

# Appendix VIII

Integrated Interpretation of Seismic,  
Gravity and Magnetic Data

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**AN INTEGRATED INTERPRETATION**  
of  
**SEISMIC, GRAVITY AND MAGNETIC**  
**DATA**  
(as available in December, 2006)

**CENTRAL TASMANIA**

**SEL 13/98**

Report for Great South Land Minerals Limited

by  
Dr. D. E. Leaman

January 2007

Note that the contents of this report represent an interpretation of geophysical data of varied and often limited quality. It represents a best technical study within the experience of the interpreter. Such an interpretation must inevitably contain some opinion and assertion and should be treated as a basis for discussion, refinement and regional guidance for further programs. It cannot provide consistent reliability or any assurance of correctness and Leaman Geophysics cannot be liable or responsible for any loss, cost damages or expenses incurred or sustained by anyone resulting from any use made of it.

Report "An Integrated Interpretation..Central Tasmania, SEL 13/98" was prepared by David Leaman and presented to Great South Land Minerals Limited.

A handwritten signature in black ink, appearing to read "D Leaman". The signature is written in a cursive style with a large, looping initial "D".

January 29, 2007

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# SUMMARY

A comprehensive review and interpretation has been completed of the central plateau region of Tasmania; an area of exploration interest to Great South Land Minerals Limited (GSL) which holds a petroleum exploration licence. This work was undertaken in order to assess the nature of structures and stratigraphy, whether any prospects were already identifiable and which areas required further data – and the nature of that data.

Previous work had suggested that the post Carboniferous cover across most of the region was relatively thin; generally less than 1000 m. Underlying structures and sequences are unknown but extrapolations from surrounding regions suggest a range of Precambrian and Palaeozoic sequences. These were thought to be arranged in folds and thrust stacks with many wedged and unconformable relationships. Well control of these deep units is restricted to one well which encountered dolomitic Precambrian rocks. All other knowledge is inference from preliminary gravity and magnetic interpretations.

Acquisition of some high quality seismic data has led to a review of such preliminary studies and the present work is the most detailed study yet done of the region. It has exposed the considerable weaknesses in the data available and of the problems of acquiring sound data in the first instance. These problems involve the terrain (often rough and of high relief), non straight traverses, and irregular sheets of Jurassic dolerite which intrude the cover rocks and which are often exposed. Each of these factors work to degrade the quality and value of seismic data. The present traverse coverage also leaves much to be desired and recommendations have been offered on this point.

The fragmentary nature of reflections and lack of continuity, coupled with negligible factual control of lithology, has required the integration of potential field data in order to assess structures and probable lithologies from inferred property and geometry combinations. It should be noted that all previous work amounted to free potential field interpretations since no significant seismic data coverage existed until the GSL surveys of 2001 and 2006, nor did well Hunterston-1 which, at least, confirmed an earlier prediction of basement type at the site. Assessment of the disjointed and block nature of structurally framed elements requires use of many methods.

Unfortunately this type of analysis places demands on the data which the gravity coverage (Tasmanian state data base) could not meet uniformly across the region. The magnetic coverage, acquired by Conga Oil, was of useful quality but restricted in value due to its line spacing. Further, the geological data base is woefully inadequate across nearly all of the region and further analysis, analysis using improved data and able to handle the issues posed within the cover sequence, will need some improvements in this knowledge. Improved gravity and magnetic coverage, so critical to full integration of blind seismic data, or poorly controlled seismic data, has been recommended: as has some ground inspection of critical exposures and areas.

The analysis essentially confirms the structural style predicted by earlier, less detailed studies completed in the absence of seismic data. Most major reflections appear to involve Cambrian ultramafics and are thrusts. Both east-dipping and west-dipping thrusts have been identified and many blocks are fully enclosed by such structures and such materials.

Folded structures may be traced beneath the cover from exposed elements in the west near the Florentine River valley and Mt King William, and from the north at Golden Valley. In some cases most major Palaeozoic rock sequences, as exposed in western Tasmania, may be inferred. There are many cases where key elements are missing and the most common omission is Cambrian in age (volcano-sedimentary sequences and volcanics). Not all units can be identified with confidence but the presence of the lower density, non magnetic Silurian and Devonian members have been deduced in various areas, mainly south of Great Lake. These rocks may offer reservoir potential and older source rocks may underlie them.

The only region which, given present data and analysis, might contain a nest of potentially closed structures is near Lake Echo, east of Bellevue. These structures are tiered and not concentric but are not yet defined to the east. Much effort should be focussed on this region.

Many other structures which present apparent crests would seem, at this stage, to be open in at least one direction. This is especially true of any structures involving the post Carboniferous (Parameener Supergroup) cover, plus dolerite. The cover, indeed the entire region and the basal unconformity involved, is ramped with long wavelength regional dips. Apparent domes are not closed domes; they open, usually to the north. This observation will have implications for migration and reservoir assessment involving these rocks.

A number of ambiguities and conflicts have arisen which cannot be resolved with present data, and without further well control. Recommendations have been offered of drill sites which would resolve some of these uncertainties, constrain any future analysis and improve general understanding of the region.

The preparation of such recommendations, coupled with suggestions about structures, structural style and some sequence compositions, can be considered both the aim and result of this integrated review.

It must be clearly understood, however, that the interpretation has stretched the data sets to their power of resolution and, in some cases – especially gravity in western areas, exceeded this. Some aspects of some models offered are over-interpretations of gravity data, but within the resolving power of the seismic and magnetic data available.

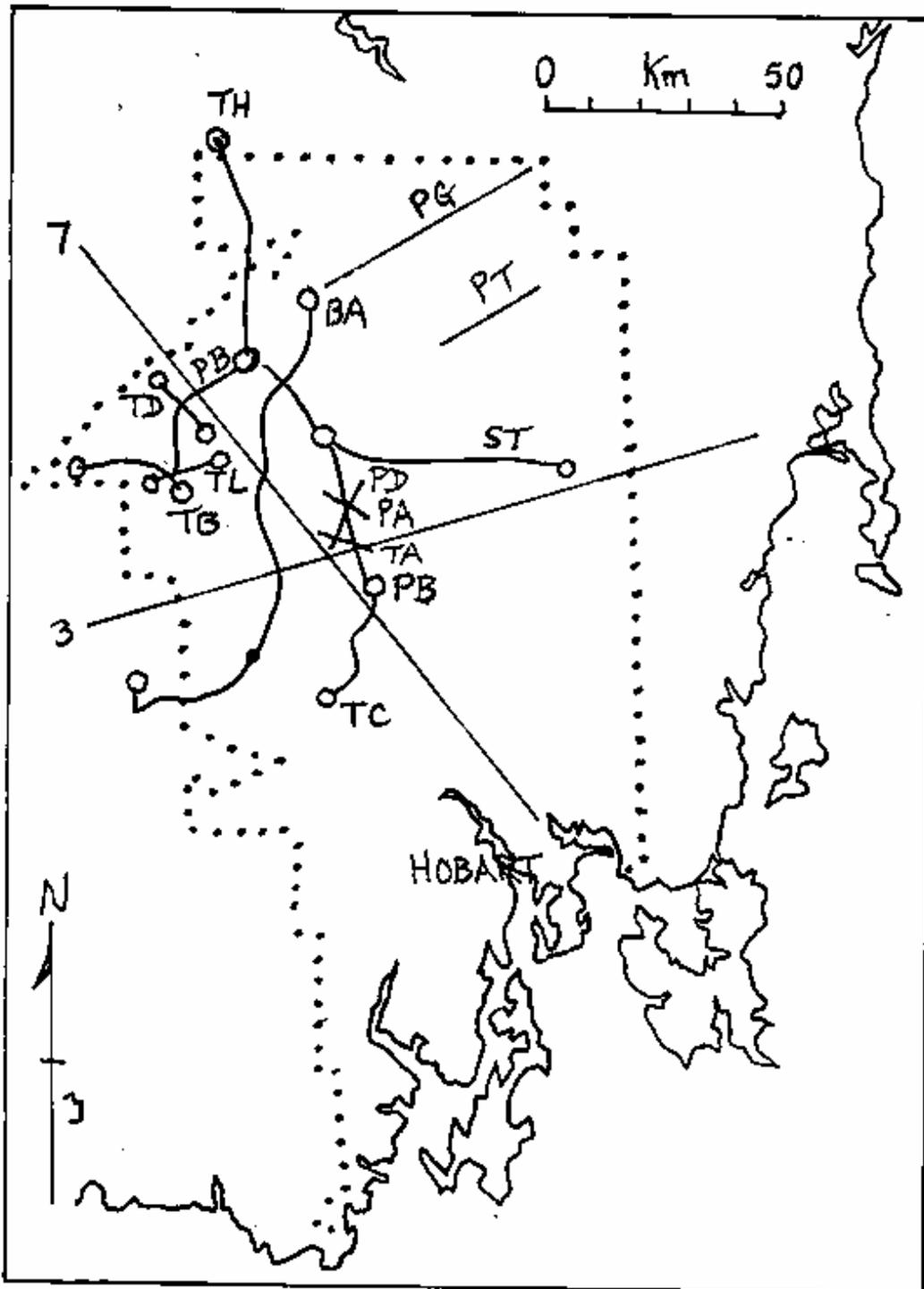


Figure 1: Location of licensed area and seismic lines, central Tasmania.  
 (Additional lines are available in the northeast part of the licence area but these map post Parmeener structures and are not generally relevant to the present study. Lines PG and PT have been included from this set for reference purposes only)

## INTRODUCTION

The integrated interpretation presented in this report was commissioned by Great South Land Minerals Limited (GSL) for several reasons. It is important that those reasons be stated, along with some comments about the inevitable limitations contained in the analysis. This interpretation is, at least, a current update of past research and a comprehensive improvement will not be attained until many elements of the data sets are themselves improved, and there is significant coverage of deep well control in the complex – and largely unknown – pre-Permian geology of central Tasmania.

### **The geological setting**

The licence area, and adjacent region, is largely blanketed by a nearly flat-lying cover of Permian and Triassic rocks intruded by sheets of Jurassic dolerite (or dolerites) of varied thickness. This cover largely blinds the explorer seeking stratigraphic relationships (sequence thicknesses, contents, onlaps, unconformities, variations) or structural features (folds, ramps, faults and thrusts). These two classes of relationship form the heart of petroleum exploration. They are not evident in central Tasmania although it is clear that rock units, as exposed laterally, do possess considerable variations which may well offer potential. Further, some lower Palaeozoic rocks can generate, and have generated, hydrocarbons, as may some Lower Permian formations. Previous documents (such as GSL 2002) prepared for Great South Land Minerals Ltd have demonstrated these facts, essentially supported by Bacon *et al* (2000).

A few studies of the pre-Permian (essentially pre-Permian) sequences and structures beneath central Tasmania have been completed. These are by Leaman (1987, published as Leaman, 1990) which considers southern Tasmania, Leaman (1991a, b) which reported a more preliminary study of northern and central Tasmania, a private revision used as a framework for Leaman (1996b), and elements of TASGO project (2001) and selected sections of Leaman & Webster (2002). The original 1990 study of central Tasmania was begun by an earlier parent of the present company but work was halted due to funding and data constraints. The implications were summarized in Leaman (1991) and incorporated in Leaman (1992) and Leaman *et al* (1994).

These relatively limited studies, undertaken in the absence of significant seismic coverage, indicated a complex, repeated thrust regime in which the thrust packages generally dip eastward but, in the western part of Tasmania, and the western part of central Tasmania, often dip westward. Both regimes are known to exist in western Tasmania. This pattern could be expected across the entirety of basement Tasmania but it appears that east dipping thrusts become dominant in eastern Tasmania.

### **The first seismic problem**

There is little about the geological setting which, in normal circumstances could not be clarified, perhaps resolved, using the seismic method. The crucial factor is the Jurassic dolerite, its variable presentation on the land surface – in terms of soil and weathering cover, and its variable and generally very high velocity at shallow depths.

Any failure to appreciate these variables has devalued and degraded seismic data. Early work (Leaman, 1978b, Leaman & Richardson, 1980, Richardson & Leaman, 1981) showed that good reflection records could be obtained where high dynamic ranges were sustained using a wide frequency range (15 to 120 Hz at least). In such conditions the depth of fracture closure (and its velocity step) was recognisable, as was the base of the intrusion and some features beneath it. Overstacking was not always found to be beneficial and best results were obtained in this early work where dolerite occurred at some depth (> 100-200 m), and preferably beneath water or low velocity sedimentary materials (< 2000 m/s). Most problems were encountered when dolerite was at surface and this was exemplified by test profiles at various locations (Leaman, 1978b; 1996a; Leaman & Richardson, 1980). Indeed, Leaman (1978a) suggested varied firing and stacking patterns might be needed for optimal results: a potentially costly option. This research was summarised in Leaman (2002).

The problem for central Tasmania is apparent: dolerite is on surface for much of the region.

### **Why is dolerite a problem?**

Dolerite is a high velocity medium but this need not be cause for difficulty. Many other formations may possess similar velocities and, provided they are part of the stratigraphic cake, will be mapped and defined.

Dolerite, however, is rarely “part” of the stratigraphic cake. The intrusions tend to be irregular, transgressive, multiple, near surface, and extremely variable physically. All such characteristics disturb the assumptions of the reflection method, data stacking, processing and migration.

The issues related to dolerite have been summarized in Leaman (2002). See Figure 2.

### **The second seismic problem**

Other seismic problems are related to line location and terrain. It is simply unrealistic and expensive to traverse straight, cut lines across the body of the Tasmanian countryside, and few valleys offer any line length. Consequently, traverses must be irregular in three dimensions: a factor which is not critical for deeper reflections in general since these can be inferred, located and shifted in processing provided the line excursions are not too great. Unfortunately, the dolerite-near-surface problems (geometry and physical variability) compound the line geometry issues and degrade reflection quality – typically for two way times of less than 0.5 to 0.8 seconds. This time range tends to contain all the Parmeener (post Carboniferous unconformity) information – including the dolerite.

