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# LEAMAN GEOPHYSICS

Survey Review, Specification, Reduction, Interpretation  
Wide Experience Most Methods  
Specialties:- Gravity, Magnetics, Seismic Methods

Registered Office:  
461 OCEANA DRIVE, HOWRAH, TAS. 7018  
All Correspondence to:  
G.P.O. BOX 320 D, HOBART, TAS. 7001.  
TELEPHONE: (002) 47 8849

870001

## PHASE 1 INTERPRETATION GRAVITY AND MAGNETIC DATA

D'ENTRECASTEAUX REGION SOUTHERN TASMANIA  
EL 29/84; 6-7/86; 52-53/86; 8-14/87; 46/87

for  
CONGA OIL PTY LTD

by  
D. E. LEAMAN

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## SPECIAL NOTE

This report presents the results of the first phase of a gravity-magnetics interpretation process. Although these results exceed normal final standards in the industry for treatment of this type of data in oil exploration they are far short of what may be extracted. These results carry, for me, an unacceptable level of ambiguity and uncertainty and form only the feedstock for a refinement process.

Staged reporting of results has been provided in order that progress, concepts and current thinking can be circulated within the company.

The material presented does not constitute an adequate interpretation; there are still too many issues unresolved. This is a discussion paper which must not be described as, or implied to be, a final or satisfactory interpretation. In this region the geological and economic issues are such that an understanding will evolve.

Several phases of interpretation are envisaged if optimum use is to be made of gravity-magnetic data. In an area where basic structural and stratigraphic control cannot, either as a result of terrain, cost or technical reasons, be based on a coarse regional seismic reflection coverage it is important to use alternate techniques in order to provide the basic overview and then to play a more active role in support of subsequent, restricted coverage seismic surveys than is usual practice.

PHASE 1: Simple assessment of data, structural trends and controls, qualitative overview and material-structure-result relationships, and provision of regional elementary interpretation which might guide seismic work (if proven feasible and cost effective) as well as identify foci for more detailed or specific analyses.

PHASE 2: Regional confirmation of Phase 1 using 3D methods. This may be coupled with some detailed work.

Phases 1 and 2 essentially uncontrolled.

PHASE 3: Selective examination of areas with a view to definition of particular objectives including dolerite and stripping to reveal deeper section. Needs some control.

PHASE 4: Iteration and review leading to fuller appraisal of pre-Permian structuring.

A report of this type will be prepared after completion of each phase of interpretation, significant block of work or derivation of some aspect of interpretation which is considered critical to regional appraisal or well siting.

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## SUMMARY

An initial interpretation of gravity and magnetic surveys in SE Tasmania has confirmed the presence and development of Late Precambrian and Lower Palaeozoic basins and troughs. While some of the Late Precambrian materials; dolomites, shales and phyllites, are exposed to the NW and SW of the area studied no surface indication of thick Palaeozoic sedimentation exists as the entire region is blanketed by Permo-Triassic rocks intruded by Jurassic dolerite.

The Late Precambrian-Early Cambrian dolomitic sequences are up to 5 km thick and unconformably overlie, or onlap, older Precambrian siliceous crystalline basement referred to as the Tyennan Block. The present day Ficton and Huon Rivers lie near the effective margin of this deposition and the unit thickens eastward. The overall trend of the deposit is NW-SE with major exposures NW of Conga's licences in the Lake Pedder-Maydena region. These dolomitic sequences form the effective basement for much of the licence area and been drilled at Woodbridge.

The bulk of the Palaeozoic material fills a "Y" shaped trough with its major arm extended to the NW. The trough overlaps the margin of Late Precambrian deposition. Inferred properties for this material suggest that most of it is Cambrian volcanogenic or derived material. No other rock suite known in Tasmania has the required scale, form or content. The volcanic suites clearly include mafic and less mafic members on a large scale. The thickness of the magnetic trough fill, considered the minimum thickness of Cambrian materials, exceeds 5 to 6 km.

Ordovician rocks outcrop peripherally in the region of the Picton, Lune and New Rivers but present data indicates that these materials (and Siluro-Devonian formations) may be more widespread. It is likely that thickest development overlies axes of older deposition but considerable overlap onto older rocks is probable. These materials and their thickness are not readily resolved at this stage due to the effects of dolerite in the younger blanket covering. A major unconformity exists at the base of the Permo-Triassic (Parmeener Super Group) cover.

The magnetics-gravity data base is able to resolve dolerite feeder systems and intrusion forms although evaluation of such details is beyond the requirements of Phase 1 work. Such review on a more specific local basis will be essential for improved appraisal of the configuration and distribution of pre-Permian rocks. The Cretaceous syenites dominate a portion of the magnetic field due to release of magnetite from interaction with dolerite sheets in the Cygnet region. A major intrusive body is implied.

The surveys stress the persistent structural controls imposed throughout the geological development of the region. Rejuvenation of basement sutures has influenced more recent events, including limits of Cambrian trough development, dolerite intrusions and present day drainage patterns. A major limiting boundary extends from Risdon to east of South East Cape.

The analysis has provided a structural statement equivalent to a regional seismic study and is able to guide and utilise any seismic coverage acquired resulting in more detailed and effective exploration.

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INTRODUCTION

Conga Oil Pty Ltd with licences to explore some 5000 square kilometres of southern Tasmania for oil has completed a regional aeromagnetic survey and detailed the existing gravity data base in order to appraise the area structurally, define Palaeozoic basins, assess dolerite intrusions, guide seismic surveys and generally assist target selection.

The area covered by the surveys and this analysis, as well as the current licence applications, is shown in Figure 1.

Conga Oil is presently investigating the hydrocarbon potential of wholly concealed Palaeozoic sections south west of Hobart. Oil has been reported from several "seepages" over the past century and one of these has now been re-confirmed (Johnson's Well area, North Bruny). The oil geochemistry implies a carbonate source. This evidence, coupled with an apparent absence of possible Permian source rocks, indicates an Upper Cambrian or Ordovician source rock - most probably Gordon Group since both conodont colour and vitrinite reflectance indicates that this unit is locally within the oil window.

The demonstration of oil seepages and probable source rocks has provided the impetus for exploration. Since these rocks, and many potential reservoir rocks, are only exposed peripherally to the study area - along the south coast or west of the Picton River - the exploration must proceed blind. Only at Glenorchy and Woodbridge is the nature of the pre-Permian sequence known (Cambrian and Precambrian respectively). This evidence, at least demonstrates that the sought materials may persist up to 70 km east of the last known exposures.

The variable thickness of Permian Super Group (Permo-Triassic) has probably ensured ultimate entrapment of any hydrocarbons generated but, in association with the complex stockwork of Jurassic dolerite intrusions, has made evaluation difficult.

The area is not well suited, for these, terrain and environmental reasons, to regional seismic reflection coverage and it would be unwise and potentially very wasteful to attempt such surveys - even on a limited scale - without some indication of structural anisotropy. The waterways do provide an imperfect but more satisfactory means of obtaining some regional seismic coverage at reasonable cost free of the onshore problems.

In such a situation gravity-magnetic method coupling is seen as the most cost-effective introduction to the region and well able to guide subsequent reflection surveys. It has been recognised that comprehensive, iterated interpretation would be required since large scale seismic coverage is unlikely in the medium term at least. These data, and their interpretation, must be able to support an exploration programme in their own right should reflection data prove poor or inadequate, or guide the limited prospect coverages which will probably be feasible and essential.

Consequently, many objectives have been set; all intended to aid regional understanding, infer general location of targets or define issues relevant to well prognoses.

These include gross appraisal of dolerite intrusions, impact of Permo-Triassic cover, definition of Palaeozoic basins and miscellaneous changes in basement (pre-Permian) composition. Many of these factors are directly relevant to extended interpretation and most generate interrelated problems for all methods applicable.

The various objectives have been examined using an array of techniques including two dimensional guide sections, line processing, derivative and continuation analysis. This treatment is more comprehensive than that normally applied in present day industry practice. There are various reasons for this. It is common practice to rely heavily on more expensive seismic methods and, indeed, to apply them before the cheaper advance methods have suggested where seismic should be placed or oriented. This usually results in waste. In the current absence of any seismic data, although recommended, and doubts concerning acquisition results, costs or coverage in any event these methods must carry an exceptional load. Extended treatment is thus both justified and essential.

This report details the preliminary stage of this interpretation process and presents a substantial initial study of the D'Entrecasteaux region of SE Tasmania. Various concepts related to the constitution of pre-Permian structure have been evaluated in gross terms. There remains much potential for the resolution of moderate detail - including fine definition of dolerite structures. The inherent ambiguities can only be assessed and the interpretation significantly upgraded by extended analysis (phases 2-4) before or after the basic well programme or some seismic acquisition. No attempt has been made at this stage to overinterpret the data. Consequently an array of options is discussed; not all have, or can be, resolved yet. The discussion does, however, present the issues and current evidence.

## GEOLOGICAL OBJECTIVES

Although the present exploration by Conga Oil is targetted at definition of Lower Palaeozoic rocks, especially Ordovician-Silurian sequences, virtually no exposure of such rocks occurs within the survey area.

Ordovician and Cambrian rocks are exposed along the south coast from Prion Bay to South Cape, Ordovician limestone is exposed near Lune River and Hastings and small occurrences of Precambrian basement have been mapped at Hastings and along the Weld River. The principal exposures of Cambrian and Precambrian rocks lie west of the Picton River and beyond the study area. Deep boreholes at Glenorchy (Leaman, 1972) and Woodbridge (Farmer and Clarke, 1985) have demonstrated that Cambrian and Precambrian rocks extend well east of the last known exposures. Much further east, at Cape Surville, Devonian granite of east coast affinity is exposed. Somewhere between Glenorchy and Cape Surville there is a major discontinuity in the continental crust of Tasmania known as the Tamar Lineament. The location of this feature is relevant to exploration since the established source and probable reservoir rocks will not occur east of it.

The region is of high relief and the terrain is dominated by Jurassic dolerite. The dolerite has intruded all members of the Parmeener Super Group - basal Permian tillite (Truro Tillite) at Woodbridge and Cygnet to Upper Triassic coal measures at Kaoota and Catamaran. Dolerite sheets range in thickness from 200 m (inferred at Cygnet) to about 400 m on Mt Wellington. Sheets drilled at Glenorchy and Woodbridge were about 300 m thick. Dolerite forms and related structures within the northeastern part of the area have been the subject of previous study (Leaman, 1975).

Relatively few well exposed or continuous sections of the Parmeener Super Group are known. Permian sections, excluding basal tillites or conglomerates, range in thickness from about 250 m on Mt Picton to about 450 m at Cygnet, 500 m at Maydena and 600 m at Hobart. The basal tillite may be absent or have a thickness in excess of 400 m as at Woodbridge and Cygnet. The only unambiguous continuous Triassic sections (Upper Parmeener Super Group) are to be found on the north side of the Wellington Range near Collins Cap and these exceed 450 m in thickness. All other sections are either faulted, limited or prematurely terminated by dolerite.

Cretaceous igneous activity which has introduced dyke swarms and thin sheets of syenite is apparently restricted to the Cygnet - Kettering - Woodbridge region. These may locally constitute up to 200 m of the section - as at Woodbridge (Farmer and Clarke, 1985).

Tertiary activity has been restricted largely to the region east and northeast of Margate. Most Tertiary disruption has been concentrated along the Derwent River-Storm Bay axis or Coal River-Pittwater-Frederick Henry Bay. The latter seems the more significant but extant data are limited. The western limit of this activity is concentrated in the fault system extending west of Hobart toward North West Bay. With few exceptions, Tertiary basalts or sediments are not to be found west of this

limit. Tertiary sedimentation is, however, indicated in local depressions - apparently erosional - at Cloudy Bay, Middleton and the isthmus of Bruny Island.

Post Carboniferous rocks may combine to yield a cover on the prospective materials never less than 600 to 700 m and perhaps as much as 2000 m in the region east of Southport, Geeveston or Judbury and 300 to 1200 m between the Hartz Mountains and the Huon River. The precise thickness is a function of geographic position, elevation, stratigraphic horizon exposed and amount of dolerite and tillite. None of these can be reliably predicted by any unassisted geological method based on surface observations. Geophysical prediction and assistance is essential. All estimates exclude the contribution from Tertiary sediments since these can be evaluated separately by gravity methods and are not a general problem.

The relationships likely in the post Carboniferous section are suggested in Figure 3 while the relationships between the rocks below the unconformity as well as that between pre and post Permian units is suggested in Figure 4. Figure 4 presents a section from northern Tasmania but does indicate the inferred situation in this region. The D'Entrecasteaux region, as suggested by Figure 2 however, offers much less exposure of the critical formations. All these considerations combine to make investigation of the pre-unconformity rocks challenging and difficult - by any method.

The objectives set for interpretation include:-

- a) confirmation of presence and scale of pre-Permian basins,
- b) location of basin margins, major troughs and basement shelves
- c) location of major igneous piles or intrusives which must be avoided in wells, which could have destroyed source units, or which may have locally generated hydrocarbons.
- d) separation of Cambrian sequences from Ordovician-Silurian sequences,
- e) estimation of the position and any disruption of the base Permian unconformity,
- f) evaluation of the control, scale and form of Cretaceous igneous activity since this may have influenced generation,
- g) definition of dolerite intrusions patterns, forms and feeders in order to enhance resolution of pre-Permian units and improve reliability of well prognoses where shallow encounters with dolerite may pose awkward or costly problems,
- h) definition of gross structural patterns and blocking, fold systems and structural rejuvenations,
- i) guidance for design of economic seismic line layout,
- j) provision of some target and prospect definition in the absence, for whatever reasons, of seismic data. This may be a later phase of interpretation.

The level of difficulty or resolution involved in attainment of these objectives can not be easily predicted in advance.

The primary issue in this study of the region may be summarized by a single question. How to locate prospective lithology and structure beneath a structurally complex overburden where the concealed targets are patchily distributed? This problem can be best understood by considering the exposed geology of central W and SW Tasmania comprising major Cambrian troughs, overlapped Cambrian to Silurian rocks on various Precambrian suites, infolded inliers of all units and then burying it under a minimum of 1 km of sub horizontal units carrying a stockwork of igneous intrusions with the latter occupying about one half of the land surface. Having done this, ask, how can the Gordon Group be located? This Group occupies about 10% of the area overall and even the Cambrian sequences account for little more than 30%. This means that in any random drilling programme the chances of striking the principal hydrocarbon target, as a lithology only, would be 10% at most presuming that similar frequency distributions apply in SE Tasmania.

The aim of this basic interpretation was thus to define gross structure, styles, and suggest the likely limits of lithologies and possible petroleum plays and to confirm and greatly extend the preliminary work based on pre 1987 data (see Leaman, 1987).

## GEOPHYSICAL DATA

The interpretation is based on an interlocked gravity and magnetic analysis. The magnetic data was acquired specially for this programme and supersedes several older fragmented surveys with very different specifications which did not, in any event, cover the entire area. Actual observations from these surveys existed only for a small survey in the Southport area.

A substantial gravity data base was in existence prior to Conga's interest in the area and this was maintained by the Department of Mines. Coverage was, however, uneven and no surveys had been added to the data base in this region since 1972. Deficiencies in coverage, in the region between the Huon and Esperance and Picton Rivers especially, have now been greatly reduced by Conga's survey augment to the data base.

Data in existence prior to the commencement of this programme was examined and appraised in early 1987. Although limitations were substantial it was clear that gravity and magnetic data did have the potential to provide a structural skeleton and, in favourable circumstances, to provide moderate prospect definition. See Leaman (1987).

## MAGNETIC DATA:

Aeromagnetic data was acquired by Austirex during March 1987 and final presentations were supplied in June. The survey was flown at 1000 m above sea level with limited drapery flying (150 m clearance) across the few peaks above this level (Hartz Mountains and Mt Wellington). More than 95% of the survey is at the specified height. East-west lines were flown at 2.5 km spacing with north-south tie lines at 10 km separation. A Caesium vapour magnetometer with resolution of 0.01 nT was used at 20 m sample spacing. The survey was corrected for diurnal and other variations, IGRF and is presented in residual (Figure 5) and profile (Figure 6) forms. Flight lines are directly related to the grid system; i.e., lines are at almost exact grid northings based on the main grid divisions such as 5240 000 mN.

No special processing was undertaken since it was intended that all interpretation be referred to the flight height of 1000 m. This provides for inclusion of all topographic and source in terrain effects (especially dolerite). To assist the first phase of interpretation Werner deconvolution was undertaken on all profiles using an iterated seven point operator.

The ultimate precision of the presentation is of the order of 1 nT. All details of specifications are provided in Appendix 1.

## GRAVITY DATA:

The TASGRAV data base has been augmented by 850 stations. Most are located west of the Huon River. The state tie network has been extended and all stations are referred to state datum. The fully corrected data has been compiled, integrated with extant data and the resulting Bouguer anomaly compilation is presented in Figure 7. A Bouguer density of 2.67 t/cu m was employed.

Details of the survey and its precision are provided in Appendix 2. Results have been tabulated in Appendix 3.

Some reliability problems have been established with regard to the marine data available in Storm Bay. This is a potentially serious problem and some thought must be given to resolution of the problems (BMR Canberra data base) or the coverage replaced.

## Special note:

Raw data and reductions from Conga's surveys have not been included in the copy of this report provided to the Tasmanian Department of Mines. As explained in the Annual Report for 1987 (dated August 1987) this reflects problems at a very early stage in exploration which resulted in this work being undertaken prior to granting of licences and not therefore charged to expenditure commitments. At the time of preparation of this report the partners operating Conga Oil had not approved release of this data.

Figures 5, 6 and 7 summarise the observations and compilations made and are sufficient to appraise and understand the interpretation which follows.

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ROCK PROPERTIES

Bulk wet densities are listed in units of t/cu m or gm/cc  
All magnetisation and susceptibility units are cgs system

Where values have been estimated from analysis of profile a # is attached.

Koenigsberger ratio (K) is dimensionless.

Unit: age/group	Density	Suscept.	Magnetis.	K
Quat. sediments	1.50-1.80	0	0	0
Tert. sediments	1.82-2.15	0	0	0
basalts	2.90-3.20	0-0.002	0-10000	20
	unconformity			
Cretaceous syenite	2.67-2.73	0-?	100-2000	?
Jurassic dolerite	2.80-3.15	0-0.005	100-7000	1-5
Triassic coal measures	2.45-2.52	0	0	0
sandstones	2.32-2.45	0	0	0
Permian siltstone	2.50-2.52	0	0	0
mudstone	2.55-2.59	0	0	0
sandstone	2.37-2.45	0	0	0
tillite	2.59-2.66	0	0	0
	unconformity			
Devonian granite	2.59-2.65	0	0	0
granodiorite	2.69-2.72	<0.001	0	0
Silurian sandstone	2.50-	0	0	0
Ordovician limestone	2.70-2.92	0	0	0
sandstone	2.25-2.68	0	0	0
conglomerate	2.60-2.80	0	0	0
	disconformity/unconformity			
Cambrian ultramafics	2.43-3.20	0-0.006	?	1-50
gabbros	2.78-3.11	0-0.001	?	?
Mt Read volcs	2.60-2.77	0.0006-0.015	?	?
Dundas Gp	2.74-2.80	0-0.0002	?	?
Mainwaring Gp	2.74-2.85	0-0.005	?	?
granite	2.60-	0.002-0.003	?	?
	unconformity			
Precambrian dolomite	2.77-2.91	0	0	0
quartzites	2.59-2.70	<0.001	?	?
schists	2.59-2.75	<0.001	?	?
East Tas sequence:				
Cambrian-Devonian				
Mathinna Beds	2.59-2.80	0	0	0

Skarns, contact zone materials etc are not usually significant gravimetrically even though substantial density changes may be involved. Magnetic alteration, however, is usually major and very great changes in properties have been noted.

## INTERPRETATION

## QUALITATIVE COMMENTS

The potential fields (gravity and magnetic) plotted in Figures 5 and 7 are not capable of simple interpretation. This comment reflects the nature of the geology, known and unknown, and in particular the contributions due to Jurassic dolerite. However a number of major elements can be recognised which, although of ambiguous origin pending extended test calculation (phase 2 and 3 analyses), can be used to limit some of the quantitative options. Some of these elements are very revealing about the geological history of the area.

The features selected for discussion have been labelled in Figures 8 and 9. Each has subsequently been reviewed quantitatively (see from page 19). These introductory comments relate any direct relationships between features or known surface geology.

The GRAVITY field (refer Figure 7, 9 labelled) is substantially filtered and smoothed by the general 1 to 2 km station spacing. In order to keep this effect as consistent as possible the Catamaran data (code 8050) set was subsampled (also Appendix 2). Many near surface sources are, therefore, not represented in the Bouguer anomalies - including some dolerite responses, and effects of Triassic and Tertiary accumulations. Only significant bodies of material are identified or reflected in distortions of the field.

Anomalies due to localised structures filled with Tertiary sediments are readily recognised in the Hobart-South Arm region (anomalies A to F), at the isthmus (G) and Cloudy Bay (H).

No features can be directly ascribed either to Permian or Triassic sedimentary rocks or Cretaceous syenites on the basis of inspection (but see discussion of model sections).

The coverage of regions where Lower Palaeozoic or Precambrian rocks are exposed is not detailed enough to permit many reliable observations. The gravity field however is relatively positive South West of Mt La Perouse where Cambrian rocks outcrop (J). Precambrian rocks generate strong negative gradients west of the Picton and New Rivers. These gradients persist to Mt. Weld and extend via Mt. Lloyd toward Mt. Wellington (K, L, M). The entire Huon and Channel region is thus seen to be a relatively positive embayment in the field with a much denser pre Permian geology than that exposed west of the Picton River. Sections of this denser sequence may extend toward Lake Pedder and Maydena (N, O) and these may be contrasted with the lighter Weld section (L). If these correlations are systematically valid then Cambrian (or Late Upper Precambrian) sections are juxtaposed with blocks of older siliceous Precambrian. This pattern has indeed been mapped further to the North West (see Turner et al, 1983).

The strongest gradients, of clearly regional scale and certainly

unrelated to post Permian rocks, extend from Catamaran (P), Hastings (Q), Esperance River (R) to the Huon and Weld Rivers (S, L).

This gradient lies east of all known exposures of Precambrian and Lower Palaeozoic rocks. In some cases, as at Hastings (Q) the effect lies very close to outcrop of Ordovician rocks. At P and Q these rocks, and any other Lower Palaeozoic section, is downfaulted to the east. Significant throws are implied.

The gradient from J, P, R, L and M can be interpreted as due to a primary structural suture junction between very different lithologies on the margin of a significant Palaeozoic basin with a substantial content of Cambrian rocks. These possess densities in excess of 2.75 t/cu m and always contrast with siliceous Tyennan Precambrian (2.65 - 2.70 t/cu m). Late Precambrian rocks may generate a similar effect.

Within the positive "embayment" defined above there are many second order features which clearly reflect substantial variations in basement composition or relief. These imply that any Palaeozoic basin is variable in style, content, width and thickness. It is certainly folded and disrupted with lighter basement locally drawn up ((b) in Figure 9).

Within the Dover region the field is strongly positive and is contrasted with the Glendevie (b) and Leprena (c) regions. In each of these the Tyennan basement extends further east - or the basement, with or without a Cambrian Section includes a thick Ordovician - Devonian cover. The boundaries and gradient terminations to blocks (a) to (c) are consistent with modern drainage (e.g. Huon, Esperance Rivers) but are clearly more fundamental than the modern topography and quite independent of any Post Permian features - all of which are exposed. This point is developed further on page 14.

The region west of Huonville (d1 to d3) is much more complex. Although gross regional (mantle source) gradients confuse the anomaly pattern the gravity field is generally undulating and the effect is not repeated elsewhere in the area surveyed. Basement (pre Permian) relationships are compound but beyond sensible comment by inspection. Similar comments apply to most other features east of the Huon and Mountain Rivers.

These issues may only be resolved by modelling and some well control.

Obvious dolerite-sourced anomalies are not easily recognised in this region or data set. The material is ubiquitous and consequently only abnormal vertical extension is represented in the filtered gravity compilation. Most anomalies due to dolerite are less than 2 to 4 mGal in relief and can only be separated by detailed analysis. Some abnormal features (1 to 8) are suggested but quantitative study or comparison with magnetic data is needed to confirm all effects. Some conclusions are offered in following sections of this report. Note that no obvious dolerite effects are evident in the gravity field west

of the Huon River although review of surface structures implies feeders at Southport, Dover and Lonnavaile.

The MAGNETIC field bears little apparent direct relationship to the GRAVITY field. Although flown at 1000m and observed with terrain clearances in excess of 700m for most of the survey area the character displayed in Figure 5 is not as systematic as the gravity response. The contour presentation suggests a noisy and disturbed magnetic field but the profiles put this in perspective. The field is generally fairly quiet and only restricted belts are disturbed. As discussed on page 17 (filter treatment) there are two anomaly responses - one with wavelength of 10 to 30 km and another less than 5 km. The latter dominates the contour presentation but the former is clearly observable in profiles (also Figure 18).

The exceptional feature in the magnetic field is the Cygnet anomaly (AA). Refer to Figure 8 for labelled magnetic features. There is nothing comparable in the gravity field at this site or elsewhere although the E-W extension of the effect is mirrored by anomalies 3 to 8 (Figure 9). AA is certainly related to Cretaceous syenites and/or their effect on intruded dolerite. Previous work by Leaman and Nagvi (1967), Leaman (1977) has shown that many anomalous spikes occur in this region and are associated with magnetite concentrations at intrusions margins and junctions.

Most high frequency effects can be considered to be related to dolerite intrusions but the associations postulated are of three categories.

- dolerite in high relief terrain
- faulted/dyke sheet edges at lower levels
- feeders or differentiated material.

It will be observed that while parts of the field responses do have the "basic igneous texture", often noted in basalt or dolerite-covered areas of Tasmania, when flown at low levels (e.g. near M) there is no specific correspondence to exposed dolerite and the magnetic field as observed for this survey does not offer a direct means of mapping exposed dolerite or dolerite distribution. Such information is deducible only with extended modelling.

There are many areas, some of which carry two dolerite sheets, where the field is very subdued (e.g. near Geeveston, east of Margate). Equivalent character can be seen around Mount La Perouse (9) where the body of the response can be correlated with Upper Cambrian mafics exposed on the coast (J). What may be termed the "La Perouse response" can be recognised across Storm Bay and the Tasman Sea east of Bruny Island (e.g. 10, 11). Thus the presence of dolerite, by itself, does not generate significant anomaly patterns within this data.

But how much is the response enhanced by reduced terrain clearance with dolerite capping the terrain? Not much, on the basis of La Perouse where dolerite is within but not capping the mountain. This response can be contrasted with the Hartz

Mountains (12) where very high frequency spikes of high amplitude were observed. The drape clearance was 150m. Such anomalies are easily recognised within the survey (see profiles Figure 6) - especially near the northern limit of survey (e.g. M).

Significantly larger anomalies appear to be associated with dolerite at lower altitudes (e.g. 13, 14, 15, 16). This suggests that the actual form of intrusion and the particular properties of the local dolerite are more relevant than sensor clearance or terrain shape although the latter factors do contribute to the response. Several equivalent anomalies have been observed for which terrain or clearance is irrelevant (e.g. 17, 18, 19 - all water covered sources). The correlation between known granophyres and feeder systems (e.g. 14) indicates that most of the large, isolated features are of similar origin and many are not exposed. Recognition of this possibility has led to examination of dolerite properties in the indicated areas and detailed review of source requirements in modelling. In every instance where dolerite is exposed in the anomalous regions pockets of highly differentiated, granophyric and high contrast dolerite were observed. These results will be reported elsewhere.

e.g. Anomalies:

- 13 North Hartz
- 14 Nierrna, Red Hill axis
- 15 Grove
- 16 Mt. Mangana
- 17 not exposed (Southern channel)
- 18 possibly Betsey Island (in Pre-Permian))
- 19 Howrah Point
- 20 Ridgeway
- 21 Dennes Point
- 22 Bruny main road
- 23 Grey Mountain
- 24 Cremorne (mainly concealed)
- 25 not exposed (Storm Bay south)
- 26 Garden Island Creek
- 27 Nine Pin Point
- 28 ? Esperance River
- 29 ? Strathblane

The work of Leaman (1972, 1975) was based almost wholly on gravity data in the northern part of the region and some rock condition information identified or implied the presence of 14, 15, 19, 20\*, 21. It is noteworthy that the gravity data would place 20 further east toward Mt. Nelson but there is no mistaking the differentiation and granophyre development at Ridgeway. This offset may reflect actual intrusion geometry.

Clearly, only major vertical penetrations by dolerite or magnetisation characteristics, generate significant responses in the magnetic field. Terrain effects are evident but not generally important and other geometric contributions (faulted edges, dyke limbs, Tertiary channel incision, etc.) produce lesser effects such as those seen on La Perouse or in Storm Bay. The survey specifications have effectively filtered most such small scale contributions and provided a view of basement and gross dolerite sources.

Basement effects are represented by the long wavelength, semi-regional effects (Figures 6, 18). These appear to be restricted to 3 regions; near M - N in the north-west of the area, a narrow belt between Cygnet and Northern Hobart, and from the Huon River at S(12-13) to Catamaran and east to South Bruny with some offset towards the Channel near 17.

The Hobart-Cygnet and South Bruny portions of these regions is not well established on inspection alone due to the array of large dolerite sources in each of them (see modelling). It is perhaps significant, however, that Cambrian rocks directly underlie the base Permian at Glenorchy.

The region from M - N toward Maydena accords with the poorly defined gravimetric indicators and geological mapping beyond the area covered and also suggests a Cambrian origin for the effect.

The axis extending, with offset east at Lune River, from P to Q (via 17) to R and S (12-13) is wholly consistent with the gravity data and the gravity and magnetic gradients defining the western side of the zone corresponds along the entire length. Although much dolerite occurs along this trend it cannot produce either effect and its distribution is not consistent with either gradient although local superimpositions of effects do occur. It is clear that both fields are responding to a deep narrow trough or rift fill containing materials which are significantly more magnetic and denser than Tyennan basement. In terms of Tasmanian Palaeozoic or Precambrian rocks only Cambrian suites fulfill these requirements. Although such trough fills appear to occupy narrow belts (seen magnetically) the gravity field increases consistently to both E and S. This suggests, depending on Moho/mantle contributions (see Models), a denser but still virtually non magnetic basement or Palaeozoic sequence east of the magnetic troughs.

As noted in the introduction to these comments such issues cannot be resolved by qualitative inspection. The many issues raised by inspection of the data sets have been reviewed in the phase 1 modelling process.

## TREND PATTERNS

Available geological, geomorphic, gravity and magnetic data have been reviewed for suggestions of coherent or regular patterns and the inferences from each data type compared. This has proved an interesting and useful although somewhat subjective exercise.

The geological and geomorphological inferences are summarised in Figure 10. Stream and coastal lineaments are generally unambiguous and the Figure may only lack completeness. In general only features longer than 5 km are shown. Geological features include mapped faults, dykes, intrusion - filled faults, fault groups, feeder alignments (where known) and apparent elongations of igneous units. The latter may reflect both modern topographic control as well as original structure control. Detailed mapping is available only for the region east of the Huon River and inferences west of this are derived from some thesis mapping and regional compilation at 1:250 000 scale. The arc of fault systems downthrowing to the east between Esperance Peak, Lune River and the south coast appears to be a reasonable representation.

NNE and NNW-NW trending features appear predominant but, as noted by Williams 1969 and Leaman 1975, near east-west trend segments are of long standing (pre Jurassic) and ubiquitous when joint systems or regions are known in detail yet this system never appears dominant. At Sandy Bay and near Kingston this system appears to have exercised pivotal control on the orientation of the Tertiary basins. Typical dips within each major fault or intrusion roof block are also shown. While these may be influenced by dilational rotation during the Jurassic intrusive episode values obviously related to fault drags have been excluded. The prevailing dip direction is W or SW but some narrow zones consistently show easterly dips irrespective of dolerite influences.

Inferences based on the magnetic survey are shown in Figure 11. These must be considered of more limited value due to the coarse line spacing. Several of the inferred E-W features may reflect line density although the 1 : 4 ratio of tie lines should have resolved any herring-bone effects or similar problems. Other trends may be relatively subjective and the precision of trend orientation may be limited by line considerations where trend segments are less than 15 km long.

The shaded areas in Figure 11 correspond to regional rises in the magnetic field.

Similar problems afflict deductions from the gravity survey due to some gaps in survey, unreliable coverage in Storm Bay and very limited control west of the Hartz Mountains and Adamsons Peak. Some features, however, are major and as unambiguous as the topographic-geologic deductions (Figure 12). In this respect the gravity patterns, if only from about 70% of the area, are more significant than those of the magnetics. Some of the minor segments (<5 km) must be regarded with caution. It will be noted that several E-W (or nearly so) features are

deducible and there is no possibility of line bias in this data set.

The three sets of trend inferences have been superimposed in Figure 13. This presentation reveals the extraordinary correlation between modern topography and the gravity field. There are, additionally, many instances of correlation between all data sets, including the less obvious (geologically and topographically) E-W features. Some of the more significant features have been labelled.

AA marks a clear hinge line between dip systems in exposed geology and many other features are either aligned along it or terminated by it (including dolerite intrusions). It extends as far north as Grass Tree Hill and the narrow Jurassic grabens at Risdon are related to it. While B-B is a less definite break it does exhibit similar properties.

C-C reflects the gradients noted in qualitative comment. The region east of D-D appears to form a discrete block whereas the geology west of B-B-A-D north is much more fragmental.

In view of the correlation between gravity field, modern drainage and many Jurassic structures it is evident that the gravity field reflects primary basement features which have exercised and probably still do exercise, control over basin and structure development. It is clear that the non Jurassic or Tertiary orientations exhibited by much of the drainage pattern (especially the Huon River) is a direct reflection of rejuvenated basement blocks and interfaces.

## QUANTITATIVE INTERPRETATION

## Methods

A range of issues has been raised as both objectives (introduction) and implications from inspection of the data sets (previous section). These imply an array of source depths and sizes.

It is not possible in a first interpretation of a region lacking in control information to define or resolve all issues. The treatment applied represents a substantial exploration and evaluation of the available data with provision of review of feasible options short of over-interpretation. Acquisition of seismic data, however spotty, and well control will allow separation of some options and considerable sharpening of detail. This is not justified at this stage on a whole area basis.

Consequently evaluation has been limited to techniques which can crystallize options or alternatives, suggest structural style - scale - location - lithology and provide the basic framework for rapid detailed upgrades.

Within the constraints of survey coverage and density regional derivative and filter techniques have been attempted and reviewed. The main body of this interpretation is composed of a 2D guide analysis. Although such an approach is bedevilled by geometric problems it is an essential precursor to any 3D or locally detailed study while at the same time enabling a basic assessment of the entire survey area within reasonable time. Such an assessment permits identification of critical areas, problems and alternatives for 3D study. The aim of this guide study was generation of sufficient material to frame initial 3D models at any scale (whole region or areas up to 100 sq km). Such a framework is essential for a phase 2 interpretation or detailed study of any part of the region.

In these respects this interpretation is conventional and uses basic, standard procedures - albeit more extensively than is usual - to develop a regional understanding. Any extension of this analysis in the directions indicated above and as recommended (below) requires specialised interpretation technology, a greater commitment in terms of geological input and an empathy for the structural implications of the region.

Extended study based on the work reported here will be described separately.

## REGIONAL DERIVATIVE ANALYSIS

A basic first and second derivative treatment was applied to the TASGRAV data base prior to the augment of the present survey (Leaman 1987). The new compilation, due to a sampling density approaching the previous interpolations, is such as to refine detail on crustal scale without recourse to derivatives. The procedure was attempted but there was no gain on a regional scale.

The magnetic data, however, do benefit from some filtering treatment. As noted on page 11 there are two discrete frequencies within the anomalies.

The initial treatment applied a 7 point Wemer operator to all profiles using the method of Ku and Sharp (1983). Several examples of the results are presented in Figures 14 to 16. A condensed summary of the more definitive results is attempted in Figure 17. Relatively few sources deeper than 1 km below sea level were recognised. Most sources lie between the land surface and about 500 m below sea level (esp Figure 15) and represent exposed dolerites or sheet roofs and junctions. These sources are ubiquitous east of the Picton River and suggest that dolerite intrusions are contiguous across the bulk of the region. Some dip inferences are confusing but this can be interpreted in terms of intersecting bodies in those areas where these are known. Very few magnetic units can be inferred below this depth and these are generally restricted to the shaded areas of Figure 11 and near Cygnet. In no case are these deep sources clearly defined; broad deep and slightly magnetised masses can be implied. This shows that simple line filter procedures based on any set of simple body assumptions cannot reveal much useful data about the section beneath the Permian cover. Other methods must be used with their commensurate increase in effort.

Examples of deeper, major sources do occur but their definition is very limited (Figures 14, 16). In Figure 14 the deep effects at 67 km relate to a deep feeder/sheet system off Betsey Island. Note that most dips are shallow and the effective contrast is high. The source characteristics are consistent with differentiated layering products and these are only generated near feeder sheet junctions. This occurs at a depth of about 3 km and there are also shallower related effects at about 1.5 km. The deep effects are localised. All depths below aircraft. In Figure 16 the deep sources are both localised and dispersed (see 9 km window) and these effects are generally within those regions with elevated long wavelength increases in intensity of the field. This source pattern is compatible with Cambrian trough sections (below). The W edge of the trough in this region is at 35 km but there is little resolution of detail.

The Werner treatment is thus of little value to the analysis of pre-Permian sources other than to demonstrate that much of the pre-Permian succession is non magnetic - certainly east of the D'Entrecasteaux Channel and west of the Picton River. The Werner treatment does, however, provide direct guidance for any detailed review where assessment or specification of dolerite forms is required. Such review is largely beyond the scope of the present treatment but is required for any second order (phase 2 or 3) interpretation. Much data relating to the dolerite is therefore available and underutilised at this stage. Many key junctions, disruption points or changes in sheet dip are evident. This information, of itself, is not enough to define entire dolerite shapes. It does provide parametric restrictions on interpretation in the same way as surface mapping or surface distribution.

A secondary treatment is represented by Figure 18. Each profile was filtered separately and some base level problems have been introduced which reflect the effect of terrain, source-sensor range and the filter function due to imperfect extraction of overlapping wavelengths. It does, however, define those broad areas in which the pre-Permian rocks are grossly magnetic. The boundaries to these regions are poorly defined but the principal belts lie east of Catamaran, south and west of the Huon River, north and west of Huonville and perhaps from Glenorchy to Neika. Cambrian rocks can be considered to account for those responses on the basis of experience elsewhere in Tasmania, the correlation of anomalies and exposed geology SW of Mt. La Perouse and the location of pronounced gravity gradients.

Both Werner and filter procedures indicate that the bulk of the pre-Permian succession is non magnetic.

Preliminary work (Leaman 1987) using less definitive gravity data and fragmental poor quality magnetic data implied that magnetic Cambrian rocks may have been general. That this is not the case has profound implications for an uncontrolled gravity-magnetic interpretation of blind structures where these contain non magnetic units and indistinctive density contrasts. Thus wedges or units of Ordovician-Silurian rocks cannot be generally identified by deviations in gravity-magnetic assessments of the interval between the deepest dolerite (presumed to intrude basal Permian rocks) and the top of magnetic basement. This problem was carried into the modelling study and evaluated.

## TWO DIMENSIONAL GUIDE TREATMENT

## Introduction

The 2D profile modelling analysis has been termed a guide treatment for two reasons. Firstly, it uses only a small proportion of the available data as sampled by 17 sections (more than 40 were possible using actual magnetic traverses alone) and secondly, not all details on any given profile have been worked out. The sections selected have four orientations and are shown in Figure 19. Each was selected to provide a reasonable sampling of the major features of both gravity and magnetic fields and nearly half can be anchored on established pre-Permian geology. This is important for control purposes. The frequency of profile intersections was designed to be greatest in the Cygnet-Bruny Island region which contains most of the reported, and yet to be confirmed, seepages. It was accepted that this area was of most interest but the spread of sections is such that few parts of the D'Entrecasteaux Region have escaped treatment in gross aspect.

There is clearly potential for fine detailing this treatment using infill sections but I believe a better path is to use the present solutions to generate a first order 3D model, test it on a specific area basis and then refine that 3D model within the specific area(s) of interest. This interpretive path requires more input geologically and is more demanding computationally and interpretively but it is, using my refinements of modelling theory, free of geometric deficiencies (such as afflict 2D or 2.5D guides) and highly resolving. For such purposes and, in the present case, to avoid over-interpretation of the present uncontrolled data base the 17 sections provide most of the solutions required at this stage of exploration.

All 2D and 3D interpretation has been evaluated using some simple but demanding criteria. Any failure of a model solution to meet these conditions shows that it is a feasible but not valid solution in the present context. This is important. It is possible to generate a multiplicity of solutions for any potential field (gravity/magnetic) profile and it is critical that unreal solutions be rejected. These need not appear to be geologically invalid.

1. The differential between the calculated and observed field must be consistent across the entire region irrespective of the orientation or placement of the model section within it. This is a most demanding test since it ensures consistency of overall model and solution patterns irrespective of the different weightings that various sources contribute in their interaction with sections at differing orientations.

The differential may be permitted to allow regional trends but in the case of this interpretation these were not allowed.

A residual magnetic field (Figure 5) was used but the Bouguer anomalies examined were in observed form. No residual separation was attempted. This course was taken to avoid risk of filter errors, insertion of undefined errors or loss of precision due to the overlap of source depth-scale functions but has meant modelling into the solution a consistent mantle interface pattern (i.e., whole crust modelling).

The importance of the differential test to model uniformity, reduction of ambiguity and inference of realistic density or magnetisation contrasts is demonstrated in several of the following examples.

- 2. The solution must be geologically feasible and regionally believable.
- 3. There must be no discontinuities in the concept which do not accord with #2 or which simply generate a local force fit. The use of differing section orientations and #1 virtually removes such results.

It will be apparent that large numbers of interacting sources generate complex resultant effects which, in practice, dominate the differentials. My 3D modelling techniques use the property of anomaly tail accumulation to optimise solution resolution. 2D methods cannot adequately cope with such effects generally and those deficiencies are described as they arise (below).

INTERPRETATION OUTLINE

The object of each discussion, on a line basis, is to derive the framework of an interpretation. In doing this I have provided a mix of finished and intermediate or alternate solutions in the Figures. When coupled with the discussion these illustrate the issues and problems inherent in these data sets. At least one gravity and magnetic profile is shown for each section. In most cases one of these offers an advanced or complete solution (i.e., one on which the summation was based) while the other stresses some critical or turning point in the modelling process for this phase. The sections, irrespective of their use in discussion, provide coarsely sampled observed profiles for the reference of the reader. The Figures area thus intended to serve several functions.

For gravity models an observed-calculated shift differential of approximately 18m Gal was required and 100nT for magnetic models. The latter figure is curious since it should have approached zero. It appears, however, that the survey was begun in a period when the diurnals were extreme and the extreme value has been retained as the base reference for the compilation by the contractor. These shifts were universally required to interlock sections, the results of the two methods, and satisfy any line end geological control by pre-Permian rocks.

## LINE 1

A polished magnetics solution for this profile is shown in Figure 20. The gravity model (Figure 21) is an intermediate stage selected to illustrate some of the modelling issues.

Each gravity model includes a mantle shape. This extends up to 100 km beyond the limits of the specific section, in many cases both ways, and accounts for only part of the form of each profile (perhaps 20 to 25%). The mantle component induces a compound gradient which is not simply removed. Each model includes a fragment of a consistent mantle-crust interface model. For calculation purposes and to fit approximate seismic control on a statewide basis a maximum crustal thickness of 27 km has been used. There is a possible +/- 1 km band on this estimate but this does not induce any significant error since the effective relief remains constant. No such issues arise with the magnetic profile.

The magnetic profile is compound and generated by three source types; deep magnetic section, dolerite sheets and dolerite feeders. An excellent example of the effect of deep section is provided in Figure 29 (per line 4). Similar effects are fundamental to the overall form of the profile on this line. The profile is essentially sinusoidal but the anomaly group between 30 and 50 km reflects an array of sources. Dolerite feeders near Dover account for the abrupt spikes but an extension of the alkaline intrusions exposed near Cygnet is also implied. The split form of implied Cambrian rocks is required by the character of the anomalies and a simple trough structure is not feasible on the present calculation assumptions.

A similar but smaller extension of equivalent material extends under South Bruny Island (55 to 80 km). This is poorly resolved at this stage.

The gravity model supports most of the implications of the magnetic model but its preliminary character is indicated by absence of some dolerite features and the inadequate shift factor (14mGal). This was a satisfactory initial model but correlation regionally, and with other profiles, shows that the shift is too low. Since the basement is exposed to the west (0 to 25 km) and the eastern end of the profile is approximately matched as well this means that the block of questionable Cambrian/Precambrian is denser or thicker or both (probably denser). The Cambrian trough is also deeper or denser. Most importantly the Precambrian to the west of New River is denser rather than lighter than 2.67 t/cu m. This accords with regional mapping and a value of 2.70 - 2.72 t/cu m for the exposed part is much more satisfactory. Values of 2.82, 2.77 are implied for the trough and shelf materials respectively. This variation could not be inferred without use of consistent shift factors.

## LINE 2

Preliminary solutions are shown in Figures 22 and 23. These imperfect compilations illustrate the magnitude of three dimensional effects and dubious gravity data in Storm Bay. The general features have been accounted for in each case, in a consistent way. Magnetically, the critical element is the steep gradient at 25 km and the broad form of the profile to the east. This can only be generated by a major deep source of low contrast (ca. 0.001, 0.002 cgs) with some superimposed dolerite effects. Extended calculation implies, however, a core of more magnetic material of limited volume - perhaps ultramafics - given the structural context in the Lake Pedder region to the NW.

Differences are shown in terms of dolerite solutions in the Figures. The gravity model was intended to test gross contribution and the magnetic model is more accurate. Inclusion of the additional intrusions would amend the gravity deviation at 45 km but it does require, in both cases, additional deep, dense section between 40 and 50 km. Dolerites contribute little to the gravity profile at the scale displayed.

This "twin trough" effect is consistent with the requirements of Line 1.

While the general characteristics of the magnetic field have been modelled and represented, perfect fitting is impossible. The dolerite intrusions are complex and multiple sources not well explained by 2D sections. Many features or modifications of features, result from geometric influences (or other bodies) off section.

This section suggests a basic truncated shelf arrangement east of the Huon River in which Permian rocks overlie Precambrian rocks or basement. The present work does not exclude the presence of some Palaeozoic cover.

## LINE 3

Two final state models are included for this line (Figures 24, 25). The magnetic model incorporates the principal cross section of the Cygnet anomaly.

An assessment of the anomaly was completed prior to modelling. Observed surface data at, or near, 5220 000mN (the nominal northing of line 3) were plotted in profile form (see profile 1, Figure 28). The data were derived from Leaman and Naqvi (1967) and Leaman (1977). The rather spiky raw profile was continued to 1000m for comparison with the observed aeromagnetic data. The essential features of the observed anomaly have been reproduced including asymmetry and approximate amplitude. The continuation process was two dimensional and thus overstates the effect slightly but it may be concluded that the irregular surface data, and several sources, integrate to yield the 1000m observed profile. Maps of the original surface data sources have been reproduced as Figures 26, 27. These show E-W extension and patchy source configurations wholly consistent with the "Cygnet" anomaly which dominates Conga's survey. It is evident that the anomaly is made up from an array of surface sources and some deep sources. The Werner plots confirm this conclusion and indicate sources at up to 3 km depth. The continuations do suggest that resolution is far from simple.

The character of the profile depends on some deep magnetic materials (as on line 4, Figure 29) although dominated by the Cygnet feature. The model suggests the distribution of deep (Cambrian?) units, a massive intrusive related to the syenites and skin effects on the overlying dolerite where free magnetite may be observed - as at Regatta Point. These magnetite skins account for most of the anomalies at Cygnet. Several thick dolerites and feeders are implied east of Cygnet.

The modelling is very sensitive to the effects of the magnetic skins and their thickness. It was found that thin layers of high contrast are implied over a substantial area. Thickness can rarely exceed 10 m. The dolerite sheet fragment, above the intrusive syenite pile - and exposed at Regatta Point - is crucial to generation of these responses. No attempt was made to close fit the anomalies between 40 and 75 km due to contrast and 3D effects.

The gravity solution incorporates the magnetic implications and, at the shift level required, shows that the magnetic sequence is unlikely to be basal within a succession which is denser than siliceous Tyennan basement. The gradient hinge at 30 km marks the axis of the denser underlying magnetic materials. Mafic rocks (2.85 t/cu m;  $k = 0.001+$ ) underlie the Permian tillites (and possibly older Palaeozoic units if the wedge of density 2.67 is valid east of Cygnet) only in the west of the profile. Given that Woodbridge lies on this line and that Precambrian non-Tyennan basement has been drilled there it may be concluded that such material overlies ultimate Tyennan basement. The density is certainly consistent. The model east of 87 km is not necessarily viable. Both methods imply some material with neutral properties under Cygnet unless the tillite is locally up

## LINE 4

Line 4 is presented in Figures 29, 30, 31. Figure 29 illustrates the contribution of a simple magnetic trough section - probably Cambrian. This basic structure accounts for the primary features of the profile and places the dolerite contributions in context (Figure 30). These are not easily resolved due to complex forms and relationships but their essence is shown in the Figure. It is also clear from comparison of Figures 29 and 30 that dolerite anomalies are generally of the order of 50 nT unless a feeder system or extreme differentiate is involved and anomalies then range from 100 to 500 nT.

The gravity model shown in Figure 31 was based on the magnetic solution and was required to satisfy the shift criterion. This demonstrates that Tyennan basement extends irregularly east but under the magnetic wedge and beneath a thick non magnetic slab. Neither body is infinite.

The solutions are consistent with those of Line 3 and imply an irregular basement surface overlain by a dense dolomitic-lutitic series subsequently extended to generate a deep trough. It is unlikely that the thickness of Late Precambrian dolomitic rocks exceeds 5 km.

It may be noted here that it would be possible to suggest that dense non magnetic material is Cambrian. This cannot be determined but the Woodbridge diamond hole and the Hastings exposures suggest otherwise. A preliminary study of vent pyroclastics now underway has recorded phyllitic fragments from several sites east and south of Hobart. This generality would indicate a non Cambrian distribution overall.

Alternatively it may be argued that a layered distribution of Tyennan basement overthrust on Cambrian rocks which are normally related to that basement could account for the pattern east of 50 km. While possible on single profiles this solution does not offer a simple coherent view overall for intersecting lines. Occam's razor advises that this option be reserved for more evidence but it is feasible if not wholly supported by pyroclast data. Thrusting may be localised in any event. Phase 2 or 3 modelling with 3D methods would be essential to resolution of this issue.

## LINE 5

The magnetic profile (Figure 32) carries a significant non dolerite component to the magnetic field. This is reflected in the longwavelength feature superimposed near 25 km and the solution reflects the style of the probable source. In this section a contrast of 0.001 cgs has been used but the gravity data imply less depth extent and consequently a higher contrast. Other sections have required values of 0.0015 to 0.002 cgs.

No other solution style has been found which will fit the smoothed form of this profile (dolerite excluded).

The gravity solution (Figure 33) is only partly consistent. There is a marked change in gradient along the Section, at 30 km, and this mirrors the E edge of the magnetic feature. The remainder of the profile must illustrate the minimum thickness of the non magnetic sequence on ultimate basement since the shift factor for the Figure is only 15 mGal. The sequence could be as much as 1 km thicker.

Although the shift factor is imperfect in the diagram provided it seems likely that the basement exposed at the W end of the profile is more dense than Tyennan bulk materials and may be of the order of 2.70 t/cu m. This would be consistent with indicated lithologic variants.

This profile illustrates clearly the general gradient characteristics recognised in many sections. There is an abrupt gradient across the western edge of the dense trough fill and this largely mirrors the density contrast between siliceous basement (always present although locally buried at depths not much more than 3 km) and the fill. Depending upon the width or depth of trough and the amount of other high density materials (e.g. Late Precambrian dolomites etc) a relatively uniform gradient persists to the east. Section 5 marks a contrast from sections 1 to 4 (although 1 exhibits similar character which may be dolerite-related) in that the gradient becomes zero or negative from west to east on the east side of the trough. This implies that the effect of cover on ultimate basement is less significant and the negative contrast overcomes the regional gradient. This can be generated in two ways - thickening of post Cambrian Palaeozoic rocks under the Permian unconformity, or thinning of the entire section on siliceous Precambrian. The model illustrates the latter option although both views are involved in the summary contrast figures (Figures 61, 62).

## LINE 6

The magnetic profile presents the effect of a single Cambrian trough fill (Figure 34). This presentation has been used to illustrate the features of the profile and to show that the implications of lines 1 to 5 account for only part of this profile. The profile is compound and clearly implies more extensive pre-Permian magnetic units. These would appear to persist beyond the end of the profile. Water and sediment-covered dolerites cannot account for all the features observed (Compare effect on other lines). This view is at least partly supported by the gravity data. The dense, magnetic block is evident but the requirement of density extension implies either a non magnetic correlate or a dolomitic succession. The latter is suggested by the density-thickness product displayed in Figure 35. This could, however, be the minimum thickness required and a much thicker Cambrian sequence at average density 2.75 t/cu m is possible. Such a section, however, could be only partly magnetic. An alternative solution could include folded synclinal wedges of magnetic material at 60, 80 or 95 km.

The model, with the minimum gravity shift required, also shows that the basement rocks exposed to the NW are denser than a simple Tyennan succession. The value of 2.69 for a 3 km slab is clearly inadequate and a covering slab would need to be some 6 km thick at this density. This is feasible but unlikely here suggesting a density of 2.70 - 2.72 is more probable (also line 5).

## LINE 7

Magnetic and gravity profiles are presented as Figures 36 and 37. These are virtually complete, consistent and near the limits justified for this phase of interpretation. Figure 36 presents an optional solution for the magnetic profile using a shift of only 50nT and a bulk deep section contrast of 0.001 cgs. These values may be contrasted with area wide preferred values of approximately 100nT and 0.0015 or 0.002 cgs. The use of such values and shifts does not negate the implications of the model which include a deep trough fill with low magnetic contrast and a general absence of comparable materials east or west of the trough. Such values lead, however, to an overestimate of the trough section. The magnetic forms west of 10km and east of 60 km are virtually non anomalous and certainly not suggestive of sub-dolerite sources. There can be no magnetic material in the eastern end of the section and the dolerite sheets are clearly regular (where present). The profile samples the Cygnet alkaline complex and this induces much of the main central anomaly and results in some concealment of the trough boundary and form.

The gravity profile is consistent but does, in common with several other profiles, indicate a slightly shallower trough section (perhaps by 20%) than the magnetics. This is consistent with the distance - dip - volume - contrast integrations and resolving power of the methods but may also imply a higher bulk contrast for the trough fill. The alkaline complex is not gravimetrically significant. Both models suggest some form of non rift eastern boundary to the trough. This is not necessarily the case. The gravity model is based, in this presentation, on the magnetic solution which is made ambiguous by the scale and position of the Cygnet anomaly. It is possible to fit the gravity profile with a subvertical junction with clearly different implication. The high frequency anomaly effects on the profile near 60 km reflect the locally thick Triassic section which, when coupled with minor variations in trough or shelf depth extent, wholly accounts for the observed profile. The need for denser capping Precambrian at the western end of the profile (see also lines 5, 6) is demonstrated and the gradients enable a realistic estimate of the density.

## LINE 8

Profile solutions are shown in Figures 38, 39. Neither are exhaustive but both lie within the envelope desired for the data shifts.

The effective magnetics profile is relatively short due to data coverage limitations but its character is generated by dolerite effects. There is little evidence for any deep sources. It will be observed that the precise form of the anomalies has not been matched but the pattern and inflexions have. These sources are irregular and three dimensional and further detail is unjustified and unreliable at this stage.

The gravity profile provides much contrast. The solution presented here suggests a complex trough-basin form, possibly folded, with materials of density 2.85 t/cu m. Clearly the thickness would be increased by a reduction to 2.80 t/cu m. See Line 9. The change in overall slope of the profile at approximately 50 km is probably more significant. This feature suggests a change in contrast, structure or structural style at about 45-50 km - near Margate - and this would correspond to the primary NNE lineament in the region.

Thus the combined solutions suggest a dense, relatively non magnetic sequence NW of Margate but a slightly less dense, also non magnetic, sequence SE of Margate. Correlations with other sections (e.g. 14) suggest Cambrian material west of Hobart. The volume implied is not great until west of Grove. The Cambrian rocks encountered in the diamond hole at Glenorchy have been tested and found to possess very low susceptibilities. It is possible that these rocks, with a density of 2.80 t/cu m and negligible magnetic contrast, could account for part of the model section. The pyroclastic study will help verify this.

The slight negative misfits in the gravity solution can be ascribed to Triassic rocks which are of relatively small total volume and omitted from the model shown. The largest discrepancy is in the region of the Wellington Range where up to 450 m of Triassic rocks (2.45 t/cu m) could generate up to -3 mGal. A similar but smaller effect could be induced near North West Bay (50 km). The large negative excursion near the end of the section is readily explained by Tertiary sediments in a narrow basin or channel fill.

## LINE 9

Profiles are presented in Figures 40, 41. The magnetic profile presented addresses only the issue of the extent of deep trough material. The body of the profile is generated from this source. Compare with line 7 with respect of implied contrast, overall depth and shift character. The effects of dolerite generate the spiky character of the field.

The profile samples the relatively negative zone in the Bouguer anomalies ("b" in Figure 9). The model shows that a simple elevation in basement can generate all the observed characteristics. The alternative option of a thick wedge of over-lying non magnetic material is not as satisfactory or easily matched. It cannot yet be excluded as a possibility. Both methods could be satisfied by this treatment but the gradients observed in each suggest, on a 2D basis, that the presented option should be preferred at this stage. Note, however, the implications of Line 10.

The gravity profile is reversed but is essentially consistent. The solution suggests a uniform density for the sub Permian rocks. This is wholly consistent with other lines and shows that the magnetic portion of the section is only a minor component overall which may be slightly denser (note 60 - 90 km, Figure 35). A more mafic segment to the sequence is probable. The overall character of both data sets shows that the basement and overlaid rocks are folded and irregular or possibly overlapped. The trough sequence thickens southward and extends onto the continental shelf south of Tasmania.

Denser younger Precambrian extends from the west, as was found on lines 5, 6 and 7 and as might be implied from surface mapping. Its thickness is of the order of 4 to 5 km.

## LINE 10

Comprehensive solutions are presented in Figures 42, 43. These illustrate many of the features described in previous lines but the analysis is more fully developed. There is an extensive magnetic basement section with a contrast of at least 0.0015 cgs. Most of the dolerite features have been crudely accounted for. The gravity profile presents the commonly observed central depression. This may represent an alteration of density contrasts within the Palaeozoic or Precambrian rocks or an increased thickness of Mid to Late Palaeozoic rocks in the central part of the section. This possibility is raised by the magnetic solution which implies that the gravity anomaly is not produced by raised basement. Other sections, however, support the gravity contention although this is not yet an absolute conclusion. The issue of the contribution of the Cygnet anomaly to the magnetic profile is more significant. It is more likely that the profile between 30 and 50 km is abnormal due to this feature and that some excess material has been added. This may prove to be a decisive issue and cannot be determined without 3D analysis and assessment of all contributions. Should the magnetics conclusion prove valid then up to 3 km of Ordovician and Silurian rocks may be present.

