such that resistance and S-P logs can be made. Thus any drilling mud would have to be flushed out.

The strong Slingram, S-P, and IP anomalies in the central part of Area 44 Extended require drilling to test the interpretation of prominences on the underlying slate and the following holes are proposed:

11W/232S,	16W/232S	
8W/236S,	10W/236S,	12W/236S
11W/240S,	13.5W/240S	
8.5W/244S		
8W/248S,	10.25W/248S,	13W/248S
12.75W/252S		

This includes a hole to test the S-P and frequency effect anomaly with no Slingram anomaly at 16W/232S. The depths of the holes depend on the weathering, but would be less than 100 ft.

The S-P anomalies in areas of deeper weathering in Area 44 Extended require investigation and the following holes are proposed:

53W/224S, 55W/224S, 56.5W/224S, 58W/224S.

These holes would be up to 250 ft deep.

In the Coomalie Gap West area, the survey results indicate narrower conductors near the western boundary of the area surveyed than the drilling revealed. The assumptions of prominences and faults made to reconcile these results require testing, as does the S-P anomaly, and the following holes are proposed:

On 344S: 19.6E, 20E, 20.5E, 22.6E, 23.5E, 24.2E and 19.5E/340S; and 19.5E/342S, 19.5E/343S, 20E/348S.

Some of the near-surface slates in the Coomalie Gap West area do not give rise to S-P anomalies and the following holes are proposed to investigate this feature along traverse 348S, which was surveyed by IP in 1966:

On 348S: 30E, 34.5E, 39.75E. 40E, 42E.

It is unlikely that these holes in the Coomalie Gap West area need be more than 50 ft deep.

In the Woodcutters area, the S-P anomaly south of L1 should be investigated to determine the sub-surface position of the anomaly and the following deep (up to 250 ft) holes are proposed:

On 124S: 38E, 40E, 42E

On 126S: 36E, 38E, 40E, 42E

On 128S: 34E, 36E, 38E, 40E

On 130S: 35E, 37E, 39E

On 132S: 36E, 38E, 40E

On 134S: 36E, 38E, 40E

An objective of all the holes proposed is to investigate the oxidised zone with relation to the origin of S-P anomalies in the Rum Jungle area.

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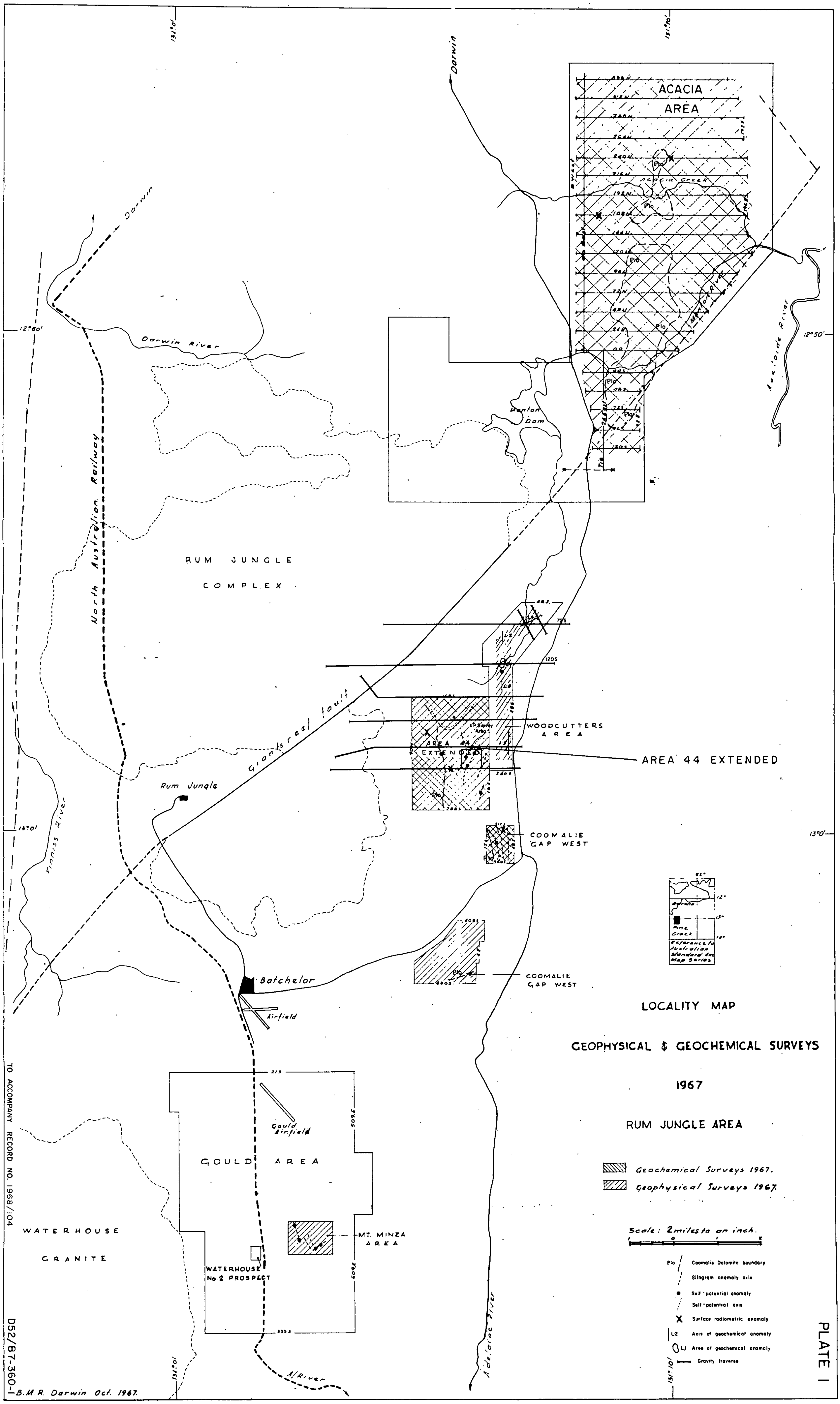
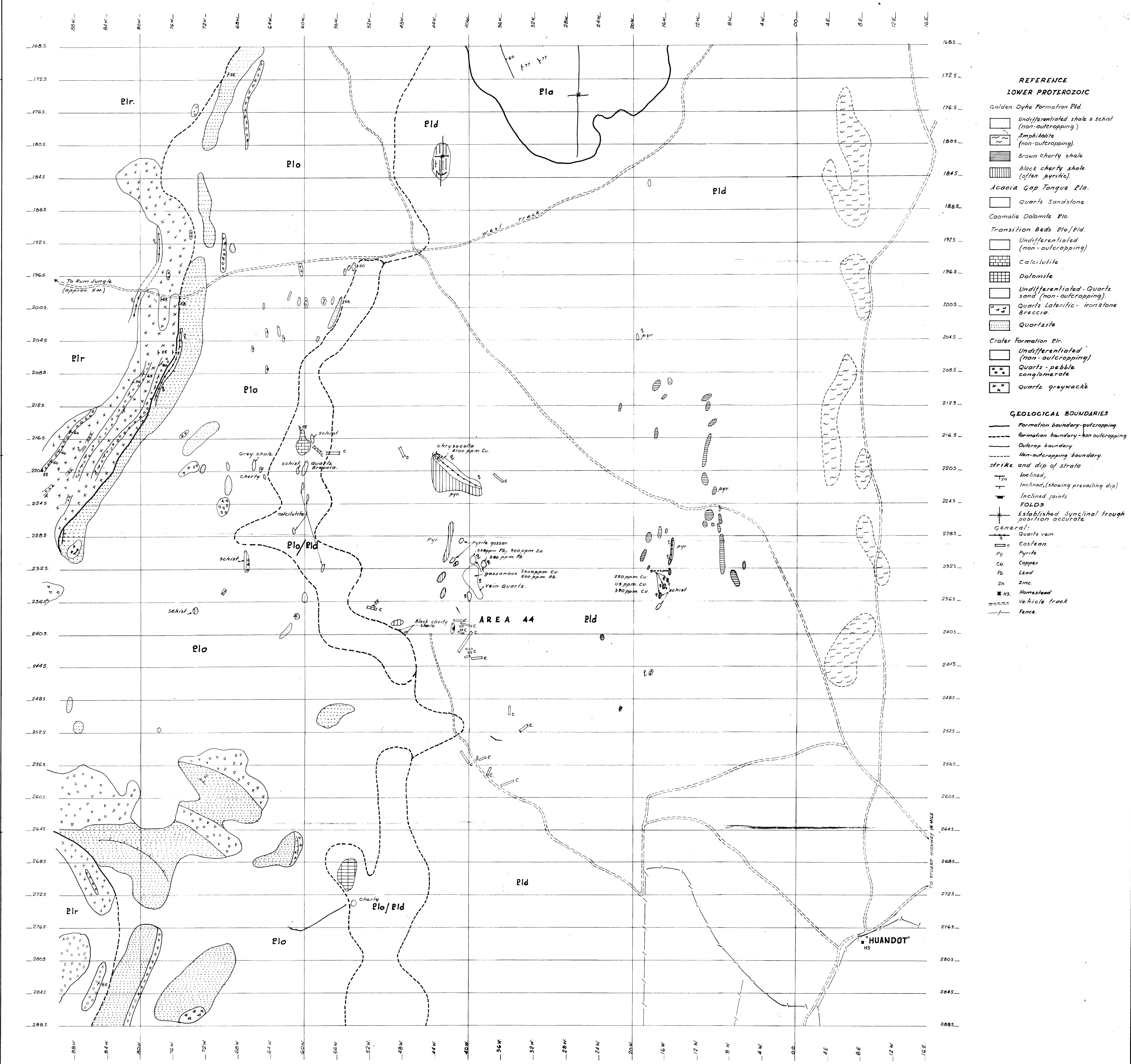

ACACIA AREA
Acacia Creek
Darwin
Darwin River
Manton Dam
Adelaide River
RUM JUNGLE COMPLEX
North Australian Railway
Giant's reef fault
Rum Jungle
Finniss River
WOODCUTTERS AREA
AREA 44 EXTENDED
COOMALIE GAP WEST
Batchelor
Airfield
GOULD AREA
Gould Airfield
MT. MINZA AREA
WATERHOUSE No.2 PROSPECT
WATERHOUSE GRANITE
LOCALITY MAP
GEOPHYSICAL & GEOCHEMICAL SURVEYS
1967
RUM JUNGLE AREA
Geochemical Surveys 1967.
Geophysical Surveys 1967.
Scale: 2 miles to an inch.
Coomalie Dolomite boundary
Slingram anomaly axis
Self-potential anomaly
Self-potential axis
Surface radiometric anomaly
Axis of geochemical anomaly
Area of geochemical anomaly
Gravity traverse
Reference to Australian Standard 4m Map Series
Pine Creek
12°50'
13°0'
131°0'
131°10'
PLATE I
TO ACCOMPANY RECORD NO. 1968/104
D52/B7-360-1
B.M.R. Darwin Oct. 1967.



GEOLOGY
AREA 44 EXTENDED
RUM JUNGLE EAST - N.T.

Scale 1" = 400 Feet

To accompany Record 1968 / 104

Geology by D. G. Semple 1967

D52/B7-383

AREA 44 EXTENDED

SLINGRAM REAL COMPONENT
CONTOURS

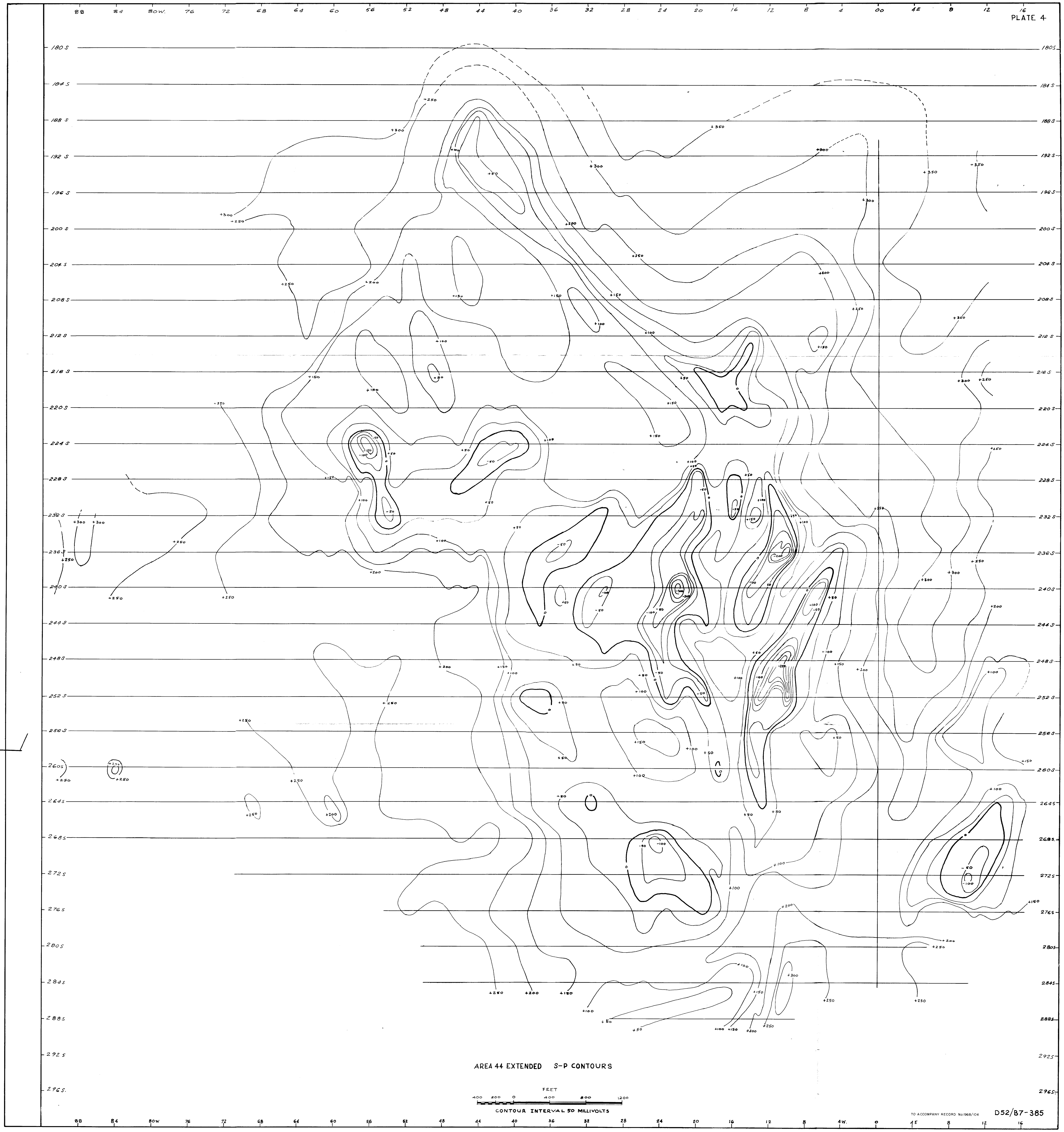
+ Peak
— Trough.