All these elements are evident in GSL’s seismic data (2001 and 2006 surveys). Fragments are shown in Figure 3. The presence of Permian and Triassic rocks at surface enables reasonably clear definition of a contained dolerite sheet. But, where dolerite is at surface, it is often difficult to recognise the intrusion base and other sequence character – including the nominal base Permian unconformity, is obscured and diffuse. There are exceptions where uniformity of dolerite character at surface, and of terrain and line orientation with respect to structures, permits adequate resolution (e.g. Figure 3A, B),

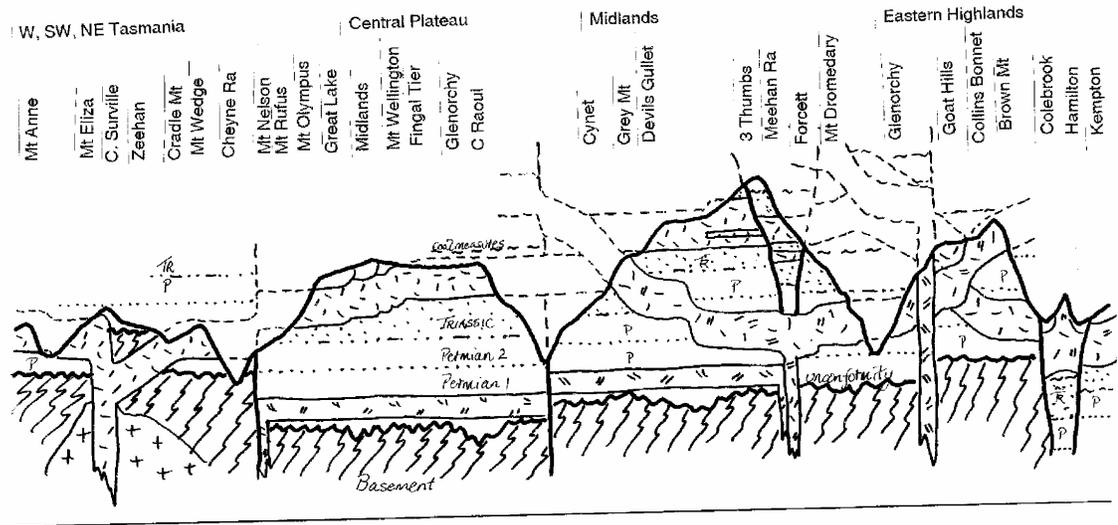
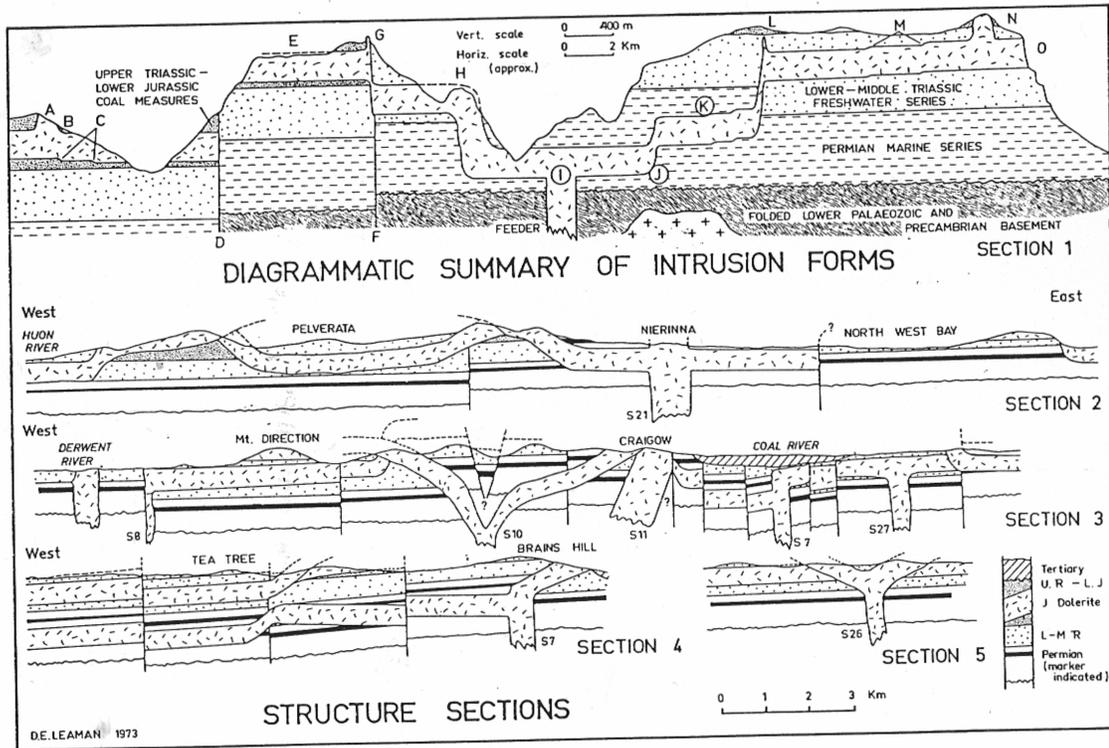


Figure 2: Examples of style of dolerite intrusion.

Upper diagram from Leaman (1975) and lower diagram from Leaman (2002). Each serves to illustrate the enormous range of intrusion relationships. It is also now known that many (if not most or all) intrusions have been multiply injected; a factor which can complicate interpretation or field decisions about apparently small intrusions or exposures.

North Great Lake), but these are quite limited in extent. Their importance cannot be over-emphasized since any clarification of section or spatial information provides vital control. Spot control, however, cannot replace continuous data or profiles. Careful specification and observation of the survey is essential.

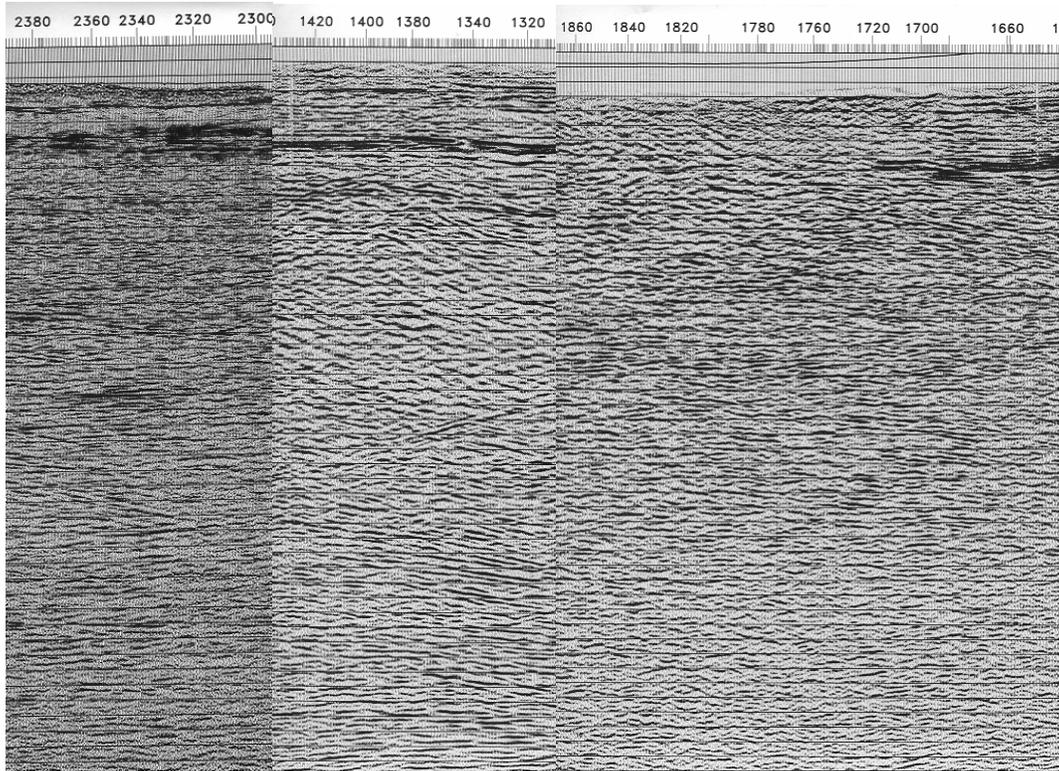


Figure 3A

Figure 3B

Figure 3C

Diagrams to illustrate the variability of responses and effect of Jurassic dolerite.

Line TB02-AA2  
North of Strickland  
Triassic rocks at  
surface

Dolerite is indicated  
by a “white” zone.  
Good result

Line TB01-TH  
High plateau, Lake Hwy  
Beside Great Lake, Lake Hwy  
Dolerite exposed at surface. Note the marked change of  
character near SP 1720 implying a major change in dolerite  
geometry or properties, or both. Much detail, in the upper  
part of the section has been lost or much obscured.

The base of the dolerite is marked by a moderate reflection.  
at about 100 ms.

Good result

Line TB01-TH

Beside Great Lake, Lake Hwy

Dolerite exposed at surface. Note the marked change of  
character near SP 1720 implying a major change in dolerite  
geometry or properties, or both. Much detail, in the upper  
part of the section has been lost or much obscured.

The base of the dolerite is marked by a moderate reflection.

at about 100 ms.  
Poor result

### The third seismic problem

Reflection character from the Parmeener (and dolerite) part of the seismic records can be reasonably correlated with known units: at least as gross packages. Figure 3B is an example of this. Many members of the Permian part of the succession can be identified in adjacent parts of this traverse at the head of the Great Western Tiers where the stratigraphy is well known. Blackburn (2004) also made this point. In these terms, and in comparison, the dolerite may be seen as bland and uniform – unless transgressive, but Triassic and Permian rocks may not be unambiguously separable.

Not enough is known of responses from Triassic rocks and definitive interpretations of sequence type (sandstone or mudstone dominant for example) is not possible. In many cases it is not yet possible to discriminate Upper Permian siltstone sequences and Lower Triassic sandstone sequences.

The real problem, of particular significance to the exploration by Great South Land Minerals, relates to identification of unit packages of Lower Palaeozoic and Precambrian rocks. Some of these may be source rocks, others reservoir rocks.

Inspection of RMS and interval velocity panels reveals that velocities involving dolerite, deeper Permian sequence, and all underlying rocks are not readily distinguished: all present velocities in excess of 5000 m/s, typically 5500-6500 m/s. Yet reflections, often high amplitude reflections, are observed from beneath the base Parmeener unconformity. Many of these features must be structural, fault or thrust elements, but some may be stratigraphic. The problem is how to link such features in geological sections and to infer lithologies, sequences and ages.

Control information is available only from the Deloraine-Golden Valley-Poatina area in the north, and from two traverses west of the central region (to Florentine Valley – line BA, and to Mt Arrowsmith – line TB). The highly patchy nature of the folded, faulted, overthrust regimes in northern Tasmania, as demonstrated in exposure and replicated potential field geophysical studies, rarely provide much assistance to interpretations of such profiles since the style of structural disruption is such that blocks are either too small (laterally), or dip too steeply. Studies beyond the confines of central Tasmania suggest the regional style which should be anticipated. Further, conditions to the west, from Mt Arrowsmith and the Florentine valley, imply major thrusting but do not permit clear tracing of units into the heart of the traverses – central Tasmania.

### **The role of other data sets**

Available geological compilations are not relevant to resolution of the critical problem: what happens beneath central Tasmania. But, as noted below, the quality of the available mapping is not sufficient to resolve secondary questions or assist other data sets (gravity and magnetics) with specific site reviews.

Extant gravity and magnetic data can contribute to an understanding of the deep structure and lithology and this has been demonstrated by interpretations offered in the last two decades (e.g., Leaman, 1990, 1991). These interpretations have depended on extrapolation of known types of relationships to the regions examined, and then some unification of the implications of the methods or data sets. Some objective tests are available to establish whether a solution is viable and credible – not necessarily correct in the absence of well control. These tests, defined in Leaman (1994), allow recognition of spurious solutions which might fit the observed data but which are not viable in the particular setting. As such, much ambiguity can be removed. These techniques for testing solution viability evolved during the period of the earliest interpretations and, indeed, that work led to the tests and an appraisal of them. Only interpretations after 1991-1994 should be assumed to have been filtered by the testing criteria and the improved methodology of Leaman (1995, 1997b).

The early interpretations were provided in the absence of usable or extensive seismic data, or useful well control – or useful distribution of such control. Sites in the upper midlands, and at Glenorchy, provided the only control on basement lithology. This problem remains.

It has also been shown that seismic data interpretation of complex terrains can be quite misleading in the absence of interpretations of other data sets. An example of this was provided by Leaman & Webster (2002) for a traverse across the Dolcoath Granite in northwest Tasmania in which the seismic interpretation did not define the intrusion. Gravity data, however, were quite definitive. Consequently, the opportunity to match seismic sections with indications of high angle or deep boundaries and gravity and magnetic data means that some assessment of the rocks and sequences involved in the reflected features might be possible.

The present preliminary interpretation is based on this premise.

### **Problems with gravity and magnetic data**

The integration of data sets is an advised approach but the results depend on the quality of data available, and the methods used for interpretation and integration.

In the case of central Tasmania, there has been no significant change in the gravity data base since the work of Leaman (1991). The manner of presentation, and direct usefulness, of the data available has been transformed by the conversion from raw Bouguer anomalies to crustal-isostatically corrected residual Bouguer anomalies. This was made possible by the series of gravity interpretations undertaken after the observations collected for the Mount Read Volcanics Project of the mid 1980s and the regional scale evaluations which followed. The reported interpretations relevant to the present study were undertaken in this environment of changing understanding and processing. The methodology was reported by Leaman & Richardson (1989b) and has been refined subsequently (Roach *et al*, 1993). The conversion to residual data, whilst not improving the detail of the coverage, does allow focus on the upper 5-10 km of the crust with no need to consider deeper crustal, mantle or oceanic effects.

These improvements do not replace the need for good, reliable data coverage – and herein lies the weakness in the present data set. Some regions, especially south and east of 480 000 mE, 5300 000 mN, are reasonably served. Others are not. The Arrowsmith, Great Lake, Bronte, Interlaken regions are poorly covered, and the region west of Tarraleah and National Park is very poorly covered.

All extant stations have been terrain corrected but reliability often depends on accuracy of elevation determinations – which have, until recently, been mainly barometric. Likely errors in the Bouguer anomalies are of the order of 0.5 to 1 mgal. Gravity data thus have varied application, depending on region and reliability, but where coverage is fair then this data set is able to guide an interpretation of pre-Parmeener rocks.

Magnetic data are both more detailed and also more problematic.

This paradox reflects the nature of coverage and the variation in rigour of survey and specification. Three relevant data sets are in existence.

The first is a state coverage with modest traverse spacing acquired by AGSO in 1985. It has an E-W line orientation but was acquired with an unknown, varied terrain clearance (150-1000m) which renders quantitative interpretation or reprocessing impossible.

The second survey, flown at high level (1600 m) but fixed height, was acquired by Conga Oil Pty Ltd (a predecessor of Great South Land Minerals Limited) in 1989. The E-W lines are spaced 5000 m apart and this coarseness limits detailed value. It remains, however, the only consistent and fully specified, recoverable regional scale survey of central Tasmania.