## LINE 11

Sections are presented in Figures 44, 45. The magnetic profile includes a broad sinusoidal form with superimposed spikes whereas the gravity profile is simpler. This section offers a good illustration of the control provided by the shift factors since the gravity data could easily be satisfied by a local source at 35 km and the mantle effect. The total shift used in the Figure is 17 mGal - a possible understatement of 1 or 2 mGal - provides a minimum estimate of the denser sections to north and south of the obvious "anomaly".

Dolerites and syenites are not especially significant gravimetrically on the scale of this section.

The gravity section could be read to include Precambrian dense basement to 25 km, Cambrian to 50 km or thereabouts and further Precambrian basement to 100 km - all on siliceous, crystalline basement - were it not for the magnetic data.

Magnetic data demonstrate that a magnetic sequence occurs from 25 km to well beyond 100 km - a result which can be contrasted with line 12 which is much subtler and more ambiguous. The sequence is however either draped over a basement block, folded or overlain by a sequence of post Cambrian rocks. This solution is not shown but is viable between 50 and 80 km and such a sequence could exceed 2 km in thickness if present. Only seismic data could resolve this (along the Channel).

Both gravity and magnetic profiles indicate a denser more magnetic and probably mafic unit near 90 to 100 km. A substantial pod of syenite is also suggested since dolerite alone cannot account for the responses at 40 km.

Figures 44 and 45 show that the features discussed on line 10 are reproduced further east and there is less ambiguity in the magnetics (Figure 44) as a result of the Cygnet anomaly. While the syenites do generate the largest anomaly their effect is clearly superimposed on a thick, older sequence rather than in an area where such units may be thin.

This section makes it clear that magnetic, older rocks probably extend the length of section.

## LINE 12

The magnetic profile (Figure 46) is spiky with little evidence of regional or deep effects - at least on line. There is a broad suggestion of a regional dip in intensity at about 50 km (near Gordon) but it is unclear whether this is due to subtle integrations on line or to sources off line (the Cambrian rift trough system west of Cygnet and the major lineament through Randalls Bay).

Although the modelling is not exhaustive the magnetic solution offered in Figure 46 suggests that dolerite features reasonably inferred from the geology and indicated properties can largely account for the observations at the established shift level of 100 nT. The deviation at the S end of the profile suggests either an additional dolerite or some magnetic basement.

The gravity profile (Figure 47) provides a genuine contrast. While the general dip in intensity is evident near 50 km there are very strong gradients - well in excess of any gross regional or mantle components - at 20 km (Margate - on lineament) and 90 km. I consider the latter to be potentially suspect due to data reproducibility and coverage problems offshore but its presence is consistent with the magnetic field and the inference of magnetic basement sections south of Bruny Island. The Margate gradient is of more interest. It implies denser material than the density reference (at least 2.79 t/cu m) but which is not obviously magnetic. These observations illustrate an awkward conclusion which must remain an interpretive option until more well control is available. That is, the presumed Cambrian drilled at Glenorchy (on line) which has these properties (2.78 - 2.87 t/cu m;  $k = 0.00003$  cgs) may be more widespread than inferred in other sections.

There is, however, little doubt that a significant change occurs near Snug (25 to 30 km) and that the SE section is thinner or lighter or both.

This is a critical section since it samples the two known basement intersections (Glenorchy, Woodbridge). The Glenorchy situation was discussed above. Presumed Precambrian basement occurs at Woodbridge (near 45 km). The denser non magnetic slab in this region clearly represents such basement. The relative thickness-density products along this section are controlled by the 18 mGal shift which establishes the presence of this slab (density 2.75 - 2.80 t/cu m at Woodbridge, 2.79 in interpretation). Given the benefit of this control it has been concluded that a denser basement section overlies the lighter siliceous basement SE of Snug but that basal Cambrian material overlies it to the NW.

The possibility that parts of the younger Precambrian section is overlain by lighter Palaeozoic units has not been excluded and the rugged form of the profile could indicate this. Some independent data and fuller treatment of the post Permian rocks is required to assess such options.

## LINE 13

Gravity and magnetic profiles are shown in Figures 48 and 49. The magnetic profile defines only some aspects of the dolerite. Most characteristics have been reproduced but the general shift difference of about 20nT suggests the presence nearby of magnetic material deep in the section. This line is east of 12 through Woodbridge where no Cambrian section exists. That section also contained a better general fit at the shift used. This suggests that lateral effects from deep sources established by this interpretation west of Woodbridge do not create the difference on this line. Thus either the deep section (presumed Cambrian) thickens to the east or SE or the difference is due to additional dolerite (s). This cannot be resolved on this Section.

The gravity profile suggests that there may be no deep magnetic section other than in the far south. An irregular (folded) Late Precambrian succession may be anticipated at the unconformity. This is supported by the pyroclastic fragments east of Hobart

In this view the irregularities of shape in the gravity profile reflect relief of the siliceous basement. As noted in discussion of line 12 it is possible that some of these variations could be produced by lighter rocks much closer to the unconformity. Second and third phase modelling and perhaps some independent control is needed to evaluate those options.

There may also be problems along this profile in terms of gravity data quality (beyond 75 km). These may have led to excessive estimate of the section.

## LINE 14

The magnetic profile (Figure 50) shows only the gross effect of a deep magnetic section but demonstrates that such materials are absent at the line ends. The gravity profile (Figure 51), however, has the general form of most E - W lines in that there is a marked break in gradient at about 40 km. This shows that a dense section persists northeastward. Only in the region of the Wellington Plateau is this pattern disturbed and the response can be related to Triassic section. The curve match discrepancy reflects the local 3D shape of the volume and the topography.

This section is interesting in that it terminates near Glenorchy where the pre-Permian rocks are considered to be effectively non magnetic Lower Cambrian.

The response NE of Ranelagh suggests a limited volume (or none) of Cambrian volcanics and if the material at Glenorchy is indeed Cambrian then two further possibilities may be raised. Non magnetic, ex volcanic, Cambrian rocks may be more widespread than the body of this interpretation has presumed or the materials at Glenorchy are locally altered. West Tasmanian experience has demonstrated that such alteration could occur in significant volumes and the recording of trace mineralisation could be significant. The Glenorchy hole could also be near the major structures limiting deposition (see also Figure 59). This may also have affected structural history and rock properties.

LINE 15

Gravity and magnetic profiles are presented in Figures 52 and 53.

The magnetic profile presented is nearly final for this level of interpretation and illustrates some of the detail induced by dolerite forms. The effect of the Cygnet alkaline complex is not dominant but still significant.

The gravity profile opens a potential conflict. Between 20 and 85 km both methods are in agreement and imply that the trough materials extend further NE than suggested by lines 5 and 8 although the latter are ambiguous. The region between 10 and 35 km reflects shallow Tyennan style basement with a cover of Ordovician siliceous rocks and limestone. This character, continued, may be the source of the central section modulations noted on lines 10, 11, 12 and 13. It is as yet uncertain if this means that the cover is extensive at these sites. See the alternate presentation as included in Figure 55 for line 16.

No mantle was modelled on this line since the section lies parallel to the strike of Moho slope.

## LINE 16

A comprehensive solution for the gravity profile is provided in Figure 55. The magnetic solution (Figure 54) shows only the principal responses and illustrates the limits of the Cambrian igneous pile. It shows that these materials are restricted to the south coast region SW of Dover.

The gravity solution, while in general agreement, shows that these materials must be inset in a much larger basin and that all materials are overlain by wedges of post-Cambrian siliceous rocks and, in this instance, limestone as well. The form of the profile after allowance for first order dolerite effects shows that the section is folded in a relatively open manner.

The gravity model illustrates the ambiguity issues raised by the options of basement insertion or thick Ordovician-Silurian cover. SW of Hastings the gradients show that the sources, of whatever origin, are shallow but do not correlate directly or simply with post Permian materials (especially the Triassic rocks). A second wedge of Middle Palaeozoic rocks has been inferred between Dover and Woodbridge. This region overlies the principal axis of Cambrian trough deposition and the material has been modelled to show that deep variations of basement interfaces do not necessarily provide the correct solution. As noted for other sections more detailed methods and perhaps some control is required to evaluate these options which are clearly of economic significance to Conga Oil's exploration programme. The principal source and reservoir rocks may occur in such onlapped or folded wedges.

## LINE 17

A basic magnetic solution is shown in Figure 56. It shows how constrained any magnetic sequence must be. The gravity profile (Figure 57) is supportive and suggests relatively thin cover (4 to 5 km) on crystalline basement. The units appear to have been folded. Siliceous Cambrian or Ordovician-Silurian rocks have a significant volume SW of 40 km. The volume indicated is the minimum likely since the contrast is extreme. A more realistic value such as 2.58 to 2.62 would imply a post Cambrian cover up to 4 km thick.

Taken together the two models suggest discontinuous dolerite intrusions in the Bruny region, no massive, deep, magnetic units and a rather shelf-like relationship between the unconformity rocks and the basement (not Tyennan). The increase in gravity field values NE of Lunawanna could be due solely to changes in dolerite forms and the issue of whether the Ordovician rocks extend north eastward can only be resolved by detailed analysis of dolerite forms.

## SUMMARY

An attempt has been made in Figures 58 to 63 to summarise this phase of interpretation. These integrations are relatively crude, are based in all cases on Occam's principle - the simplest coherent result. Some minor conflicts exist in models, such as for lines 1 and 17 on South Bruny Island. Different densities are shown for the pre-Permian section which result for varying thicknesses (Figures 21, 57). An appropriate value is 2.79 and would presume a dolomitic sequence. Such differences may also reflect the iteration status of the model provided.

Options requiring structural complexity, all dolerite details, or major alternatives such as thrust basement have often been excluded. Some matters, such as the first two listed, could be deemed an overinterpretation at this level or stage of work but thrust solutions are allowed by the data. Consider Figure 48. It is possible to explain the absence of magnetic response and the gravity field by overthrusting Precambrian basement - not especially dense - on Cambrian section. Various solutions could be varied in this way but no coherent thrust pattern was recognised or established. This may suggest either that they do not occur, are more complex than proposed (possible), 2D analysis cannot adequately define them, or there is insufficient control (geological, seismic or well) to establish the concept and justify its working out.

The depth maps of Figures 58 and 59 reveal, within the presumptions stated, that the crystalline basement is generally deeply buried in SE Tasmania. The main body of covering material is composed of younger Precambrian dolomitic sequences. A narrower Cambrian Trough has been developed within the broad basins developed in the Late Precambrian. The full extent of Cambrian deposition cannot be appraised and only the volcanic-related or igneous parts of the section are defined. Such materials, at least, do not extend onto Bruny Island.

Figure 60 summaries the relationships inferred at this level of interpretation after conversion of the model features into full geological sections (see lines 2, 10, 13). Pre Ordovician and post Devonian features are clearly indicated and established by this phase of interpretation. The wedge of Ordovician-Devonian rocks have not been well appraised by the methods used thus far. The limitations of those methods and the ambiguities related to both problems of dolerite and basement structuring have precluded it. Figures 61 and 62 sketch the styles of folding and extent of post Cambrian wedges based on different judgements of the effect of the ambiguous elements. The truth probably lies between the two but can only be derived after extended analysis, appraisal of dolerite contributions and, ideally, some independent control (wells or fragments of seismic coverage).

Dolerite features tend to be relatively subtle and can only be assessed by state-of-art modelling technology coupled with an understanding of geological possibilities for the intrusions.

Many feeders (e.g. Figure 63) appear to dominate magnetic solutions and this reflects the impact of extended, localised subvertical features of medium to high contrast. The Cretaceous syenites are not especially significant gravimetrically but their interaction with dolerite has led to large magnetic anomalies. A large intrusion has been inferred centred on Cygnet and this would account for the observed doming. The extension of the intrusion suggests primary structural controls.

## CONCLUSIONS

A regional first stage interpretation of gravity and magnetic data has been completed across a large part of SE Tasmania. This has yielded results equivalent to a first stage seismic coverage; where the latter would have yielded indications of structural style the present work has suggested unit composition. Basin location and scale have been established.

1. A large basin began to develop in Late Precambrian time. Up to 5 km of largely dolomitic sequences were deposited.
2. Rapid trough development occurred during the Cambrian and a deep, relatively narrow structure was filled by mixed igneous and volcanic-derived materials. The magnetic fill is at least 6 km thick. The trough was controlled by pre-existing structures, many of which trend NW-SE, was virtually terminated on a NNE-SSW axis extending from Risdon to SE Cape and located on the western margin of the earlier Precambrian basin.
3. The younger dolomitic Precambrian forms the effective basement for much of the region. Tyennan, siliceous basement is only significant west of the Picton River.
4. Ordovician to Devonian, and perhaps non magnetic Cambrian, sequences are not easily appraised. Some limiting conditions have been assessed and numerous significant wedges of these rocks are likely (see also Recommendations).
5. All data sets reveal consistent trend and lineament patterns and the interpreted distribution of basins, materials and structures clearly indicate a persistent structural control which extends to the present day.
6. Jurassic dolerites have not been fully appraised but a large number of feeders has been identified.
7. The Cretaceous syenite dyke swarm extends from a massive intrusion less than 2 km beneath the domed rocks at Cygnet. The radius of influence of this intrusion may locally exceed 10 km.
8. The extension of the Tamar Lineament has not been subject to detailed review but is probably located on the east side of Storm and Frederick Henry Bays.

The phase 1 interpretation has met, in general terms, the objectives set out on page 4. The present work has been terminated at the point where more sophisticated and detailed procedures are required but whose basic framework of operation has now been defined. The location of any regional seismic coverage can also be appraised.

## RECOMMENDATIONS

As noted in Introduction and Special Note this Phase 1 interpretation is provided as a basic framework and confirmation of feasible exploration objectives. As such there is much scope for detailed analysis and upgrading. The considerable limitations of the methods employed thus far requires that specific issues relevant to the petroleum exploration, well targetting or prognosis must be reviewed by more comprehensive procedures.

Application of such procedures must be more limited in application (100 or 200 sq km areas) and directed toward resolution of dolerite forms initially. Once these are better understood the gravity and magnetic fields can be stripped of dolerite effects and assessed for the more subtle pre-Permian features. Such analysis is, of itself, directly usable as part of the well prognosis study.

The use of 3D-whole geology-source component, weighted modelling procedures optimises resolution and such methods are recommended wherever seepages, the present work or any other information suggest the presence of Ordovician-Silurian rocks. It may be possible to reliably define secondary structuring and unit thicknesses by these means but the results could never replace seismic data while wholly compatible with it. Since seismic coverage will never be general in this region the combination of methods will allow satisfactory exploration. Should seismic data be unobtainable such methods might allow an acceptable level of evaluation.

Advanced evaluation of the region around North Bruny Island, Huonville and Southport should be begun as soon as possible.

## REFERENCES

- Farmer, N., and Clarke, M. J., 1985. A diamond drill hole at Little Peppermint Bay, Woodbridge. Unpub. Rept. Dep. Mines Tasm., 1985/24
- Ku, C.C., and Sharp, J.A., 1983. Werner deconvolution for automated magnetic interpretation and its refinement using Marquardt's inverse modelling. *Geophysics* 48, 754
- Leaman, D.E., 1972. Gravity survey of the Hobart District. *Bull. geol. Surv. Tasm.*, 52
- Leaman, D.E., 1975. Form, mechanism and control of dolerite intrusion near Hobart, Tasmania. *J. geol. Soc. Aust.*, 22, pp 175-186
- Leaman, D.E., 1977. Magnetic survey, Port Cygnet. *Tech. Rept. Dep. Mines Tasm.*, 20, 134.
- Leaman, D.E., 1987. Review. Pre 1987 geophysical and structural data, D'Entrecasteaux Channel region, Tasmania. For Conga Oil Pty Ltd. Report included in 1987 Annual Report to the Mines Department (Appendix 3)
- Leaman, D.E., and Naqvi, I.H., 1967. Geology and Geophysics of the Cygnet District. *Bull. geol. Surv. Tasm.*, 49
- Turner, N.J., Calver, C.R., McClenaghan, M.P., and Brown, A.V., 1985. *Pedder. 1:50000 Geological Atlas sheet 8112S*
- Williams, E., 1969. The repeated development of identical joint patterns, northeast Tasmania. *Geol. Mag.*, 106, p 362.

048

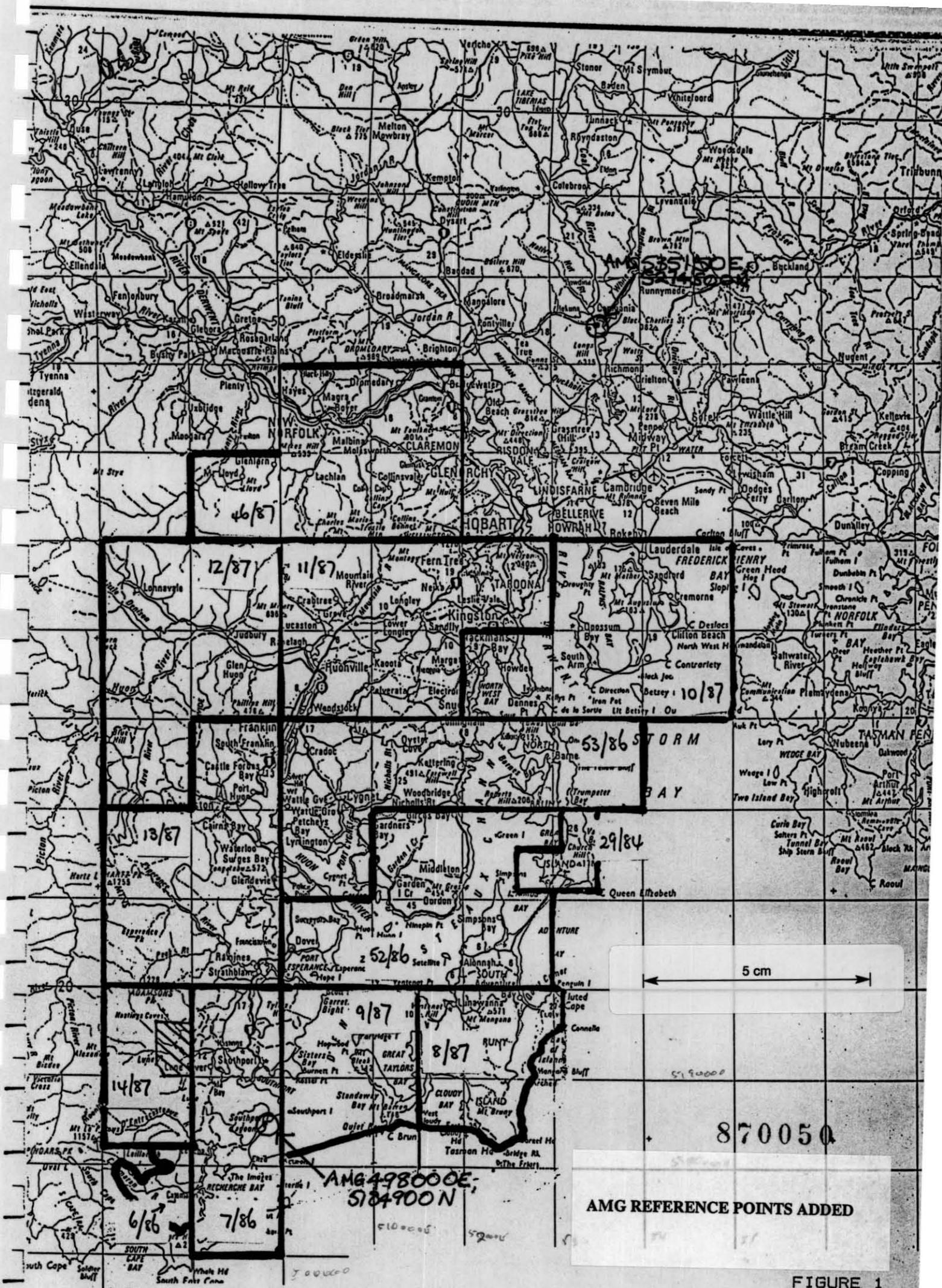
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Report submitted on behalf of  
Leaman Geophysics  
by

*D. Leaman*

Dr. D.E. Leaman, B.Sc., Ph.D  
M.Aus.I.M.M., M.M.I.C.A

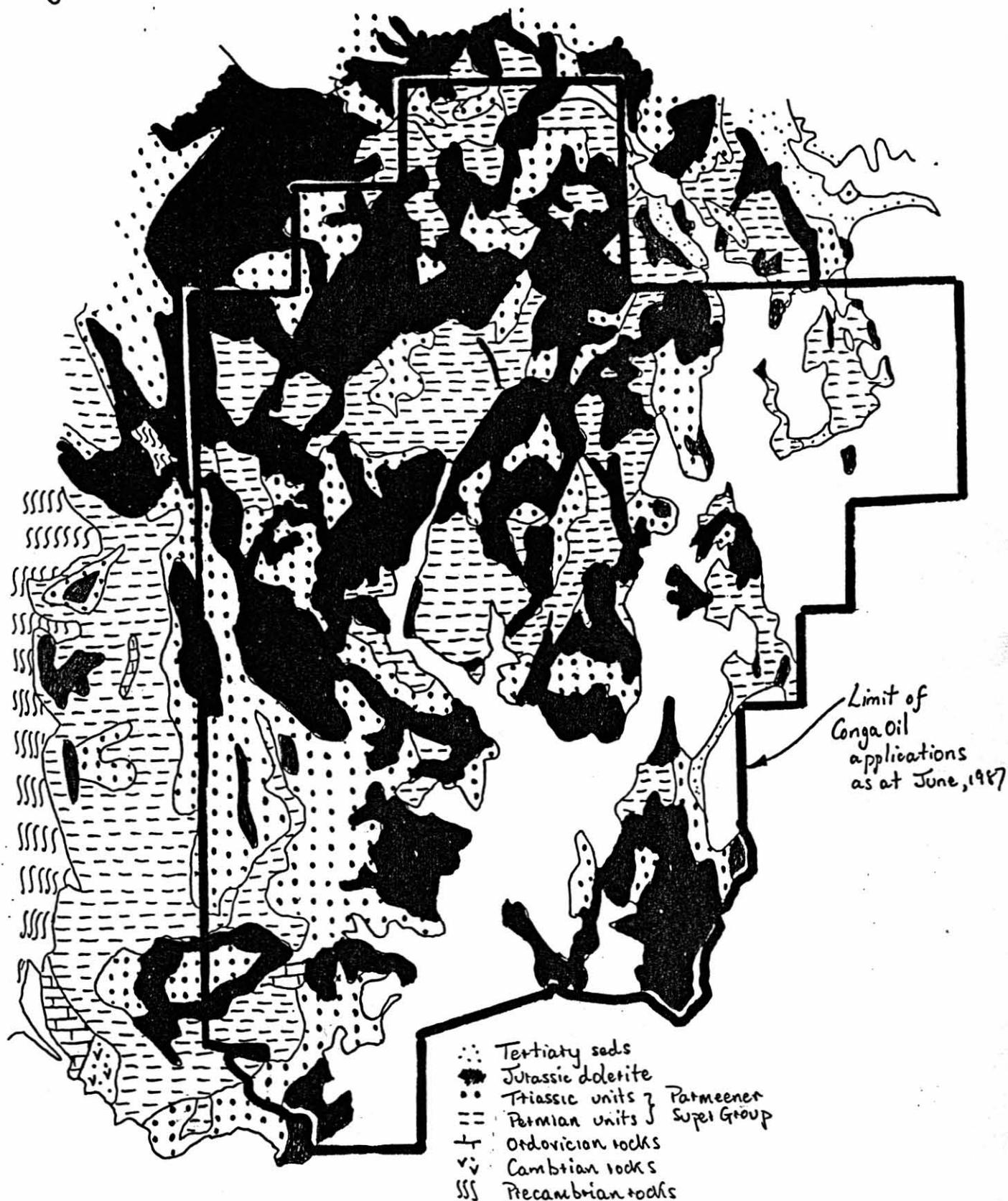
*Sept 30, 1987*



SURVEY AREA AND LOCATION OF EXPLORATION LICENCES

FIGURE 1

049



Geology simplified from "Geological Map of Tasmania"

FIGURE 2

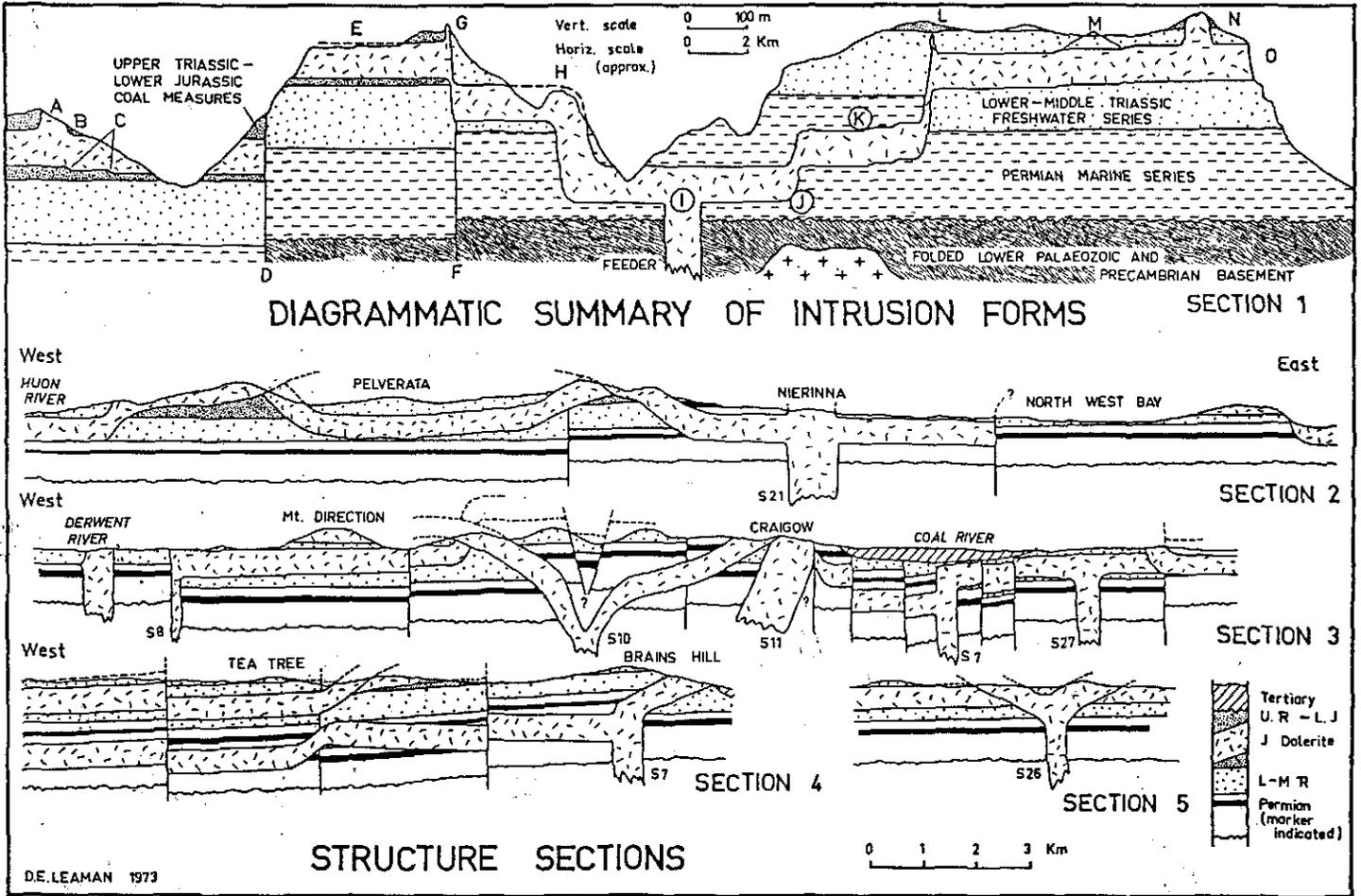


Fig. 2: Vertical sections of dolerite intrusion forms. 1: Diagrammatic summary of intrusion forms. Capital letters indicate features discussed in text. 2, 3, 4, and 5: East to west geological sections located by reference to Fig. 1 and Fig. 3. S7, S11, etc., refer dolerite sheets to their appropriate feeding sources in Fig. 3.

5 cm

FIGURE 3

POST CARBONIFEROUS SECTION: SUMMARY OF RELATIONSHIPS  
(after Leaman, 1975)

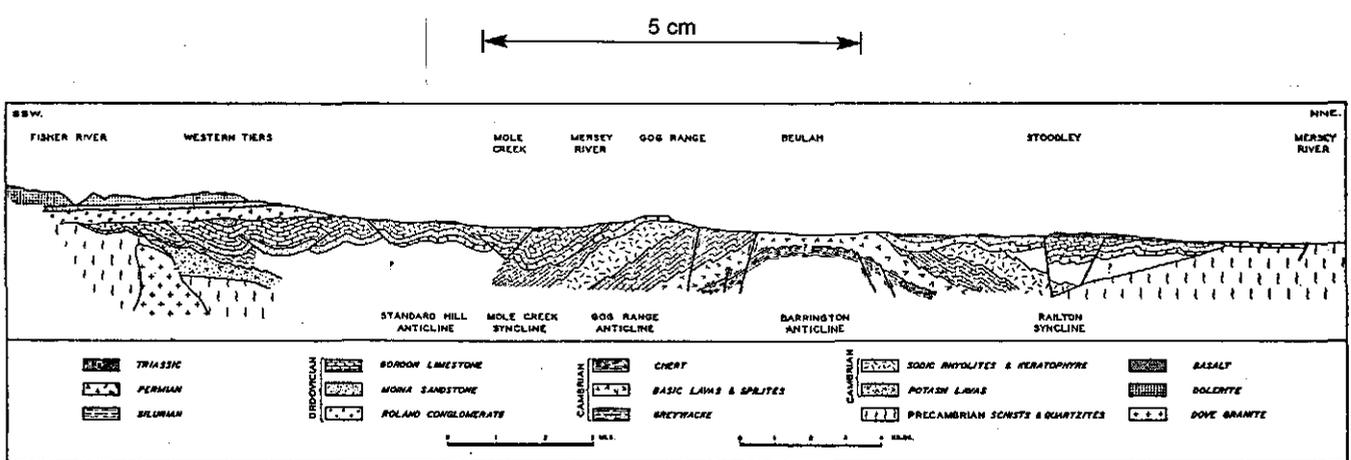


Fig. 75. Section through the North-West Coast (I. B. Jennings).

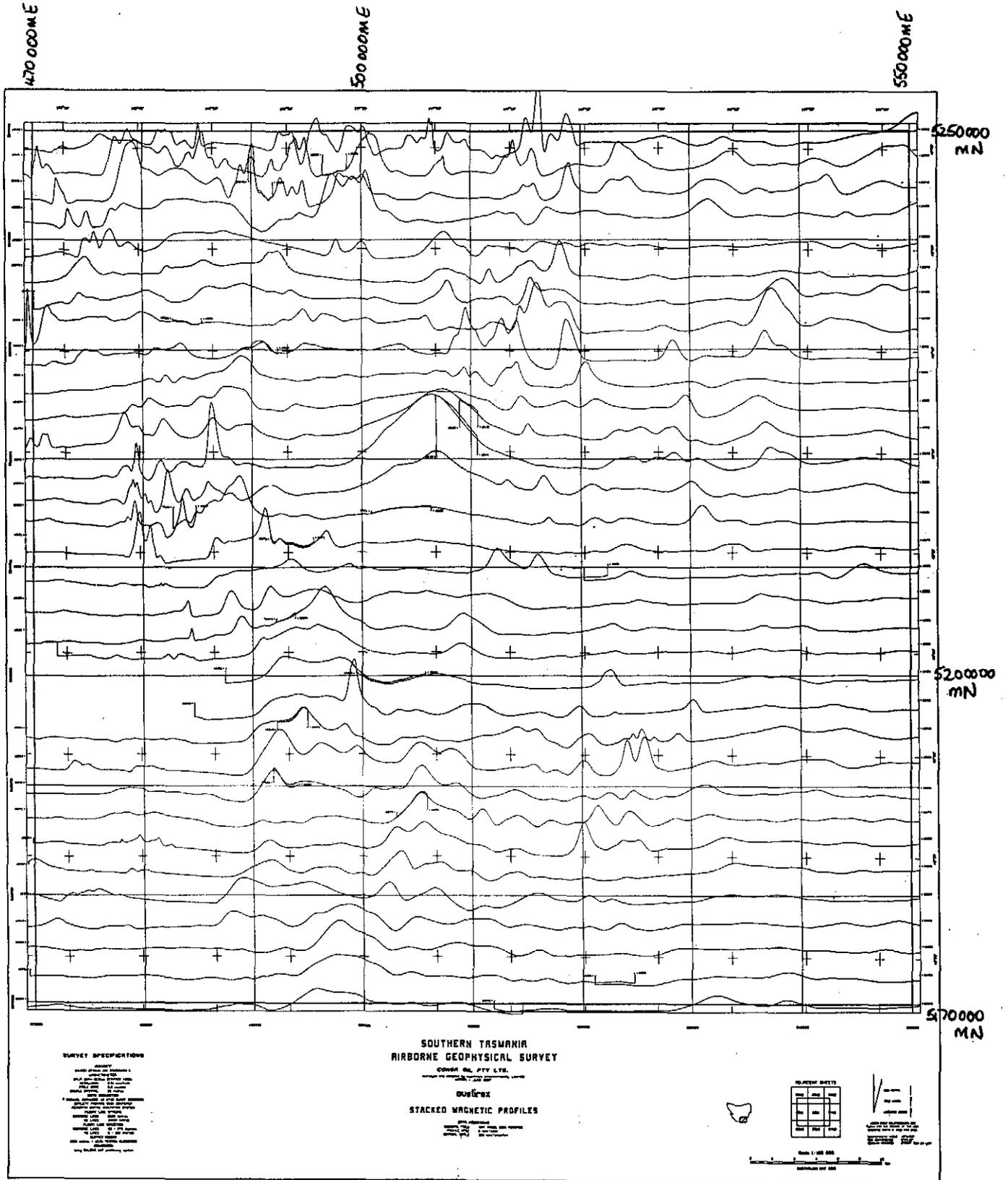
FIGURE 4

PRE CARBONIFEROUS SECTION: SUMMARY OF RELATIONSHIPS  
(from Geology of Tasmania, J.geol.Soc.Aust., 9, 1962)



054

870055



5 cm

FIGURE 6

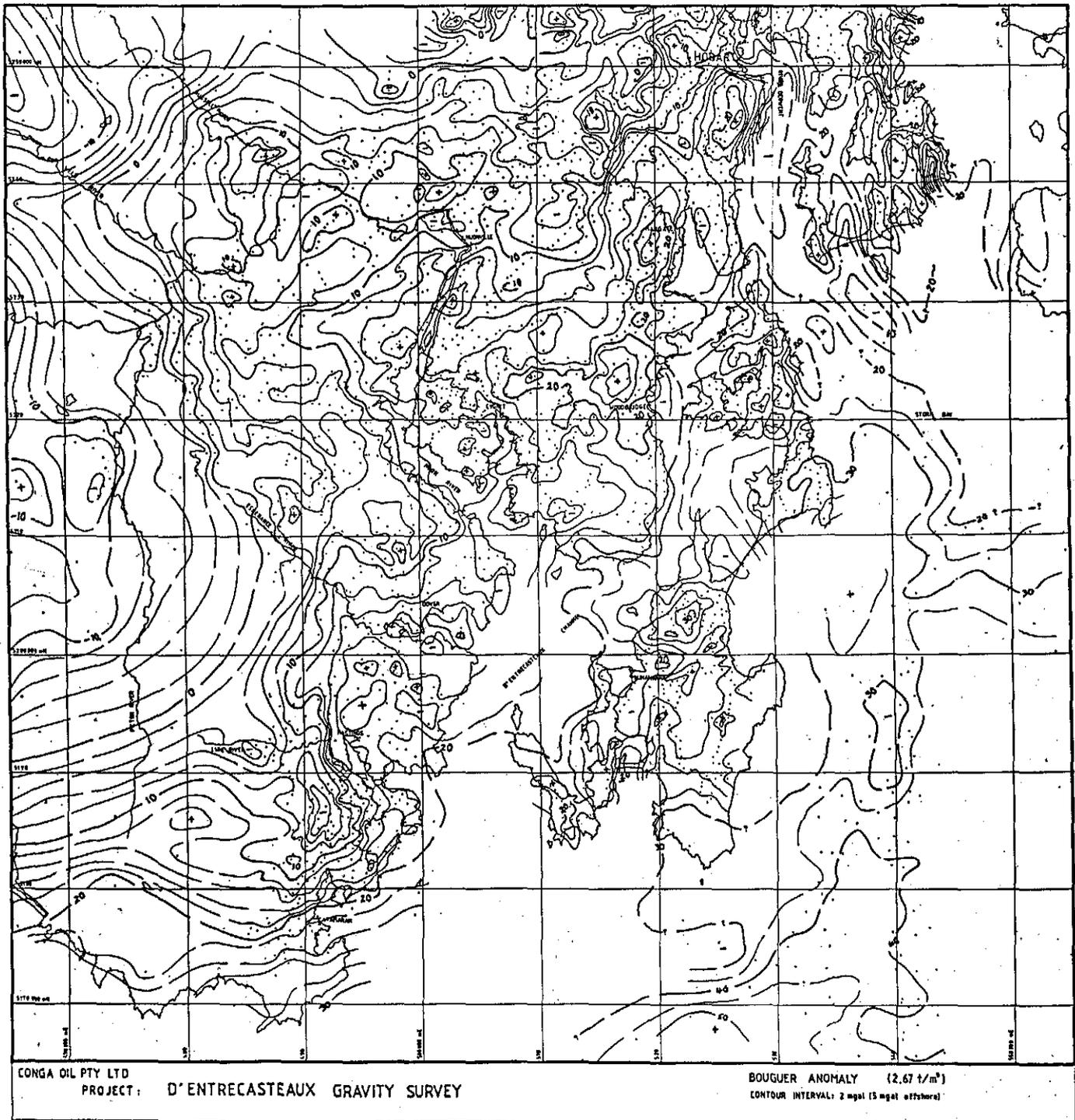
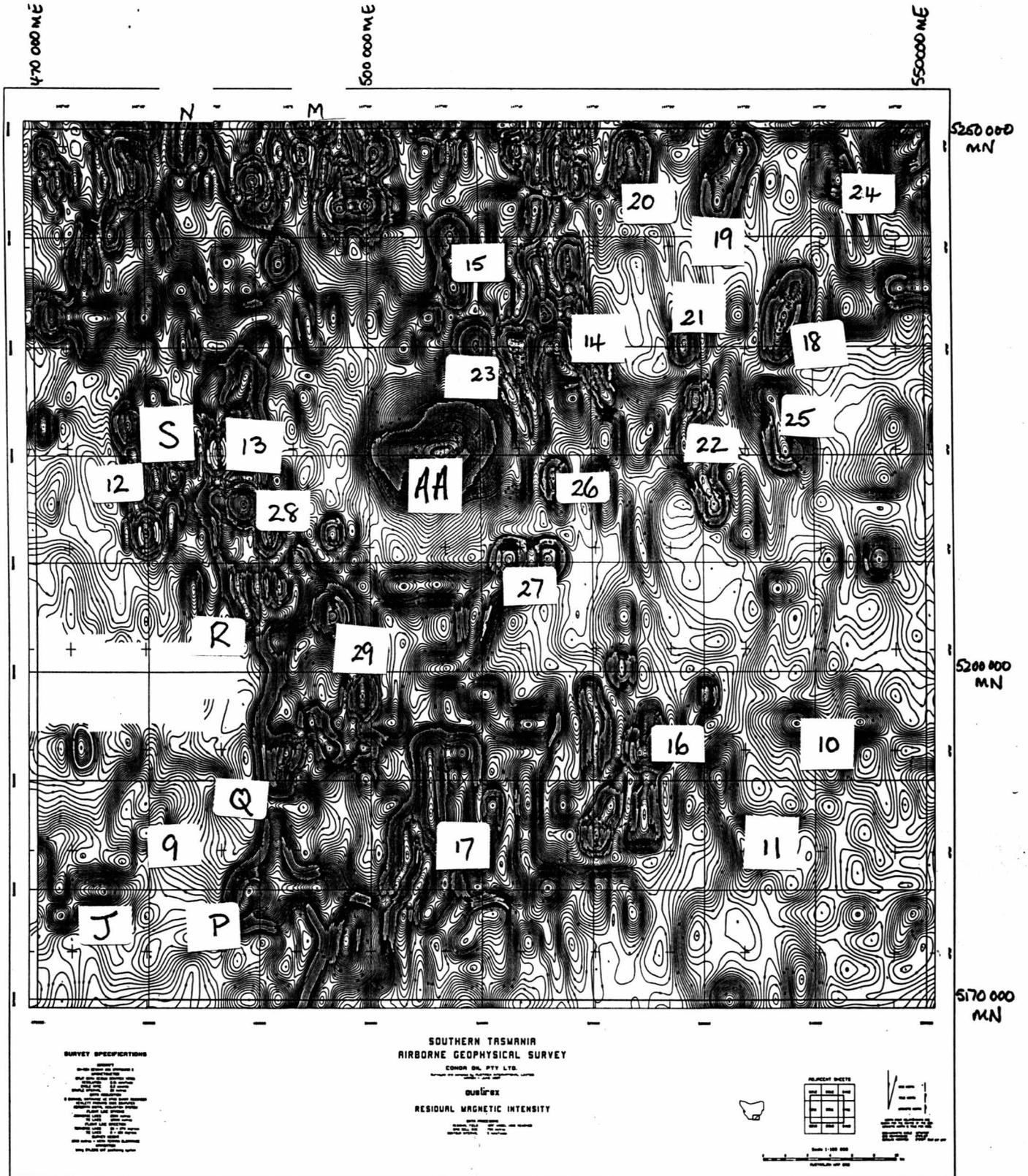


FIGURE 7

COMPILATION MAP: BOUGUER ANOMALY MAP, DENSITY 2.67 T/CU M

056

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LABELLED MAGNETIC ANOMALIES

FIGURE 8

057

870058

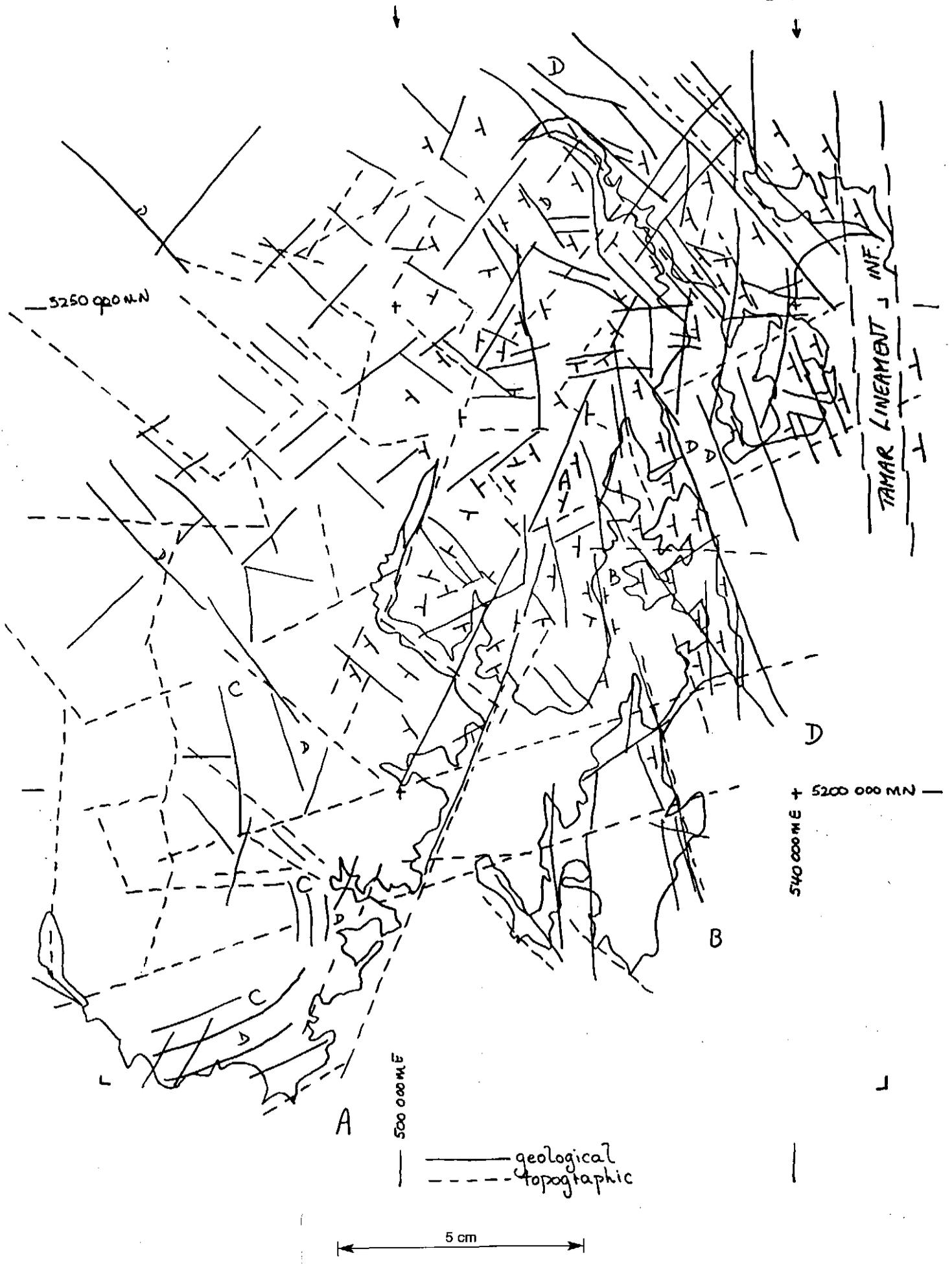


LABELLED GRAVITY ANOMALIES

FIGURE 9

058

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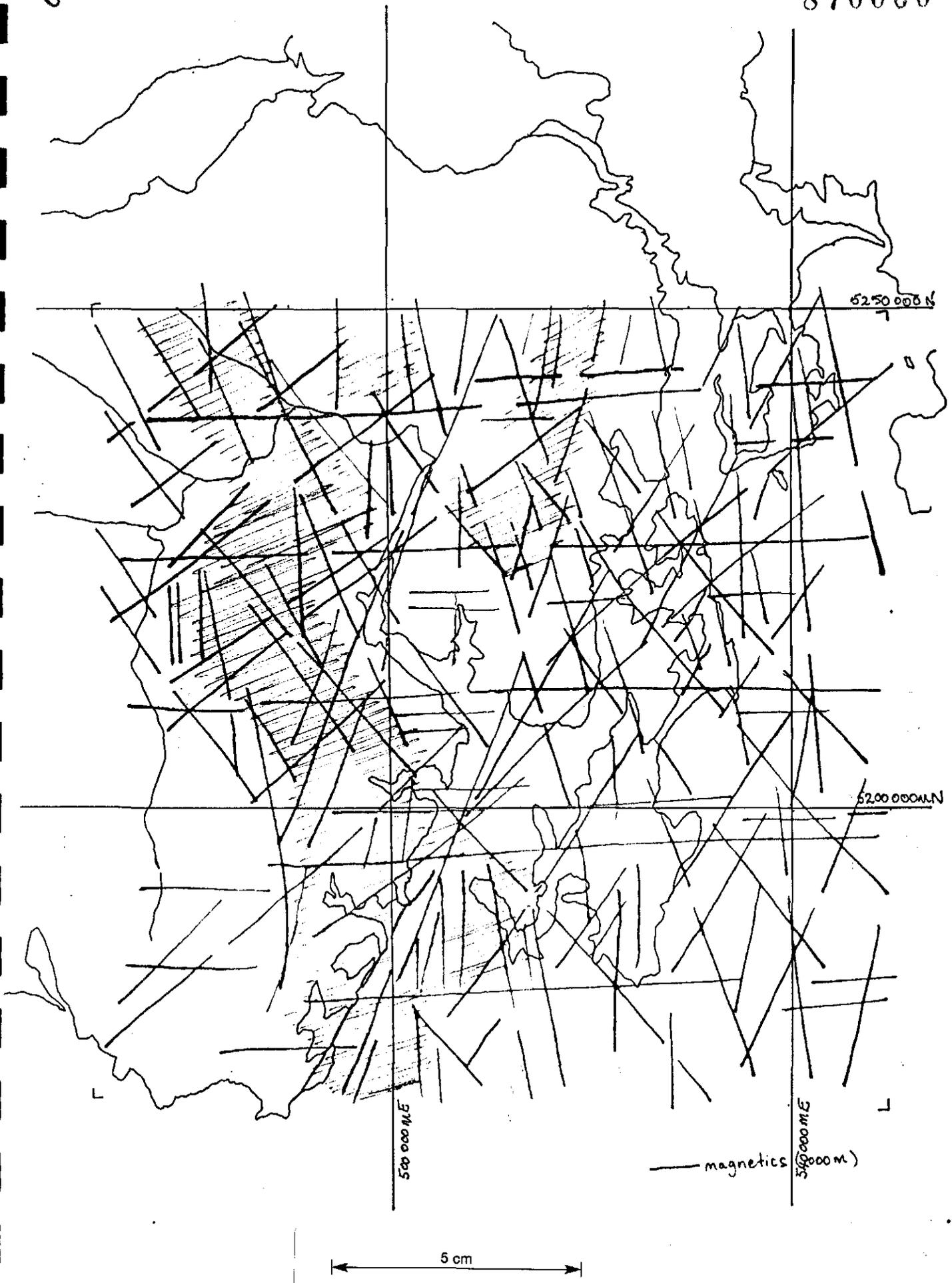


GEOLOGICAL AND TOPOGRAPHICAL TRENDS AND LINEARS

FIGURE 10

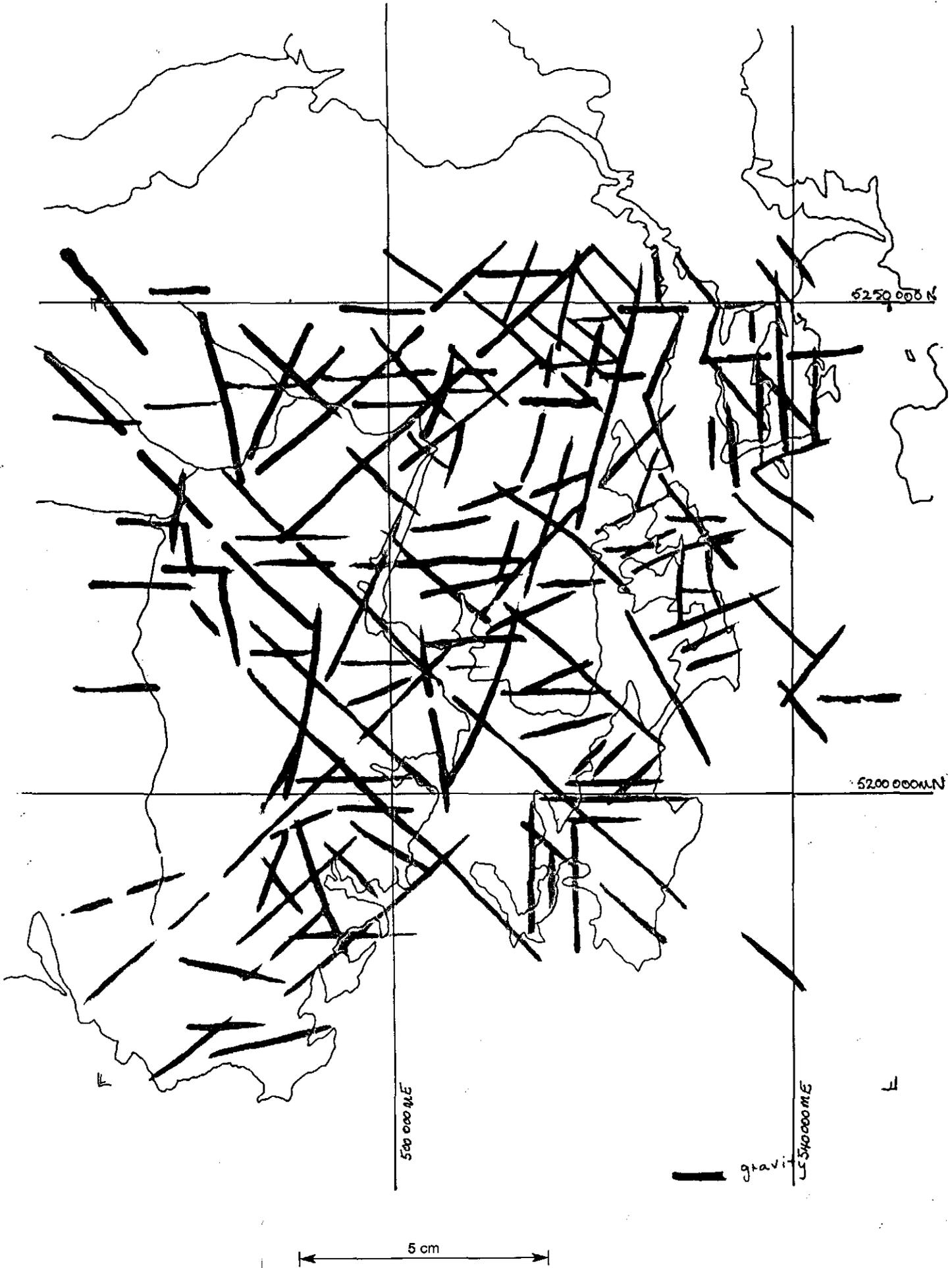
059

870060



TRENDS INFERRED IN AEROMAGNETIC DATA AT 1000 M ELEVATION  
(Shaded area represents zones of elevated intensity)

FIGURE 11



TRENDS INFERRED IN BOUGUER ANOMALIES

FIGURE 12

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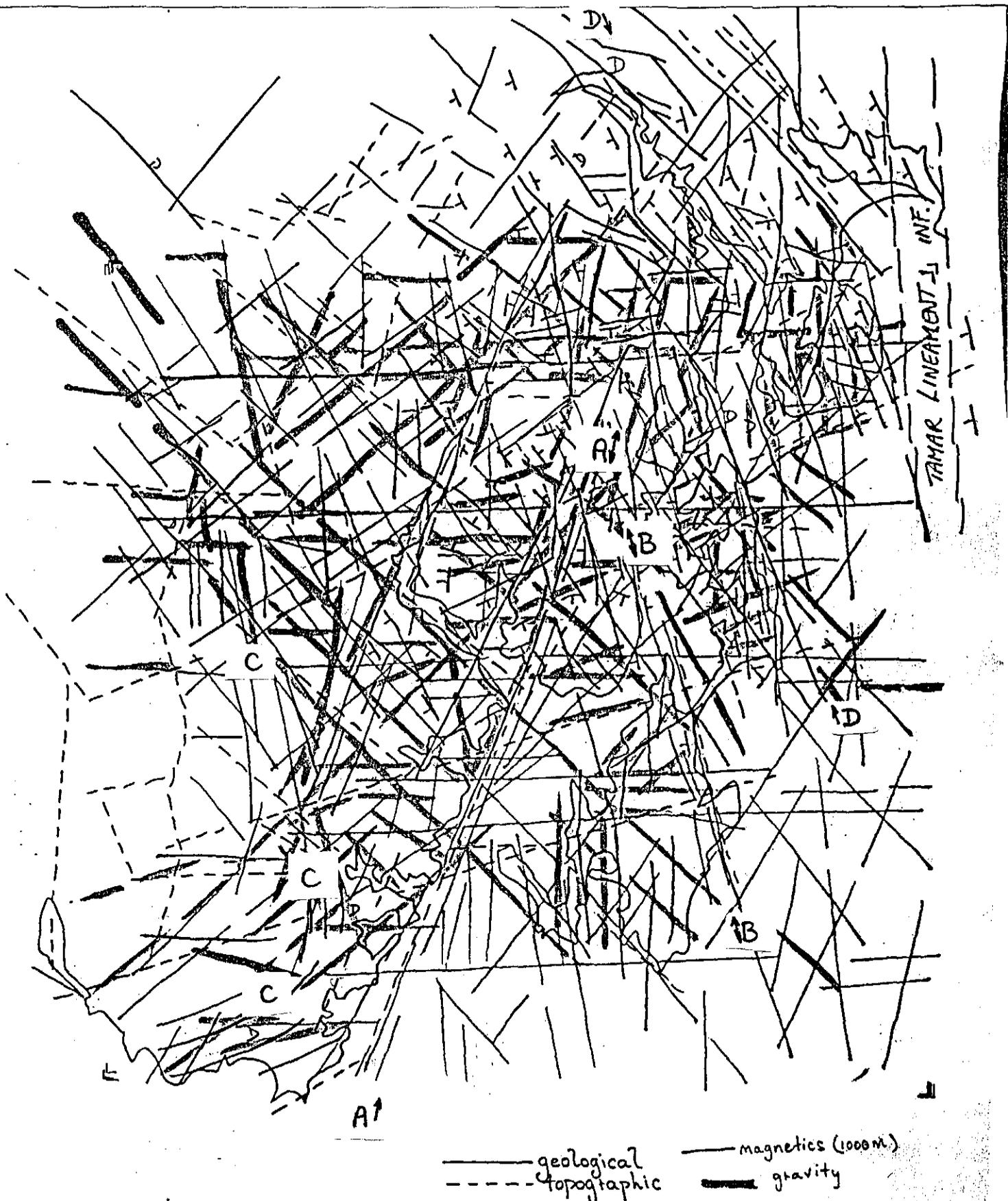