FEET
400 200 0 400 800 1200
Contour Interval 10%

TO ACCOMPANY RECORD No 1968/104

D52/B7-384

PLATE 4



AREA 44 EXTENDED S-P CONTOURS

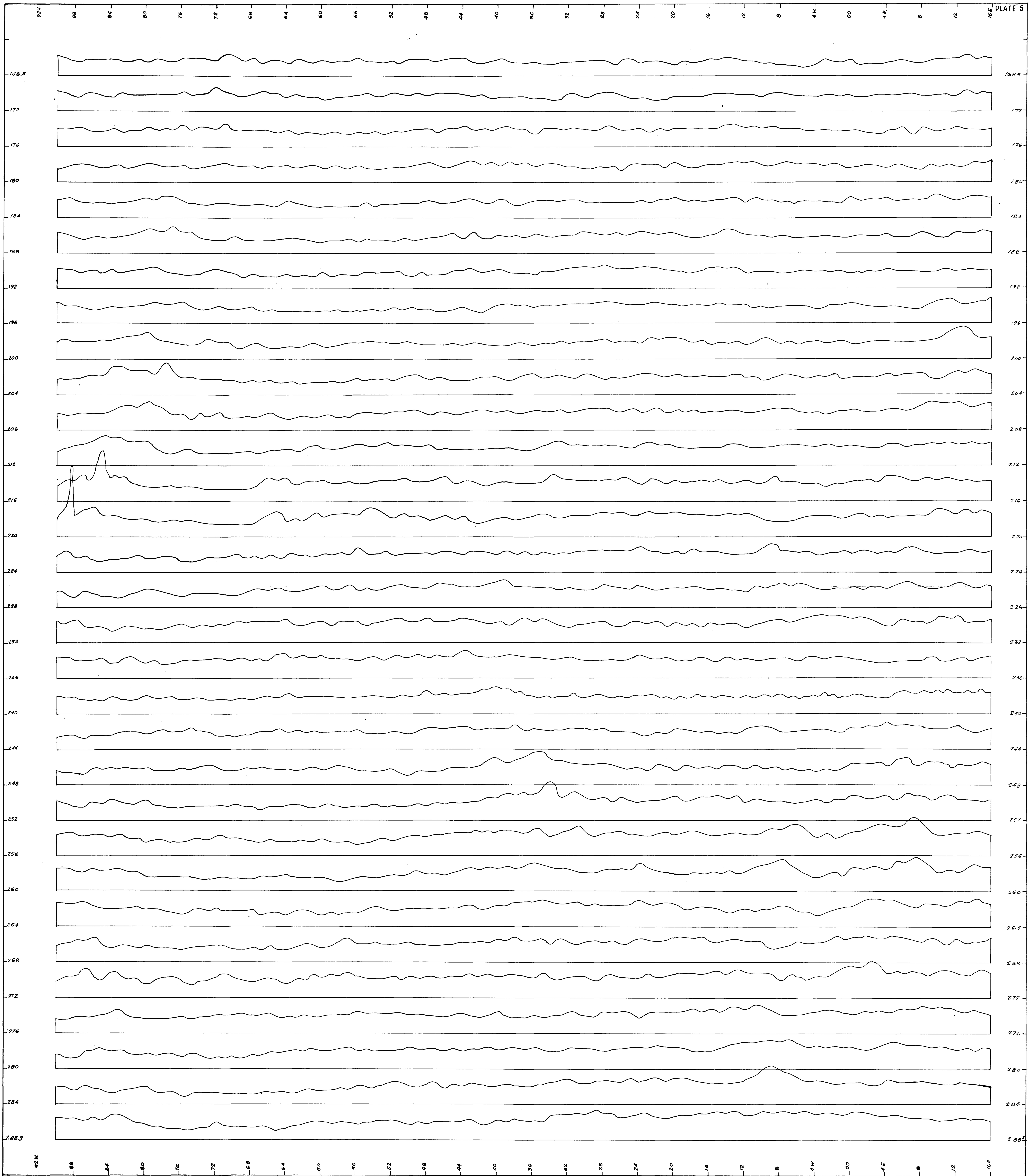
FEET

CONTOUR INTERVAL 50 MILLIVOLTS

TO ACCOMPANY RECORD No 1968/104

D52/B7-385

PLATE 5



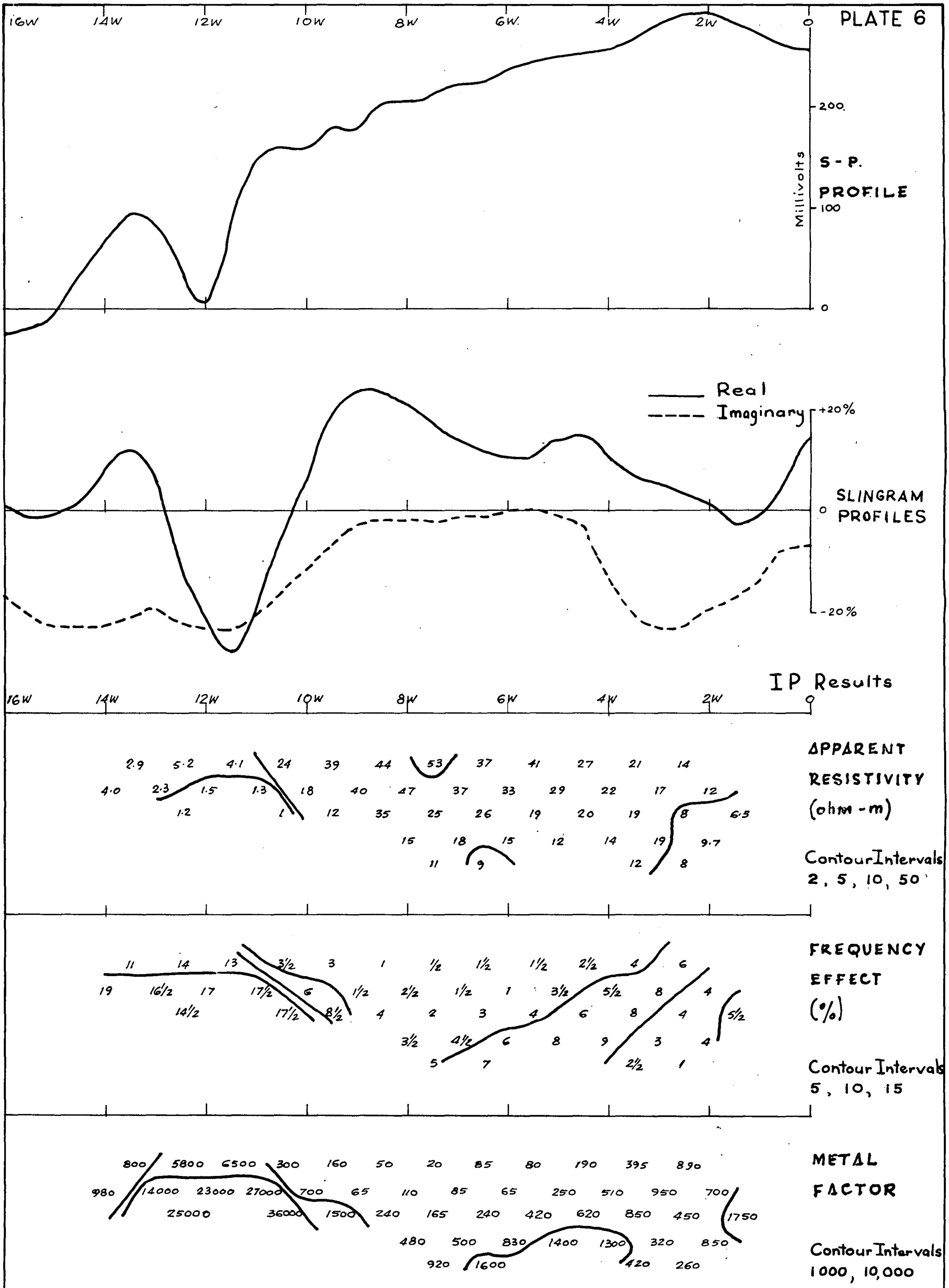
AREA 44 EXTENDED
SURFACE RADIOMETRIC PROFILES