The third survey, much more limited in coverage but more detailed, was undertaken by Mineral Resources Tasmania of the Oatlands area. The E-W lines have a separation of the order of 200 m and were flown with nominal terrain clearance of 100 m. This fine survey allows resolution of local and near surface features but lacks the coverage to allow full integration with the Conga survey or the present seismic coverage.

The Oatlands survey allows comprehensive assessment of Parmeener features and the dolerite intrusions. The AGSO data provide an indication of magnetic texture and trends of features but only the coarsely spaced Conga survey allows any quantitative regional interpretation, due to its fixed reference base. Data acquisition at high level, using coarsely spaced lines, does limit the interpretation options but a first order structural evaluation is feasible using this data, and it has been used to test various seismic and gravity implications and was used extensively by the 1990-1 interpretations to generate a view of basement structures and contents.

A relevant extract of the summary of the 1991 interpretation is shown in Figure 4. A sample of the updated revision of this interpretation provided for inclusion in the Regional Forest Agreement documents is shown in Figure 5 (from Leaman, 1996 prior to final drafting).

A more detailed, consistent magnetic data set must be acquired before any truly reliable evaluation is possible. The data interpolations, between lines, necessarily degrades certainty of location of features, or the gradients and magnitudes associated with any anomaly.

The present situation is parlous and quite unsatisfactory and probably would not be tolerated in any other Australian state. The Federal agency survey (1985), and its failure, is the fundamental reason for this condition and reflects practices which treat Tasmania as a guinea pig. State-funded surveys in west, northwest and northeast Tasmania, as well as near Oatland, are of an order better in quality but state funding has not provided an adequate coverage either of geological or geophysical information in central Tasmania as a whole.

### **Issues for interpretation**

The interpretation provided below relates limited geological surface control to seismic response, and to both gravity and magnetic anomaly patterns. Gravity data offer better resolution for much of the region, but some elements of the magnetic field are helpful, even if of lower resolution and reliability of location.

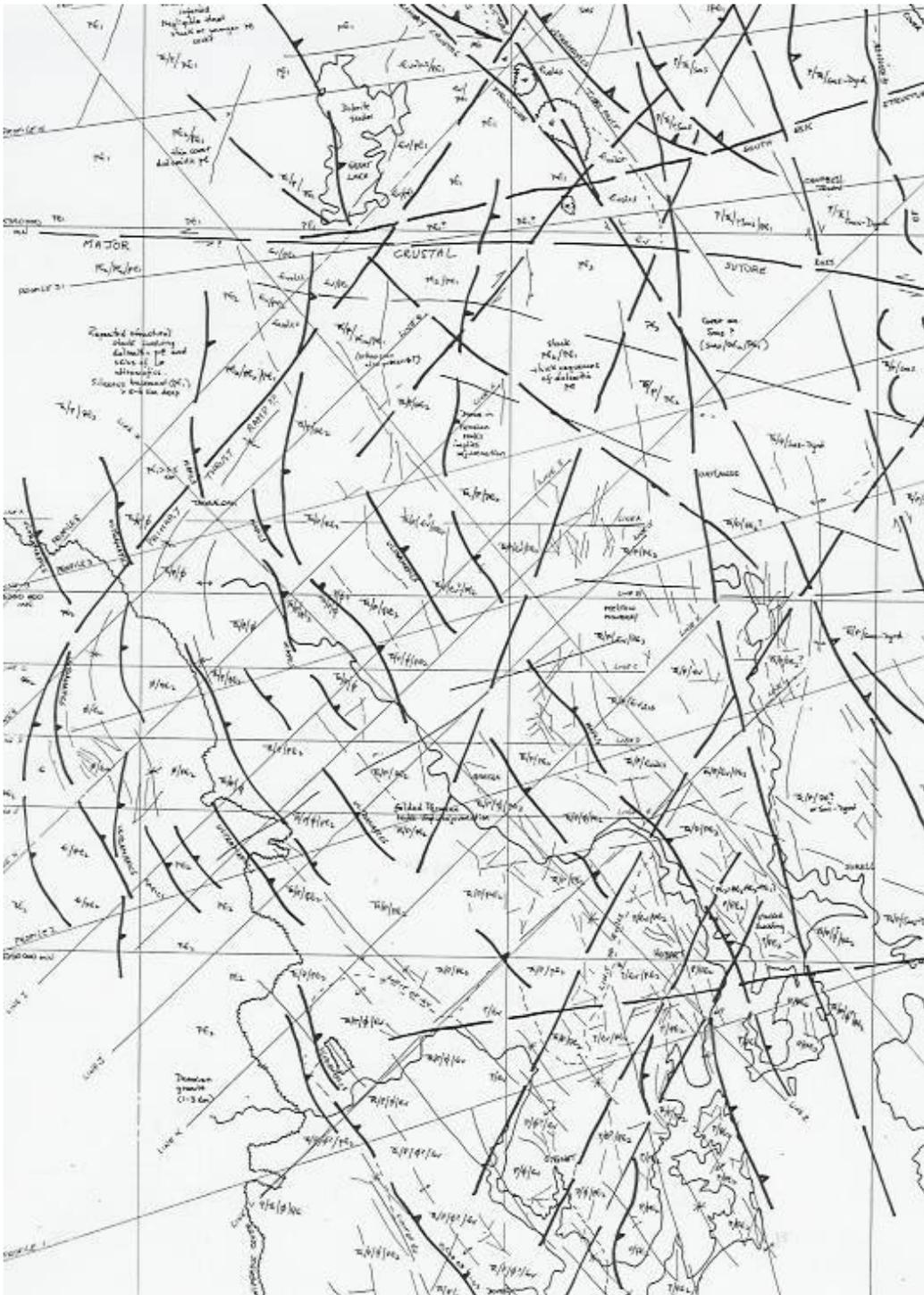


Figure 4: Extract of interpretation summary map, 1991/1992 interpretation of central Tasmania.

Note the inferred thrust character of the entire region. The comments were an attempt to indicate the general location of ultramafics and the lithologies deduced in each block.



Initial inspection of all data now available suggests that many shallow, or surface, structures are related to deeper features and may represent serial rejuvenation. Several elements and boundaries have been examined by on-ground inspection in order to assess the nature and history of displacements, contacts or the presence of multiple intrusions. Multiples are known to occur in the region (e.g., Hunterston 1) and in escarpments at Liffey Bluff (along seismic line TB01-TH, sp 1300) and may lead to variations in dolerite thickness, transgression and source patterns. Corrections and assessment of such variables must be included in both the depth analysis, and feedstock for test by potential field methods.

Each seismic line has been reviewed. This approach may be contrasted with the 1991 interpretation which used a net of gravity and magnetic profiles extracted from the data base. No seismic correlation was then available. However, since the seismic lines are not straight traverses, the assessed profiles have either been segmented or selected to approximate the location of the seismic lines. Character projections have been made based on indicated, exposed geology. Preliminary geological sections were then generated using inferences about intrusion forms, stratigraphic setting and dilational patterns and faults. Such sections may depend on decisions about, and information of, intrusion multiples and the direction of intrusion: factors which usually requires direct inspection. Not all critical sites have yet been visited. Gravity and magnetic modelling may then be applied to test consistency, or existence of paradoxes and alternatives. Such alternatives are almost never crucial for interpretation of gravity-magnetic data at upper crustal scale since the details of any structures within the Parmeener cover tend to be gravimetrically trivial in comparison. *The bulk of the gravity field responses are generated beneath the base Permian unconformity.* An understanding of the cover section is, however, relevant to interpretation of the more obscure parts of the seismic records and more reliable time depth estimates for other parts.

There are some limitations upon the various contributions and features assessed. All structures, and at all scales, are three dimensional. The layout of currently available seismic lines rarely permits any such view. Exceptions are very local to Hunterston, Bronte and perhaps Bellevue. Further, the surface structures, especially those involving dolerite, are also three dimensional. This is particularly critical in the case of magnetic data, especially where the data are controlled only on widely spaced lines. Consequently, any potential field profile based on 2D analysis may only provide an indication of structure or sequence. There is, however, no reasonable case for 3D analysis: something which can only be justified when the implications of 2D studies have been fully appraised and controlled by some relevant drilling. Not enough is known about any part of the region at this stage and the available geophysical data sets are not of sufficient quality or distribution to permit such refinements.

### **Caveat**

The present interpretation is thus a second pass of existing data. The first pass (1989-1991) was based only on indicated geological trends and potential field data. This new study incorporates seismic constraints, where any can be distinguished, even though the source of the reflector is not seismically identifiable. **The aim, here, is to use the other data sets to suggest the nature of lithologies and structures recognised seismically.**

It will be evident that any inferences must be simply that, inferences, pending further seismic coverage and well testing.

This study was thus designed to review the alternative explanations for both seismic features and, particularly, gravity anomalies. Magnetic information, such as it is, has been used to constrain or check any aspect which has magnetic character. The deductions offered may be used to define potential targets for further seismic coverage or to locate critical sites worthy of drilling for either direct prospecting value or critical stratigraphic control.

The acquisition of relevant well information, further general seismic coverage, and better coverage of gravity and magnetic data will allow review and revision of the present interpretation with direct application to target focus.

## INTERPRETATION

As noted in Introduction this interpretation was begun with a major review of all previous interpretations, even though the basic data available had changed little. Methodology and assessment of factors which make for more reliable judgments have been evolved (Leaman, 1994) and the regional and sketchy nature of the early interpretations involved under-sampling of the existing data. For this study, the existing data has been sampled to its limit of reliability or definition and this has led to more detailed and comprehensive analyses – if far from satisfactory. The interpretations have also been polished and completed, and tested with alternatives suggested by the experience of basement studies undertaken elsewhere in Tasmania since 1991.

### REGIONAL LINES 3 AND 7

Two examples of the review of the 1991 interpretation are presented here: for lines 3 and 7. In each case emphasis is placed on the style or content of basement contributions. These lines were used for regional indications and no detail is included for the Parmeener cover: that is included in the models which relate to the seismic traverses.

Line 3 is oriented WSW to ENE and extends from near Philips Lookout west of the Gordon River, to the Derwent River at Wayatinah, to Dungrove Hill near Hunterston, to Woodbury and ending on the eastern side of the Eastern Highlands north of Swansea. Coordinates on traverse: 441 000 mE, 5301 000 mN; 500 000 mE, 5319 000 mN; 540 000 mE, 5331 000 mN; 576 000 mE, 5342 000 mN.

Line 7 is oriented NW to SE and extends from Clumner Bluff above the Mersey River to Lake Fanny (447 000 mE, 5366 000 mN), to north end of Lake Echo (470 000 mE, 5340 000 mN), to west of Hunterston (497 000 mE, 5309 000 mN), to Bagdad and ending at the head of Pittwater, at Horatio Point.

These two lines sample and integrate the implications of all previous work and each has been recalculated with new data sampling, and with gravity data in residual form.

**LINE 3** provides a true dip line across the multitude of structures inferred in earlier interpretations (see Figures 4 and 5).

Figure 6 presents an interpretation which is directly derived from previous views. Lines such as Line 3 allow some control of the density assumptions included since it extends far enough east to sample the effects of the East Tasmanian batholiths (Leaman & Richardson, 1989a, 1992). The density of these lithologies is well established and can be used to provide constraints elsewhere in the model. Only the depth to granite may be uncertainly defined. This model also suggests the minimum thickness of the Parmeener cover but other models, as shown below, thicken this cover – depending on the number of dolerite intrusions involved. The gravity model extends the exposed Lower Palaeozoic folded section to the easting of Wayatinah. Major changes occur at this easting and this combination of rocks cannot continue. A large volume of relatively dense material must be introduced (a dense variant of Precambrian basement – approx 2.72-2.74 t/m<sup>3</sup>). This core block, which generates the relatively positive gravity field character across much of central Tasmania, tapers eastward.

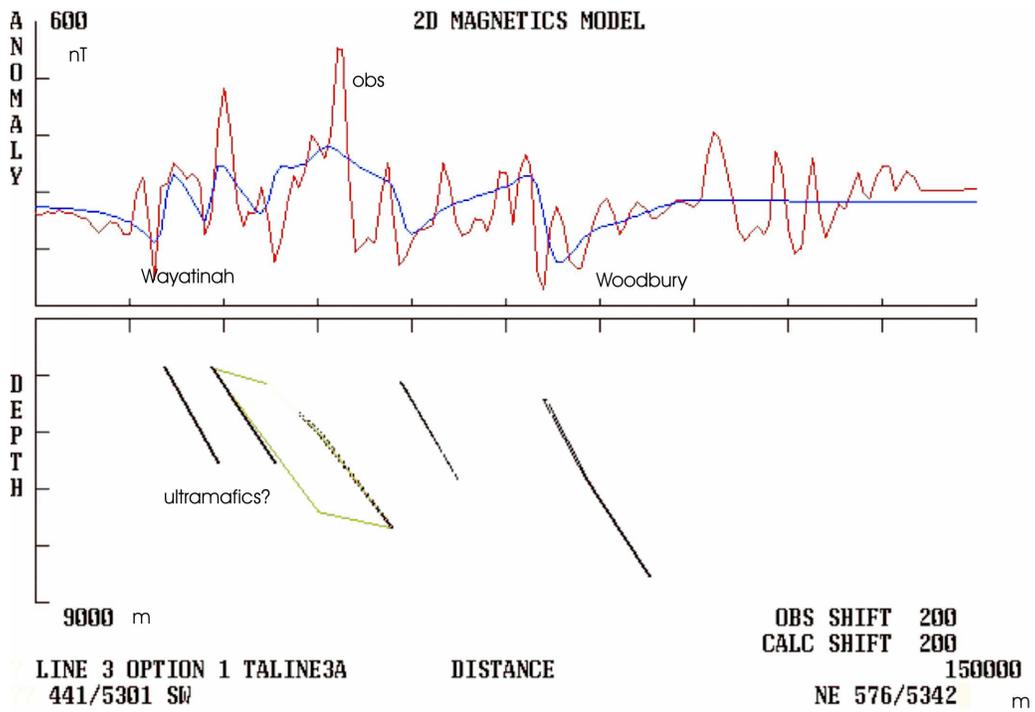
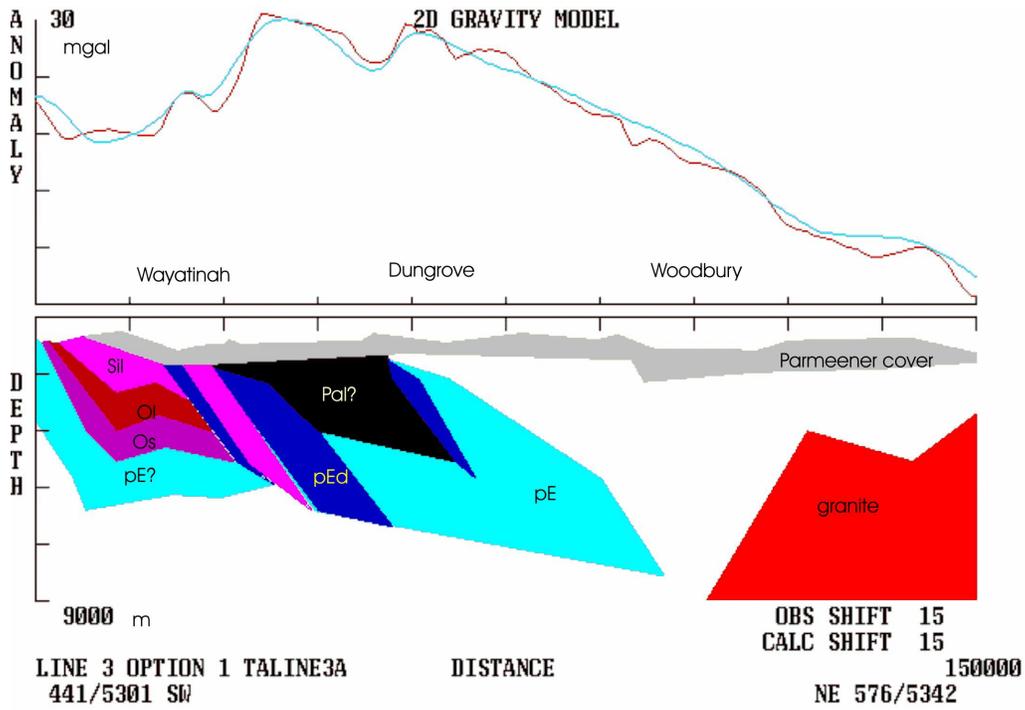


Figure 6 East dipping multi-thrust concept. Line 3 potential field model.