FIGURE 13

TREND SUMMARY MAP - COMPILATION OF ALL INFERRED TRENDS

870063

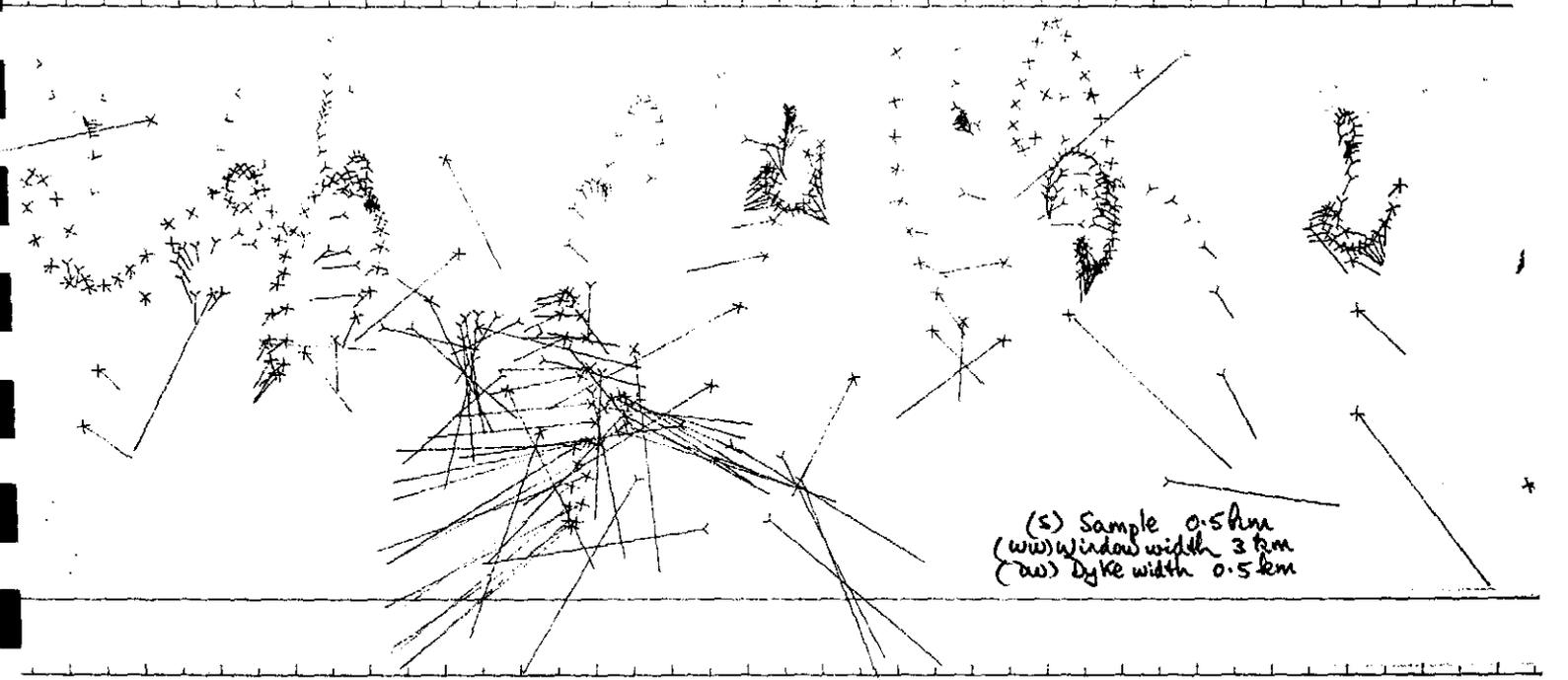
062

1 Km

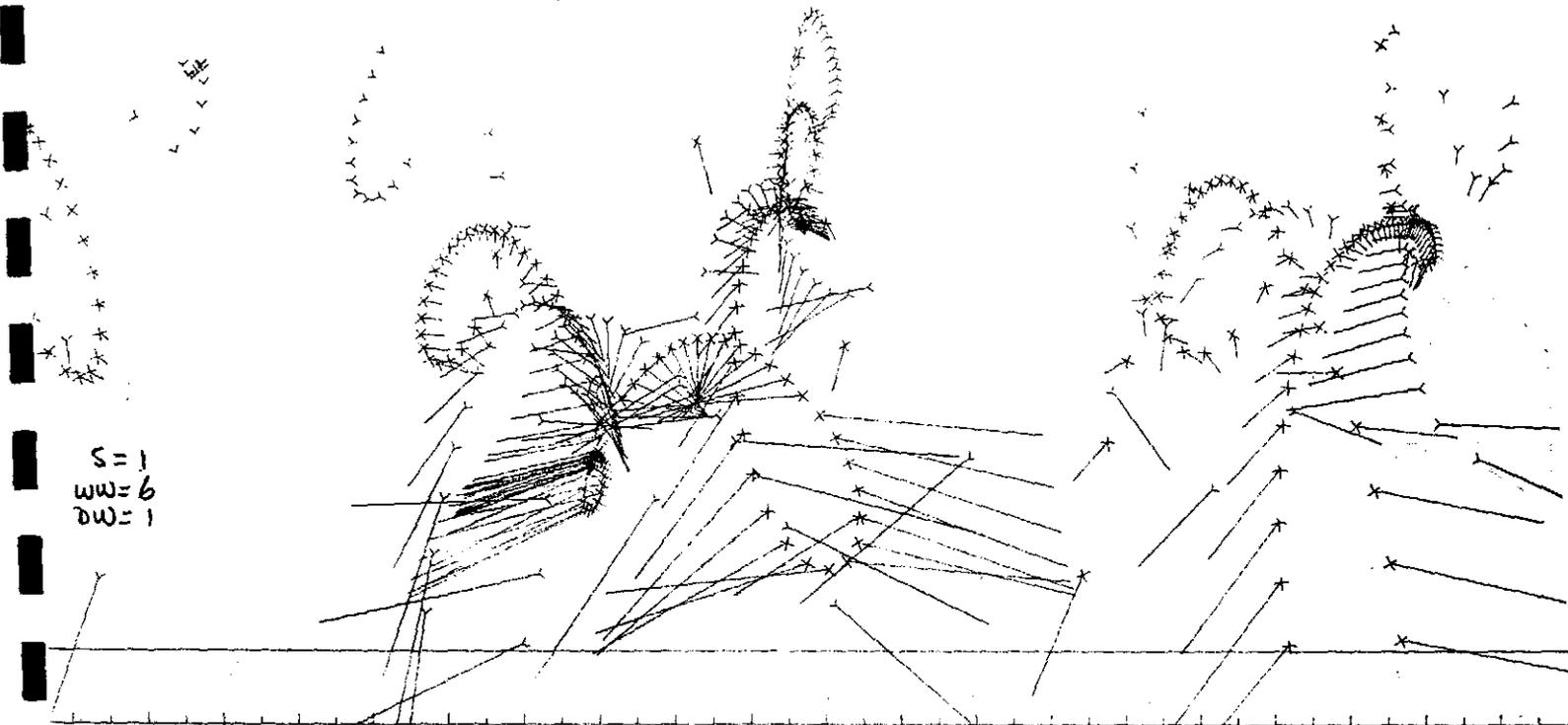
60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79

540 000 ME

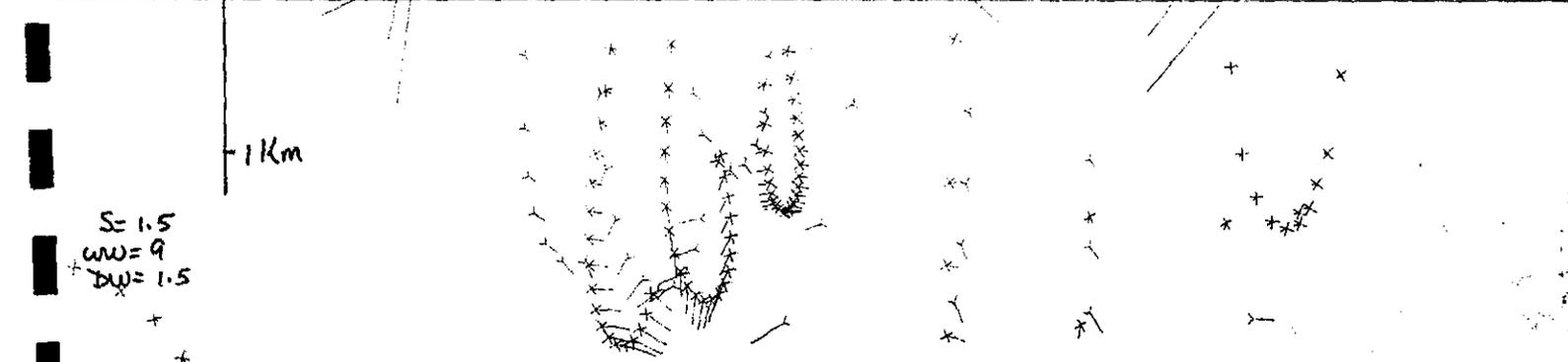
LINE 8



(s) Sample 0.5 km  
(ww) Window width 3 km  
(dw) Dyke width 0.5 km



S=1  
WW=6  
DW=1

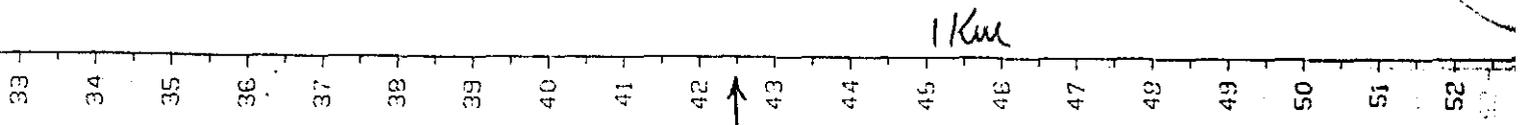


S=1.5  
WW=9  
DW=1.5

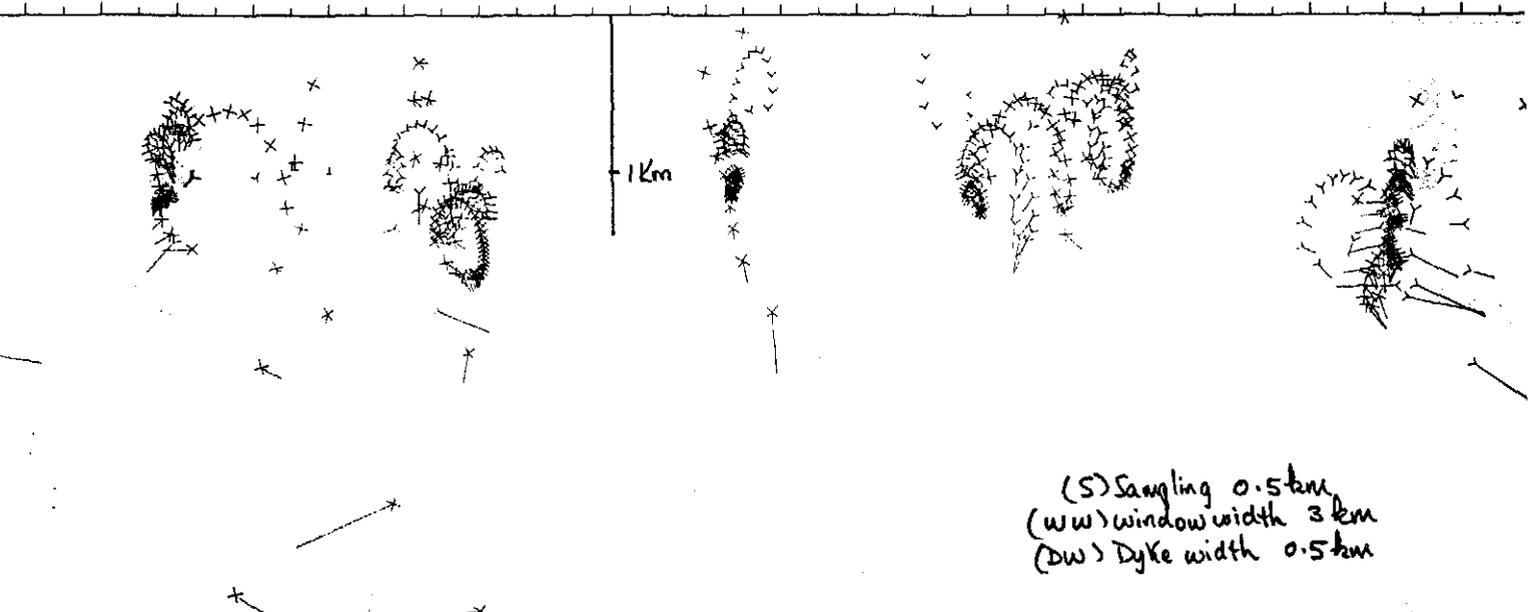
WERNER PROFILES FOR AEROMAGNETIC LINE 1008 - 5235 000 MN  
(The fainter results represent inference from the horizontal gradient)

063

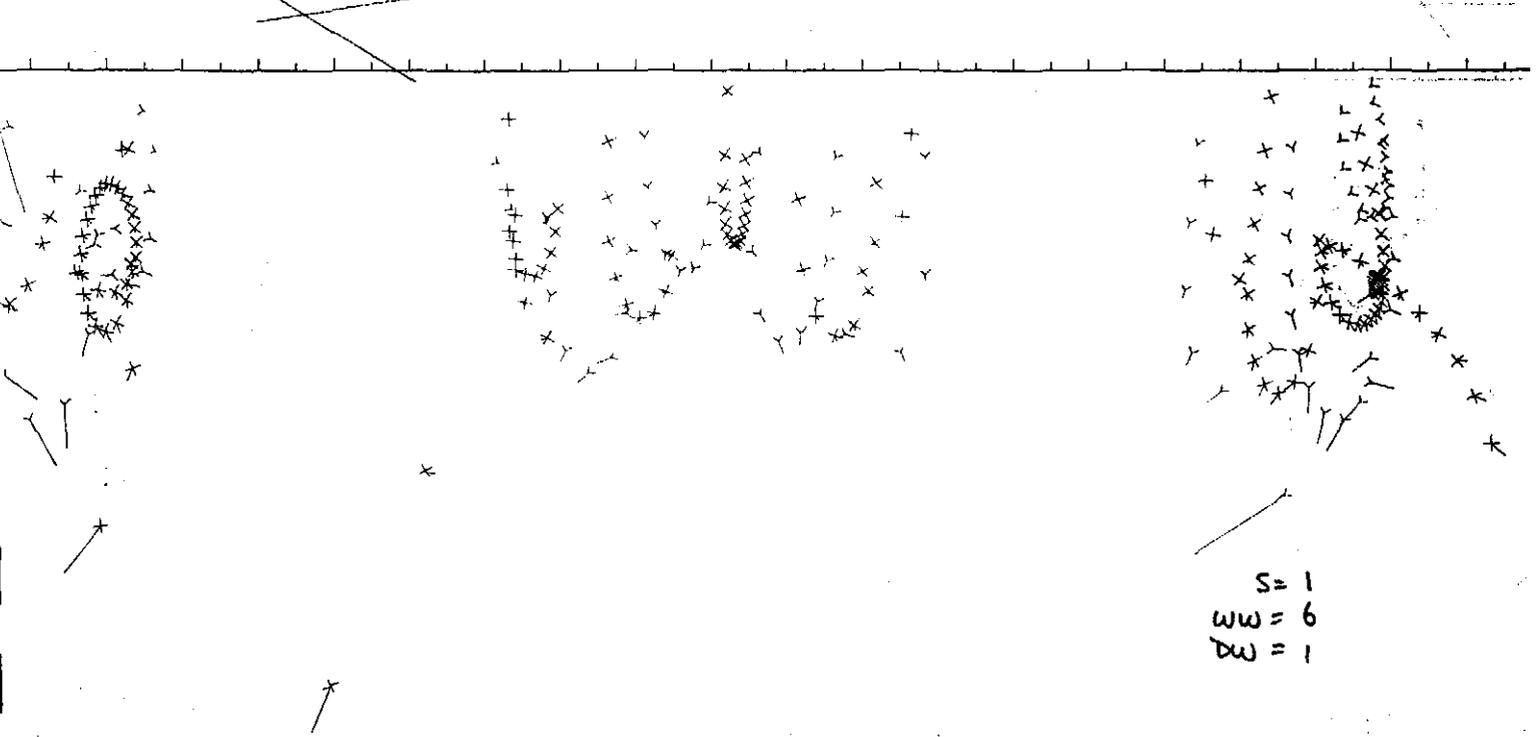
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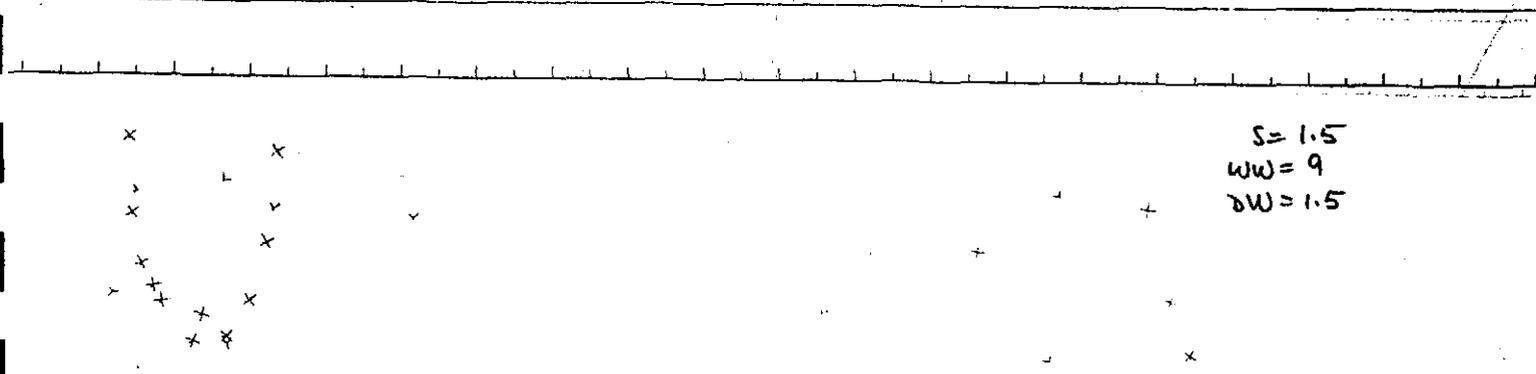
LINE 27



(S) Sampling 0.5 km  
 (WW) window width 3 km  
 (DW) Dyke width 0.5 km



S = 1  
 WW = 6  
 DW = 1



S = 1.5  
 WW = 9  
 DW = 1.5

WERNER PROFILES FOR AEROMAGNETIC LINE 1027 - 5187 500 MN  
 (The fainter results represent inference from the horizontal gradient)

FIGURE 15

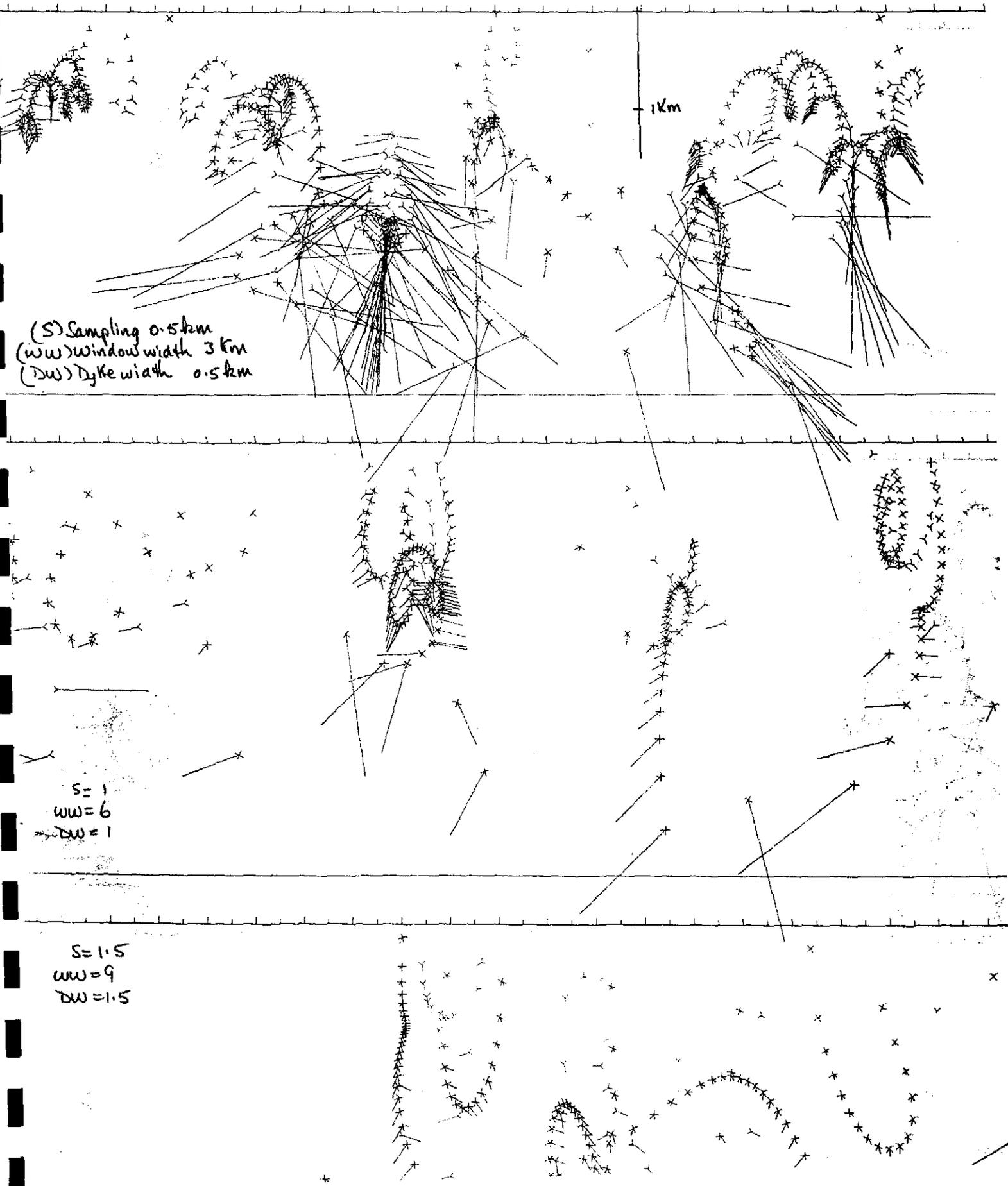
870065

28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47

1km

500 000 m E

LINE 31



(S) Sampling 0.5km  
 (WW) Window width 3km  
 (DW) Dyke width 0.5km

S=1  
 WW=6  
 DW=1

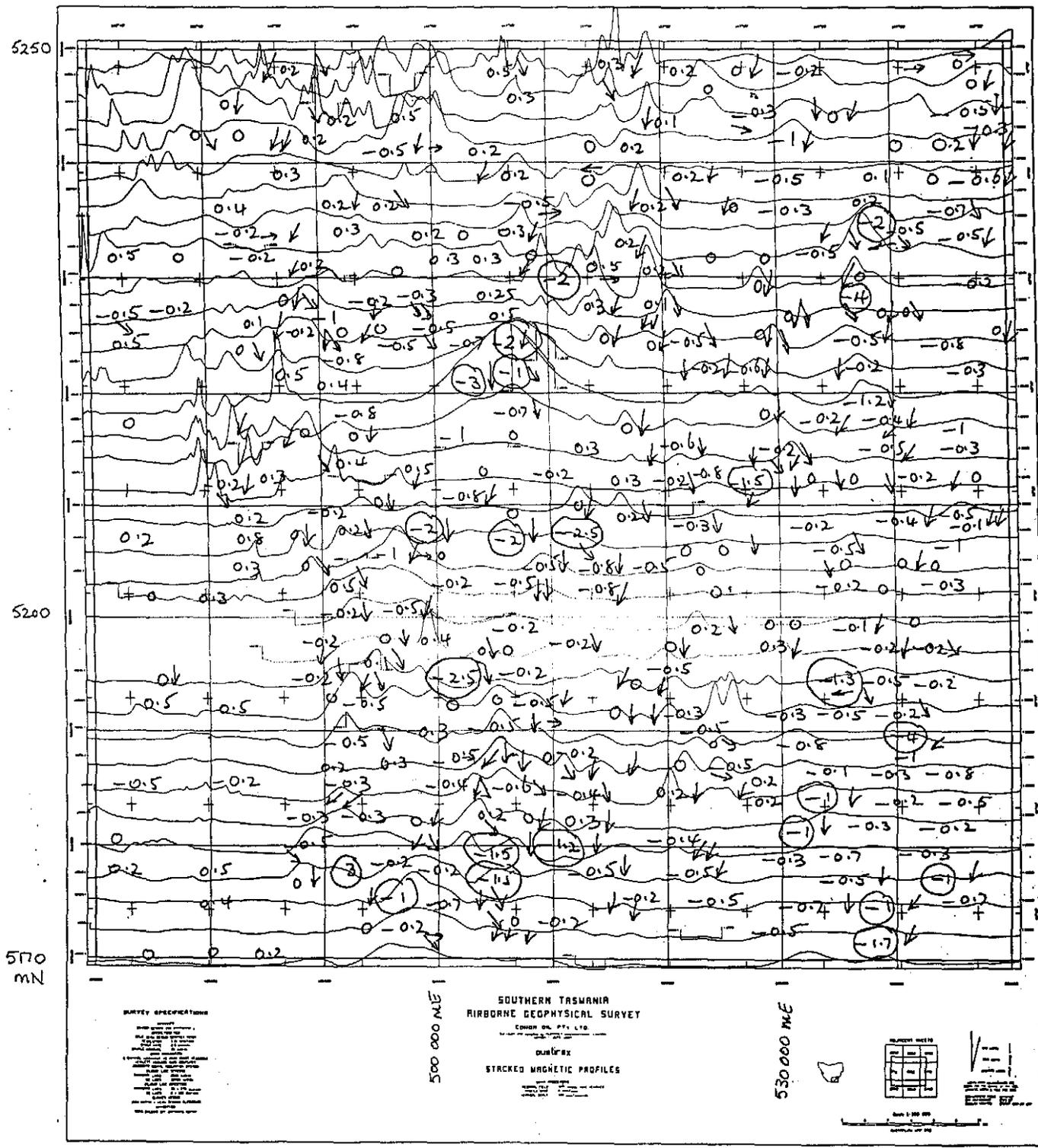
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 WW=9  
 DW=1.5

WERNER PROFILES FOR AEROMAGNETIC LINE 1031 - 5177 500 MN  
 (The fainter results represent inference from the horizontal

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Source depth (-0.2) and dip sense (↙) and angle indicated.  
 Selection from profile interpretation.  
 All depths relative to sea level.  
 Most sources due to dolerite exposure, dykes, sheet ends and some feeders

FIGURE 17

5 cm

SUMMARY OF WERNER DECONVOLUTION DEPTH AND DIP INDICATIONS  
 AEROMAGNETIC SURVEY AT 1000 M  
 All estimates with respect to flight elevation. Most dolerite-

066

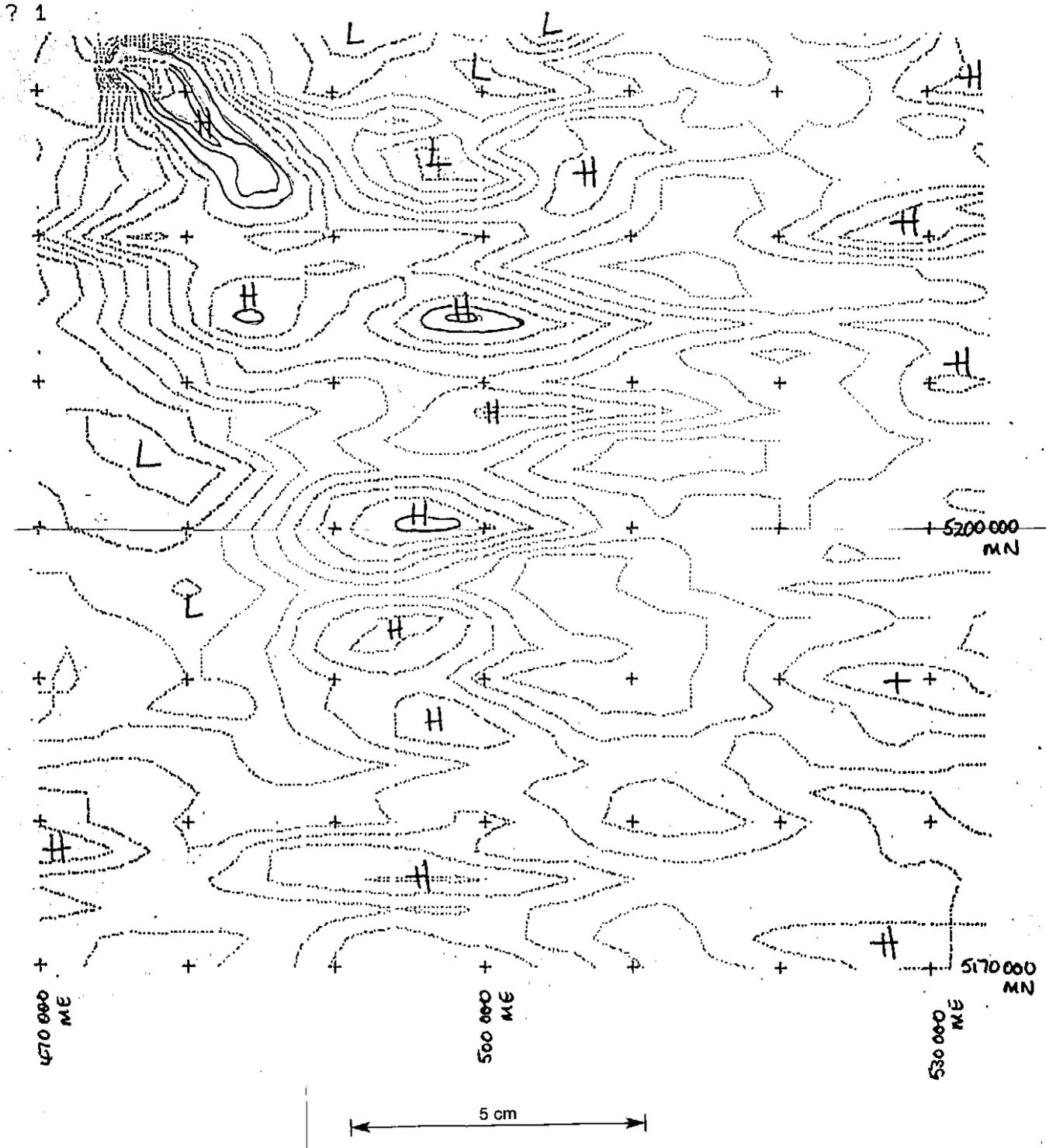
870067

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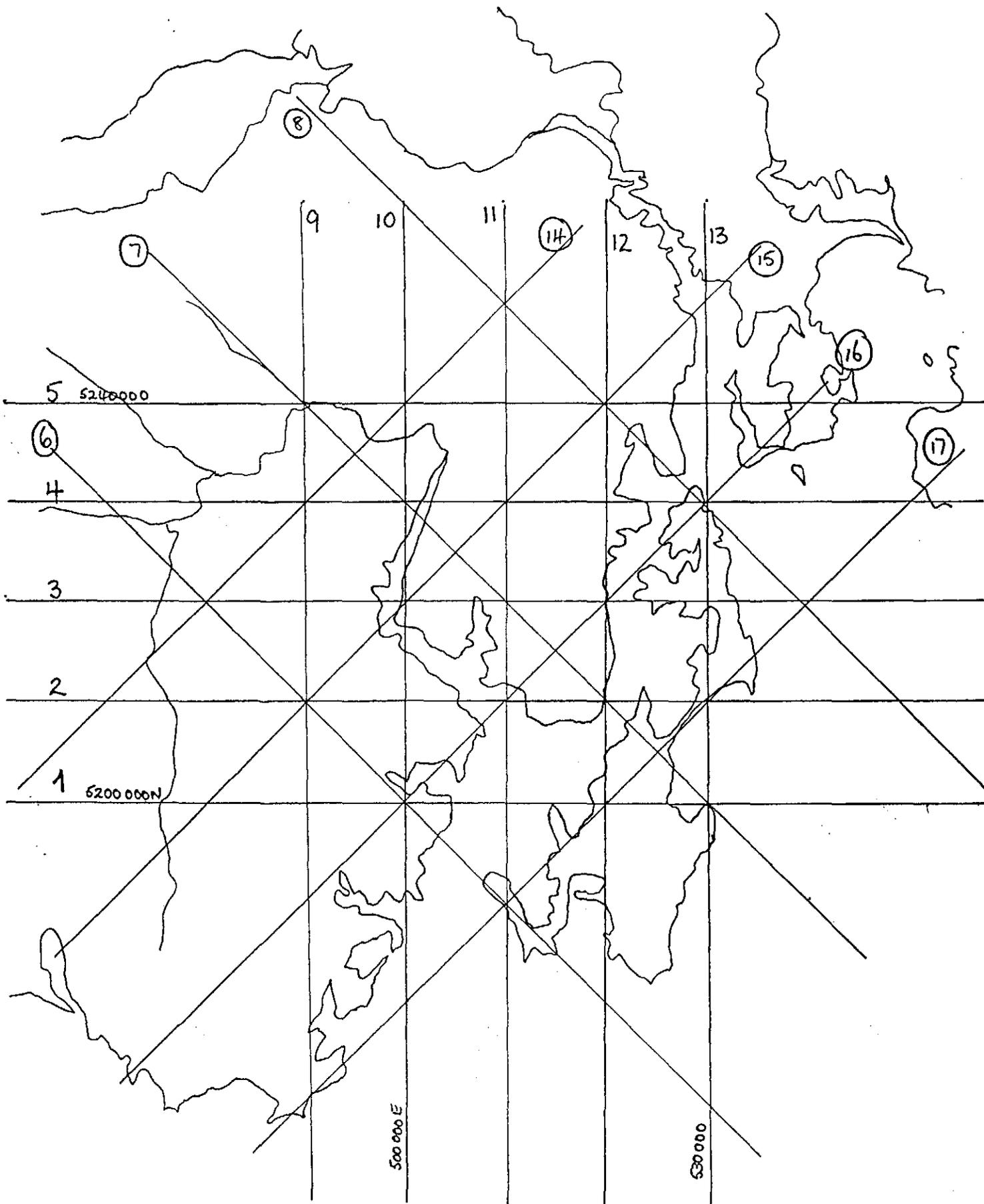
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CONGA AEROMAGNETICS DATA 1000 M FILTER SELECTION  
DENTRECASTEAUX PROJECT SW 490/5170  
SCALE 500000  
SAMPLE SPACING 2500



LINE FILTERED COMPILATION OF MAGNETIC FIELD AT 1000 M  
(Filter selected to remove all high frequency effects)  
FIGURE 18



LOCATION OF 2D MODEL GUIDE SECTIONS

FIGURE 19

068

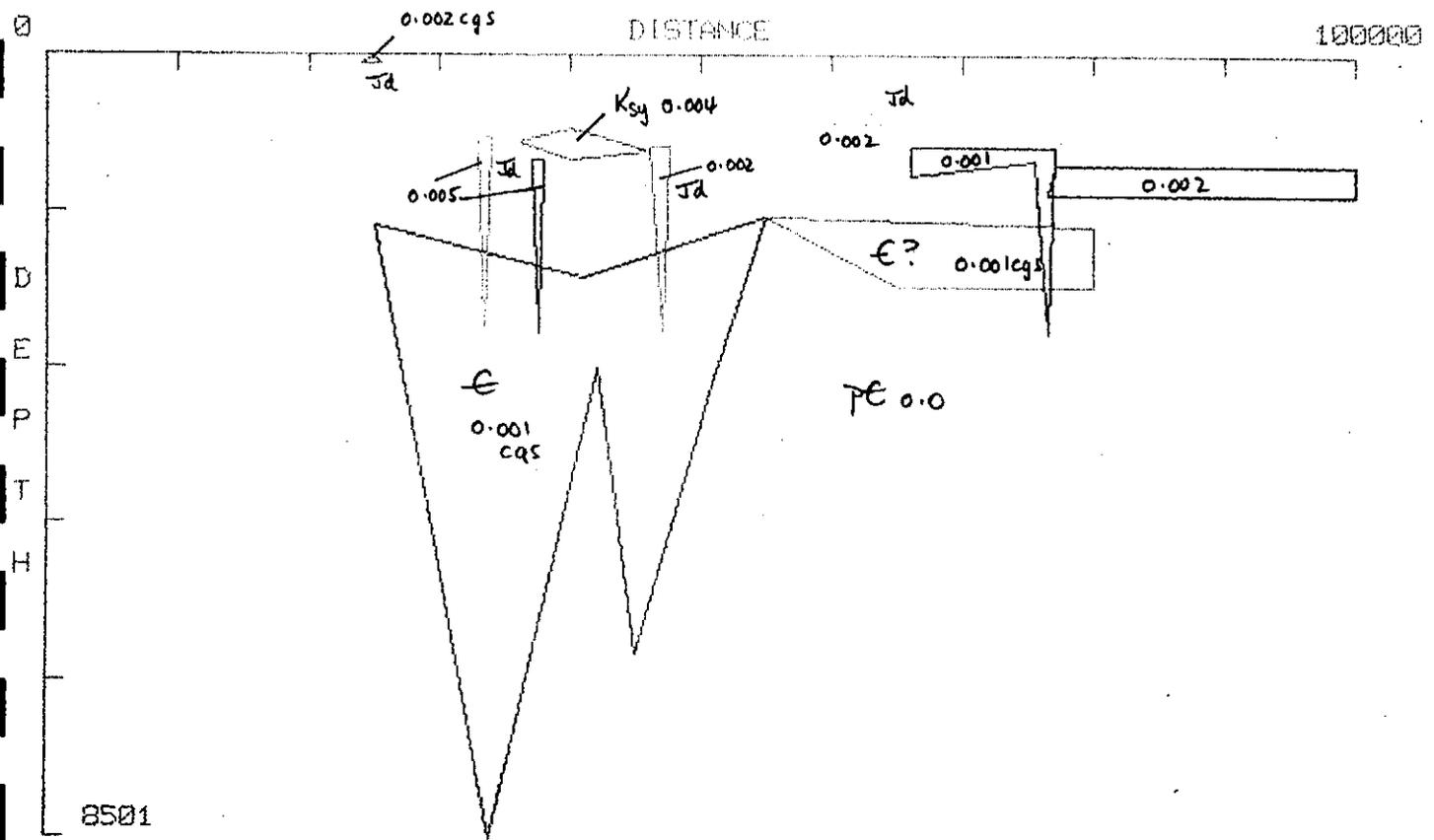
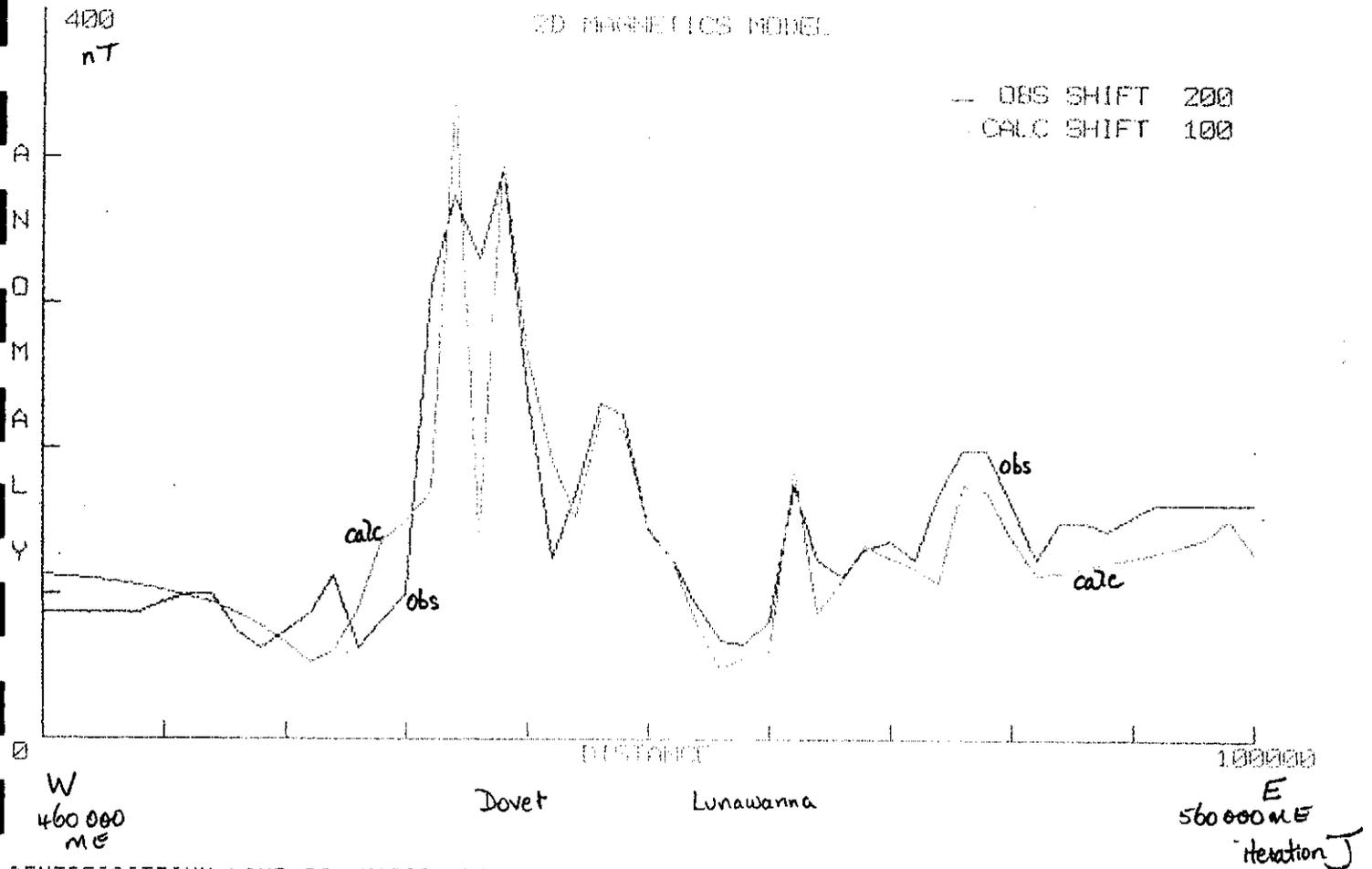
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## 3D MAGNETICS MODEL



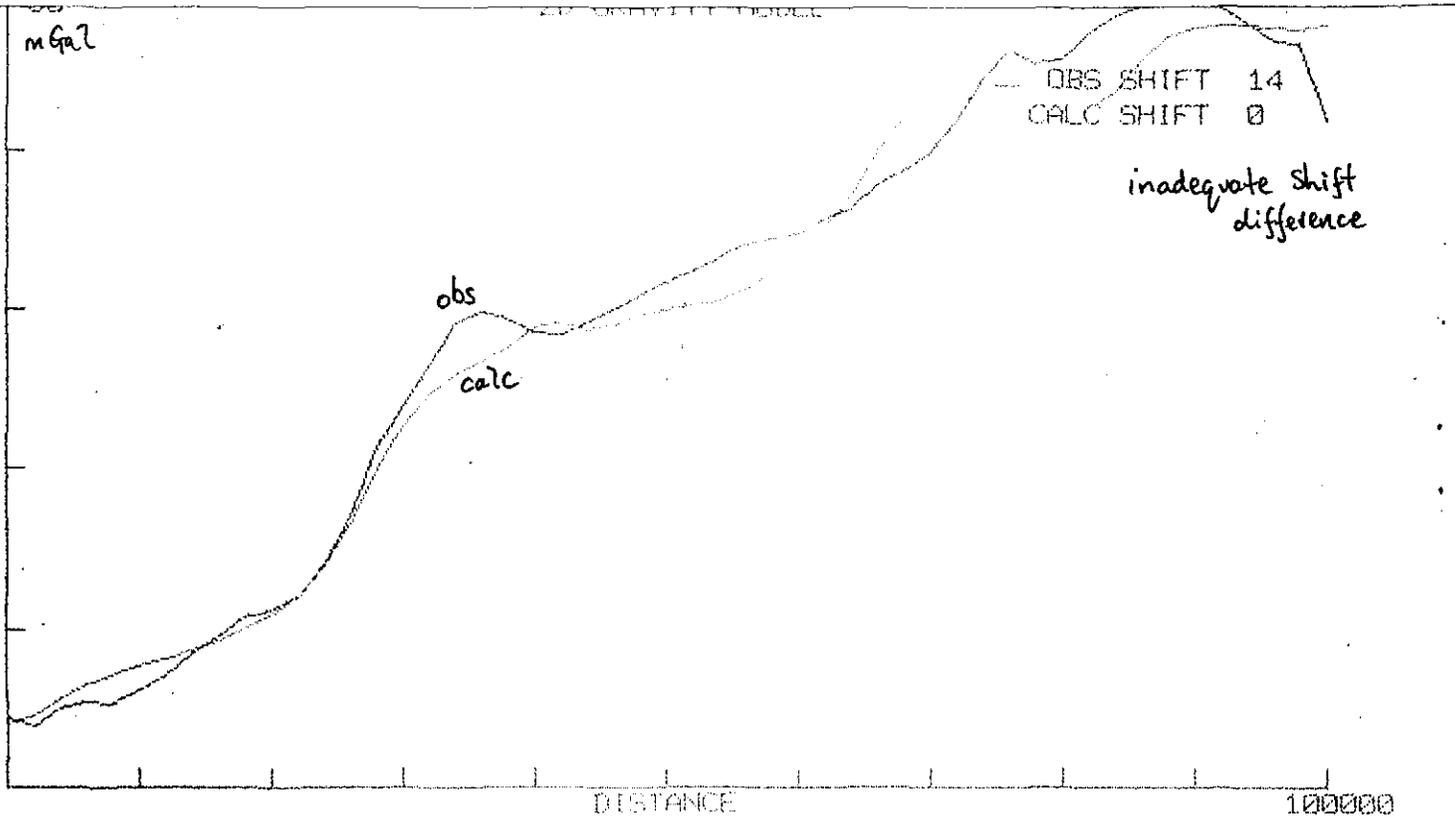
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870070



W 460000 ME

Dovek

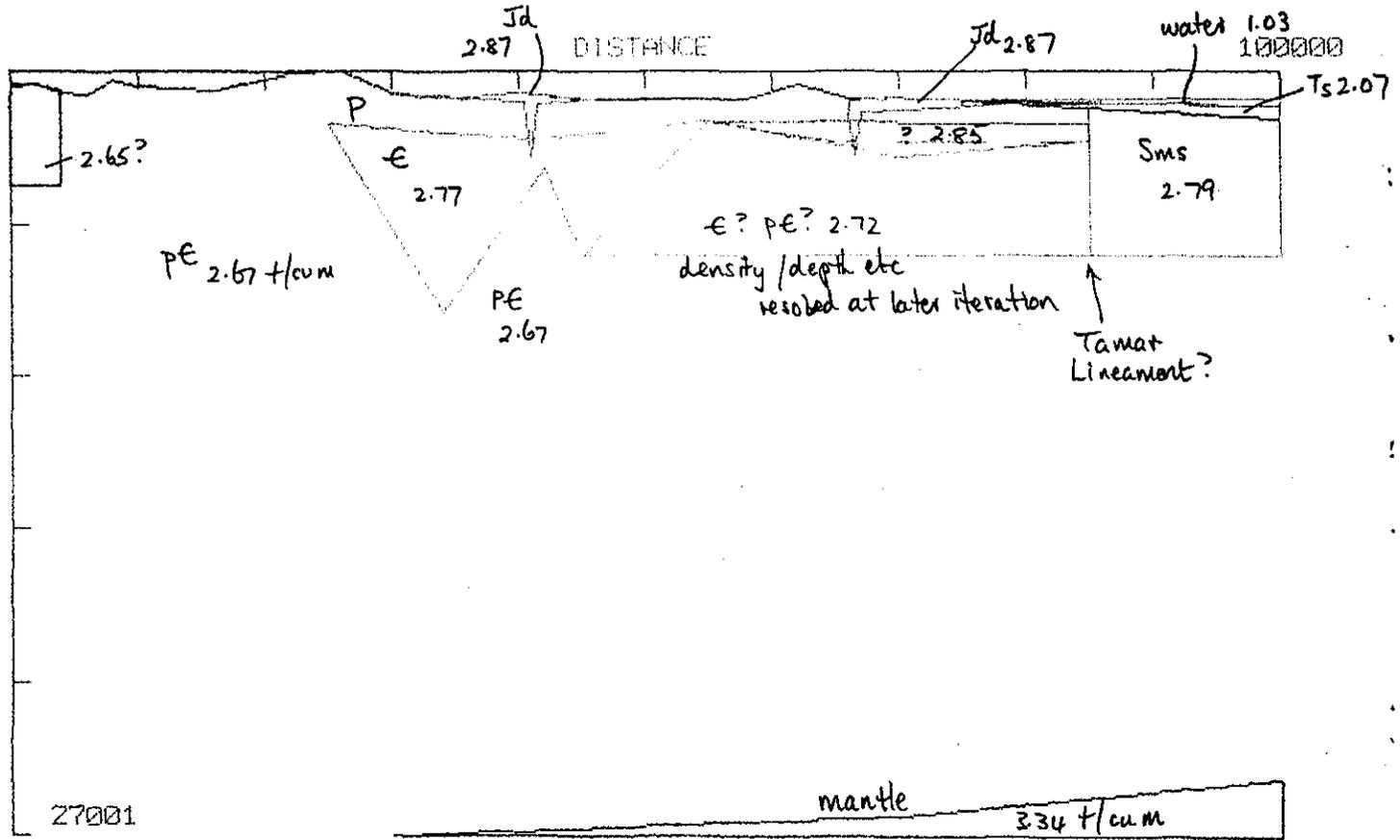
S Bruny Is

5200 000 mN

E 560000 ME

ENTRECASTERAUX LINE

AD DENSE EASTERN BASEMENT



070

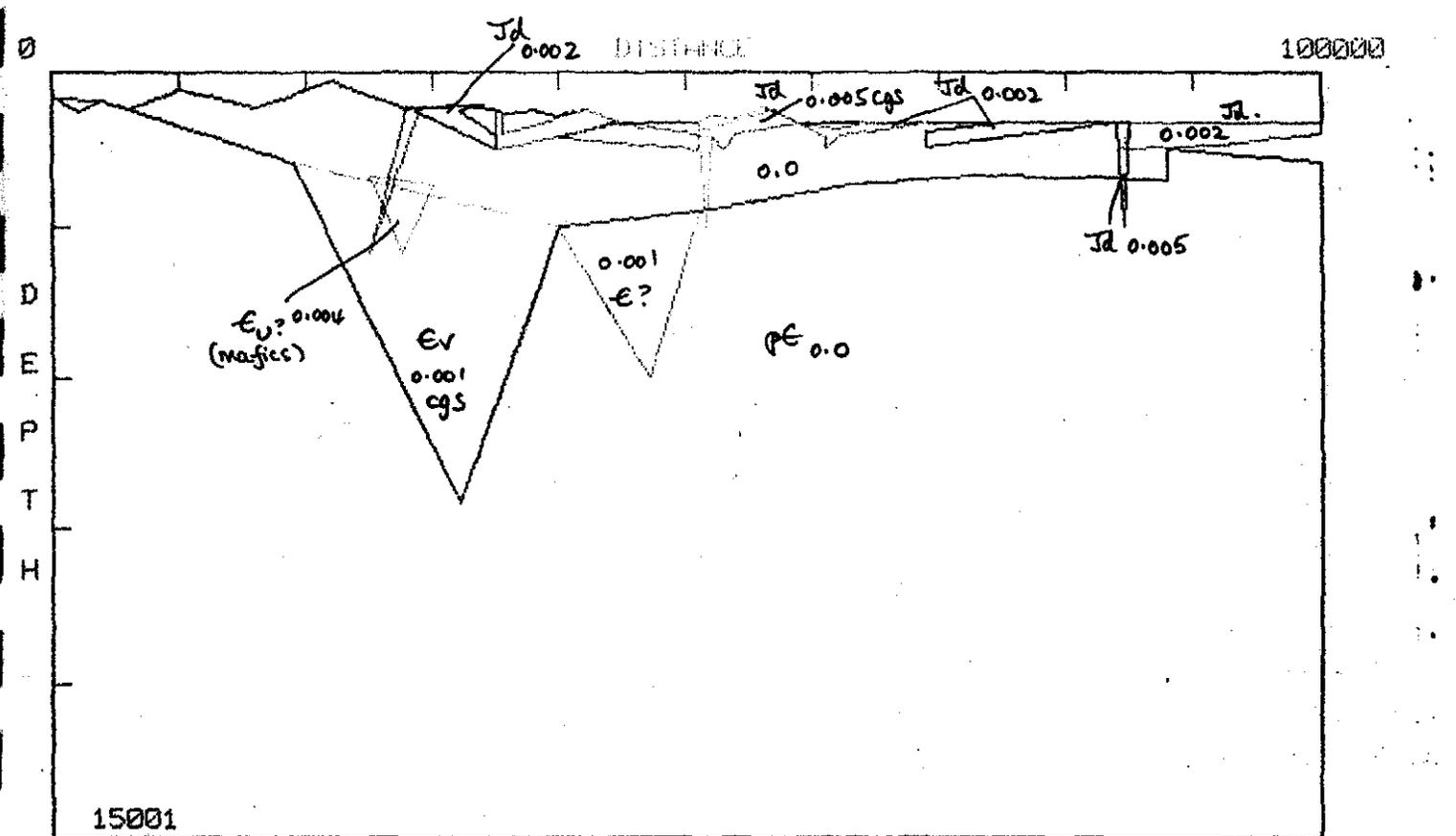
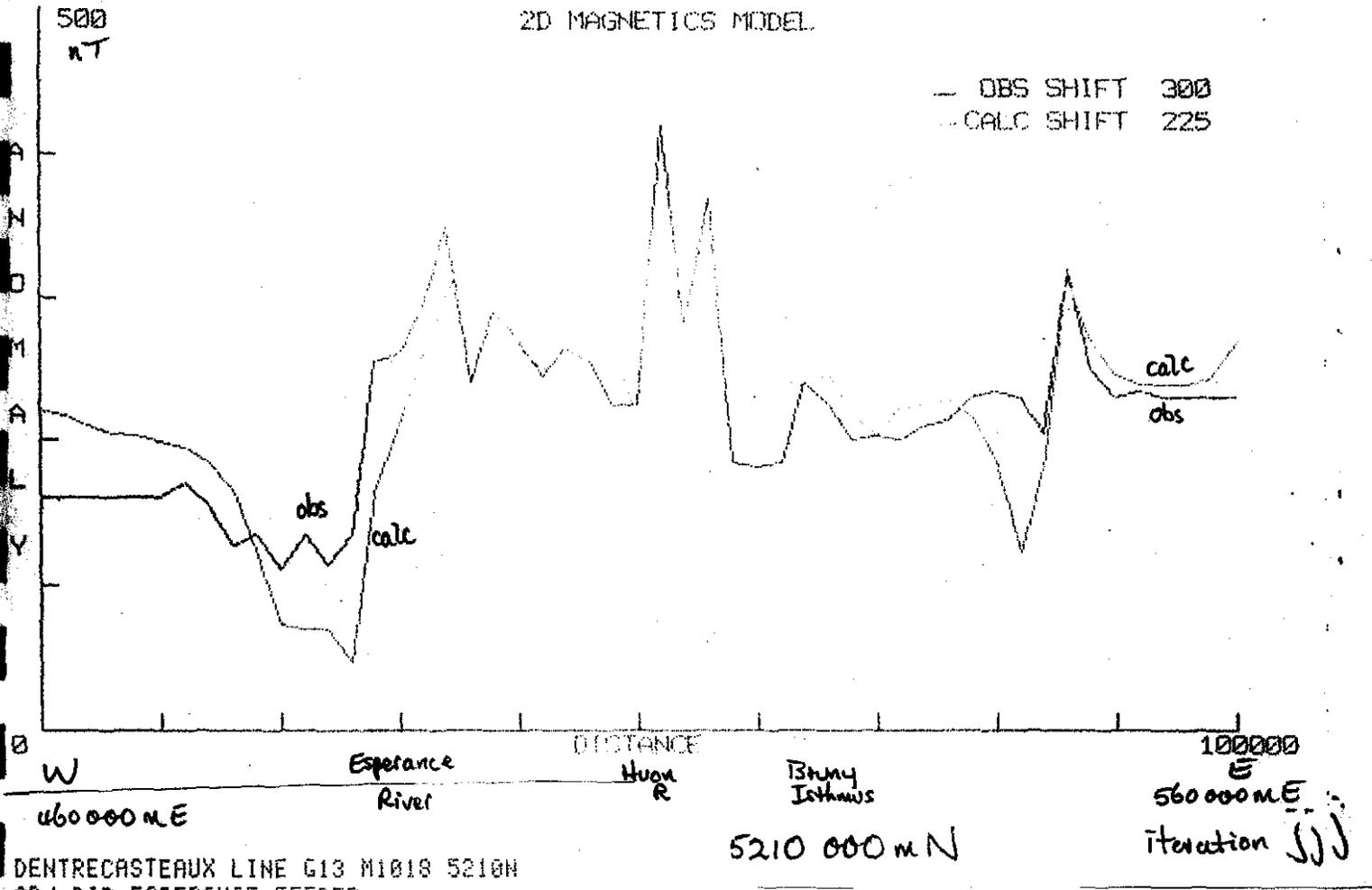
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## 2D MAGNETICS MODEL