Horizontal 400 200 0 400 800 1200 Feet
Vertical 0·01 0 0·01 0·02 0·03 mR/hours

TO ACCOMPANY RECORD No 1968/104

D52/B7-386

PLATE 6



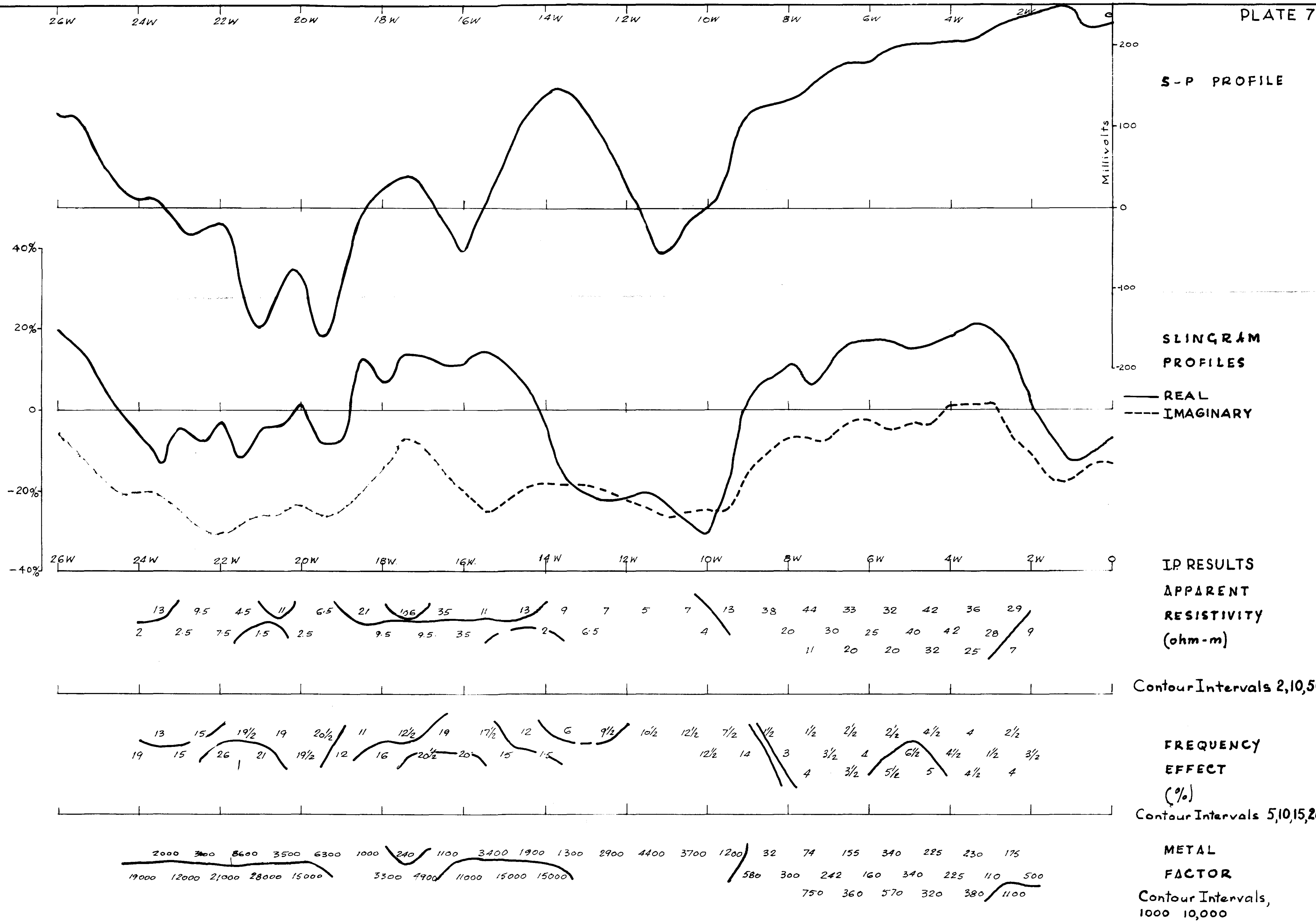
AREA 44 EXTENDED
GEOPHYSICAL RESULTS ON TRAVERSE 228 S

PLATE 6

TO ACCOMPANY RECORD No 1968/104

D52/B7-387

PLATE 7

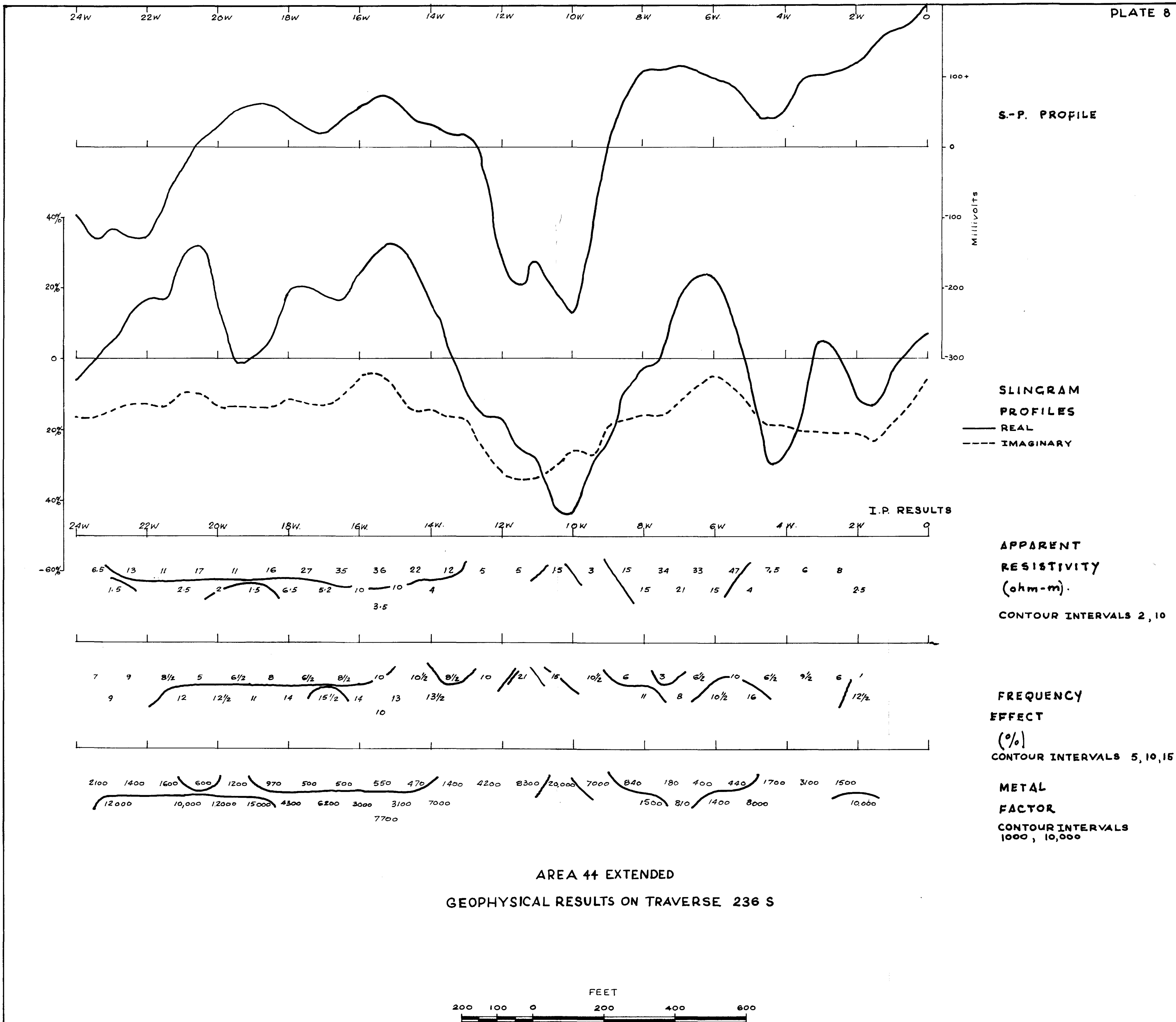


AREA 44 EXTENDED

GEOPHYSICAL RESULTS ON TRAVERSE 232 S

TO ACCOMPANY RECORD No 1968/104

D52/B7-388



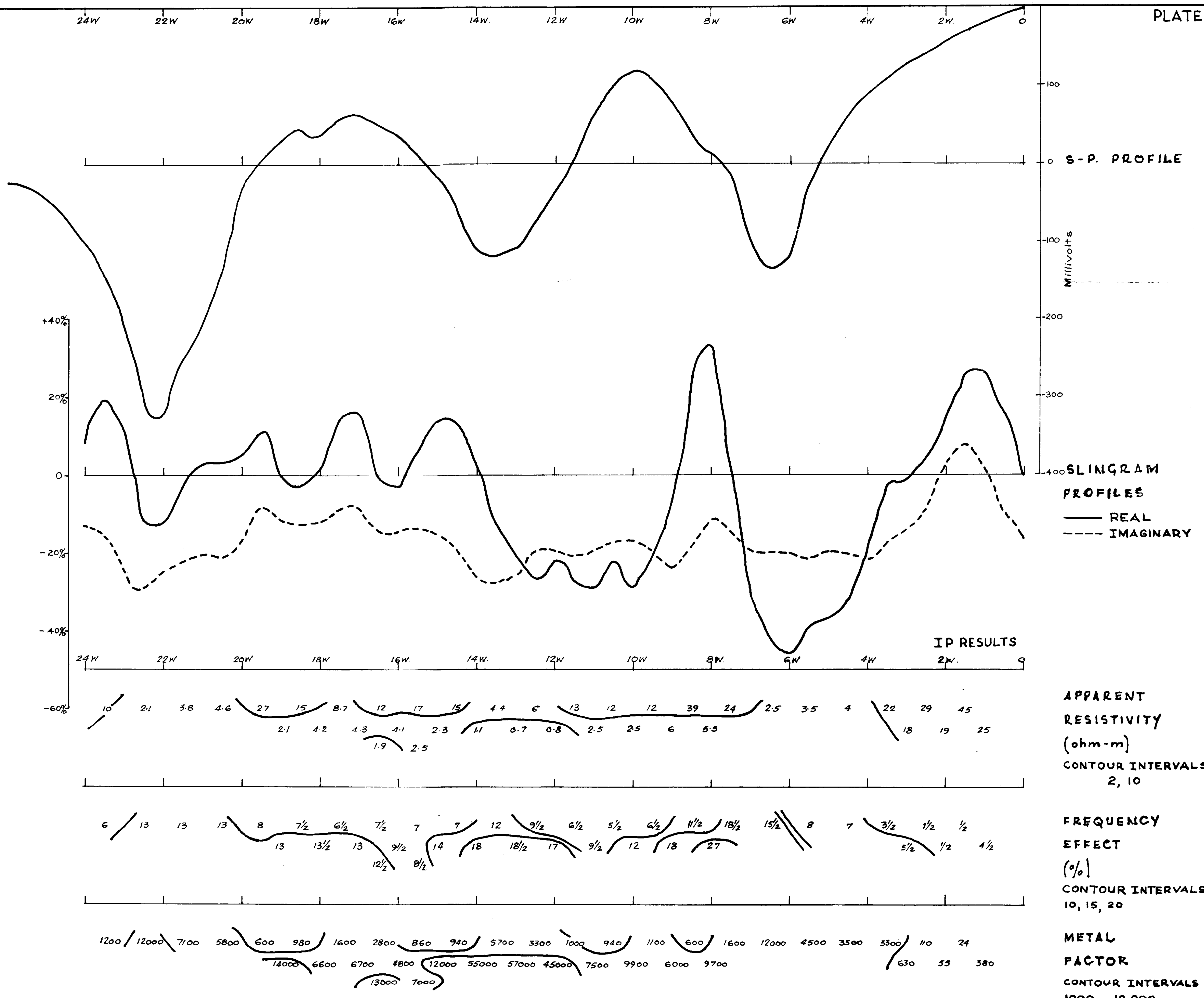
AREA 44 EXTENDED

GEOPHYSICAL RESULTS ON TRAVERSE 236 S

TO ACCOMPANY RECORD No 1968/104

D52/B7-389

PLATE 9



AREA 44 EXTENDED

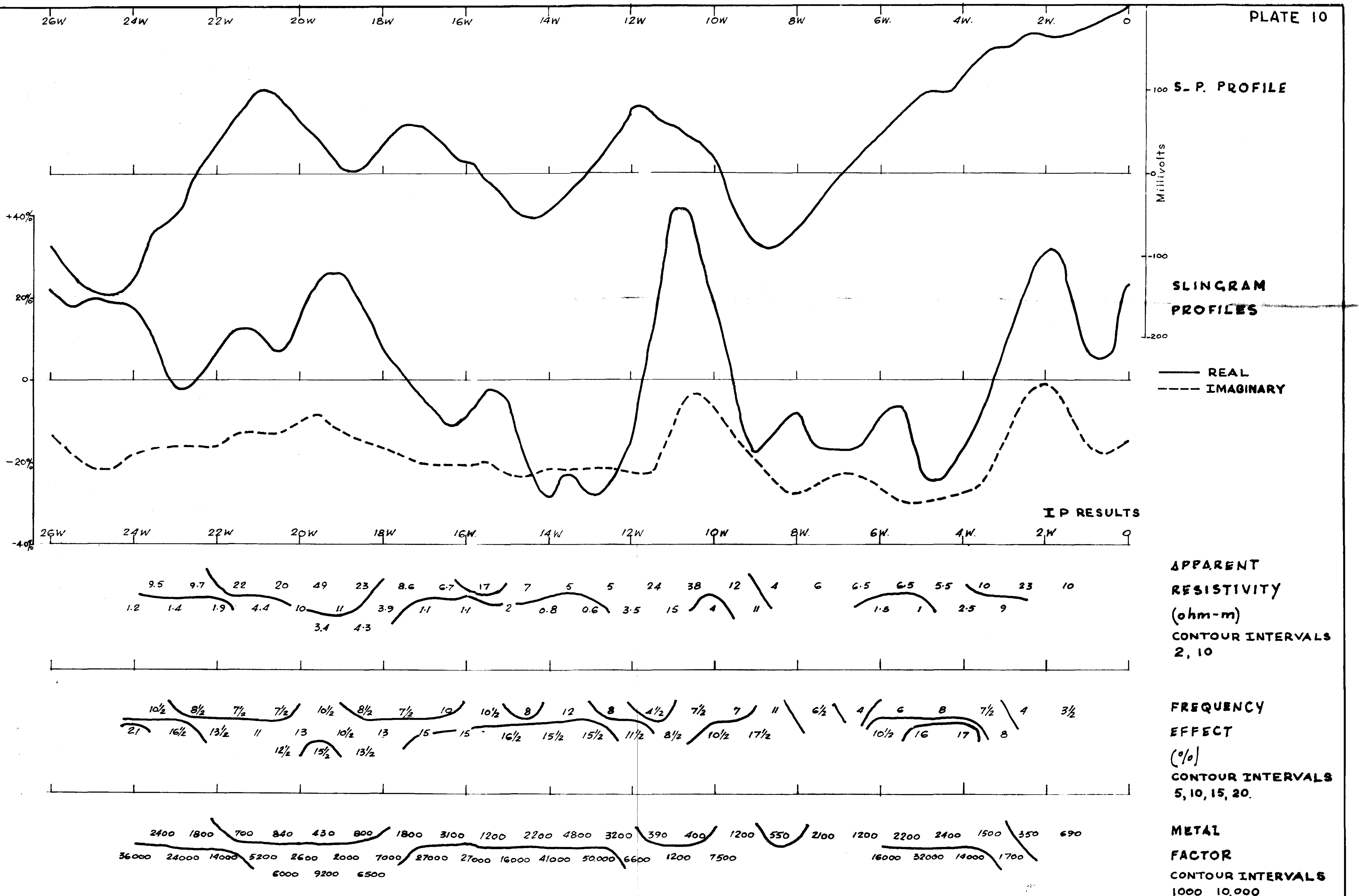
GEOPHYSICAL RESULTS ON TRAVERSE 240 S

FEET

200 100 0 200 400 600

TO ACCOMPANY RECORD No 1968/104

D52/B7-390

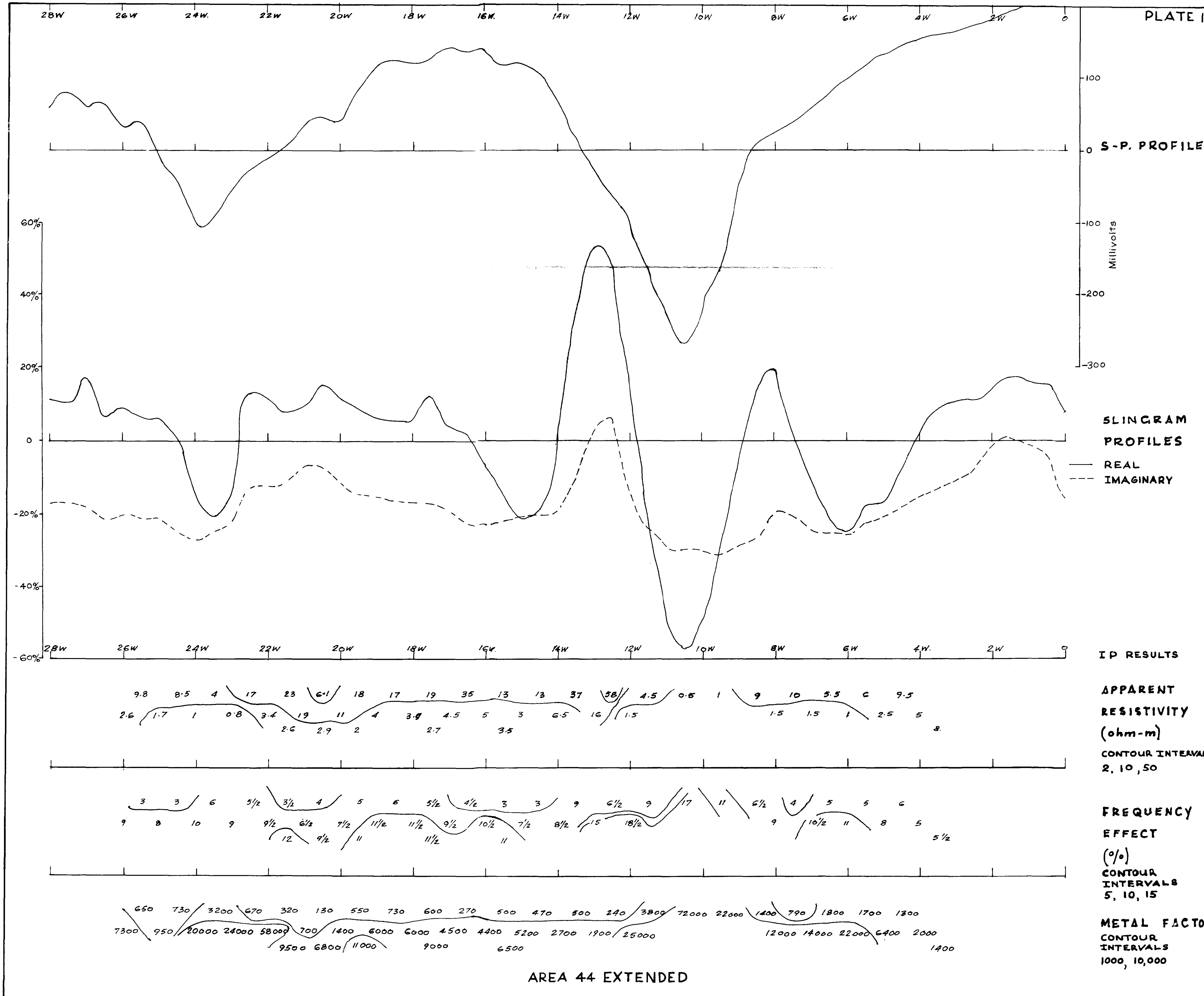


AREA 44 EXTENDED

GEOPHYSICAL RESULTS ON TRAVERSE 244 S

TO ACCOMPANY RECORD No 1968/104