Basement materials in the eastern half of the section must be dominated by siliceous rocks or suites comparable to the Mathinna Beds. Granites control the east end of the gravity profile. Two other lower density sequences can also be inferred. The first occurs as a structural (?) slice beneath Wayatinah, the other just west of Dungrove-Hunterston. This material (labelled Pal?) is almost certainly some combination of Ordovician-Silurian rocks dominated by siliceous members. Although there is no seismic control for this profile there is seismic evidence for this interpretation (discussed below for Line TB01-PB, part 1, Figure 12). The model cannot resolve whether these rocks simply overlie basement rocks or are structurally emplaced.

A test of the east-facing multithrust concept, and the issue of structural emplacement, can be provided by magnetic data. The deficiencies in the present data set are immediately evident. It is not possible to completely separate the effects of “noise” due to near surface dolerite, or dolerite feeders, and deeper sources, but there are gross features which can only be explained for when deep, narrow, intense sources are incorporated in the model. Such sources, in a Tasmanian context, are almost certainly Cambrian ultramafics and structurally emplaced. The models of Figure 6 would suggest that any component of Lower Palaeozoic rocks within the section east of Wayatinah has been structurally emplaced.

Figure 7 considers the implications of seismic sections such as TB02-BA and TB01-TB, TH (see below, Figures 10, 17, 21) that structures dip to the west in the western part of the region. This option was never considered in previous work due to time constraints, and the incomplete nature of the studies, although other work in western Tasmania (e.g., Leaman, 1986; Leaman, 1992) had revealed a preponderance of west-dipping structures, overprinted by east-dipping structures. Figure 7 not only shows that the available data support such a view, but that it is more likely. Note especially the magnetic model. Both parts of the model make clear that virtually all major relationships between units are structurally controlled.

Hole Hunterston-1 can be located in this framework. It was drilled just east of the slice of presumed Lower Palaeozoic rocks (black in Figure 7) and into the denser Precambrian core block sequence. This basement composition had been largely predicted by Leaman (1991, 1992) but considered more massive dolomite, rather than a dolomitic association, as here implied.

**LINE 7** samples the entire core zone of central Tasmania and intersects Line 3 about mid section (at 90 km). There are limitations on the density range which can be applied to the basement core but all packages in the northwest appear to dip west while those at the southeast end of the section dip east. The wedged character of the core is reinforced with this orientation and the cause is probably due to offset thrust blocks. A lower density zone has been located southeast of Waddamana.

Various options are possible for block dip, volume and mass on the basis of gravity data alone. Magnetic data are, however, sufficient to separate alternatives and support the particular gravity solution offered. Ultramafics are involved along at least three of the major boundaries or contacts inferred and those west of Waddamana may only dip westward. The wedge of undifferentiated Lower Palaeozoic rocks, with densities consistent with Silurian and perhaps Devonian (?) rocks, or extremely thick Permian tillites (most unlikely), are bounded by an east-dipping structure and rejuvenations.

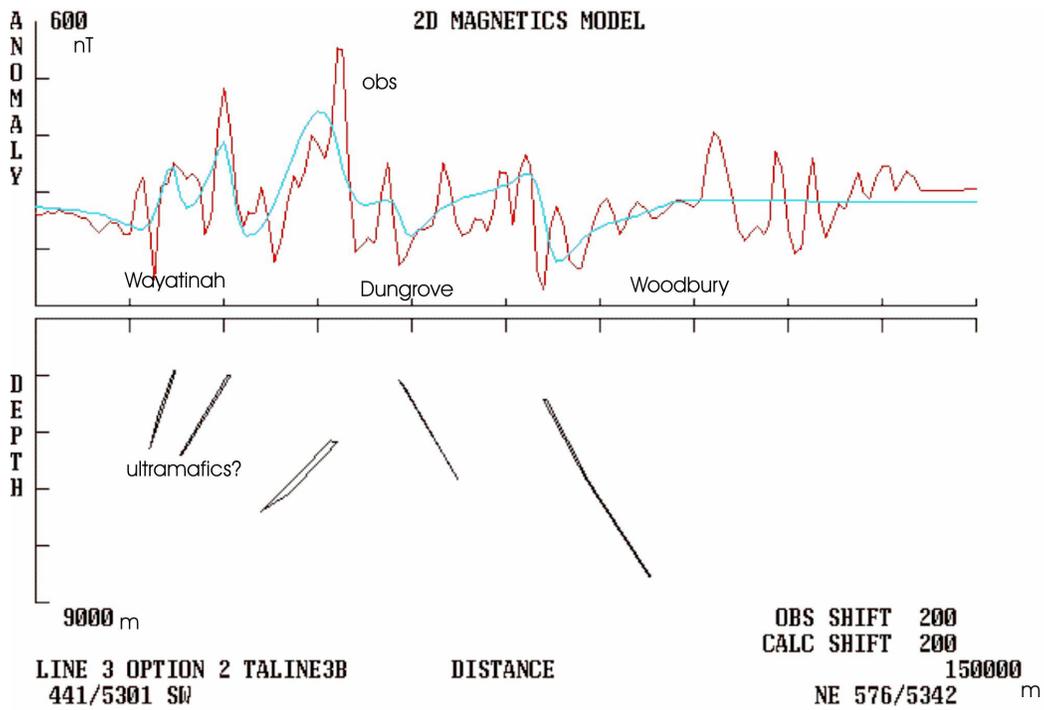
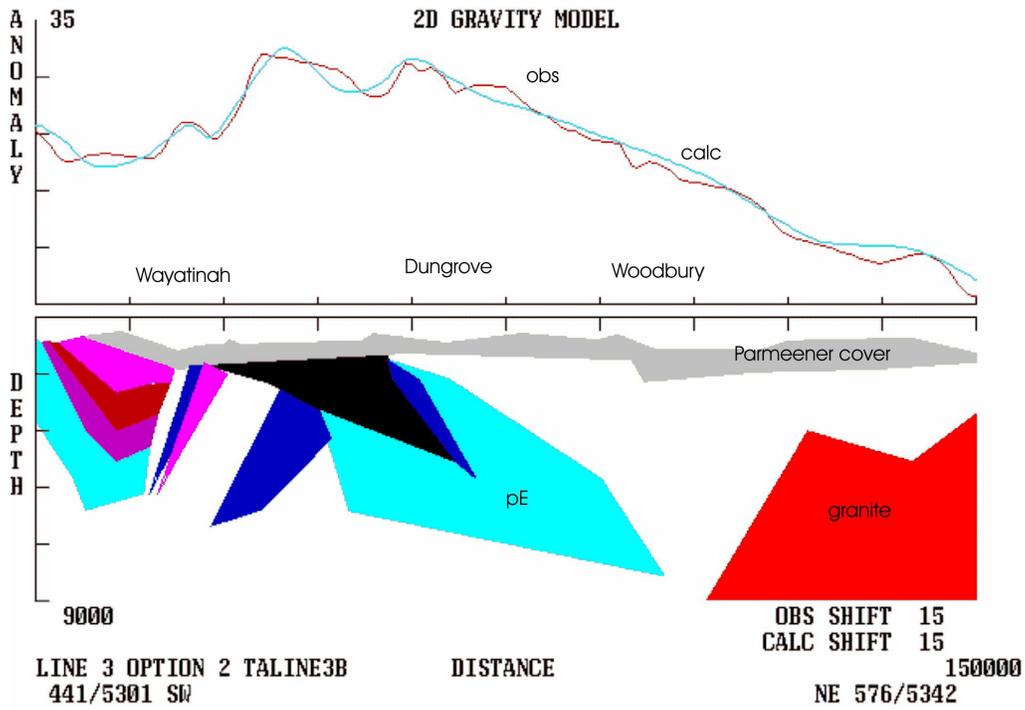


Figure 7. Opposing thrust concept. Line 3 potential field interpretation.

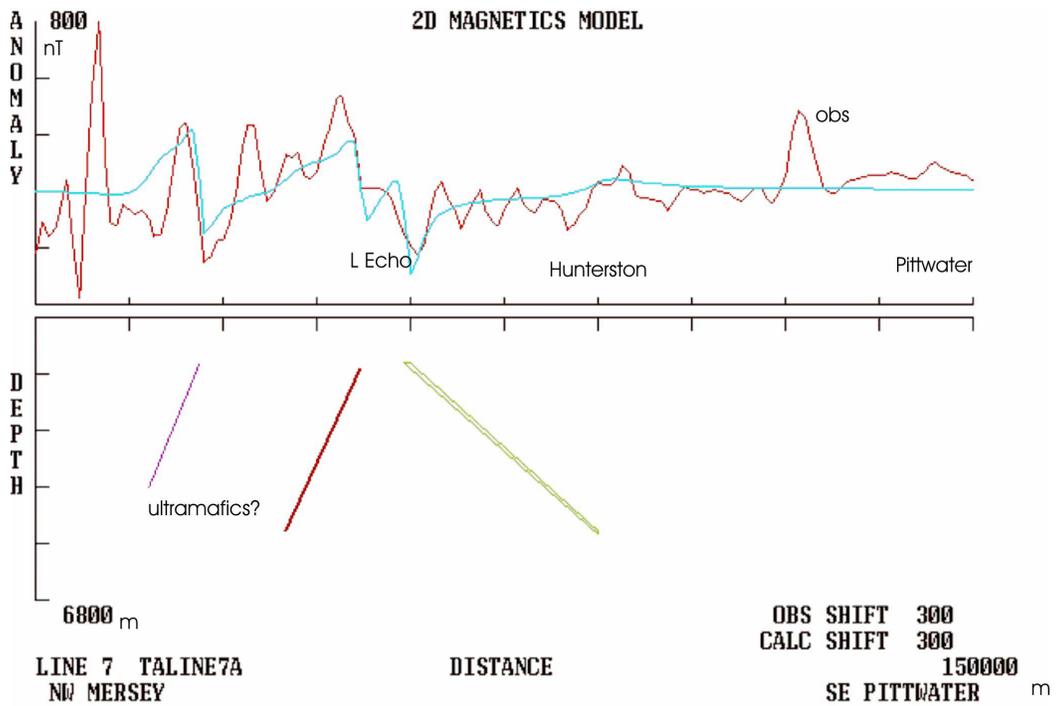
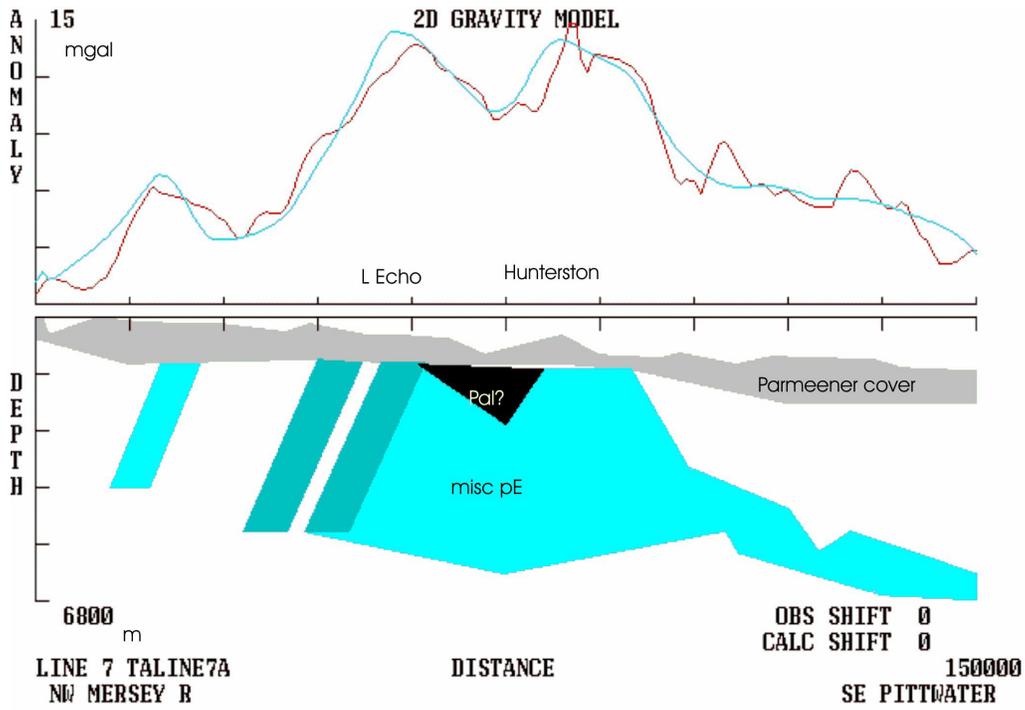


Figure 8. Line 7. Opposing thrust stack concept. Potential field interpretation.