071

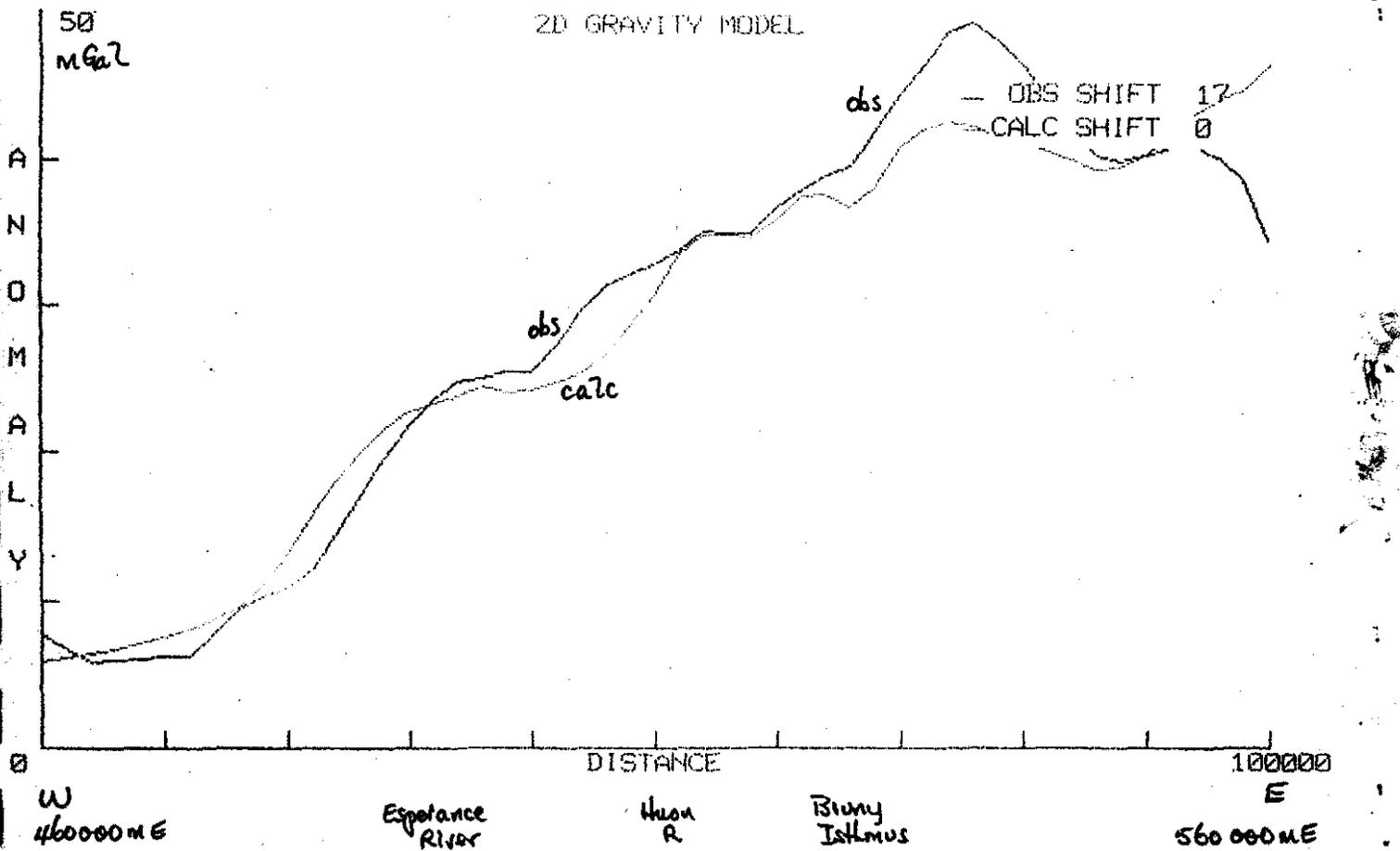
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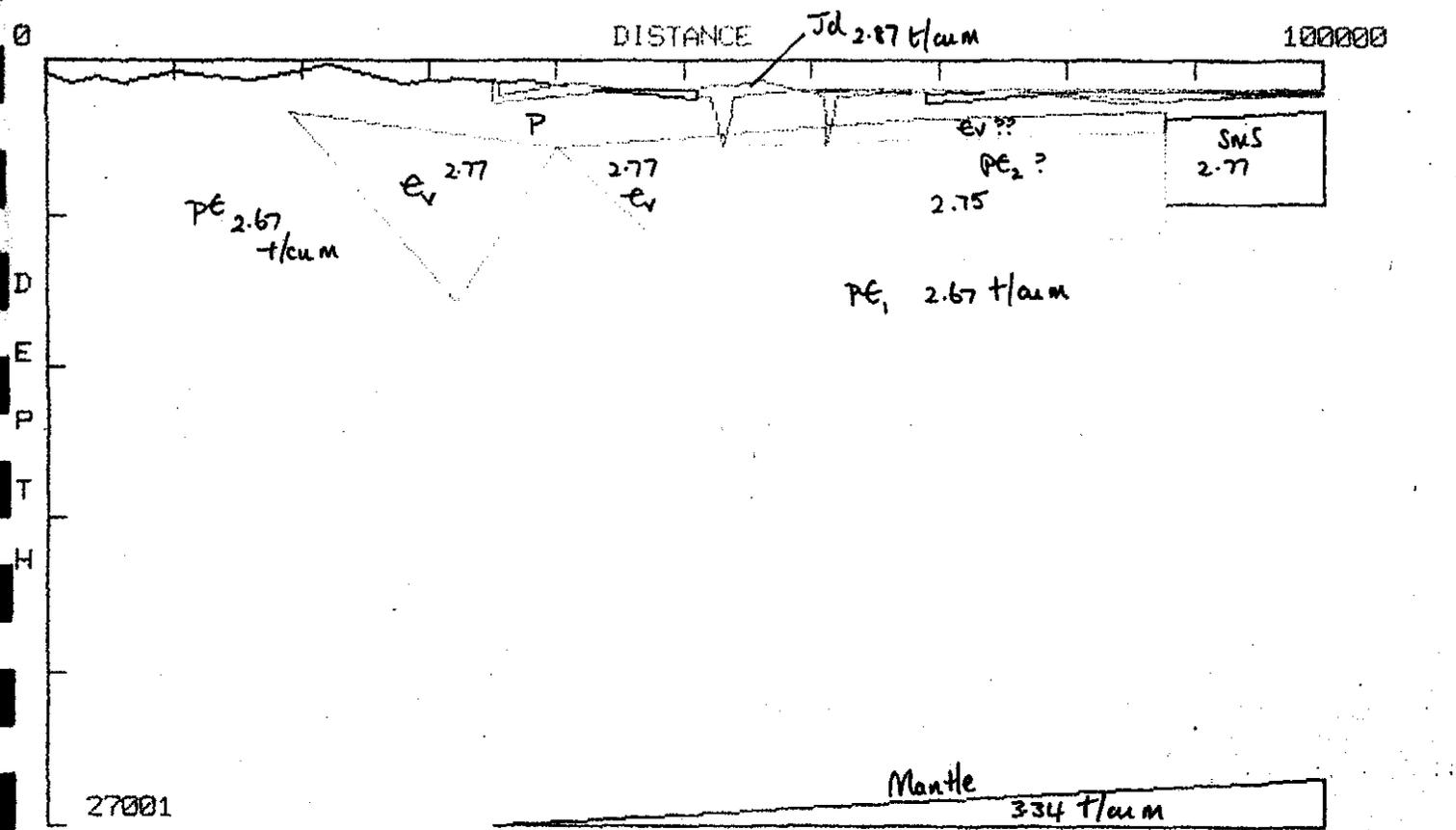
## 2D GRAVITY MODEL



DENTRECASTEAUX LINE 2  
ADJ 9 15

5210 000 mN

Iteration 4



27001

INTERIM GRAVITY INTERPRETATION SECTION 2 FIGURE 23  
(Emphasis on regional components at required shift balance)

072

870073

# LEAMAN GEOPHYSICS

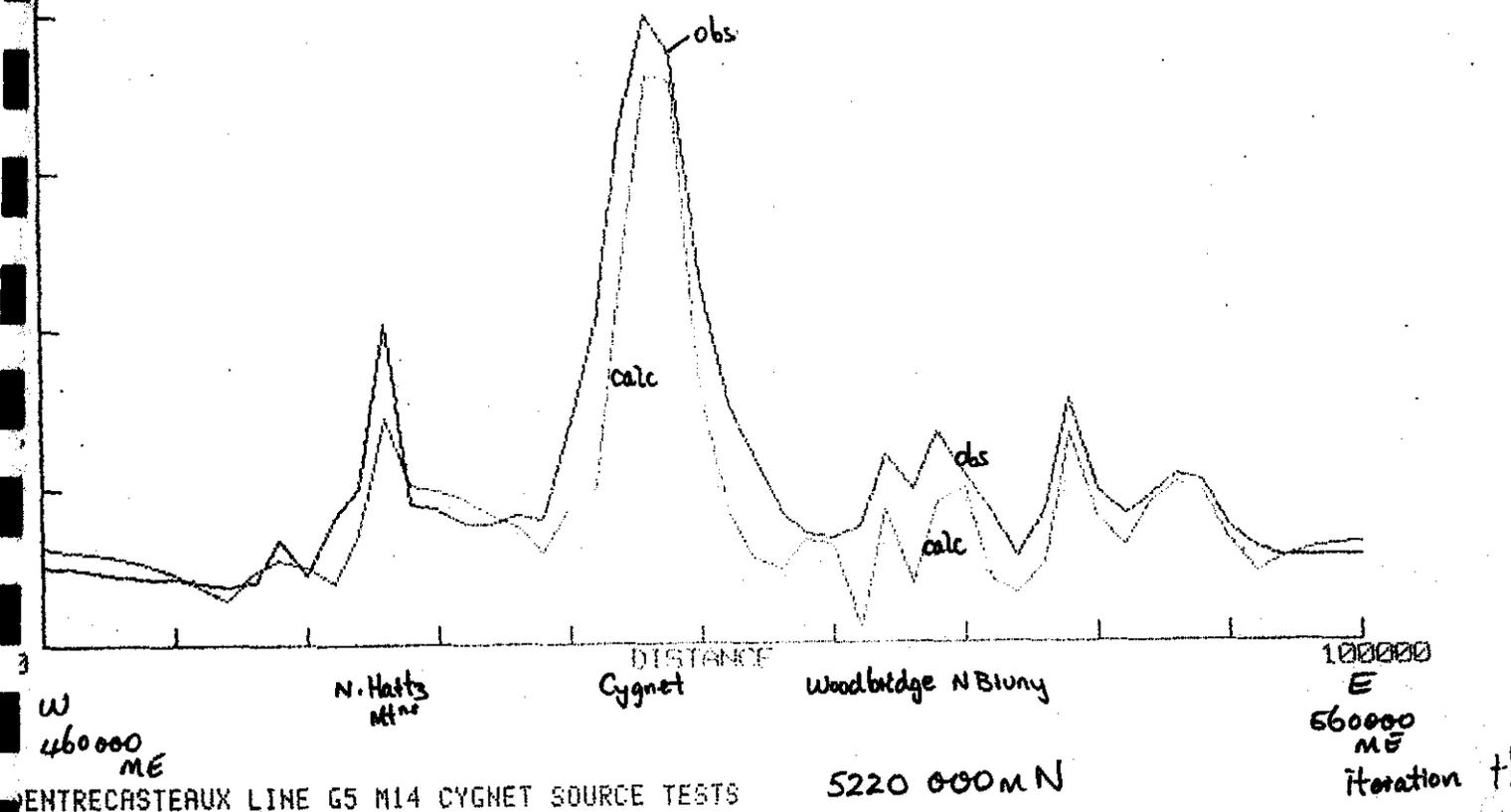
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## 2D MAGNETICS MODEL

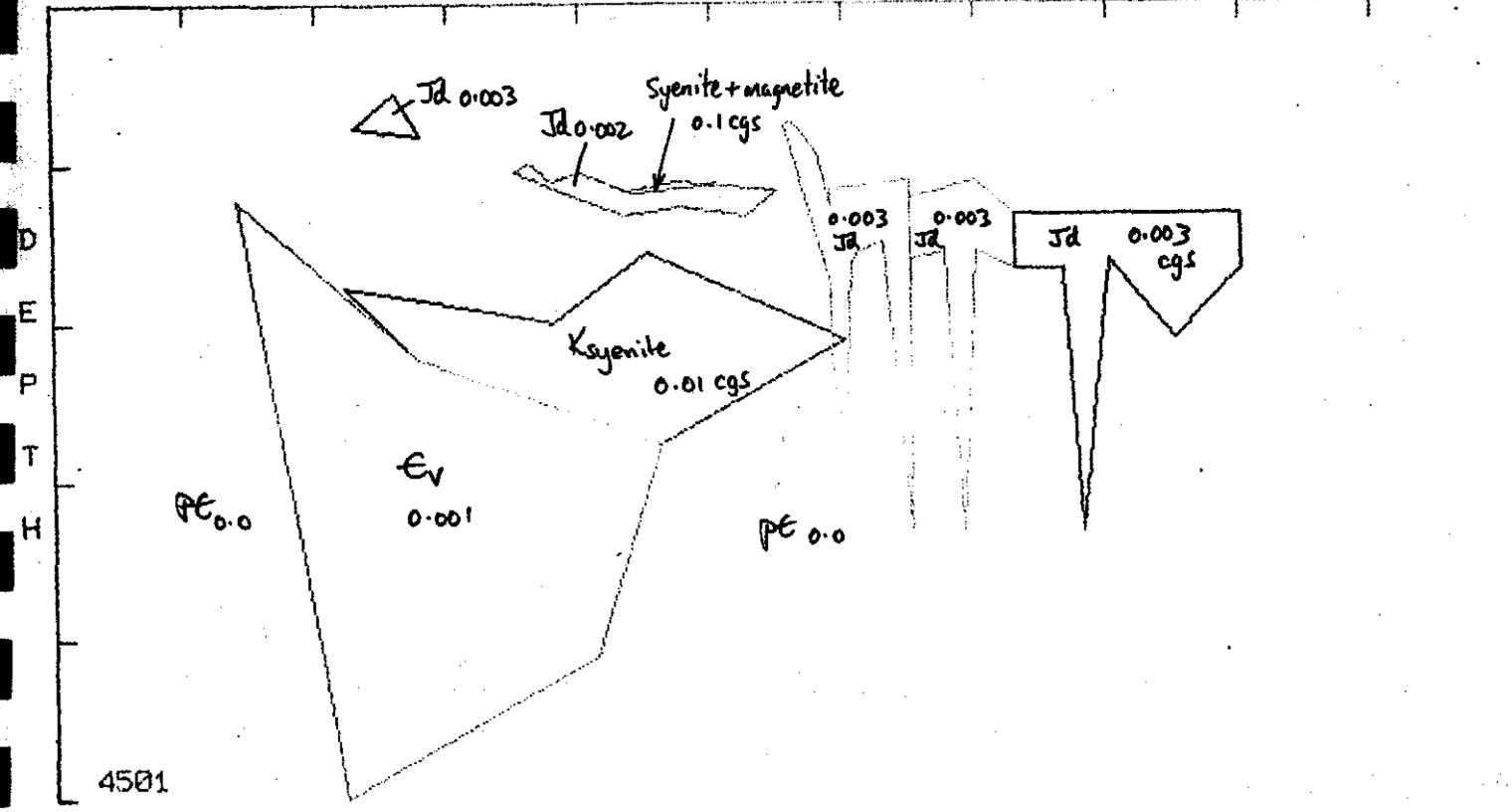
1000  
nT

... OBS SHIFT 250  
... CALC SHIFT 150



## DISTANCE

100000



4501

MAGNETIC INTERPRETATION SECTION 3  
(Cygnat anomaly AA dominant feature)

FIGURE 24

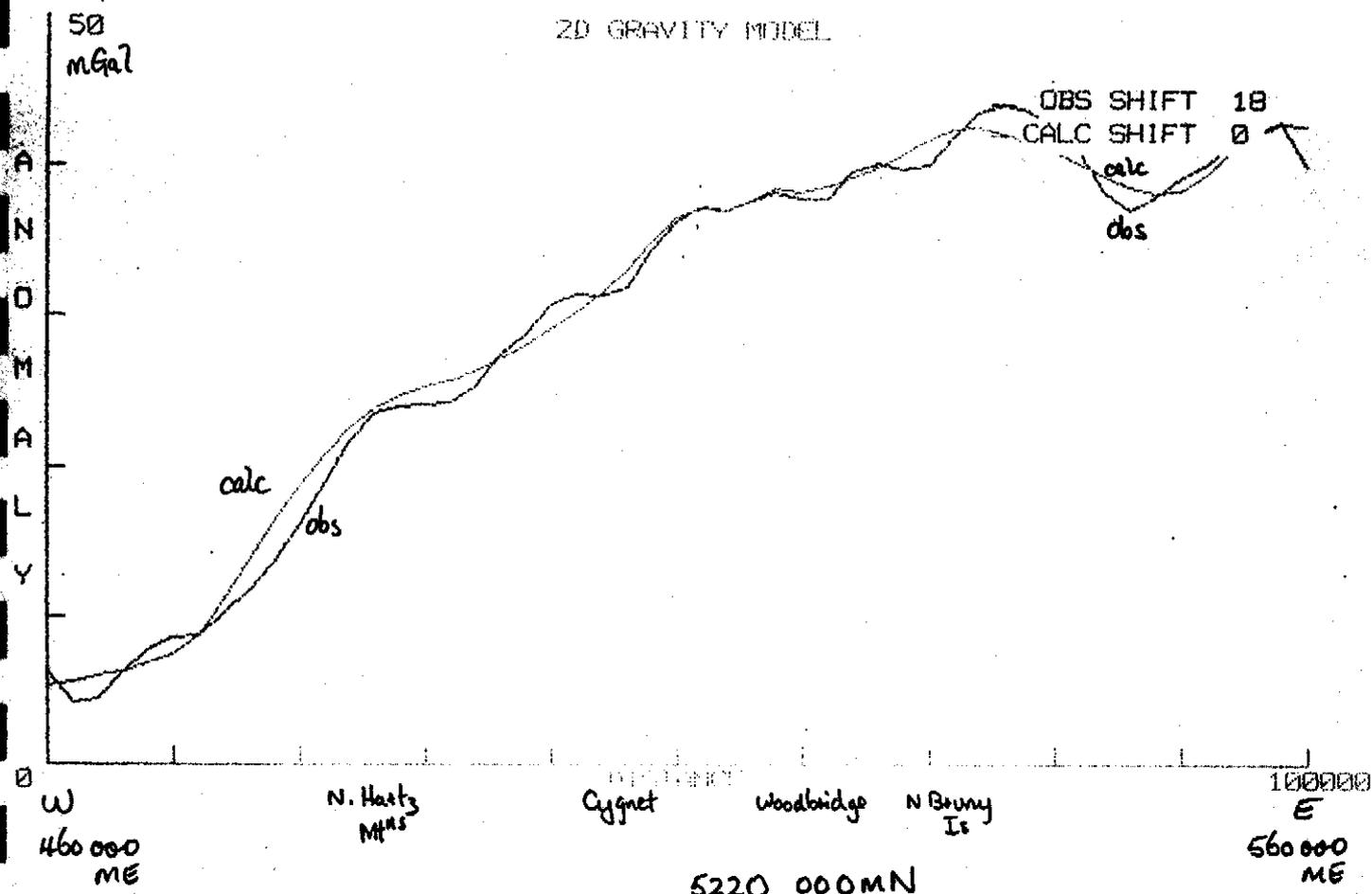
073

870074

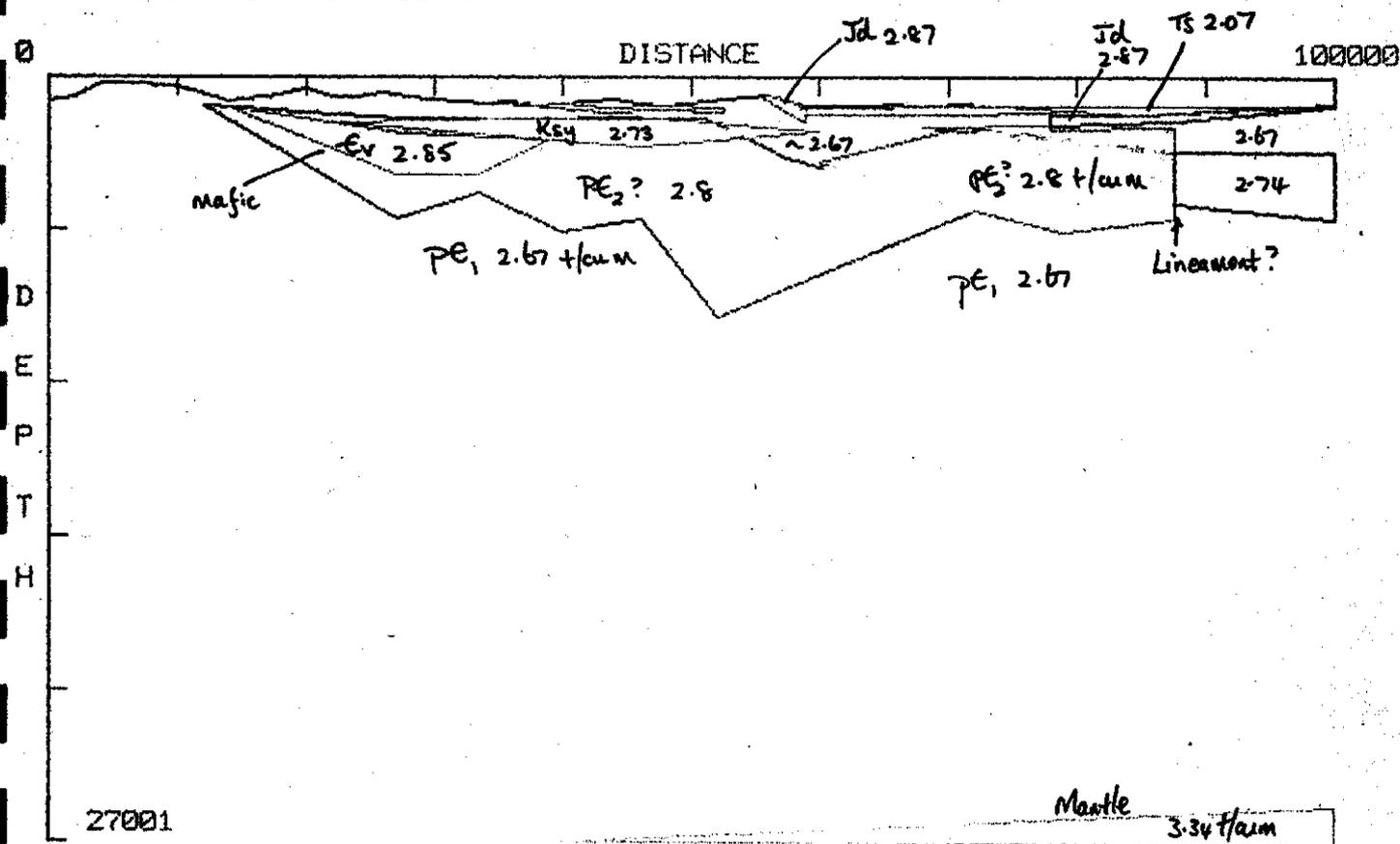
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DENTRECASTEAUX LINE 3  
ADD SYENITE AFTER MAG MODEL FORM



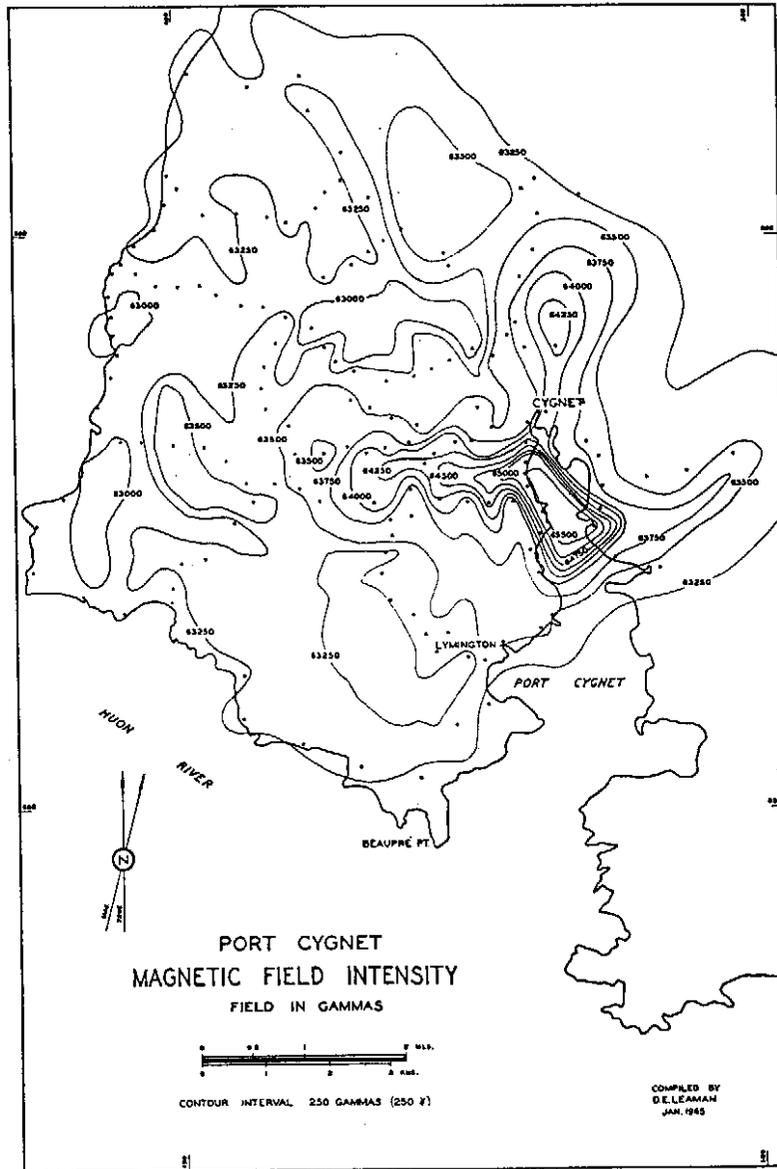


FIGURE 15.

5 cm

075

870076

CYGNET

# MAGNETIC SURVEY PORT CYGNET

D.E. LEAMAN 1974

Contour Interval 100 nT (up to 2000 nT)

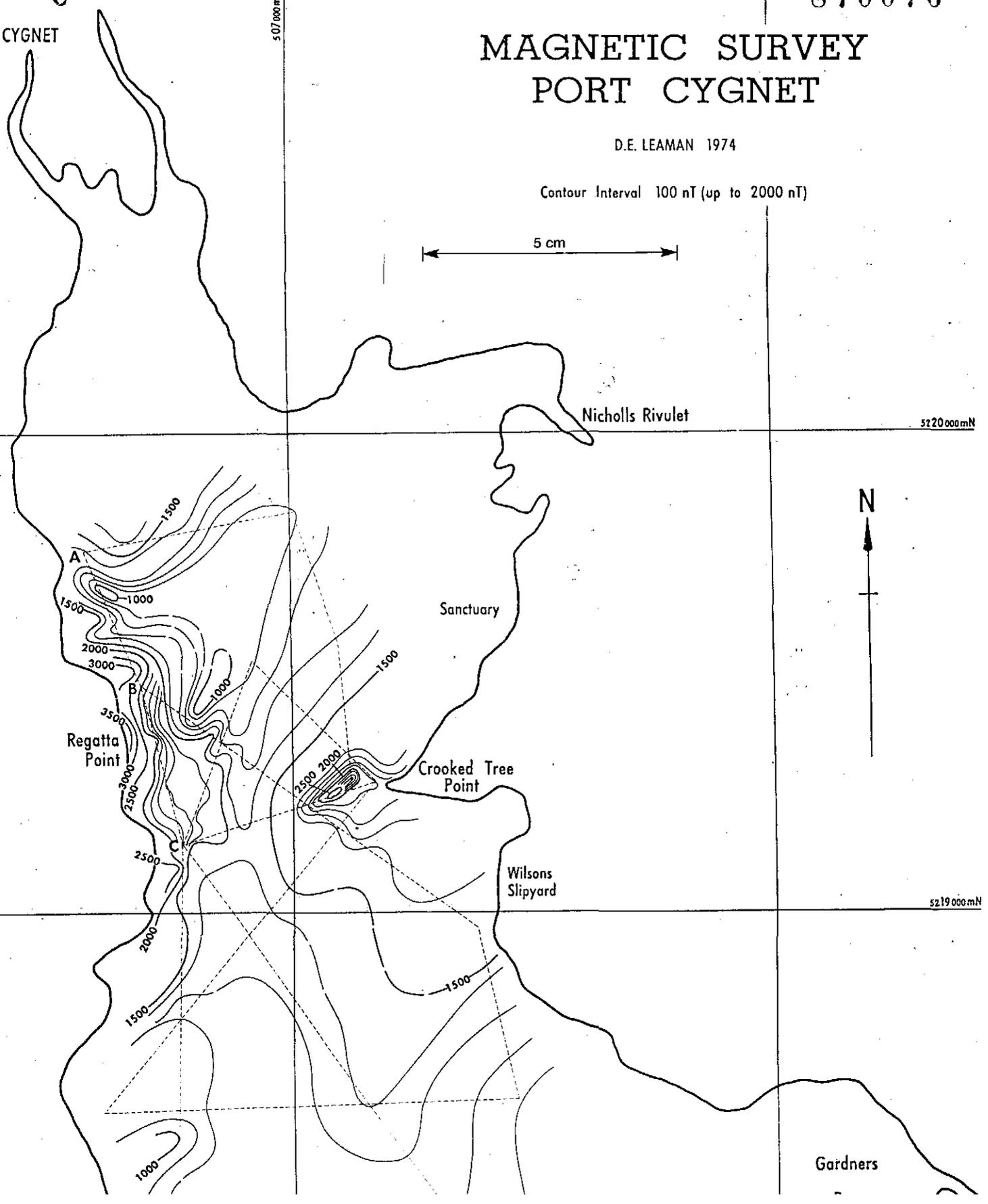
5 cm

507000mE

520000mN

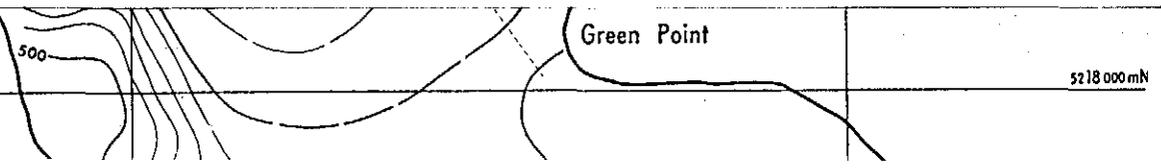


5219000mN



MAGNETIC FIELD ACROSS PORT CYGNET - MARINE SURVEY  
from Leaman (1975b)

FIGURE 27



076

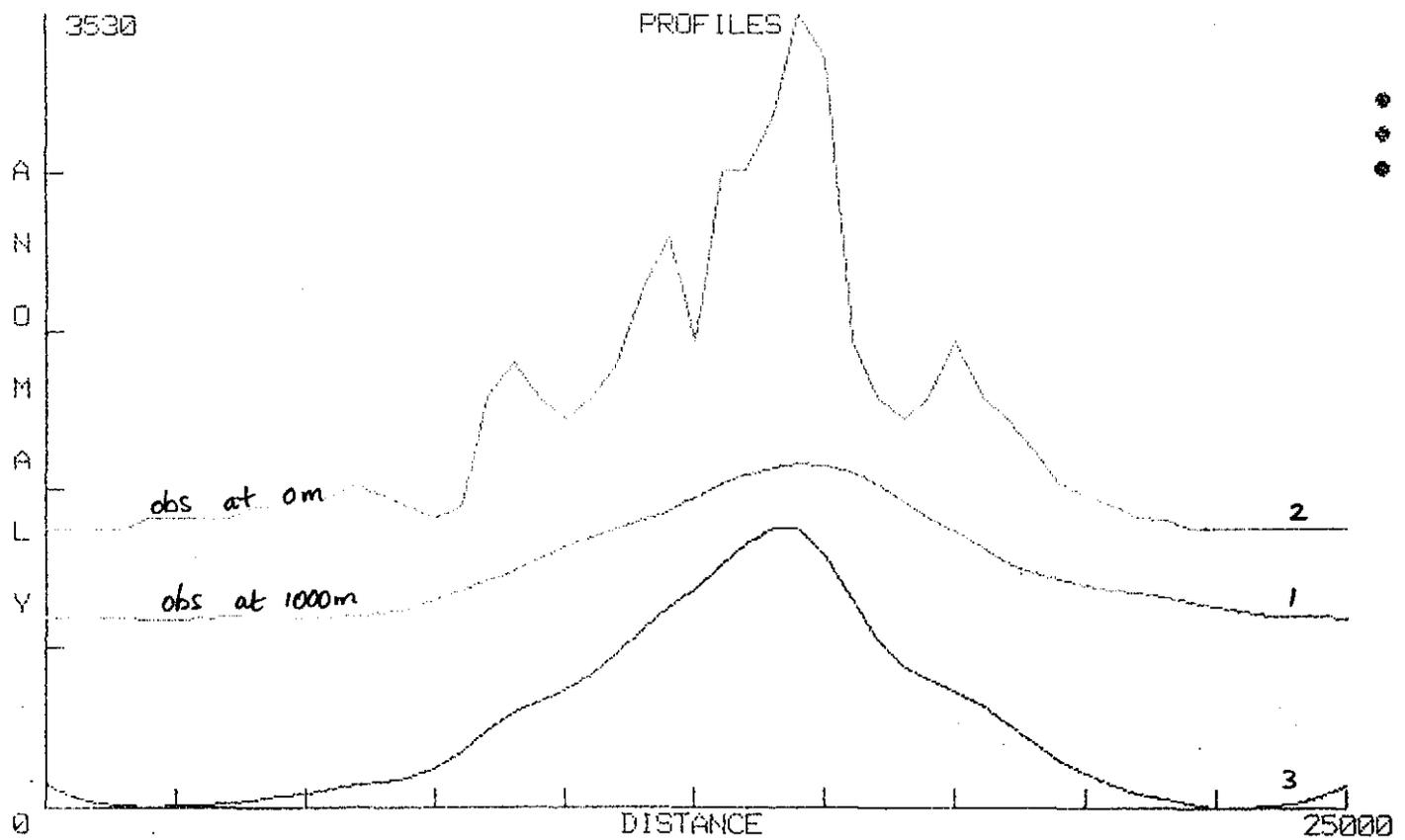
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1 B-CYGNETM.OBS CYGNET AEROMAGNETICS PROFILE 5220 N AT 1000 M  
2 B-CYGNETMS.OBS  
CYGNET SURFACE MAGNETICS PROFILE 5220 N  
3 B-CYGNETM.CON CYGNET SURFACE DATA 5220 M CONTINUED TO 1000 M  
ZERO SHIFT : 328,3345



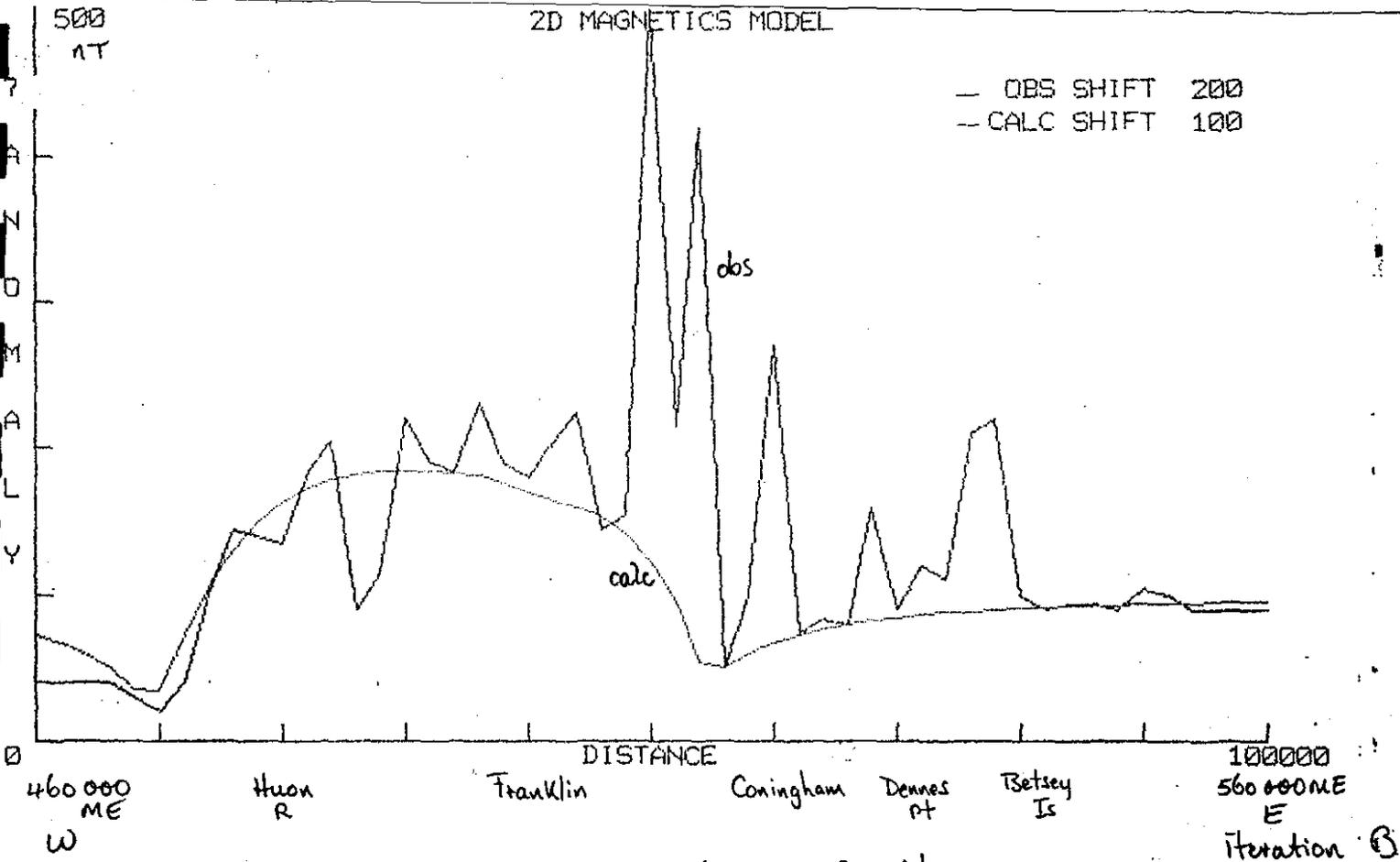
492000 ME  
W

517000  
ME  
E

COMPARISON OF CONGA AEROMAGNETIC DATA AT 1000 M AND CONTINUATIONS OF SURFACE DATA  
FIGURE 28

2D MAGNETICS MODEL

— OBS SHIFT 200  
 — CALC SHIFT 100

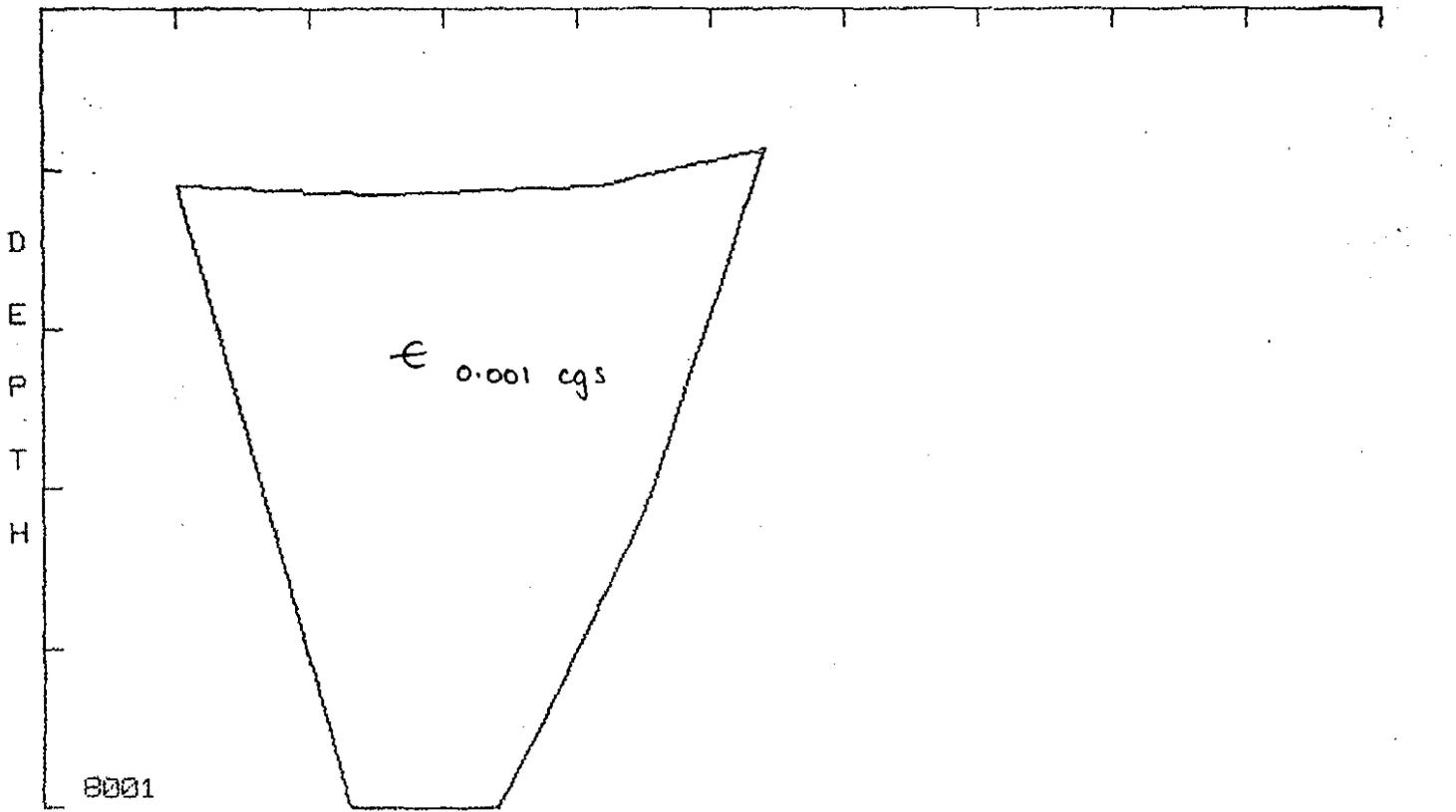


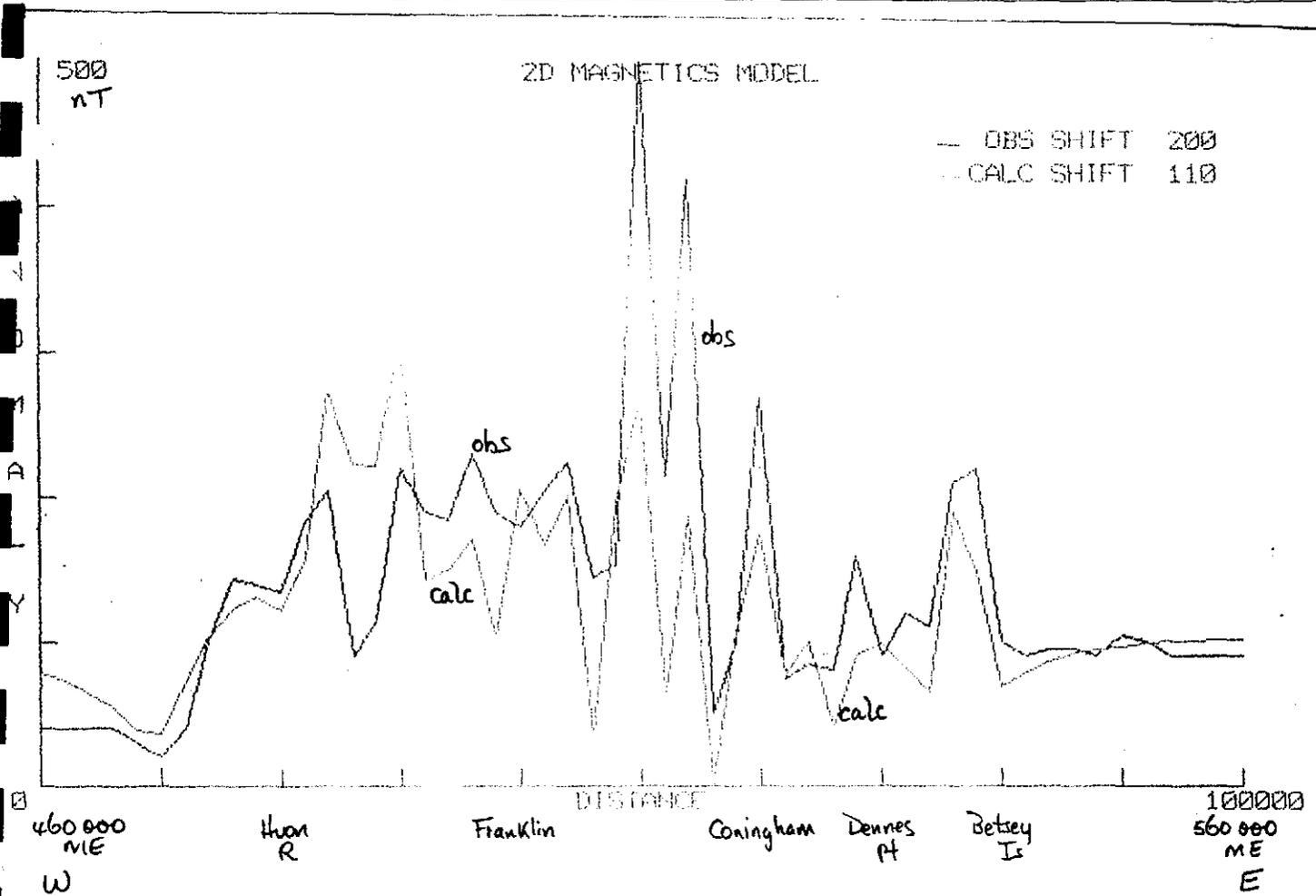
DENTRECASTEAUX LINE G14 M1010 5230N  
 ADJ BASEMENT FORM

5230 000 MN

Iteration 6

DISTANCE 100000

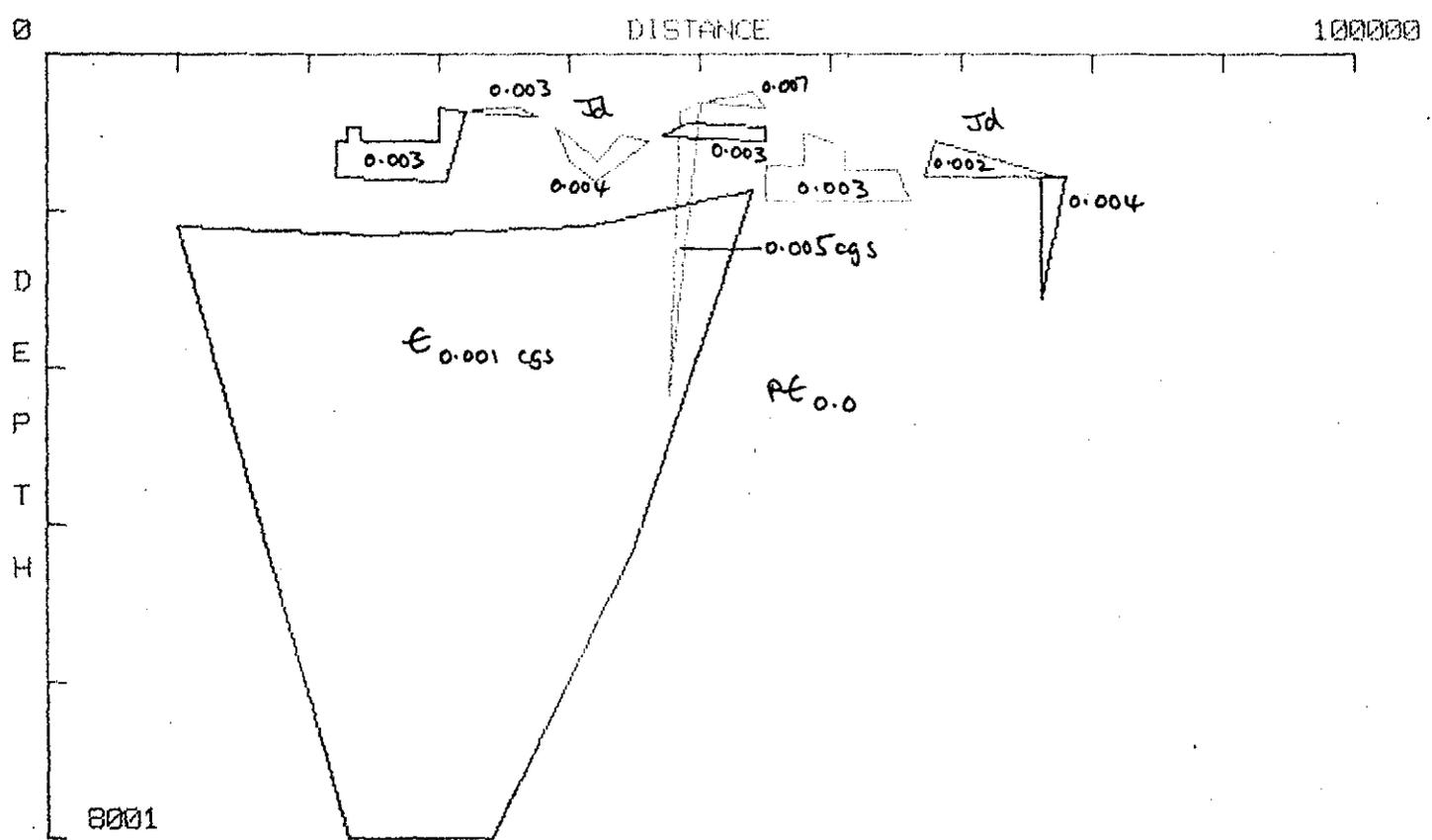




DENTRECASTEAUX LINE G14 M1010 5230N  
ADJ K8 TO 004 + 9 10 WESTERN DOLERITES

5230 000 MN

iteration G



079

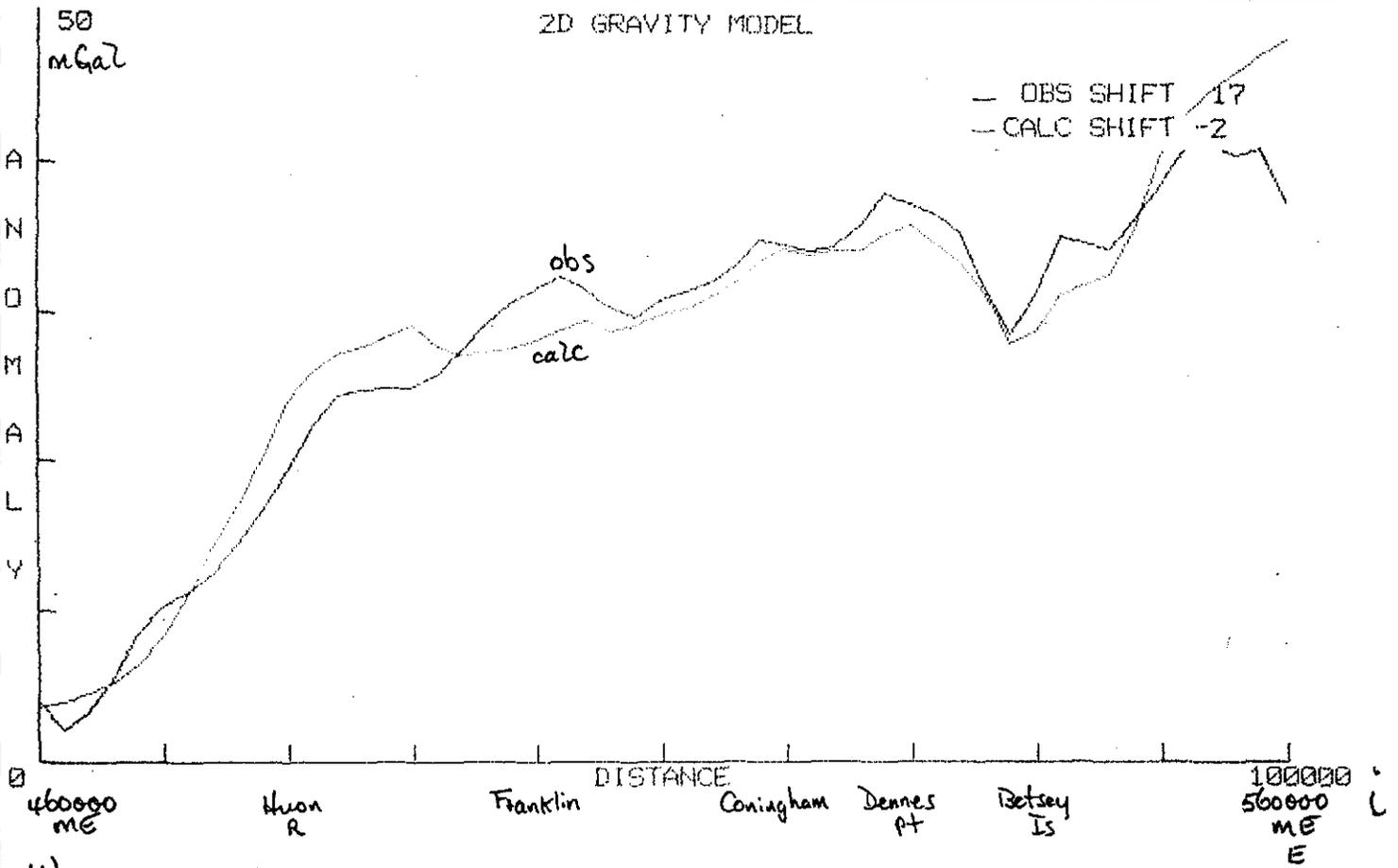
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870080

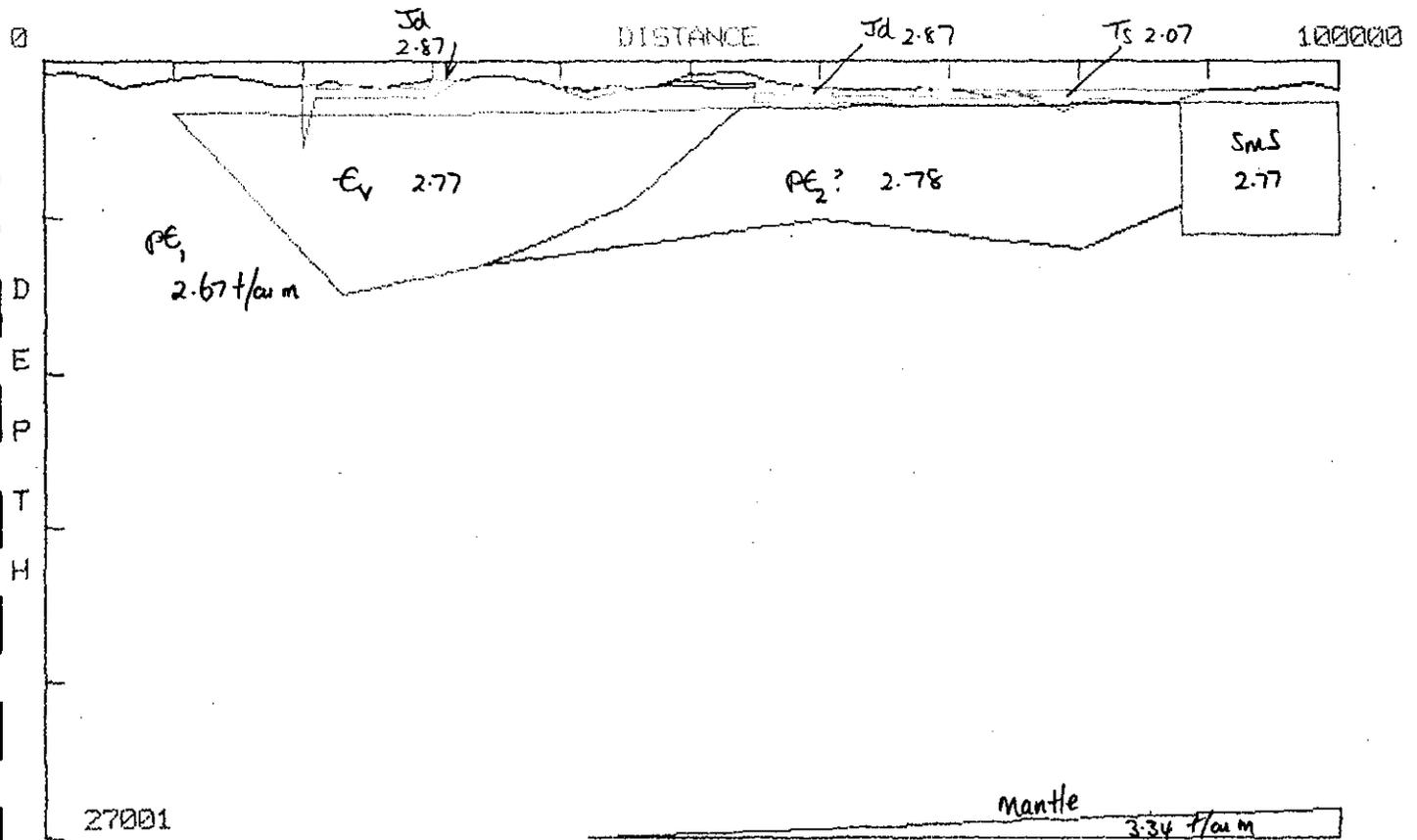
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## 2D GRAVITY MODEL



DENTRECASTEAUX LINE 4  
ADJ 11

5230 000 mN



ADVANCED GRAVITY INTERPRETATION SECTION 4  
(Dolerite fine detail not included)

