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ELECTRICAL PROPERTIES OF ROCKS AND SURFICIAL COVER AS A GUIDE FOR EXPLORATION FOR MINERALS AND GROUND-WATER ON EYRE PENINSULA, S.A.

by

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ABSTRACT

The effectiveness of electrical geophysical methods in exploration is determined not only by the electrical properties of the minerals being sought but also by those of the environment in which the prospective horizons are located. Any prior knowledge of these parameters that can be provided to the explorer should be useful in selecting areas worthy of exploration effort and in planning initial surveys. Eyre Peninsula has both prospectivity for base metals and a wide range of background electrical parameters, from areas where electrical methods can be expected to be very effective to those where such techniques are virtually useless. This report summarises all available (open file) electrical information in the area, and has been organised so as to facilitate the tasks of area selection and the identification of viable survey techniques.

1. INTRODUCTION

This report presents the results of a regional evaluation of the near-surface (within 100 metres) geoelectrical properties of the area of Eyre Peninsula covered by the 1:250 000 map sheets STREAKY BAY, ELLISTON, YARDEA, KIMBA, LINCOLN, PORT AUGUSTA AND WHYALLA, and a compilation of the geoelectric properties of selected zones prospective for lead-zinc mineralization within that area. Information used in this evaluation was extracted from mining company exploration reports and South Australian Department of Mines and Energy (SADME) reports held on open-file by the SADME.

The specific aims of the study (constrained within the limits of the available information) were:

1. to locate and tabulate all ground electrical geophysical surveys descibed in reports held on open file by the SADME.

2. to derive characteristic electrical properties of metamorphic-igneous basement and overlying sedimentary materials within the study area,

3. to derive characteristic response styles of various electrical geophysical exploration techniques to lead-zinc mineralization, and,

4. to recommend electrical geophysical exploration techniques appropriate to the search for lead-zinc mineralization in Eyre Peninsula.

The main text of this report was written by consultant mineral exploration geophysicist T.V. Harvey. Much of the initial geophysical data search work and preparation of original graphical material was carried out by contract geophysicist L.M. Harvey. Final editing and compilation were done by A.R. Dodds.

2. SUMMARY.

The near surface geology of the study area comprises exposed Precambrian Gawler Craton basement, mainly in the east and northeast, and Cainozoic sedimentary cover, mainly in the centre and west. Cainozoic thicknesses vary widely, but are typically less than 50 metres; a major exception is the east-west Polda Basin where over 150 metres of Cainozoic and older sedimentary cover overlie the basement. Surficial Quaternary calcrete and Tertiary silcrete-laterite layers are widespread in the study area, and the top section of the basement is invariably weathered.

Electrical geophysical techniques have been used in exploration programmes for uranium, lignite and water in the cover rocks, and for uranium, diamonds, base metals and graphite in the basement

rocks. An assessment of all open file electrical geophysical data showed that three categories of near surface resistivity patterns can be recognised in the study area. All categories may include a few metres of silcrete at surface with a resistivity of around 100 ohm-metres and basement with resistivity of 1000 ohm-metres or more. The different categories are:

- a 2- (or 3-) layer case in areas of basement outcrop and subcrop in the east, where the intermediate layer is weathered basement with a thickness of up to 50 metres and a resistivity of 10-100 ohm-metres;

- a 3-layer case in inland areas of Cainozoic cover in the centre and west, where the intermediate layer is 50-100 metres of saline-water saturated sediments and weathered basement with a resistivity of 1-10 ohm-metres;

- a 4-layer case in coastal areas of Cainozoic cover in the west, which is the same as the above, but with an additional layer of up to 40 metres of fresh-water saturated sediments with a resistivity of 10-70 ohm-metres replacing the upper part of the saline layer.

Exploration for lead-zinc mineralization in the study area has concentrated on Hutchison Group jaspilites, schists and metacarbonates; magnetite is a common constituent of some jaspilites, and sulphidic and graphitic layers are often present in the schists and marble. Examination of open file geophysical data over five sites explored in detail shows that magnetic surveys can be used to investigate the magnetitic jaspilites, and electro- magnetic and IP/resistivity surveys can be used to detect significant sulphidic and graphitic zones. Several electrical geophysical targets remain untested in these areas.

The geophysical exploration procedure recommended for lead-zinc mineralization in areas of basement outcrop and subcrop comprises

The geophysical exploration procedure recommended for lead-zinc mineralization in areas of basement outcrop and subcrop comprises appropriate combinations of magnetics, electromagnetics and IP/resistivity. With some modifications, similar techniques may also be used in areas of Cainozoic cover where 50 to 100 metres of low resistivity material (sediments plus weathered basement) overlie the target. Basement targets in some areas of Eyre Peninsula will be beyond the reach of electrical geophysical exploration.

3. SURFICIAL GEOLOGY.

Crystalline Gawler Craton basement, composed almost entirely of igneous and metamorphic Archaean and Palaeoproterozoic rock types, is exposed, or lies at shallow depths, over most of Eyre Peninsula (Parker et al., 1988). In the north and east, basement rocks are well exposed; in the west, basement rocks are typically covered by a relatively thin (often less than 50 metres) but variable veneer of Cainozoic (Quaternary and Tertiary) sediments. The exception to this pattern is the east-west, fault-bounded Polda Basin, where basement lies beneath much greater thicknesses (in excess of 150 metres) of Quaternary, Tertiary, Jurassic and Carboniferous-Permian sediments (Flint & Rankin, 1989). Consideration of the Polda Basin area was not part of this evaluation. The extent of significant basinal features, and of areas of basement outcrop, are summarized in Figure 1.

In very general terms, Eyre Peninsula Quaternary deposits comprise clays, silts, sands and gravels in a range of alluvial, colluvial, fluvial, lacustrine and dune environments inland, and mainly aeolian calcarenites and clays closer to the coast; surficial calcrete is common (Flint & Rankin, 1989; Rankin and Flint, 1990). Maximum developments of Quaternary sediments occur in shallow basins along the western coastal margin, where thickness may exceed 100 metres; typical thicknesses of Quaternary sediments over most of the area are less than 10 metres.

Tertiary deposits comprise a distinctive silcrete-laterite layer, whose presence is widespread but scattered everywhere inland except on recently-active erosion surfaces, and older, less widespread clays and sands, often pyritic and carbonaceous (with lignite interbeds), present in broad shallow basins and in Tertiary palaeochannels cut into the basement (Parker, Fanning and Flint, 1985). The Tertiary silcrete-laterite, which can be over 10 metres thick inland though typically much less, may be developed in the upper section of the Tertiary sand and clay sequence, or may be developed directly on weathered basement, either as exposed, resistant topography or buried beneath later Quaternary deposits. The underlying Tertiary sand and clay sequence varies greatly in thickness, sometimes exceeding 100 metres within the palaeochannels.

Where mapped, Archaean and Proterozoic basement comprises mainly igneous and metamorphic rocks of the Sleaford Complex, Hutchison Group and Lincoln Complex in the east, dacites and rhyolites of the Gawler Range Volcanics in the north, and Hiltaba Suite granitic rock types to the west. Lead-zinc mineralization investigated in exploration programmes to date has been typically associated with Hutchison Group schists, dolomites, quartzites and jaspilites.

The near-surface section of the basement is invariably weathered, even where the basement is covered by Quaternary and Tertiary deposits. The degree of basement weathering is partly controlled by the rock type itself, but there is a clear relationship between the presence of overlying Tertiary silcrete-laterite and the development of intense underlying chemical weathering, typically manifest as complete kaolinization of silicate minerals and destruction of the rock fabric. The degree of basement weathering is frequently of sufficient severity to blur the exact position of contact with the overlying sediments.

Ground water occurs at shallow depths (around 20 metres) over much of Eyre Peninsula. Shallow fresh water deposits, overlying deeper saline waters, provide town water supplies along the Eyre Peninsula west coast.

4. ELECTRICAL GEOPHYSICAL EXPLORATION.

The present review of company and SADME open file information showed that electrical geophysical techniques have been employed on Eyre Peninsula in exploration programmes for uranium, lignite and ground water deposits within the Cainozoic cover, mainly in the central and western sections of the study area; and for uranium, diamonds, base metals and graphite in the basement rocks, mainly in the east.

Electrical techniques variously employed in cover rock programmes comprise profiling and sounding surveys with galvanic resistivity (mainly Schlumberger array), transient electromagnetics (TEM) (mainly SIROTEM), and drill hole logging with self potential (SP) and resistance or resistivity. In basement exploration programmes, electrical techniques variously employed include ground surveys with SP, EM (time and frequency domain), resistivity and induced polarization (IP)(time and frequency domain), drill hole logging with SP, SIROTEM and IP/resistivity, and airborne surveys with INPUT and VLF electromagnetics. A summary of all open file electrical geophysical exploration work (mining company and SADME) carried out in the study area is presented in Table 1.

The quality of open file data reporting varies widely, ranging from a mere mention in passing of survey work, to complete and thorough documentation of all survey details and field results; problems were also experienced in establishing the geographic location of some early electrical surveys. Although routine electrical logging of drill holes was a widespread practice in exploration programmes for Tertiary lignite and uranium, most data were not suited to the simple derivation of rock type resistivities - either the point resistance (rather than resistivity) logging technique was employed, or insufficient information on plotting scales was provided with the resistivity logs. Electrical logging was not carried out above the water table, so assessment of resistivities of the surficial materials was only possible from resistivity sounding results. Summarized versions of all vertical resistivity sections (derived from open file resistivity and electromagnetic soundings, and resistivity drill hole logs) were initially plotted on 1:100 000 scale maps of the SADME geophysical index series. The locations of all sites from which such geoelectrical information was obtainable are shown in Figure 2.

Where appropriate, the total conductance has been computed and the results plotted in Figure 3. The total conductance is the sum of the conductivity-thickness product for all layers above basement, and has the units of mhos. It can be best calculated from VES and SIROTEM inversion data, and sometimes, but less reliably, from other methods such as IP/Resistivity or INPUT airborne TEM. In cases of incomplete data, such as soundings which did not penetrate to basement, a minimum conductance figure has been computed, assuming a depth to basement of 50 metres. This is probably an underestimate in most cases.

Five sites were identified as having a sufficiently diverse range of electrical and other geophysical survey information, plus adequate geological control (from mapping and drilling) to provide case history examples of electrical geophysical response styles over zones prospective for basement lead zinc mineralization. Detailed discussions of each of these sites are presented in Section 6 of this report. Locations of the sites are shown on Figure 1.

The extent of all airborne electrical surveys flown within the study area and mentioned in open file reports is shown on Figure 2. No evaluation of the results of these airborne electrical surveys was undertaken in this present study.

5. GEOELECTRICAL REGIMES.

5.1 Introduction

The main factors determining the resistivity of geological materials are the porosity and permeability (resistivity decreases as porosity and permeability increase), the resistivity of the pore fluid, and the resistivity of the composite minerals.

The last factor is only significant when conductive minerals (eg graphite and most sulphides) are present. Four distinct classes of geological material occur within the study area; the relative contributions from each of the factors determines the resistivities of these materials.

Quaternary calcrete and Tertiary silcrete-laterite layers were developed at the top of weathering profiles by the precipitation from solution of carbonates, silica, and iron oxides in pore spaces. High resistivities (usually over 100 ohm-metres, and often much more) have resulted from the attendant reduction in rock porosity and permeability. Where these materials occur at or near the present land surface, along with other desiccated unconsolidated material (eg sand) above the water table, they form a high resistivity surficial layer. Resistivities of calcrete and silcrete-laterite will be somewhat lower when located below the water table.

Quaternary and Tertiary sediments overlie weathered basement in much of the study area. With the exception of the calcrete and silcrete-laterite layers discussed above, these sediments are either highly porous, or clay rich, and the most influential factor in determining formation resistivity is the resistivity of the pore water. Where relatively fresh water is present, as is the case in shallower sections of the sequence along the west coast, resistivities are moderately low (usually in the range 10 to 70 ohm-metres). Where saline water is present, as is the case inland and at depth beneath the shallower fresh water, resistivities are low (usually below 5 ohm-metres).

A weathering profile is developed in basement rocks throughout the study area, even when the basement is covered by large thicknesses of Quaternary and Tertiary sediments. Much of this weathering was contemporaneous with the formation of the Tertiary silcrete-laterite layer. Weathering leads to an increase in rock porosity and the replacement of silicate minerals with clays; both effects tend to reduce resistivity. The determining factors for resistivity are the degree of weathering (influenced partly by the original rock type) and the resistivity of the pore water.

Weathered zone resistivities are typically in the range 10 ohm-metres to 100 ohm-metres in areas of basement outcrop and subcrop, and are less (around 1 ohm metre) elsewhere in the study area where kaolinization or saline ground waters are present.

Moisture retention by clays means that weathered zone resistivities will be low even above the water table.

The resistivity of unweathered basement depends on the nature of the rock type. Factors determining resistivity in the predominately igneous and metamorphic rock types are porosity and permeability (schists versus gneisses) and the occasional presence of conductive minerals (graphite). Drill hole resistivity logging at several sites in the study area has encountered basement resistivities ranging from less than 1 ohm metre (graphitic schists) to over 10 000 ohm-metres (gneisses and granites).

The regional assessment of geoelectrical properties was limited to the single parameter resistivity, and was constrained over much of the study area by the sparse distribution of investigation sites, as demonstrated in Figures 2 and 3. Figure 3, the surficial conductance summary map, also gives an indication of the distribution of resistivity regimes.

Although three discrete, regionally significant styles of near surface resistivity pattern (resistivity regimes) are described for the study area, in reality there is a continuous gradation between them.

5.2 Basement Outcrop and Subcrop.

Archaean and Proterozoic basement crops out extensively in the east and north of the study area, and is also present as small, isolated areas of outcrop in the west. Both the nature of the basement rock type and the depth and degree of weathering (themselves interrelated) influence the surficial resistivity pattern. The situation is further complicated by the presence of Quaternary calcrete in the soil horizon and, where physical erosion has been less active, Tertiary silcrete-laterite capping and an associated zone of often severe chemical weathering.

Because geophysical exploration in these areas of basement outcrop and subcrop has been directed to primary targets in the underlying unweathered basement, few electrical measurements have been made in the surficial zone. However, estimates of surficial electrical properties can be made, based on experience in other areas of Eyre Peninsula. The expected resistivity profile comprises either a two-layer case where the surficial material is simply weathered basement, or a three-layer case where this weathered material is capped by calcrete or silcrete-laterite.

The calcrete or silcrete-laterite layer, if present, can be expected to have a resistivity in excess of 100 ohm-metres, possibly much higher; the thickness of the layer can reach 10 metres, but it is more typically a thin veneer. Expected resistivity values for the weathered zone are in the range 10 ohm-metres to 100 ohm-metres, lower if weathering is extreme or saline ground waters are present; basement weathered zone thicknesses range from virtually zero over some granitic outcrops to more than 50 metres in extreme cases. Resistivities of the unweathered basement in the area have been measured by resistivity logging over the range 1 ohm metre (graphitic schist) to 10 000 ohm-metres (gneisses and granites). A gradational contact between resistivities of the weathered zone and resistivites of the basement can be expected where a gradational decrease in weathering with depth is present.

5.3 Inland Cainozoic Cover.

Away from the coast, the Cainozoic cover comprises relatively thin Quaternary aeolian calcarenites grading further inland to sands, plus gravels, silts and clays, overlying variable thicknesses of Tertiary sands and clays. The underlying basement is invariably weathered (kaolinized). Surficial calcrete is common, and the Tertiary silcrete-laterite layer is widespread.

Quaternary sediments are usually less than 5 metres thick, although locally they may exceed 15 metres. The Tertiary sequence is highly variable, ranging from a few metres of silcrete-laterite developed directly on basement, to over 100 metres of sands and clays within the palaeochannels. Weathering may extend 10 to 50 metres, or more, into the basement.

Resistivity information was derived from two sources. Several long traverses of broadly spaced resistivity soundings were undertaken for Carpentaria Exploration Company Ltd. in their exploration programme for Tertiary uranium around the margins of the Gawler Volcanics in the north and northeast of the study area. An examination of these data suggests that in some cases high surficial resistivities have artificially increased the interpreted resistivities of the underlying layers. Occasional resistivity and SIROTEM soundings and profiles were also undertaken for various mining companies in the northeast in exploration programmes for base metals in the underlying basement. Assessment of all the resistivity data indicates that a three-layer case is present.

At the surface is a relatively thin layer of highly resistive calcrete and desiccated sand; sounding results indicate resistivities of over 100 ohm-metres and thicknesses generally less than 10 metres. Beneath this surficial layer are low resistivity Tertiary clays and sands, and weathered basement. Soundings indicate resistivities in the range 1 to 10 ohm-metres, with thicknesses of 50 to 100 metres, or more. There are indications of some subtle variations in resistivity between sands and clays within this layer, but the values are always low, suggesting that saline water is the dominant feature. Low resistivities extend above the water table where clays which have retained water are present. Weathered basement is indistinguishable from the overlying Tertiary clays in the resistivity pattern. Soundings indicate that mainly high resistivity (over 1000 ohm-metres) basement exists below this layer.

5.4 Coastal Fresh Water Zones.

In the western coastal regions of the study area, the water table is relatively shallow (often around 10 metres), with fresh water overlying deeper saline water. Cainozoic cover in this area comprises Quaternary aeolian calcarenites overlying Tertiary sands and clays. Surficial calcrete is widespread, and the upper surface of the Tertiary sequence is often characterised by silicification and ferruginization, indicating the presence of a Tertiary silcrete-laterite layer. The underlying basement is typically weathered (kaolinized), and is not always readily distinguishable from the overlying Tertiary clays.

Resistivity information for this area was derived from two sources. SADME carried out resistivity soundings at several locations along the west coast, usually for water supply assessment purposes, and CRA Exploration Pty. Ltd. (CRAE) logged six drill holes for resistivity during their exploration programme for Tertiary uranium in the Robinson Basin.

Amalgamation of these resistivity results indicates that a four-layer case is generally present.

At the surface is a thin (less than 10 metres) high resistivity layer composed of calcrete and dry sands; sounding results indicate resistivities over 100 ohm-metres, and often over 500 ohm-metres. Underlying this surficial layer is a moderately resistive layer of fresh water saturated Quaternary calcarenites and/or Tertiary sands; combined sounding and logging results indicate resistivities of 10 to 70 ohm-metres, and thicknesses of 10 to 40 metres. Low resistivity saline water saturated clays, sands and weathered basement lie beneath the fresh water layer; resistivities from soundings and logging are invariably less than 5 ohm-metres and thicknesses can range up to 50 metres or more. Weathered basement is indistinguishable from the overlying clays and sands in the resistivity pattern for this layer. Soundings indicate that high resistivity (over 1000 ohm-metres) basement exists below this layer.

6. LEAD-ZINC MINERALIZATION CASE HISTORIES.

6.1 Introduction

Exploration effort for lead-zinc mineralization in the study area has been concentrated on the jaspilitic chemical metasediments, metacarbonates and graphitic schists of the Hutchison Group, mainly in areas of exposed or thinly covered basement in the east. For the present evaluation, geophysical and geological data have been selected from open file company exploration reports for five areas (see Figure 1) to illustrate the response styles of various electrical geophysical techniques over geological environments prospective for base metal mineralization. Nine composite sections of combined ground geophysical survey results and geophysical drill logs, plus geological control information, are appended as Plates 1 to 9 inclusive.

The Miltalie Mine provides another interesting case-history, which is discussed in detail in a separate report (SADME RB 91/3) and will therefore only be summarised here. The mine is located some 20 kilometres north-north west of Cowell, in an area of Mangalo Schist and dolomite of the Hutchison Group. Residual mineralization in the mine workings is disseminated and of small extent. Being an area of basement outcrop, resistivities are quite high and both IP and SIROTEM surveys had no trouble penetrating to the necessary depths. The IP detected a weak anomaly over the workings, associated with a shallow low resistivity zone. Similar anomalies were located along strike and further east. Fixed-loop SIROTEM detected a very weak early-time anomaly over the mine, coincident with the IP conductor, and a similar feature 100 metres further east that is close to an IP response. Drilling of the mine IP anomaly intersected weak sulphide mineralization, but a hole drilled under an IP anomaly 450 metres further east failed to detect a source for the IP response.

A discussion of the other five case-histories follows. The envelope number from which the information was obtained, and the relevant 1:250 000 map sheet, are given at the start of each case-history, for reference with Table 1.

6.2 Lady Franklin Area (Env 5247, LINCOLN)

The old Lady Franklin mine workings, located 45 kilometres northwest of Port Lincoln, exploited base metal mineralization developed on, and proximal to, a contact between carbonate (dolomite/marble, argillaceous in part) and phyllite lithologies at shallow depths. Weathered bedrock is covered by only a thin layer of alluvium in much of the area. CRAE carried out detailed ground geophysical surveys (IP/resistivity, magnetics and gravity), and both shallow and deeper drilling, to investigate the mineralization. Drillhole 83WP3 intersected 14 metres of weakly anomalous base metal values straddling the contact at a vertical depth of 50 metres; correlation of this zone with surface indications suggests a near vertical dip. Anomalous base metal values were also recorded in the first 25 metres of this drill hole. The composite geophysical and geological section for Lady Franklin line 5000N is appended as Plate 1.

The detailed (25 metre) dipole-dipole IP/resistivity survey detected a weakly anomalous zone of chargeabilities (attributable to sulphide mineralization) in the vicinity of the Lady Franklin workings, on the western margin of a zone of higher resistivities (attributable to the dolomite/marble unit). Neither the magnetic nor the gravity profiles show any significant response over the mineralization; a small positive 0.2 milligal gravity anomaly at 5100E may reflect the marble/dolomite unit.

To the west of the Lady Franklin workings, the layered low resistivity pattern, the background level chargeabilities, and the lower gravity values are all consistent with deeper weathering of phyllitic schists in this area; the anomalous magnetic response suggests magnetite in some sections of the phyllites.

To the east of the Lady Franklin workings, the slightly higher resistivity zone in the reconnaissance (100 metre) IP/resistivity survey data and the positive gravity anomaly centred at 5350E reflect resistant, less weathered quartzite (a thicker unit is present off-line to the north). The sharp 1 station positive 500nt magnetic anomaly at 5400E is part of a broader zone of irregular magnetic response extending further east, which is also present on lines to the north and south; this response may be due to maghemite developed over a Tertiary palaeochannel, which has been interpreted from gravity and SADME seismic results to cross line 5000N around 6000E.

In summary, the relatively weak base metal mineralization at the Lady Franklin workings was only detected by IP, as a marginally elevated chargeability response. Resistivity, magnetic and gravity survey results did provide some additional information about geological features in the area. Most of the relief in the gravity profile appears to relate to differences in the depth and degree of basement weathering. The area along strike to the south of the workings was not drill-tested by CRAE.

6.3 Silver Monarch Area (Env 3541, KIMBA)

The old Silver Monarch workings, located 6 kilometres northwest of Cleve, exploited lead-zinc mineralization developed in Mangalo Schist adjacent to amphibolites. Weathered bedrock is covered by only a thin layer of alluvium and calcrete in most of the area. The Shell Company of Australia Limited (Shell) carried out mapping, soil sampling, ground magnetics and SIROTEM surveys, and tested the mineralized zone at depth with a single diamond drill hole SS1. Shell also geophysically logged the hole with down hole IP and resistivity below the water table. Correlation of drilling results with surface geology suggests a 45 degree dip to the northwest for the amphibolite-schist contact; other dips measured in the area range from 45 to 85 degrees northwest. The composite geophysical and geological section for Silver Monarch line 14500E is appended as Plate 2.

There is no significant response associated with the mineralization evident in the SIROTEM or magnetic results. The resistivity drill hole logs show the environment to be quite resistive (1000 ohm-metres in schists, over 5000 ohm-metres in amphibolites), with a narrow conductor (20 ohm-metres) centred at 70 metres attributable to carbonaceous schists. Notably anomalous IP effects below 60 metres on the logs correlate with carbonaceous schists and disseminated sulphides. SIROTEM confirms the elevated resistivity values over the Mangalo schist, but understates the high resistivities, as it usually does. Lower resistivities to the west coincide with quartzite, while an increase in resistivity with depth may indicate decreasing weathering of these rocks.