Note that all profiles modelled for lines 3 and 7 display minor oscillations ( $\pm 1$  mgal,  $\pm 100$  to  $200$  nT) which can be ascribed to data imperfections (gaps, poor definition, errors) or near surface effects such as the local characteristics of dolerite intrusions. Few of these have been examined in detail since close inspection of outcrops and much better magnetic data are required to make sense of the variations. More precise gravity models of the Parmeener section may also be developed when this is possible. It would be possible to present perfect fits for the model and observed field calculations but this would not guarantee their efficacy or reliability in the present circumstances. Gross effects only, as guide sections, have been established in these models.

The regional interpretations may be considered free, or unconstrained, since no independent structural constraints can be, or have been, applied.

All following sections and interpretations are based on observed seismic lines and combine the implications of that seismic data, in so far as useful detail may be discerned, and the potential field data. Seismic data can offer some structural constraints additional to the gravity-magnetic combination and suggest more precise location of structural boundaries.

It must also be noted that the seismic results are far from perfect, clear or definitive and rarely able to provide continuity of features. These deficiencies result from the very high velocities involved, the lack of contrast between velocities, the steepness of structures and the presence of major structures off, but near, traverse. Diffraction and sideswipe effects are very common – as might be expected given the implications of the regional potential field interpretations (Figures 4, 5, 6, 7, 8).

The objective of this integrated interpretation has been to place some scaling on blocks of material, thereby to constrain the physical property range, and allow inference about composition or lithology and, perhaps, age.

The order of lines, as presented, is generally north to south then west in order to provide a linked, systematic view from what is a skeleton coverage.

#### **Seismic LINE TB02-AA2 (2006).**

This traverse extends along the Strickland Road from the Lyell Highway north of Ouse (472/53011) to Duckhole Lagoons north of Strickland (4717/5312).

This data set is isolated from other existing seismic traverses and can only be linked to them via regional Line 3 at the northern end of the survey. A consistent solution is shown in Figure 9. The tie point with Line 3 involves the inferred mixed Lower Palaeozoic package some 2 km thick overlying several km of dolomitic sequence (presumably Precambrian). More siliceous Precambrian rocks occur nearby (beneath).

The basic model includes the Parmeener cover, with dolerite, possible Silurian and Ordovician sequences and then the Precambrian base. The white colour indicates generally siliceous Tyennan-type basement. Comparison of Figure 9 with Figures 6 or 7 reveals an excessive thickness of denser Precambrian types. It should be noted that these are relatively dense ( $2.84$  gm/cc) and that their replacement with lower density

Precambrian or Cambrian, Ordovician limestone, units would compound the problems and require a thicker section. The thicknesses suggested are compatible with seismic data and velocities.

The seismic section clearly reveals dolerite within the sequence and the base Parmeener unconformity lies some 300 ms deeper. The deeper section, below this, includes at least three relatively flat-lying reflecting boundaries. The first of these is of the order of 2000 m below the Parmeener cover.

Since the regional solutions are tied to granite densities which are tightly constrained, and set in a much lower Precambrian density framework this section presents a problem. The paradox is almost certainly due to three dimensional features assessed using two dimensional methods and sampling (all data: seismic, gravity and magnetic). The problem develops near the cross tie position (with Line 3) since the remainder of the model is consistent with the rest of Line 3. Note that Line 3, on the basis of all that is known of structural trends, is a dip line: AA2 is a strike line (at least approximately) and may not represent features reliably.

Complete resolution of the issues posed by this line fragment may not be resolved until the line is extended (as planned), nor until a cross line can be observed which ties both AA2, PB and any other new traverses along the Lyell Highway.

Magnetic data do, however, provide an interesting test by suggesting the existence of an ultramafic slice within the dense Precambrian segment. This depth, within a few hundred metres, is quite consistent with the structural boundaries implied along Line 3. The magnetic profile has a most distinctive form: it is a step anomaly of long wavelength and cannot be explained by any near surface materials (basalt or dolerite) or shallow structures. Such elements generate the "noise" on the profile. High contrast magnetic materials at moderate depth are required to account for this profile. The subhorizontal nature of the causative body indicates a structure whose strike virtually parallels the model section.

Line 3 model B (Figure 7) stresses the crucial setting of Strickland. Model B is the preferred solution and it suggests the tangle of basement structures which underlie the Strickland area: many of which involve ultramafics.

Shallow structures involving the Parmeener cover are much simpler. All data indicate one dolerite sheet within the section but this sheet passes to an unroofed plug form south of Strickland. Seismic data resolve most of the dolerite character along this short traverse but only patchily define the base of the cover sequence.

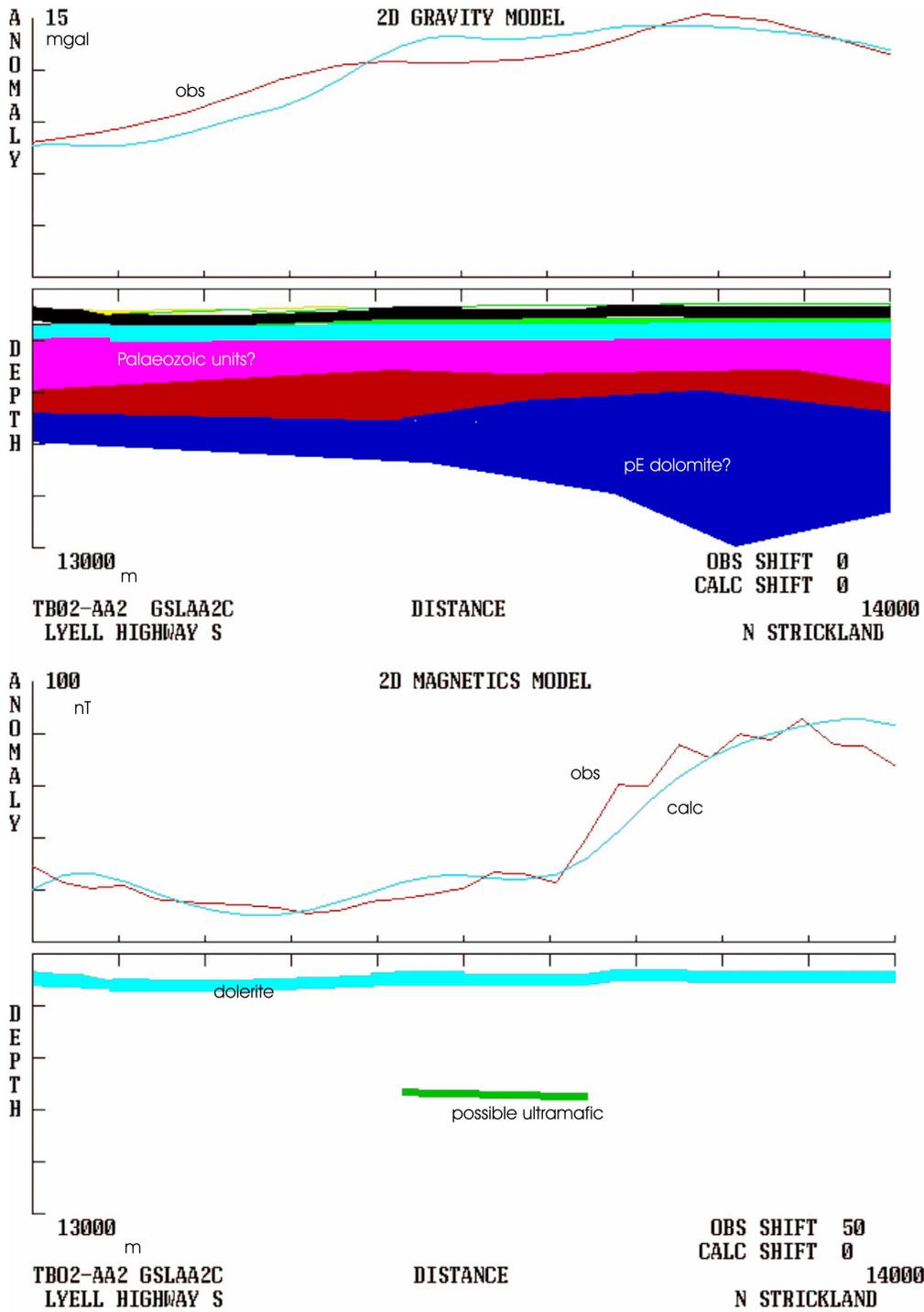


Figure 9. Possible structuring consistent with seismic profile TB02-AA2.

### **Seismic LINE TB02-BA (2006).**

Line BA extends from the Tiger Range above the Gordon River (450/5201), where there was some redundant acquisition which did not assist profiling, migration or correction, to the central plateau and terminates northeast of Great Lake at the very edge of the Great Western Tiers above Poatina (487/5369). The line crosses the topographic ramp onto the plateau. Refer to Figure 10. This line begins on the exposed Lower Palaeozoic rocks of interest to Great South Land Minerals Limited – in the Florentine Valley region.

Both regional control lines intersect this traverse (at about 44 and 77 km; lines 3 (42 km) and 7 (65 km) respectively). No difficulty was experienced correlating the few seismic features observed and the implications of the potential field data. Thus the multiple reflection pattern observed deep in section near Line 7 is probably related to the fault/thrust offset at depth and a similar relationship can be observed near Line 3. North or east-dipping structures are implied consistent with Figure 4. Major steps in the basement complex are implied in all data sets. Magnetic data confirm most of these concepts even though resolution is limited.

Near Line PB (at 85 km), where Palaeozoic rocks are inferred beneath Parmeener cover, magnetic data indicate that the south face of the sequence is either deposited on an old, thrust surface, on exposed ultramafics, or has been thrust subsequently. Each option is possible and all have been observed, somewhere, in western Tasmania. None of the extant geophysical data can separate these possible solutions. All, however, suggest major basement structuring at various times from the Proterozoic to the Permian (and presumably the Present). The situation is simpler south of the River Derwent. Structural facings oppose and the constitution of the pre Permian basement is quite different. Magnetic data even suggest that part of the basement sequence, thought to be dolomitic on the basis of gravity anomalies, may be magnetic – which would imply equivalents of the Crimson Creek Formation are present. Between shot points 700 and 1600 reflections wedge and dip west. This effect has been reproduced in the models (from 10 to 22 km).

The most distinctive magnetic feature is near Waddamana and may, partly, have a basement origin although there is no suggestion of a density offset. There is a flower-like fan of structures in the seismic record. It is possible for dolerite to account for some of the effect observed and this could be confirmed with more detailed survey. Much of the section north of Ouse contains two dolerites: an irregular sheet base near surface, and a hidden sheet at depth. A feeder may be present south of Native Tier and also north of Waddamana, near Shannon. North of Shannon it appears that only one major sheet is present: exposed. Around the Waddamana area, however, two almost entire sheets intersect and intrude each other. The inter-sheet transgressions are ghosted in the seismic data. Tertiary basalt conceals much of the geometry and alters reflection character. All this structuring, and volcanics, overlie the fan of basement structures which may be hinted seismically.

Long sections of this seismic record are bland and without major event. The implied synformal wedge of Palaeozoic material at the north end of the line is supported by changes in seismic character and dipping reflections.

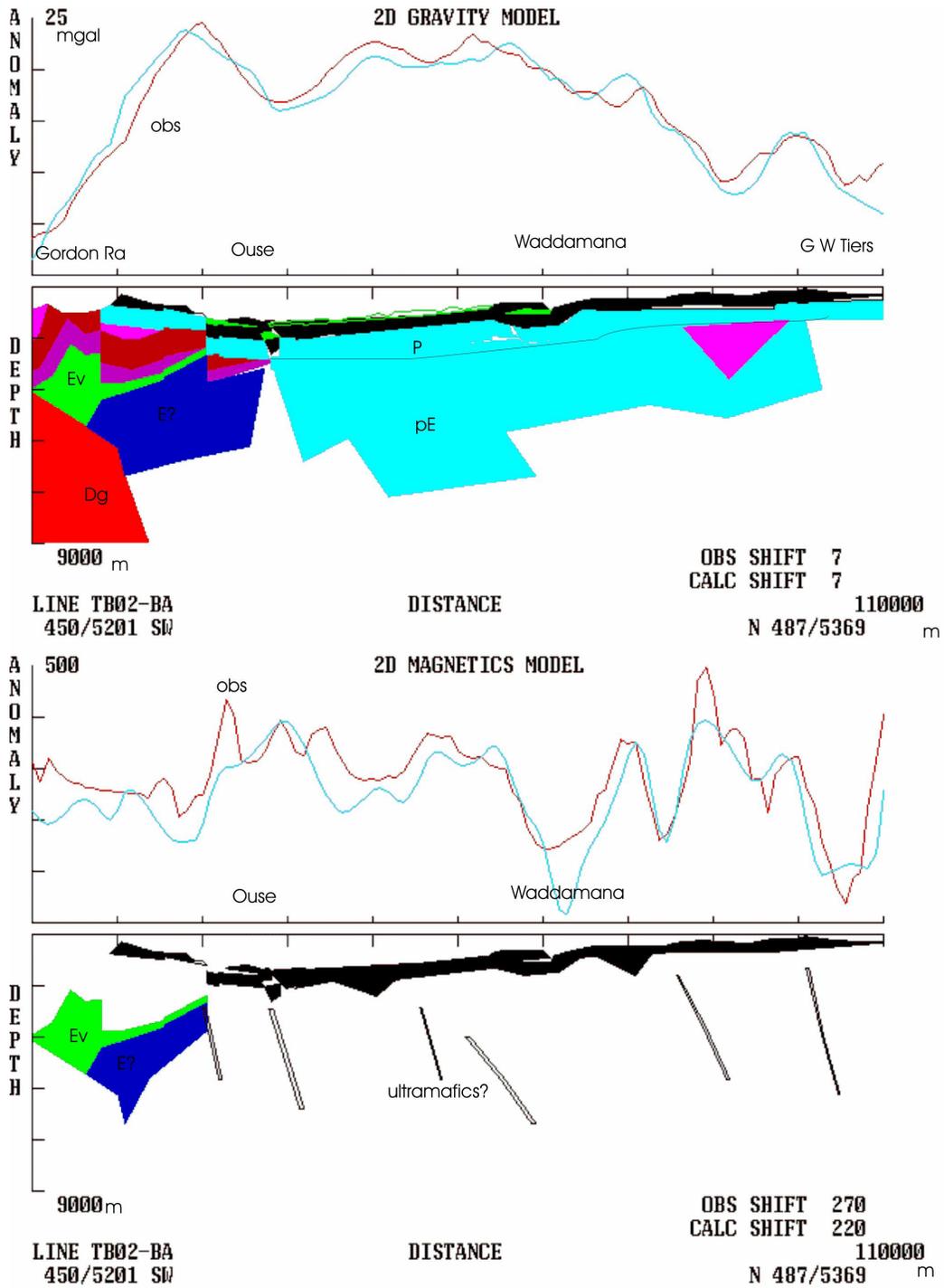


Figure 10. Possible structures consistent with features of seismic line TB02-BA

**Seismic LINE TB01-TC (2001).**

Seismic line TC extends from the Lyell Highway south of Hamilton (489/52883), to Bothwell (5005/53074), using Hollow Tree Road. Line 7 (at 94 km) intersects this line near Bothwell.