FIGURE 31

080

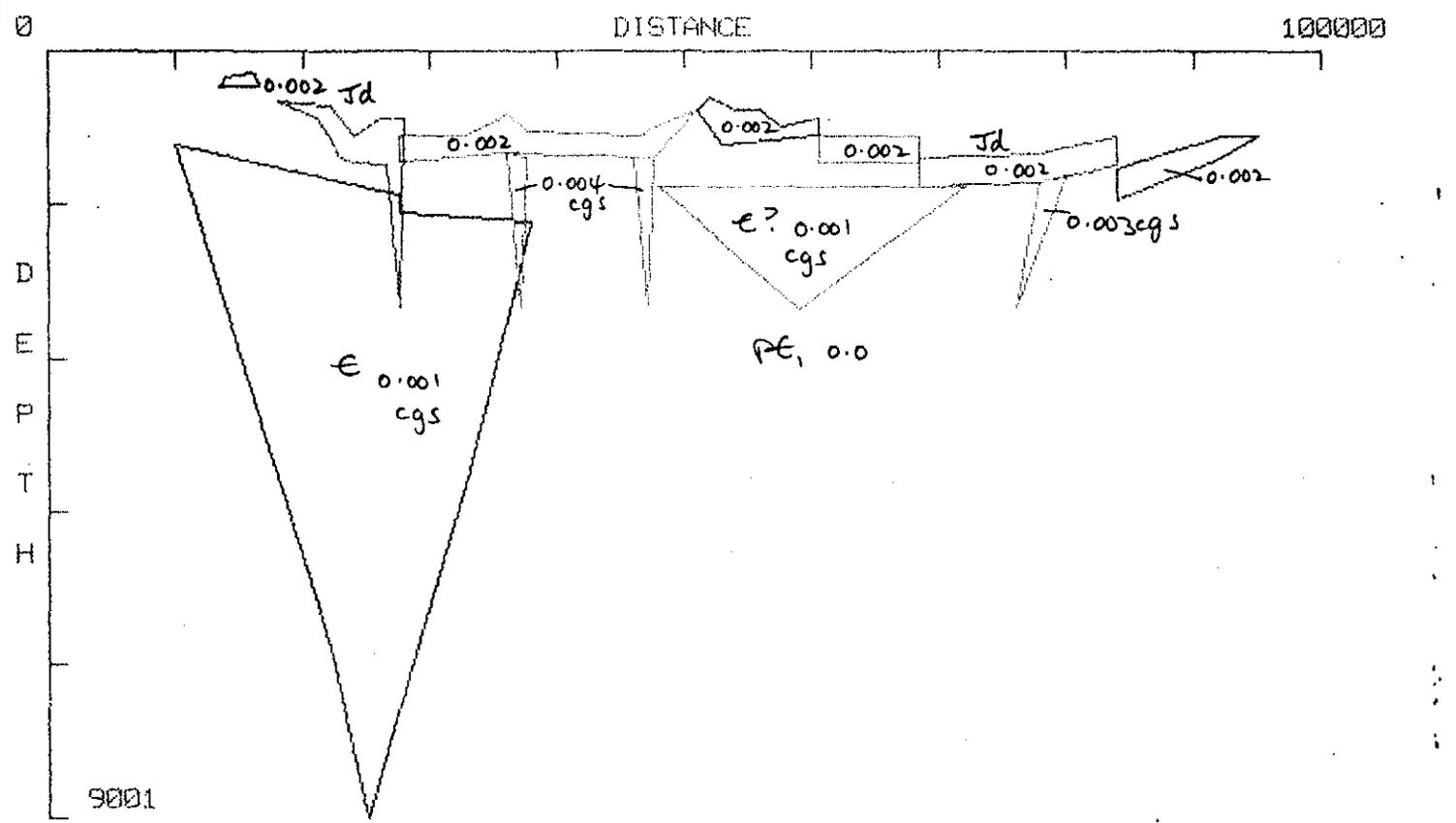
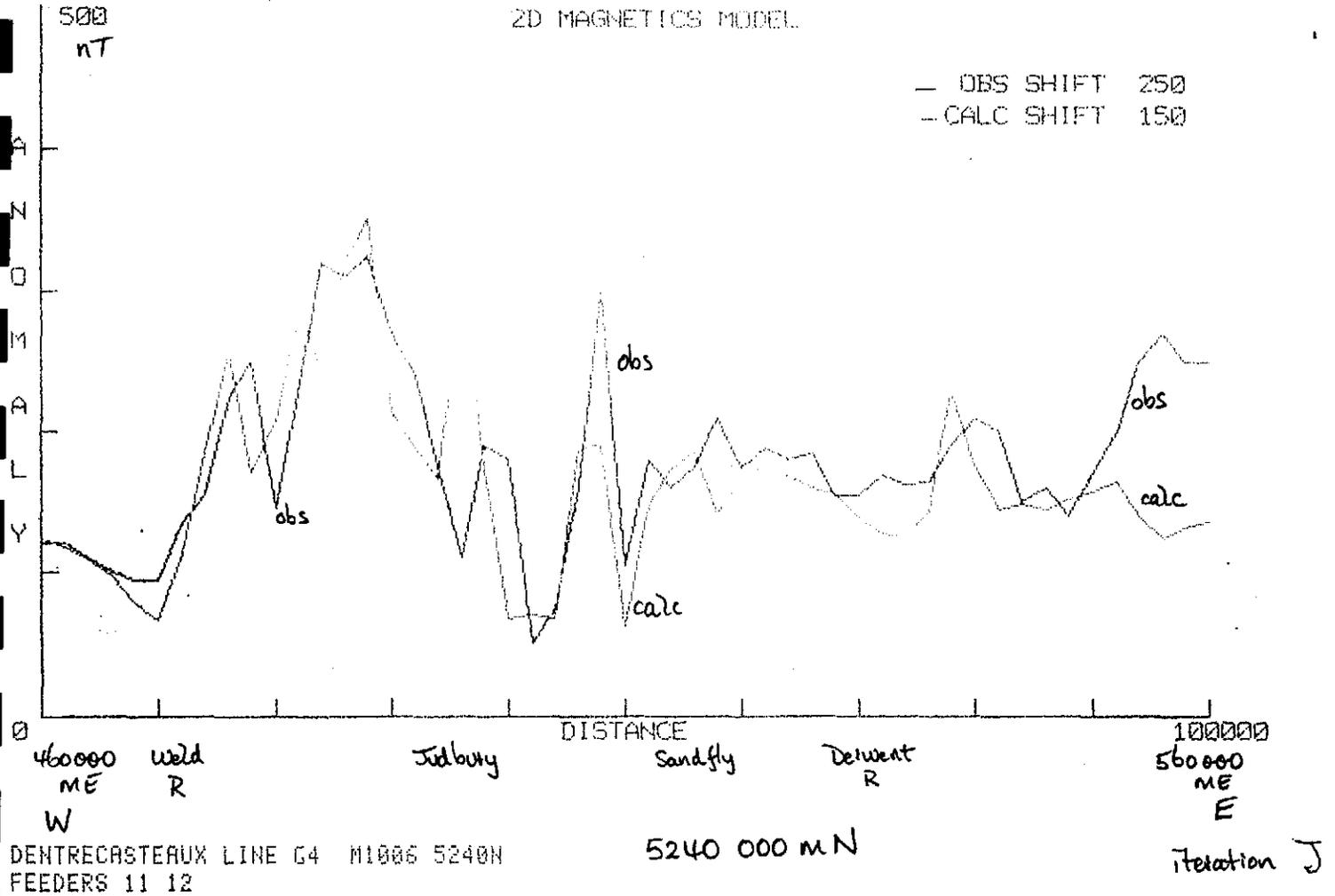
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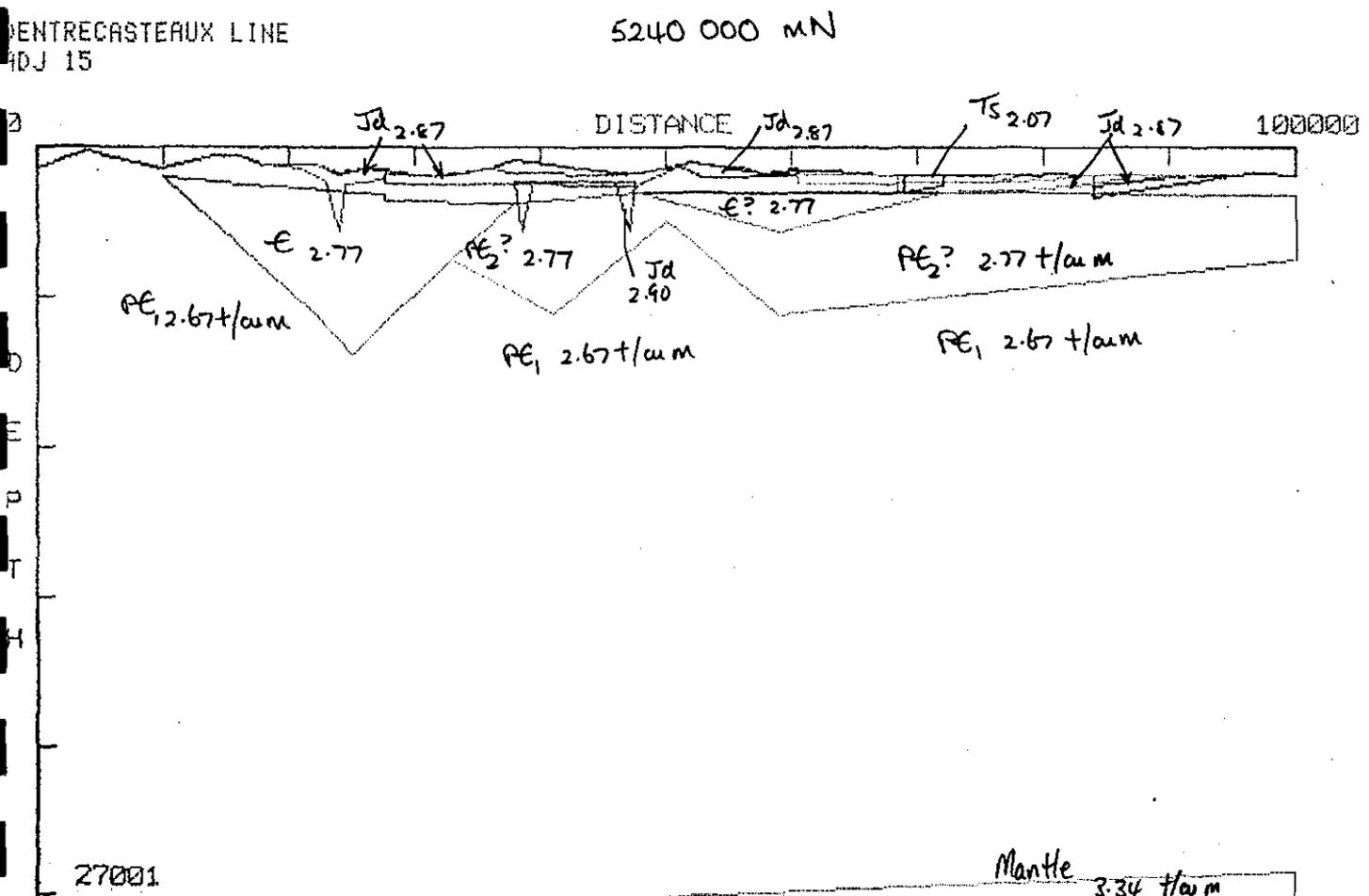
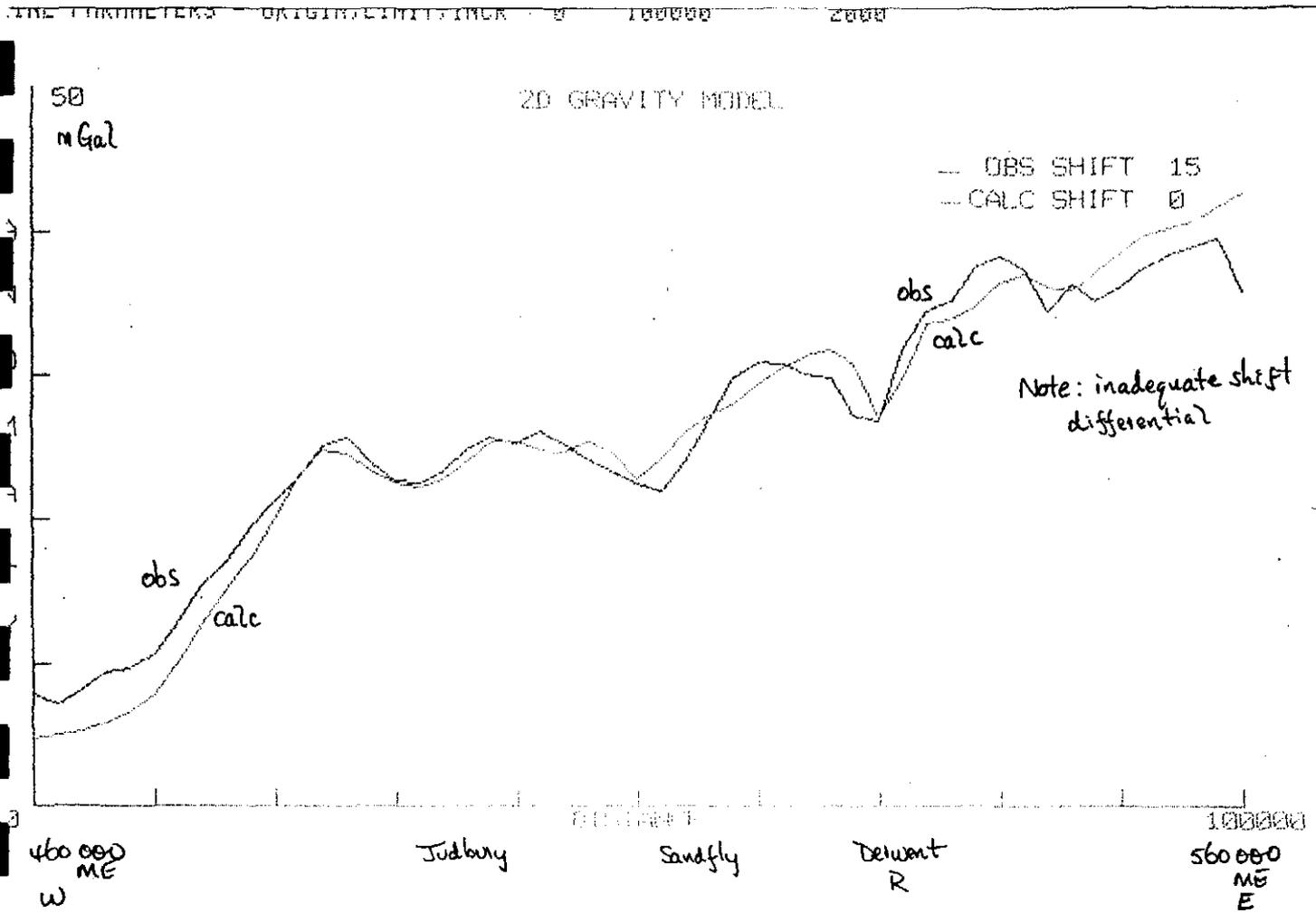
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## 2D MAGNETICS MODEL



MAGNETIC INTERPRETATION SECTION 5

FIGURE 32



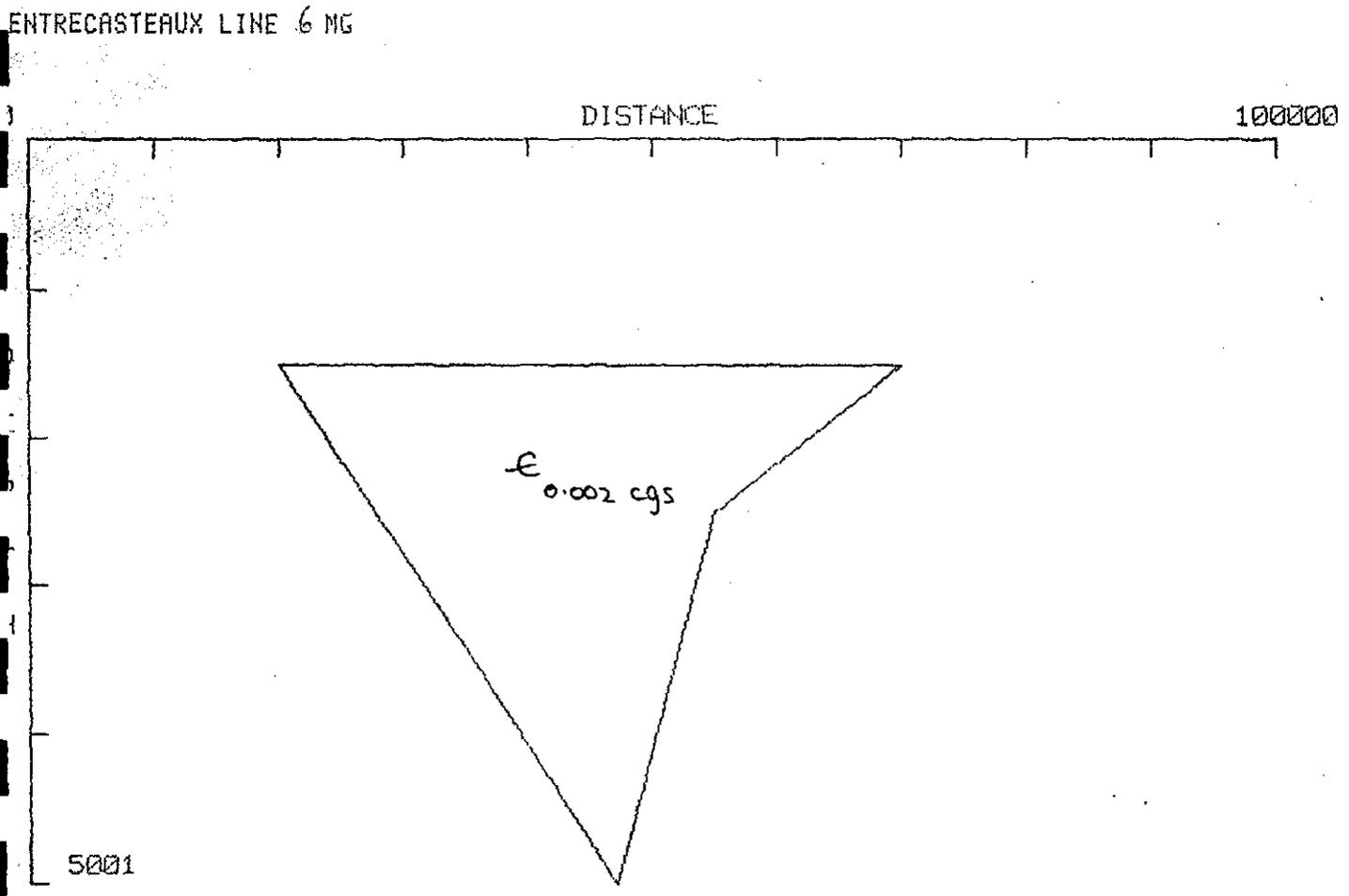
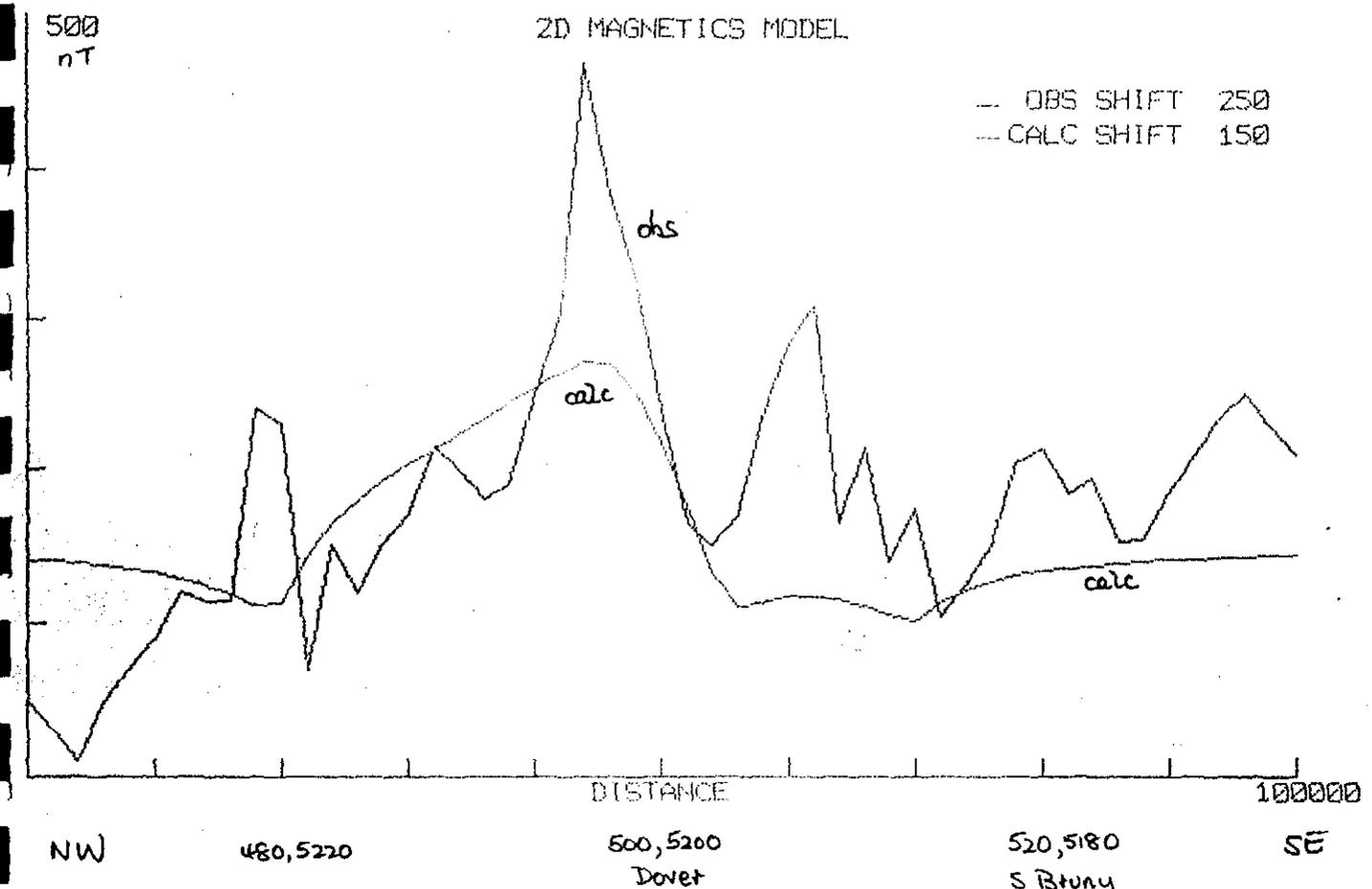
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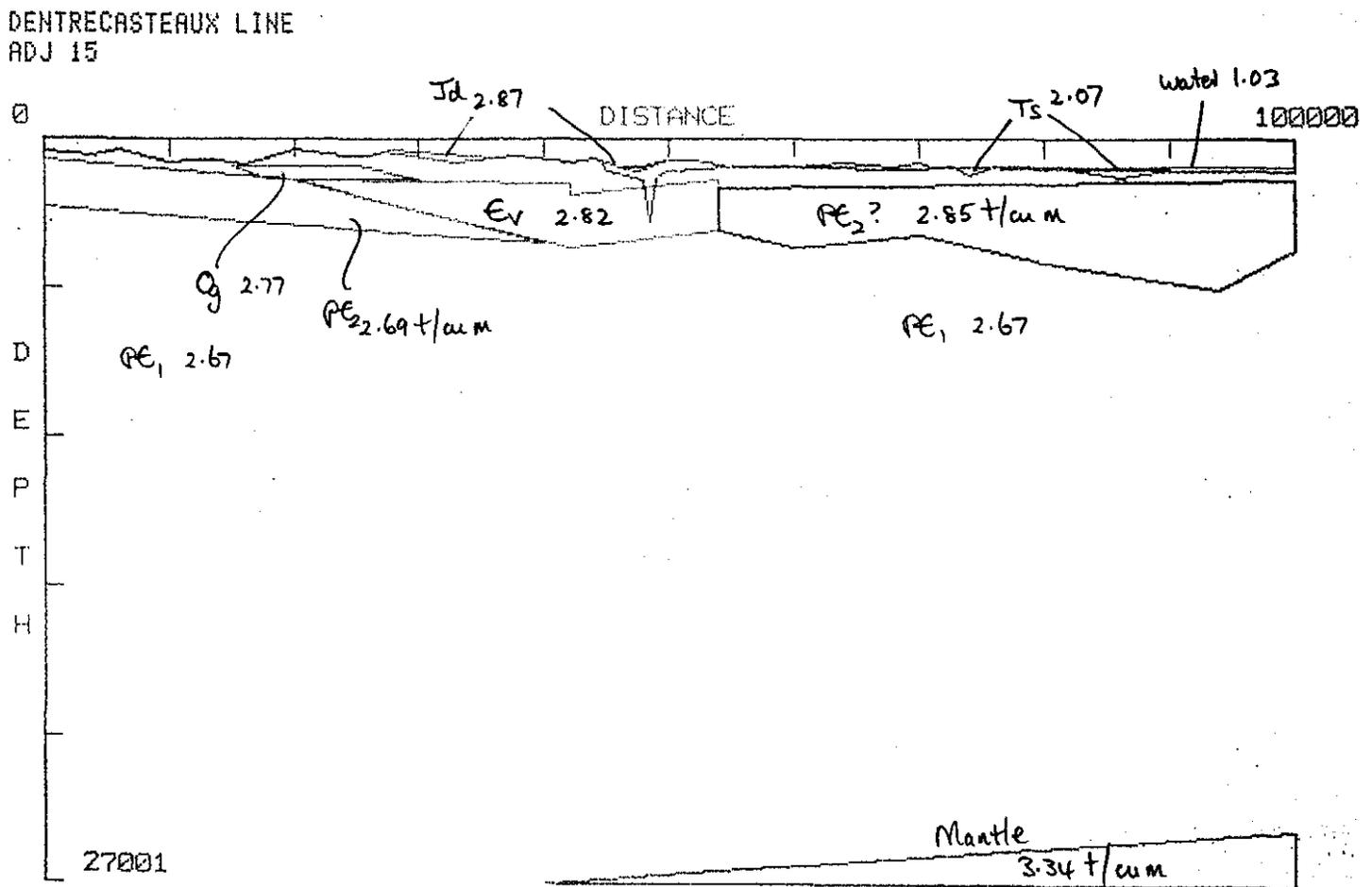
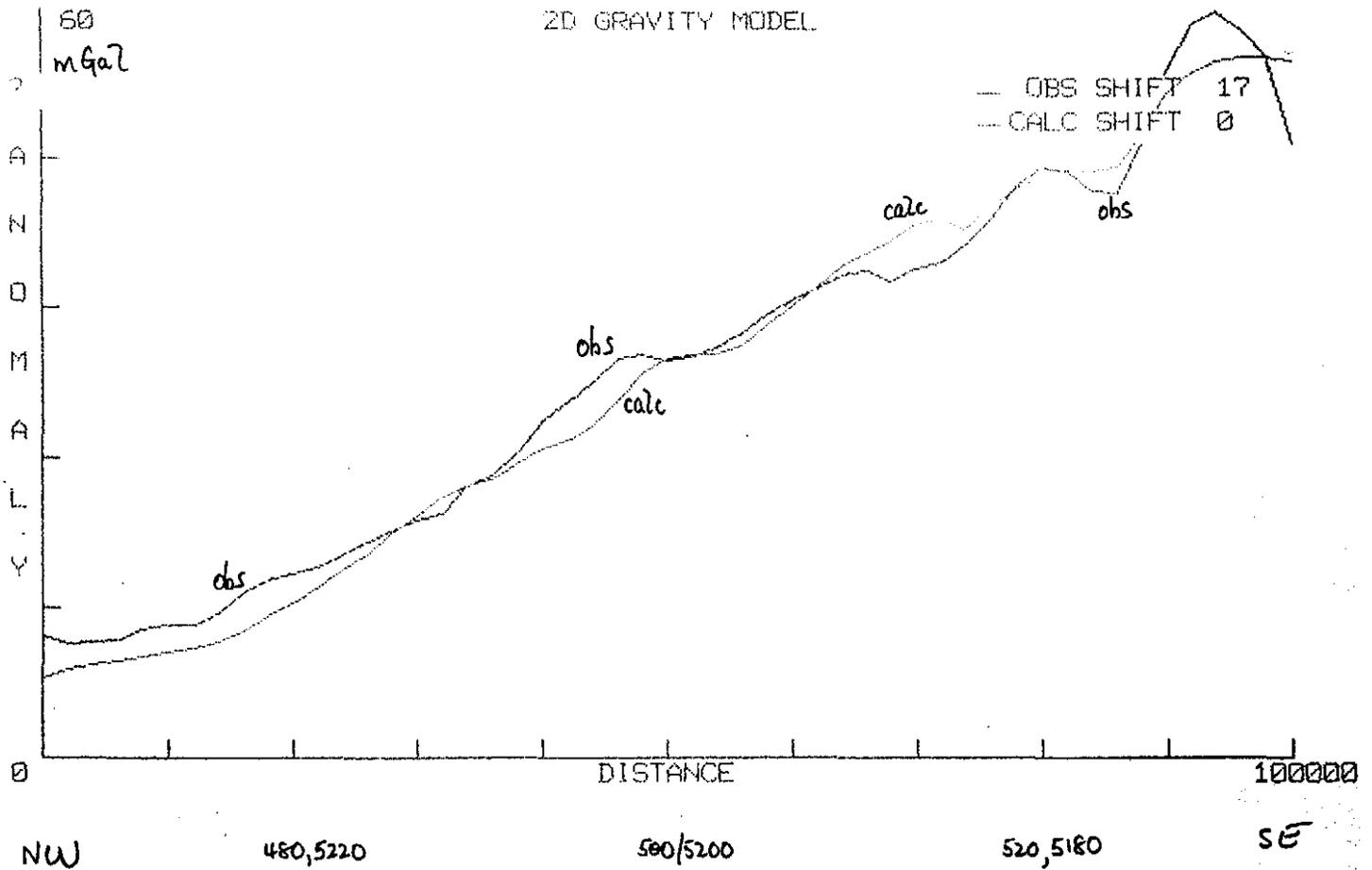
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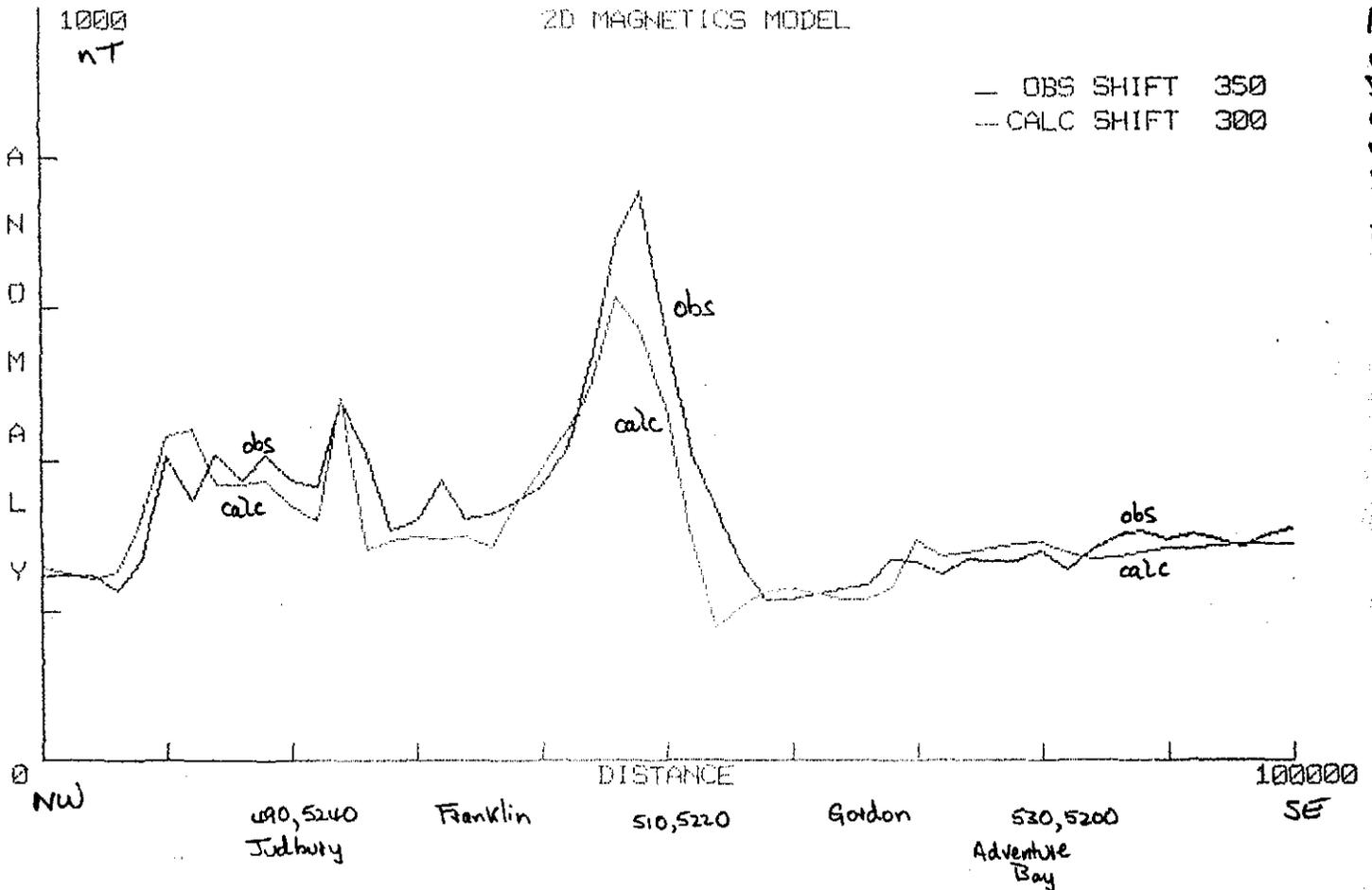
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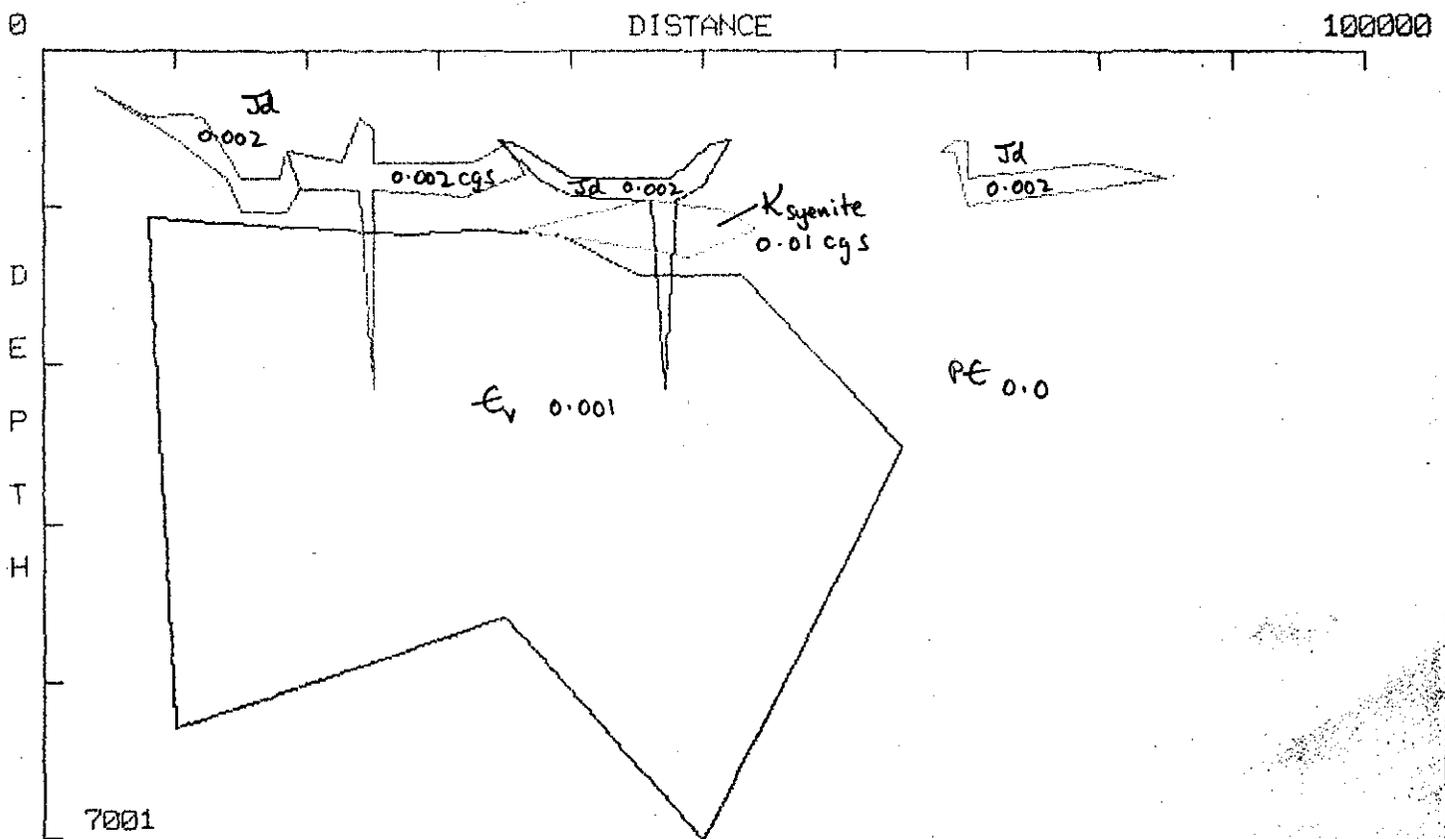
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DENTRECASTEAUX LINE MG2  
ADJ 2 5 + 6



085

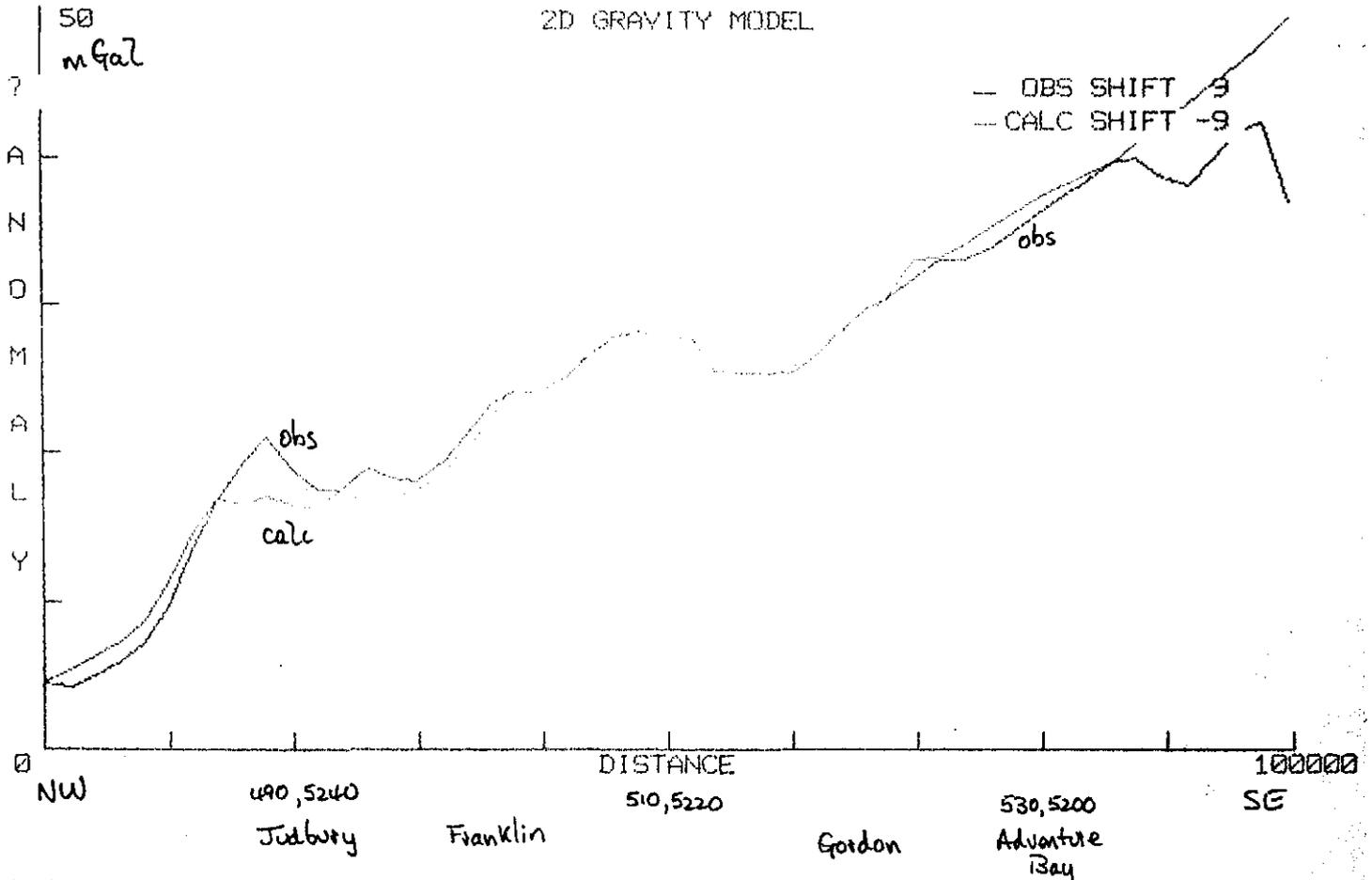
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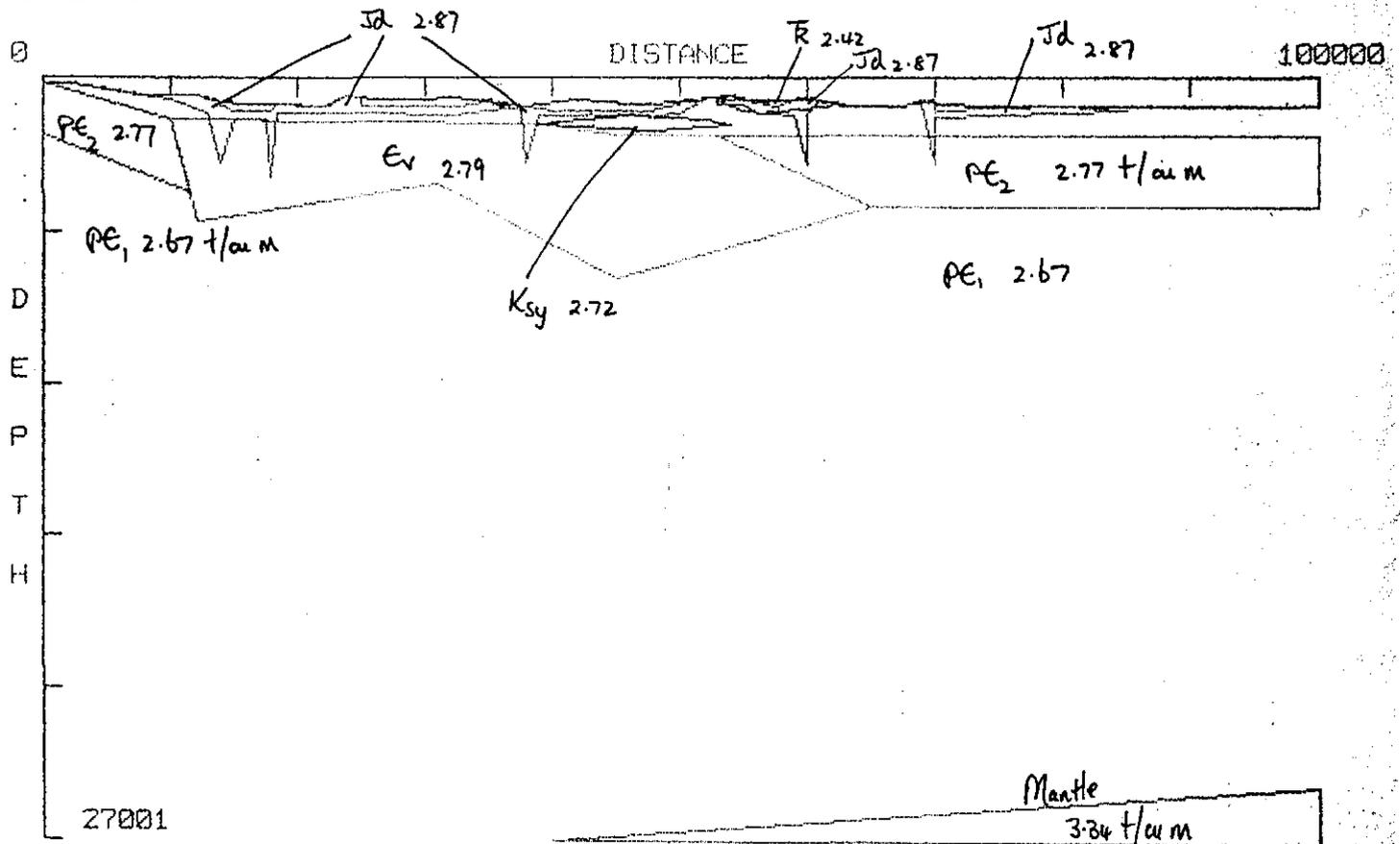
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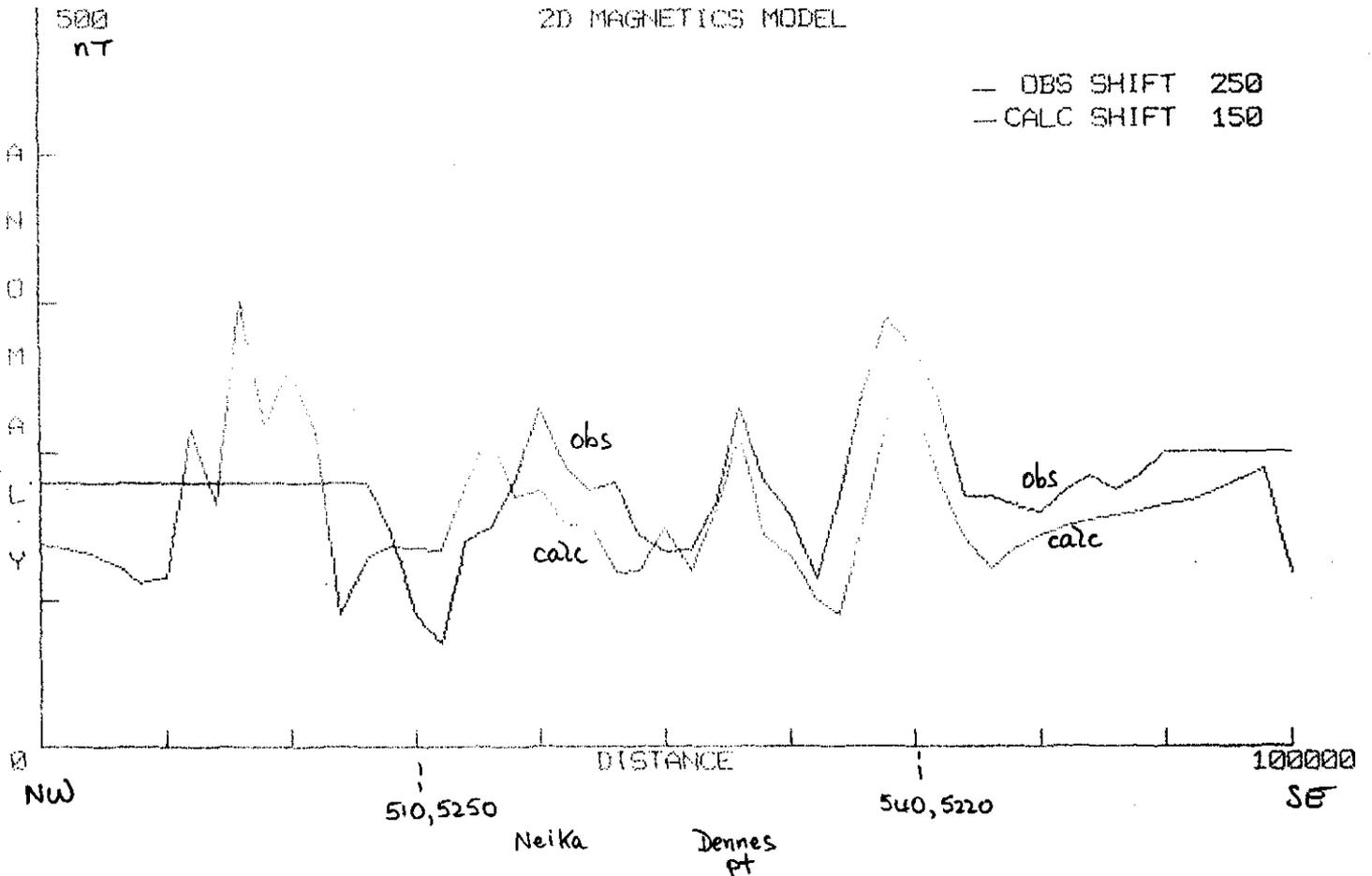
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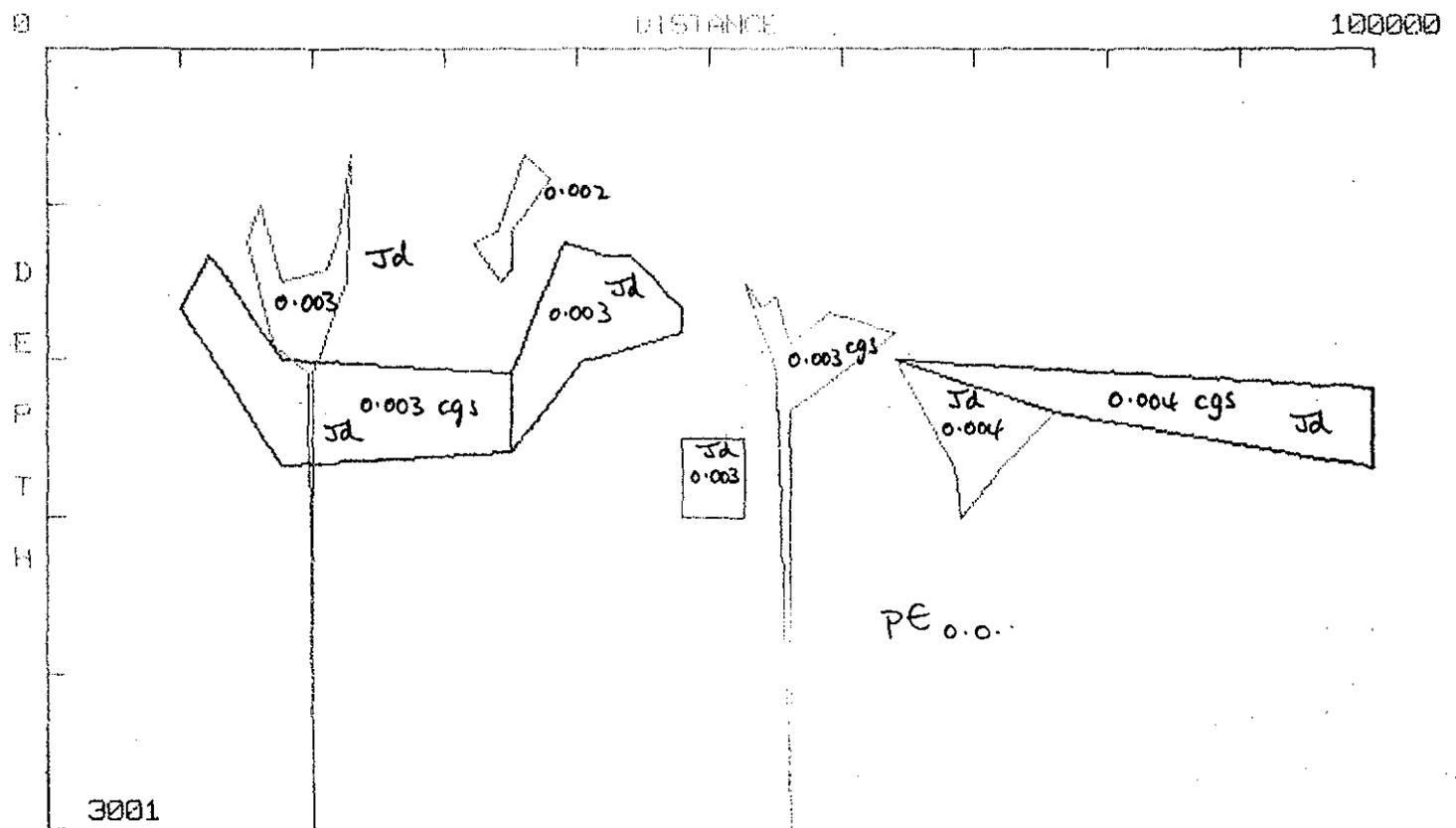


DENTRECASTEAUX LINE 7  
ADJ 2 3 6 13





DENTRECASTEAUX LINE MG1  
ADJ 4 6 K7=004



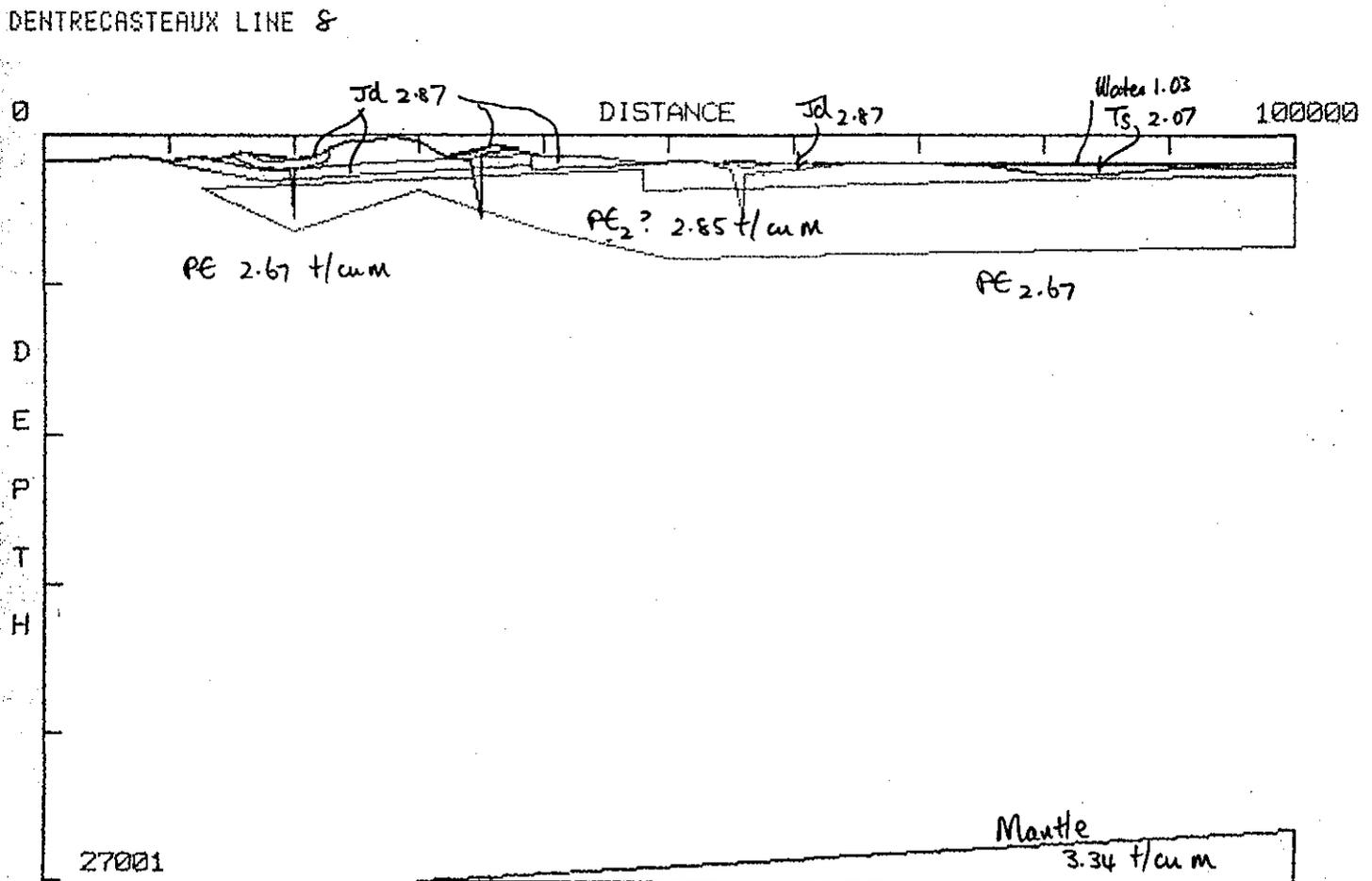
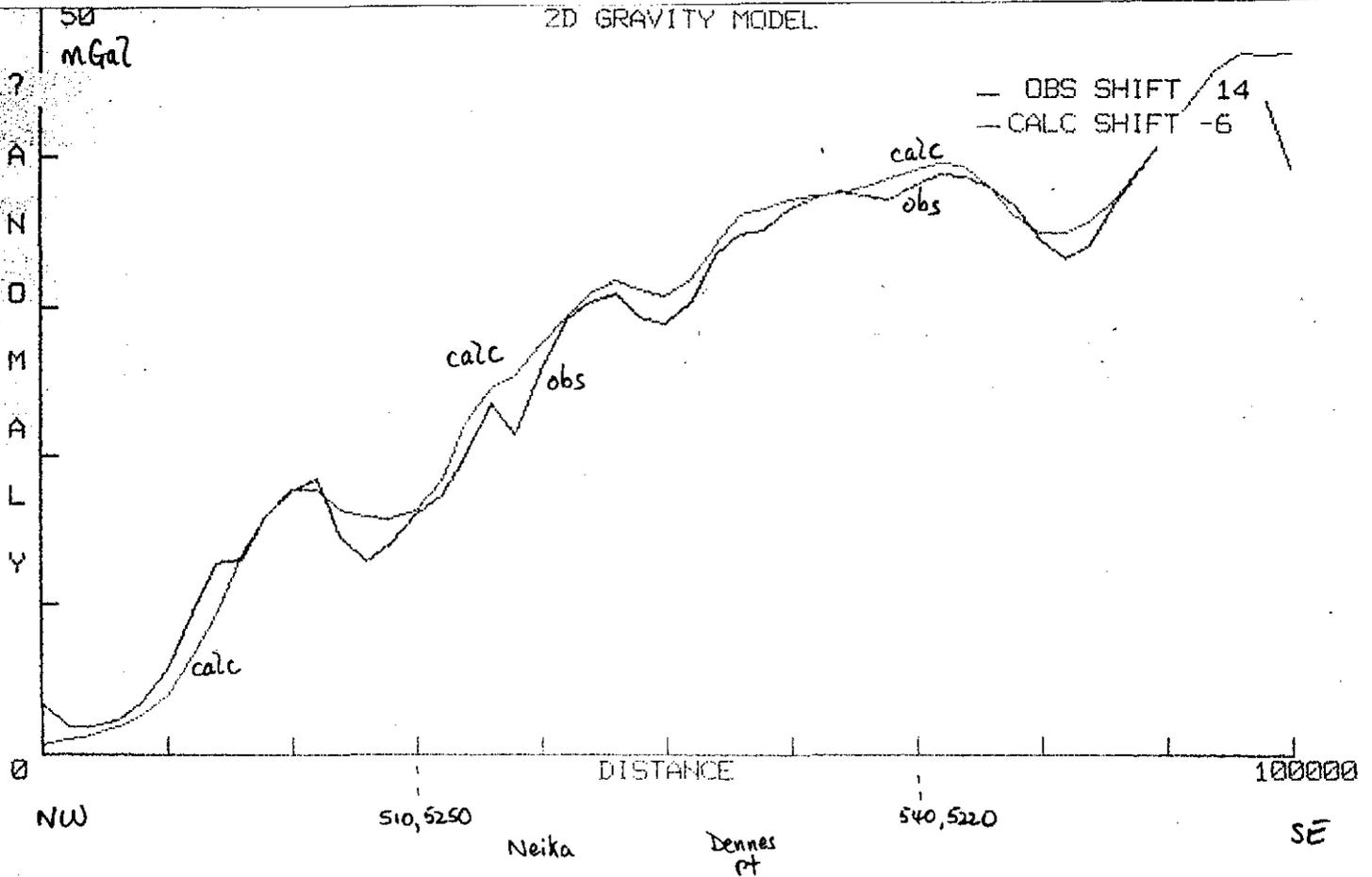
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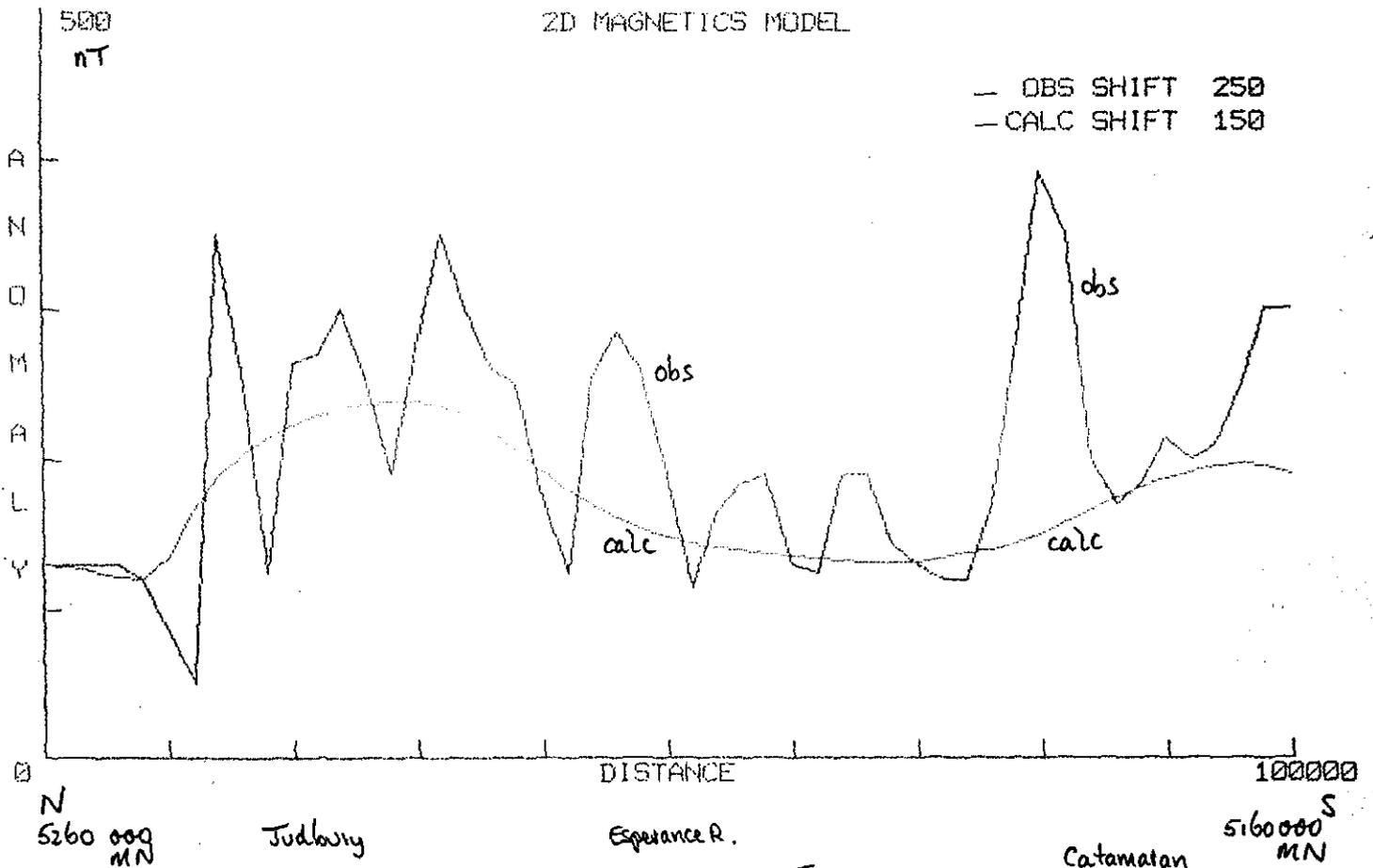
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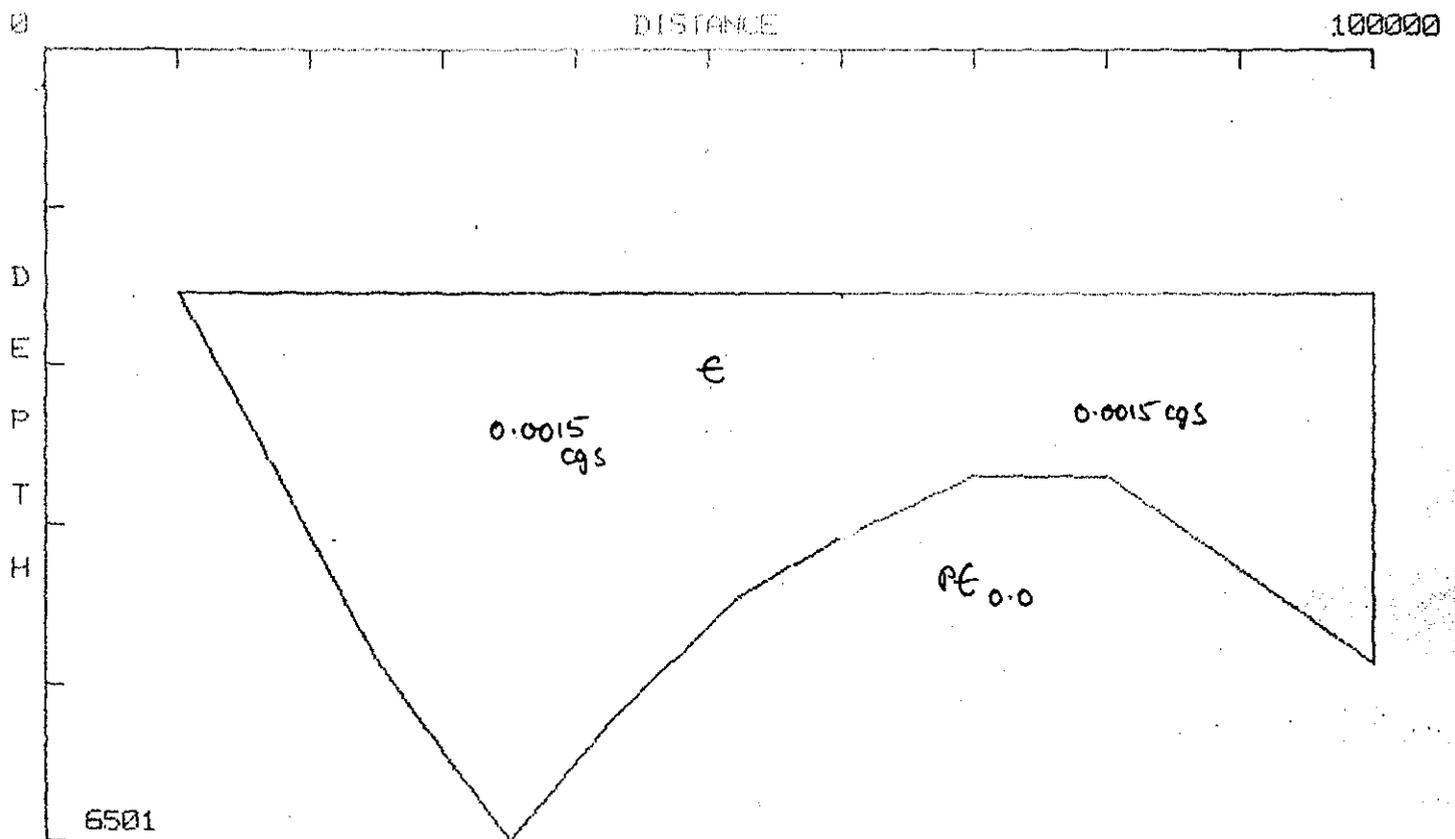
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870088