D52/B7-391

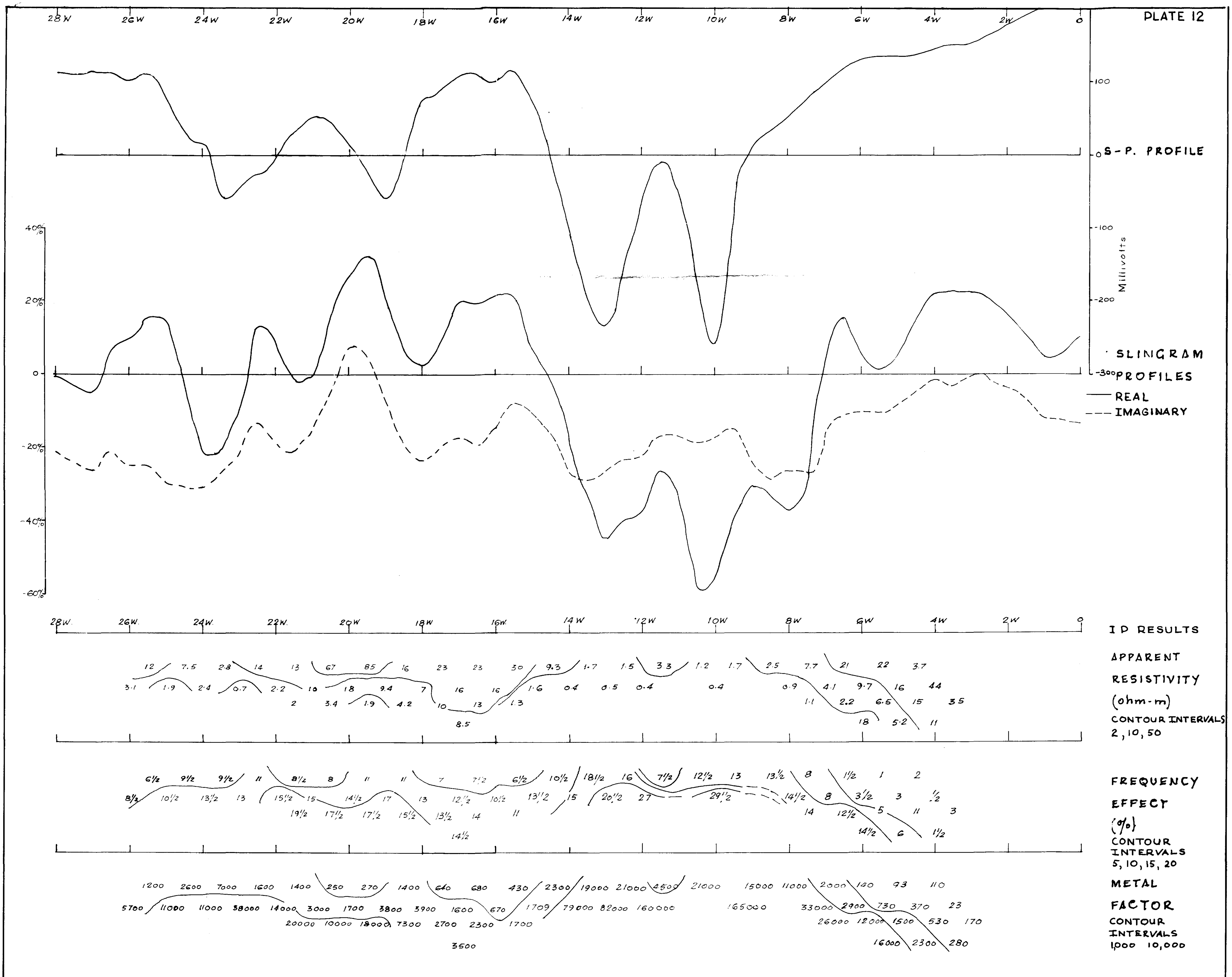


AREA 44 EXTENDED

GEOPHYSICAL RESULTS ON TRAVERSE 248 S

TO ACCOMPANY RECORD No 1968/104

D52/B7-392



AREA 44 EXTENDED

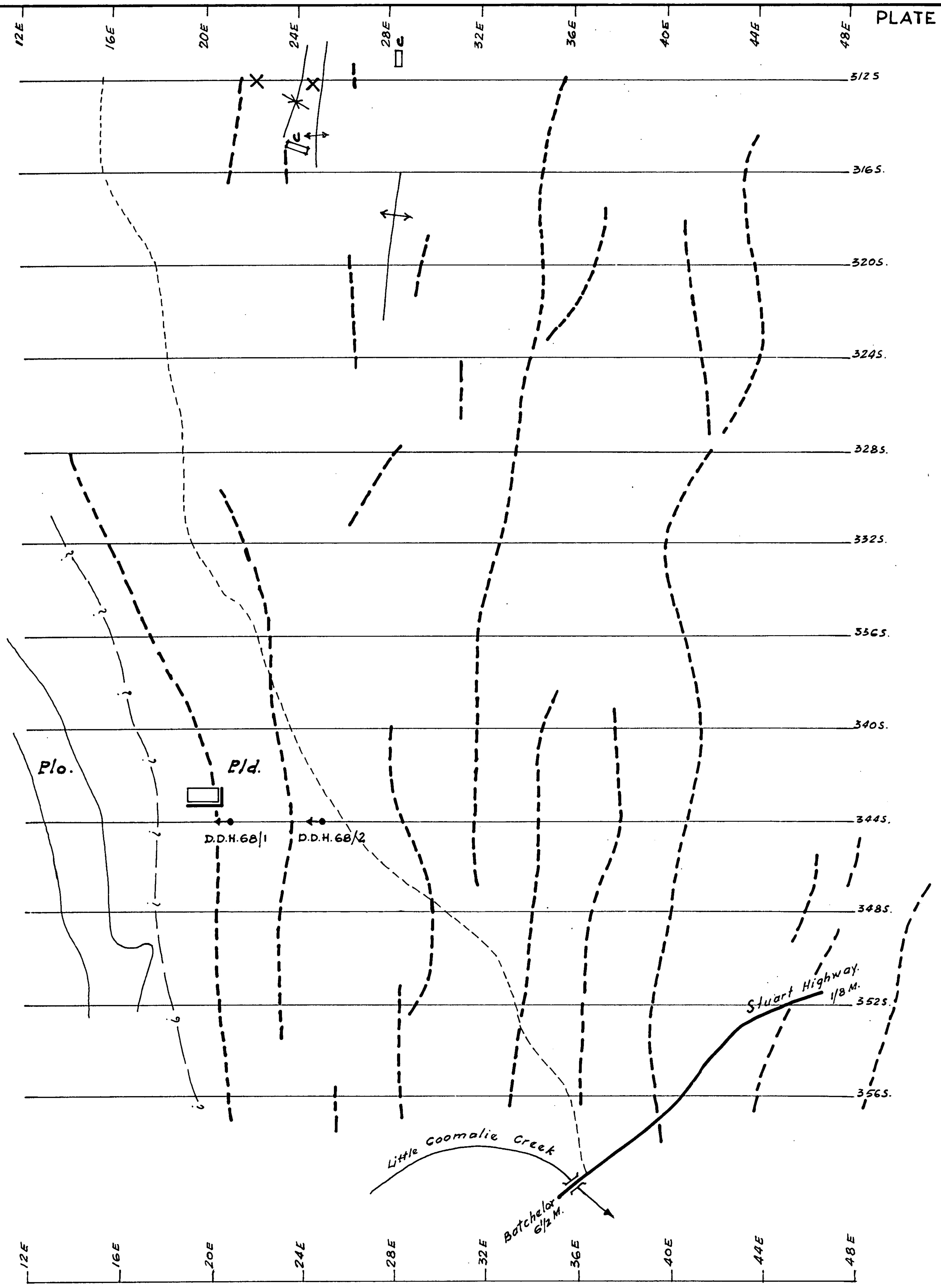
GEOPHYSICAL RESULTS ON TRAVERSE 252 S

FEET

200 100 0 200 400 600

TO ACCOMPANY RECORD No 1968/104

D52/B7-393



Plo - Coomalie Dolomite
Pld - Golden Dyke Formation
Syncline, Anticline
—?— Inferred Geological Boundary
Costean

COOMALIE GAP WEST (NORTHERN SECTION)
GEOLOGY

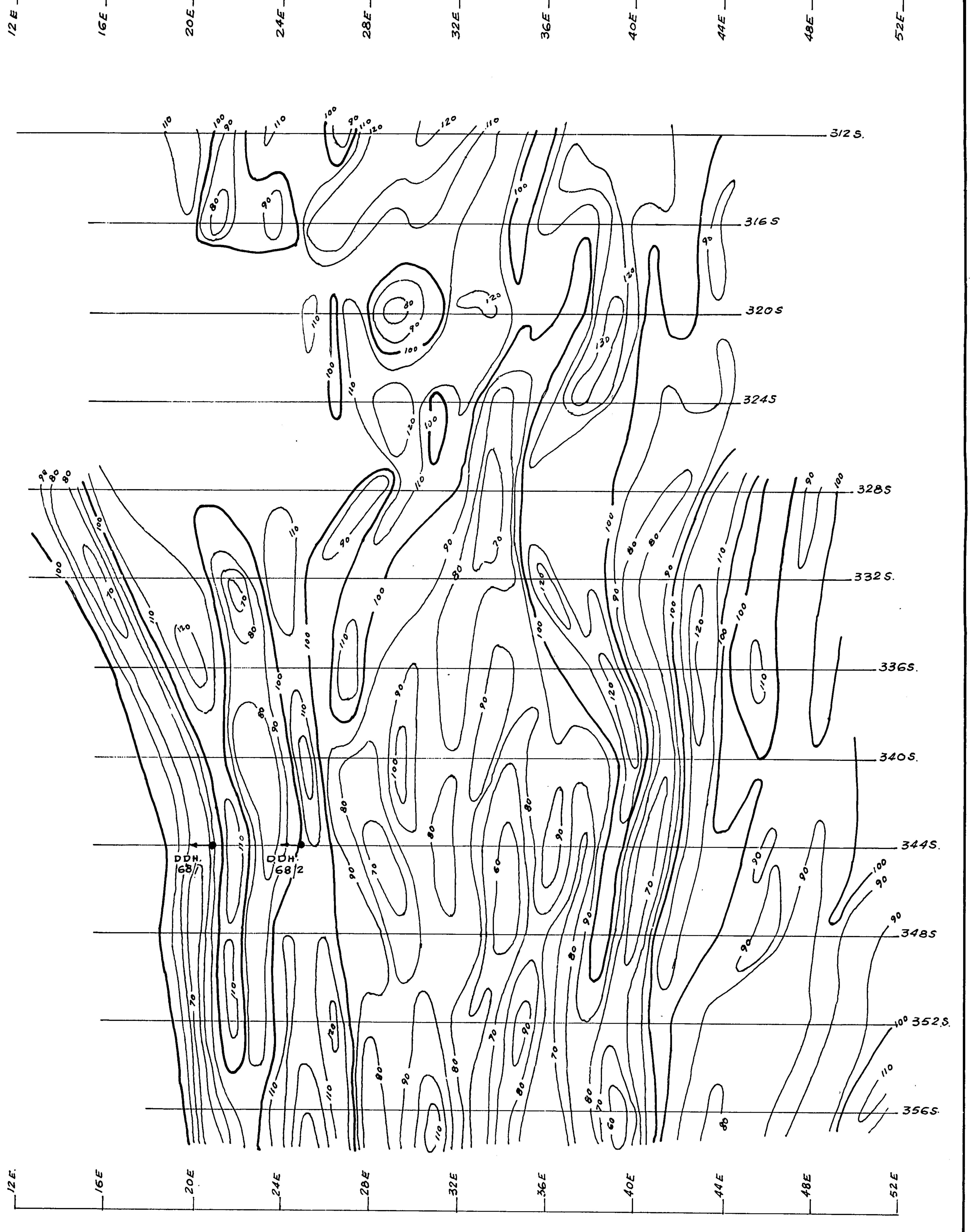
Slingram Axis
S-P negative centre
Track
Road

FEET
400 200 0 400 800 1200

PLATE 13

TO ACCOMPANY RECORD No 1968/104

D52/B7-394



COOMALIE GAP WEST (NORTHERN SECTION)

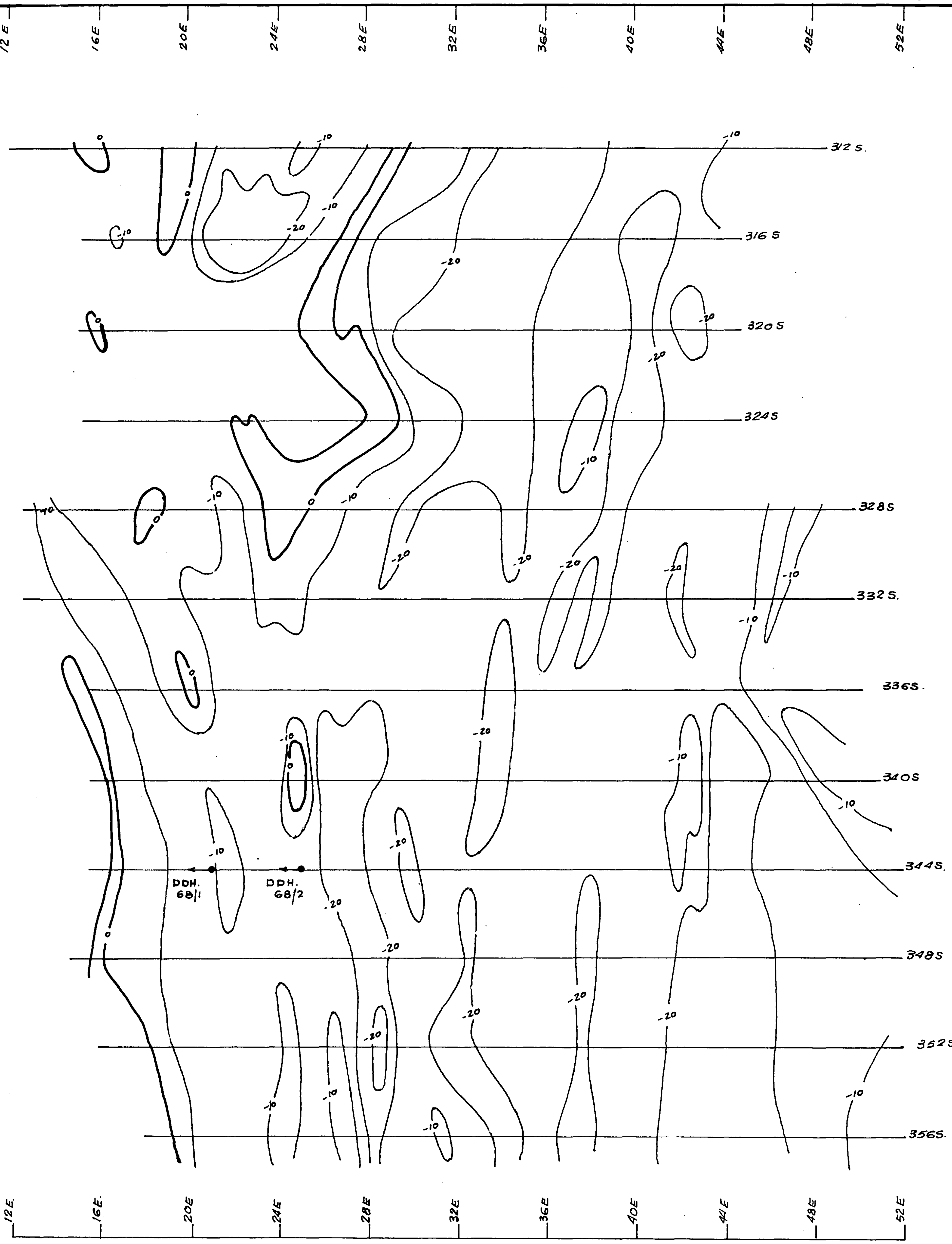
SLINGRAM REAL COMPONENT CONTOURS

FEET

400 200 0 400 800 1200

CONTOUR INTERVAL 10%

PLATE 14



COOMALIE GAP WEST (NORTHERN SECTION)