To the southeast of the mineralization, a positive 250 nanoTesla magnetic anomaly centred at 11720N (plate 2) correlates with amphibolites (and possible banded iron formations) encountered towards the bottom of drillhole SS1. A second positive 100 nanoTesla magnetic anomaly at 12230N coincides with the mapped iron-rich dolomite facies of the banded iron formation.

Shell carried out further exploration to the north of the Silver Monarch workings using SIROTEM and a single line of IP/resistivity. Two successive in-loop SIROTEM surveys detected a sharply defined anomaly characterised by a very strong negative core response. The detailed (25 metre, 50 metre) dipole-dipole IP/resistivity survey outlined well-defined, shallow depth low resistivity and high chargeability zones coincident with the SIROTEM feature. Interpretation of the SIROTEM anomaly by Shell suggested a conductive target at 50 metres depth dipping 70 degrees to the northwest. Shell attempted to test this feature with a single percussion drill hole SM1, but had to abandon the hole at 96 metres because of caving and the influx of saline water. The composite geophysical and geological section for Silver Monarch lines 15200E - 15350E is appended as Plate 3.

The wet and caving zone which terminated drill hole SM1 may well be a vertical(?) shear zone, thus explaining the conductor indicated by SIROTEM. However, insufficient sulphides were encountered in the drill hole to account for the IP anomaly. Unrecognised finely disseminated graphite, or an as yet untested sulphide or graphite zone, are possible sources for this feature. A second, smaller chargeability anomaly associated with high resistivities and centred at 12400N was not tested by Shell. In summary, SIROTEM detected no significant response over the Silver Monarch workings; drill hole SS1 encountered anomalous base metal values, and drill hole logging showed the environment to be mainly resistive and IP anomalous. To the north, drill hole SM1, sited to investigate a strong negative SIROTEM anomaly and associated low resistivity and high chargeability zone, encountered a possible conductive shear zone, but failed to explain the source of the anomalous IP effects.

6.4 Campoona Grid Area. (Env 3573 and 2965, KIMBA)

At the Campoona grid, located 25 kilometres northwest of Cleve, a folded sequence of Hutchison Group stratigraphy considered favourable for base metal mineralization was investigated in detail by CRAE and Shell. Weathered basement crops out, or lies beneath thin alluvial cover, in this area. A single traverse in the southern section on the western limb (10250N), and two traverses in the northern section on the fold closure (14000N and 14500E), have been selected for consideration here.

Geophysical investigations in the southern section of the grid comprised ground magnetics, two campaigns of SIROTEM, and dipole-dipole IP/resistivity. CRAE and Shell each drilled a single hole to investigate the iron formation at depth, and core from the Shell diamond drill hole SC1 was logged for magnetic susceptibility. Disseminated sulphides were encountered in the drill holes, notably between 60 and 105 metres in SC1; graphite was noted towards the bottom of this hole. Correlation of the magnetite amphibolite intersected in drill hole SC1 with the mapped iron formation at surface implies a dip of 65 degrees to the east. The composite geophysical and geological section for Campoona Grid line 10250N (equivalent to CRAE line 10500N) is appended as Plate 4.

The geophysical survey results confirmed the anomalous nature of the iron formation environment rather than of the sulphides. The IP/resistivity survey outlined a well-defined chargeability anomaly associated with locally lower resistivities in this general position. SIROTEM results also indicated a conductive zone in this area. Graphite and disseminated sulphides proximal to the iron formation are the probable sources of these anomalous effects. A second, stronger high chargeability and low resistivity zone detected to the east of the drilled section was left untested. Ground magnetics detected a positive, somewhat irregular 300 nanoTesla magnetic anomaly over the iron formation, and magnetic susceptibility logging of the core confirmed the magnetite content at depth.

Geophysical investigations in the northern section of the grid focussed on the fold closure. Traverse 14000N was initially surveyed by CRAE with coincident loop SIROTEM and tested with two drill holes CW3 and CW4 sited to test two interpreted SIROTEM conductors; results were inconclusive. Subsequent resurveying by Shell with SIROTEM and dipole-dipole IP/resistivity suggested that the data could be reinterpreted to imply a single central conductor. Shell tested the section with two further drill holes SC2A and SC5, intersecting significant graphitic schists in both holes. Traverse 14000N was also investigated with RAB drilling for geochemistry, and surveyed with ground magnetics and gravity.

The composite geophysical and geological section for Campoona Grid line 14000N is appended as Plate 5.

The IP/resistivity survey detected a very strong chargeability anomaly (peak values 70 millivolts per volt) and associated low resistivity zone (minimum values less than 1 ohm-metre) coincident with the position of the SIROTEM conductor as interpreted by Shell and confirmed as graphitic schist by drilling. Well defined positive anomalies were detected by both magnetic and gravity surveys over the mapped and drilled iron formation to the west of the graphitic schist. The iron formation was not IP anomalous, nor was it associated with low resistivities, where tested.

The fold closure position was also investigated with grid north-south lines. Traverse 14500E was surveyed with coincident loop SIROTEM (twice), magnetics and gravity, and sections of the traverse were covered with RAB drilling for geochemistry. Shell drilled two diamond drill holes SC3 and SC6 on the traverse, and logged drill hole SC6 for down hole IP and resistivity below the water table. The composite geophysical and geological section for Campoona Grid line 14500E is appended as Plate 6.

Drill hole SC3 penetrated an 82 metre section of metacarbonate and pyritic and graphitic schists, plus intrusive pegmatite, overlying Warrow Quartzite. This result is consistent with the SIROTEM interpretation which shows conductive rocks overlying resistive in this area. The 0.3 milligal gravity anomaly over the section probably relates to locally shallower weathering associated with elevated topography. No magnetic anomaly was detected in this area.

Drill hole SC6 penetrated 46 metres of magnetitic iron formation rocks overlying Mangalo Schist. IP/resistivity drill hole logging recorded a 100 millivolt per volt chargeability anomaly over graphitic material at 133 metres, and very anomalous chargeabilities and locally lower resistivities (less than 100 ohm-metres) over pyritic schists towards the end of the drill hole. Very high resistivities (5000 ohm-metres) and low chargeabilities (less than 10 millivolts per volt) were logged over the iron formation. The ground magnetic profile shows a peak positive anomaly response of 4500 nanoTeslas well to the south of SC6, implying that the bulk of the magnetite unit lies in that direction. Gravity survey results show a broad positive 0.5 milligal anomaly in the same position, attributable to the combined effects of higher densities and lesser weathering of iron formation rock types. The SIROTEM results here show resistive near-surface rocks with a flat lying conductor at depth, perhaps with a shallow westerly dip. This would correlate with the graphitic schist.

In summary, detailed geophysical investigations and drilling at two sites on the Campoona grid have partly tested a prospective sequence of iron formations, metacarbonates and schists. Graphitic and pyritic zones within the schists were conductive and IP anomalous. Magnetite iron formations were generally resistive and not IP anomalous, and had associated anomalous ground magnetometry and core magnetic susceptibilities. Most gravity responses could be related to variations in weathering patterns, indirectly indicative of underlying rock types.

6.5 Paney Grid Area (Env 4267, YARDEA)

Shell's exploration activity in the Paney area was initially directed to linear aeromagnetic anomalies, which were located on the ground with reconnaissance traverses then mapped out in detail with grid surveys. A subsequent 200 metre in-loop SIROTEM survey detected the Prairie Anomaly (Plate 7), and interest was further heightened by anomalous geochemistry in an adjacent RAB borehole.

Quaternary and Tertiary sediments completely obscure the basement. Interpretation by Shell of the SIROTEM results suggested a conductive target at 95 metres depth; interpretation of the ground magnetics suggested a 50 metre dyke-like body at 160 metres depth to the west of the SIROTEM target.
Shell carried out detailed fixed loop SIROTEM surveys to further investigate the anomaly, then drilled a single diamond drill hole PP1. This hole was logged with down hole SIROTEM (for four surface loops), resistivity and IP; the core was logged for magnetic susceptibility. The composite geophysical and geological section for Paney Grid line 12000N is appended as Plate 7.

Drill hole PP1 passed through over 70 metres of Quaternary and Tertiary sediments (including a silcrete-ferricrete layer) before entering weathered basement. Graphitic schist conductive zones, with some anomalous base metal sections, were encountered at 134 to 147 metres and from 231 metres to the end of the hole, consistent with the SIROTEM interpretation. Correlation of the second graphitic schist intersection with the interpreted SIROTEM conductor implies a steep east dip. The resistivity log showed values of 1 ohm metre and less for the graphitic schists, and 50 to 100 ohm-metres elsewhere in the basement; chargeabilities were anomalous (over 40 millivolts per volt) for most of the log. Down hole SIROTEM confirmed the interbedded nature of the main graphitic zone. Anomalous magnetic susceptibilities, mainly observed in core from the weathered zone, probably relate to the magnetic body interpreted to lie to the west.

In summary, at Paney Grid, 200 metre in-loop SIROTEM successfully detected a major graphitic zone carrying minor base metals beneath 70 metres of Quaternary and Tertiary cover. Drill logging confirmed the graphitic schists to be very conductive and IP anomalous. Ground magnetics suggested that magnetite concentrations are present to the west of the graphitic schists.

6.6 Harris Bluff Area (Env 4994, PORT AUGUSTA)

The Harris Bluff Area is located in the northeast part of the Eyre Peninsula, on the southern edge of the Gawler Ranges, extending west from 10km. north of Iron Knob. Hutchison Group metasediments crop out in the southern central part of the area, with Corunna Conglomerate to the east and west and Burkitt Granite to the east, of Palaeoproterozoic to Mesoproterozoic age. The northern boundary is underlain by a continuous blanket of Gawler Range Volcanics (GRV).

Interest centres on the Triumph prospect, where a GRV dyke is bordered on east and west sides by deeply weathered Hutchison Group sediments. A 200m in-loop SIROTEM survey with 100m station interval produced a convincing double-peaked anomaly on the west side of the GRV, with an associated but not coincident magnetic anomaly (Plate 8). Interpretation of this anomaly is complicated by the background resistivity change at this location from very high resistivities over the GRV (low SIROTEM response) to lower levels over the Hutchison Group to the west of the anomaly.

The source of the SIROTEM anomaly was interpreted as a narrow tabular conductor dipping steeply to the west within the Hutchison Group metasediments. A 200 metre drillhole plunging 60 degrees east was proposed to intersect the target at a vertical depth of 120 metres. This hole (HB-2) intersected a shallow mylonite zone, followed by magnetic volcanics from 50-60 metres and a porous zone containing very saline groundwater from 60 metres to the end of the hole at 101 metres. The combination of conductivity and thickness in the porous zone is sufficient to cause the SIROTEM anomaly. It is also evident that the conductor is located within the GRV rather than the Hutchison Group, a fact that is, perhaps, indicated by the drop in SIROTEM response to the west of the anomaly.

A second SIROTEM anomaly some 3.5km to the northeast is located in similar geology (Plate 9). The in-loop results show a broad anomaly at depth, while fixed loop (TURAM mode) results show a typical response from a flat-lying conductor. Drilling (HB1) confirms this with an intersection of horizontally bedded pyritic black shales, while downhole TEM shows that this is indeed the conductor.

In summary, the SIROTEM survey was initially effective in mapping the geology, even though the lower resistivities over the sediments may be partly due to a deep weathering profile. The fault zone saline groundwater anomaly would, presumably, have lacked an IP response, which could have saved drilling costs in this instance. The flat-lying pyritic shale gave a typical response for this type of target, both for in-loop and fixed loop configurations.

7. CONCLUSIONS

Exposed Precambrian Gawler Craton basement in Eyre Peninsula is mainly limited to the eastern and northern areas; elsewhere basement is covered by a variable, but often relatively thin (less than 50 metres) layer of Cainozoic sediments. Typical near surface resistivity conditions range from less than 50 metres of moderately resistive (10 to 100 ohm-metres) weathered basement in areas of basement outcrop and subcrop in the east, to over 100 metres of low resistivity (less than 5 ohm-metres) saline water-saturated Cainozoic sediments and weathered basement in areas of deeper Cainozoic cover in the west. A surficial veneer (less than 10 metres) of high resistivity (over 100 ohm-metres) dry sand, Quaternary calcrete and/or Tertiary silcrete-laterite is present in most areas, and up to 40 metres of moderately resistive (10 to 70 ohm-metres) fresh water-saturated sediments overlie low resistivity saline material in areas along the west coast.

Previous exploration for lead-zinc mineralization in basement rocks has concentrated on the jaspilite, schist and metacarbonate sequence in the Hutchison Group in areas of basement outcrop and subcrop in the east. Sulphidic and graphitic zones (with associated anomalous base metal concentrations) within the sequence have been readily detectable with electromagnetic and IP/resistivity techniques. The magnetite-bearing jaspilites did not provide electrical targets unless sulphides were associated, but magnetic surveys have been utilized to map these units for structural information. Resistivities of weathered basement in the east are expected to mainly lie in the 10 to 100 ohm metre range; depths of weathering typically range up to 50 metres.

Clearly, in areas of basement outcrop and subcrop, significant Hutchison Group lead-zinc mineralization within 100 metres of the ground surface should be detectable with IP/resistivtiy and/or electromagnetic geophysical techniques. In the sites reviewed in detail in this report, untested electrical geophysical targets remain in the Silver Monarch and Campoona Grid areas.

Elsewhere in the study area, detection of Hutchison Group style lead-zinc mineralization with electrical geophysics in areas of Cainozoic cover where unweathered basement was covered by a 50 to 100 metre layer of low resistivities was relatively difficult. For both IP and TEM methods, penetration of signals through the layer was restricted, and the situation was further complicated by the generation of spurious anomalies related to localised variations of resistivity and thickness within the layer itself. No data were available to assess the effect on the IP/resistivity technique of disseminated pyrite present in some Tertiary sediments. However, high contact resistances caused by the presence of the surficial high resistivity layer added to the difficulties by restricting the amount of current which could be introduced into the ground and electromagnetic coupling in the very low resistivity environment was also a problem for some IP systems. SIROTEM did not have these difficulties, and was successfully used to locate a graphitic schist zone beneath 70 metres of (presumably) conductive cover in the Paney Grid area, and through 120 metres at Harris Bluff. IP/resistivity apparently penetrated to basement through over 50 metres of conductive material at sites southeast of Kyancutta. (CRAE, Env 4230).

There was insufficient density of information on basement resistivity characteristics for any regional conclusions to be drawn on the prospectivity for lead-zinc mineralization of the basement beneath Cainozoic cover.

8. RECOMMENDATIONS ON THE SEARCH FOR BASE METAL SULPHIDES.

Given the magnetic and conductive nature of individual rock types within the prospective section of the Hutchison Group, any regional assessment of basement rocks for lead-zinc potential should incorporate a review of available airborne magnetic and electromagnetic data.

Ground geophysical exploration for Hutchison Group style lead-zinc mineralization in areas of shallow basement is probably best carried out with appropriate combinations of ground magnetometry, to map magnetite-bearing jaspilites, electromagnetics (eg SIROTEM), to locate and map conductive zones, and IP/resistivity, to discriminate between those conductive zones which are sulphidic and graphitic and those which are, for example, clay filled shears. IP/resistivity has the additional capacity to locate non-conductive, disseminated zones.

The extension of this approach into areas where conductive targets lie beneath 50 to 100 metres of variable, conductive Cainozoic sediments and weathered bedrock requires care. TEM has fewer problems than IP in this environment, and appears to be preferable as the primary exploration tool. For IP, penetration of this layer may be achievable with appropriate arrays, and identification of unwanted, non-basement conductors may be possible with judicious use of combined electromagnetics and IP/resistivity. As to the other problems with the use of IP/resistivity, high contact resistances can be minimized by scheduling surveys after winter rains to take advantage of higher surface moisture levels, and electromagnetic coupling can be avoided by selecting instrumental systems which allow removal of such effects. High transmitter currents will be necessary to ensure sufficient signal strengths at the receiver in this low resistivity environment (a transmitter current of 10 amperes is necessary to develop a 1 millivolt signal for an n=4, 100 metre dipole-dipole reading in a 5 ohm metre environment).

Even with every care taken, it is to be expected that a combination of practical problems will effectively prohibit electrical exploration in some areas of Eyre Peninsula. Areas with Cainozoic cover in excess of 100 metres must be considered in this category.

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Listed in Table 1

SADME Open File Report Books
Listed in Table 1

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SUMMARY OF ELECTRICAL GEOPHYSICAL ACTIVITY ON OPEN FILE REPORT
CENTRAL AND WESTERN EYRE PENINSULA, S.A.

YARDEA 1:250 000 SHEET

SML/EL NUMBER(S)	ENV. NO.	TARGET MINERALIZATION	ELECTRICAL TECHNIQUES EMPLOYED	OTHER GEOPHYSICAL TECHNIQUES USED	COMMENTS	MINING COMPANY/SADME
EL 442	3420	uranium (Tertiary)	resistivity profiles and soundings SP, point resistance drill logging	airborne magnetics, radiometrics gamma ray drill logging, magnetics	see also Envelope No. 4010	Carpentaria Exploration Coy. P/L
EL 540	3716	uranium (Tertiary)	resistivity profiles and soundings SP, point resistance drill logging	airborne magnetics, radiometrics gamma ray drill logging	see also Envelope No. 4010	Carpentaria Exploration Coy. P/L
EL 541	3717	uranium (Tertiary)	resistivity profiles and soundings SP, point resistance drill logging	gamma ray drill logging	see also Envelope No. 4010	Carpentaria Exploration Coy. P/L
numerous ELs	4010	uranium (Tertiary)	resistivity profiles and soundings	airborne magnetics, radiometrics gamma ray drill logging	ELs 442, 540, 541, 586, 610, 805, 913, 914, 979, 1104, 1108	Carpentaria Exploration Coy. P/L
ELs 842, 843 844, 1157, 1158, 1159	4267	diamonds, base metal	airborne VLF SIROTEM, SIROTEM, IP/resistivity drill logging	airborne magnetics, radiometrics magnetics magnetic susceptibility core logging		Stockdale Prospecting Limited Shell Company of Australia Ltd. Western Mining Corporation

KIMBA 1:250 000 SHEET

SML/EL NUMBER(S)	ENV. NO.	TARGET MINERALIZATION	ELECTRICAL TECHNIQUES EMPLOYED	OTHER GEOPHYSICAL TECHNIQUES USED	COMMENTS	MINING COMPANY/SADME
SML 158	0838	uranium (Tertiary)	SP, resistivity drill logging	airborne radiometrics radiometrics gamma ray drill logging	insufficient scale data provided for resistivity logs continued in Envelope No. 1108	Kerr-McGee Australia Ltd.
SML 163	1108	uranium (Tertiary)	SP, resistivity drill logging	gamma ray drill logging	insufficient scale data provided for resistivity logs continued from Envelope No. 0838	Kerr-McGee Australia Ltd.
SML 344	1238	uranium (Tertiary)	SP, resistivity drill logging	airborne radiometrics gamma ray drill logging	insufficient scale data provided for resistivity logs	Mines Administration Pty. Ltd.
SML 343	1326	uranium (Tertiary)	SP, resistivity drill logging	airborne radiometrics gamma ray drill logging gravity	no scales provided for resistivity logs	Mines Administration Pty. Ltd.
SML 642	1943	uranium (Tertiary) kaolin	SP, point resistance drill logging	gamma ray drill logging reflection seismics		Le Nickel (Australia) Exploration Pty. Ltd.
SML 667	1966	base metals	dipole-dipole IP		drill tested Yeldulknie Pb, Zn targets continued in Envelope No. 2966	Pacminex Pty. Ltd.
EL 131	2419	uranium (Tertiary) uranium (pre Cambrian)	SP, resistivity drill logging	gamma ray drill logging radiometrics	no scales provided for resistivity logs	Urangesellschaft Australia P/L
EL 285	2965	base metals	dipole-dipole IP, SIROTEM	airborne magnetics magnetics, radiometrics	drill tested sites on Campoona grid continued in Envelope No 3573	CRA Exploration Pty. Ltd.
EL 286	2966	base metals	(dipole-dipole IP)	radiometrics	referenced previous IP survey continuation from Envelope No. 1966 continued in Envelope No. 3541	CRA Exploration Pty. Ltd.
EL 378 EL 613 EL 1026	3235	uranium (pre Cambrian) base metals	SIROTEM	airborne radiometrics magnetics, radiometrics gamma ray drill logging	RAB drilling of various targets	Crest Exploration Pty. Ltd. Wyoming Mineral Corporation Shell Company of Australia Ltd.
EL 431 EL 803	3412	uranium (Tertiary) uranium (pre Cambrian)	(SIROTEM)	airborne magnetics, radiometrics magnetics, radiometrics, gravity gamma ray drill logging	no SIROTEM data supplied	Pancontinental Mining Ltd. Power Reactor & Nuclear Fuel Dev. Corp. Afmeco Pty. Ltd.
EL 485 EL 876 EL 1182	3541	base metals	airborne INPUT SIROTEM, dipole-dipole IP SIROTEM, IP/resistivity drill logging	airborne magnetics, radiometrics magnetics gamma ray drill logging	drill tested Silver Monarch and Iragie sites continuation from Envelope No. 2966	CRA Exploration Pty. Ltd. Shell Company of Australia Ltd.
EL 492 EL 893	3551	uranium (pre Cambrian)	SIROTEM	airborne magnetics, radiometrics magnetics, radiometrics gamma ray drill logging		Pancontinental Mining Ltd. Power Reactor & Nuclear Fuel Dev. Corp. Afmeco Pty. Ltd.
ELs 285, 494, 877, 1185	3573	base metals	airborne INPUT SIROTEM, dipole-dipole IP, maxmin EM IP/resistivity drill logging	airborne magnetics, radiometrics magnetics, gravity magnetic susceptibility drill logging	drill tested several sites on Campoona grid continuation from Envelope No. 2965	CRA Exploration Pty. Ltd. Shell Company of Australia Ltd.
EL 507 EL 895 EL 1181	3583	base metals	airborne INPUT (trial) SIROTEM	airborne magnetics, radiometrics magnetics, gravity	drill tested various targets	Mines Exploration Pty. Ltd. Western Mining Corporation Ltd.
EL 541	3717	uranium (Tertiary)	resistivity profiles and soundings SP, point resistance drill logging	gamma ray drill logging		Carpentaria Exploration Coy. P/L
ELs 670, 687, 688, 1032, 1054	3973	lignite (Tertiary) coal (Jurassic) potash	SP, point resistance, resistivity drill logging EM soundings (EMR 16 Maxiprobe) (SIROTEM and resistivity soundings)	caliper, density, gamma, neutron drill logging. Gravity	resistivity logging of hole 83KD1A only no data supplied for SIROTEM and resistivity soundings. Continued in Envelope No. 4659	CRA Exploration Pty. Ltd.
ELs 541, 914, 610, 1104	4010	uranium (Tertiary)	resistivity profiles and soundings	airborne magnetics, radiometrics gamma ray drill logging		Carpentaria Exploration Coy. P/L
EL 756 EL 980	4230	base metals	resistivity soundings, dipole-dipole IP	airborne magnetics, radiometrics magnetics, gravity	drill tested various targets	North Broken Hill Ltd. CRA Exploration Pty. Ltd.
EL 670 EL 687 EL 688	4659	lignite (Tertiary) coal (Jurassic)	SP, point resistance drill logging	caliper, density, gamma, neutron drill logging. Gravity	continuation from Envelope No. 3973 - relinquishment report	CRA Exploration Pty. Ltd.
EL 1005	5449	uranium (Tertiary) base metals	airborne INPUT (trial)			Carpentaria Exploration Coy. P/L
	RB 57/81	groundwater	resistivity profiles and soundings		Polda Basin investigation	SADME
	RB 59/40	groundwater	resistivity soundings		Polda Basin investigation	SADME
	RB 59/98	groundwater	resistivity soundings		Polda Basin investigation	SADME
	RB 65/52	groundwater	resistivity profiles and soundings			SADME
	RB 65/101	groundwater	resistivity profiles and soundings			SADME
	RB 77/57	coal	resistivity soundings			SADME
	RB 87/92	base metals	resistivity drill logging	density, gamma, neutron drill logging magnetic susceptibility core logging		SADME

LINCOLN 1:250 000 SHEET

SML/EL NUMBER(S)	ENV. NO.	TARGET MINERALIZATION	ELECTRICAL TECHNIQUES EMPLOYED	OTHER GEOPHYSICAL TECHNIQUES USED	COMMENTS	MINING COMPANY/SADME
SML 354	1264	base metals talc	McPhar VHEM, SP	airborne magnetics, radiometrics magnetics	refenced McPhar IP survey carried out for Mines Exploration Pty. Ltd. in 1962	Pacminex Pty. Ltd. Pechiney (Aust.) Exploration P/L
SML 642	1943	uranium (Tertiary) kaolin	SP, point resistance drill logging	gamma ray drill logging reflection seismics		Le Nickel (Aust.) Exploration Pty. Ltd.
EL 106	2378	base metals uranium (pre Cambrian) gold	airborne INPUT Crone PEM	also airborne magnetics	drill tested 3 targets	Australian Anglo American Ltd.
EL 185	2552	uranium (Tertiary)	SP, point resistance drill logging	gamma ray drill logging		Uranerz (Australia) P/L
EL 1062	4979	graphite base metals uranium (pre Cambrian)	airborne INPUT SP	also airborne magnetics, radiometrics magnetics	continued in Envelope No. 6934	CRA Exploration Pty. Ltd.
EL 1142	5233	graphite	maxmin EM		Kookaburra Gully, Koppio Mine graphite	Pancontinental Mining Ltd.
EL 1154	5247	base metals	dipole-dipole IP	magnetics, gravity	drill tested Lady Franklin and Moonlight prospects	CRA Exploration Pty. Ltd.
EL 1314	6538	graphite	HLEM (maxmin)			Pancontinental Mining Ltd.
EL 1139	6934	graphite base metals	SP, dipole-dipole IP, EM 34	magnetics	continuation from Envelope No. 4979 drill tested 4 targets	CRA Exploration Pty. Ltd.
	RB 32/73	groundwater	resistivity soundings		Lincoln Basin investigation	SADME
	RB 58/154	molybdenum	dipole-dipole IP		Spilsby Island survey	SADME
	RB 69/93	molybdenum	dipole-dipole IP	magnetics	Spilsby Island survey	SADME
	RB 90/26	groundwater	TEM, resistivity soundings		Wanilla Catchment investigation	SADME

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TABLE 1

SUMMARY OF ELECTRICAL GEOPHYSICAL ACTIVITY ON OPEN FILE REPORT
CENTRAL AND WESTERN EYRE PENINSULA, S.A.