DENTRECASTEAUX LINE 17 N30  
ADJ 1



089

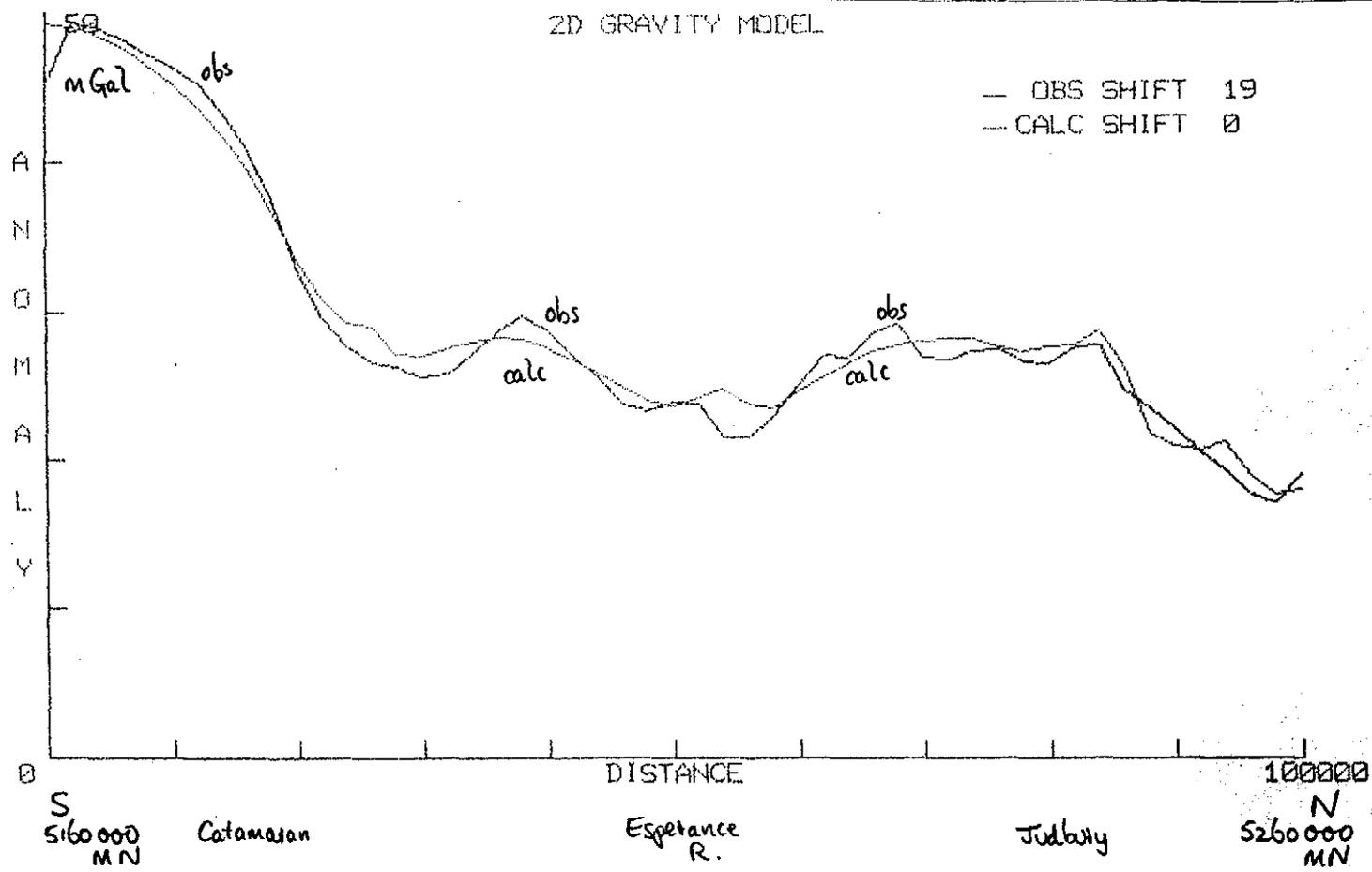
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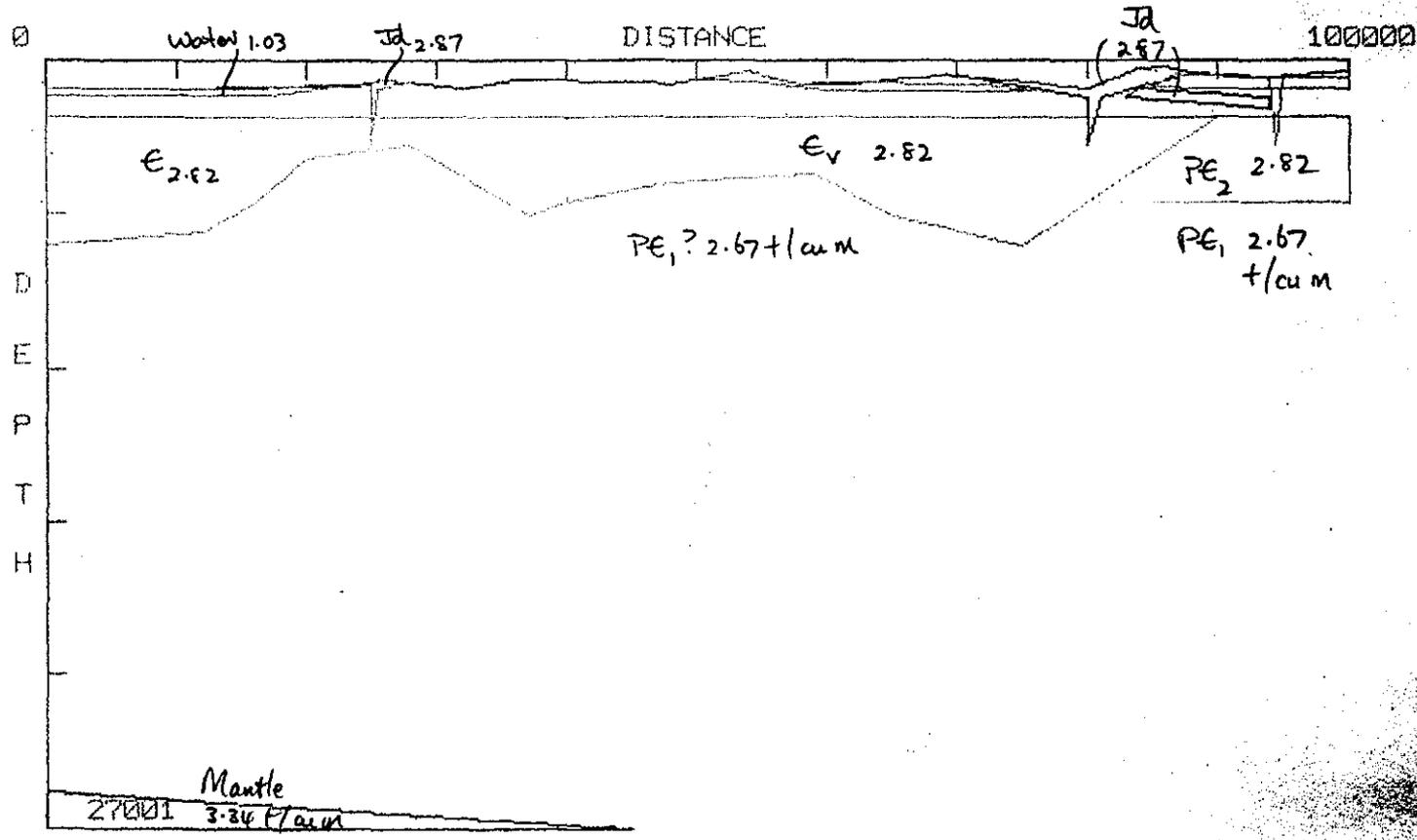
870090

## 2D GRAVITY MODEL

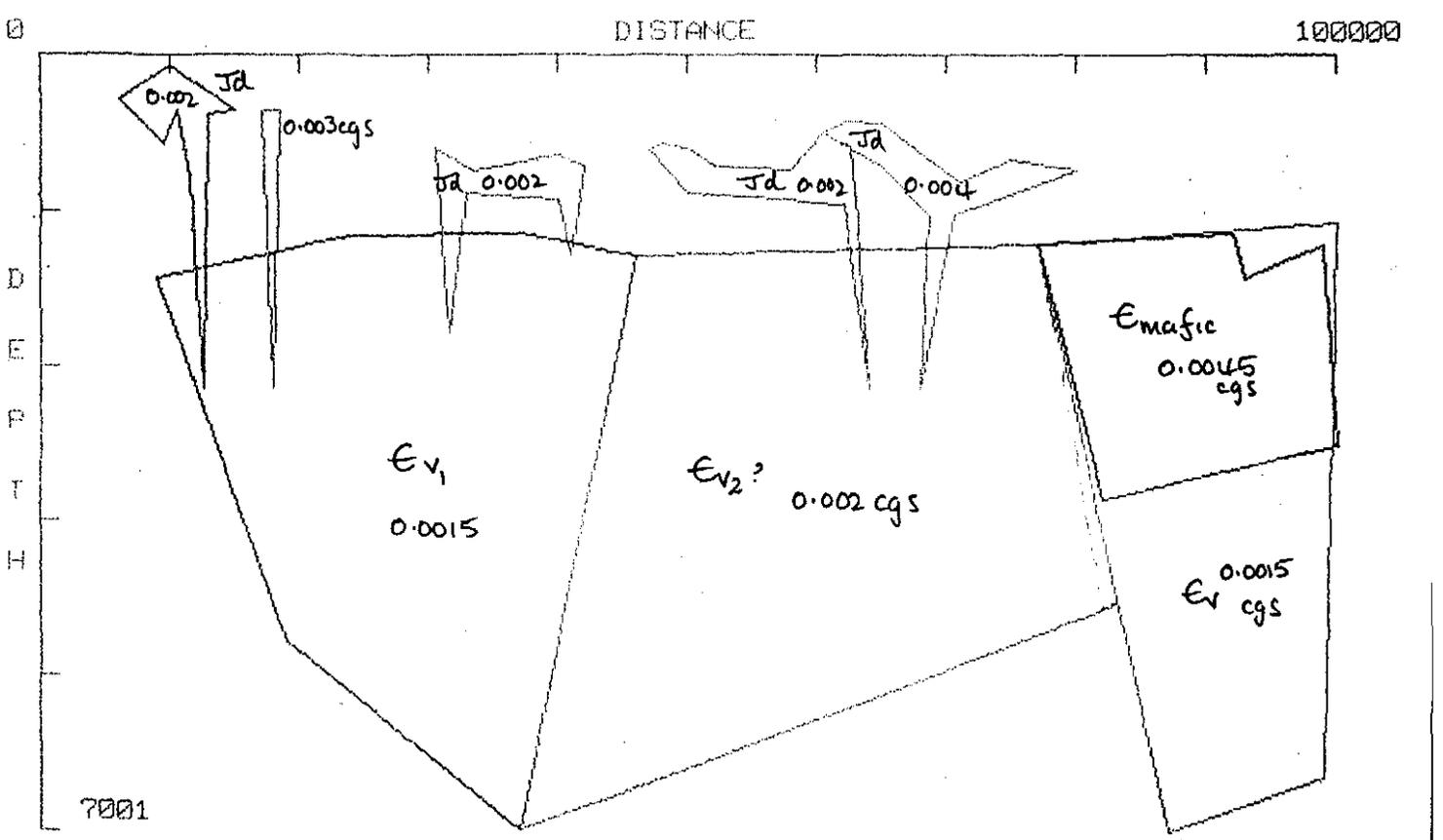
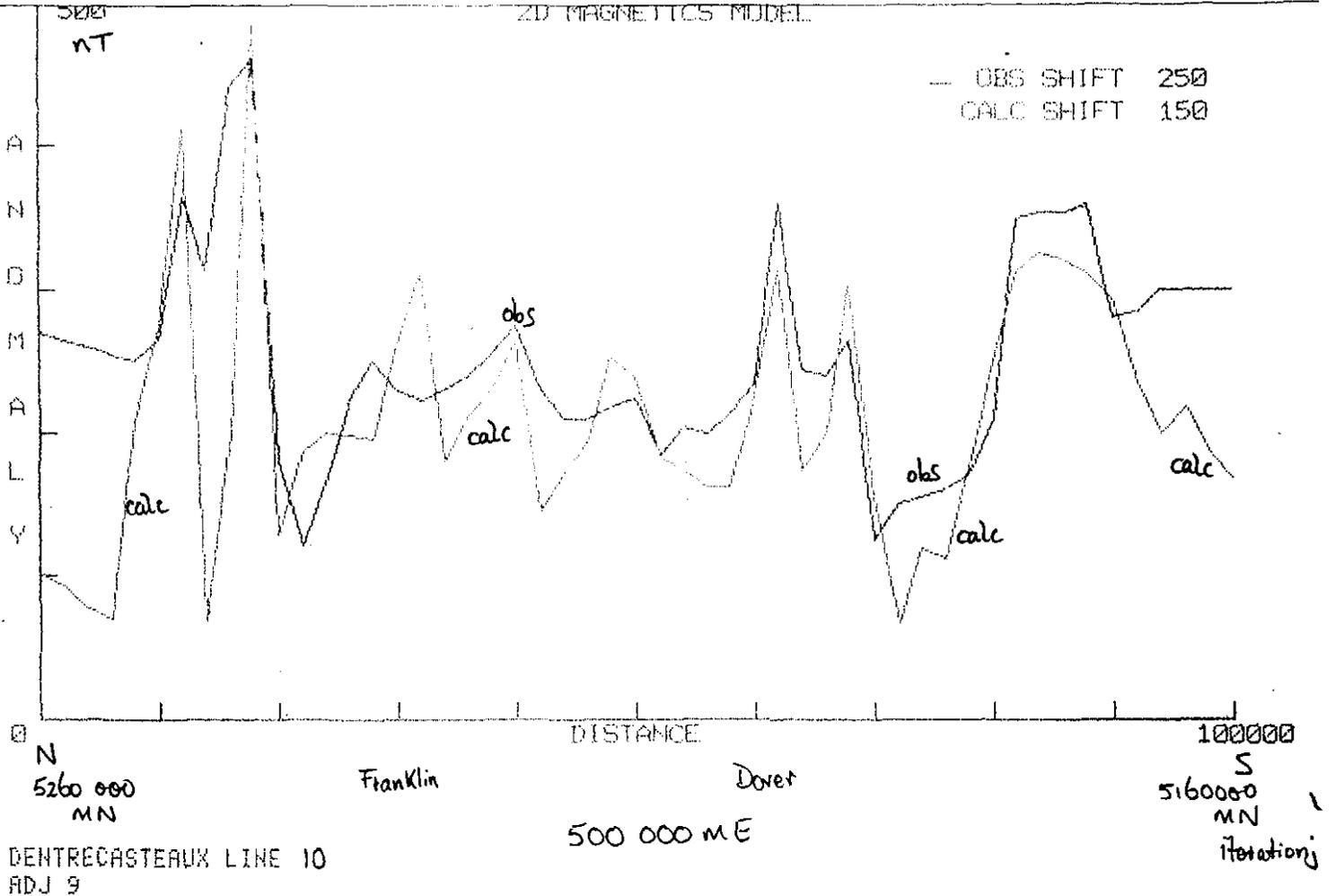


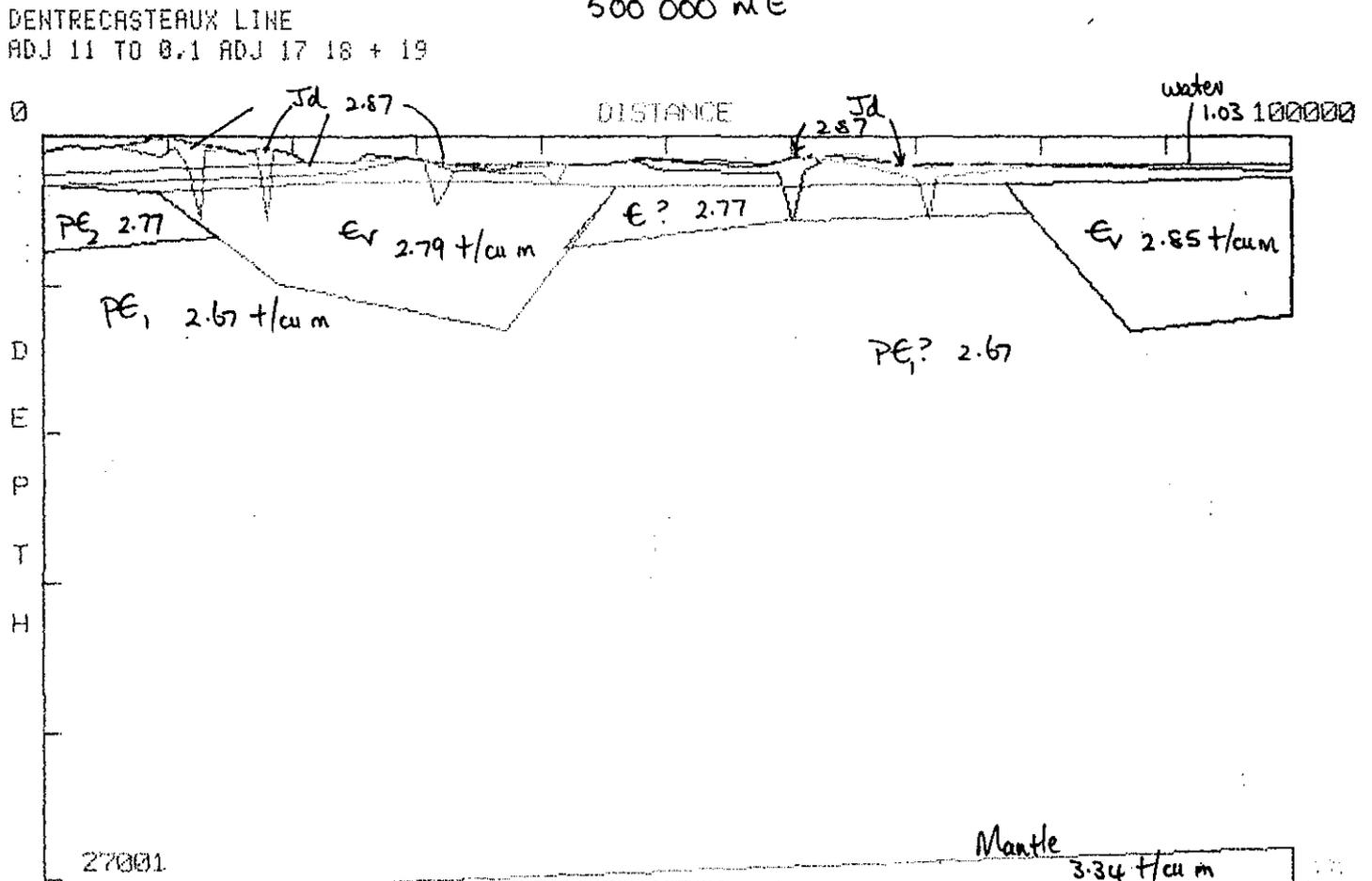
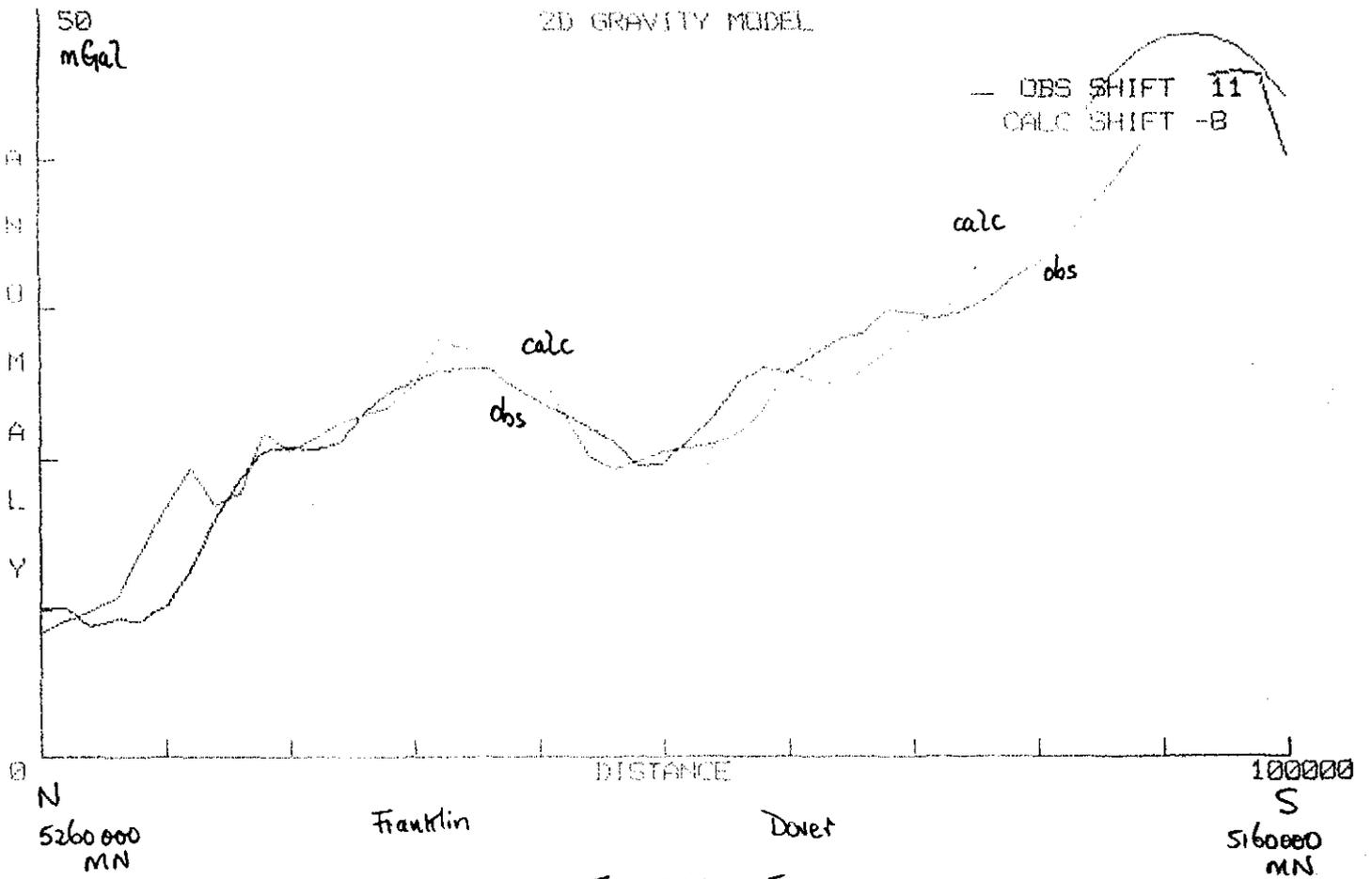
DENTRECASTEAUX LINE 9  
ADJ 11'13

490 000 mE



ADVANCED GRAVITY INTERPRETATION SECTION 9  
(Note that omitted dolerite detail not significant to general fit) FIGURE 41





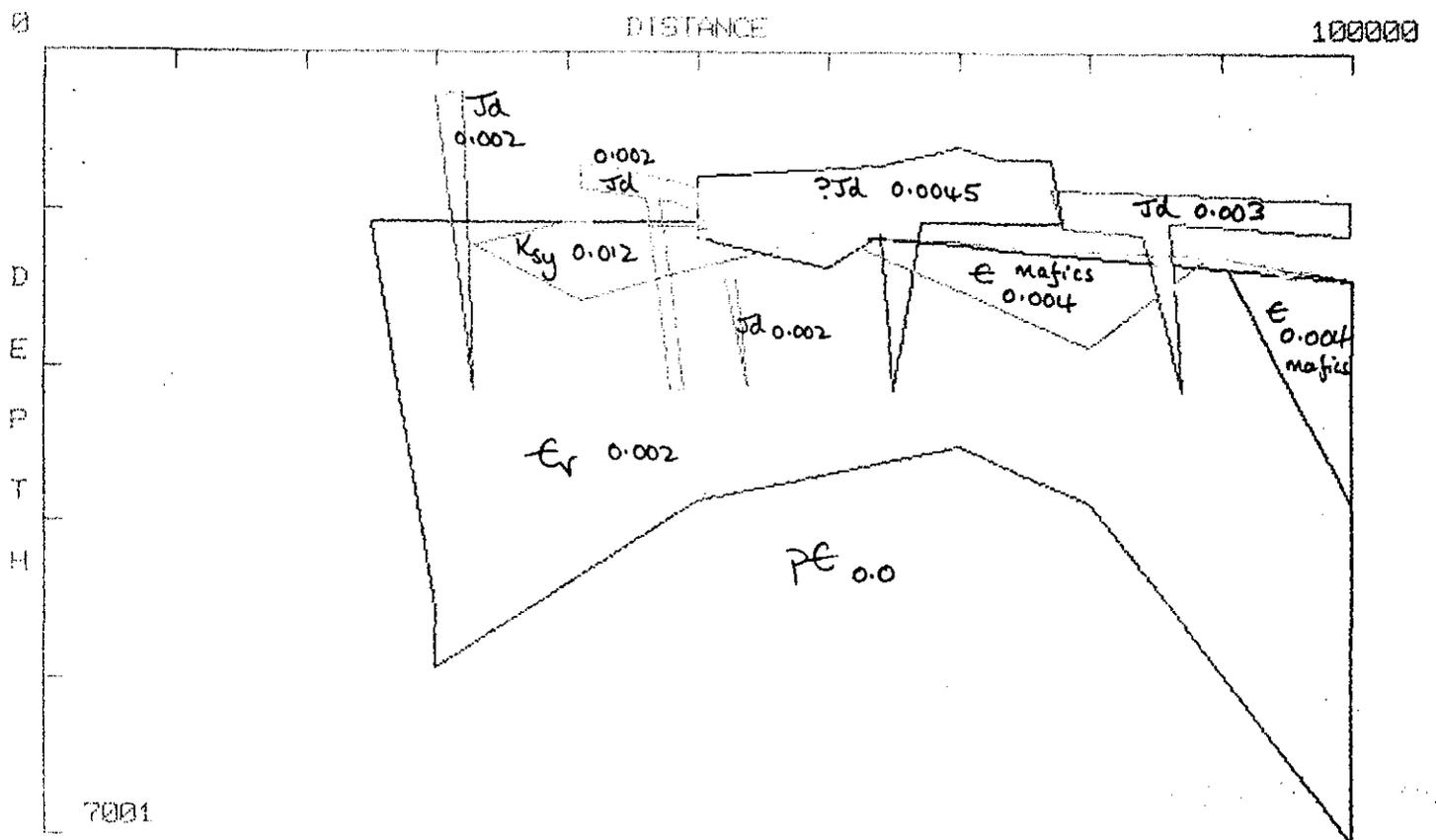
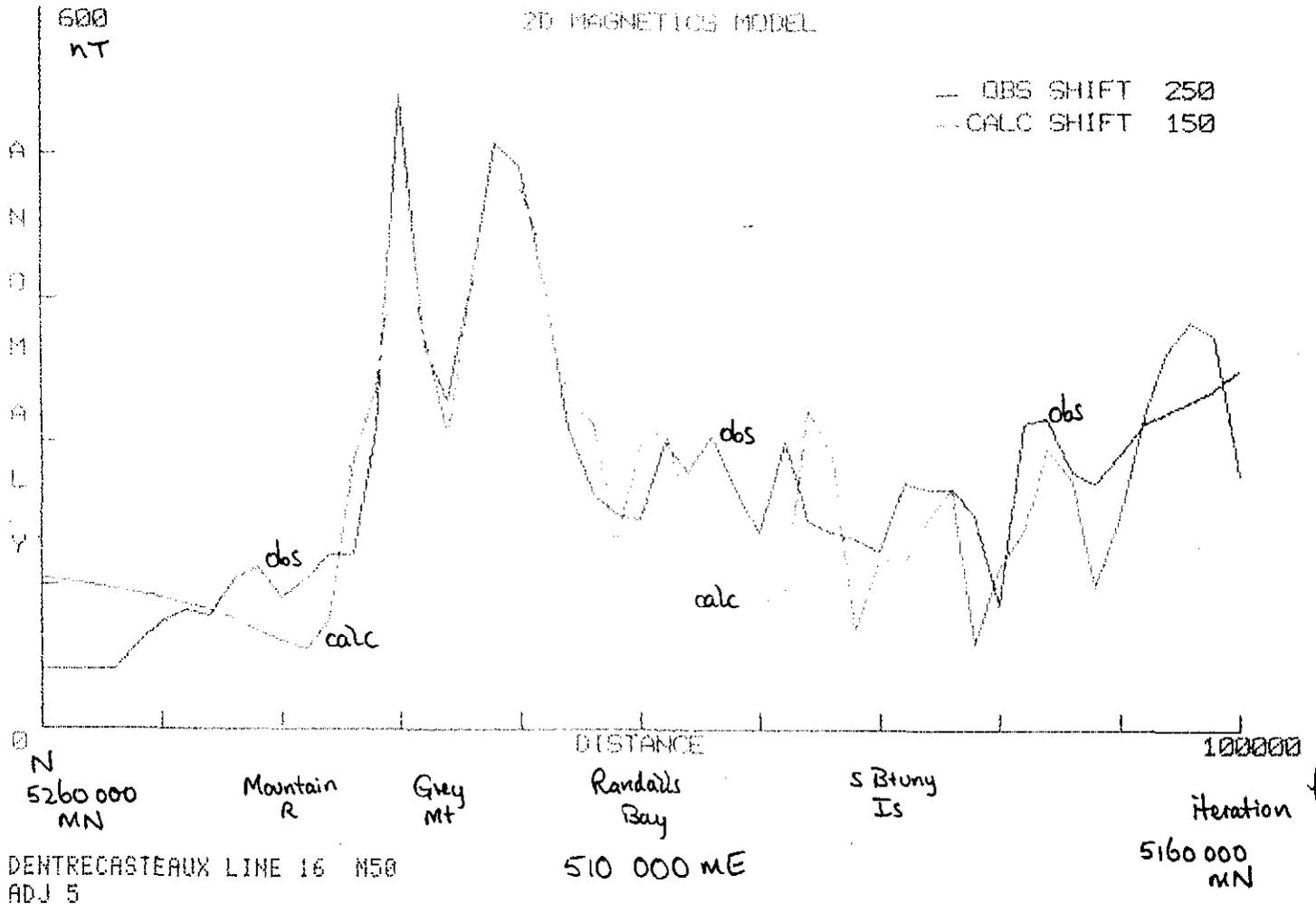
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870093



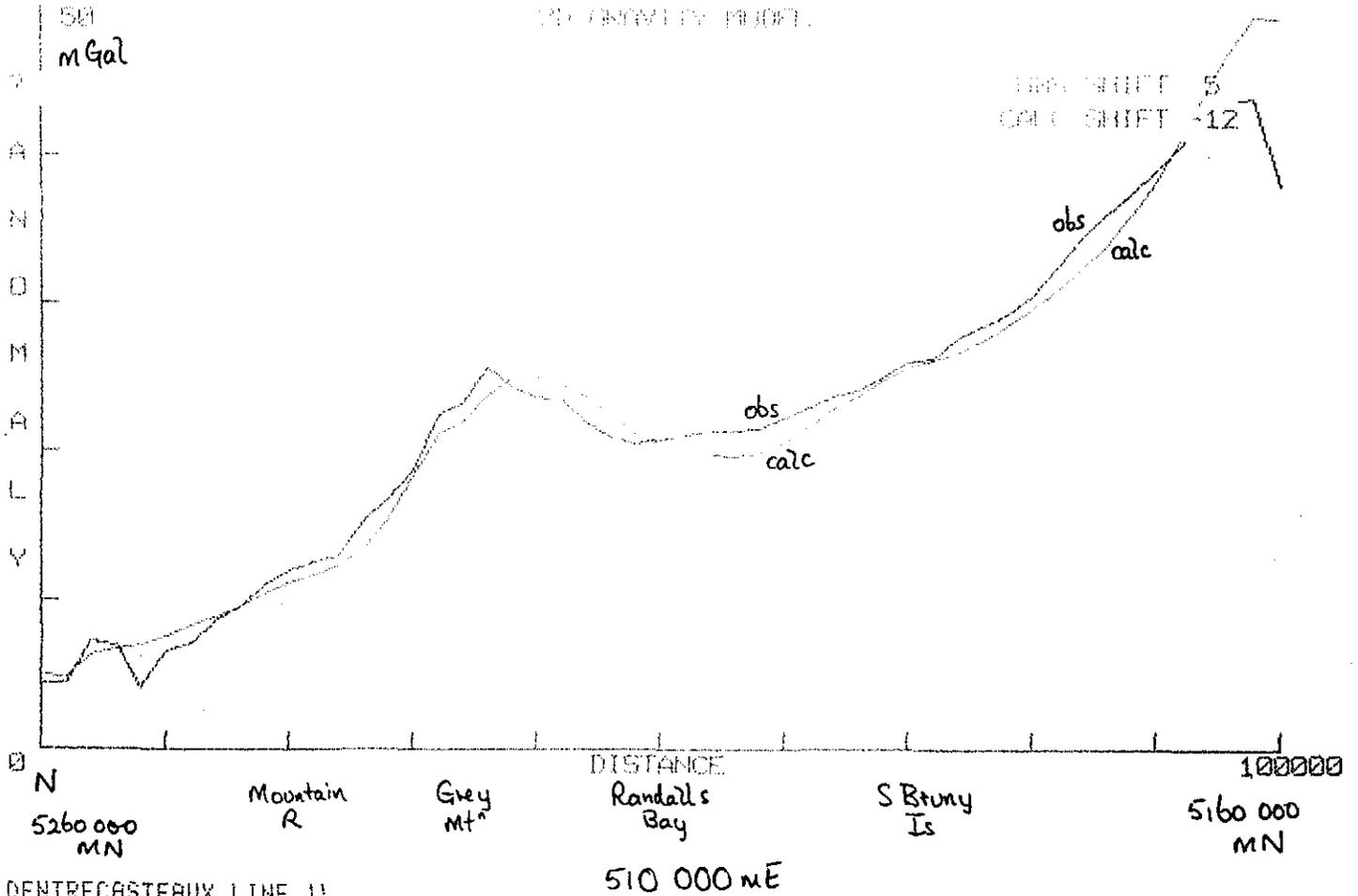
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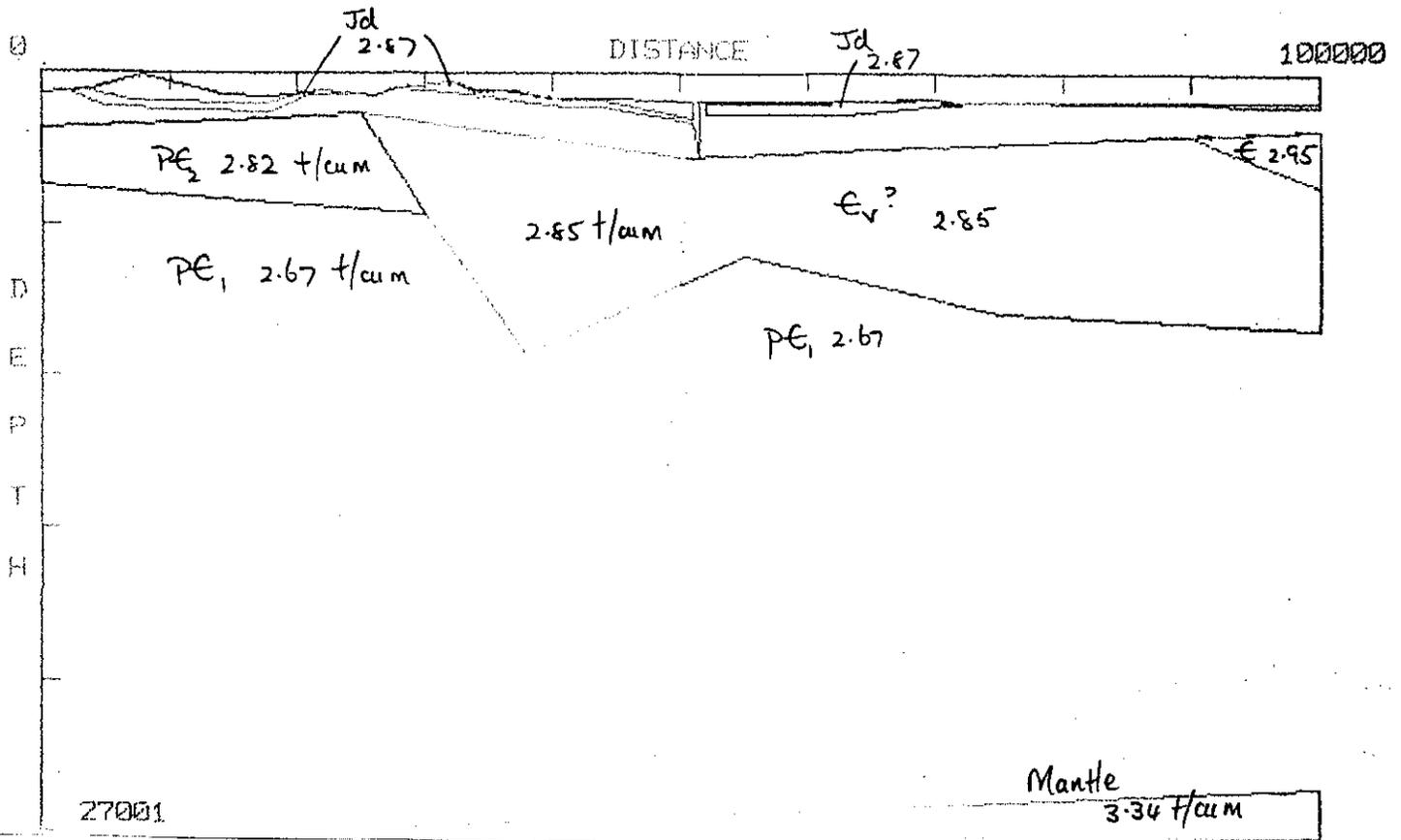
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870094



DENTRECASTEAUX LINE II  
ADJ 8 9 10



094

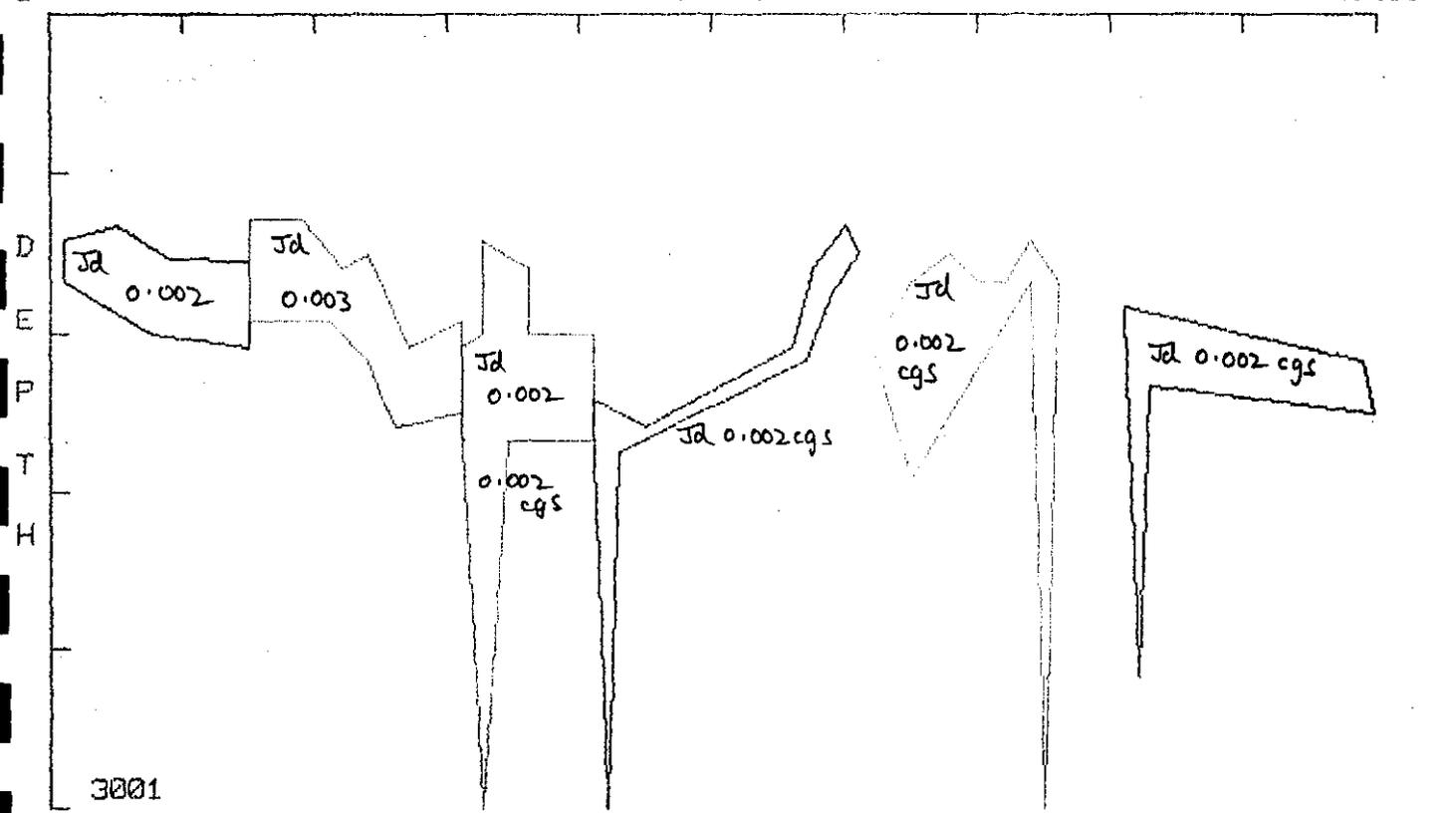
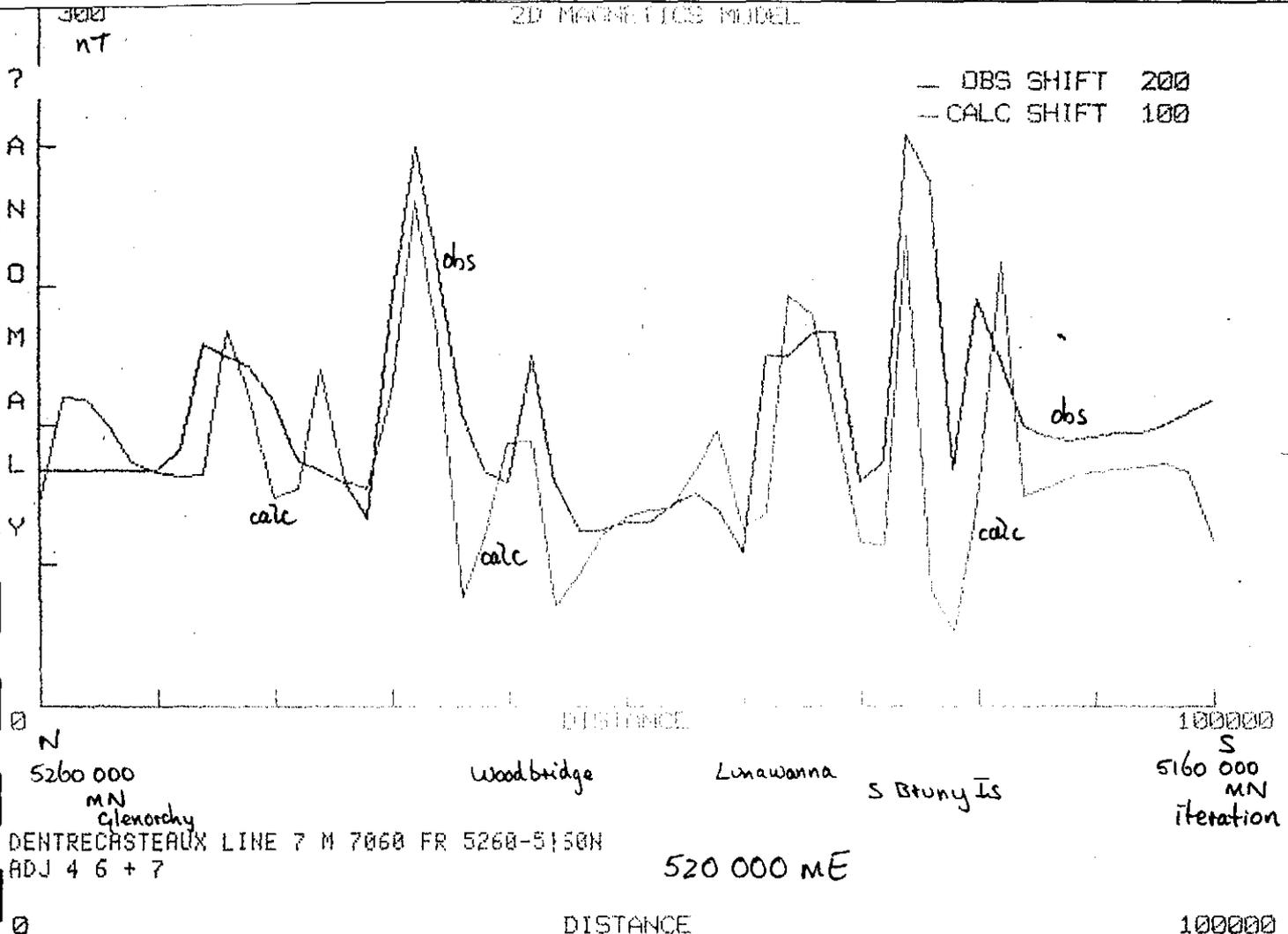
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## 2D MAGNETICS MODEL



ADVANCED MAGNETIC INTERPRETATION SECTION 12 FIGURE 46  
(Note that the effect of any subtle regional effect has not been included)

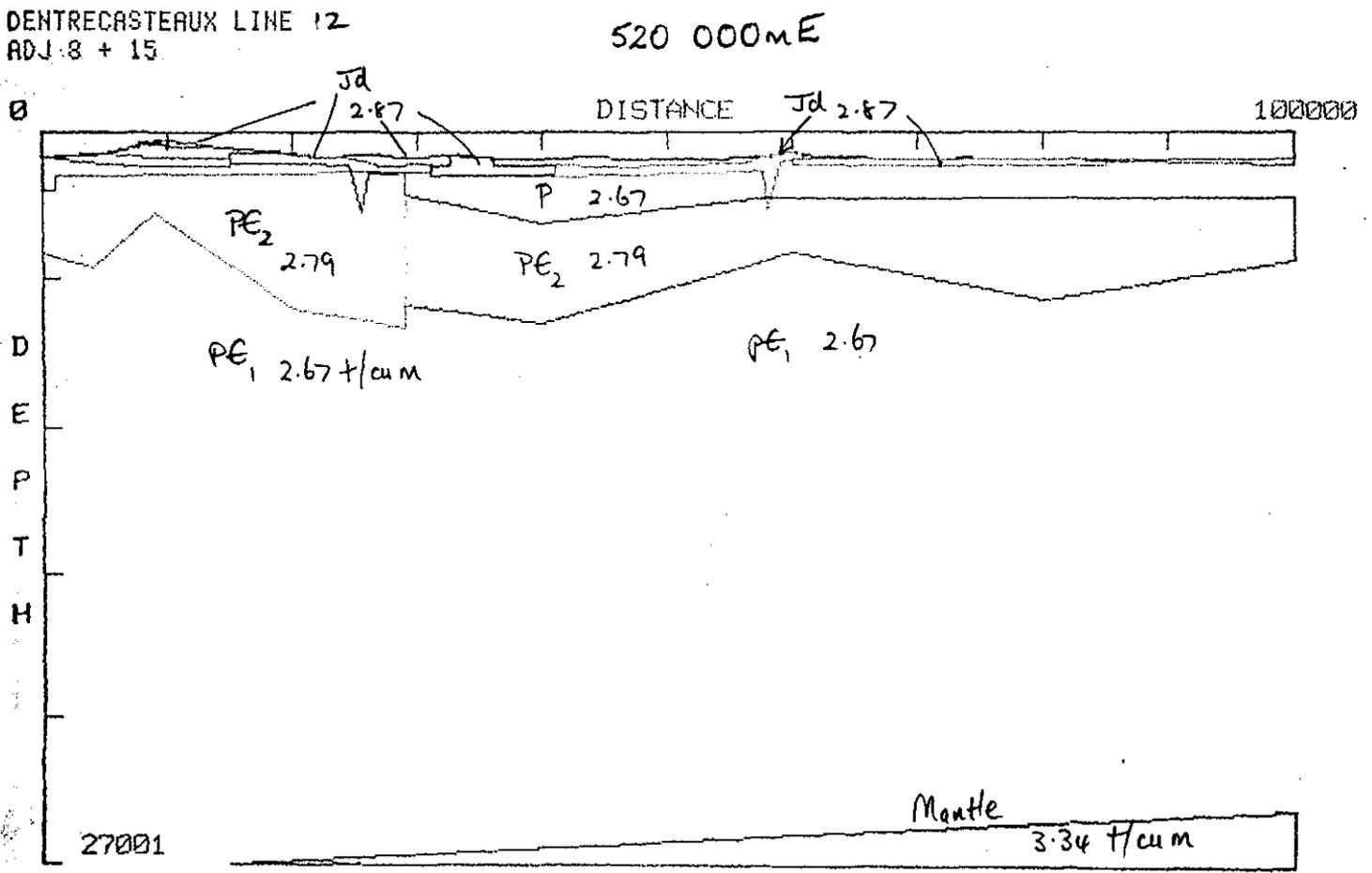
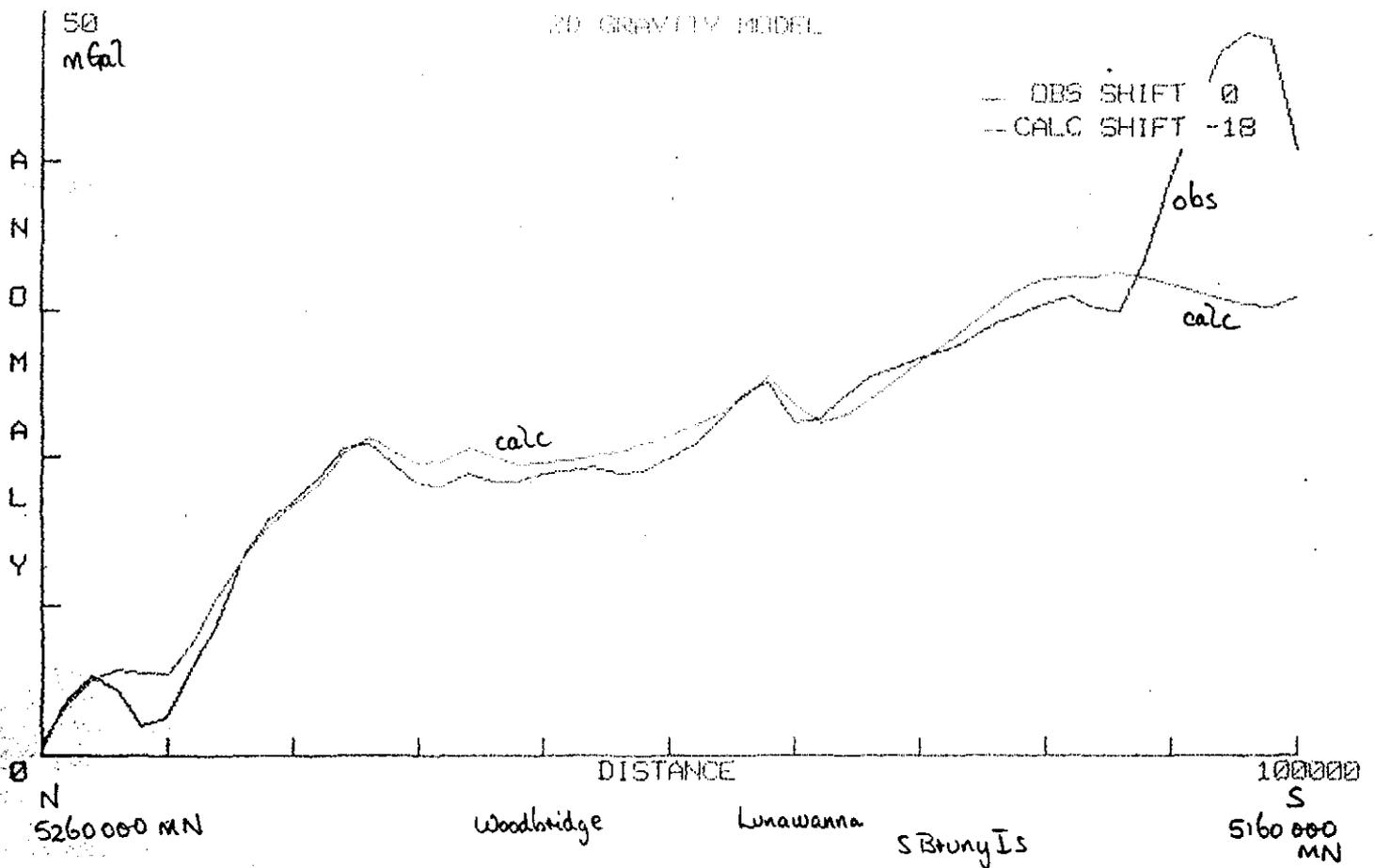
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095

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870096



GRAVITY INTERPRETATION SECTION 12 FIGURE 47  
(Note that positive effect observed at line end may be an artifact of errors in the marine data)