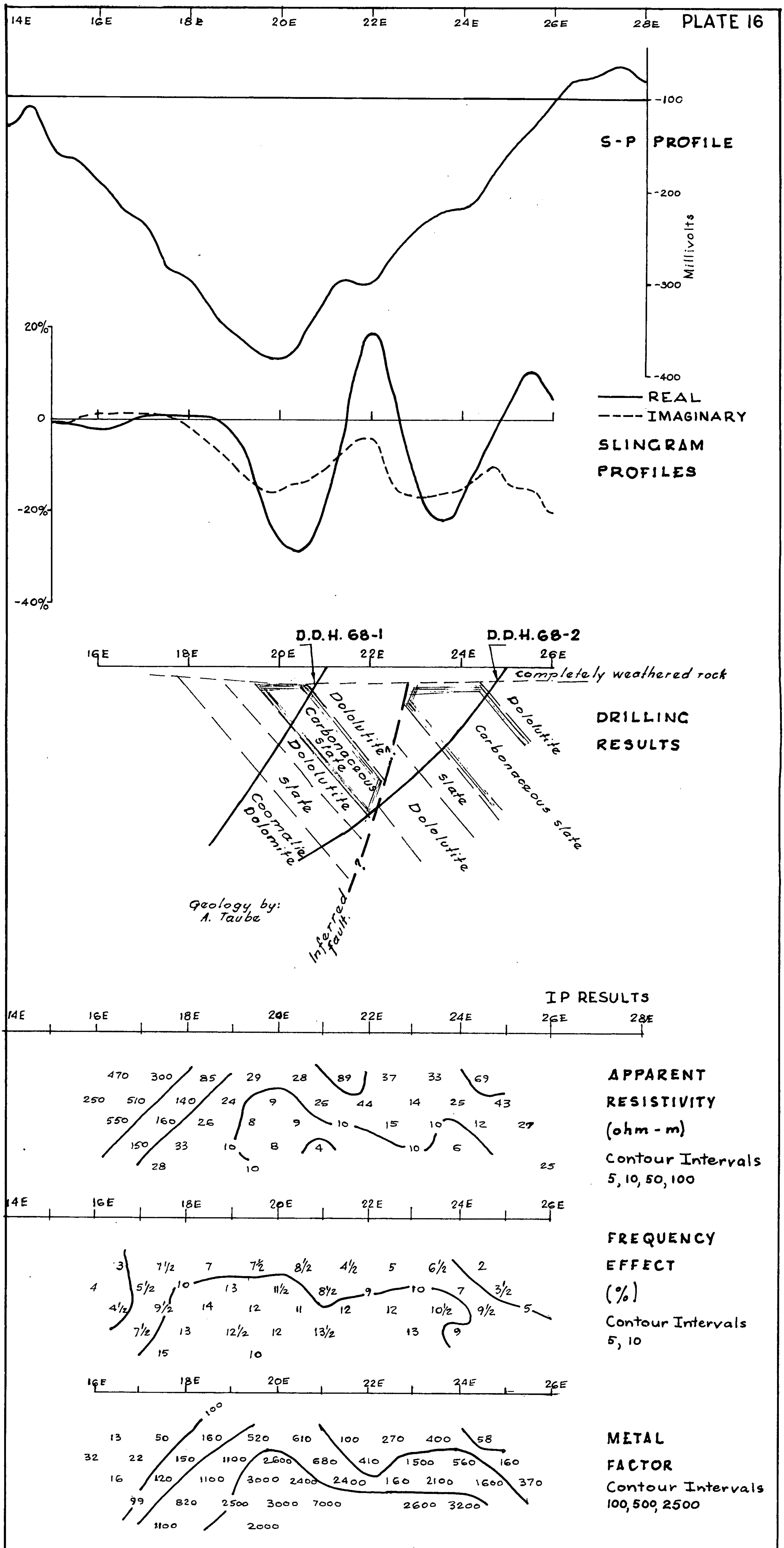
SLINGRAM IMAGINARY COMPONENT CONTOURS

FEET

400 200 0 400 800 1200

CONTOUR INTERVAL 10%

PLATE 15

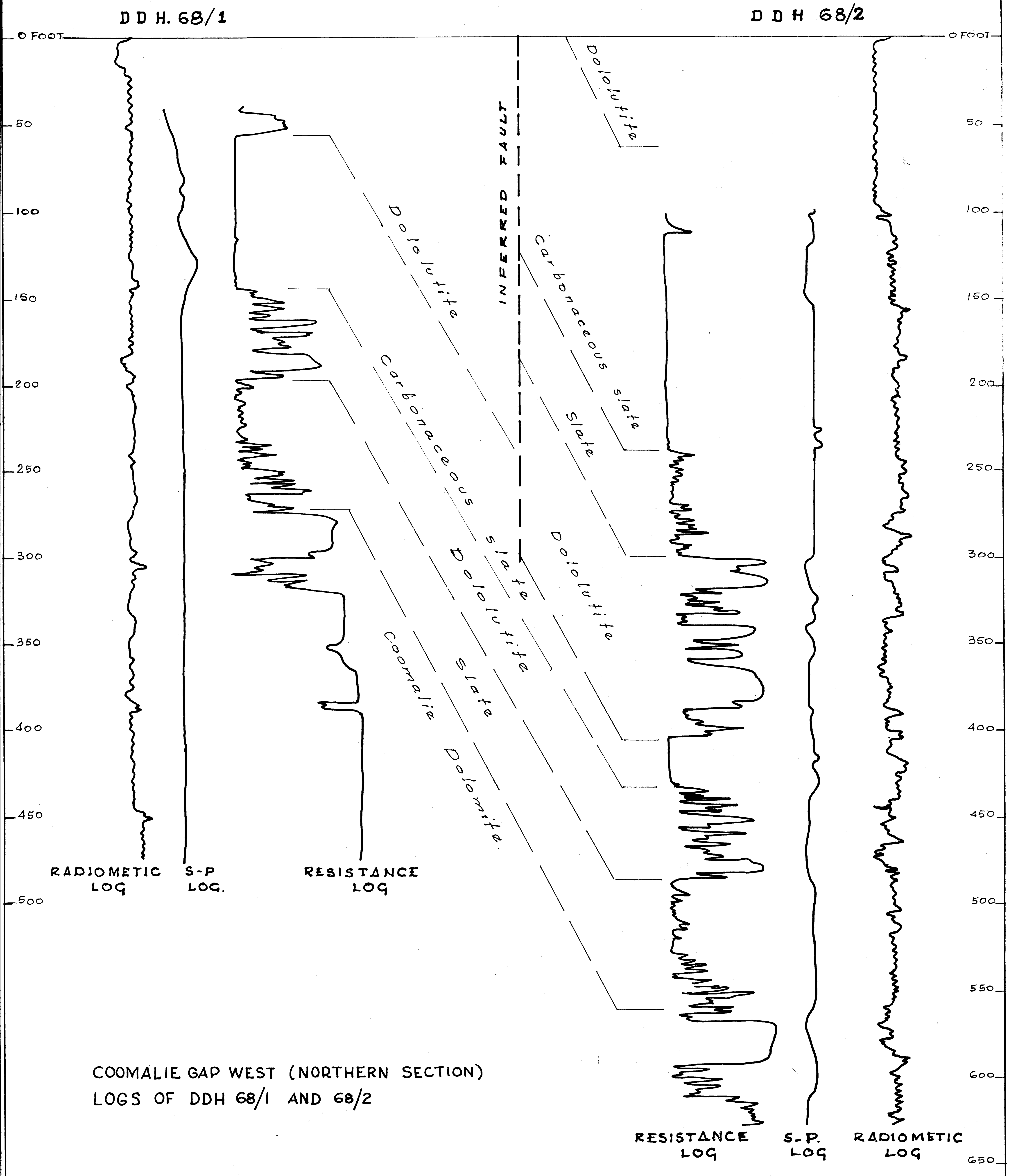


COOMALIE GAP WEST (NORTHERN SECTION)
DIAMOND DRILLING AND GEOPHYISICAL RESULTS
TRAVERSE 344 S

FEET
200 100 0 200 400 600

TO ACCOMPANY RECORD No 1968/104

D52/B7-397



COOMALIE GAP WEST (NORTHERN SECTION)
LOGS OF DDH 68/1 AND 68/2

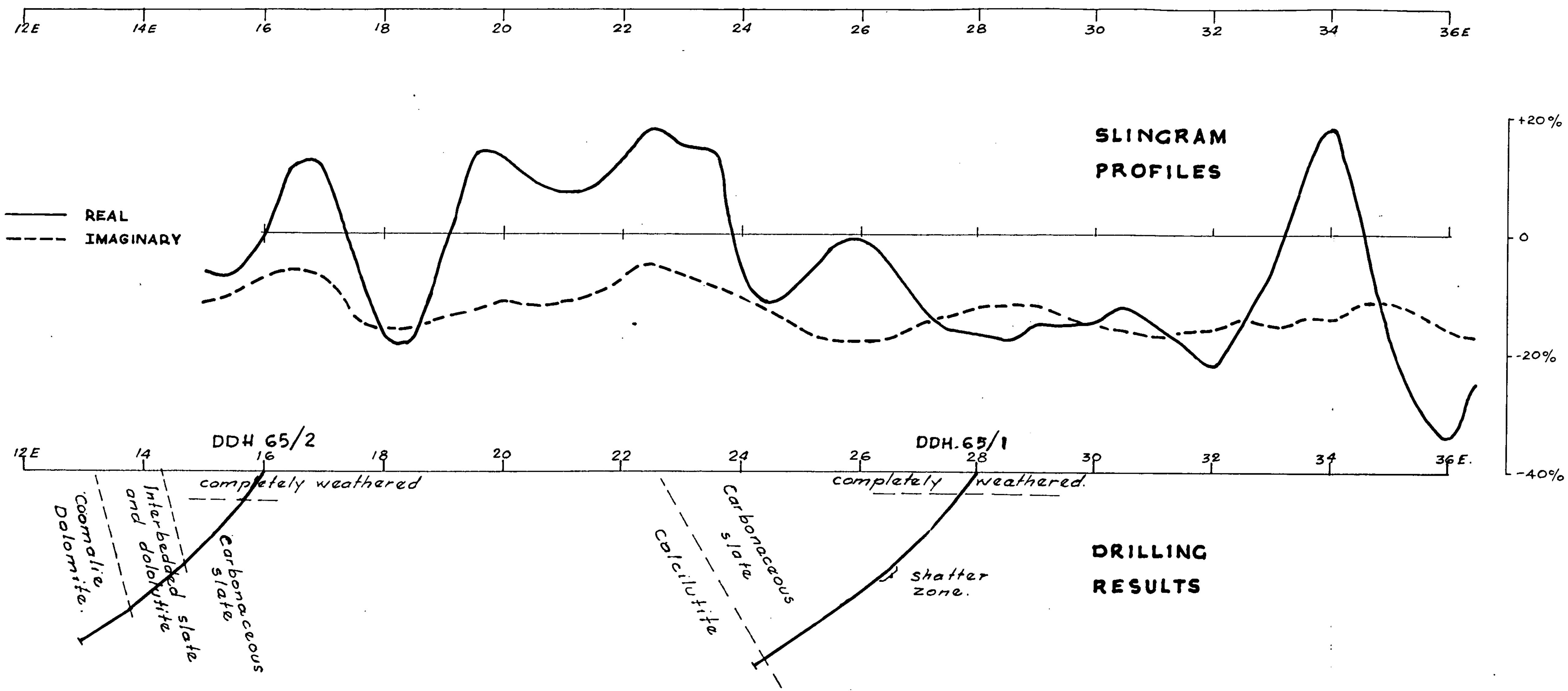
SCALES

RADIOMETRIC	0·1 mR/hr/inch
RESISTANCE	1000 ohms/inch
S-P	500 millivolts/inch

TO ACCOMPANY RECORD No 1968/104

D52/B7-398

PLATE 18



COOMALIE GAP WEST (SOUTHERN SECTION)

SLINGRAM AND DIAMOND DRILLNG RESULTS

ON TRAVERSE 412 S

FEET

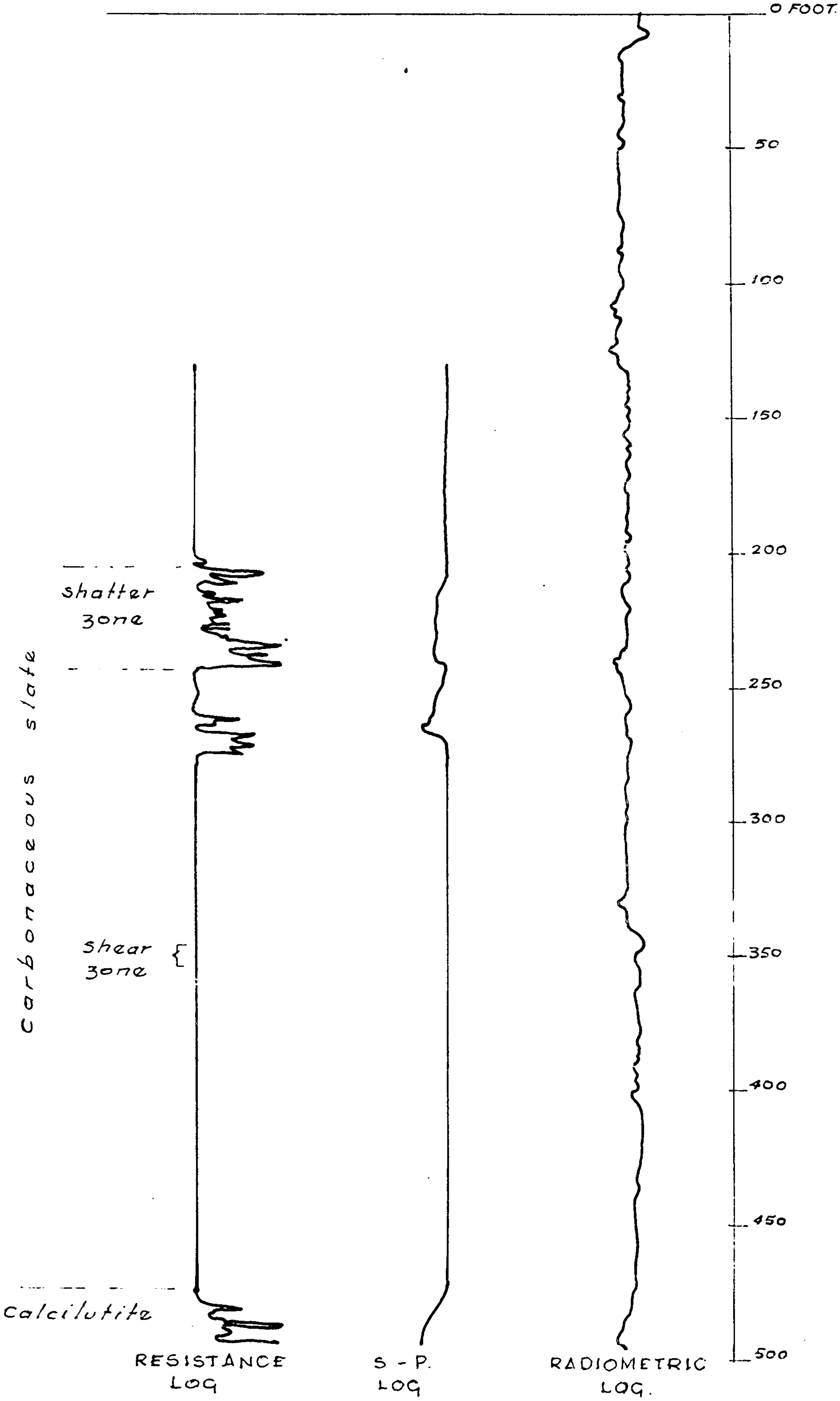
400 200 0 400 800 1200

TO ACCOMPANY RECORD No 1968/104

D52/B7-399

PLATE 19

DDH 65/1



COOMALIE GAP WEST (SOUTHERN SECTION)

GEOPHYSICAL LOGS OF DDH 65/1

SCALES

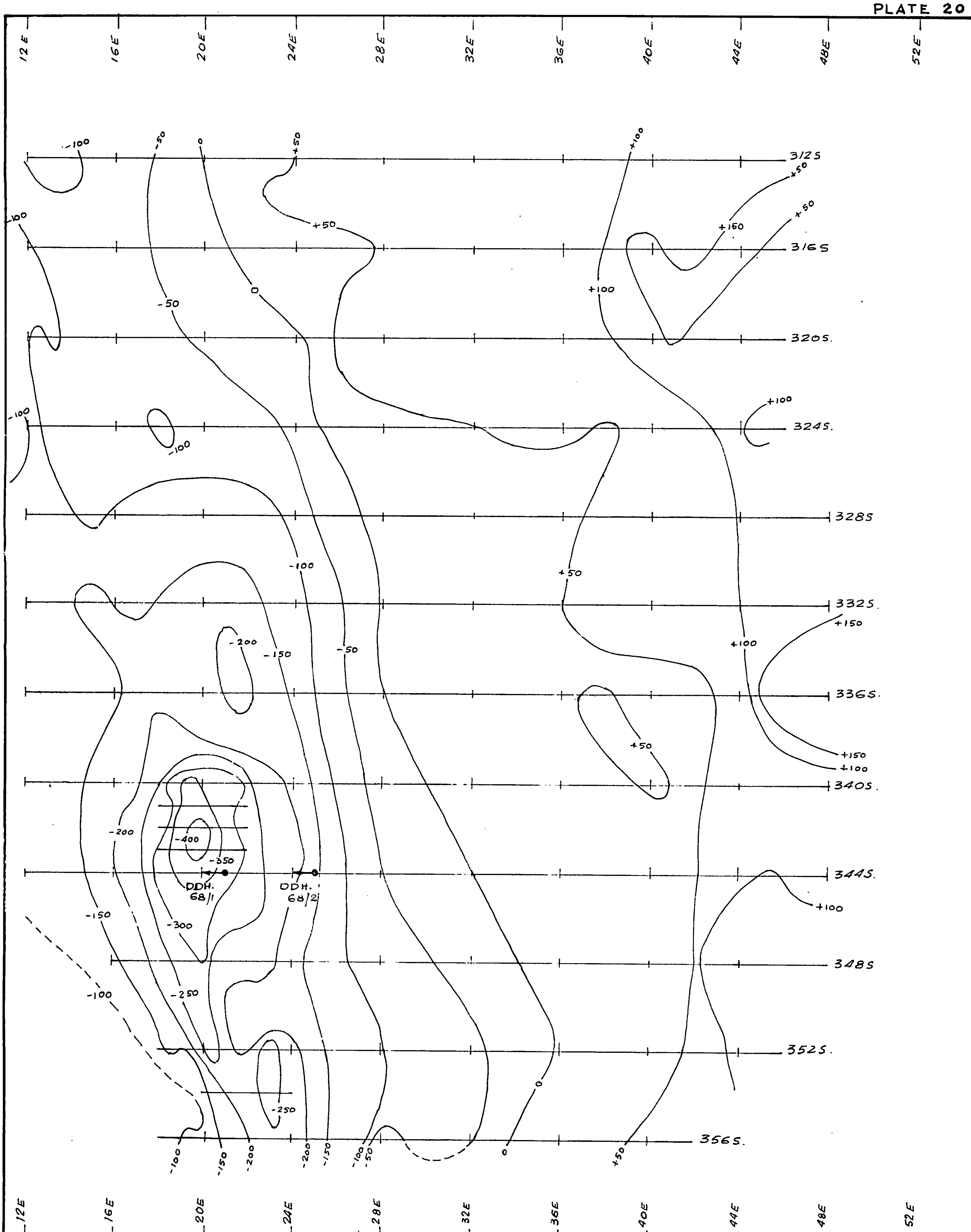
RADIOMETRIC 0·2 mR/hr/inch

RESISTANCE 1000 ohms/inch

S-P 1000 millivolts/inch

TO ACCOMPANY RECORD No 1968/104

D52/B7-400



COOMALIE GAP WEST (NORTHERN SECTION)