SML/EL NUMBER(S)	ENV. NO.	TARGET MINERALIZATION	ELECTRICAL TECHNIQUES EMPLOYED	OTHER GEOPHYSICAL TECHNIQUES USED	COMMENTS	MINING COMPANY/SADME
PORT AUGUSTA 1:250 000 SHEET						
ELs 1041, 398, 692	3292	base metals uranium	VES, I.P., S.P. Mise-a-la-masse resistivity	magnetics gravity		Samedan Oil Corp. of Australia Esso Australia Ltd
EL 186	6678 2564	base metals	Resistivity VES		fluvial channels	CSR Ltd Pacminex Pty. Ltd.
EL 1031	4994	base metals gold (conglomerate)	SIROTEM	magnetics		Billiton Australia Ltd.
EL 1339	6778	uranium	IP	magnetics ground radiometrics		PNC Exploration (Australia) P/L
ELs 537, 965	3643		EM	magnetics gravity		Stockdale Prospecting Ltd Mobil Energy Minerals Australia Inc.
EL 186	6674	base metals	INPUT			CSR Ltd Pacminex Pty Ltd
ELs 827, 834, 841, 842, 843, 844	4267	diamonds	airborne VLF EM	magnetics airborne magnetics, radiometrics		Stockdale Prospecting Ltd
SML 205	1175	base metals	IP			BHP Co. Ltd.
SML 204	1174	base metals	IP			BHP Co. Ltd.
SML 306	1163	base metals	VLF EM	magnetics		Asarco (Australia) P/L
EL 186	2720	base metals	airborne EM	airborne magnetics		Pacminex Pty Ltd
	1722		resistivity, IP	magnetics		Serem (Aust)
EL 529	3613	base metals	TEM	airborne magnetics, radiometrics magnetics, gravity		Esso Exploration
EL 637	3279	base metals	resistivity soundings resistivity profiling	airborne magnetics, radiometrics magnetics		Esso Exploration
	RB 73/186		resistivity soundings (VES, Schlumberger)	seismic		SADME
WHYALLA 1:250 000 SHEET						
EL 500/901	3575	uranium (Tertiary)	IP, SIROTEM	airborne magnetics, radiometrics gravity, ground magnetics, ground radiometrics		Pancontinental Mining Ltd Power Reactor and Nuclear Fuel Dev. Corp. Afmeco P/L
EL 286	2966	base metals	IP		RAB Auger drilling, costeens	CRA Exploration Pty Ltd
EL 1241	5792	uranium	INPUT	airborne magnetics, radiometrics gravity		PNC Exploration (Australia) P/L
ELs 507, 895, 1181	3583	base metals	INPUT, SIROTEM	airborne magnetics, radiometrics magnetics, gravity		Mines Exploration P/L Western Mining Corporation
ELs 415, 742, 1079	3338	uranium base metals	SIROTEM	airborne magnetics, radiometrics ground magnetics		Uranerz (Australia) P/L Pancontinental Mining Ltd Power Reactor and Nuclear Fuel Dev. Corp. Billiton Australia Ltd Western Mining Corporation
EL 397	3343	uranium base metals	VES (Schlumberger)	gravity resistivity logs		CRA Exploration Pty Ltd
EL 766	4387	coal oil shale		geophysical logs		BHP Co. Ltd.
	RB 76/698	graphite	IP			SADME
EL 485	3541		IP			CRA Exploration Pty Ltd
SML 667	1966		IP			Pacminex Pty Ltd
	RB in prep	base metals	IP		Miltalie Mine testing	SADME
STREAKY BAY 1:250 000 SHEET						
EL 442	3420	uranium (Tertiary)	resistivity profiles and soundings SP, point resistance drill logging	airborne magnetics, radiometrics gamma ray drill logging magnetics	see also Envelope No. 4010	Carpentaria Exploration Coy. P/L
EL 539	3715	uranium (Tertiary)	resistivity profiles and soundings SP, point resistance drill logging	gamma, neutron drill logging	see also Envelope No. 4010	Carpentaria Exploration Coy. P/L
numerous ELs	4010	uranium (Tertiary)	resistivity profiles and soundings (SIROTEM, MIP)	airborne magnetics, radiometrics gamma ray drill logging	no data supplied for SIROTEM, MIP ELs 442, 539, 540, 632, 740, 741, 805, 912, 913, 1014, 1108	Carpentaria Exploration Coy. P/L
EL 678	4049	uranium (Tertiary) also lignite, kaolin	resistivity profiles and soundings SP, point resistance drill logging SP, resistivity drill logging	caliper, density, gamma, neutron drill logging	resistivity logging restricted to final 6 holes	CRA Exploration Pty. Ltd.
	RB 63/94	groundwater	resistivity profiles and soundings			SADME
	RB 65/101	groundwater	resistivity profiles and soundings			SADME
	RB 78/77	groundwater	resistivity soundings	magnetics	Streaky Bay water supply investigation	SADME
ELLISTON 1:250 000 SHEET						
EL 589	3783	uranium (pre Cambrian) base metals lignite, oil shale	SP, point resistance drill logging	gravity caliper, density, gamma, neutron drill logging	SP, point resistance drill logging preliminary only	Esso Expl. and Prod. Aust. Inc.
EL 678	4049	uranium (Tertiary) also lignite, kaolin	resistivity profiles and soundings SP, point resistance drill logging	caliper, density, gamma, neutron drill logging		CRA Exploration Pty Ltd.
	RB 59/98	groundwater	resistivity soundings		Polda Basin investigation	SADME
	RB 63/94	groundwater	resistivity profiles and soundings			SADME
	RB 65/52	groundwater	resistivity profiles and soundings			SADME
	RB 65/101	groundwater	resistivity profiles and soundings			SADME
	RB 89/56	groundwater	SIROTEM and resistivity soundings		Port Kenny water supply investigation	SADME

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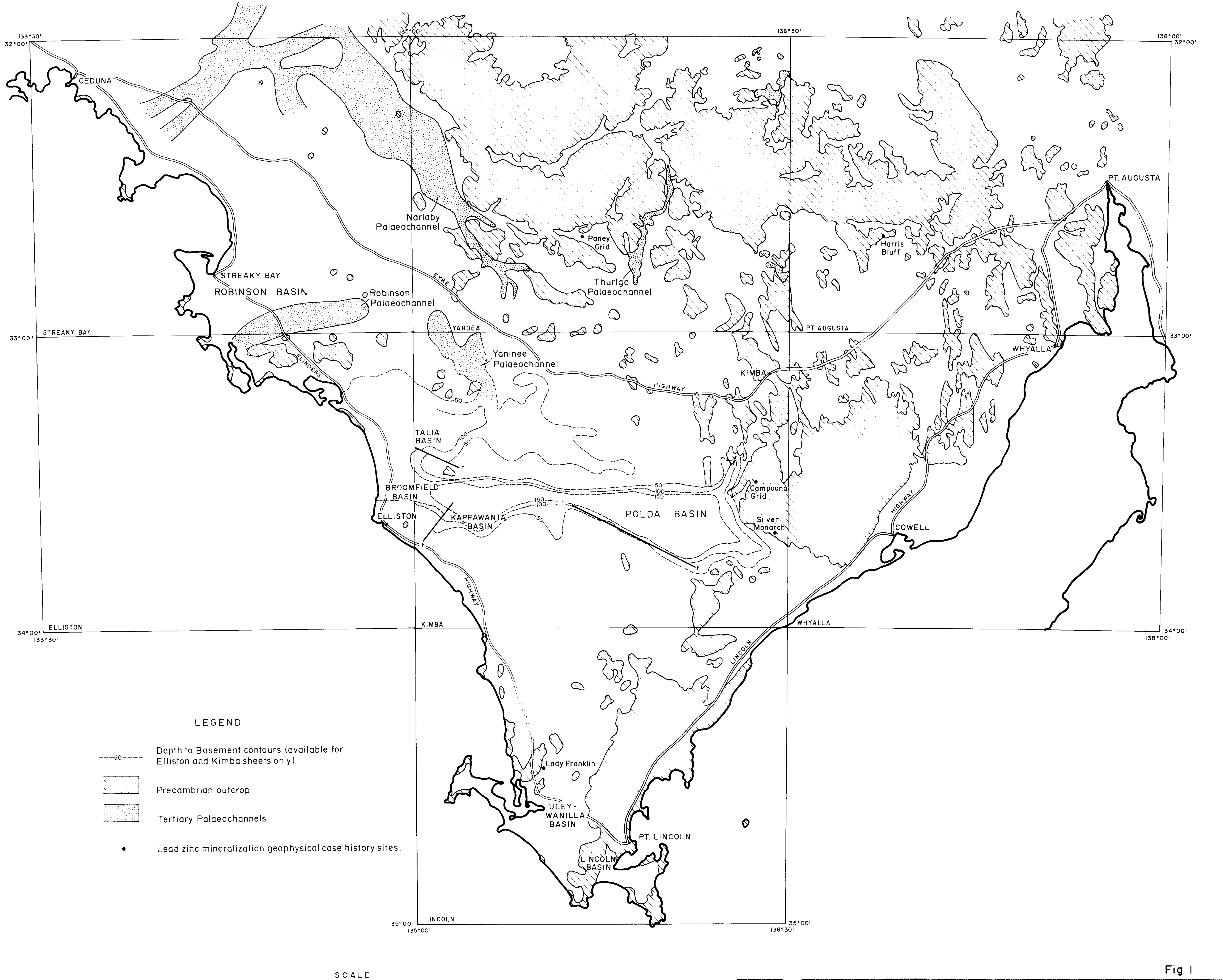
S.A. DEPARTMENT OF MINES AND ENERGY

90-821b TABLE 1



SCALE

Kilometres 20 0 20 40 60 80 100 Kilometres

Fig. 1

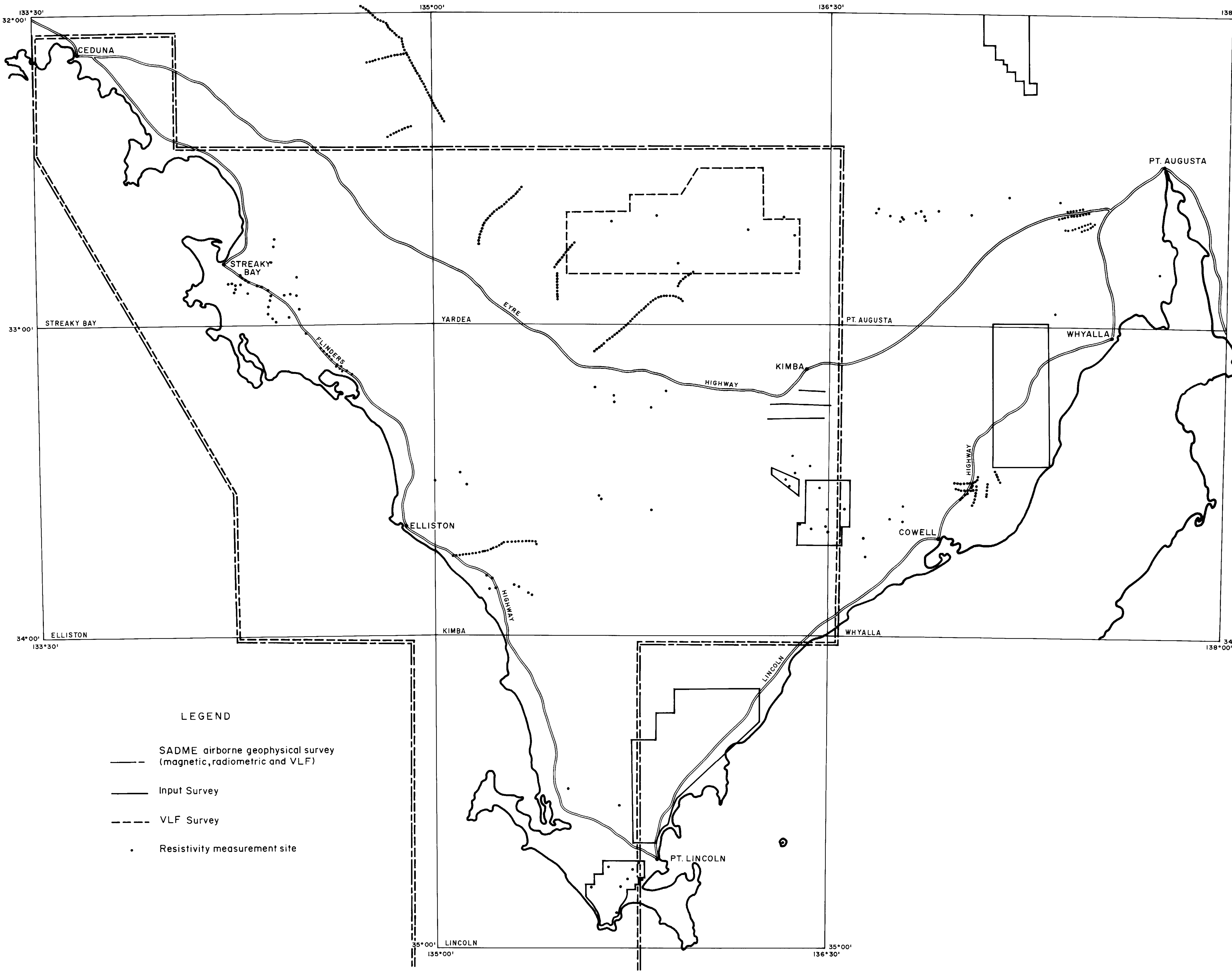
DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

EYRE PENINSULA
GEOPHYSICAL SURVEY

GEOLOGICAL SUMMARY MAP

S. Dodds
J. Gray
July 1990
27.2.91
1:1000000
90-809

5075



LEGEND

SADME airborne geophysical survey (magnetic, radiometric and VLF)

Input Survey

VLF Survey

Resistivity measurement site

SCALE

Kilometres 20 0 20 40 60 80 100 Kilometres

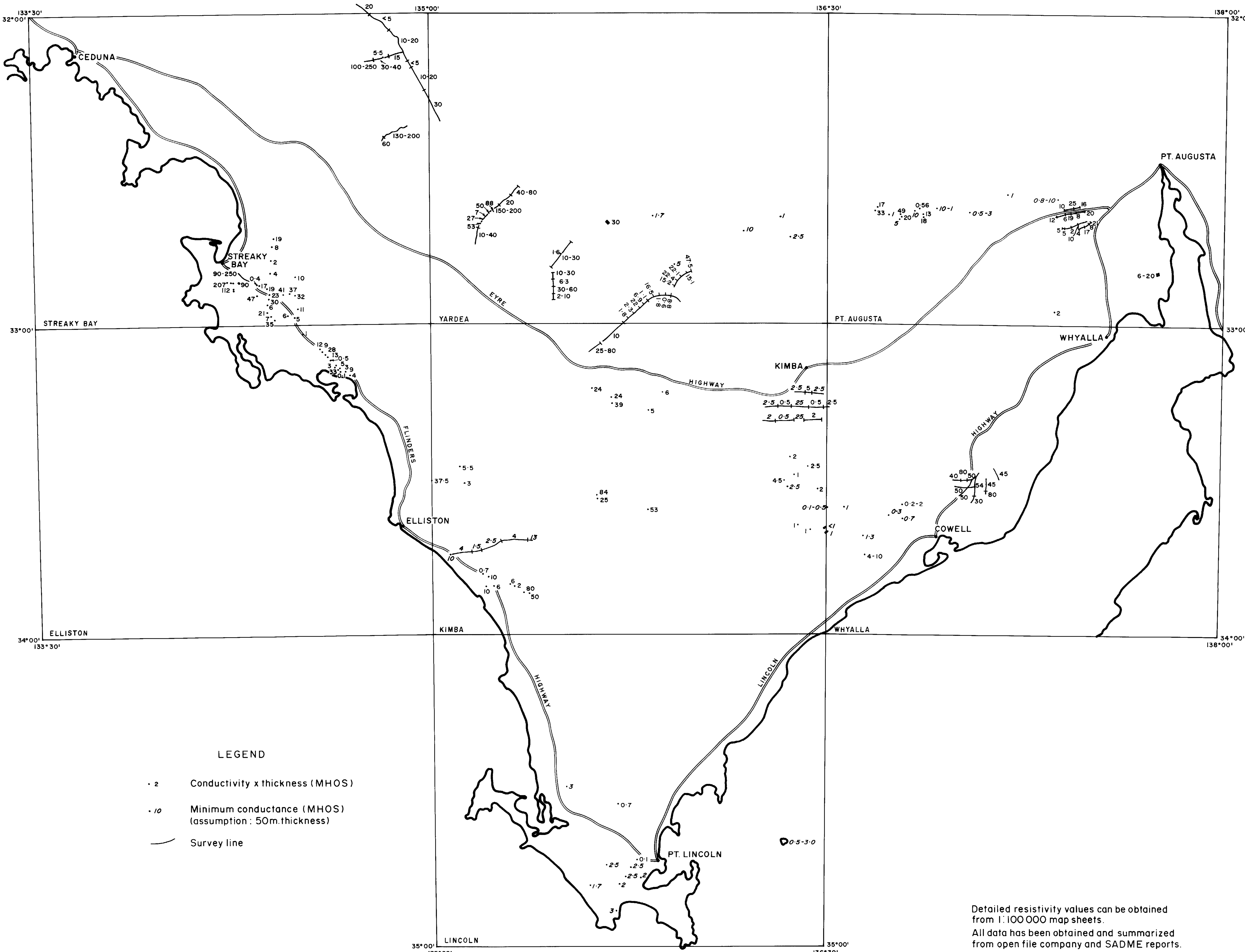
Fig. 2

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

EYRE PENINSULA
GEOPHYSICAL SURVEY
ELECTRICAL GEOPHYSICS SUMMARY MAP

COMPILED	S. Dodds	CDO	27.2.91 DATE
DRAWN	J. Gray	SCALE 1:1000000	
DATE	July 1990	PLAN NUMBER	
CHECKED		90-810	

5075



LEGEND

- •2 Conductivity x thickness (MHOS)
- •*10* Minimum conductance (MHOS) (assumption: 50m. thickness)
- Survey line

Detailed resistivity values can be obtained from 1:100 000 map sheets.
All data has been obtained and summarized from open file company and SADME reports.

SCALE

Kilometres 20 0 20 40 60 80 100 Kilometres

Fig. 3

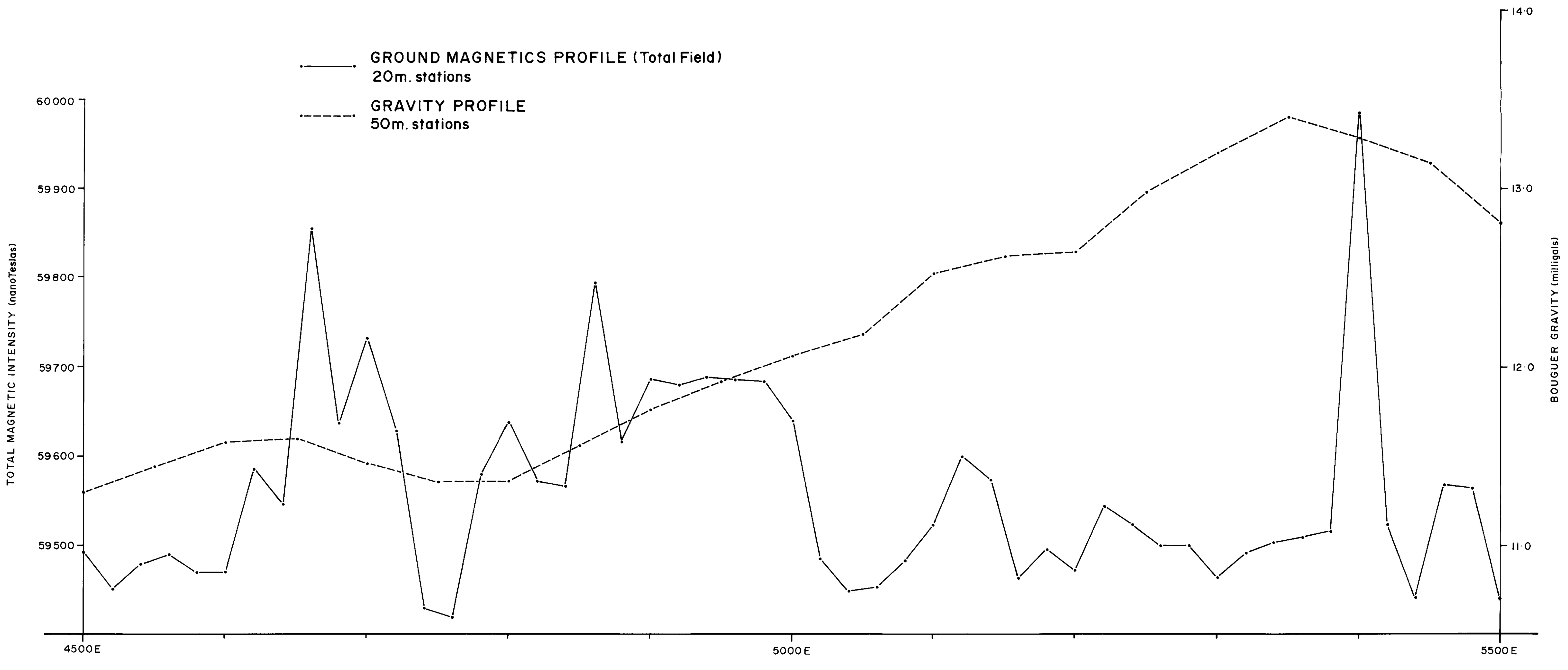
DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