The seismic record indicates up to 6000 m of massive units beneath Hamilton but with a possible shear zone at about 1500 m. The heart of the record includes an apparent arch of reflectors, dipping steeply to the south but more shallowly to the north. Some shallower synformal character is evident south of mid section. The deep record reveals a set of north dipping reflectors.

Various changes in seismic character, and which mark short sections of the line, appear to be related to the zig-zag nature of the traverse with respect to the orientation of deep structures (as inferred and indicated in Figures 4 and 5). No features present with any significant continuity.

The gravity anomaly is distinctive (Figure 11) and requires a considerable thickness of dense material in mid section. This conflicts with the arched reflectors since the depth proportions required of known lithologies cannot account for the anomaly. Matching implications from Line 7 suggests that a slab of Precambrian dolomitic sequence overlies a less dense sequence. These elements can be aligned with the few reflectors observed and account for the gravity field observations at the Bothwell end of the section. The anomaly roll over to the south thus reflects absence of the dolomite but the dominant presence of the moderately dense Precambrian rocks. The uncoloured basement is siliceous Precambrian, probably of Tyennan type.

The observed magnetic field mirrors the gravity field and, given the density links which exclude piles of strongly magnetic volcanics, the solution offered depends on two elements. Two slices of ultramafics, defining the base of the moderate density Precambrian basement and extending into the fan of structures mid section, and granophyric dolerite and feeders, account for the effect. The feeders appear to be slightly off section. The implication from the thrust relationships is that the east-dipping structure is younger but this cannot be confirmed since modest variations in volume and distribution cannot be resolved.

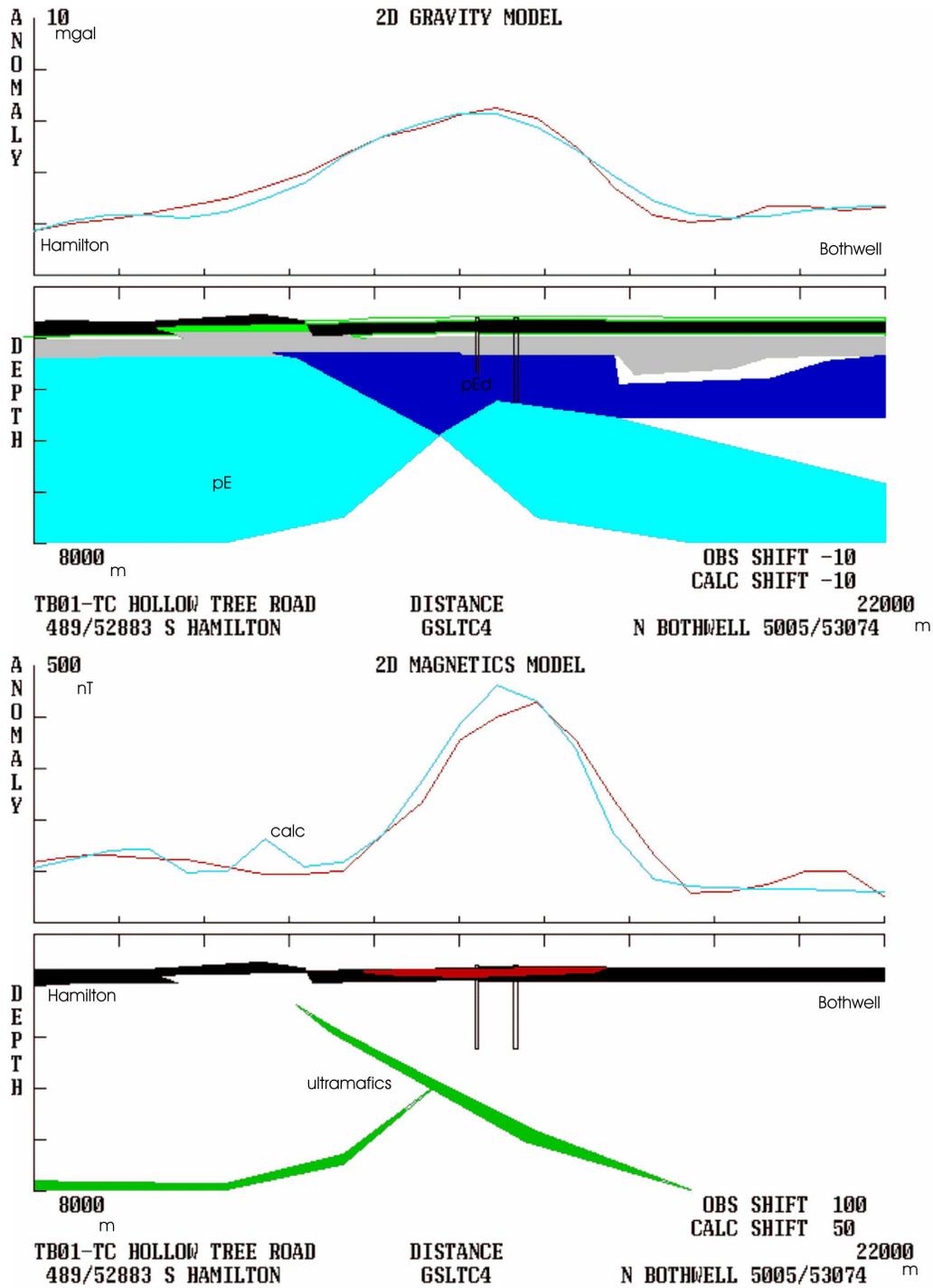


Figure 11: Interpretation of seismic line TC, Hollow Tree Road.

### Seismic LINE TB01-PB (2001). Part 1: Bothwell to Steppes.

Line PB is a long, complex traverse and it has been divided into three sections for analysis. Each of these is approximately straight and the segments allow regional linkage free of the total bend in the traverse, or orientation interactions.

The first segment extends from Bothwell (5005/53074) to Steppes (4912/5339) via Highland Lakes Road and Hunterston. This segment can be cross tied to both regional lines (at 10 km to Line 3 at 65 km; at Line 7 at 95 km near Bothwell).

The pre-Parmeener part of the seismic section contains large scale antiformal elements which crest near Hunterston. The antiform is truncated by a ramp reflection at considerable depth (about 5500 m near Lines 3 and 7) and there is an even deeper feature (5000 m deeper). In the region of Steppes there are other shallow reflectors which show strong character (at about 2500-3000 m) and these are truncated by the north limb of the antiform. None of these features are well defined.

Hunterston 1 was drilled near the crest of the antiformal feature and demonstrated the presence of multiple dolerites and a dolomitic basement (pEd). This poses a question about the nature of the rocks above the seismically marked antiform. If the dolomitic content of materials encountered in Hunterston 1 is used to set a minimum contrast for density ( $2.74 \text{ t/m}^3$ ) then it is possible to provide an approximate depth match for the deep seismic interface. The density cannot much exceed this value and cannot be as high as pure dolomite ( $2.84 \text{ t/m}^3$ ). Constraints may then be set for the amount of this material present toward Steppes. If the upper section is siliceous Precambrian and no more than 2000 m thick (consistent with character-filled seismic zone) then some variation might be allowed in the dolomitic core but a maximum depth of around 7000 m is fixed for the lower surface. A gross fault system is implied.

The Bothwell end of the section is quite different. The Precambrian core is thicker and this can only be mass-balanced by a wedge of lower density rocks (presumed mid Palaeozoic). Beneath Bothwell there are other subhorizontal interfaces and the gravity field requires some dense member (dolomite) to balance the other materials.

These conditions may be summarised in reflection and thickness terms below Parmeener cover.

At Bothwell: reflections at 1500, 3200, 5600, 6800? and 11000 m

Line 7: dense pE to 5000 m and thrust at 4000 m.

At 10 km: reflections <1000, 6500, 11300 m

Line 3: 400 m pE, 800 m pE dense, 2600 Pal?, 6100 dense pE

model: 400 m pE, 800 m pE, 3000 Pal?, 5500 dense pE

Steppes: reflections at 2500-2700 m, 7000-7500 m.

Extant magnetic data are not helpful (Figure 12) since dolerite effects could account for all observations as presently defined. Dolerite along the section involves two intrusions from a feeder presumed to lie offset from Hunterston with transgressions from the south upstepping toward Steppes. The current disposition of the entire sequence re-inforces the effect of regional ramping: ramping due to regional dips and dolerite transgression, both in the same sense (up to north). There is no closure at Hunterston.

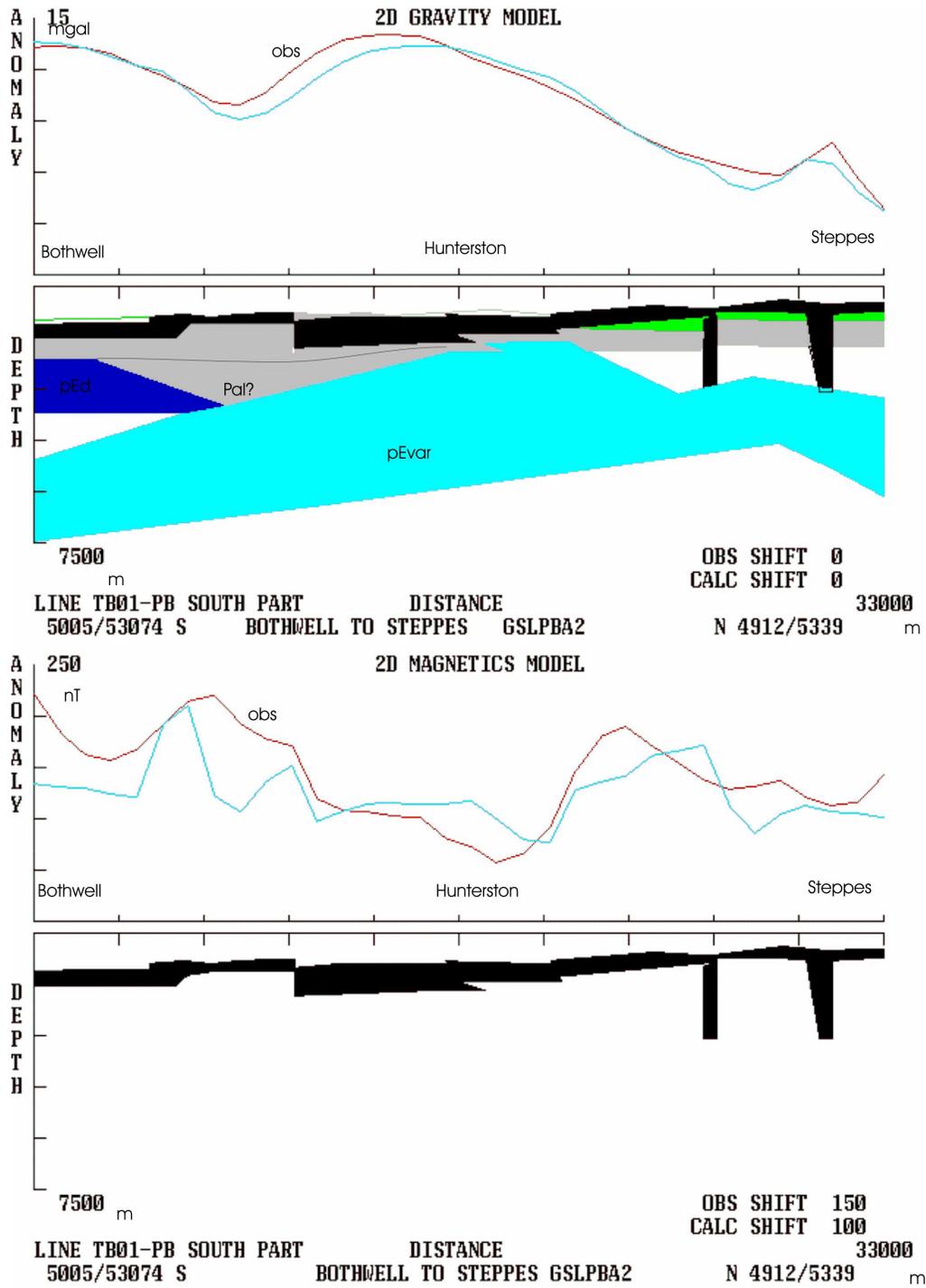


Figure 12. An interpretation of seismic line TB01-PB (first section, to Steppes)

**Seismic LINE TB01-PA (2001).**

This short traverse provides a cross line on Line PB at north Hunterston and well Hunterston 1 was drilled on this line (4915/5327-4974/53262).

Little seismic character can be discerned below the Parmeener cover, although the dolerite in the section can be identified, until there are transgressions toward the present surface. Character is lost where the dolerite crops out.

The models of Figure 13 provide a reasonably consistent view with Line 7 (nearby to the west) and the intersection with Line PB. The gravity model provides a limiting scale on both density and depth (thickness) of the modestly dolomitic Precambrian core block. The maximum estimate is greater than seen in the longer lines since these also carry the direct effects of denser segments. Some three dimensional elements are not properly represented on this short line.

The magnetic data require the package of Precambrian rocks to be defined by a slice of ultramafic rocks. No concentrated magnetic source, such as Cambrian volcanics or the like, can be involved. The depth to such a slice, which has clearly been sampled acutely to strike at this orientation, cannot be refined without more information but could range from 5000 to 8500 m depending on structure, properties and thickness. This range is consistent with the implications of the longer lines.

**Seismic LINE TB02-TA (2001).**

This short traverse (Figure 14) extends east from Hermitage across the southern part of the so-called Hunterston dome (4876/53218-4984/53192).

Two steeply dipping reflectors (diffractions?, off line effects) can be identified in the pre-Parmeener seismic section. the most easterly of these may be inferred to lie at about 5500 m at the position of line PB and imply such a thickness of moderately dense Precambrian section. The gravity model is consistent with this and magnetic data support the concept that an ultramafic slice forms the base to the entire core block.