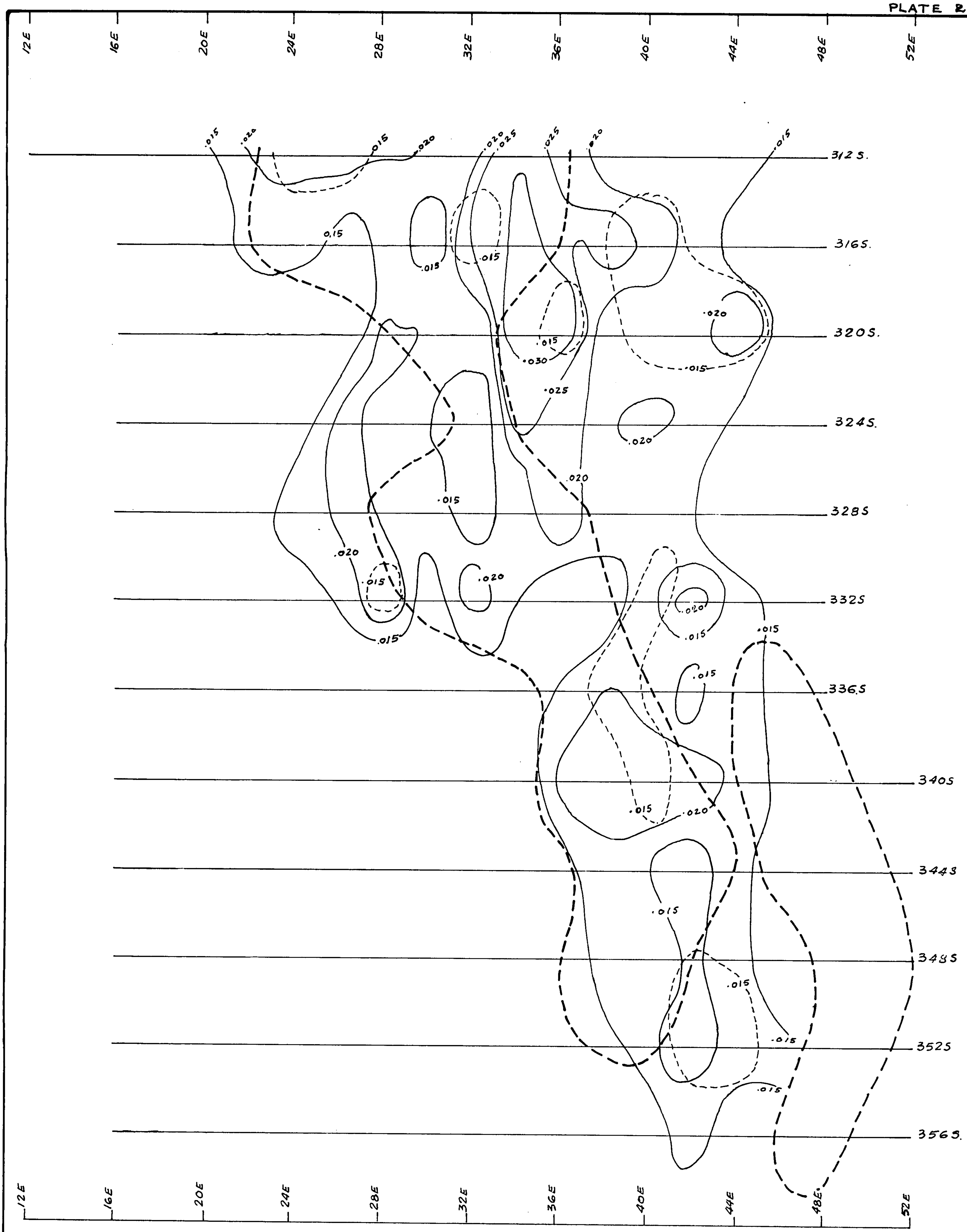
S-P CONTOURS

FEET

400 200 0 400 800 1200

CONTOUR INTERVAL 50 MILLIVOLTS

PLATE 20



COOMALIE GAP WEST (NORTHERN SECTION)

RADIOMETRIC RESULTS

— — — SURFACE RADIOMETRIC ANOMALY
——— A/B HORIZON RADIOMETRIC ANOMALY
------ C HORIZON RADIOMETRIC ANOMALY

FEET

400 200 0 400 800 1200

PLATE 21

TO ACCOMPANY RECORD No 1968/104

D52/B7-402

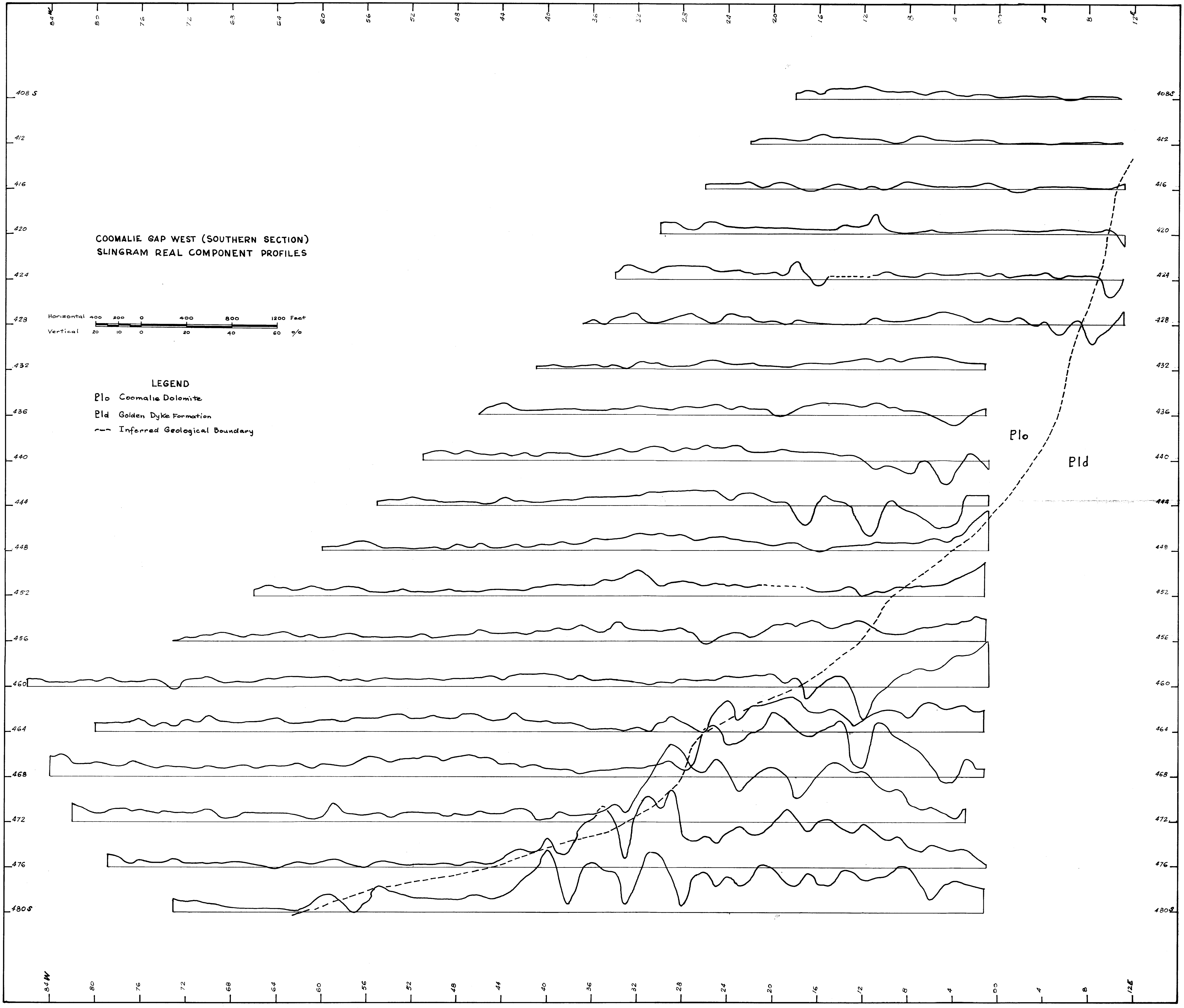
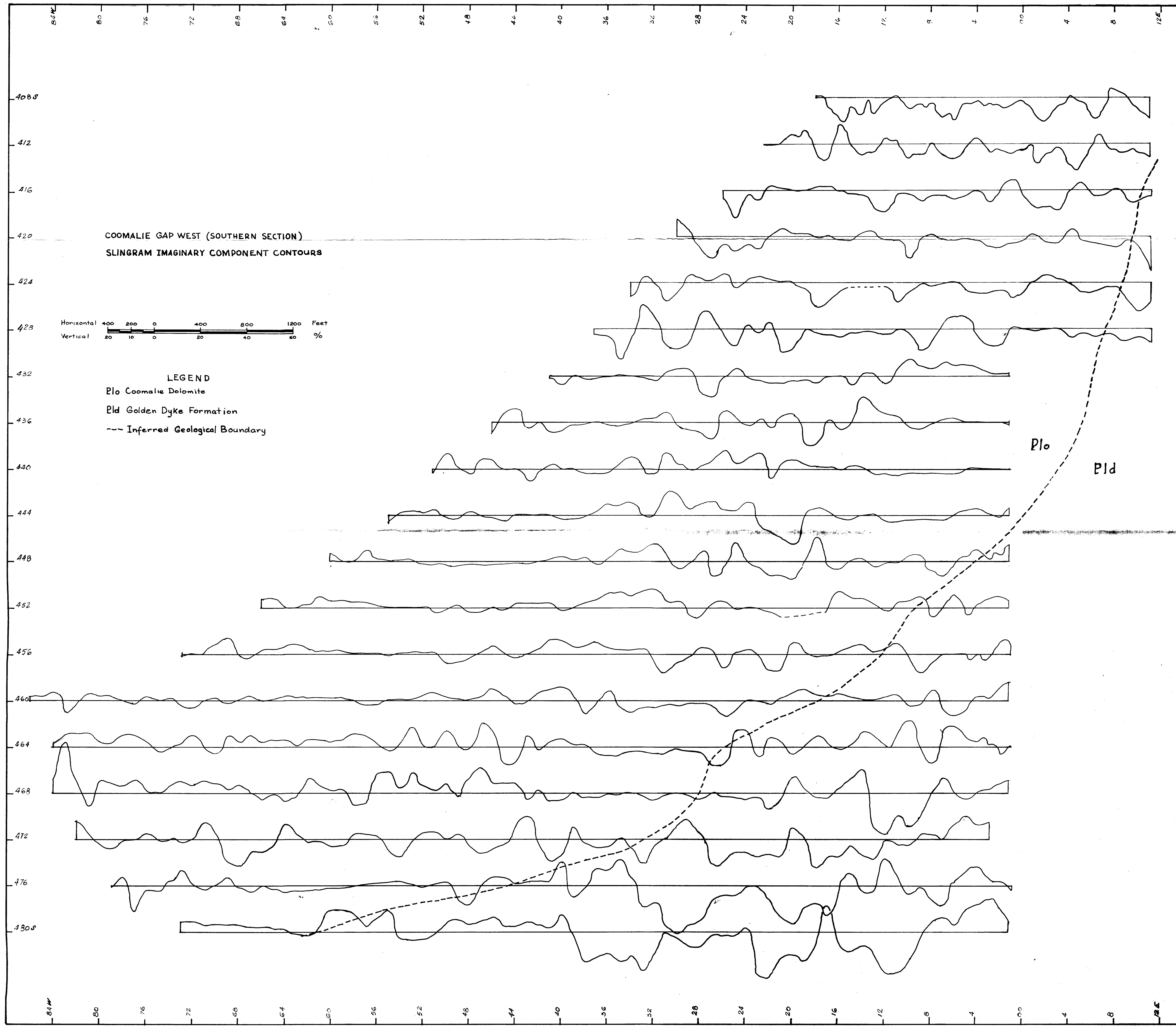
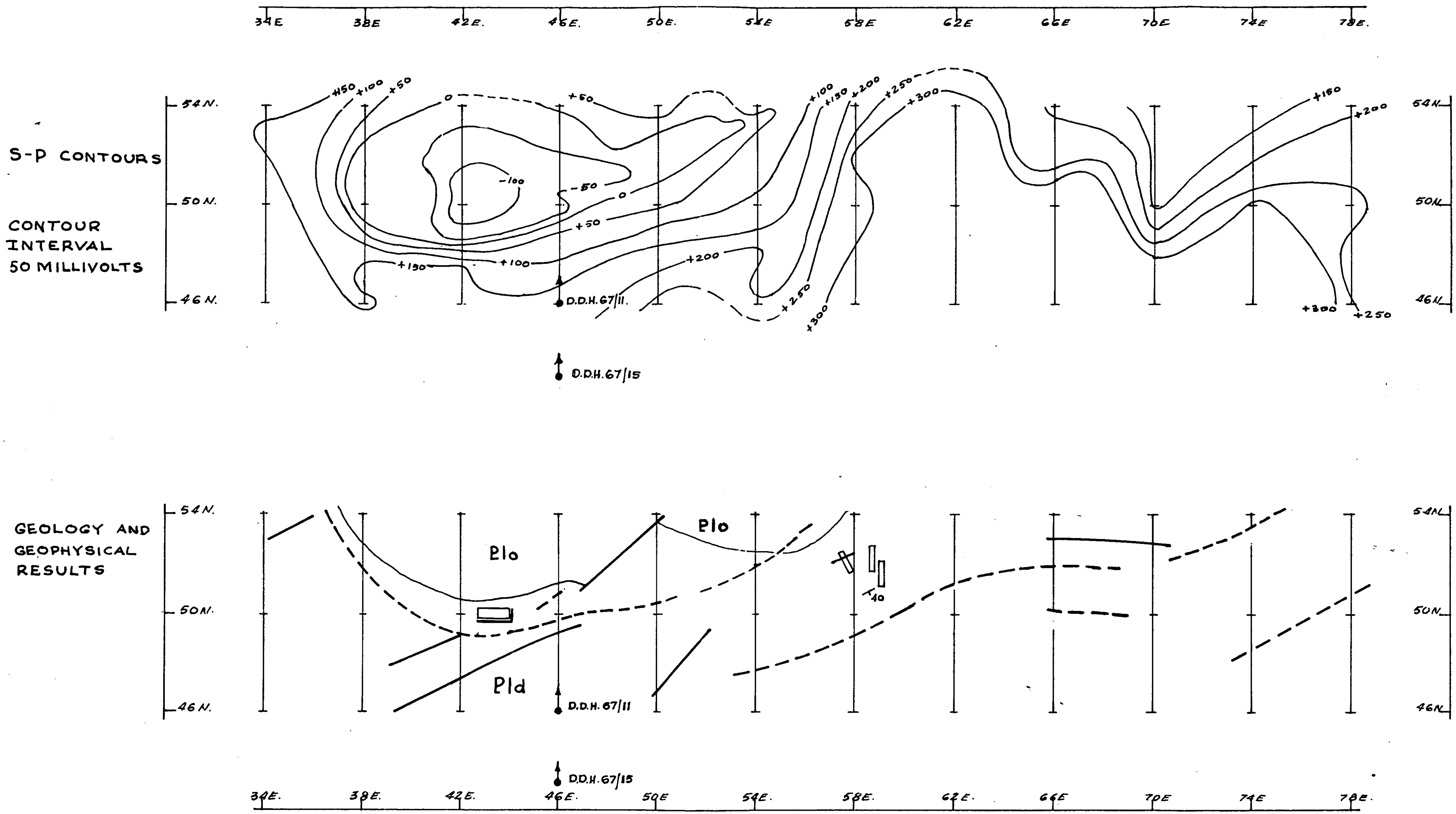