EYRE PENINSULA GEOPHYSICAL SURVEY

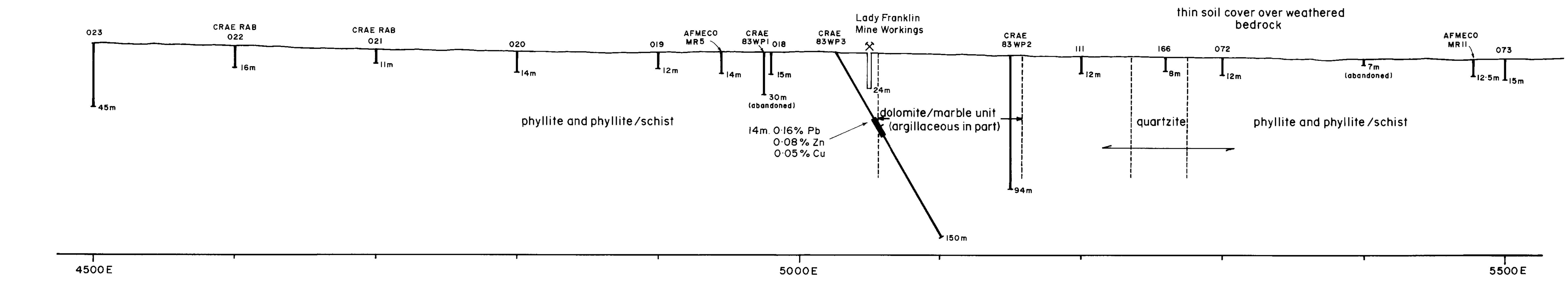
SURFICIAL CONDUCTANCE SUMMARY MAP

COMPILED S. Dodds	27.2.91 C D O DATE
DRAWN J. Gray	SCALE 1:1000 000
DATE Aug. 1990	PLAN NUMBER 90-811
CHECKED	

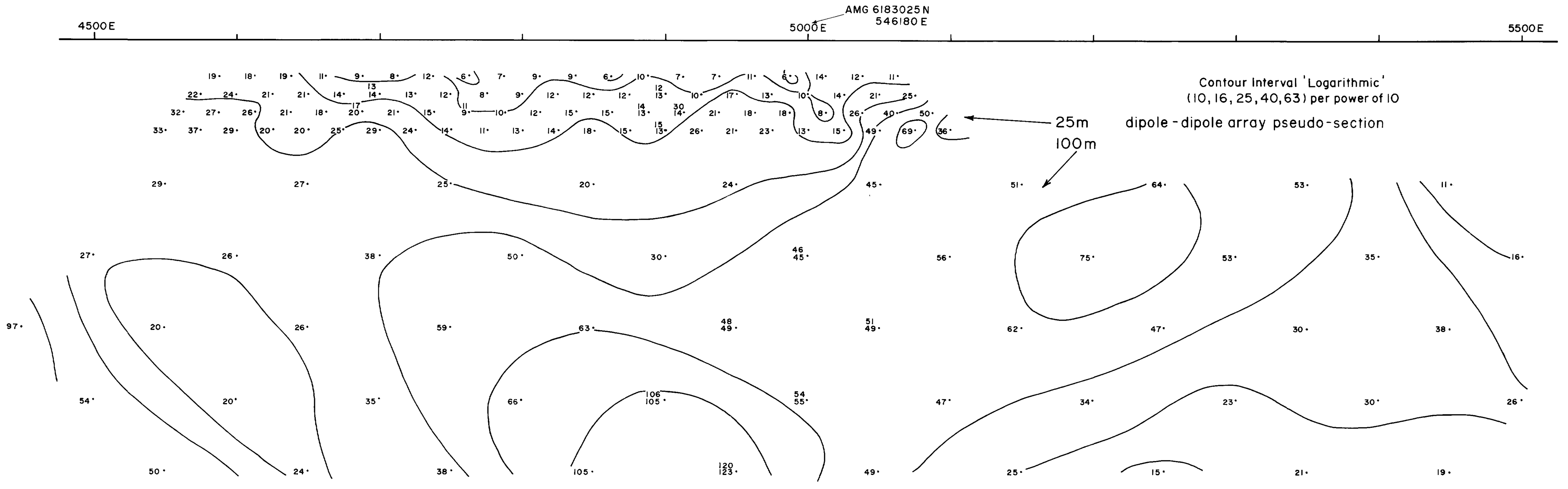
5075



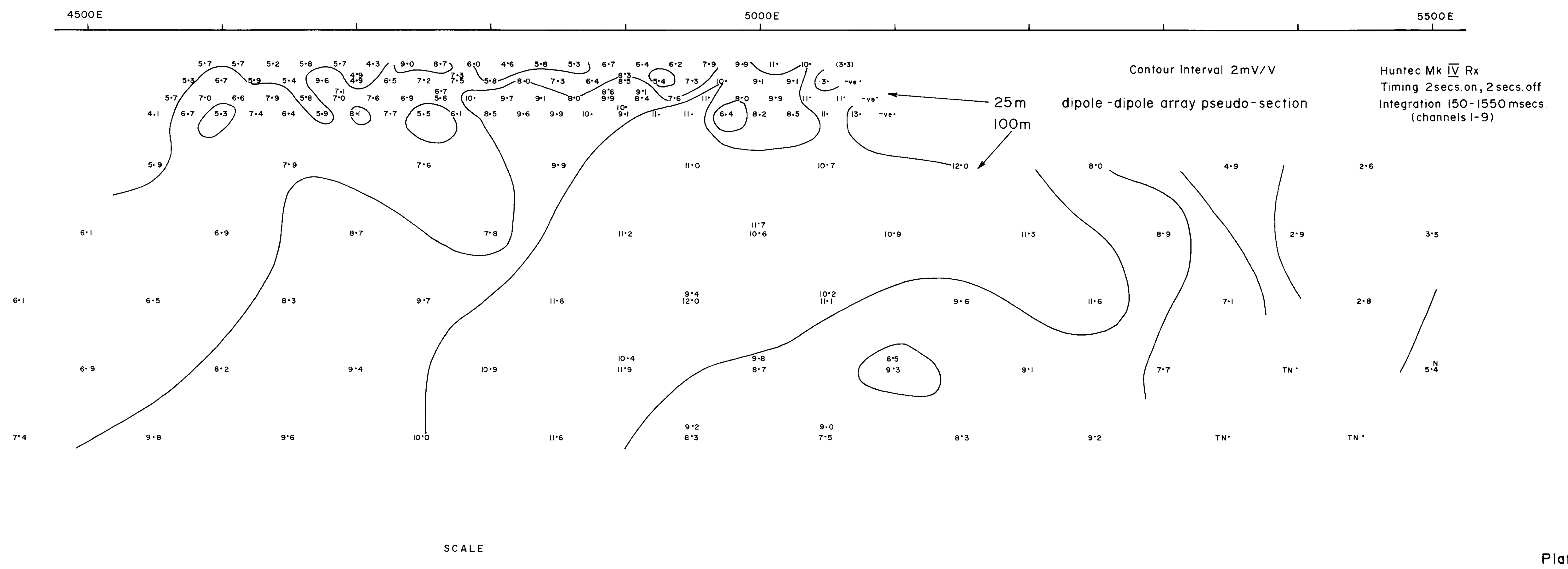
TOPOGRAPHY, DRILLING AND GEOLOGY CROSS SECTION



APPARENT RESISTIVITY (Ωm)



APPARENT CHARGEABILITY (mV/V)



SCALE

Metres 50 0 50 100 150 200 250 Metres

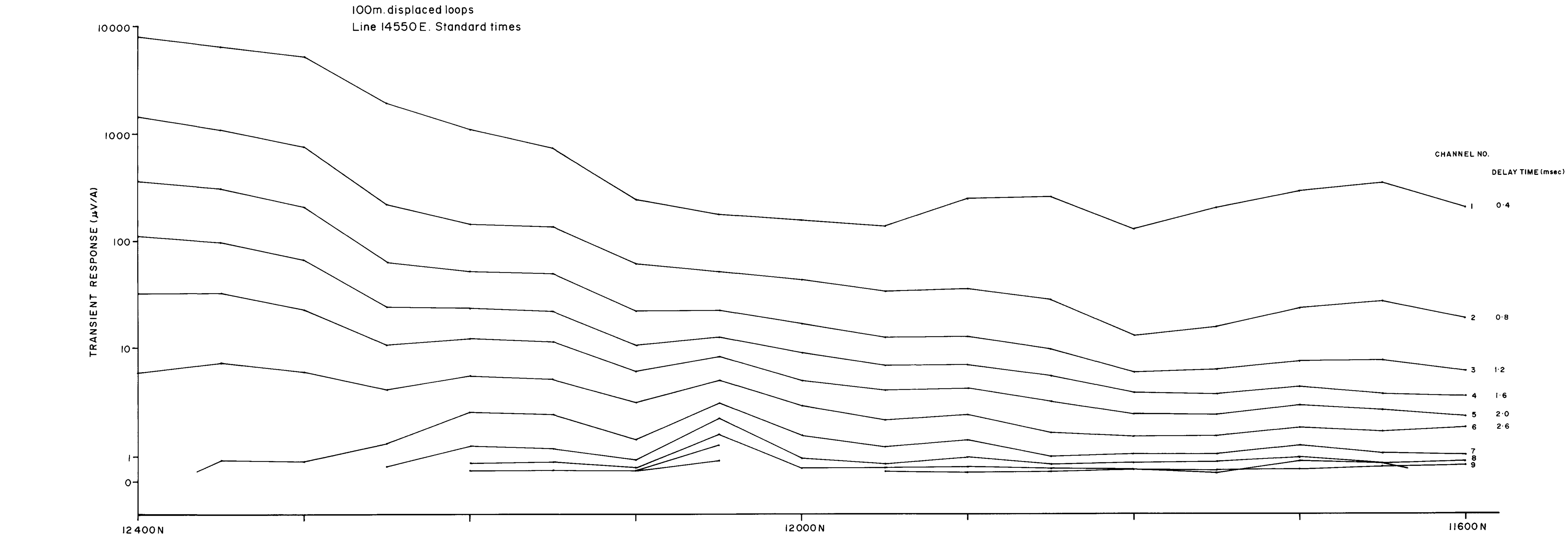
Line bearing 106° true

Plate 1

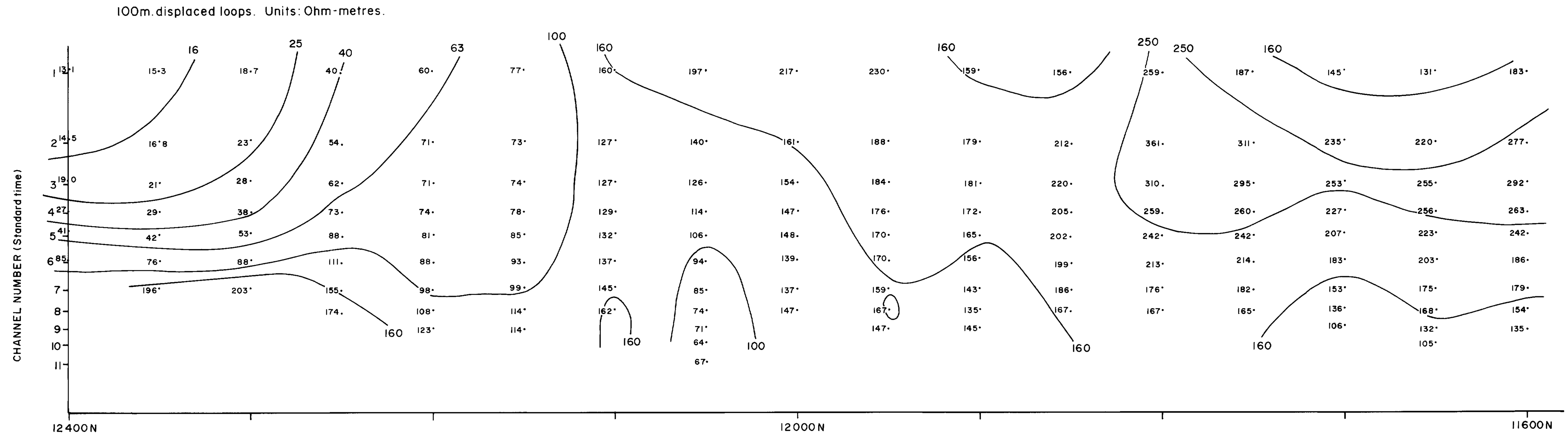
DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED S. Dodds	27-2-91 C.D.O. DATE
EYRE PENINSULA GEOPHYSICAL SURVEY	DRAWN J. Gray	SCALE 1:2500
LADY FRANKLIN AREA - CRAE LINE 5000N	DATE July 1990	PLAN NUMBER
COMPOSITE GEOPHYSICAL & GEOLOGICAL SECTIONS	CHECKED	90-812

5075

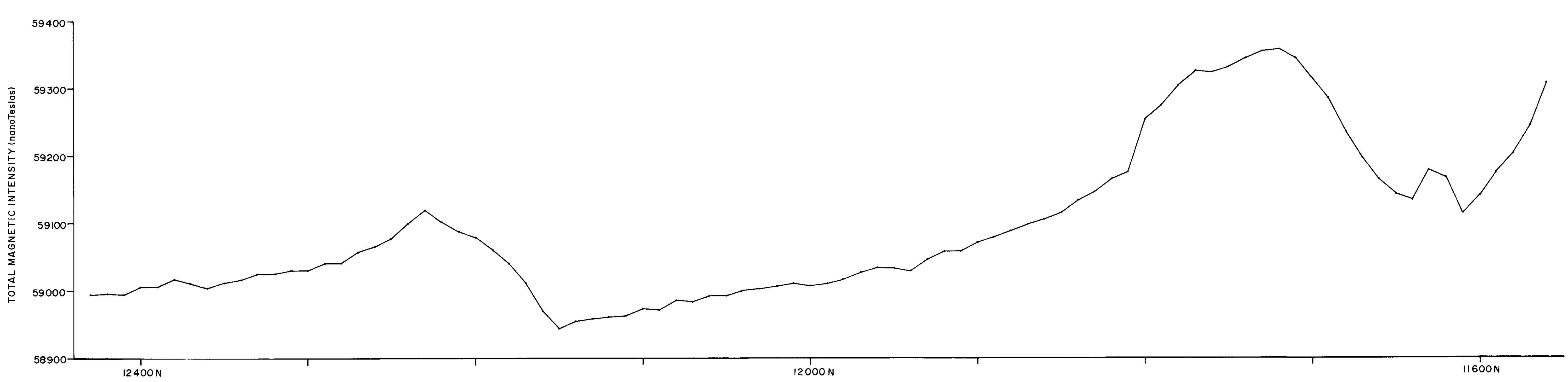
SIROTEM TRANSIENT RESPONSE



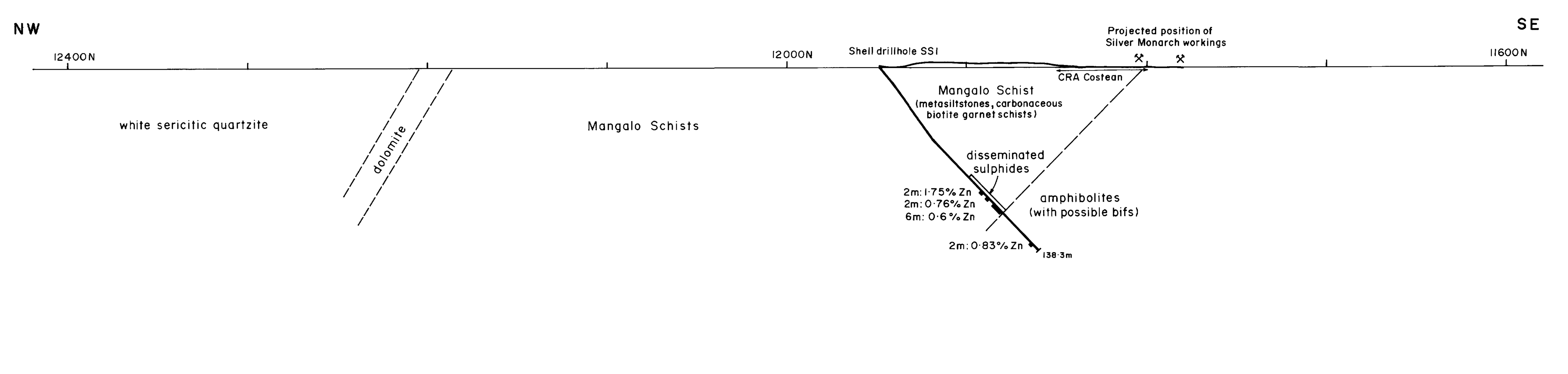
SIROTEM APPARENT RESISTIVITY PSEUDO-SECTION



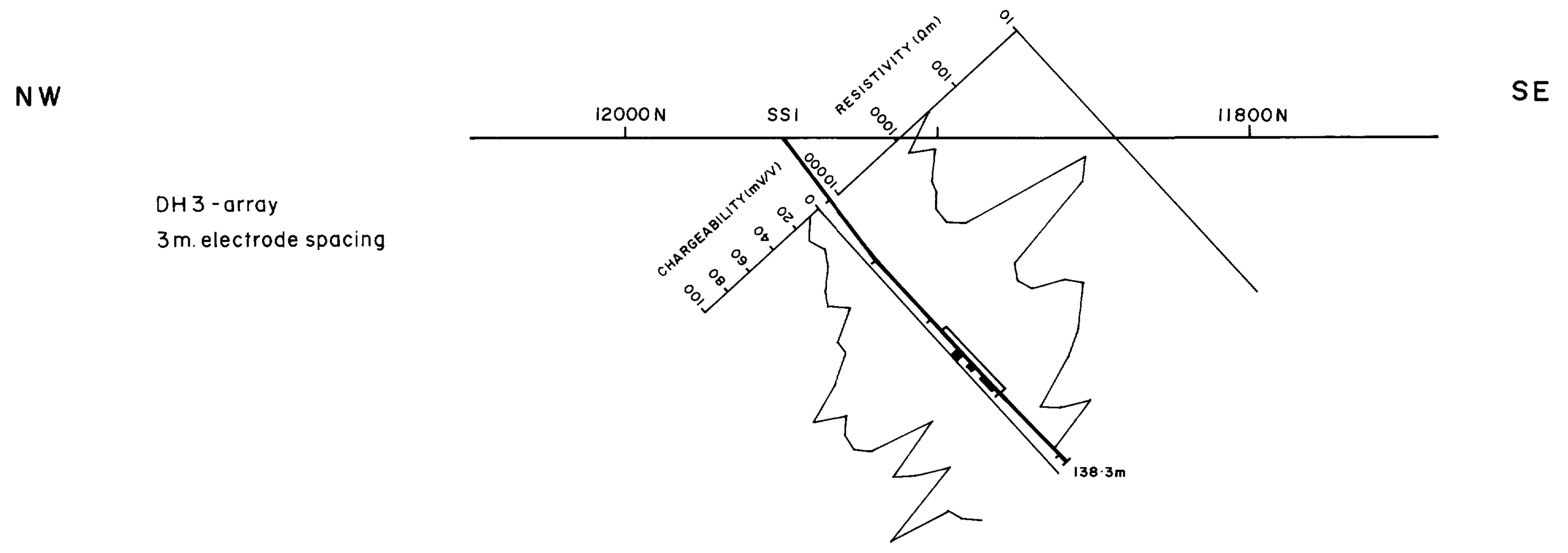
GROUND MAGNETIC PROFILE (Total Field)



TOPOGRAPHY, DRILLING AND GEOLOGY CROSS SECTION



DRILLHOLE LOGGING, IP AND RESISTIVITY



SCALE

Metres 40 0 40 80 120 160 200 Metres

Line bearing 147° true

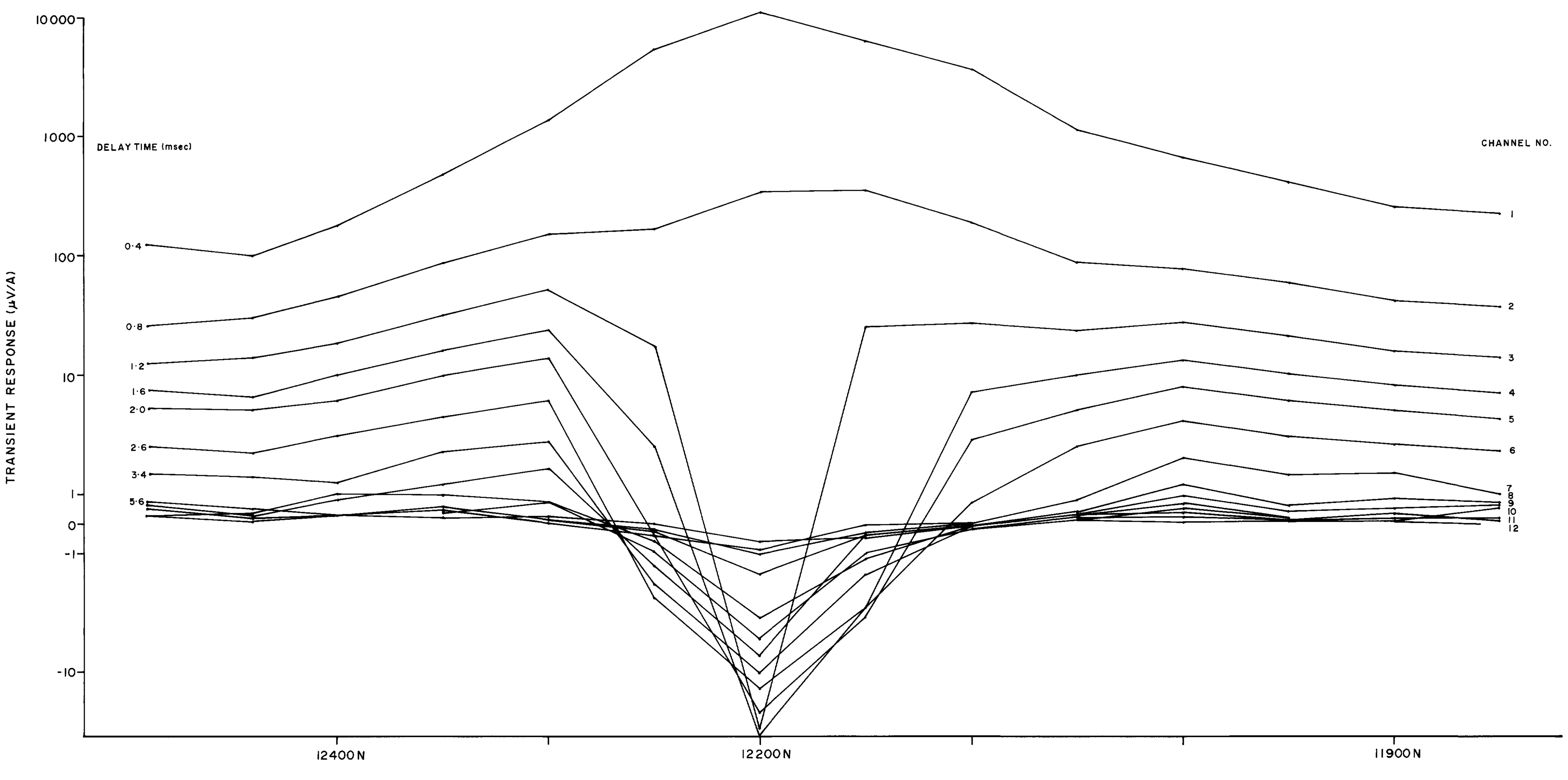
Plate 2

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED S. Dodds — CDO 27·2·91 DATE
EYRE PENINSULA GEOPHYSICAL SURVEY	DRAWN J. Gray — SCALE 1:2000
SILVER MONARCH AREA - CRAE/SHELL LINE 14500E	DATE Aug. 1990 — PLAN NUMBER 90-813
COMPOSITE GEOPHYSICAL & GEOLOGICAL SECTIONS	CHECKED

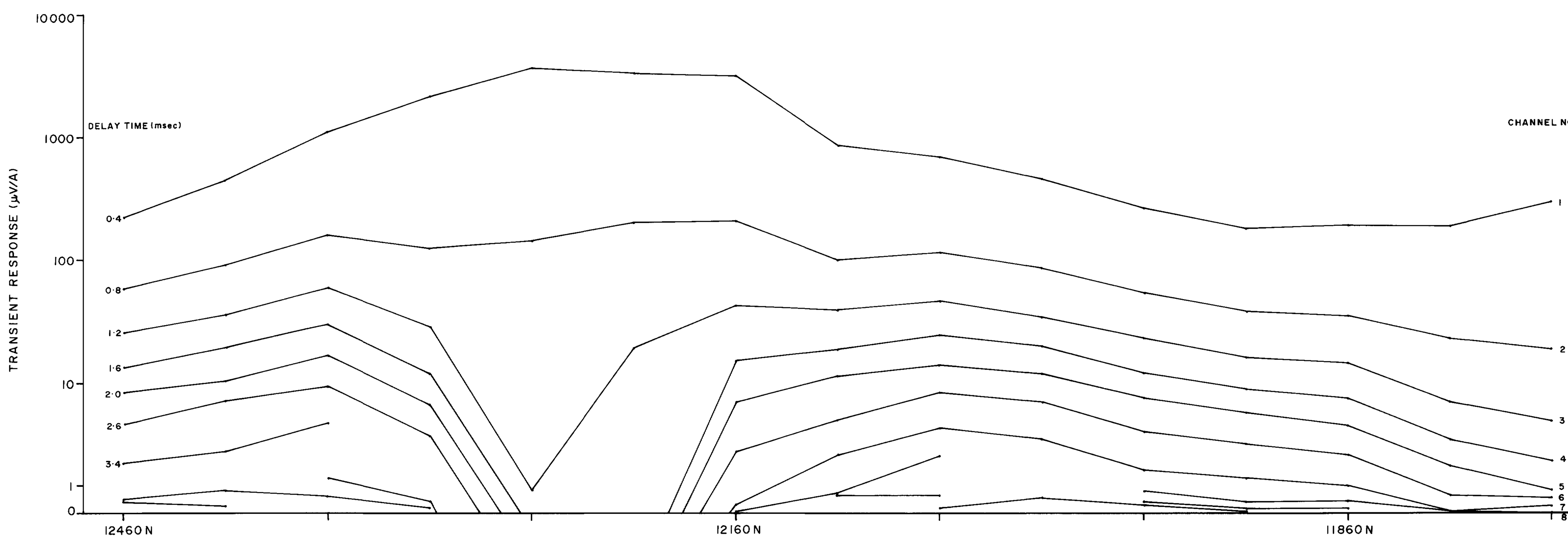
5075

NOTE: Section positions displaced by 40metres grid south per 100metres grid east to align responses from different sections.