West of the main central block one of the main reflectors seems also to be related to ultramafics. The gravity model would extend this structure to the base of the Parmeener cover but the magnetic data is not able to resolve this detail. The two ultramafic slices can be associated with volumetric offsets in the basement block.

Part of the principal magnetic anomaly is due to near surface variation in the dolerite and a granophyre and, or, feeder, is suspected nearby. Since this location is close to Waddamana Road this inference should be checked.

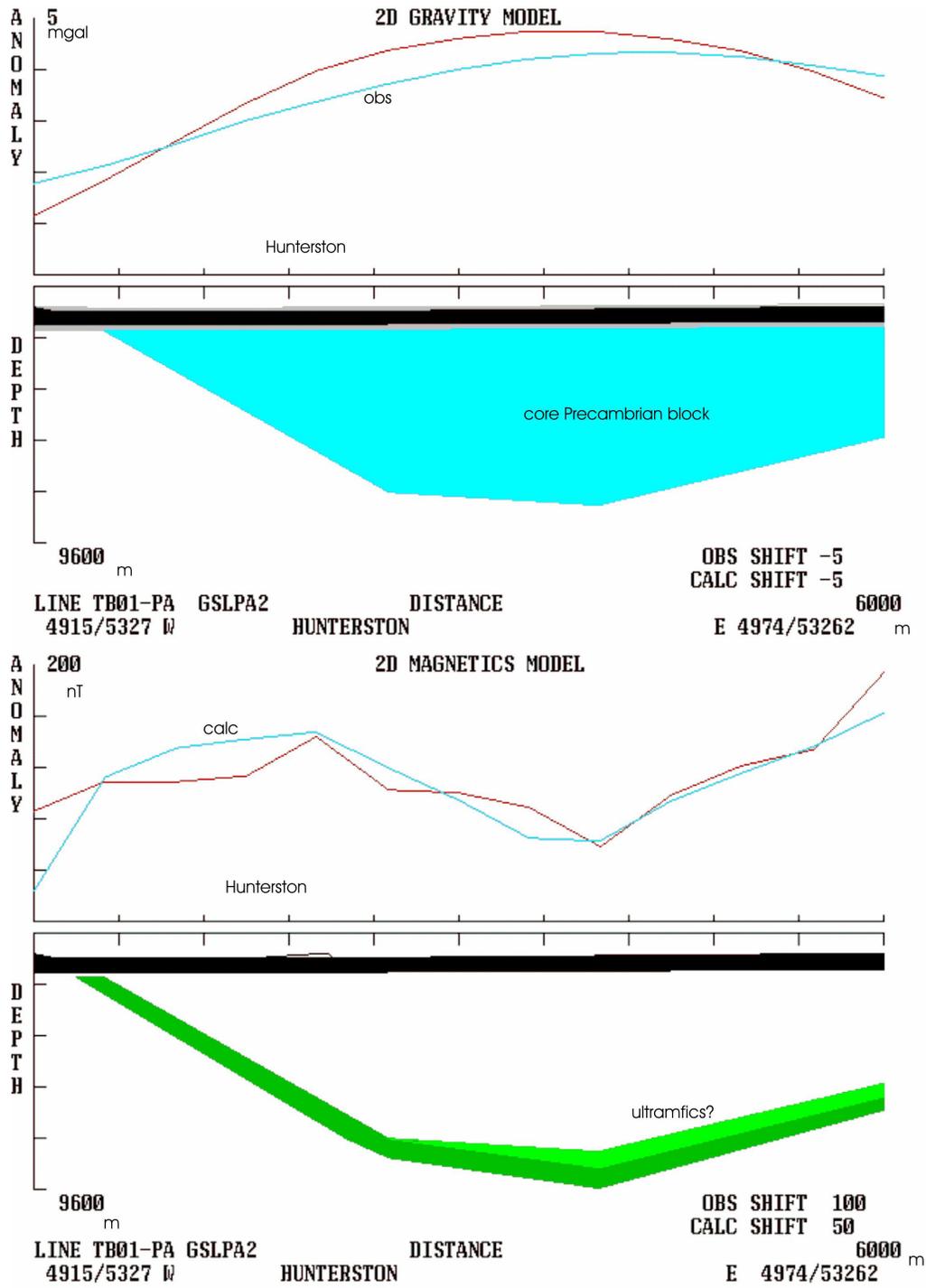


Figure 13. Interpretation of Hunterston cross line, TB01-PA.

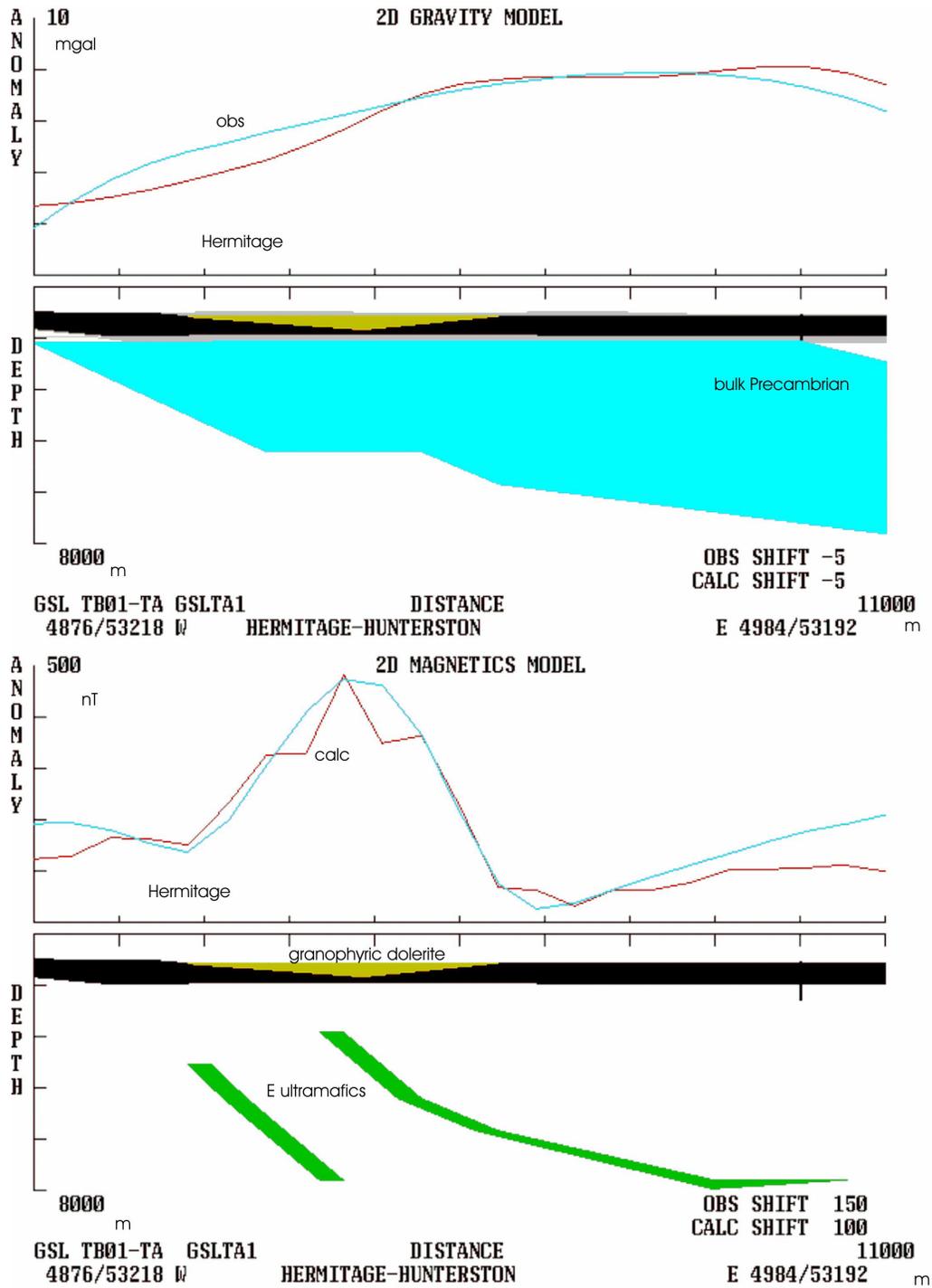


Figure 14. An interpretation of Hermitage cross line, TB01-TA.

**Seismic LINE TB01-PB (2001). Part 2: Steppes to Great Lake**

This segment of Line PB extends from the road junction at Steppes (4911/53388) to the Marlborough Highway junction at Great Lake (4795/53545).

The portion of the seismic record is marked by two strong reflections which dip south. Other character is very limited. There is a suggestion of a north dipping feature near Steppes and a possible sub horizontal element above it. From mid section toward Great Lake reflectors at little more than 100-1500 m below the Parmeener cover dip synformally and become multiple near Great Lake. There are very deep reflectors across this entire record segment. Some of the shallow reflectors dip into the base Parmeener unconformity about 10 km northwest of Steppes.

The modelled structures extend the previous segment of Line PB. On the basis that a moderately dense Precambrian sequence is present – and represented by the wedge of reflections just north of Steppes – it is possible to account for the pattern of major reflections with reasonable consistency across the entire model. The synformal character of reflections approaching Miena can be explained with the presence of mid Palaeozoic rocks, some of which must wedge out about 10 km north of Steppes. The large gravity anomaly near Great Lake is consistent with the presence of a more massive dolomitic sequence and the reflections in this region may represent the upper surface of this block of material. These features are shown in Figure 15.

Magnetic data provide considerable support for the structural interpretation and suggest that the southernmost south-dipping structure contains ultramafics, or the reflection is due to them, and that the other strong reflections – both midsection and near the synform – are also due to the presence of ultramafics. The structure some 4 km south of Miena is comparable with that of the Huskisson Syncline of western Tasmania and the main Precambrian block is also marked by bounding ultramafics on its upper surface. Strong reflections occur in the zone where magnetic data imply the presence of mafic slices.

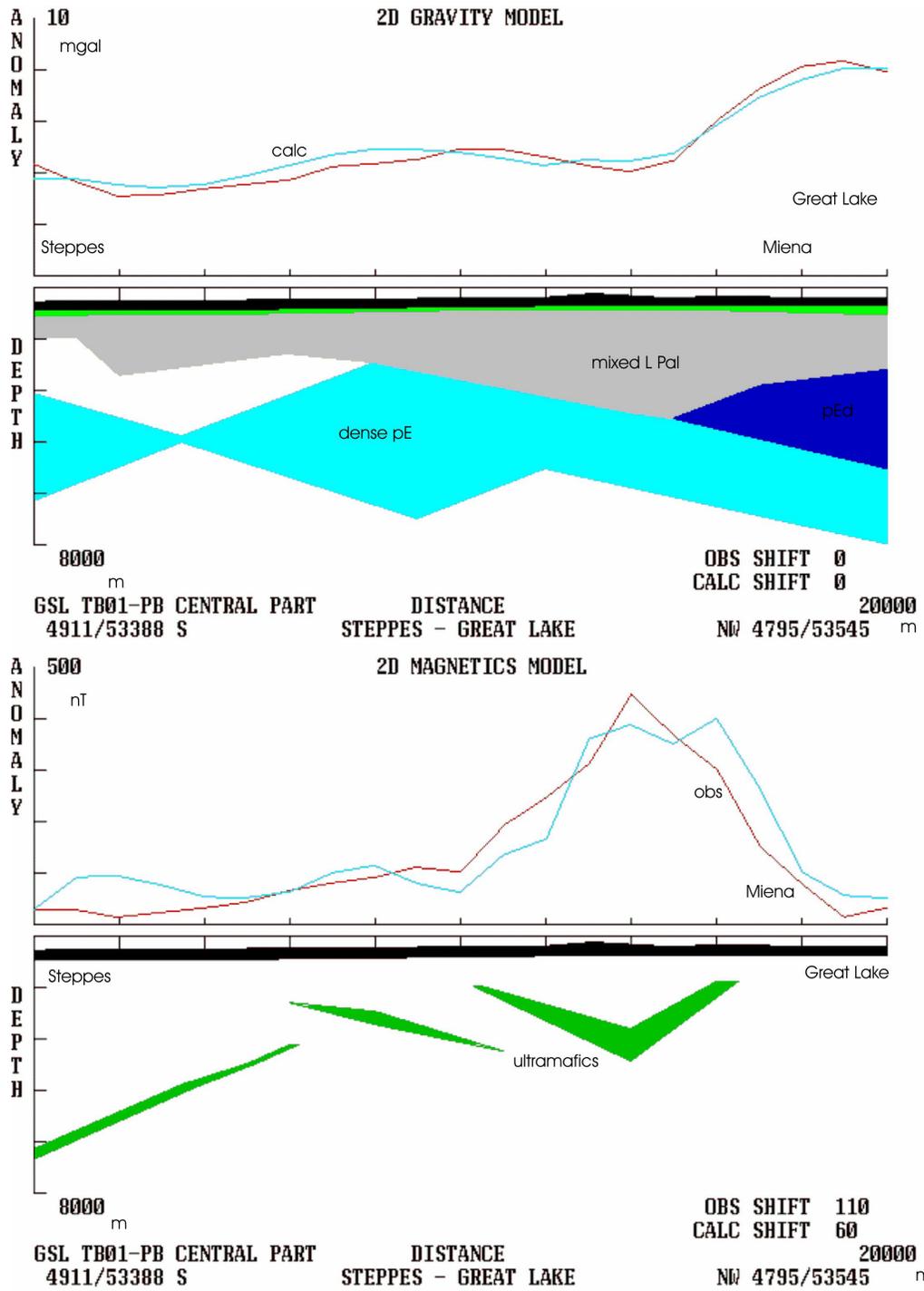


Figure 15. An interpretation of seismic line TB01-PB (Steppes to Great Lake segment)

### **Seismic LINE TB01-ST (2001).**

Seismic line ST extends along Interlaken Road east from the Steppes (4912/53388), down the Tiers escarpment, to Tunbridge (Midland Highway, 53405/533415) to Chapel Hill near the Macquarie River (54205/53335).

Seismic data contain much character. Several interfaces dip steeply eastward from Steppes and appear to unite. The reflections are then disrupted. East of the high plateau reflectors tend to dip east and up to four can be recognised. Some possible folding may be indicated below the fault zone at the foot of the Great Western Tiers but the effect may be a processing and terrain artefact. A thick, bland, non reflecting zone is present mid section but this is underlain by several subhorizontal, and deep reflectors. There are also several out-of-section features.