COOMALIE GAP WEST (SOUTHERN SECTION)
SLINGRAM REAL COMPONENT PROFILES
Horizontal 400 200 0 400 800 1200 Feet
Vertical 20 10 0 20 40 60 %
LEGEND
Plo Coomalie Dolomite
Pld Golden Dyke Formation
Inferred Geological Boundary
Plo
Pld
408 S
412
416
420
424
428
432
436
440
444
448
452
456
460
464
468
472
476
480 S
84 W
12 E

PLATE 23



TO ACCOMPANY RECORD No 1968/104

D52/B7-404



LEGEND

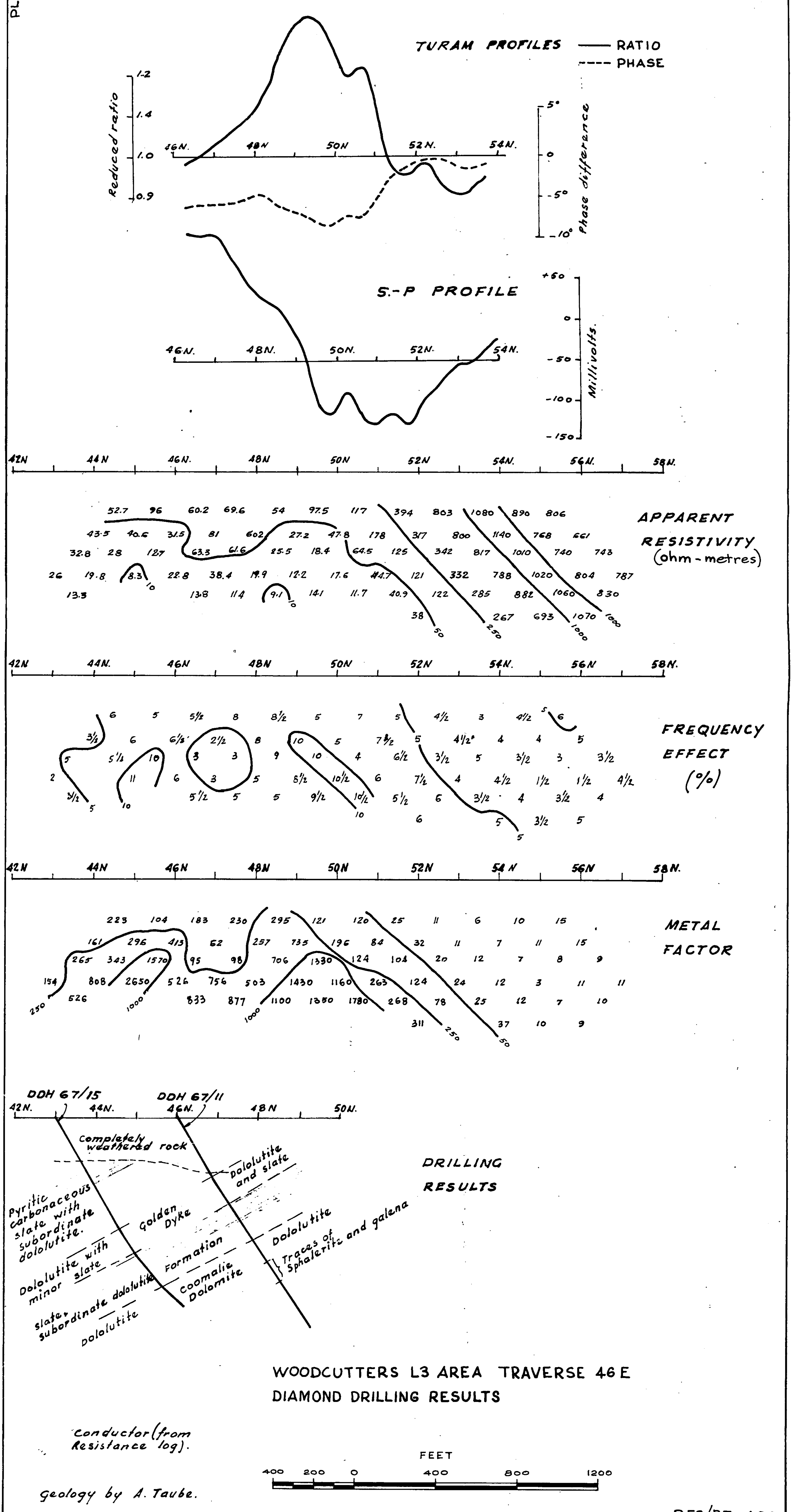
Pld Golden Dyke Formation
Plo Coomalie Dolomite
Geological Boundary
Fault
Turam Axis
Costean
S-P negative centre

WOODCUTTERS L3 AREA
GEOPHYSICAL RESULTS AND GEOLOGY

FEET
400 200 0 400 800 1200

TO ACCOMPANY RECORD No 1968/104

D52/B7-405

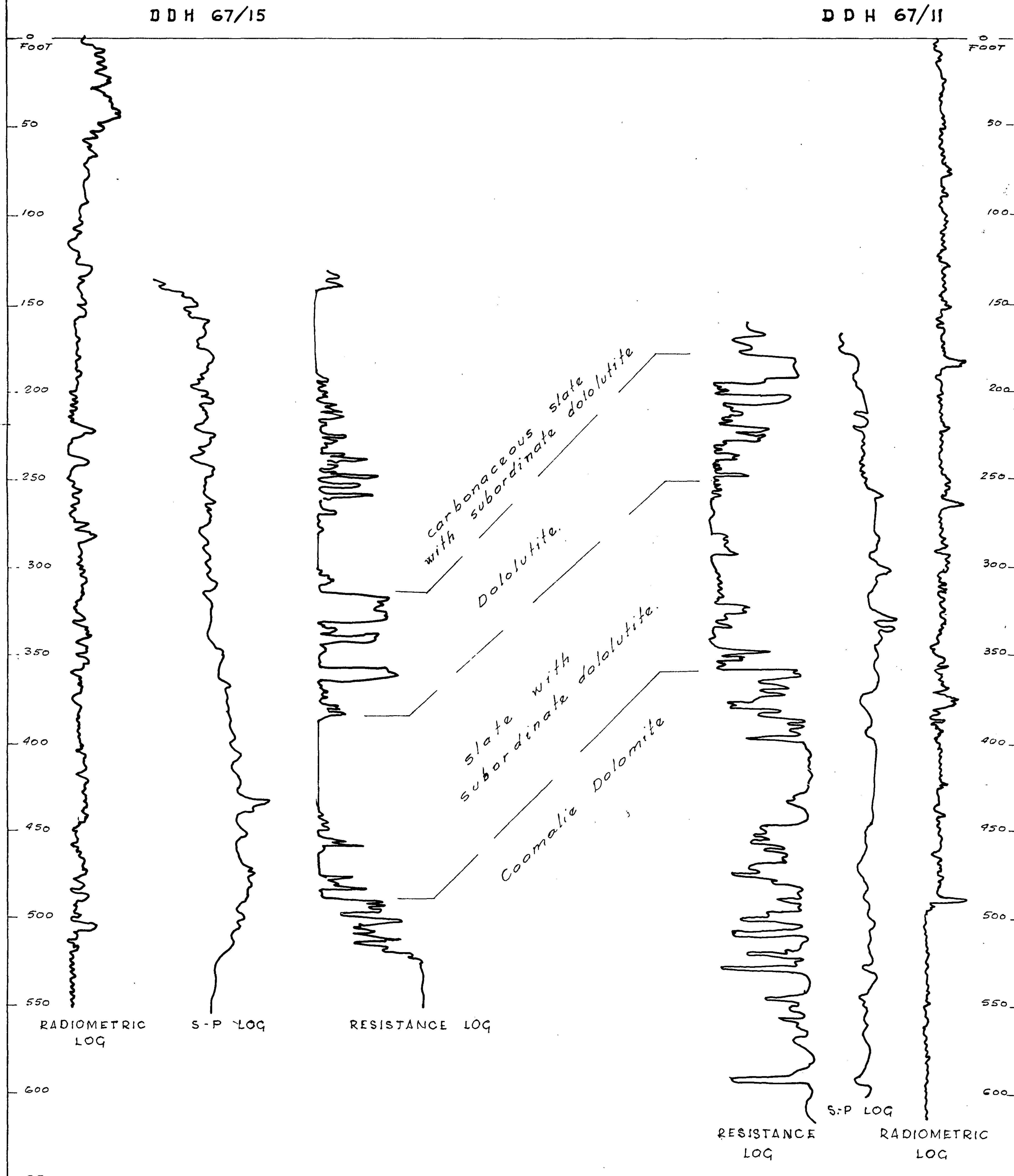


WOODCUTTERS L3 AREA TRAVERSE 46 E
DIAMOND DRILLING RESULTS

TO ACCOMPANY RECORD No 1968/104

D52/B7-406

PLATE 26



WOODCUTTERS L3 AREA

LOGS OF 67/11 AND 67/15

SCALES

Radiometric - 0·1 mR/hr/inch

Resistance - 1000 ohms/inch

S-P 500 millivolts/inch (DDH 67/11)
250 millivolts/inch (DDH 67/15)

TO ACCOMPANY RECORD No 1968/104 D52/B7-407

WOODCUTTERS AREA
S-P CONTOURS

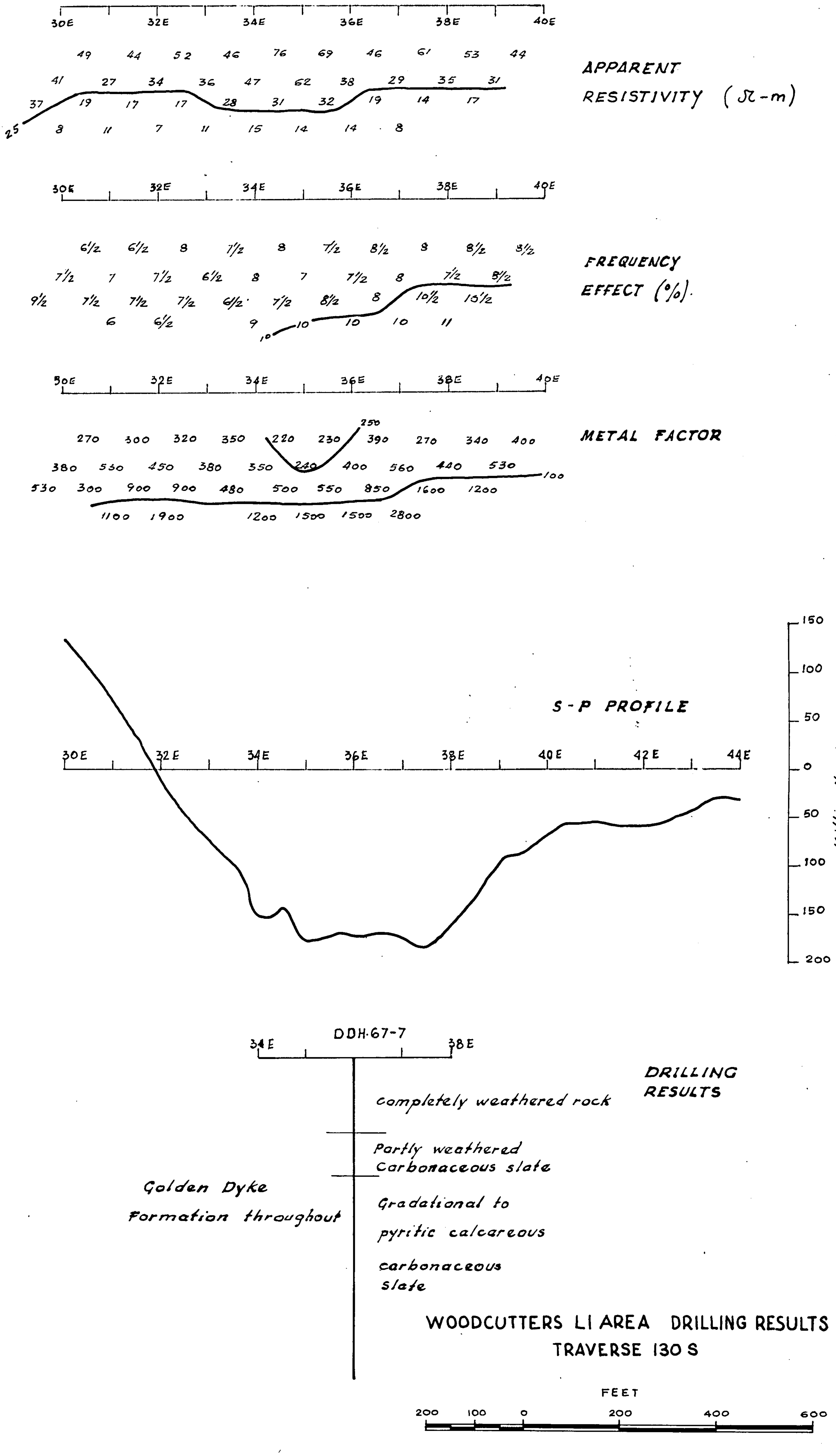
FEET
400 200 0 400 800 1200

CONTOUR INTERVAL 50 MILLIVOLTS.
--- 100 p/m lead geochemical contour (after Shatwell 1966)