SIROTEM In-loop configuration
100m. square Tx loop
Reading interval 50m.
1984 Line 15300E

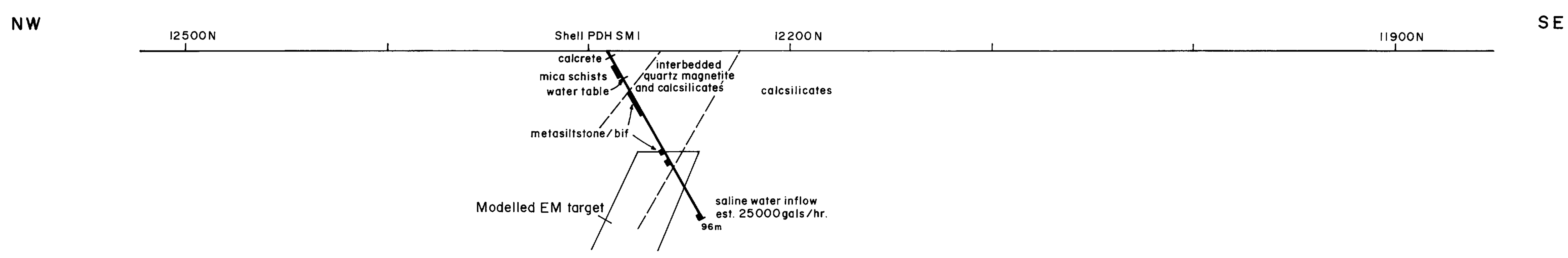


SIROTEM In-loop configuration
100m. square Tx loop
Reading interval 50m.
1982 Line 15200E



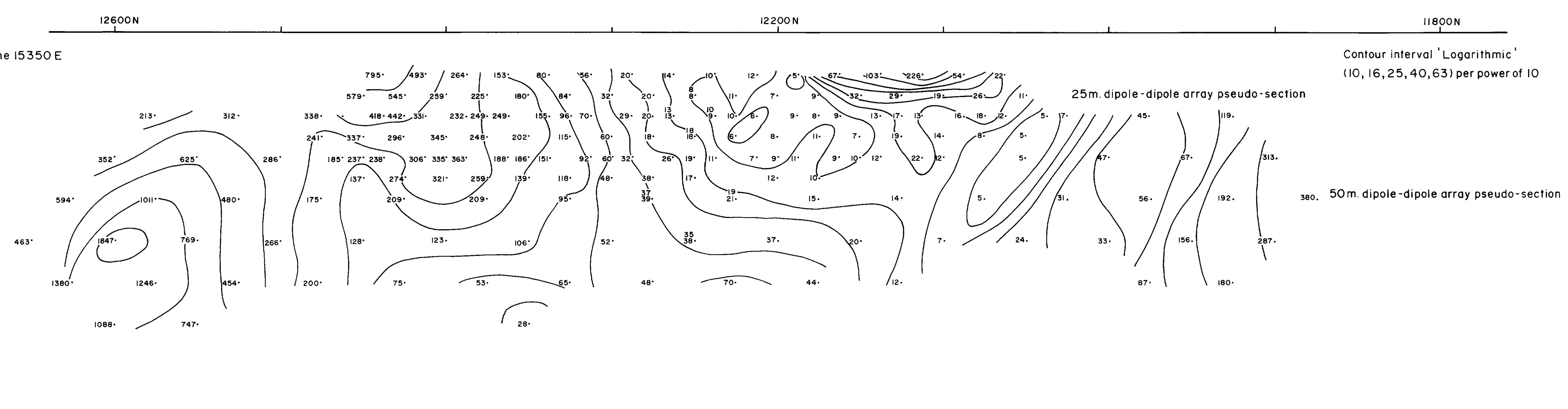
DRILLING AND GEOLOGY CROSS SECTION

Line 15200E
Shows Shell's EM Interpretation



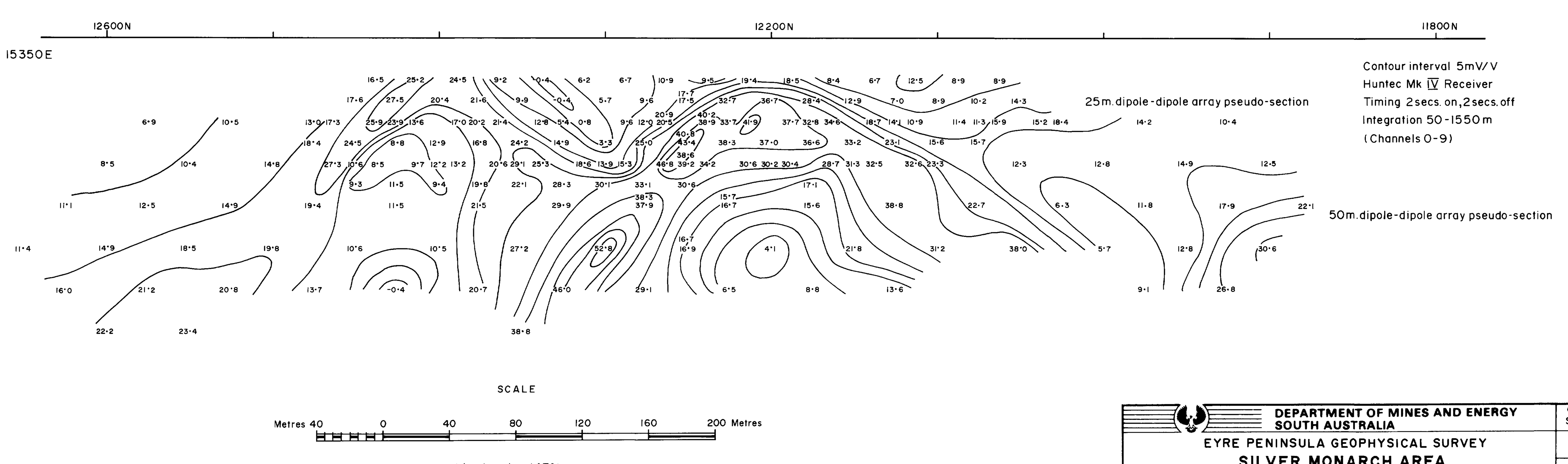
APPARENT RESISTIVITY (Ωm)

Line 15350E



APPARENT CHARGEABILITY (mV/V)

Line 15350E



SCALE

Metres 40 0 40 80 120 160 200 Metres

Line bearing 147° true

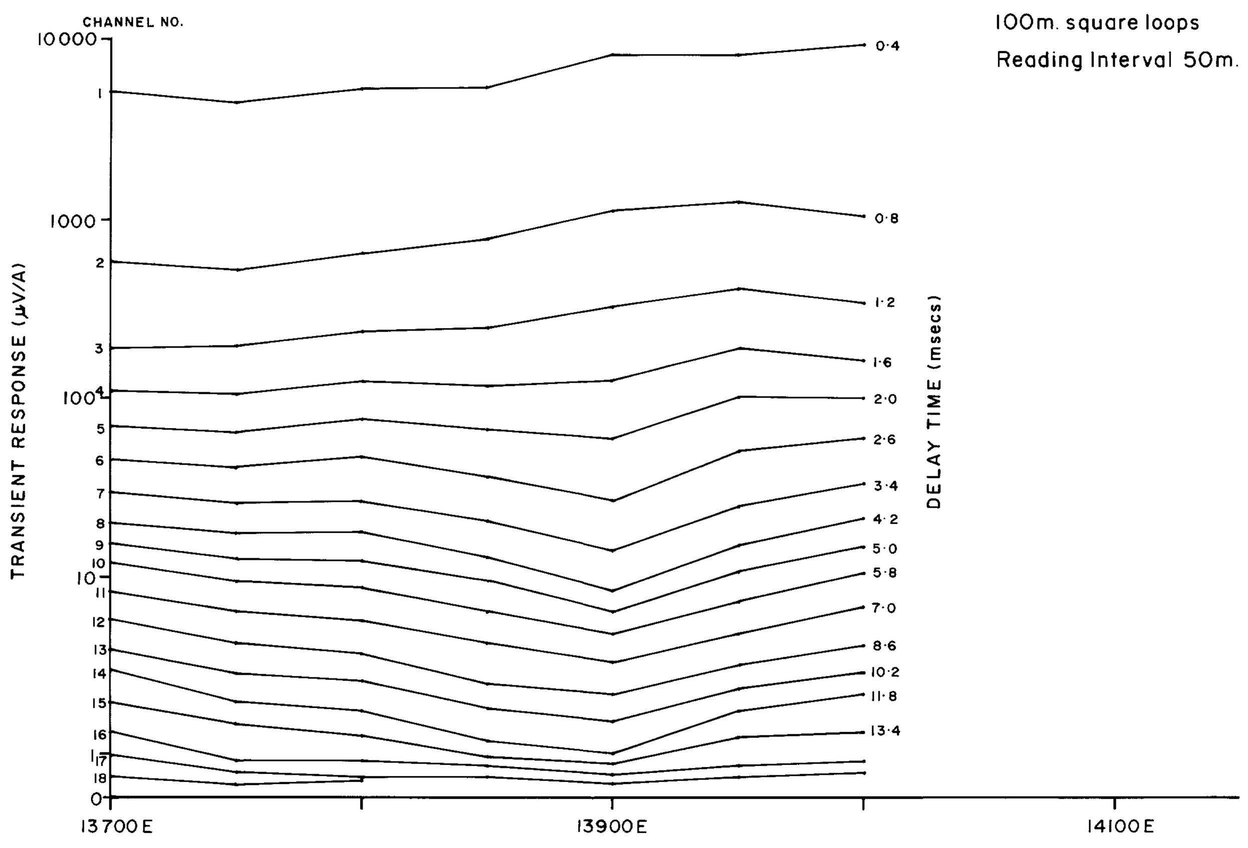
Plate 3

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED S. Dodds	27.2.91 C.D.O. DATE
EYRE PENINSULA GEOPHYSICAL SURVEY	DRAWN J. Gray	SCALE 1:2000
SILVER MONARCH AREA CRAE/SHELL LINES 15200E-15350E	DATE Aug. 1990	PLAN NUMBER 90-814
COMPOSITE GEOPHYSICAL & GEOLOGICAL SECTIONS	CHECKED	

5075

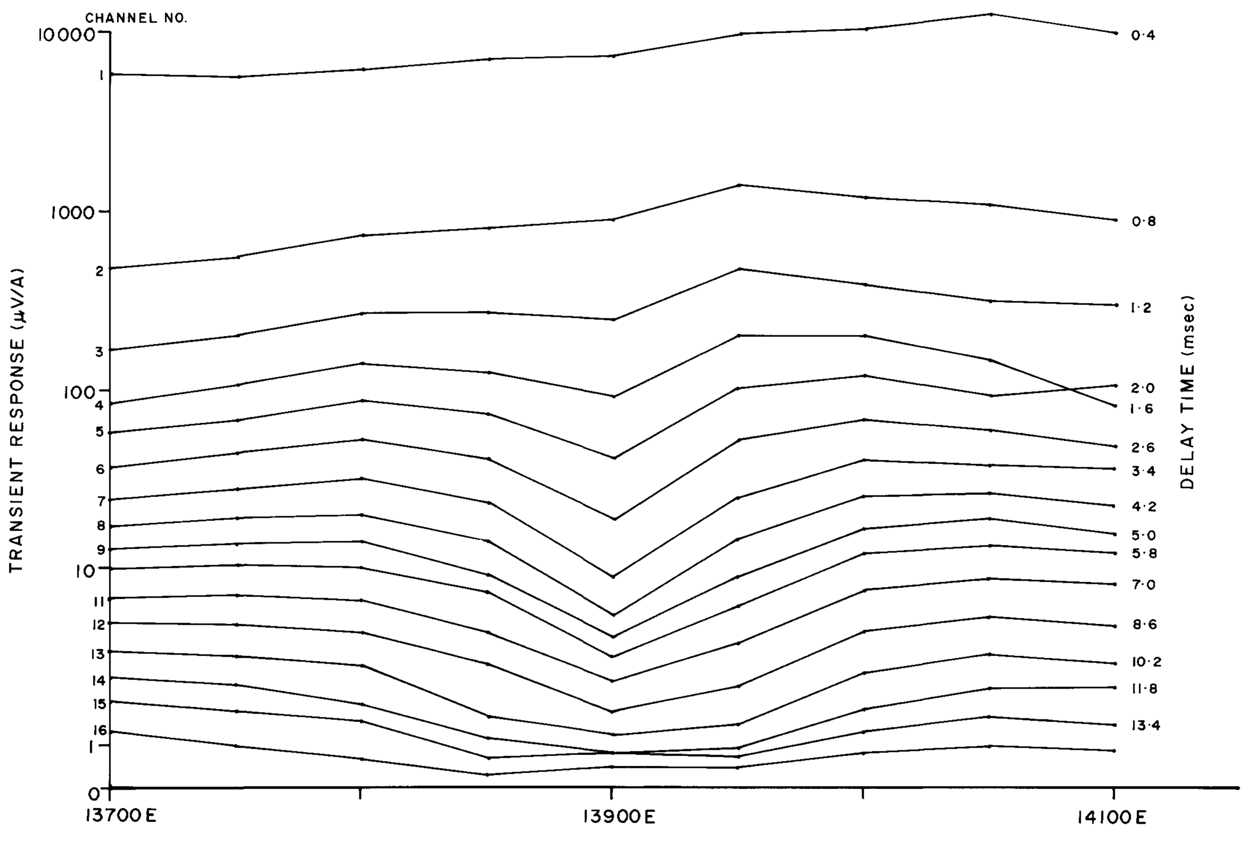
SIROTEM Displaced loop configuration
100m. square loops
Reading Interval 50m.

CRAE LINE 10500N



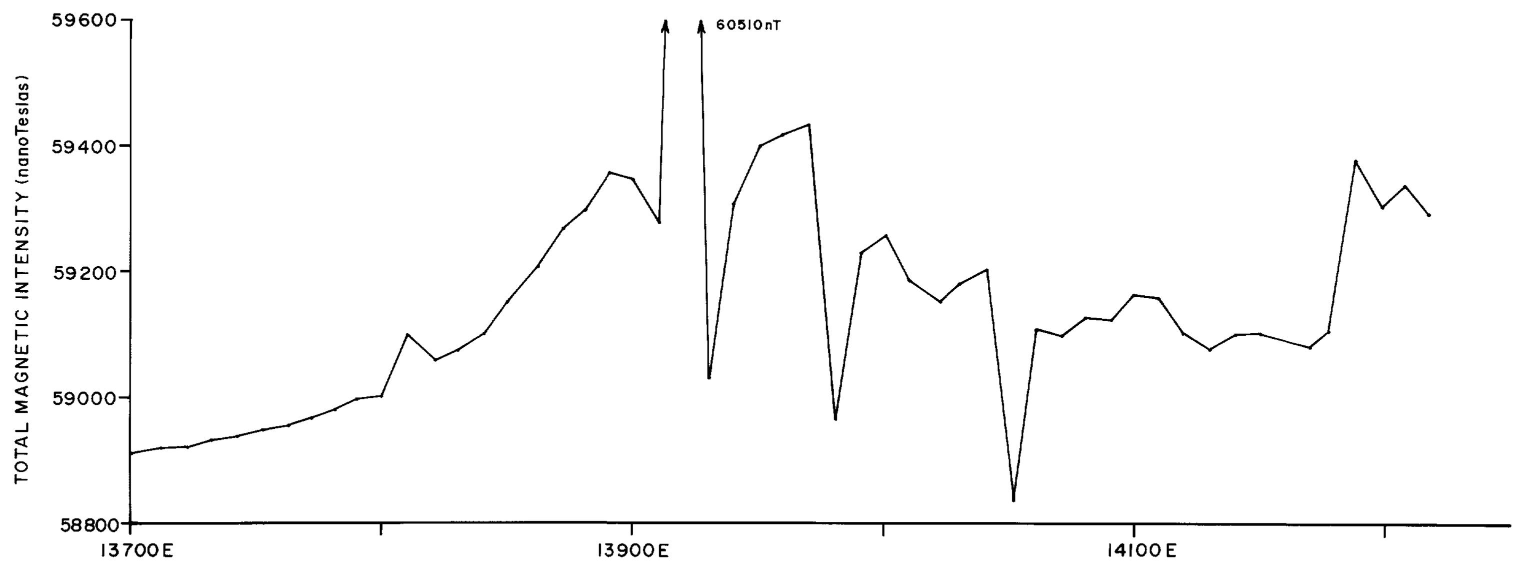
SIROTEM In-loop configuration
100m. square Tx loop
Reading Interval 50m.

CRAE LINE 10500N



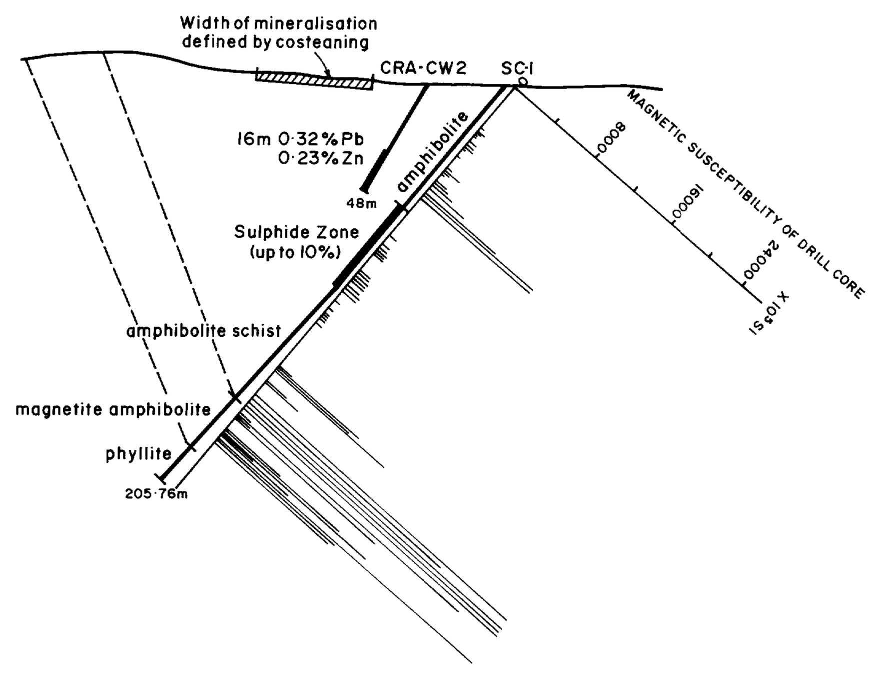
GROUND MAGNETIC PROFILE

CRAE LINE 10500N



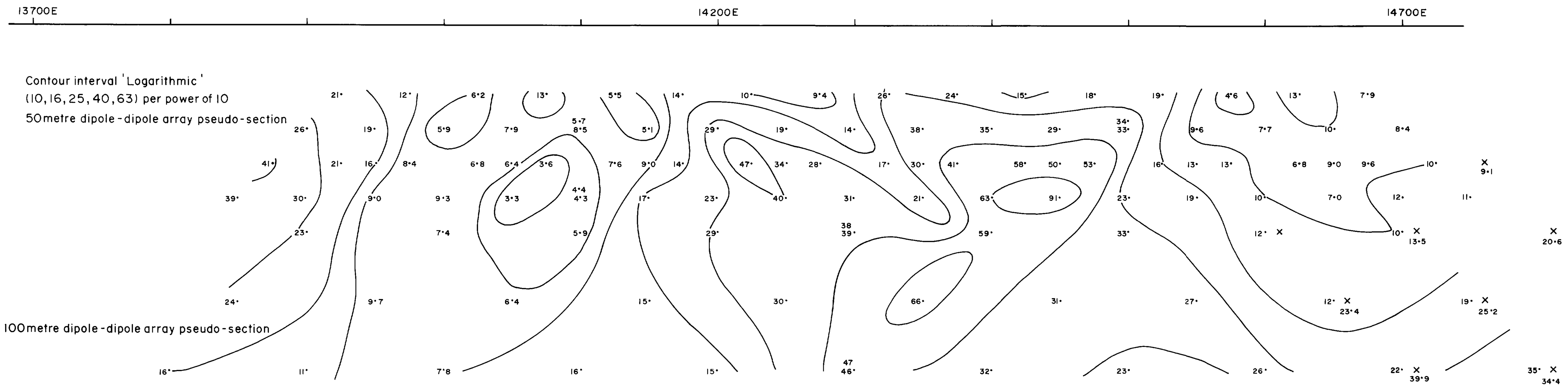
TOPOGRAPHY, DRILLING AND GEOLOGY CROSS SECTION & MAGNETIC SUSCEPTIBILITY

CRAE LINE 10500N



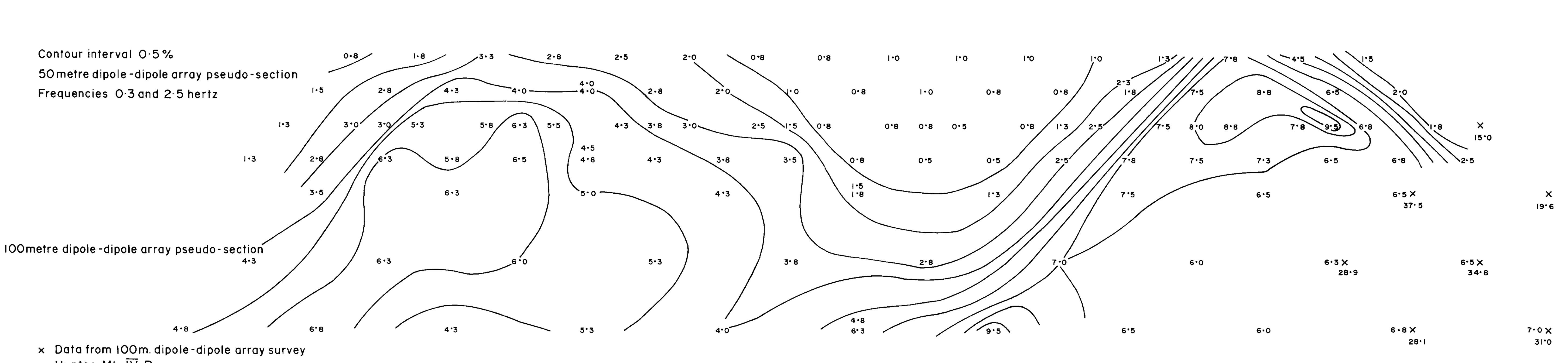
APPARENT RESISTIVITY (Ωm)

SHELL LINE 10250N



APPARENT FREQUENCY EFFECT (%)

SHELL LINE 10250N



× Data from 100m. dipole-dipole array survey
Huntec Mk IV Rx
Integration time 50-1550 msecs.