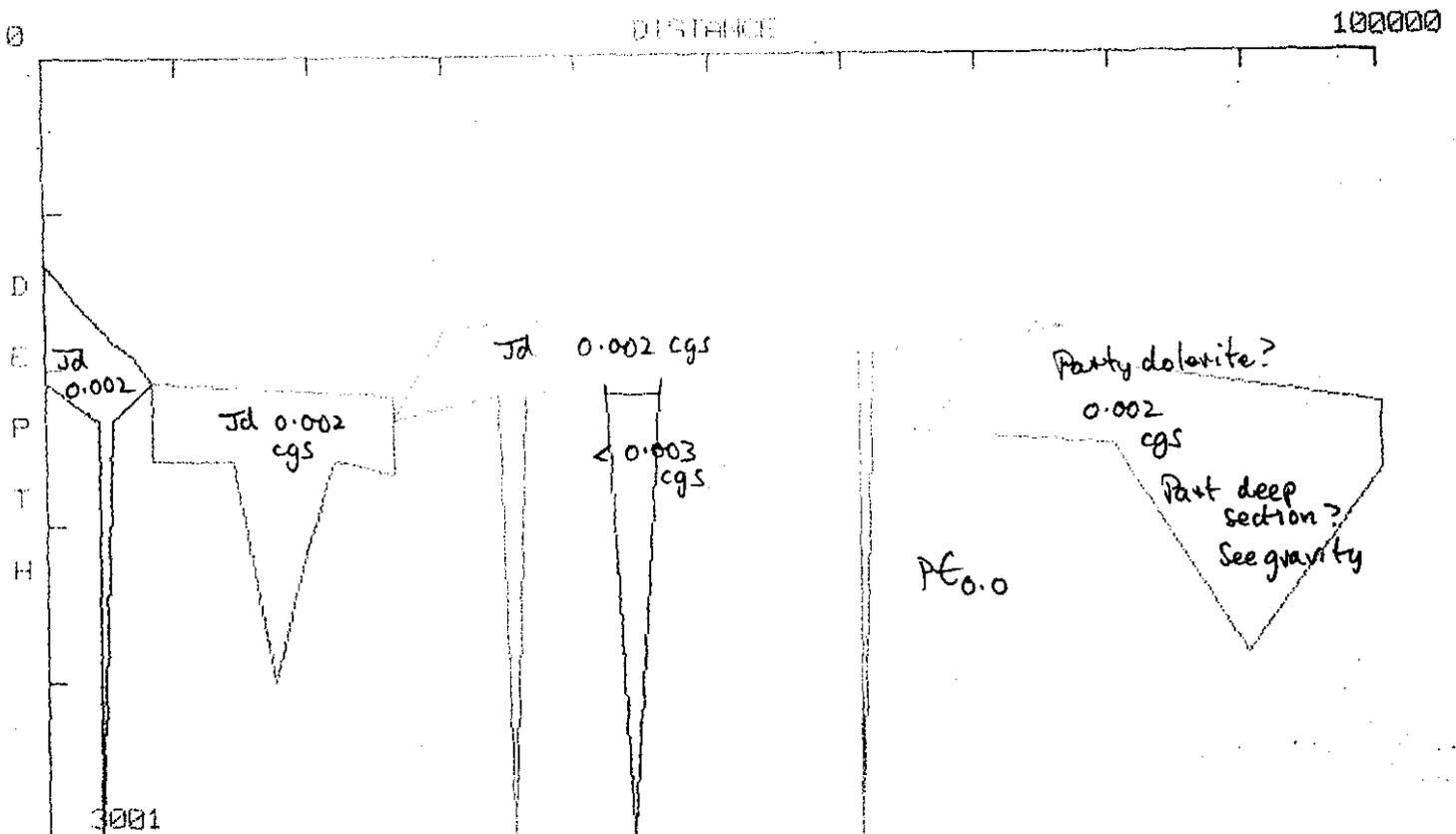
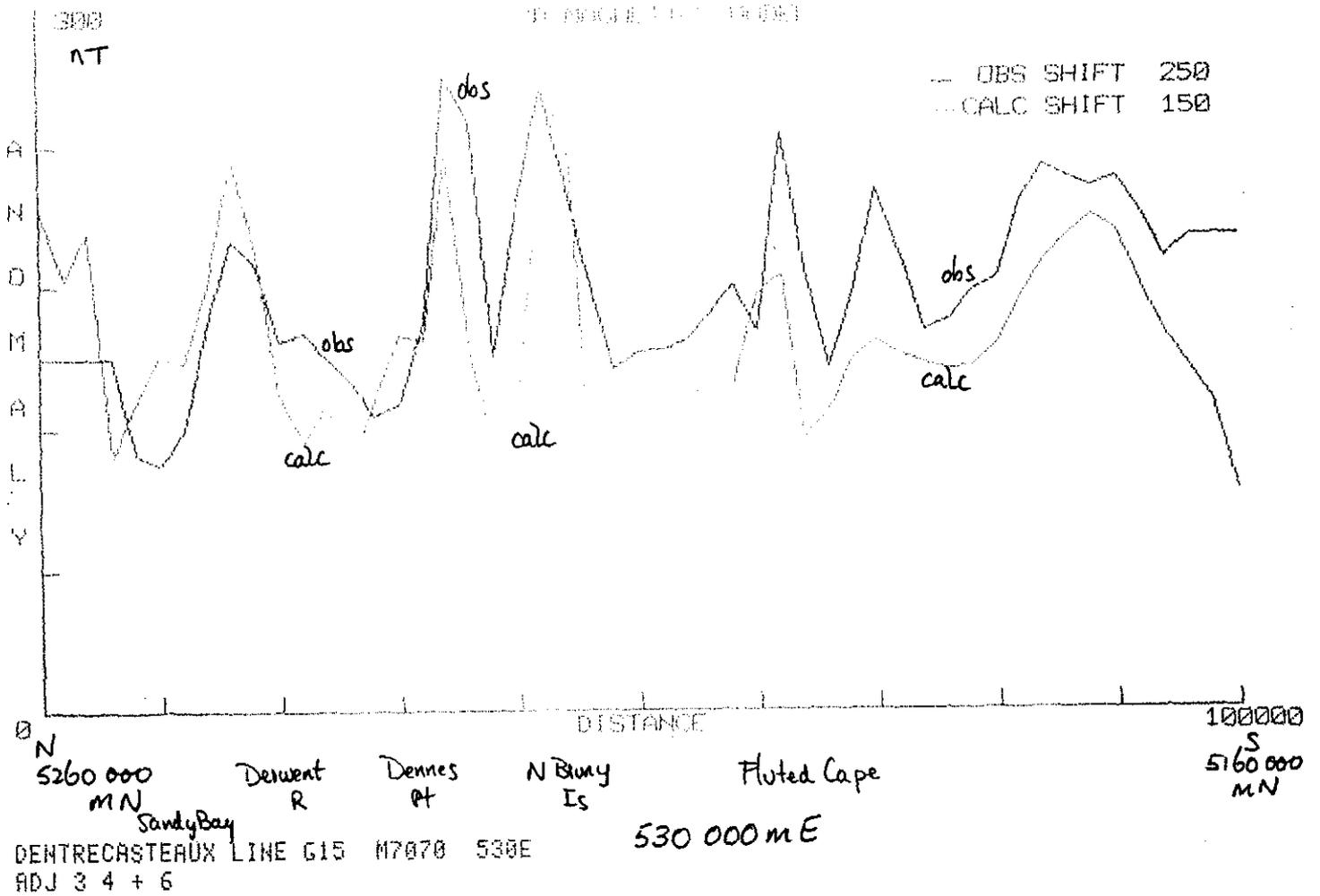
096

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870097

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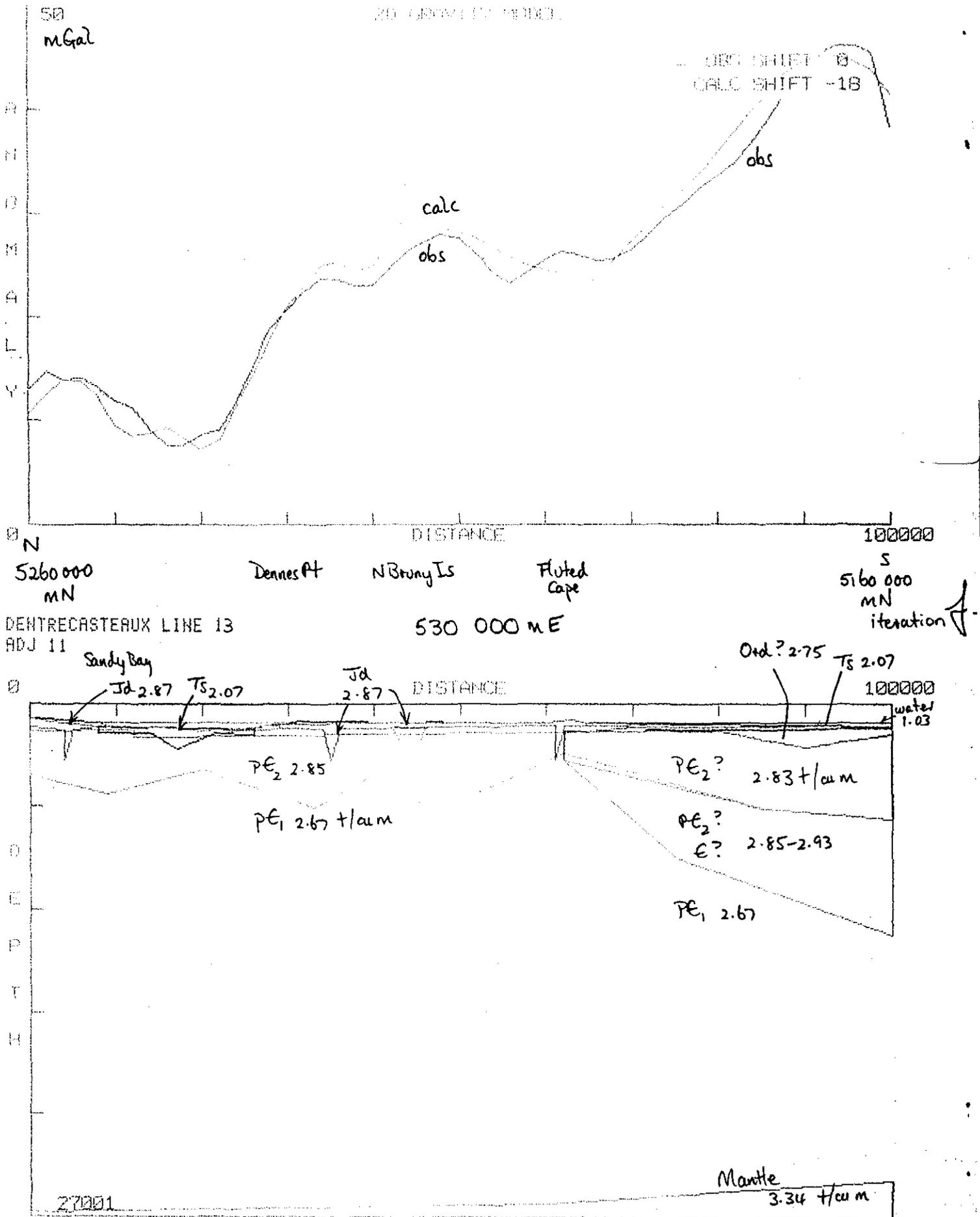
097

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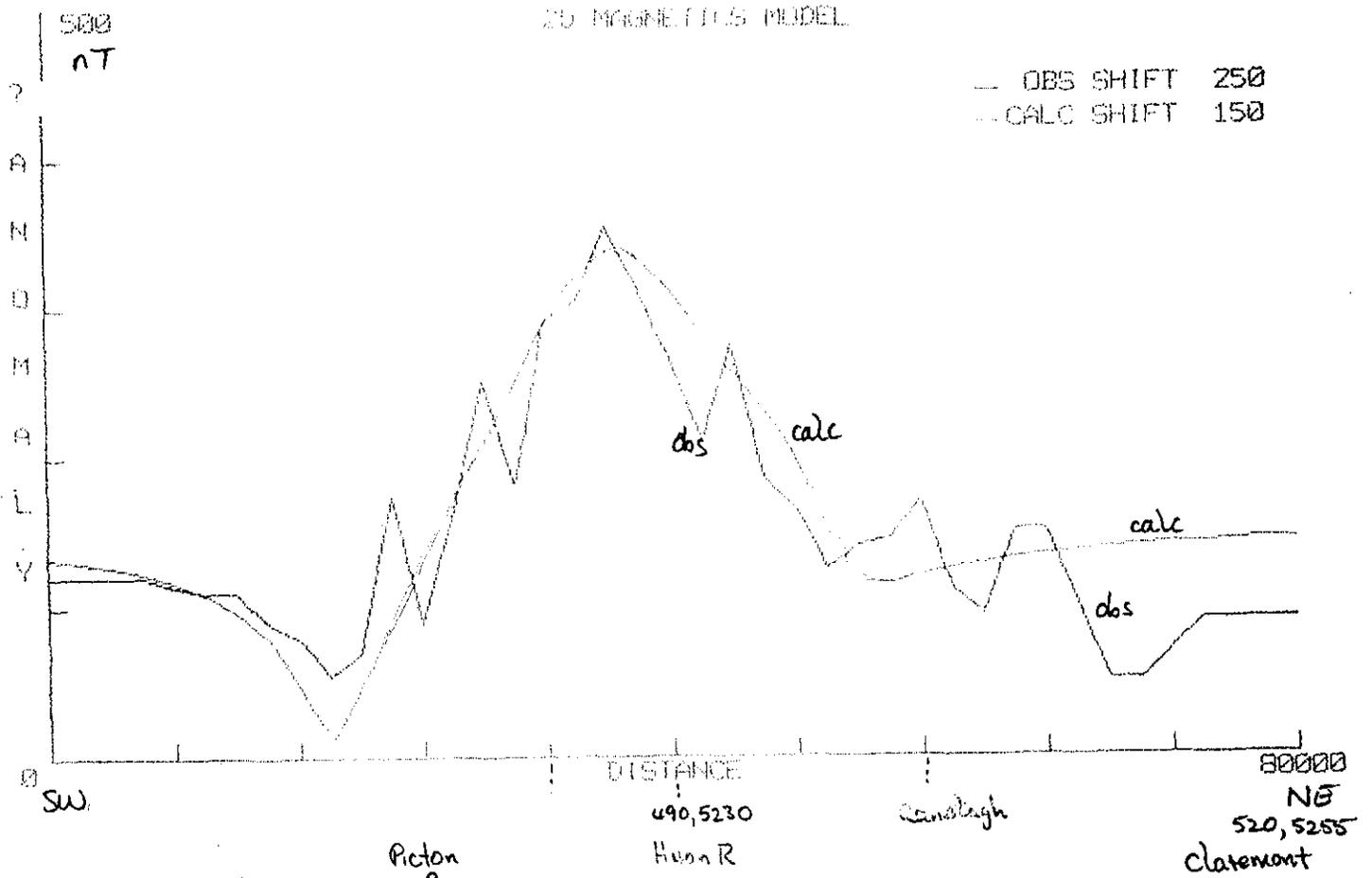
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870098

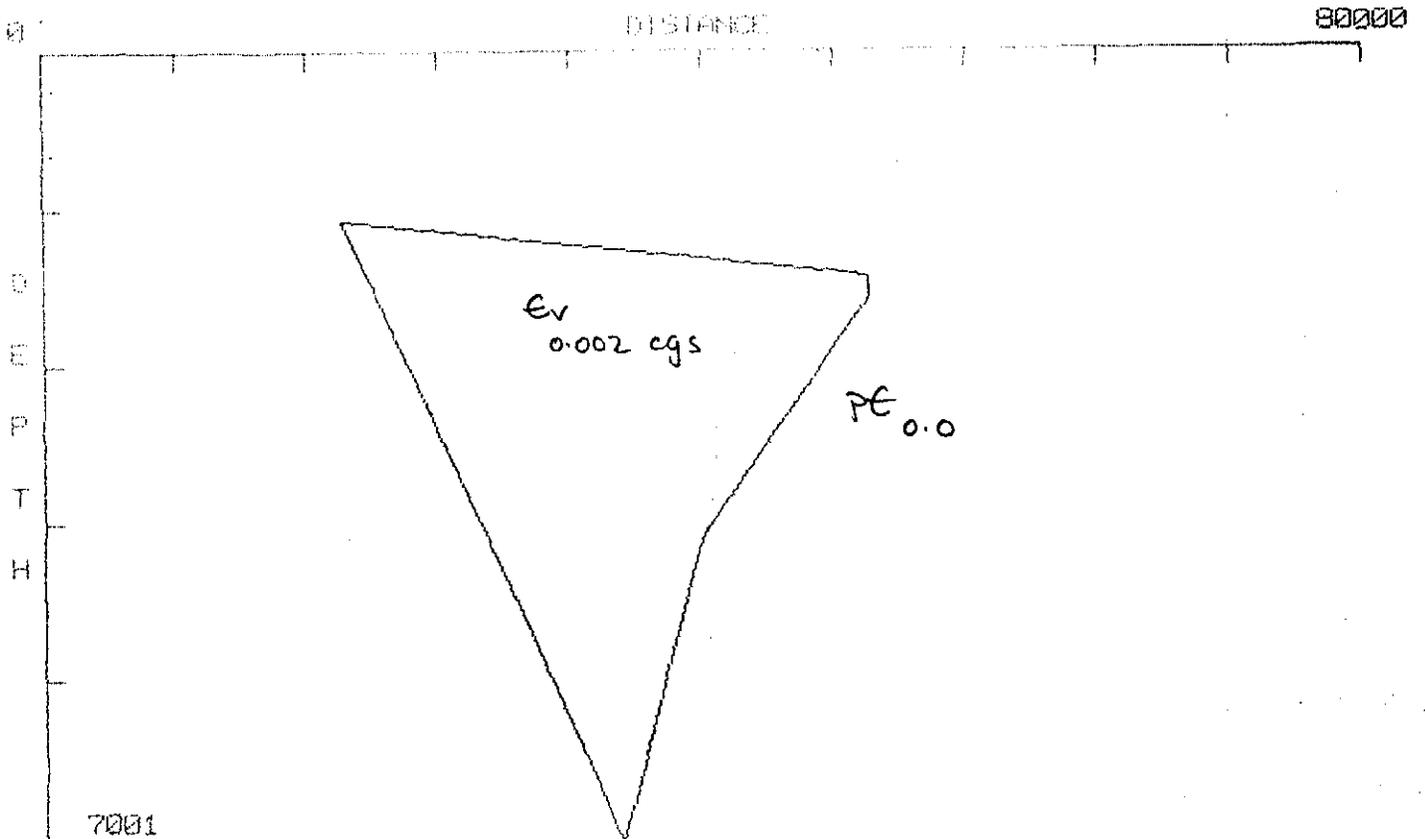


GRAVITY INTERPRETATION SECTION 13  
(Option accepting some measure of validity in marine data)

FIGURE 49



DENTRECASTEAUX LINE 14  
K 002



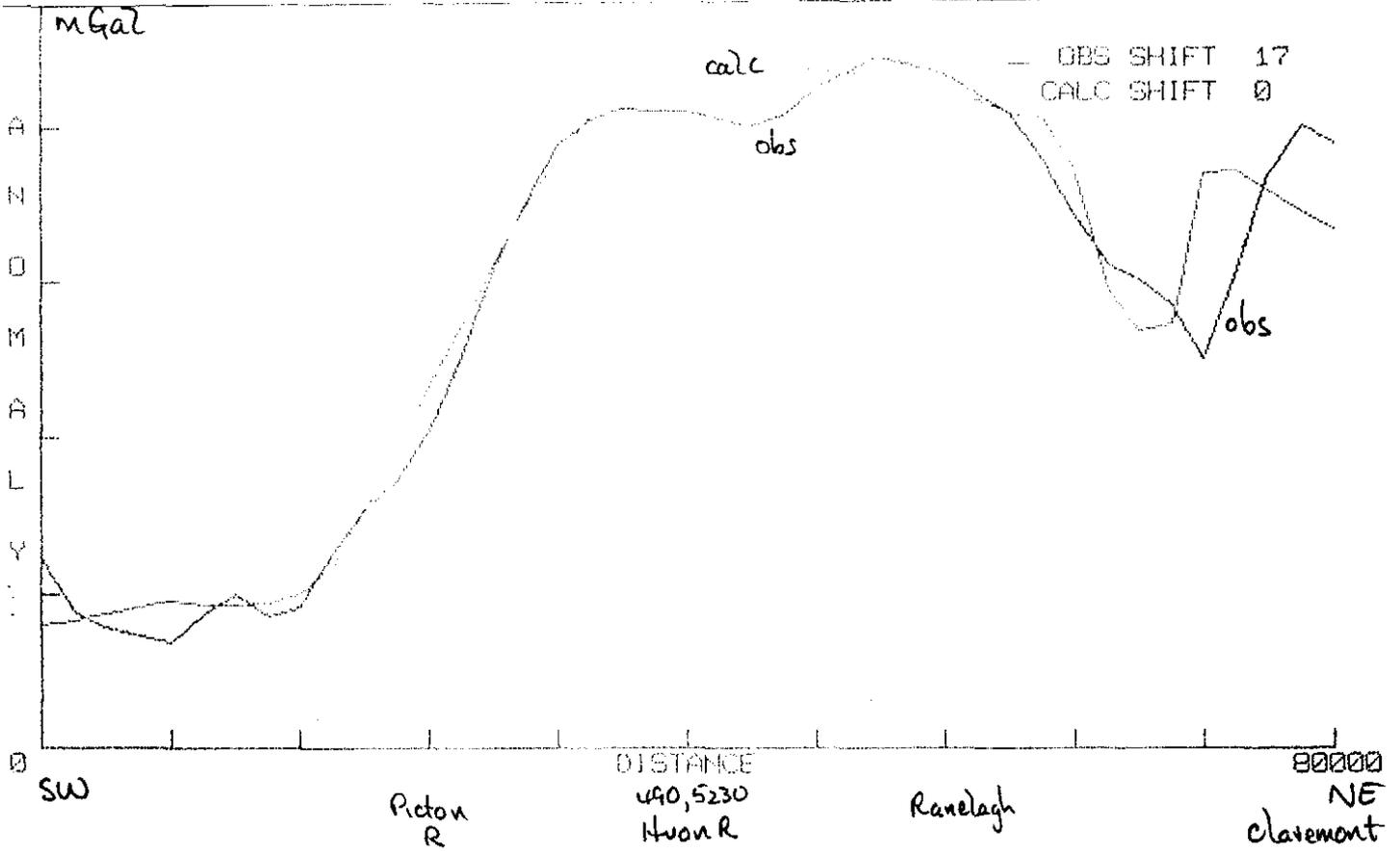
099

870100

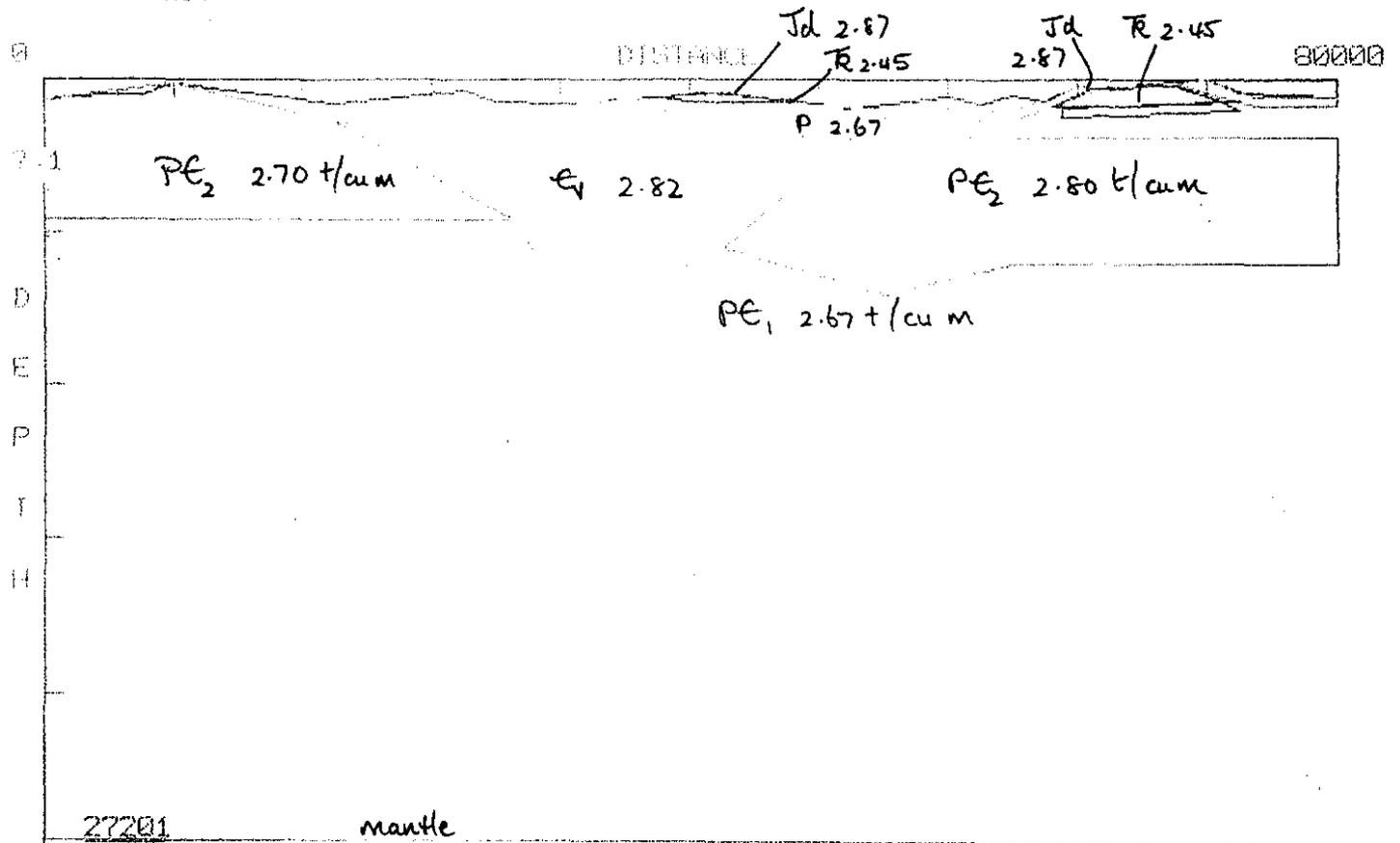
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DENTRECASTEAUX LINE 1.  
ADJ 10 + TR14



100

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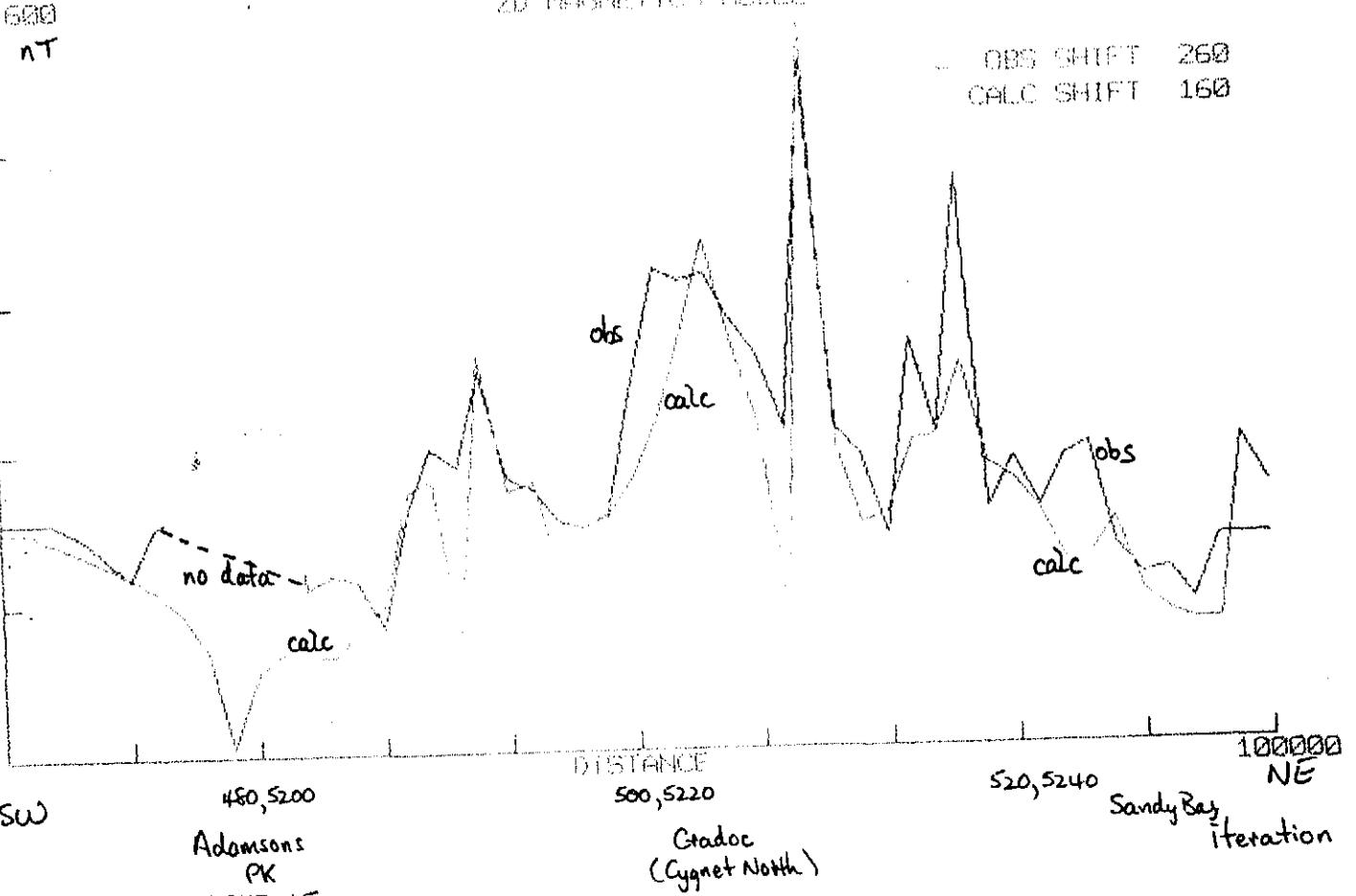
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Registered Office:  
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870101

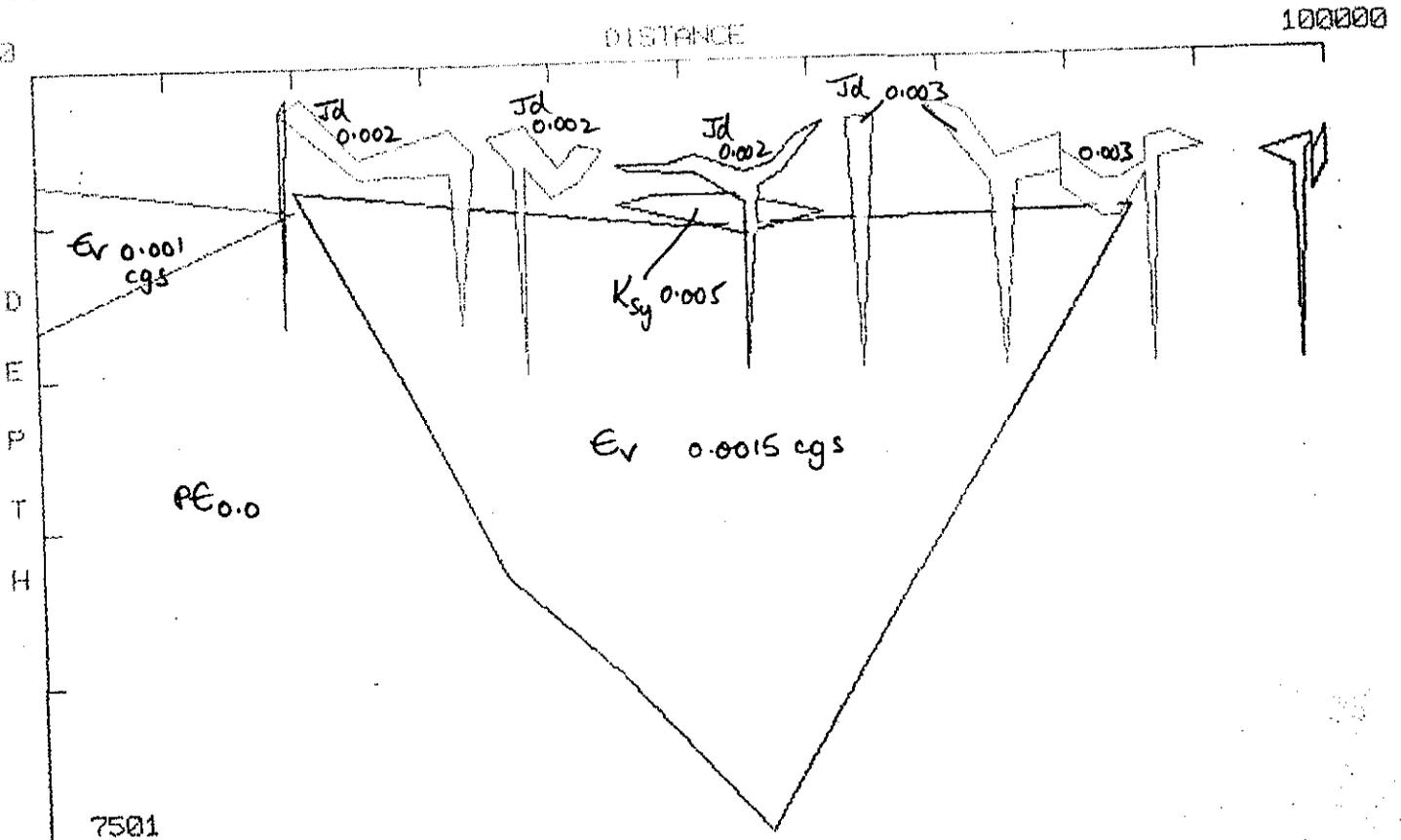
All Correspondence to:  
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TELEPHONE: (002) 47 8849

## 2D MAGNETIC MODEL



DENTRECASTEAUX LINE 15  
ADJ 11 K9=002 + 12

## DISTANCE

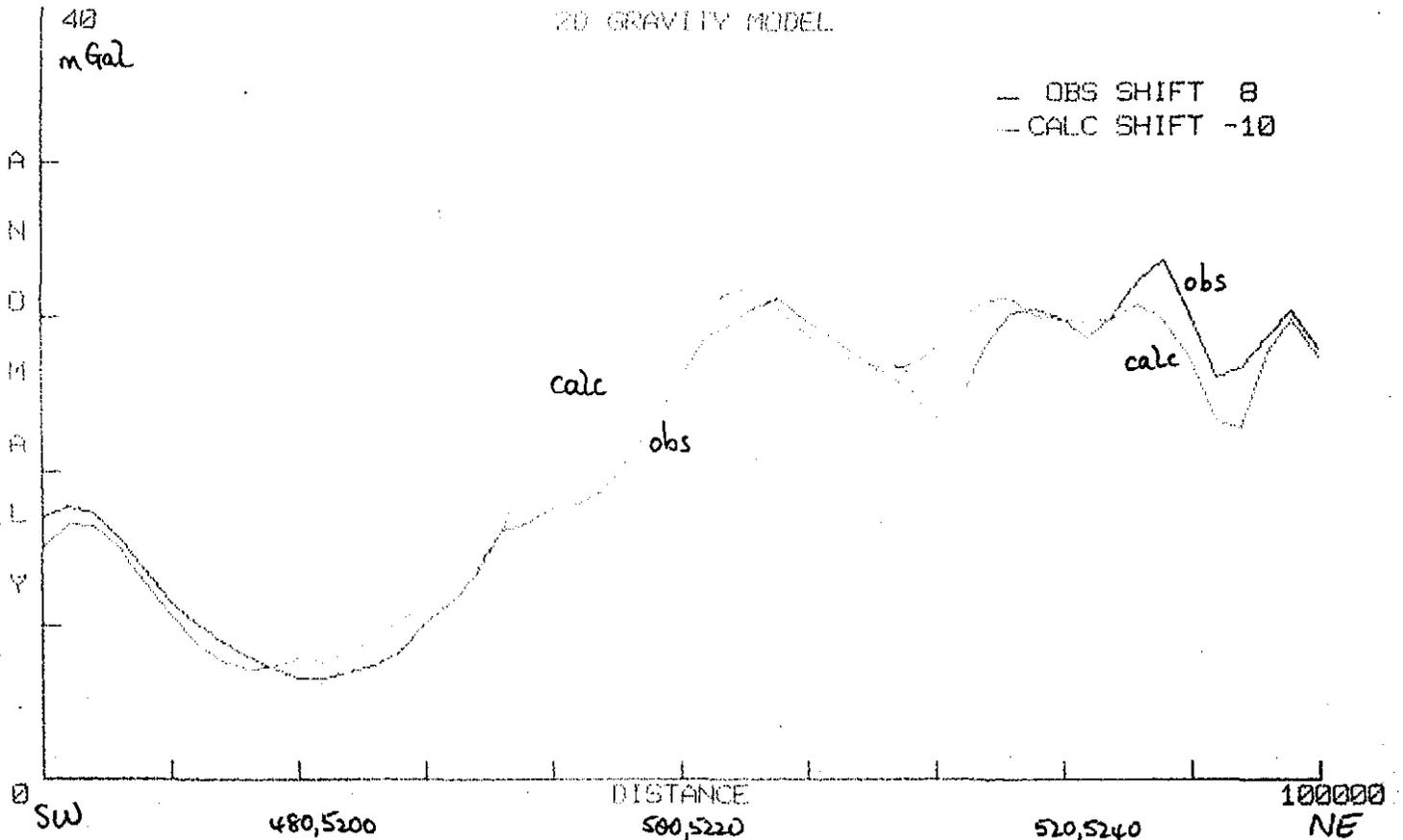


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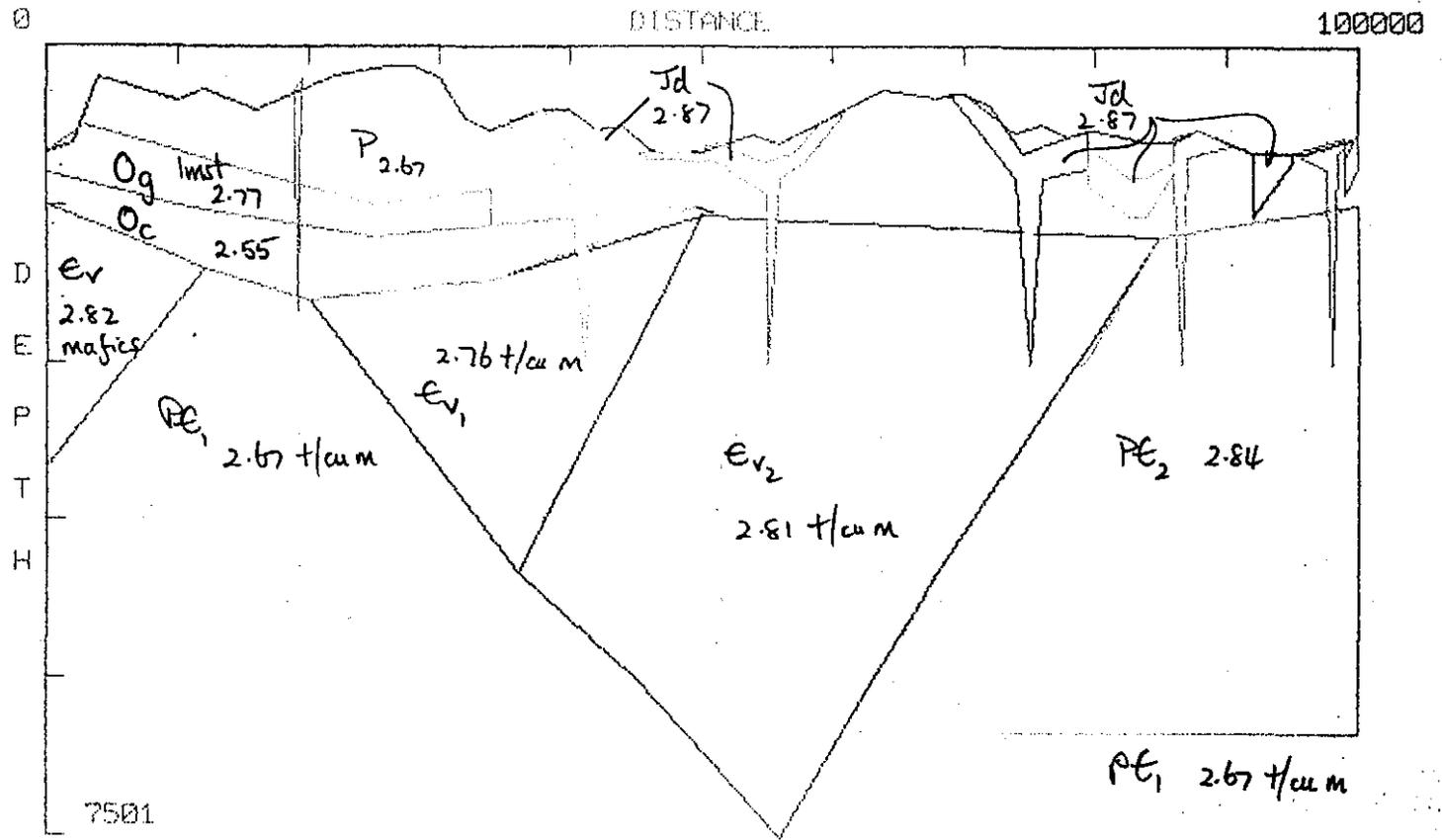
870102



Adamsons Pk  
DENTRECASTEAUX LINE 15  
ADJ 10 17 18

Cradoc  
(Cygnets North)

Sandy Bay



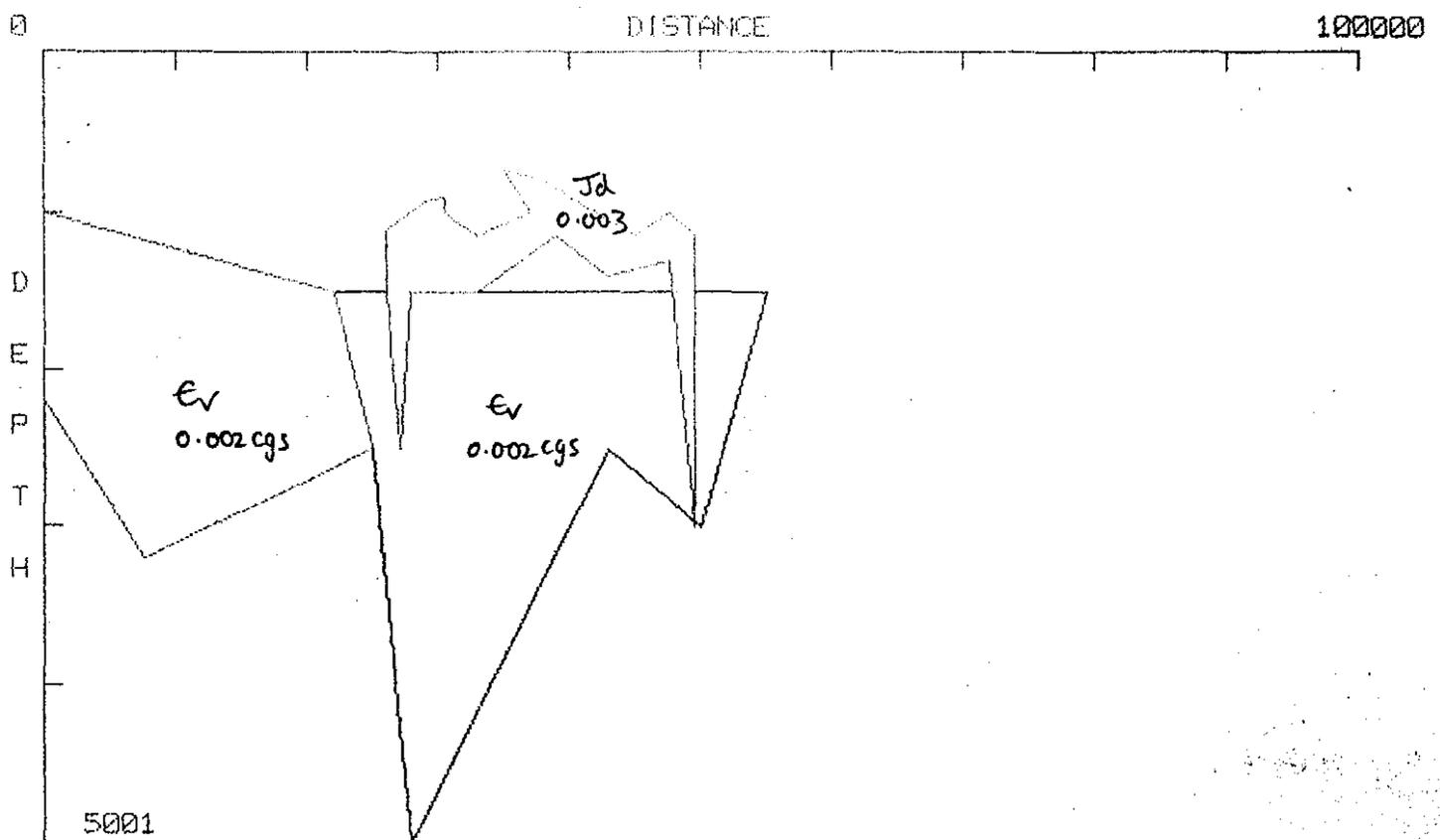
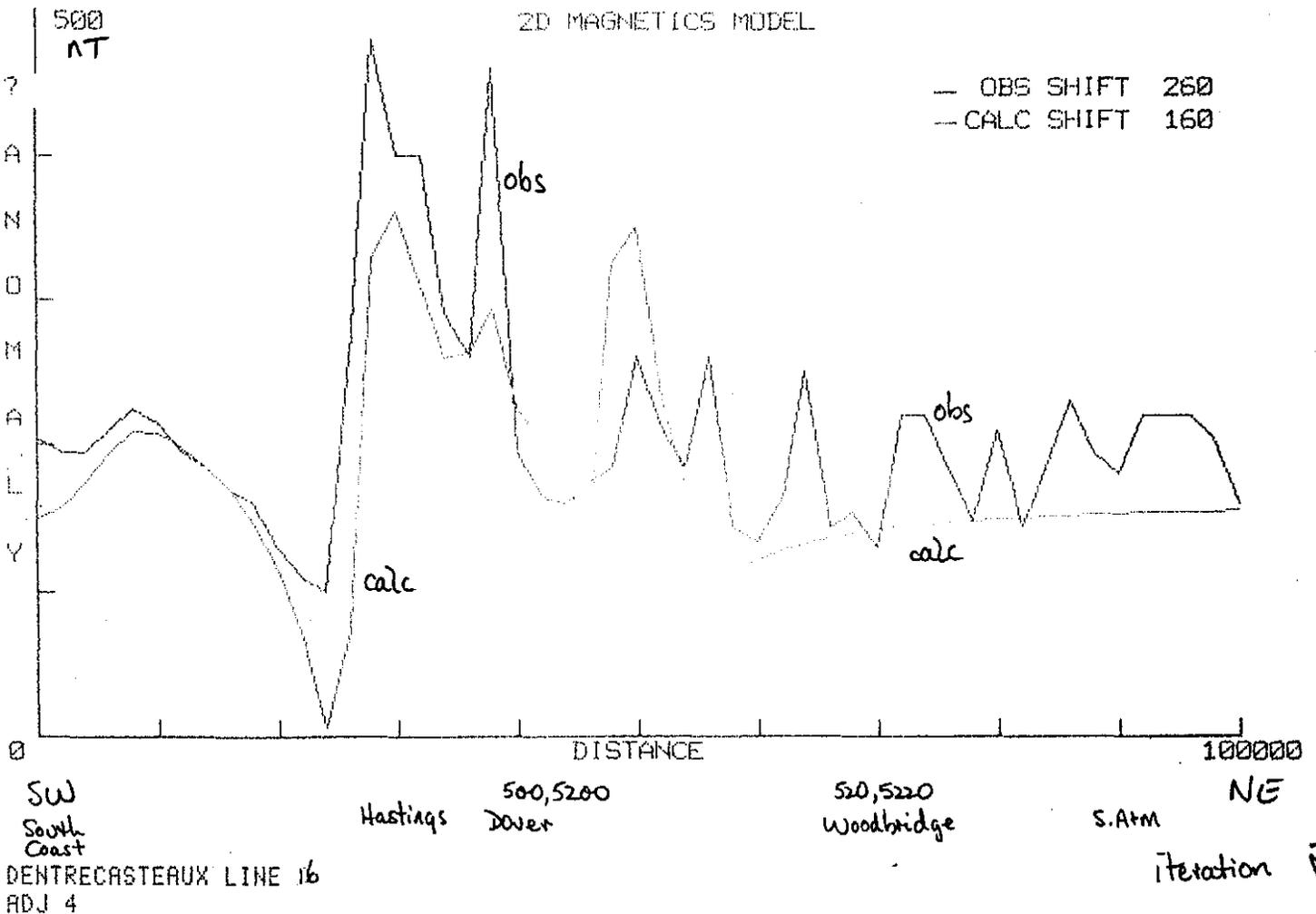
GRAVITY INTERPRETATION SECTION 15

FIGURE 53

# LEAMAN GEOPHYSICS

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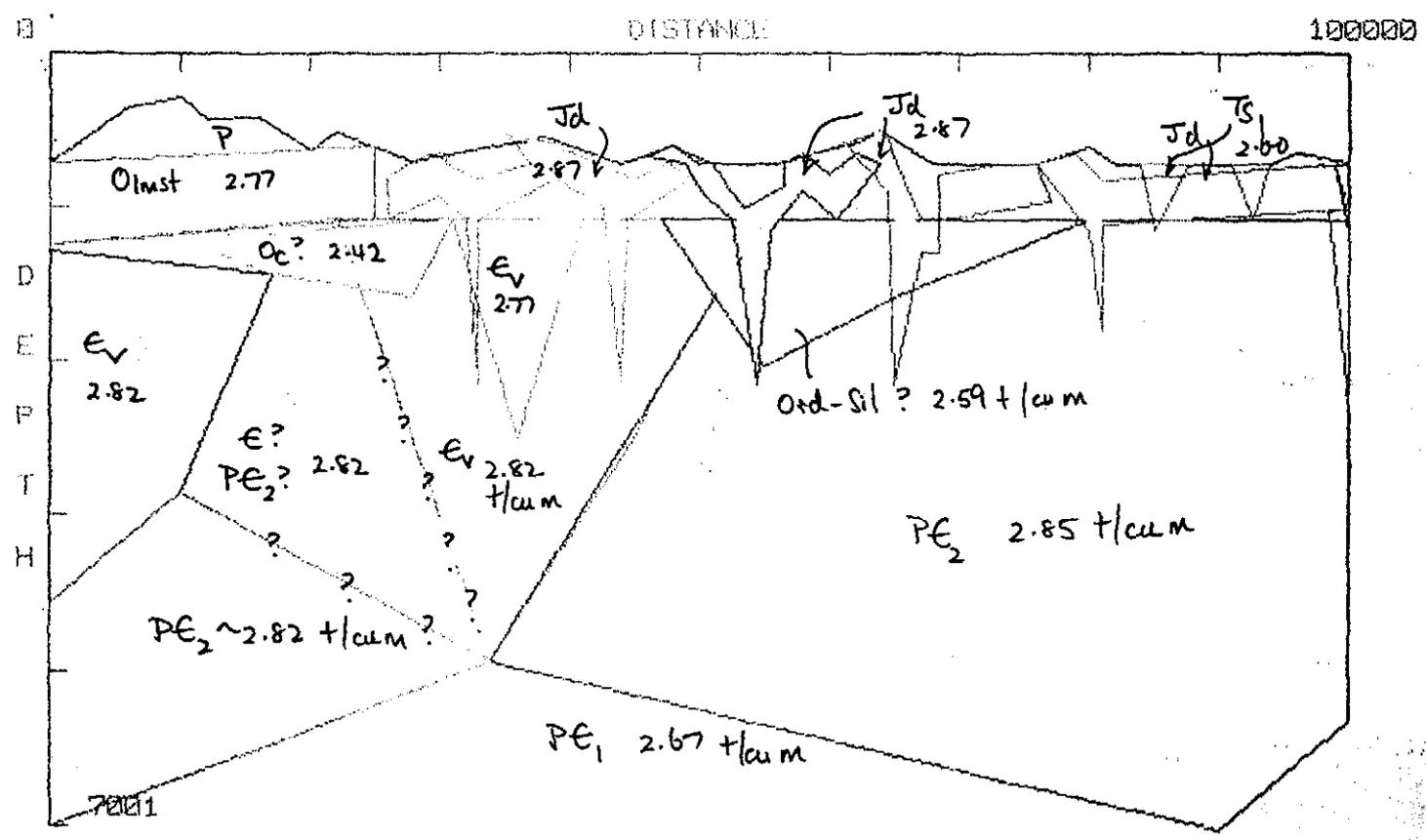
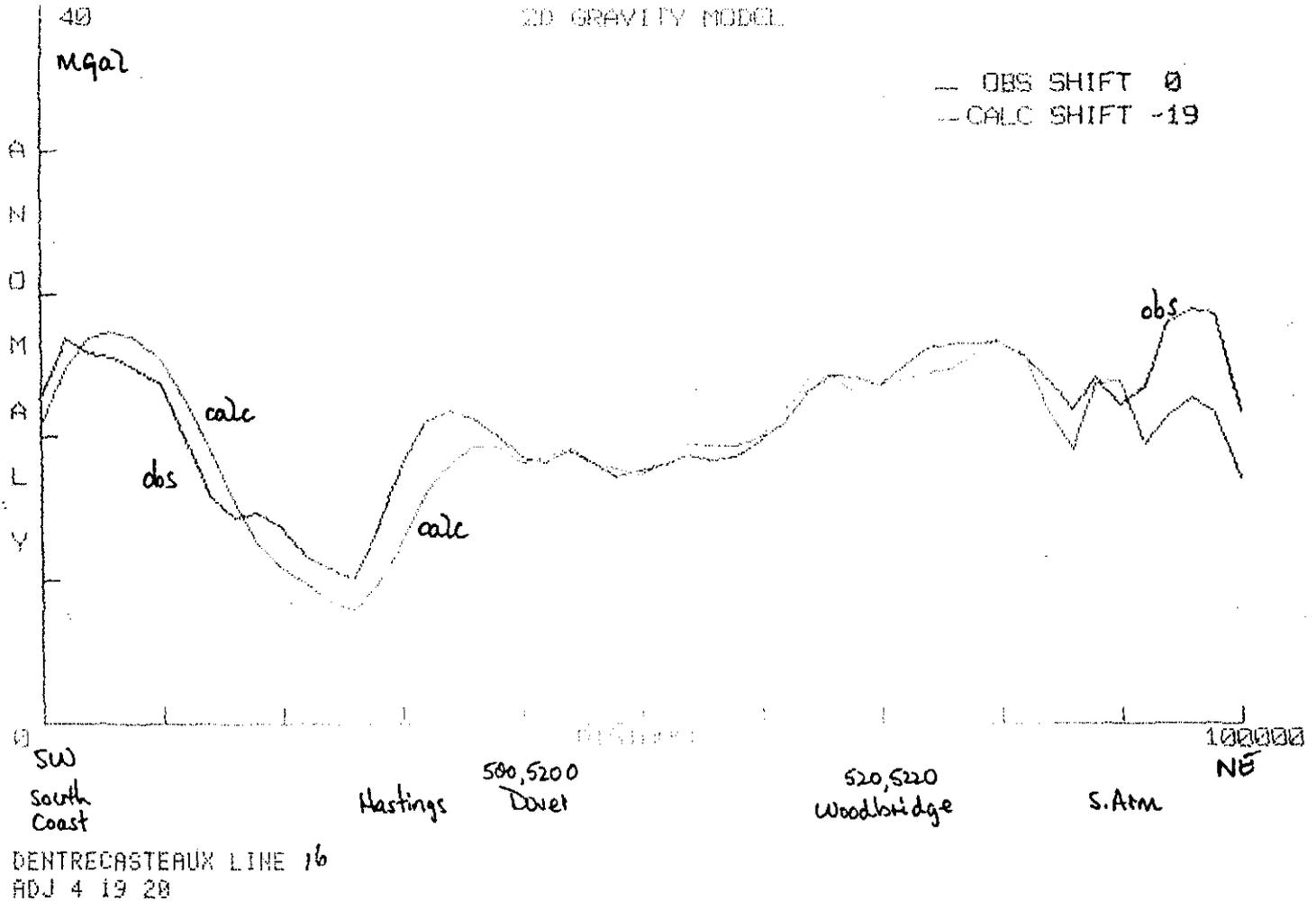
Registered Office: 870103  
461 OCEANA DRIVE, HOWRAH, TAS. 7018  
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GRAVITY INTERPRETATION SECTION 16

FIGURE 55

104

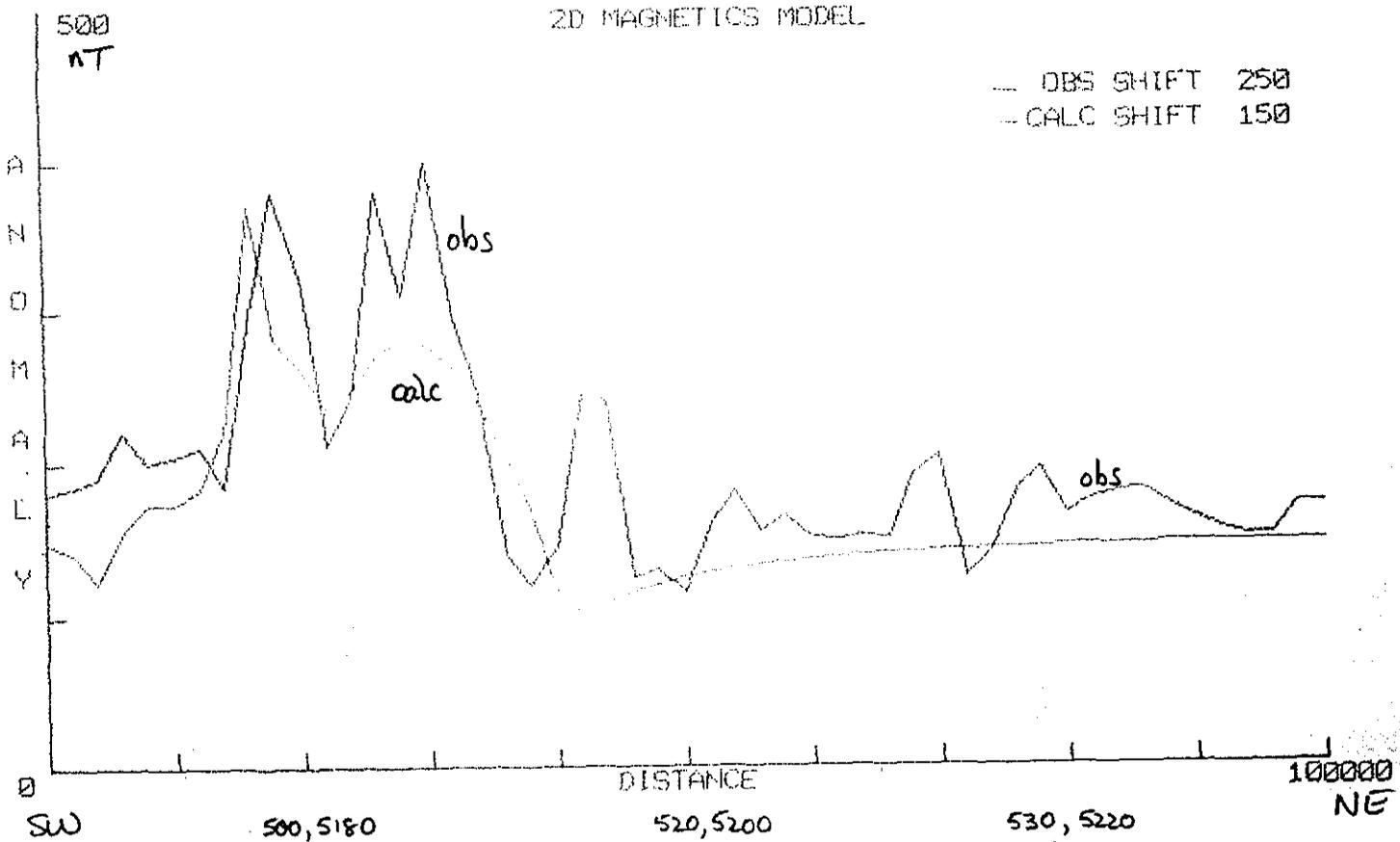
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870105