TO ACCOMPANY RECORD No. 1968/104

D52/B7-408

PLATE 27

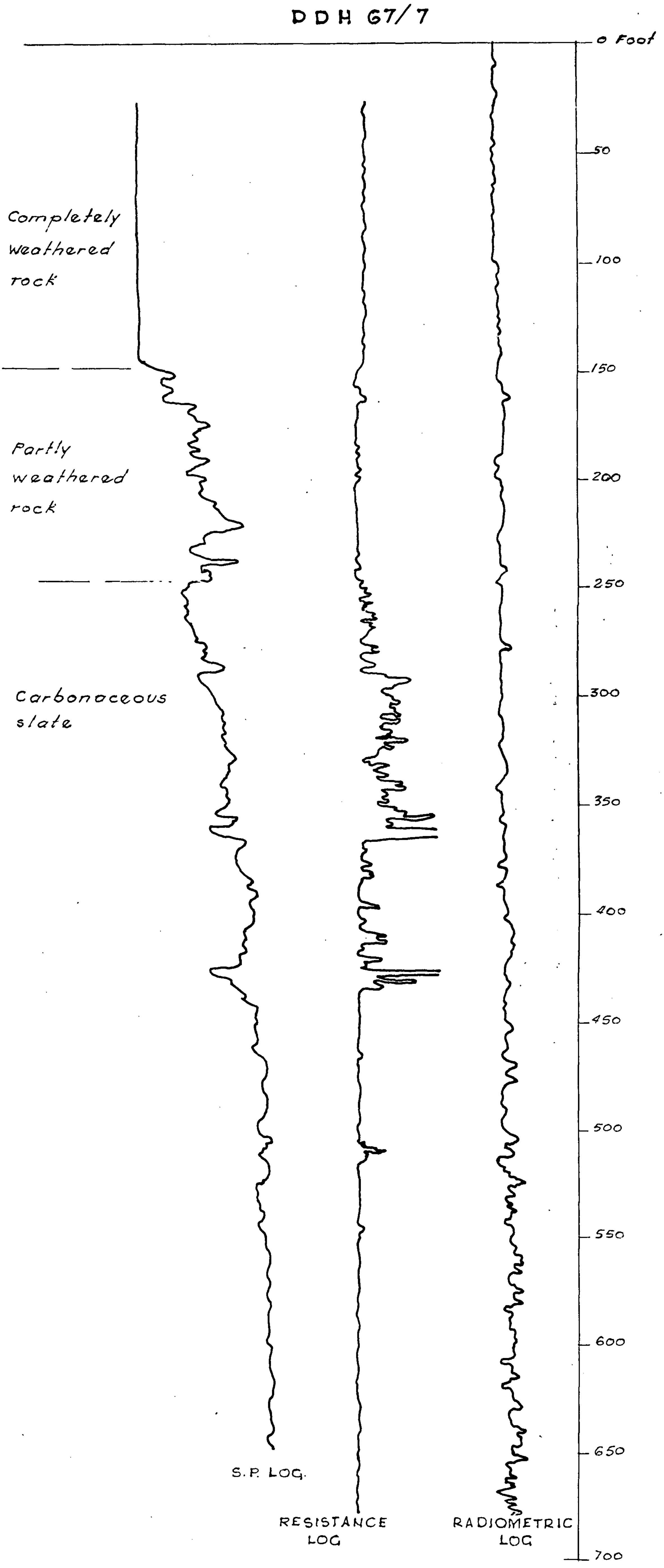


WOODCUTTERS L1 AREA DRILLING RESULTS
TRAVERSE 130 S

PLATE 28

Geology by J.L. Willis

TO ACCOMPANY RECORD No 1968/104 D52/B7-409



SCALES
RADIOMETRIC 0·1 mR/hr/inch
RESISTANCE 1000 ohms/inch
S-P 500 millivolts/inch

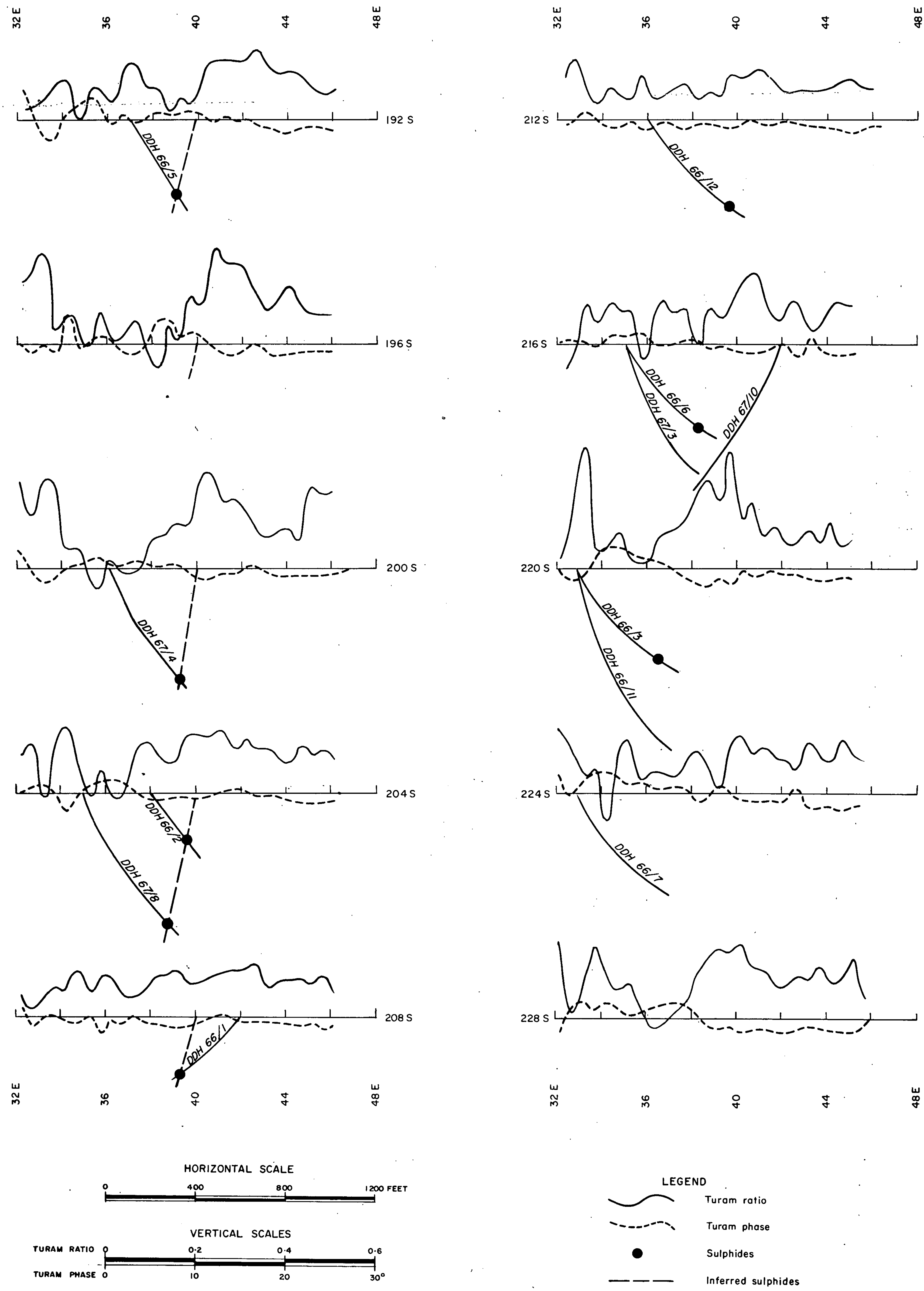
WOODCUTTERS L1 AREA
LOGS OF DDH 67/7

PLATE 29

TO ACCOMPANY RECORD No 1968/104

D52/B7-410

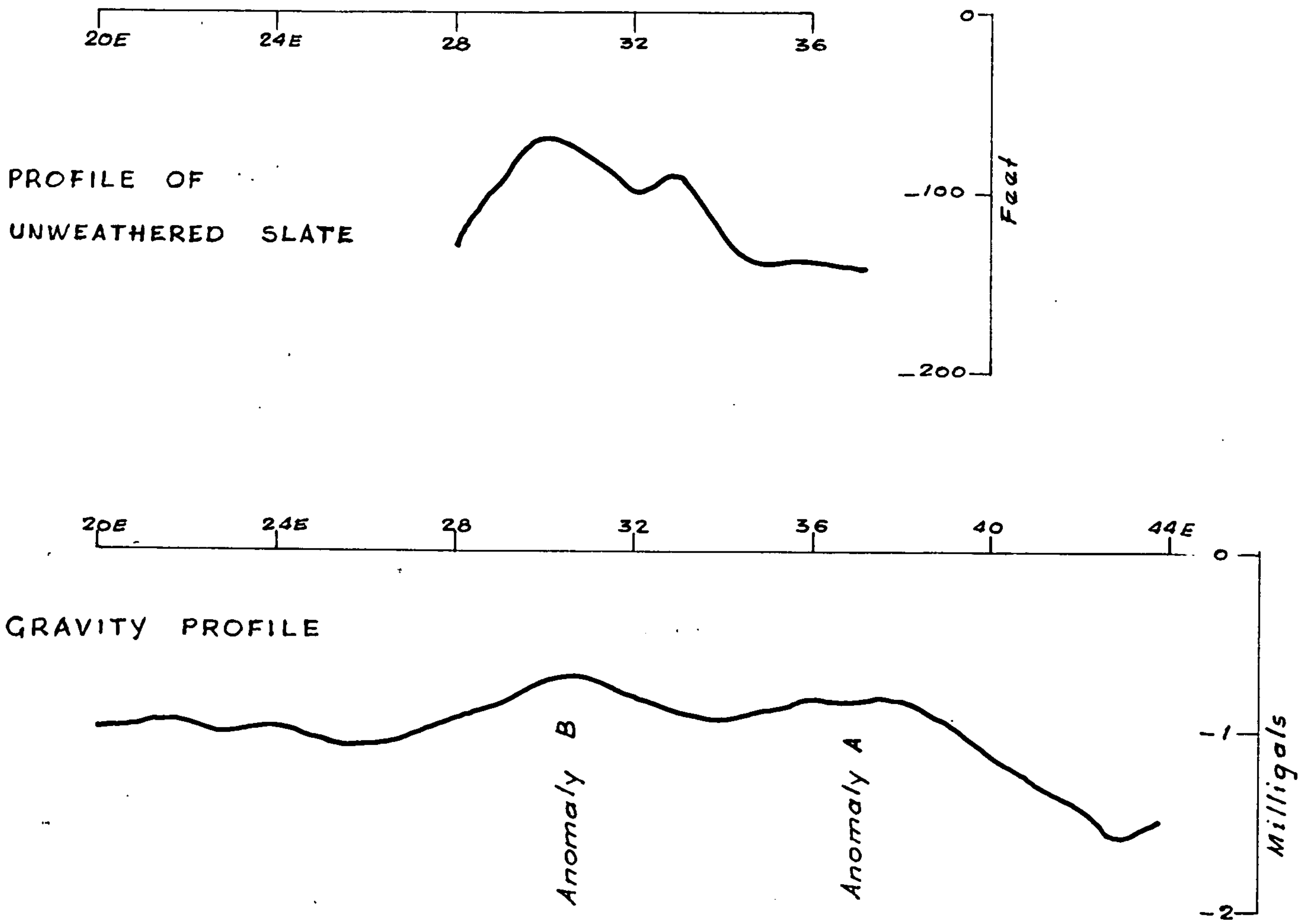
PLATE 30



WOODCUTTERS L5 AREA, NT, 1967
TURAM PROFILES & DRILLING RESULTS

TO ACCOMPANY RECORD No 1968/104

D52/B7-342



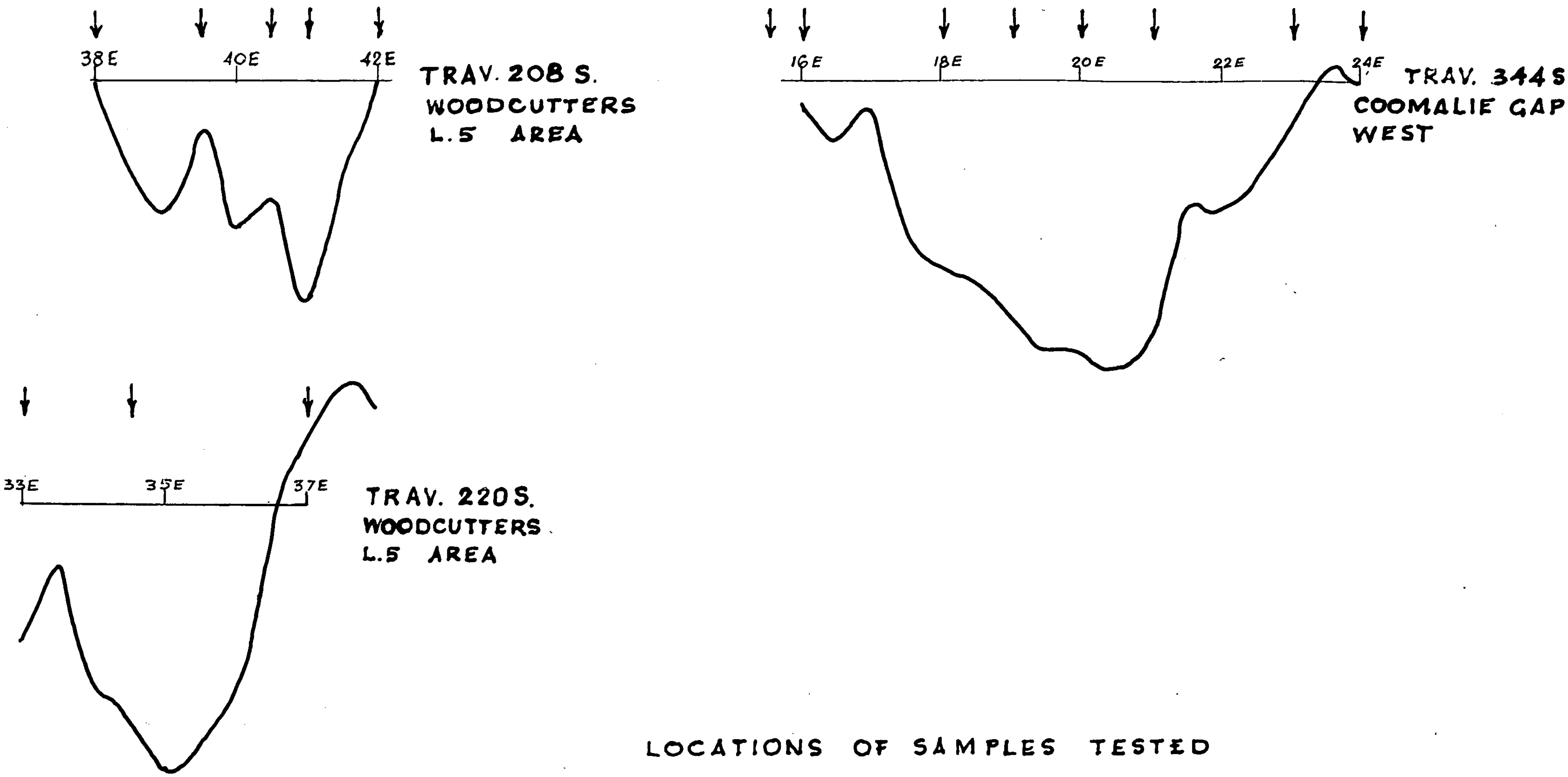
WOODCUTTERS L5 AREA TRAVERSE 220S
SLINGRAM DEPTH PROBE RESULTS

FEET

400 200 0 400 800 1200

PLATE 31

PLATE 32



LOCATIONS OF SAMPLES TESTED
FOR pH
TOGETHER WITH S-P PROFILES

↓ SAMPLE LOCATION