SCALE

Metres 50 0 50 100 150 200 250 Metres

Line bearing 119° true

Plate 4

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

EYRE PENINSULA GEOPHYSICAL SURVEY

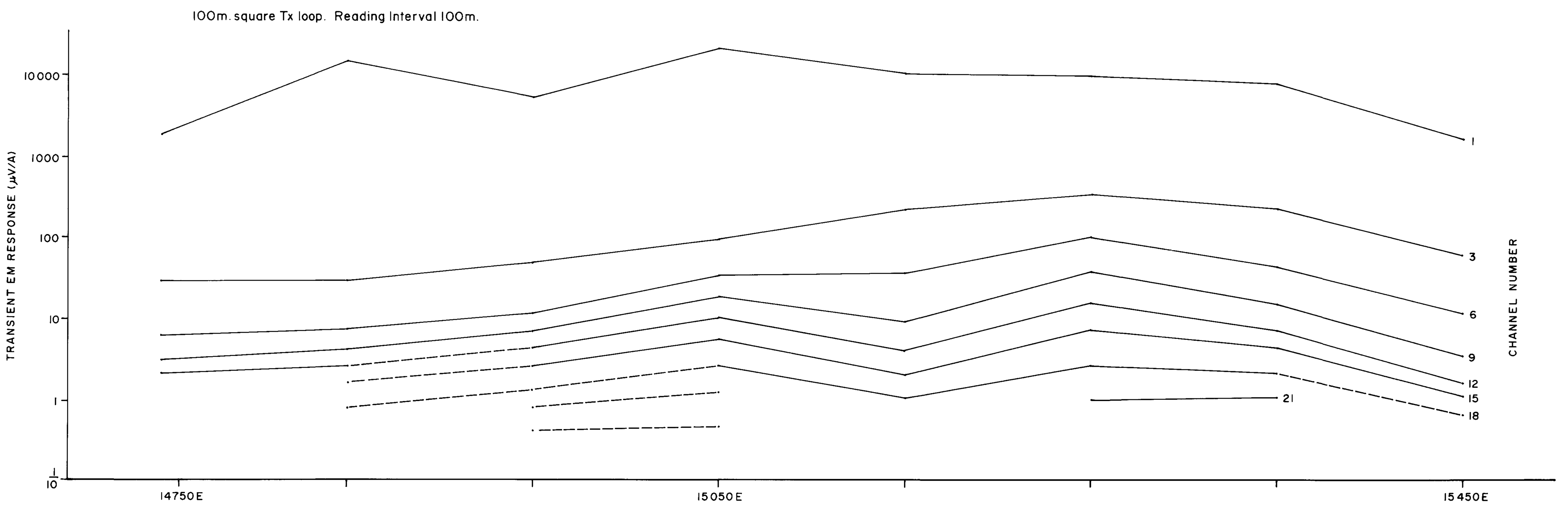
CAMPOONA GRID AREA - CRAE LINE 10500N, SHELL LINE 10250N

COMPOSITE GEOPHYSICAL & GEOLOGICAL SECTIONS

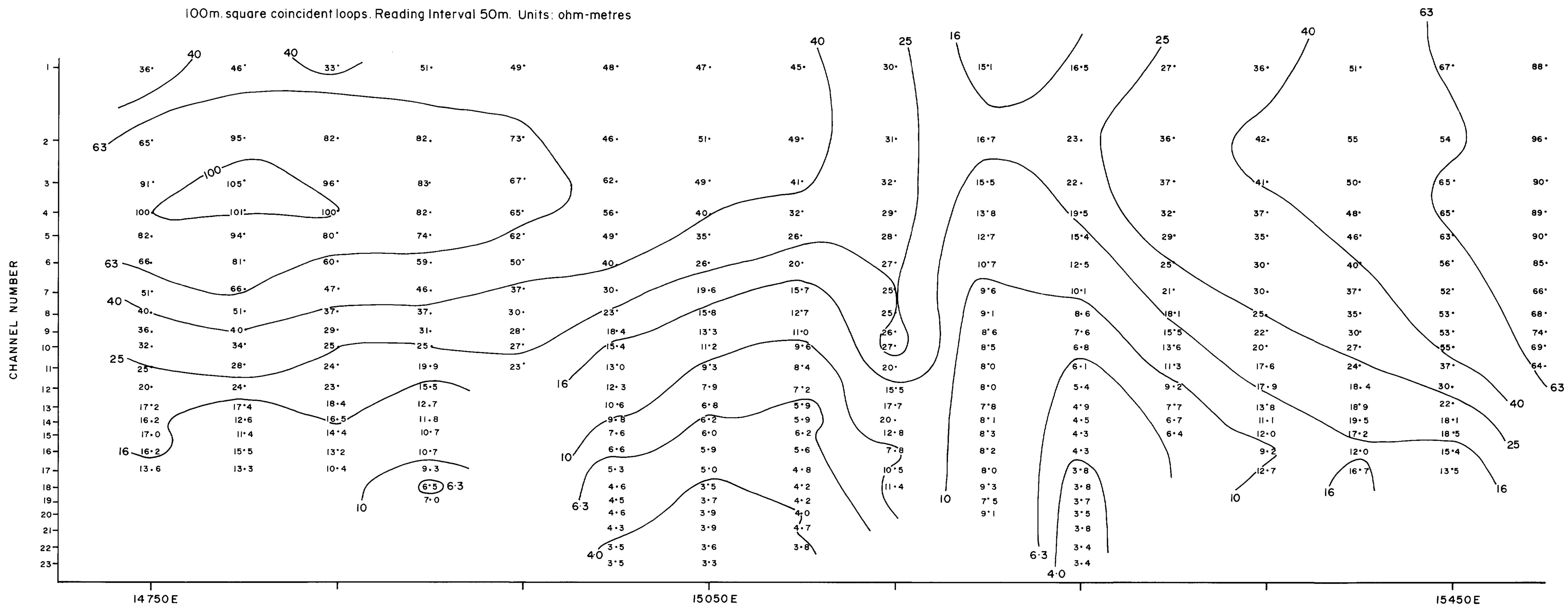
COMPILED	S. Dodds	27.2.91 C.D.O.	DATE
DRAWN	J. Gray	SCALE 1:2500	
DATE	Aug. 1990	PLAN NUMBER	
CHECKED		90-815	

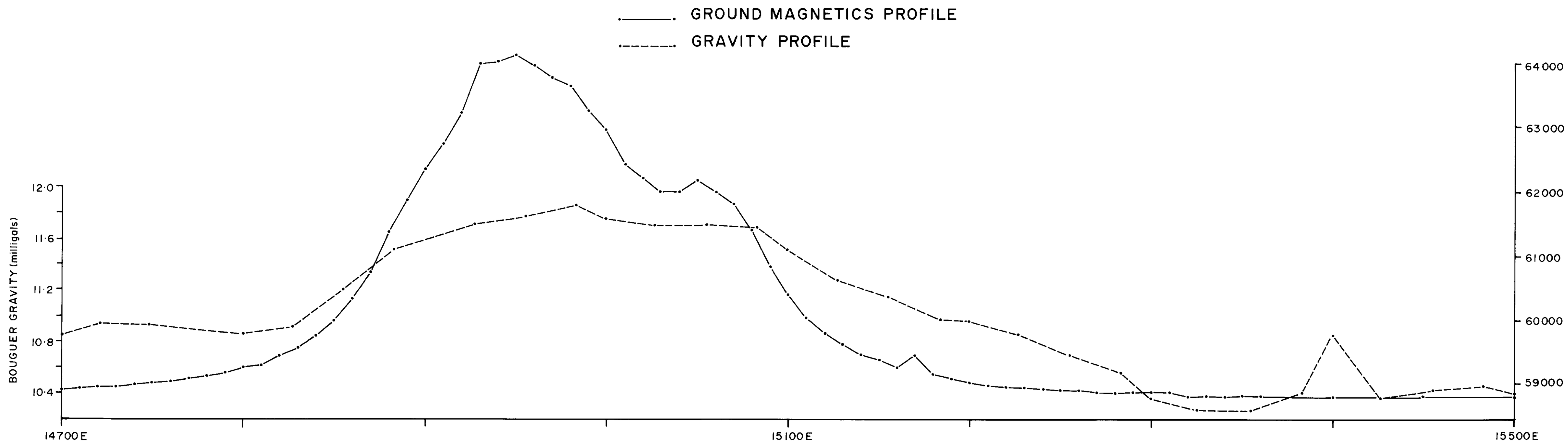
5075

SIROTEM 1979 LINE 14050N



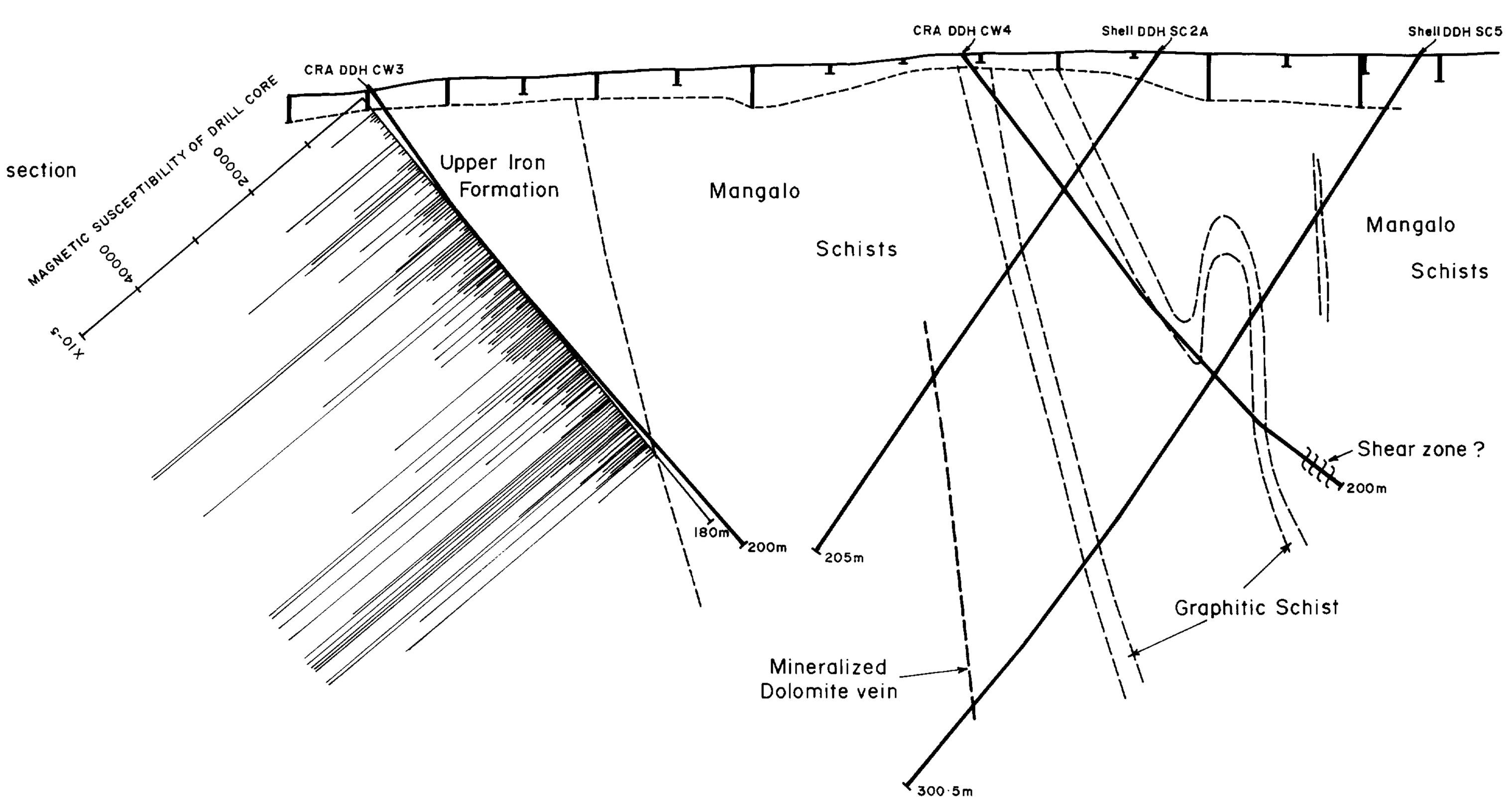
SIROTEM 1980 LINE 14050N APPARENT RESISTIVITY PSEUDO-SECTION



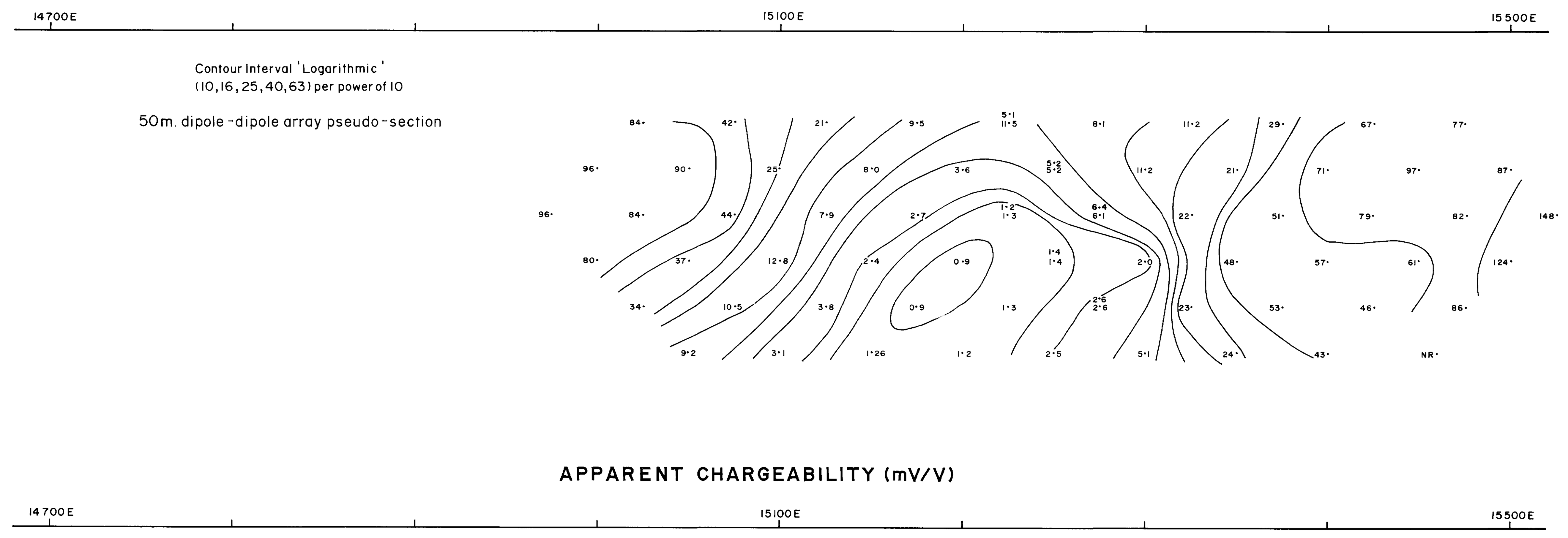


MAGNETIC SUSCEPTIBILITY, DRILLING AND GEOLOGY CROSS SECTION

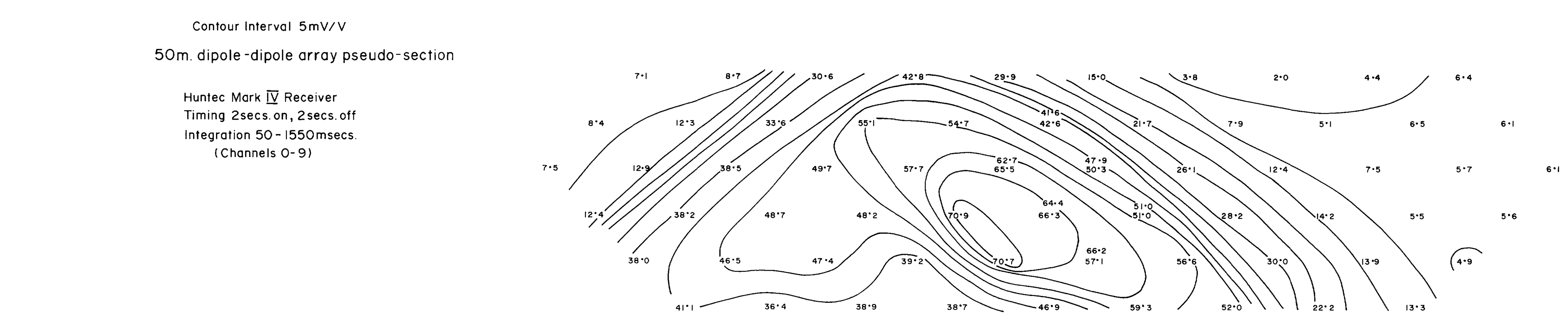
Drillholes variously projected onto the section



APPARENT RESISTIVITY (Ωm)



APPARENT CHARGEABILITY (mV/V)



SCALE

Metres 40 0 40 80 120 160 200 Metres

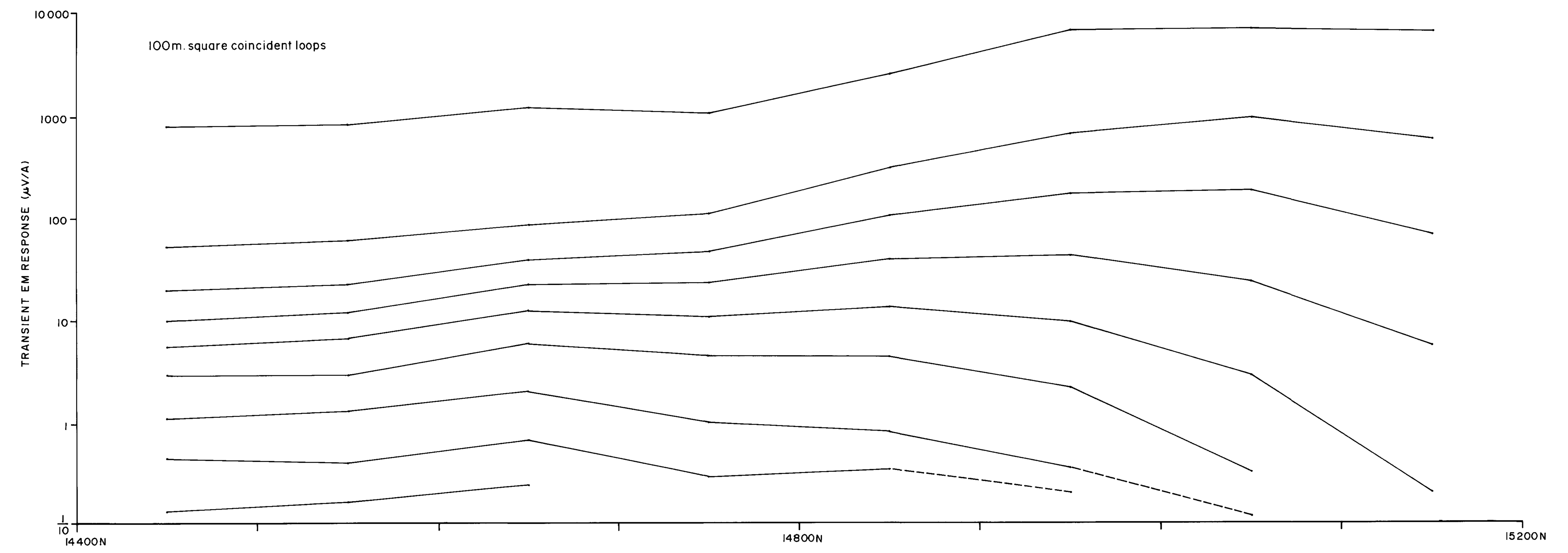
Line bearing 119° true

Plate 5

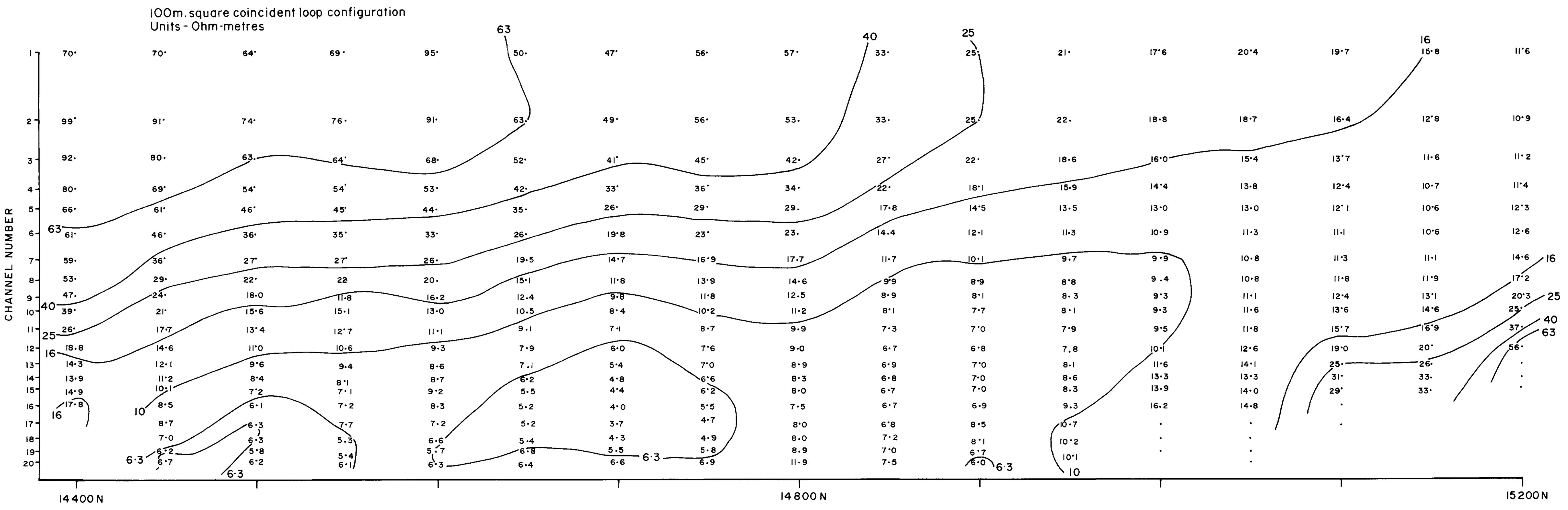
DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED S. Dodds	C.D.O. 27.2.91 DATE
EYRE PENINSULA GEOPHYSICAL SURVEY	DRAWN J. Gray	SCALE 1:2000
CAMPOONA GRID AREA - CRAE/SHELL LINE 14000N	DATE July 1990	PLAN NUMBER 90-816
COMPOSITE GEOPHYSICAL & GEOLOGICAL SECTIONS	CHECKED	