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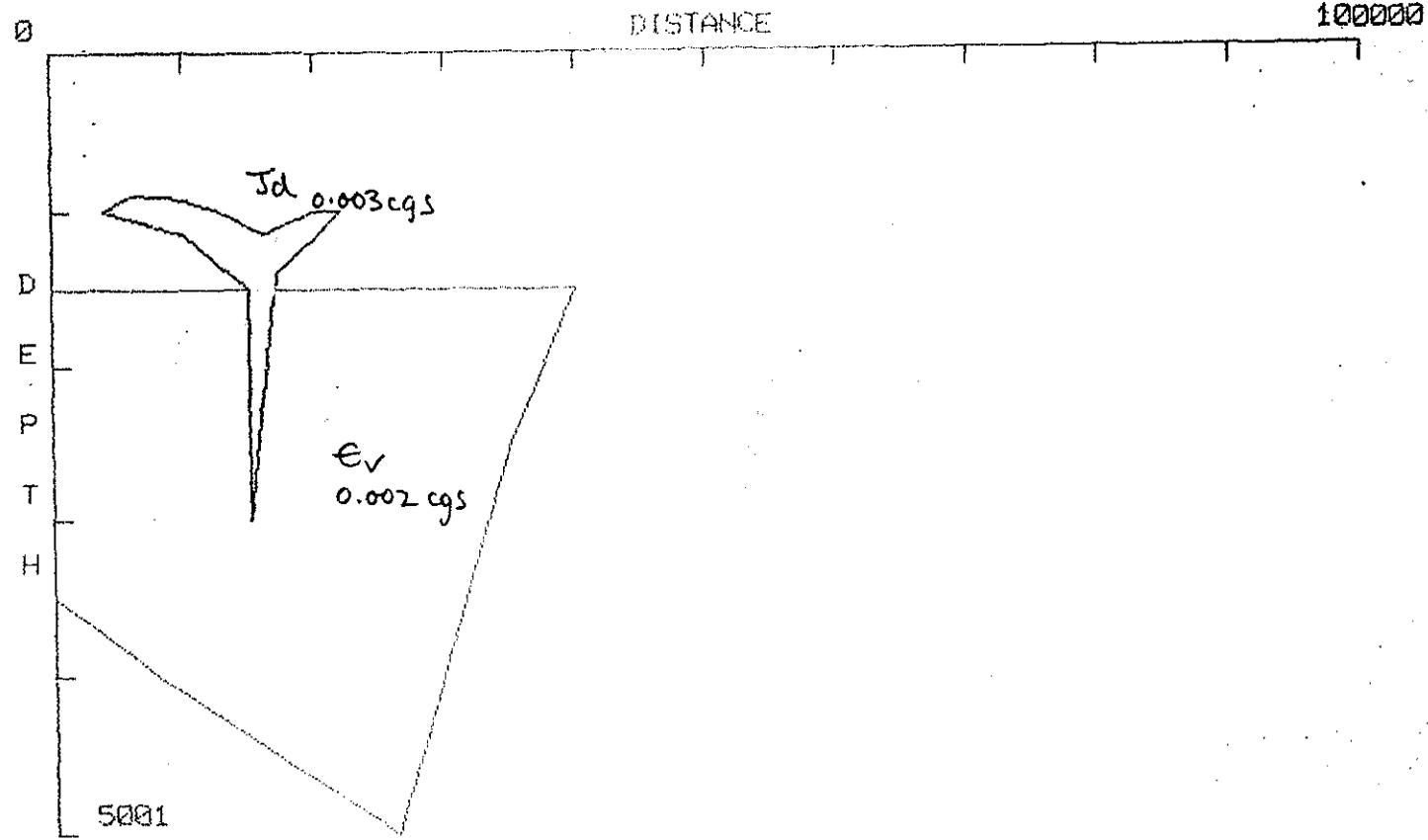
## 2D MAGNETICS MODEL



S.E. Cape  
DENTRECASTEAUX LINE 11 NG  
ADD CAMBRIAN

Lunawanna C.Q. Elizabeth

iteration 6



105

# LEAMAN GEOPHYSICS

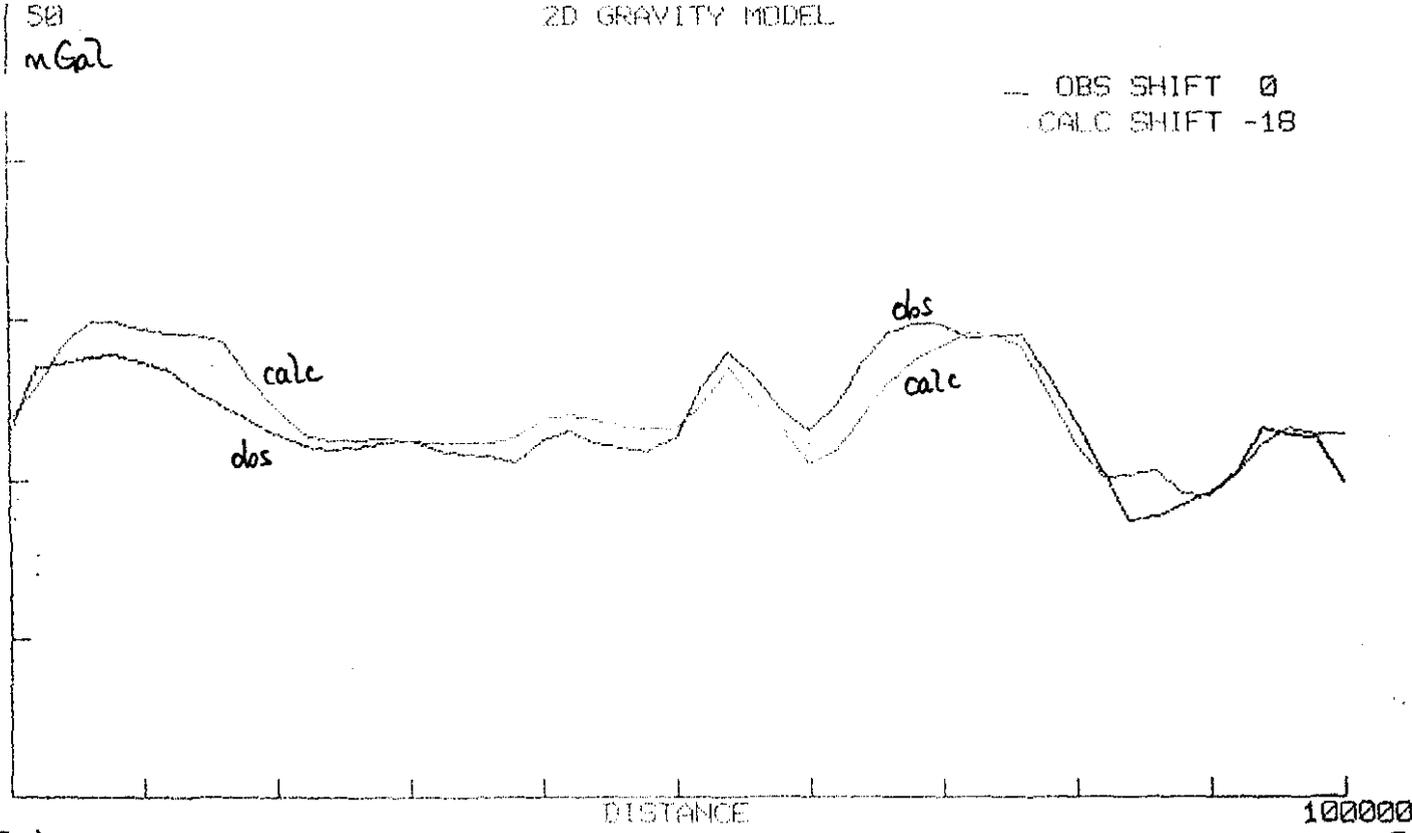
Survey Review, Specification, Reduction, Interpretation  
Wide Experience Most Methods  
Specialties:- Gravity, Magnetics, Seismic Methods

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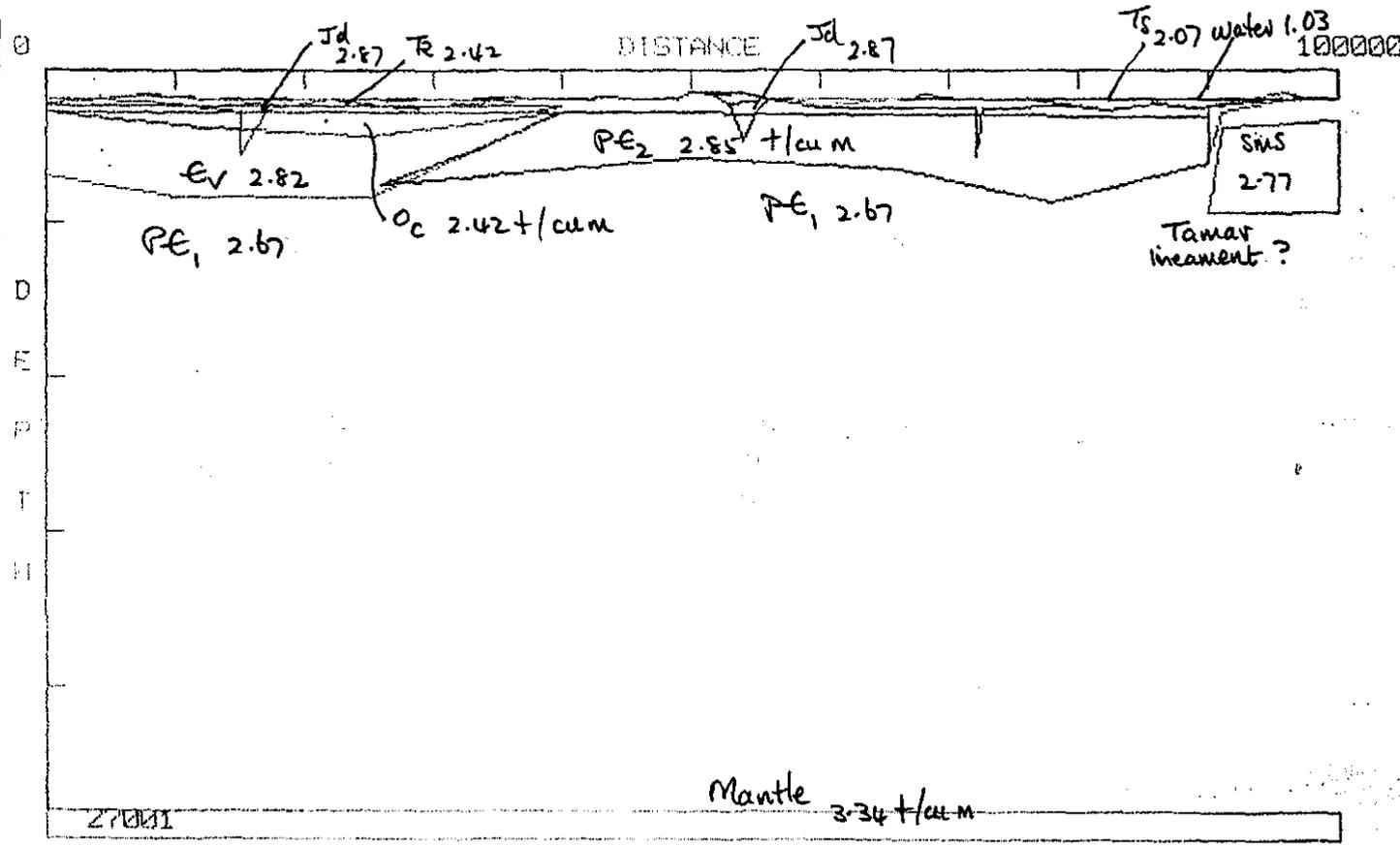
870106

## 2D GRAVITY MODEL

OBS SHIFT 0  
CALC SHIFT -18



SW 500,5180 NE  
S.E. Cape Lunawanna C.Q. Elizabeth  
DENTRECASTEAUX LINE 17  
ADJ 8 20  
iteration 5

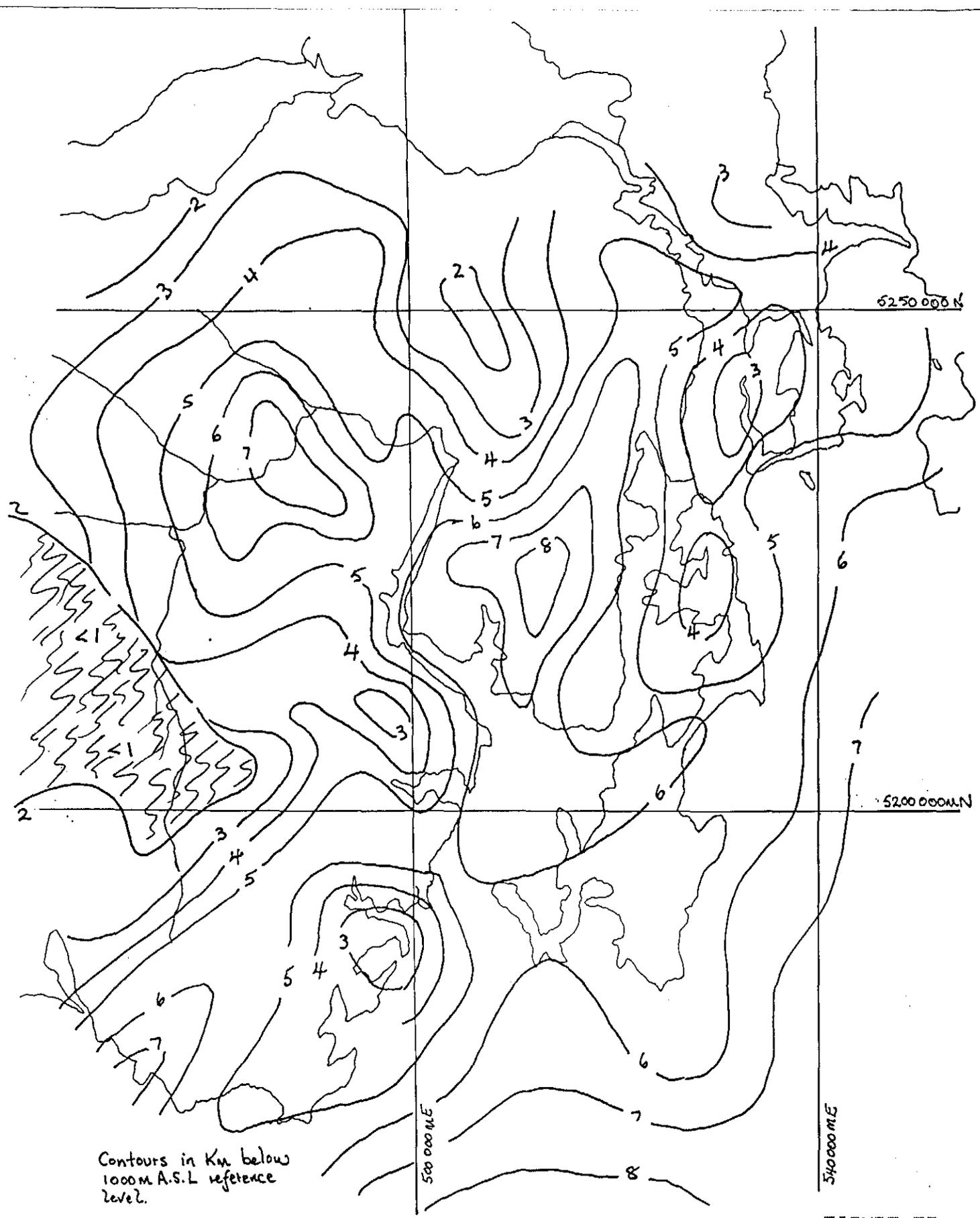


DENTRECASTEAUX LINE 17

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Contours in Km below  
1000m A.S.L. reference  
level.

FIGURE 58

DEPTH MAP: CRYSTALLINE BASEMENT (Tyennan Precambrian)

Derived from initial gravity-magnetic interpretation and not

870107

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870108

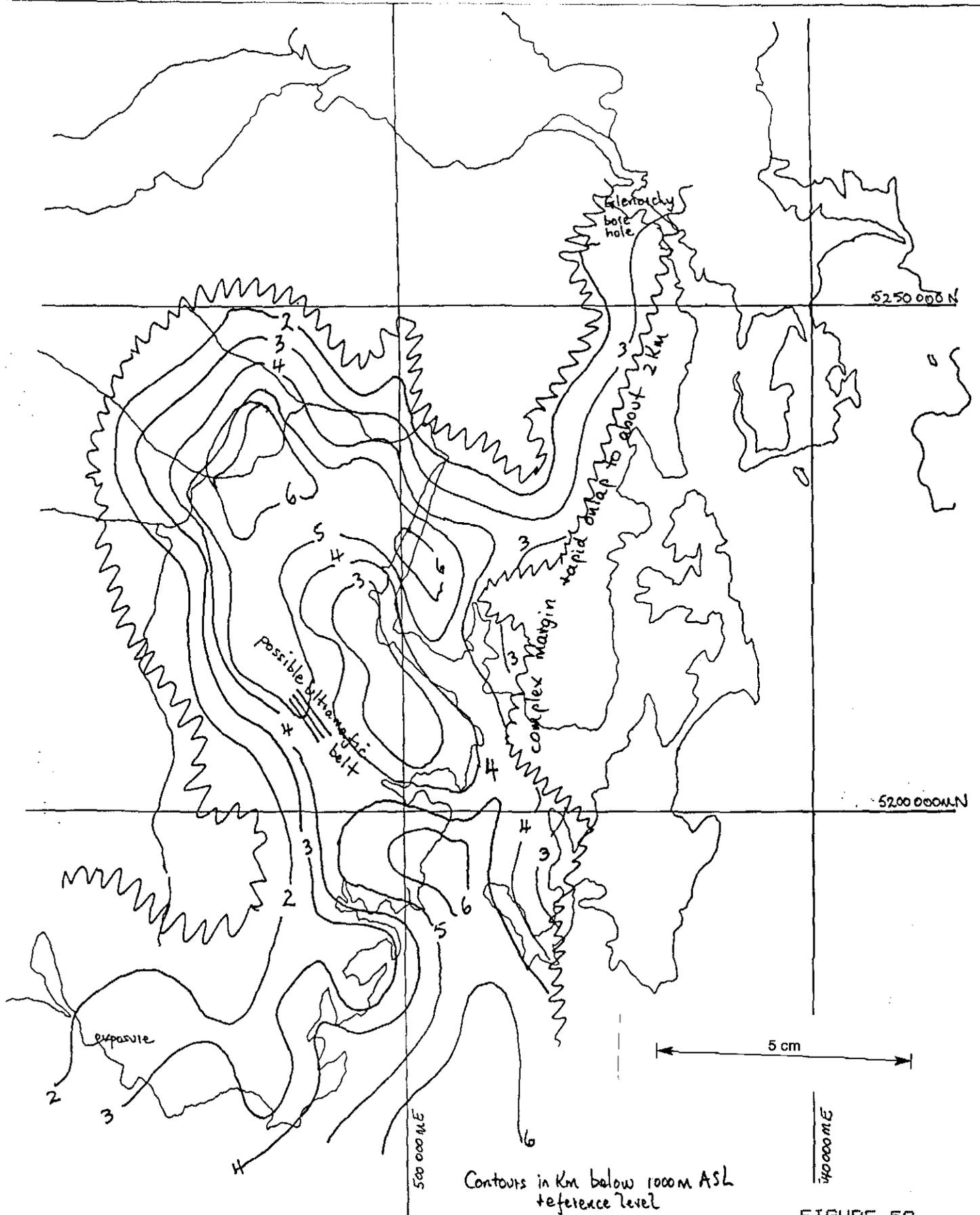
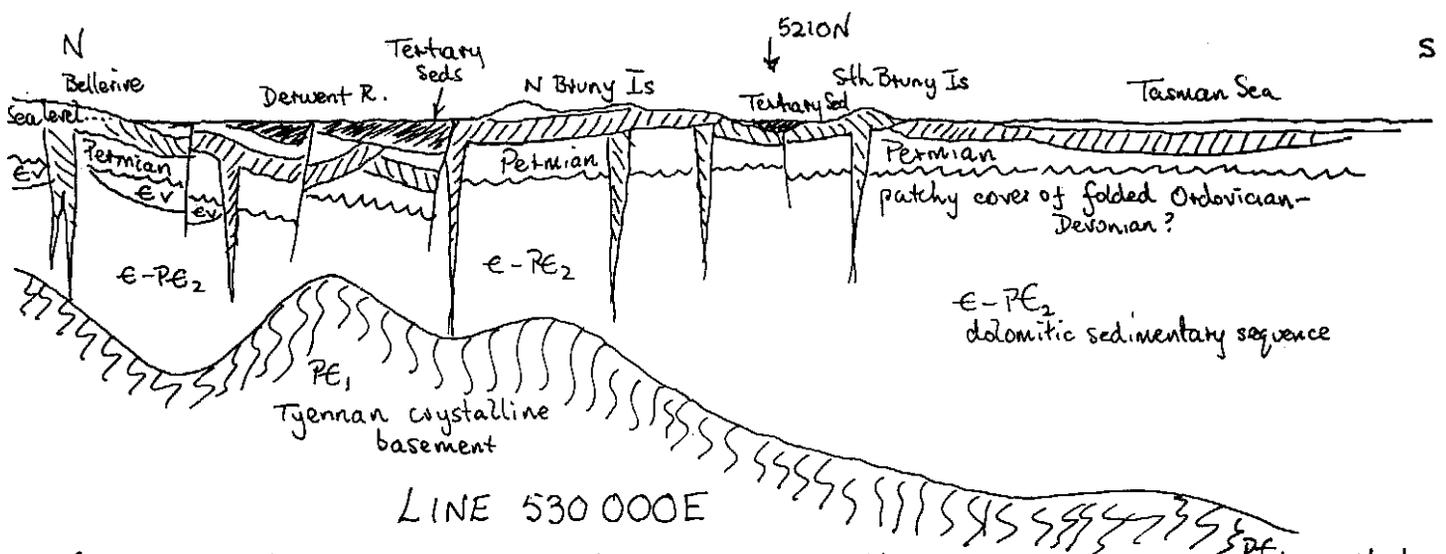
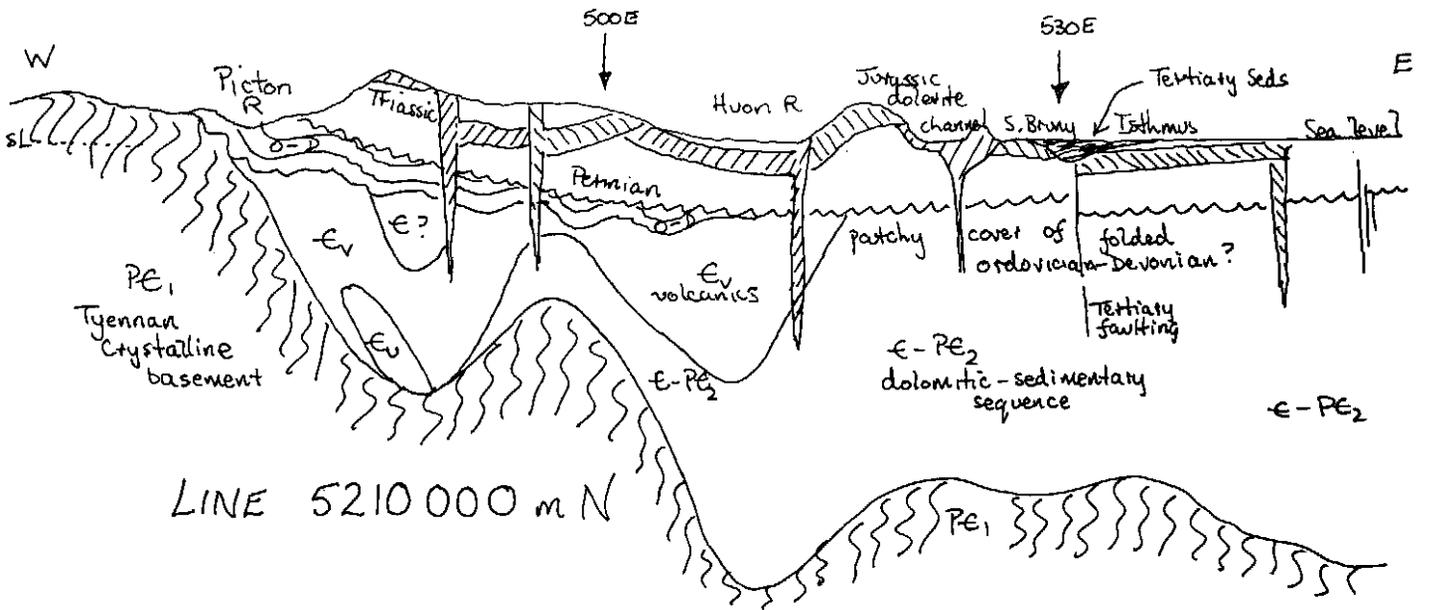
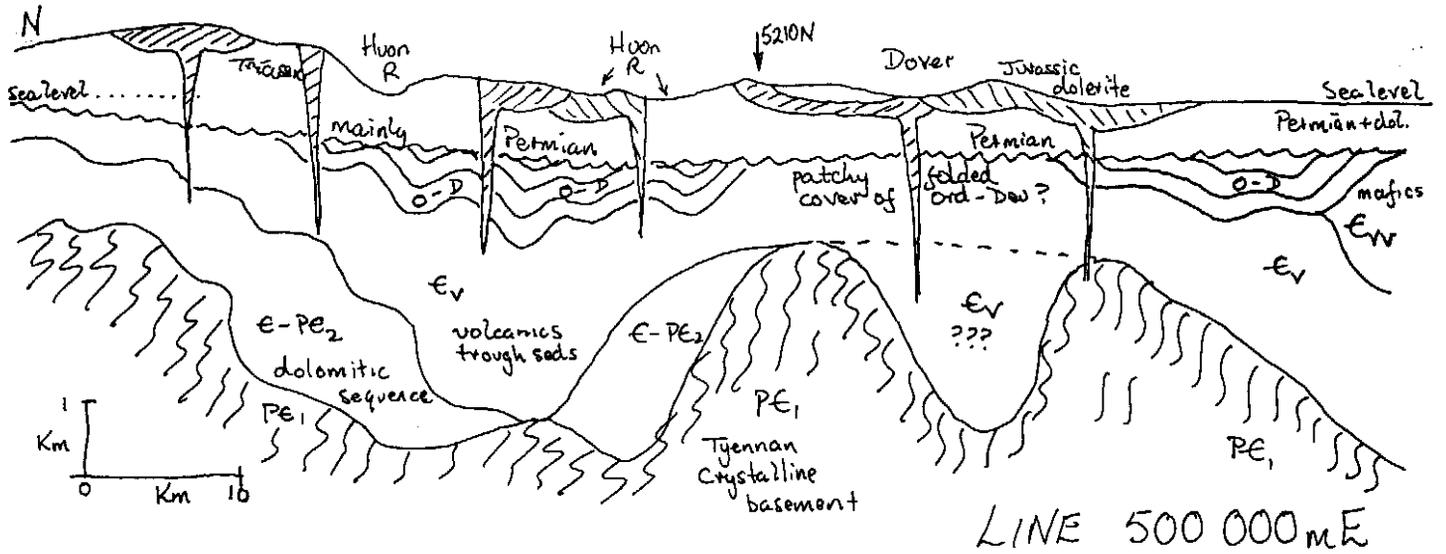


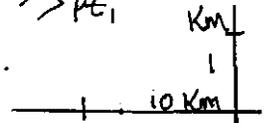
FIGURE 59

DEPTH MAP: BASE OF CAMBRIAN VOLCANIC (MAGNETIC) SEQUENCES

Derived from initial gravity-magnetic interpretation and not confirmed by 3D or second phase modelling. (no control)



Minimum dolerite stockwork shown. Other intrusions possible and not resolved in phase I interpretation. Sections subject to modification.



SUMMARY OF INFERRED STRUCTURAL STYLES INDICATED BY INITIAL INTERPRETATION

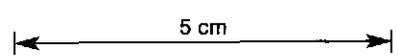
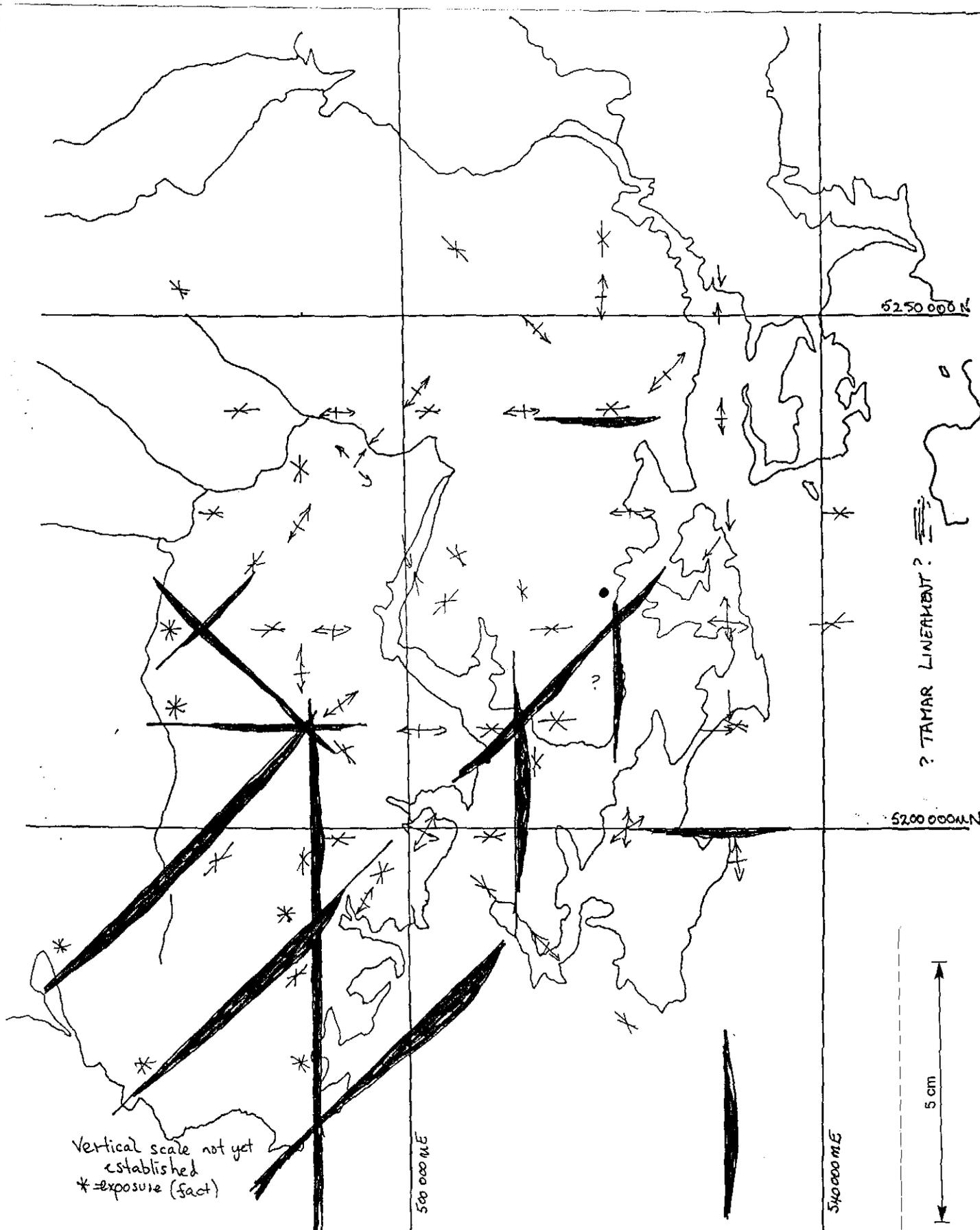
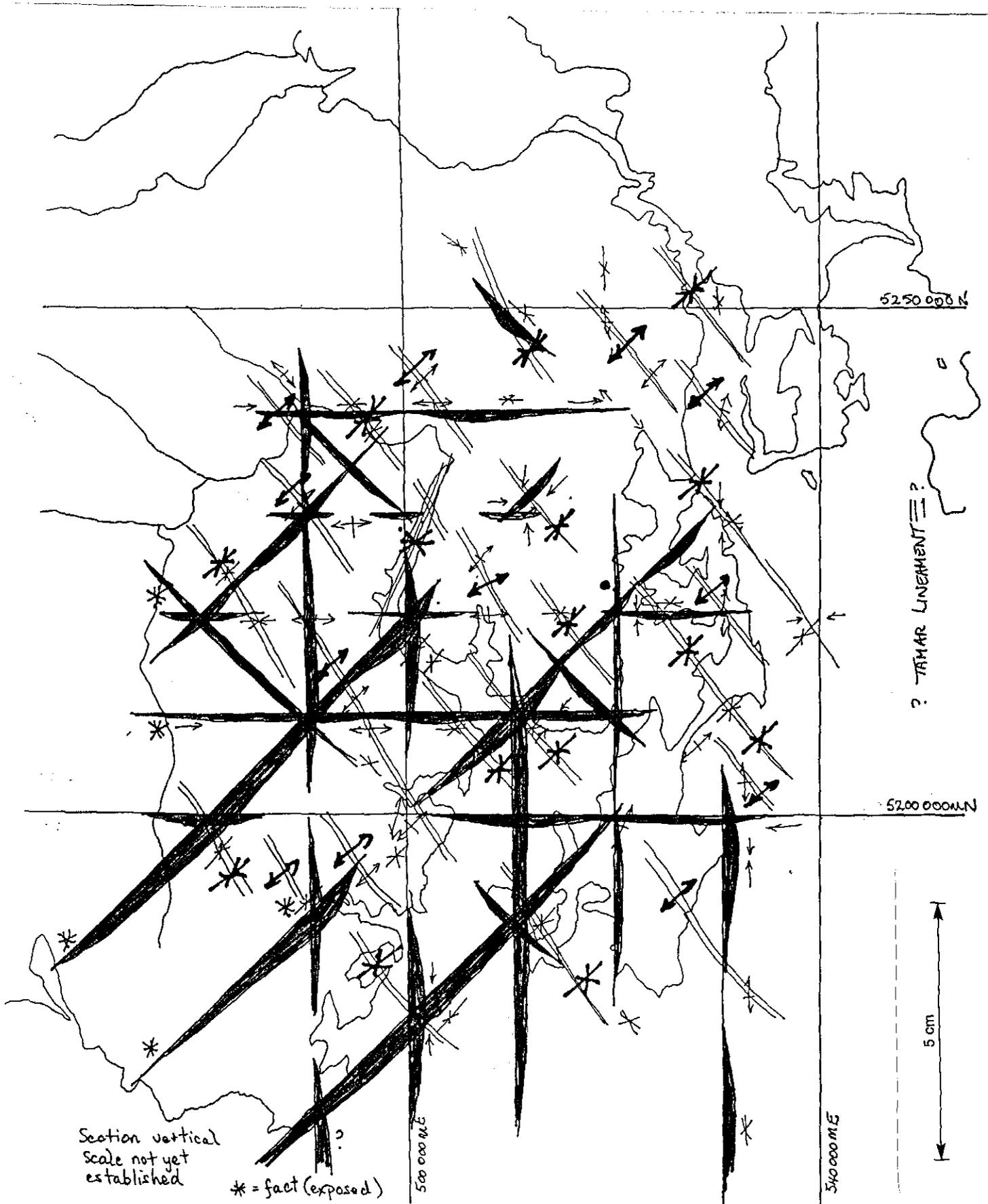


FIGURE 60



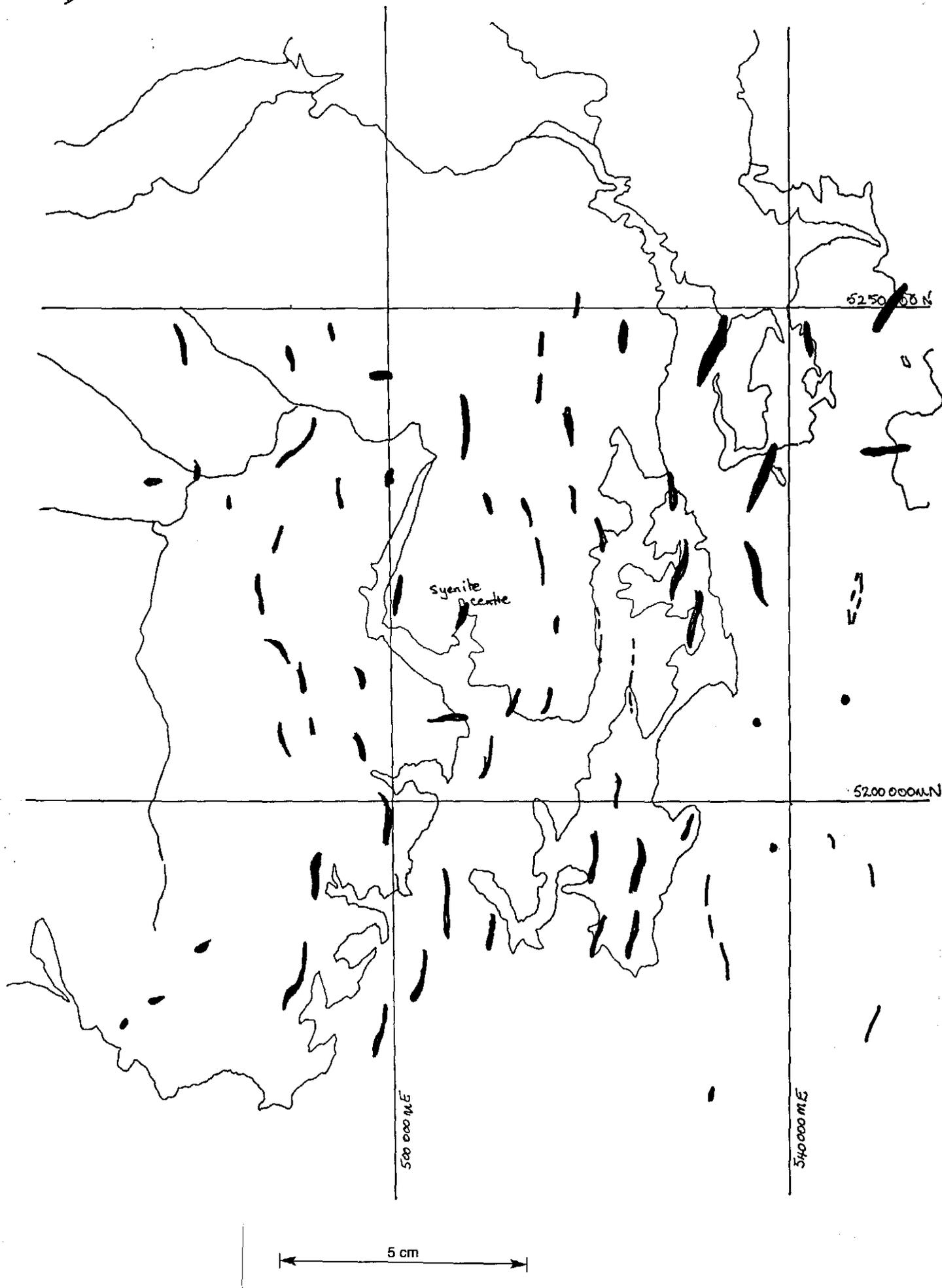
INFERRED DISTRIBUTION: ORDOVICIAN - DEVONIAN UNITS FIGURE 61

Pessimistic solution: Unconfirmed indications derived from initial gravity-magnetic interpretation not tested by 3D or



INFERRED DISTRIBUTION: ORDOVICIAN - DEVONIAN UNITS FIGURE 62

Optimistic solution: Unconfirmed indications derived from initial gravity-magnetic interpretation not tested by 3D or second phase modelling. Indicated fold trends most consistent inference on present data using assumption of presence of



LOCATION OF JURASSIC DOLERITE FEEDERS  
(Preliminary interpretation)

FIGURE 63

APPENDIX ONE

SPECIFICATIONS OF AEROMAGNETIC SURVEY

CONTRACT

D'ENTRECASTEAUX MAGNETIC SURVEY  
SOUTHERN TASMANIA

FOR  
CONGA OIL PTY LTD.

BY  
AUSTIREX INTERNATIONAL LTD.

## CONTRACT

SCHEDULE ONE1. PROJECT

The name of the project is "D'Entrecasteaux magnetic survey Southern Tasmania."

2. WORK TO BE PERFORMED

The work to be performed by the Contractor consists of the acquisition, processing and presentation of airborne magnetic data in one survey block in Southern Tasmania.

The work to be performed consists of:-

- a) a survey block within the AMG co-ordinates 470 000mE to 555 000mE and 5170 000mN to 5250 000mN.
- b) a survey with flight lines flown with an orientation of 090 degrees and 270 degrees magnetic. The flight line spacing shall be 2.5 kilometres and the sensor height will be 1000m above sea level.
- c) tie lines flown generally perpendicular to the flight lines at a line spacing of 10 kilometres and the sensor height will be 1000m above sea level.
- d) an approximate total of 3,280 linear kilometres including traverse lines and tie lines.

3. CONTRACTOR'S OBLIGATIONS3.1 Survey navigation, flight path recovery and synchronisation

- a) The Contractor will use electronic radio positioning equipment for navigation and flight path recovery.

The system to be used will be the Syledis long range UHF radionavigational system. Syledis is an over the horizon radio ranging technique which provides high accuracy position determines for a mobile station from two or more fixed beacons in real time. The Syledis position information will be directed for navigation of pre-determined flight lines and subsequently recorded on digital tape along with the geophysical data.

b) Fill-in flight lines:

Fill in flight lines will be required at the expense of the Contractor if flight line plots show gaps between individual flight lines in excess of 50% of line spacing over a distance of more than 10% of the line length.

Reflying of fill-in lines or repeated flight lines will be required at the expense of the Contractor if flight path recovery or geophysical data do not comply with these specifications. Fill in lines or repeat lines must be of sufficient length to cross at least two tie lines.

c) Synchronisation:

The geophysical data and navigation systems will be synchronised to a 1.0s time base generator. The magnetometer will be sampled twice each cycle, giving an effective sampling rate for the magnetometer of 0.50s. The average sample distance along each flight and tie line for the magnetometer will be about 30m.

3.2 Data to be provided by Contractor:

a) Original data required at conclusion of processing:

All data will be correctly annotated before being delivered to the Principal. Analogue charts will be edited, folded and bound. The following is a list of data which will be delivered.

Magnetic charts and digital records;  
Barometric-altimeter charts;  
Magnetometer storm warning charts and diurnal records;  
Flight logs - originals;  
Flight index - originals;

b) Processed data to be provided by the Contractor:

The Contractor shall reconstruct flight path plots and provide contour plans and profiles of magnetic intensity after removal of the IGRF.

i) Flight Path Maps:

The flight path maps will be prepared to high-order cartographic standards and plotted on stable base film. Final maps will be prepared at a scale of 1:100,000. The maps will be produced using a transverse Mercator projection and a format as specified by the Principal.

ii) Magnetic Contour Maps:

The magnetic data will be levelled from diurnal and tie line records, the effect of the IGRF will be removed and contours of residual field plotted at a selected intervals. Final maps will be prepared at a scale of 1:100,000. The map formats will be prepared as in (i) above.

iii) Stacked magnetic profiles.

The Contractor will prepare stacked profiles of the reduced magnetic data. Final maps will be prepared at a horizontal scale of 1:100,000. The vertical scale shall be chosen by the Principal.

iv) Colour coded magnetic contours.

The Contractor will prepare a contour map of residual magnetic intensity using different coloured contour lines. The contour interval chosen for each of the colours will be decided by agreement between the Contractor and the Principal.

v) Werner deconvolution profiles.

The Contractor will provide Werner plots of all or selected lines. Each plot will show total field magnetics, depth, horizontal location, dip and susceptibility parameters for both thin dyke and edge solutions. Presentation scale will be 1:100,000.

vi) Located data tapes.

The Contractor will prepare located data tapes of the reduced geophysical data.

vi) Logistics report.

The Contractor will provide a logistics report at the conclusion of the survey. This logistics report will include:

- a) Survey specifications;
- b) Description of survey equipment and data acquisition equipment including base station magnetometer;
- c) Description of procedure used to conduct system calibration and checks;
- d) Results of all pre and post flight system calibration checks, and all test flight lines; and
- e) Log of survey logistics and navigators logs.

4. PERSONNEL, PLANT AND EQUIPMENT

The Contractor shall provide, maintain and operate at its own expense all aircraft plant and equipment necessary to perform the work.

The Contractor will ensure that qualified personnel are in charge of all aspects of the work.

a) Type of Aircraft:

The Contractor will use a Rockwell Shrike AC500S Aerocommander aircraft, a twin engined aircraft.

The aircraft is fitted with a Collins ALT-50 radio altimeter, and a Penny and Giles barometric pressure sensor. Radar altitude and barometric pressure are digitally recorded.

The aircraft is also fitted with a Sperry-Decca type 72 doppler navigation system coupled with a Tactical Air Navigation system (TANS) computer 9447D. This computer can be programmed to a variety of specific survey functions. Navigation may be in latitude/longitude, metric grid, or range and bearing modes. Navigation information is digitally recorded on magnetic tape with the geophysical data, and is used in conjunction with photographic records to define the aircraft's flight track. The aircraft is also equipped with a Global GNS VLF/Omega navigation system.

b) Electronic Navigation Equipment:

The Contractor will use Syledis positioning equipment comprising one mobile unit, three beacons, navigation computer and support for field stations.

c) Equipment for collection of data:

i) Airborne Magnetometer:

The Contractor will use a Scintrex V2321 alkali vapour magnetometer sensor coupled to a Sonotek AADC automatic digital compensator as the airborne magnetometer. The resolution of the system is 0.01nT at 0.5 seconds sampling and the noise envelope should not exceed 0.10nT's except in extremely turbulent conditions.

The compensated magnetometer data will be recorded both on analogue strip charts, and on digital magnetic tape. The analogue charts will show the coarse and fine magnetometer record. The full scale deflections on these charts will be adjusted according to magnetic activity expected in the survey area, but are typically 0-100 nT and 0-1000 nT.

ii) Ground Magnetometer:

The Contractor shall use a modified Geometrics G856 proton magnetometer, coupled to a HP 85 computer as the base station magnetometer. The recording sensitivity of this magnetometer is 0.01nT. This magnetometer will be cycled each 20 seconds.

iii) Altitude Measurements:

The Contractor will measure and record digitally the ground clearance and barometric pressure at each data point. A Collins ALT-50 radio altimeter and a Penny and Giles barometric pressure sensor will be used. The barometric altimeter record will be recorded on analogue charts in real time.

iv) Ground Tracking Camera:

The Contractor will use a Geocam model 75SF 35mm single frame camera, fitted with a 17mm wide angle lens, to monitor the aircraft flight path. The focal length of this camera ensures ground coverage overlap on exposed film. The fiducials are imposed on the exposures.

v) Analogue Chart Recorders:

The Contractor will use a Watanabe multi channel recorder for magnetic, altimeter and fiducial data recording. Combinations of some selected channels can be multiplexed.

vi) Computer Equipment:

The Contractor will use the following computer equipment for data compilation and map preparation:

- one Data General MV/10000 supermini computer with 6 Mb real memory;
- 1.2 GB on-line storage
- eight 9 track 800 bpi magnetic tape units and two 1600 bpi units;
- one Calcomp 9100 digitiser;
- one Calcomp 960 high speed plotter;
- one 300 lpm line printer;
- eight VDU's and two graphic terminals.

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## d) Geophysical Operations:

Strict quality control of data shall be maintained with equipment calibration being checked before and after each flight. If during the course of a flight it is necessary for the flight to be aborted due to insufficient daylight or equipment failure, then the aborted flight line will be repeated in whole, or between appropriate tie lines, at the Contractor's expense.

## e) Magnetic diurnal activity:

On days when magnetic variations greater than 5nT occur in less than 5 minutes, flying, if not already commenced, shall be cancelled. If flying is commenced and if variations greater than 10 nT in 5 minutes are encountered, lines flown during the period of magnetic disturbance must be re flown. Any tie lines flown during a period in which the variation is in excess of 5nT in 5 minutes shall be re flown.

APPENDIX TWO

GRAVITY SURVEY COMPLETION REPORT

## 120 LEAMAN GEOPHYSICS

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1987 GRAVITY SURVEY  
PROJECT D'ENTRECASTEAUX

CONGA OIL PTY LTD

Following a preliminary assessment of available gravity data in southeast Tasmania which established the value of the gravity method as an aid to resolution of both dolerite and pre-Permian structuring additional data was acquired. This was essential outside the Cygnet and Catamaran areas since the existing TASGRAV data base was limited south and west of Margate.

The aim of the survey was provision of a greatly improved coverage and definition of the gravity field across the study area with some infill between the Huon River and the D'Entrecasteaux Channel and on Bruny Island where the primary coverage was poor to fair. The initial budget set aside for the survey meant that only those sites readily accessed could be observed and no attempt was made to generate a regular or uniform station distribution. It was felt that if such further improvement was needed that the new survey and its interpretation would reveal those zones in which more data acquisition would be critical or advisable.

Consequently all available road access and some of the better vehicular tracks were utilised. Where any track presented problems (as by washout, fallen trees, locked gates and hard to find owners, etc) the traverse was terminated. No walking of stations was entertained.

Application of these principles has produced a considerably improved data base but there are still major gaps both within the developed areas and in the less accessible regions marginal to them. A second generation survey using helicopters and walking tracks could resolve any deficiencies. It is not yet known if this will be necessary.

Specification and supervision:

The survey was supervised and specified by Dr. D. Leaman of Leaman Geophysics, Hobart.

A tie station network was formed which was ultimately tied to BMR Isogal station 6091.0260 at Mount Nelson and cross linked to 6851.9354 at Snug.

A nominal station spacing of 1 to 2km was to be employed on all traverses.

Elevations were barometrically determined using base barometers, multiple roving barometers and spot control methods coupled with many repeat observations.

Contractor:

Solo Geophysics of Adelaide, Graham Rao observer.

Period of survey:

March 13 to April 24, 1987

## Active licences during survey:

Only EL 29/84. Others pending and not advised.

## Reductions:

Completed, checked and integrated with Tasgrav data by May 1, 1987 using a density of 2.67 t/cu m. Reductions by Leaman Geophysics.

## Costs:

Survey: \$24974

Reduction: 5180

\$30054 or \$35.36 per station

## Tie station detail:

Base reference Mt Nelson:	6091.0260	980389.56
Snug	: 6851.9354	980467.47
Huonville bridge NE	: .9902	980459.03
Port Huon wharf	: .9903	980475.94
Geeveston 4 ft bridge	: .9904	980465.58
Dover library	: .9905	980487.59
Strathblane hall	: .9906	980490.82
Southport/Hastings jn	: .9907	980492.42

## Survey and compilation notes:

Some mismatches were noted between Tasgrav values and the new survey. These related mostly to old barometric surveys which lacked the benefit of new techniques and the good control now provided by Lands maps. Most previous work predates 1970 when basemaps were generally unavailable.

Other problem stations have been identified by reviewing patterns within the gravity field or the consistency of results upon re-occupation of sites. In most cases the Bouguer anomaly is within 0.5 mGal which indicates a long history of sound technique and reliable base networks.

Where possible, errors have been traced and the stations corrected. Very few have been deleted. In the case of parts of the Cygnet (6560), Hobart (6851) and Marathon (8050) surveys most errors relate to elevation but occasionally gravity difference or terrain correction errors were noted. Where height errors were recognised the precision on recovery is probably no better than 2 to 4 m. It must also be appreciated that no more than 30 stations were affected by any of these problems and only three were deleted from the data base.

The final recovery and compilation as presented at May 1, 1987 is satisfactory for the regional objectives of the D'Entrecasteaux project but any detailed replot of survey 6560 west of Cygnet should be reviewed with moderate caution and survey 8050 west of Lune River requires some additional confirmatory coverage. There may still be odd stations in these surveys which are suspect in elevation. The compilation provided uses a subset of the Marathon (8050) data and is thus

partly filtered to provide a nominal 500 to 1000 m spacing. Very detailed coverage of local areas within the Hobart district have been similarly treated.

Several BMR traverses in Storm Bay have also been compiled. All stations listed on the BMR marine file have been reduced. Not all were assigned water depths on that file and estimates have been inserted using the supplied coordinates and Admiralty charts. These depths are likely to be accurate to within 5 m in most cases although some sites may be suspect by up to 10 m. These problems are, however, minor compared to the variation in results generated by the various surveys and traverses, and along some traverses. I suspect that not all corrections have been properly applied on ship and the plot is based only on those values which afford some consistency, both internal and between surveys. The entire Storm Bay result should be considered suspect until confirmed by new survey.

**Precision:**

Observed gravity: Stations reproducible to within 0.03 - 0.05 mGal after loop and drift correction.

Elevation: Generally better than 2 m; equivalent to an error of about 0.5 mGal in the Bouguer anomaly.

Position: Generally better than 100 m; equivalent to an error of no more than 0.1 mGal in the Bouguer anomaly.

Terrain correction: variable but estimated at 5% based on reproducibility; or about 0.05 to 0.15 mGal for most stations.

The RMS error is of the order of 0.6 mGal. Many stations will be much better than this but some could be of the order of 1 mGal. A general 2 mGal contour interval is justified. Some areas could be contoured at 1 mGal contour interval.

D.E. Leaman  
May 1, 1987

APPENDIX THREE

TABULATION OF GRAVITY RESULTS

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8700.0719	532850.0	5219800.0	114.0	980467.10	980464.60	1.00	25.82
8700.0720	532900.0	5218850.0	119.0	980468.80	980465.40	1.10	27.88
8700.0721	533150.0	5218600.0	130.0	980466.70	980465.60	1.72	28.35
8700.0723	527350.0	5219350.0	1.0	980487.80	980465.10	0.18	23.11
8700.0725	526100.0	5219600.0	1.0	980485.40	980464.80	0.84	21.55
8700.0726	525350.0	5219200.0	1.0	980486.80	980465.20	0.76	22.52
8700.0730	526800.0	5218700.0	1.0	980489.60	980465.60	0.10	24.32
8700.0731	528000.0	5218350.0	1.0	980490.60	980465.90	0.35	25.27
8700.0732	528900.0	5218400.0	1.0	980490.50	980465.80	0.24	25.13
8700.0733	529250.0	5219000.0	1.0	980489.80	980465.30	0.21	24.83
8700.0740	532250.0	5219250.0	33.0	980486.80	980465.10	0.20	28.40
8700.0741	532200.0	5218900.0	73.0	980477.40	980465.40	0.37	26.76
8700.0742	531800.0	5218700.0	30.0	980486.10	980465.60	0.19	26.67
8700.0743	531550.0	5219150.0	12.0	980487.90	980465.20	0.20	25.27
8700.0744	532900.0	5217950.0	132.0	980466.40	980466.10	1.30	27.48
8700.0745	532250.0	5217900.0	40.0	980486.20	980466.20	0.25	28.19
8700.0746	531900.0	5218250.0	20.0	980489.30	980465.90	0.15	27.46
8700.0747	532850.0	5217600.0	111.0	980472.10	980466.40	1.08	28.52
8700.0748	533050.0	5214750.0	160.0	980464.40	980468.80	1.10	28.19
8700.0749	533000.0	5214150.0	178.0	980462.60	980469.20	1.70	30.11
8700.0750	532950.0	5213150.0	177.0	980464.20	980470.10	1.60	30.61
8700.0751	532750.0	5212350.0	96.0	980481.60	980470.70	1.00	30.77
8700.0752	532450.0	5211950.0	1.5	980501.50	980471.00	0.44	31.22
8700.0753	531200.0	5211450.0	10.0	980498.20	980471.40	0.15	28.84
8700.0754	531800.0	5212200.0	2.0	980500.40	980470.80	0.25	30.18
8700.0755	531025.0	5212600.0	3.0	980498.50	980470.50	0.16	28.75
8700.0756	530700.0	5213400.0	8.0	980497.10	980469.90	0.16	29.01
8700.0757	530125.0	5213900.0	15.0	980494.10	980469.40	0.23	27.76
8700.0758	530150.0	5214600.0	5.0	980495.80	980468.90	0.20	28.06
8700.0759	531400.0	5214350.0	121.0	980475.80	980469.10	2.00	32.50
8700.0760	531100.0	5214850.0	85.0	980482.50	980468.70	0.69	31.21
8700.0761	531450.0	5215050.0	61.0	980486.40	980468.50	0.32	30.25
8700.0837	530500.0	5215350.0	1.0	980496.80	980468.20	0.38	29.06
8700.0838	529550.0	5215750.0	1.0	980494.90	980467.90	0.29	27.45
8700.0839	528300.0	5215350.0	1.0	980494.60	980468.20	0.10	26.59
8700.0840	527600.0	5214600.0	1.0	980494.90	980468.90	0.12	26.29
8700.0841	528250.0	5212050.0	1.0	980499.10	980470.90	0.15	28.52
8700.0842	528200.0	5212600.0	1.0	980498.30	980470.50	0.15	28.17
8700.0843	528800.0	5213000.0	1.0	980497.50	980470.20	0.10	27.62
8700.0844	528350.0	5213600.0	1.0	980497.60	980469.70	0.16	28.23
8700.0845	534100.0	5212550.0	33.0	980495.60	980470.50	0.38	31.97
8700.0846	533700.0	5213100.0	18.0	980497.40	980470.10	0.31	31.21
8700.0847	533850.0	5213650.0	25.0	980496.20	980469.60	0.27	31.72
8700.0848	533900.0	5214150.0	41.0	980492.40	980469.20	0.26	31.52
8700.0849	533750.0	5214700.0	49.0	980490.70	980468.80	0.30	31.81