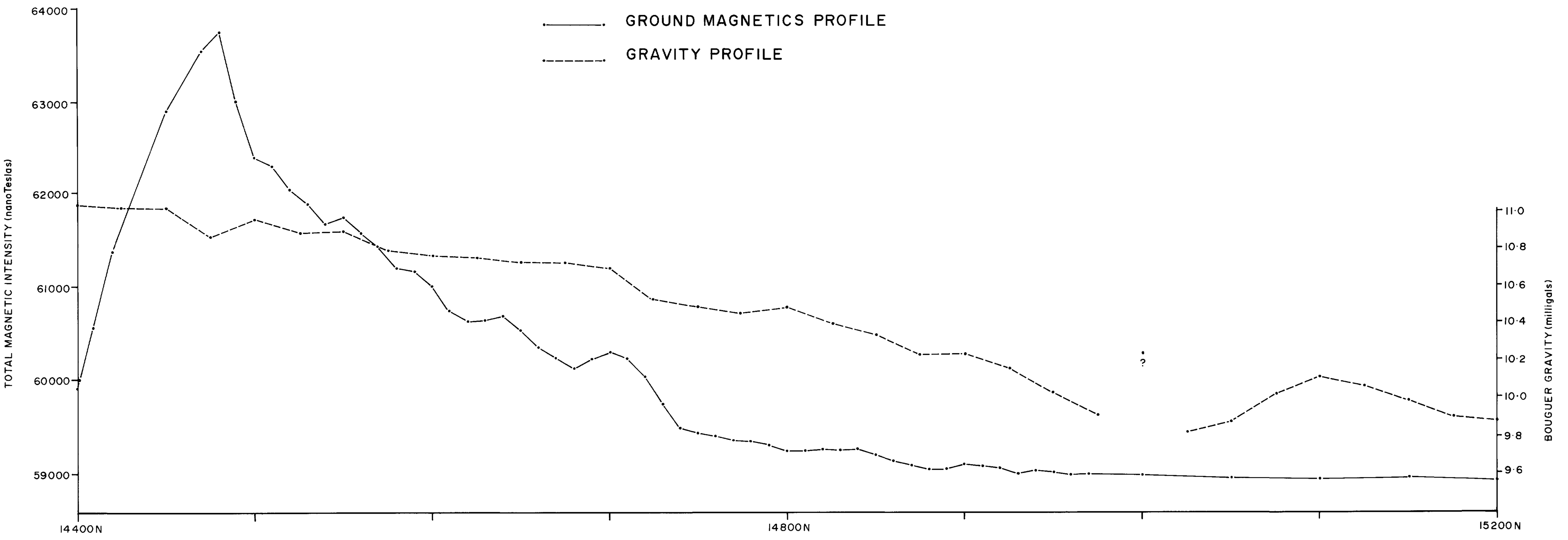
5075

SIROTEM LINE 14550E

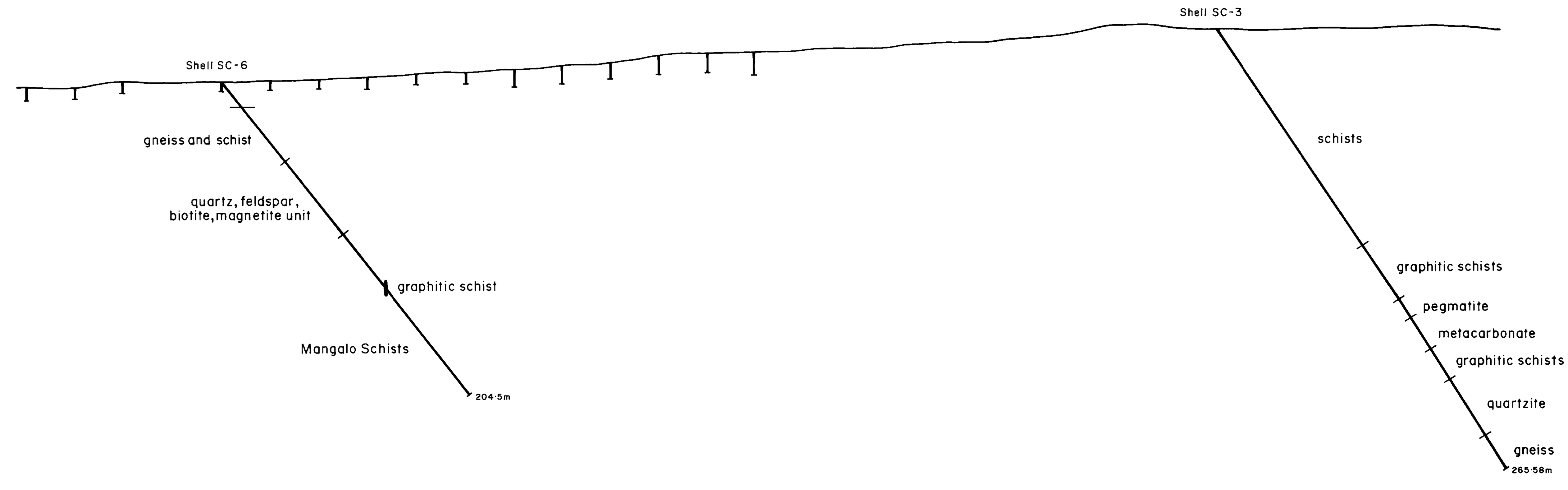


SIROTEM APPARENT RESISTIVITY PSEUDO-SECTION LINE 14550E

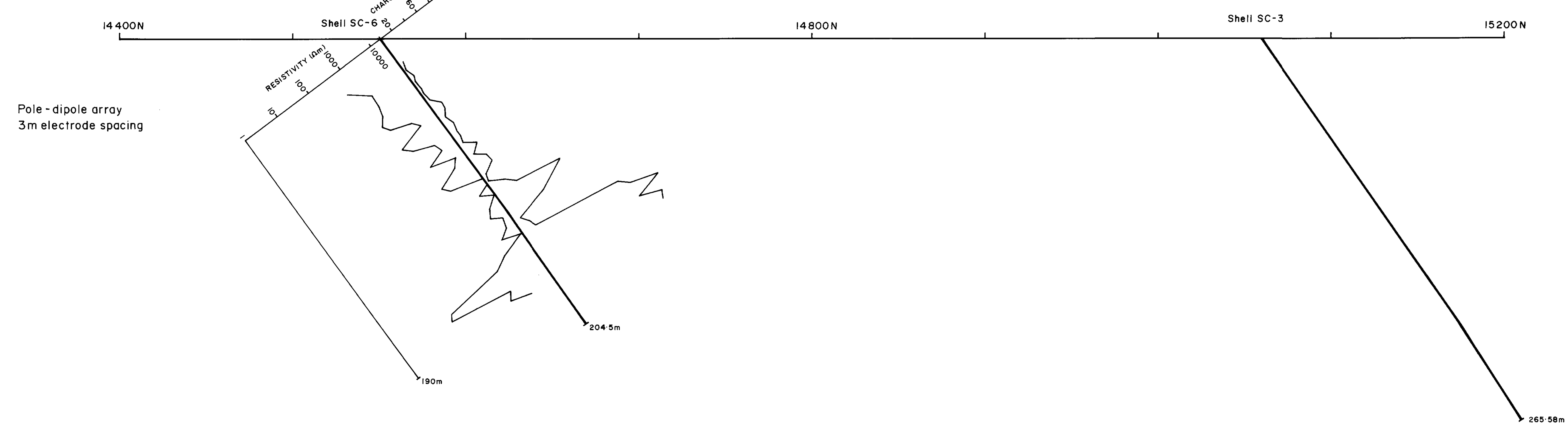




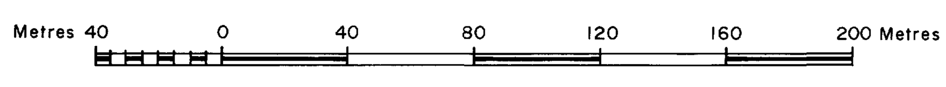
TOPOGRAPHY, DRILLING AND GEOLOGY CROSS SECTION



DOWNHOLE IP/RESISTIVITY



SCALE



Line bearing 027° true

Plate 6

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

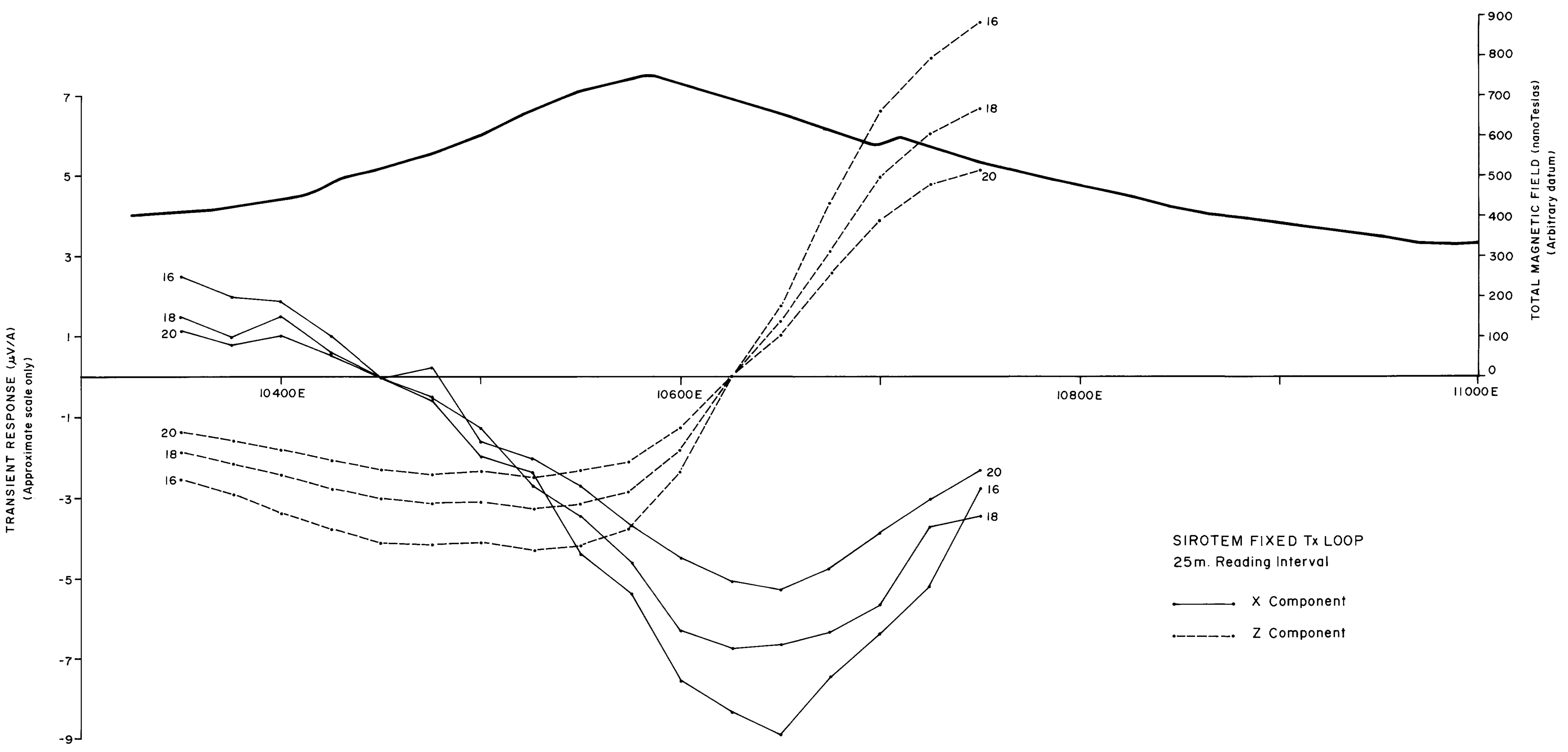
EYRE PENINSULA GEOPHYSICAL SURVEY

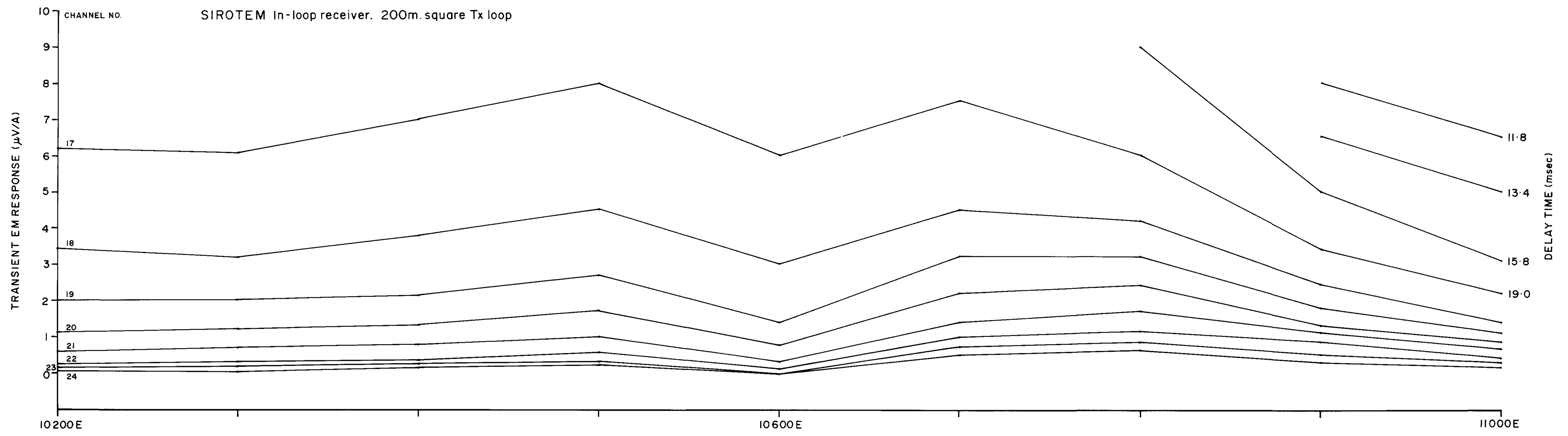
CAMPOONA GRID AREA - CRAE/SHELL LINE 14500E

COMPOSITE GEOPHYSICAL & GEOLOGICAL SECTIONS

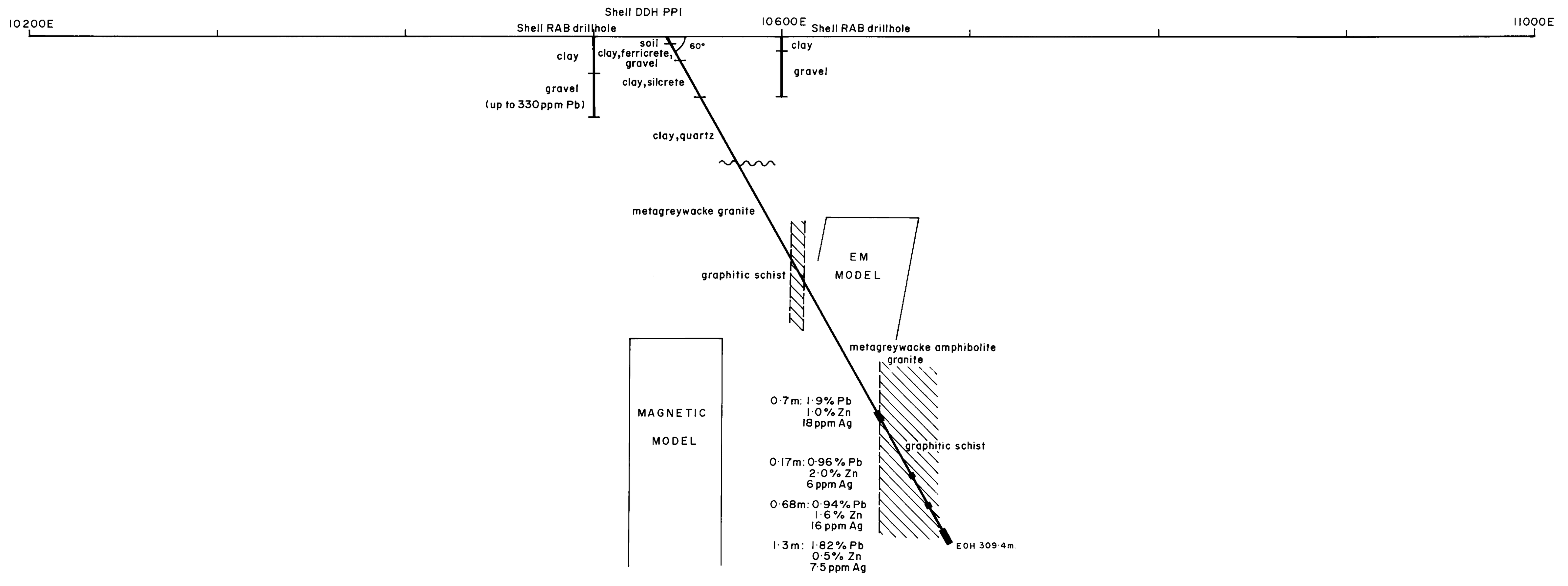
COMPILED S. Dodds	27·2·91	C.D.O. DATE
DRAWN J. Gray	SCALE 1: 2000	
DATE July 1990	PLAN NUMBER 90-817	
CHECKED		

5075

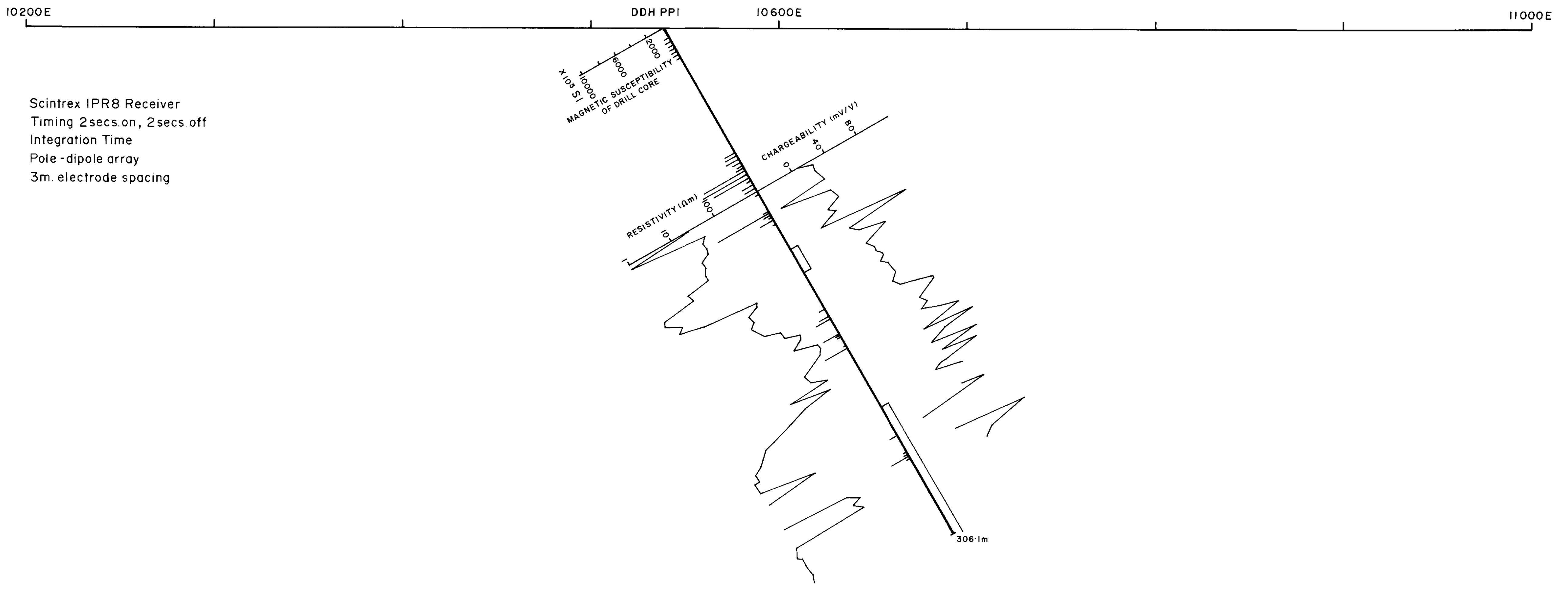




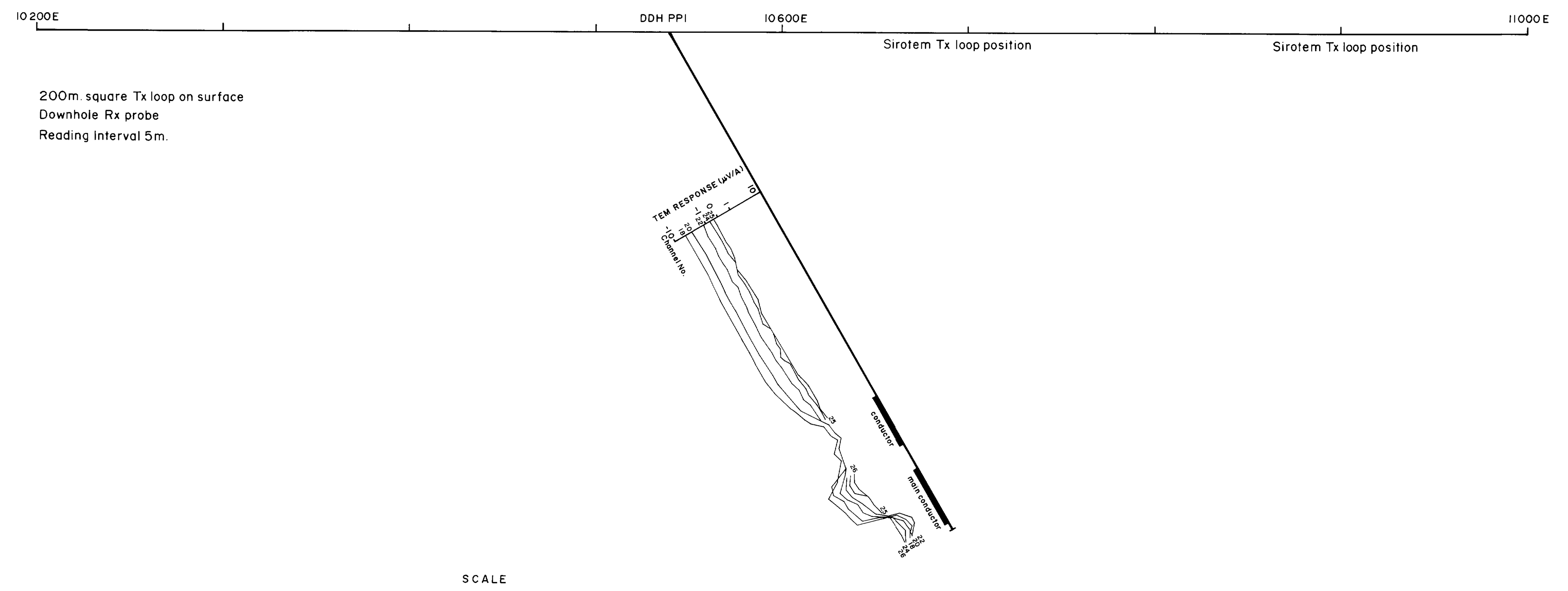
DRILL SECTION AND GEOLOGY WITH MODELS



DOWNHOLE IP/RESISTIVITY AND DRILL CORE MAGNETIC SUSCEPTIBILITY



DOWNHOLE SIROTEM



SCALE

Metres 40 0 40 80 120 160 200 Metres

Line bearing 060°true

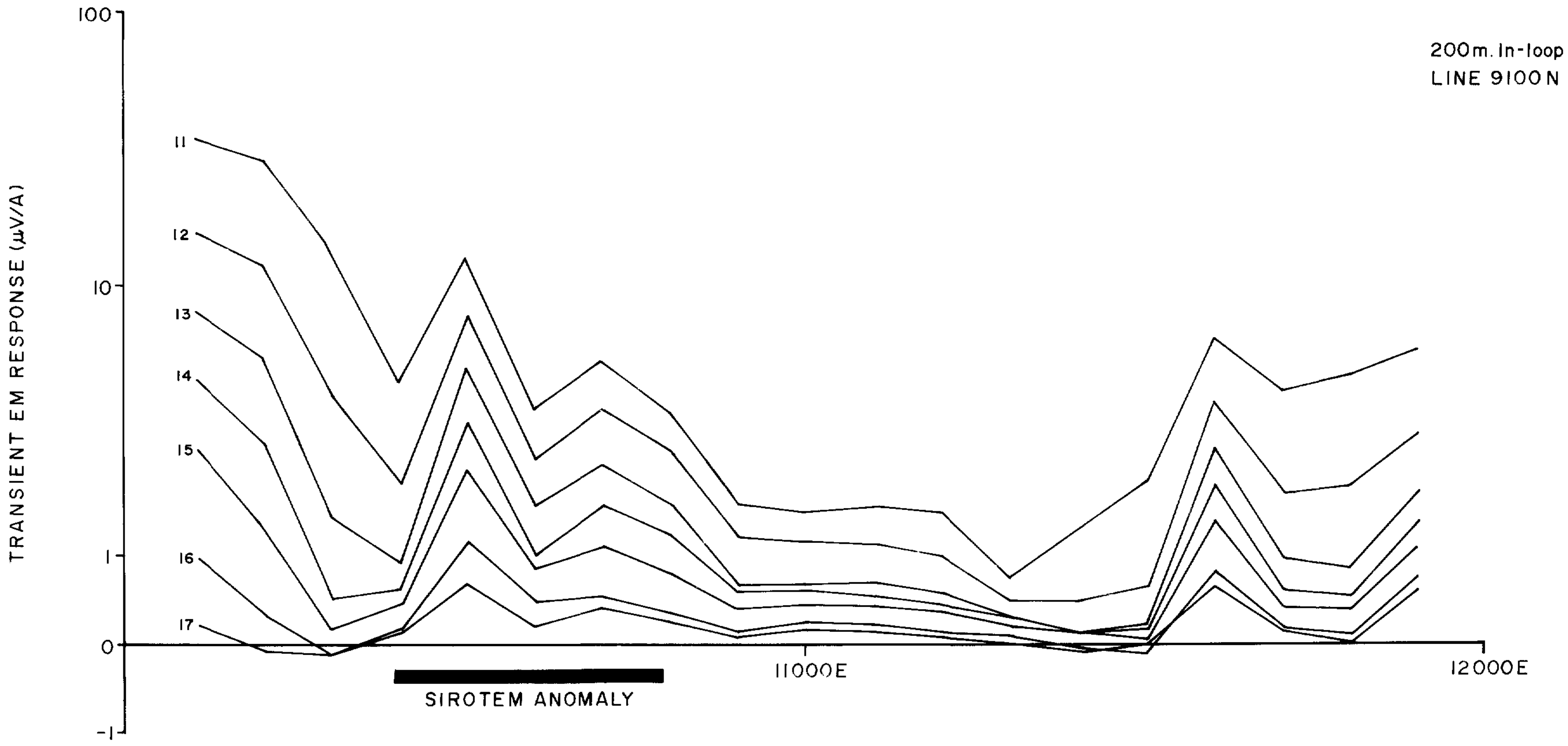
Plate 7

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED S. Dodds	27·2·91 C.D.O. DATE	
EYRE PENINSULA GEOPHYSICAL SURVEY	DRAWN J. Gray	SCALE 1:2000	
PANEY GRID AREA - SHELL LINE 12000N	DATE July 1990	PLAN NUMBER	
COMPOSITE GEOPHYSICAL & GEOLOGICAL SECTIONS	CHECKED	90-818	

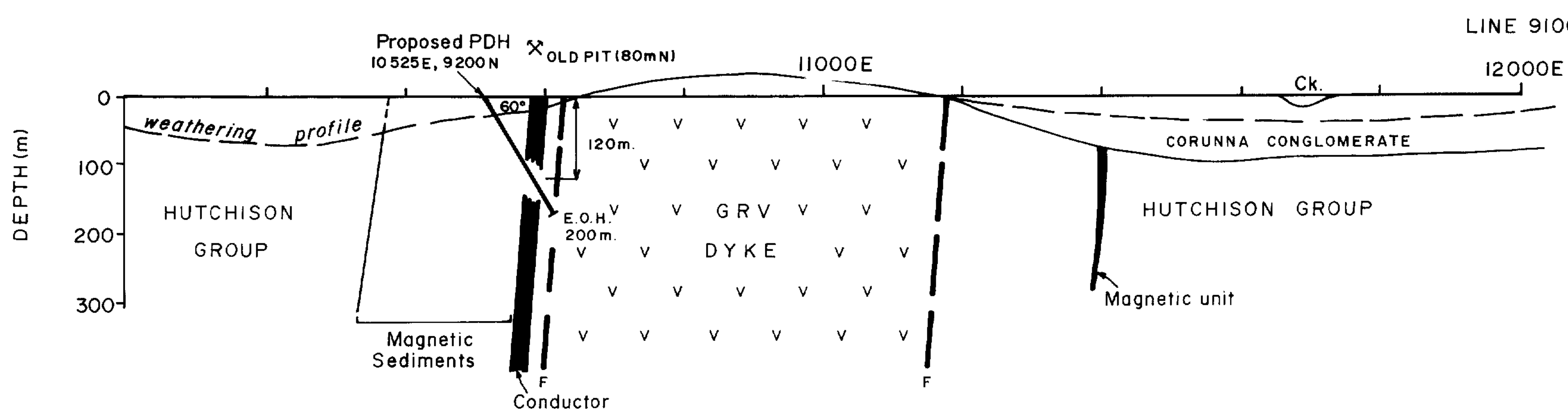
5075

GROUND MAGNETIC PROFILE

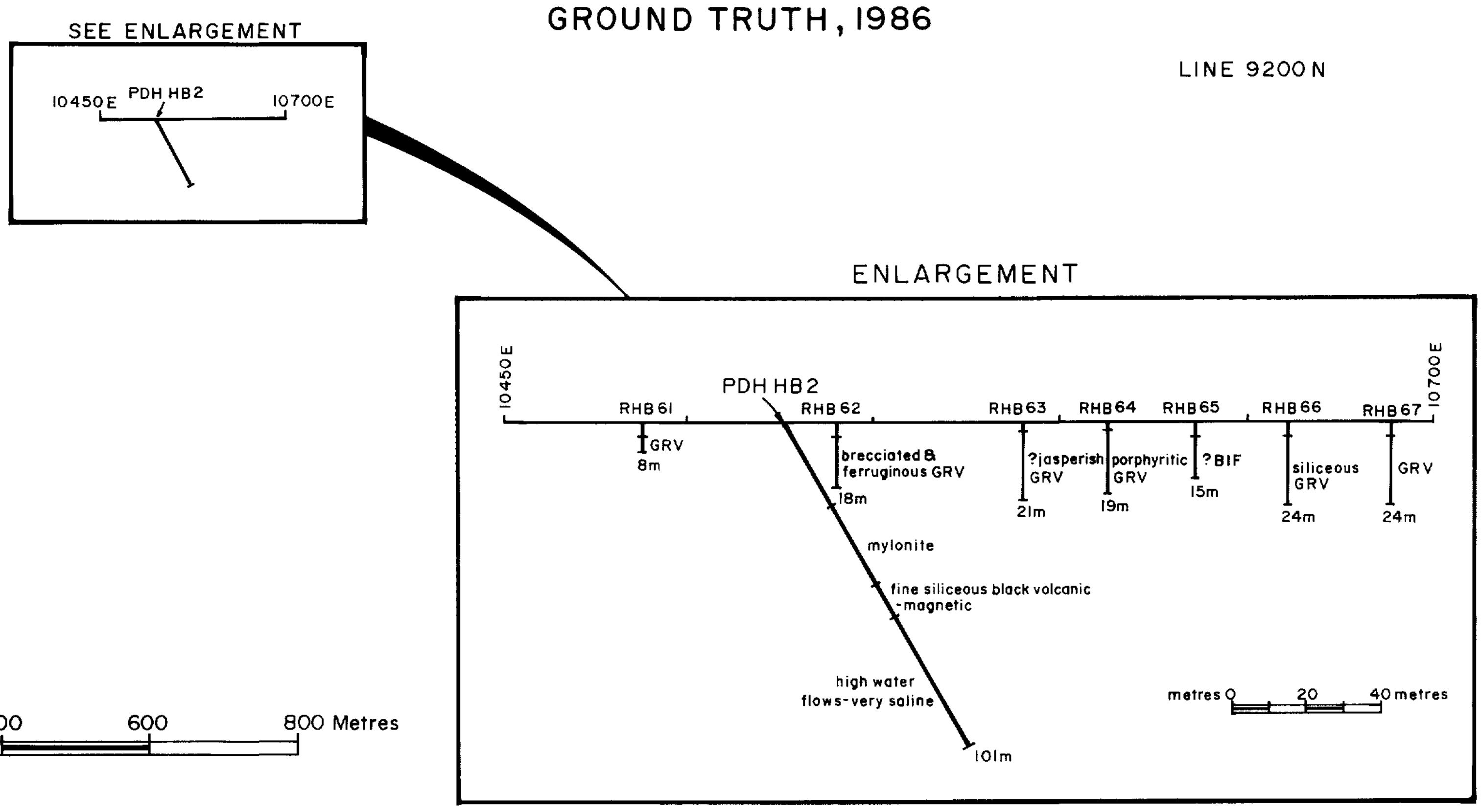
SIROTEM VOLTAGE PROFILES



GEOLOGY (Schematic, anticipated)



GROUND TRUTH, 1986



SCALE

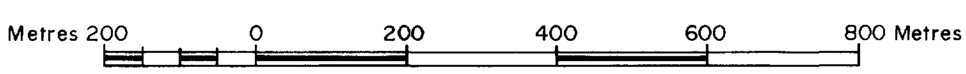


Plate 8

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

EYRE PENINSULA GEOPHYSICAL SURVEY

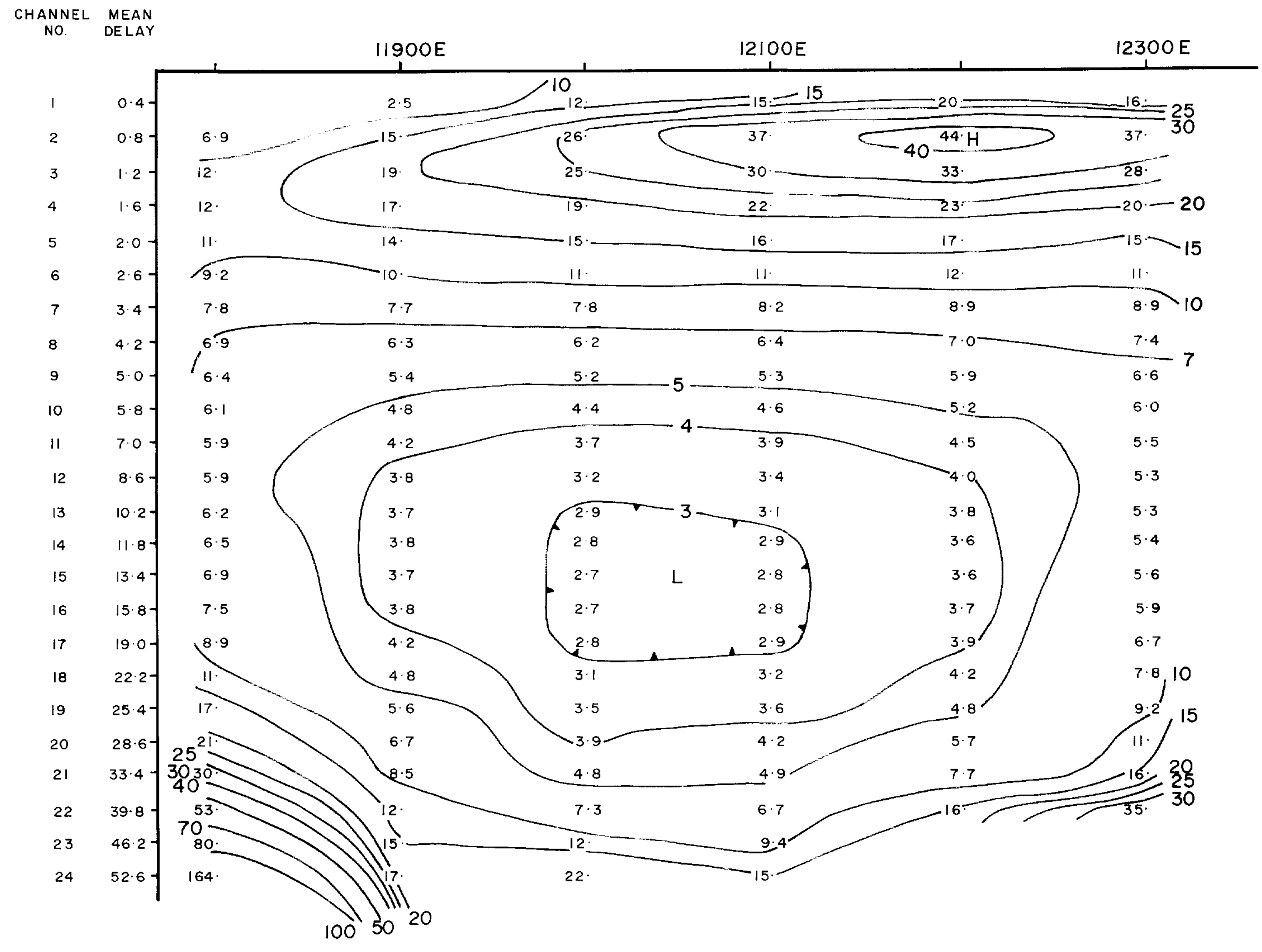
HARRIS BLUFF - TRIUMPH PROSPECT
SHELL LINES 9000, 9100 & 9200 N

COMPOSITE GEOPHYSICAL & GEOLOGICAL SECTIONS

COMPILED S. Dodds	27 - 2 - 91 C.D.O. DATE
DRAWN J. Gray	SCALE 1: 10 000
DATE Aug. 1990	PLAN NUMBER
CHECKED	90 - 819

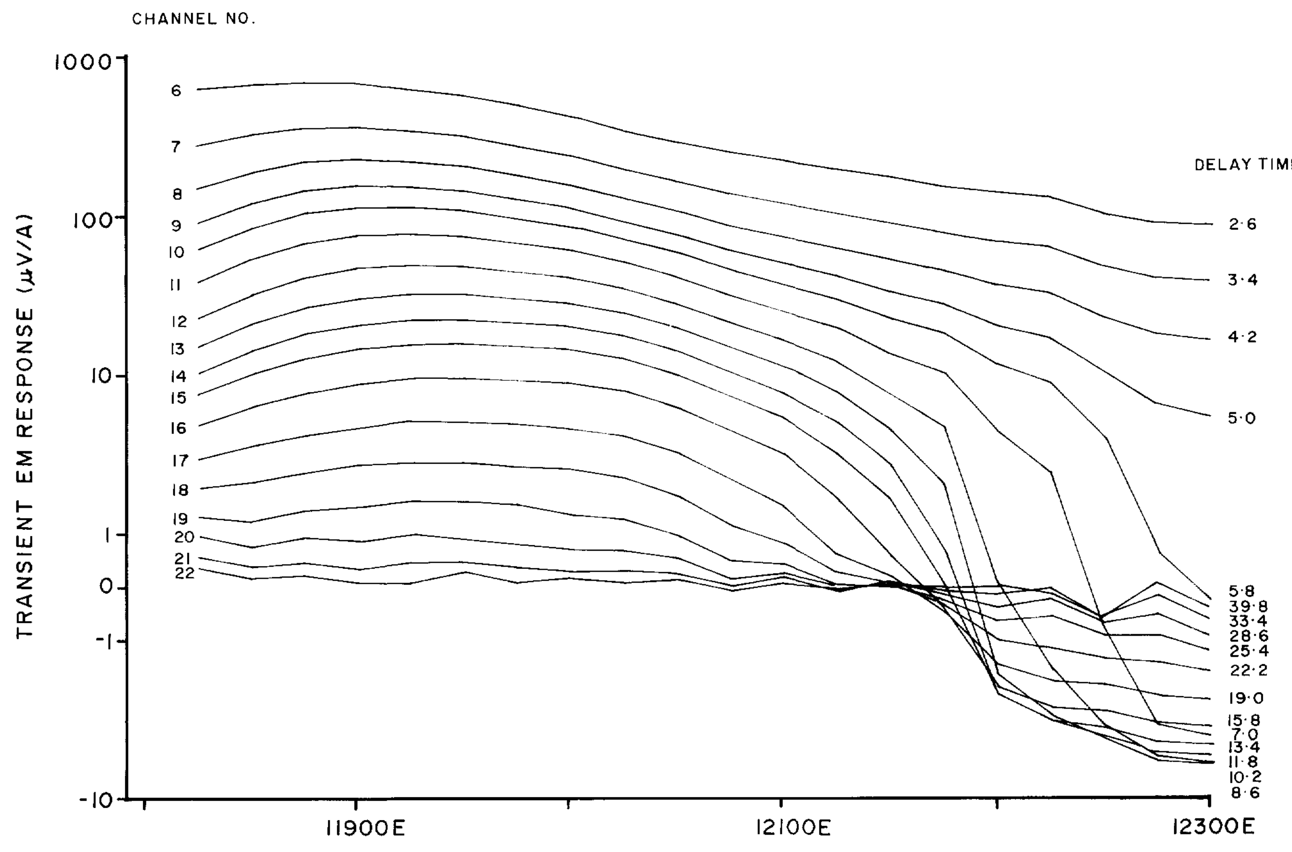
5075

Apparent resistivities plotted in ohm-metres
Loop configuration : In-loop receiver

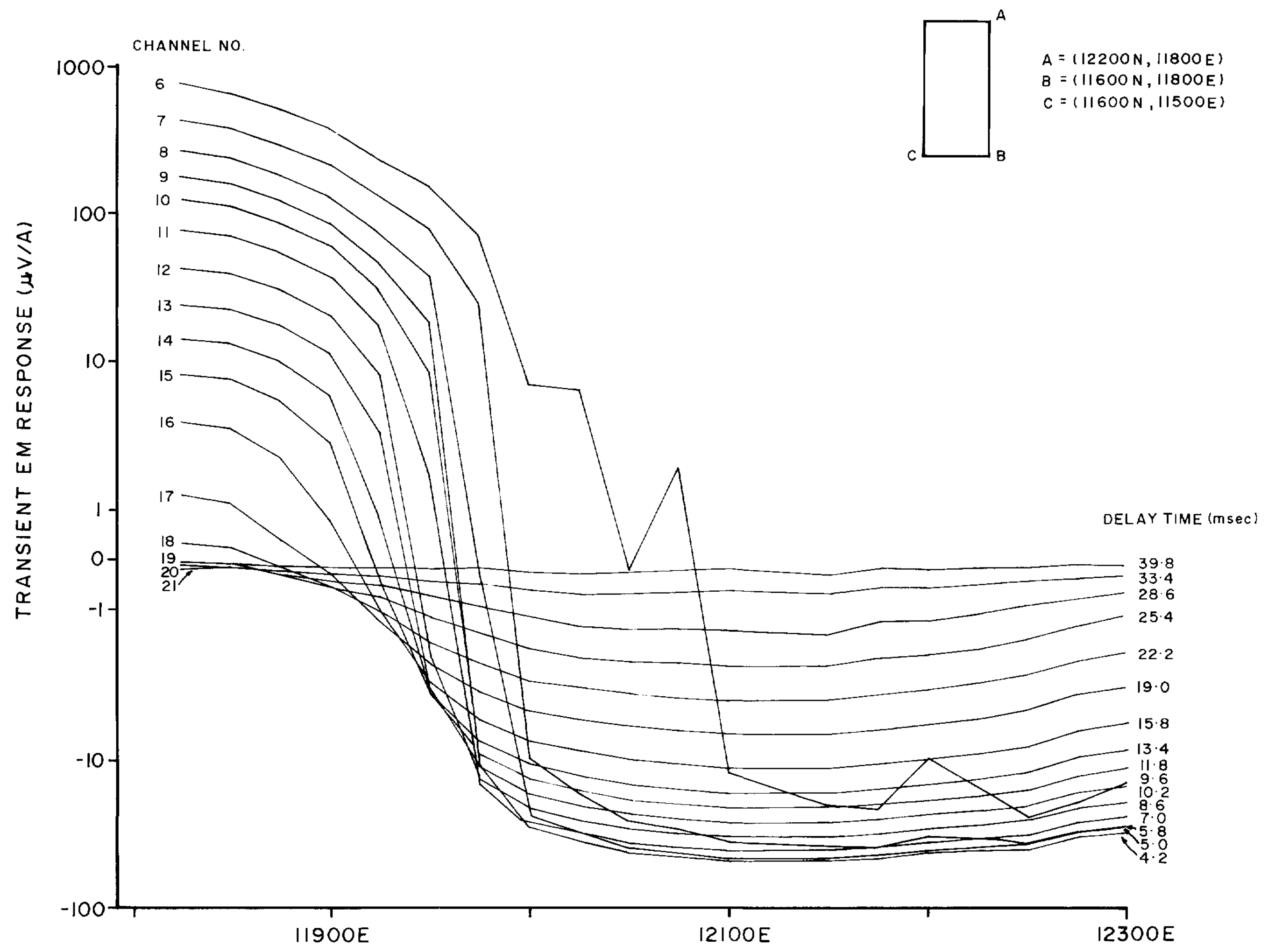


Loop configuration : TURAM mode (X component)

Reading interval 25m



Loop configuration : TURAM mode (Z component)



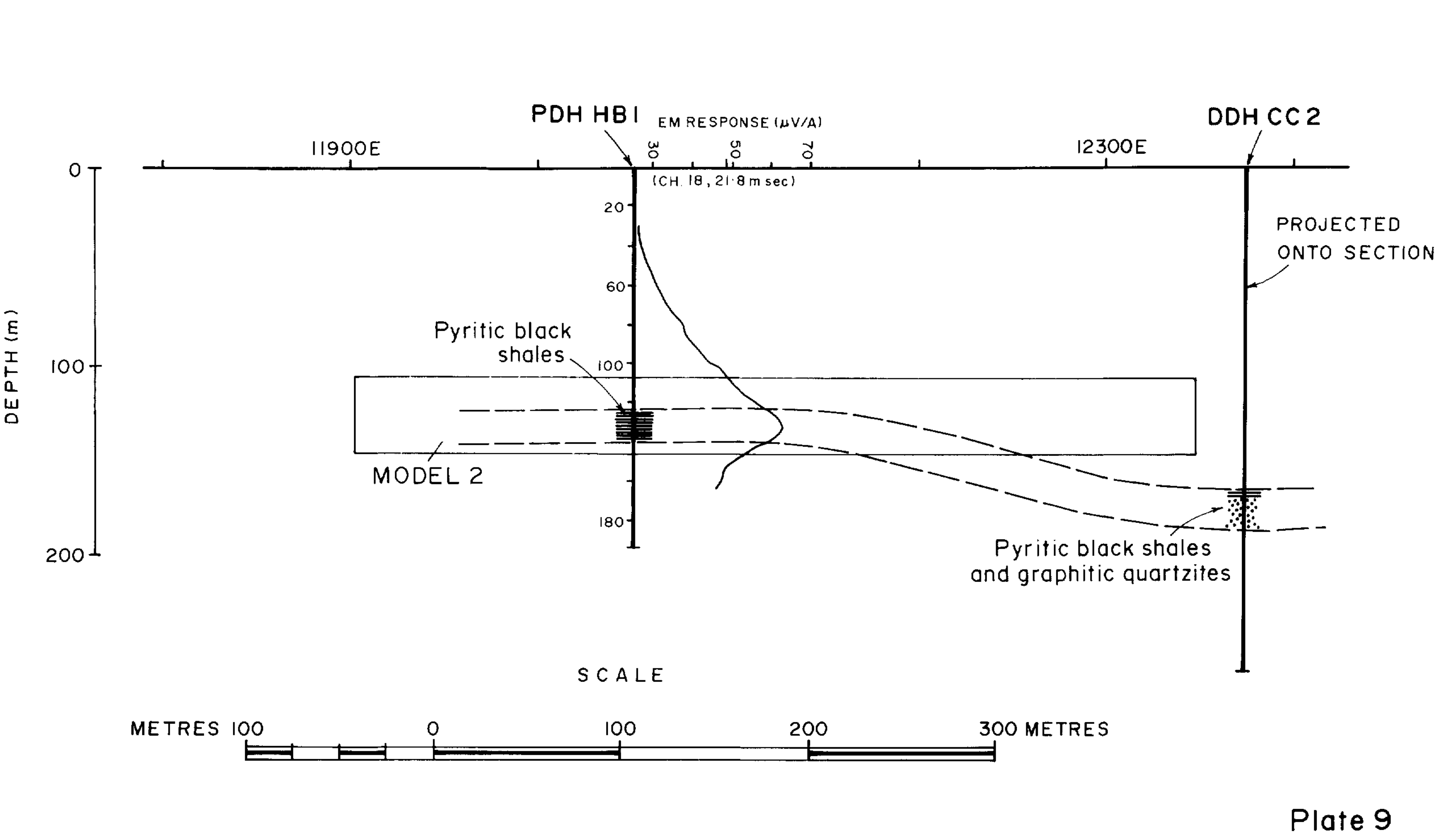


Plate 9

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED S. Dodds	27-2-91
EYRE PENINSULA GEOPHYSICAL SURVEY	DRAWN J. Gray	SCALE As shown
HARRIS BLUFF-TRIUMPH PROSPECT SHELL LINE 11900N	DATE Oct. 1990	PLAN NUMBER 90-820
COMPOSITE GEOPHYSICAL & GEOLOGICAL SECTIONS	CHECKED	

5075