Initial review of the gravity data and comparisons with regional Line 3 indicated that many of the reflections could not represent unit boundaries at which significant density contrasts were present. Most are clearly structural margins. Since part of the very low gravity field near Chapel Hill is due to batholiths at depth (just off end of section, Figure 16) some constraints may be applied to the possible solutions within the boundaries imposed by the reflectors. The bulk of the gravity field can be satisfied by slabs of moderately dense Precambrian rocks of the type encountered in Hunterston 1. These appear to be thrust-bounded. The sequence appears to include slices of modestly dolomitic material, interspersed with more siliceous rocks. The small positive anomaly near Chapel Hill may be due to a further slice of Precambrian rocks (inserted in the form of the Badger Head thrust block west of the Tamar River) or a denser version of the Mathinna Beds. The lower density sequence (magenta) is inferred to be mid Palaeozoic and is almost certainly Mathinna Beds.

The situation at Steppes is consistent with that inferred on parts 1 and 2 of Line PB, in which a sequence of siliceous rocks overlies the denser Precambrian basement. Both sequences may be Precambrian. A little east of Steppes, however, a segment of low density Palaeozoic rocks may be inferred and these are possibly Silurian or Devonian in age given other correlations. A major offset structure, dipping west extends beneath Steppes, and is the origin of the disruption in all reflection character between SPs 720 and 850.

Magnetic data offer some interesting insights on this profile. Nearly all major blocks appear to be defined by magnetic slices of high magnetisation. Ultramafics are clearly universal. These materials define the base of the main central slab and the top of the western slab. A further slice of mafics appears to lie within the possible Mathinna Beds series beneath Tunbridge but these are not accurately located with the present data and may be situated along the unit boundary inferred gravimetrically. If this is indeed the case then it would suggest that the upper block beneath Chapel Hill could be Precambrian.

The relatively flat-lying deep reflections near SP 1220 probably mark a sheared siliceous sequence beneath the slab of modelled, partly dolomitic Precambrian. East-dipping character then predominates to the east as indicated seismically. All features are either thick or widely separated.

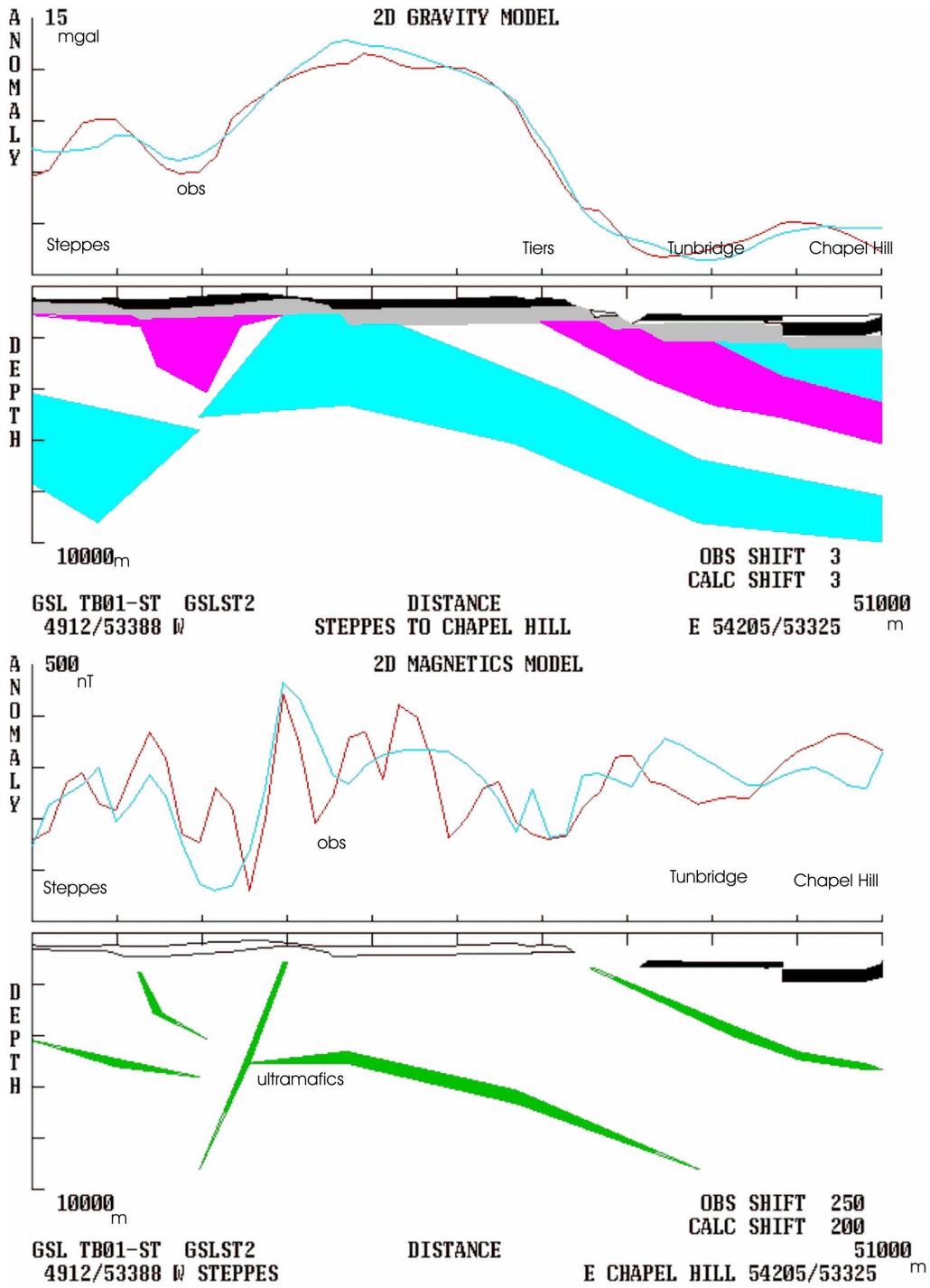


Figure 16. Interpretation for seismic line TB01-ST, Steppes to Chapel Hill.

### **Seismic LINE TB01-TH (2001). Great Lake to Golden Valley**

Seismic Line TH seems to offer an opportunity for considerable control and inspection of the types of reflection event to be expected from exposed Palaeozoic rocks and the Parmeener sequence on the Great Western Tiers. This line presents some of the best seismic data in the surveys to date but the variability of the geology and the uncontrolled nature of the basement possibilities confounds simple assessment. The southern end of the section is at the south end of Great Lake (4733/53521) and the modelled section has been terminated near Golden Valley (4761/5392) where the basement rocks are again concealed.

Detailed inspection of the seismic data reveals some major features with continuity in depth and a number of isolated features which extend laterally. At least two erratic, wavy reflections can be identified at the Great Lake end of the section but there is a large break in character south of Breona. This feature dips northward (or eastward); between Breona and Pine Lake there are some marked events also dipping northeast, then nothing at greater depth. No specific features can be related to the Tiers or the Tiers boundary but there is a nest of both north and south-dipping features beneath the slopes of the Tiers. The principal problem is that none of the many isolated blocks can be directly correlated to any Palaeozoic suite in the section or along strike. The interpretation is thus dependent on the size and shape of the elements recognised and the possible physical properties which are consistent with these.

The common tie for three profiles (TH, PB parts 2 and 3) is along the southern shore of Great Lake and there are simpler and more direct controls from the other lines which link out less ambiguously. The real problem is that the southern part of the traverse is quite different in character from the northern part and the bounding structure is clearly major (Figure 17). Near Great Lake a sequence involving relatively low density Palaeozoic rocks, inferred to be Silurian and, or, Devonian, overlies a dense dolomitic unit and the modestly dolomitic Precambrian basement. The absence of any clear magnetic correlation suggests that the dense unit is a Precambrian dolomite. The large gravity anomaly mid section can only be explained by dolomites since the gradients are critical. The anomaly contrast to the south is striking and cannot be managed within the reflection frame unless the block is relatively low density siliceous material: the obvious candidate is west Tasmanian Silurian rocks. This would then imply major thrust dislocation to also draw in the dolomite above them. The truncation of all these blocks is unusual but there is a ghost of reflection in the required position suggesting another structure cutting into the section.

A more ordered situation can be deduced between Breona and Golden Valley in which a large fold may be mapped. This fold includes a full sequence of Lower Palaeozoic rocks and representatives of all members exposed around the region are included. Gordon Limestone must be included as one of the few positive density agents and generates the low positive bulge in the gravity profile. Note that this is not in the position inferred by Blackburn (2004): that position, with formations wedging up to the unconformity is occupied by probable Silurian rocks.

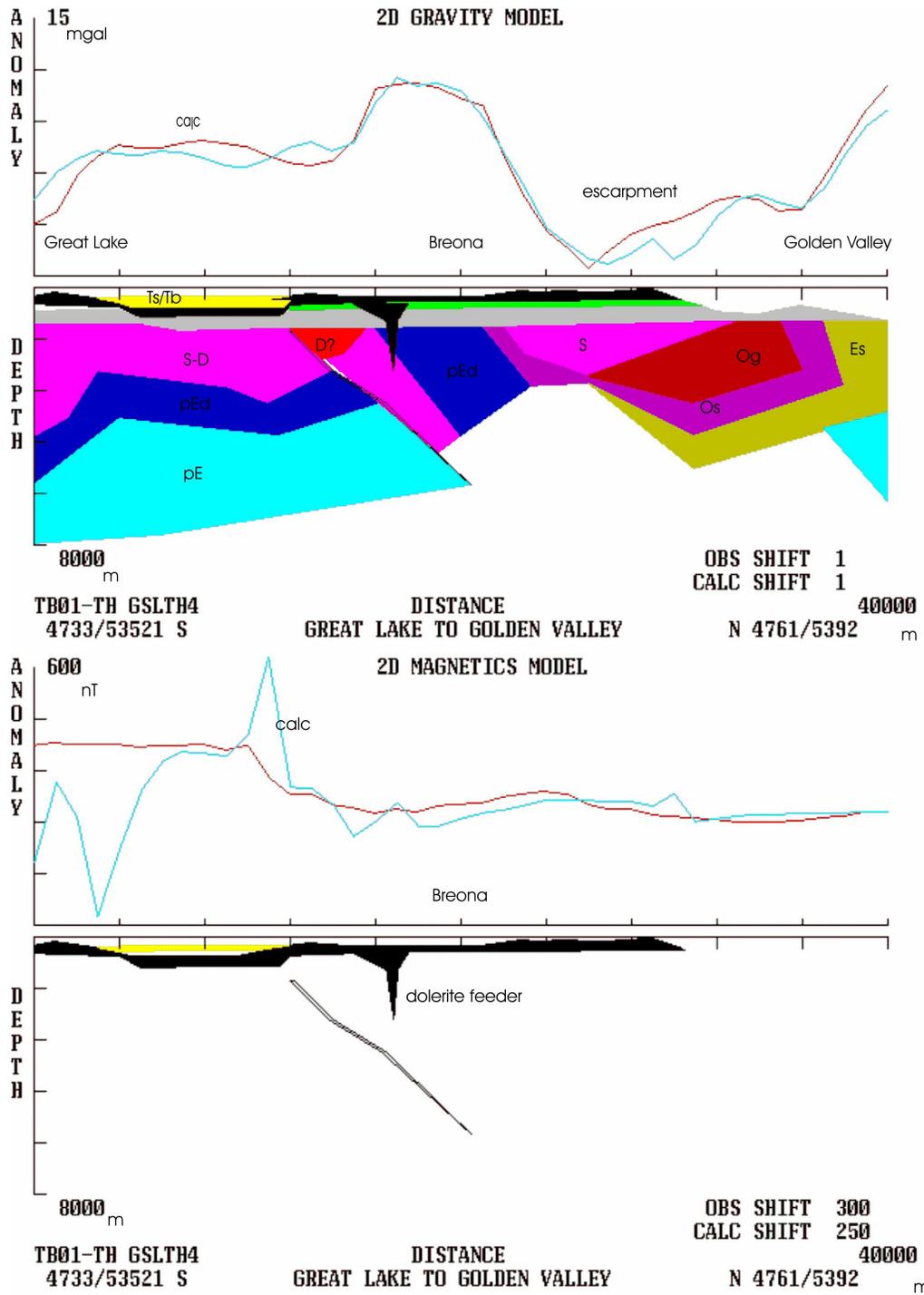


Figure 17. An interpretation of seismic line TB01-TH, Great Lake to Golden Valley.

Magnetic data define ultramafics in the main offset structure. The data are not adequate to fully assess the effect of dolerite, dolerite feeders or basalt at Liaweenee. Gravity data skirt the main dolerite feeder beneath Great Lake and the effect of this feature is to sharpen the crest of the central anomaly.

A dolerite feeder (see McDougall, 1964) has probably used the lower dolomite dislocation surface.

### **Seismic LINE TB01-PB (2001). Part 3: Bronte to Great Lake**

The third part of Line PB extends from Bronte (457/53305) via Bellevue and cross Line TD, to Great Lake (4725/5353) via the Marlborough Highway.

This portion of Line PB contains some of the most interesting and striking reflections in the entire survey. At least four major reflections can be seen in three segments of this portion of the line. Unfortunately none of them can be traced unambiguously across the record but together they present a giant antiform effect with structures dipping both south and north and almost flat-lying in the region of Bellevue. What do these elements represent?

Other lines (PB part 2, and TH) suggest possible Silurian rocks and Precambrian dolomite overlying a modestly dense core of Precambrian rocks. This can be accepted in the present model (Figure 18) but the gravity profile suggests that the Palaeozoic component rapidly thickens to the south before shallowing toward the Bellevue area. This is consistent with the reflector dips north of Bellevue. It is possible that most members of the Lower Palaeozoic formations of western Tasmania are present – with the possible exception of Cambrian rocks. The gravity profile is not compatible with any significant volume of these units and the magnetic data do not appear to support their presence either. The central anomaly can be readily accommodated by the common Precambrian member and density consistent with the upper reflection set. Other reflections, approximately 1000, 1500 and 4500 m deeper, do not have any gravimetric or magnetic relevance and must represent structures which dip through the section.

Near Bronte the reflections can be explained by Lower Palaeozoic rocks (Ordovician to Devonian) overlying Precambrian dolomites and dolomitic sequences. There is no continuity demonstrable between the southern and central parts of the profile. A vertical offset is shown in the model but a steep dip to the south (or west) might yield a better solution. In the absence of any control information this amounts to overinterpretation. The time map (Figure 20\_ shows the location of this major break. Magnetic data pick out at least two horizons which may contain ultramafics, one lies within the Precambrian complex at Bronte, but may be beneath it, and the other is within the Palaeozoic sequence at Great Lake.

The apparent antiform is thus in several parts, each constituted rather individually and not in a stratigraphic stack and, when seen in conjunction with line TD, the main form is found not to be closed near this profile.

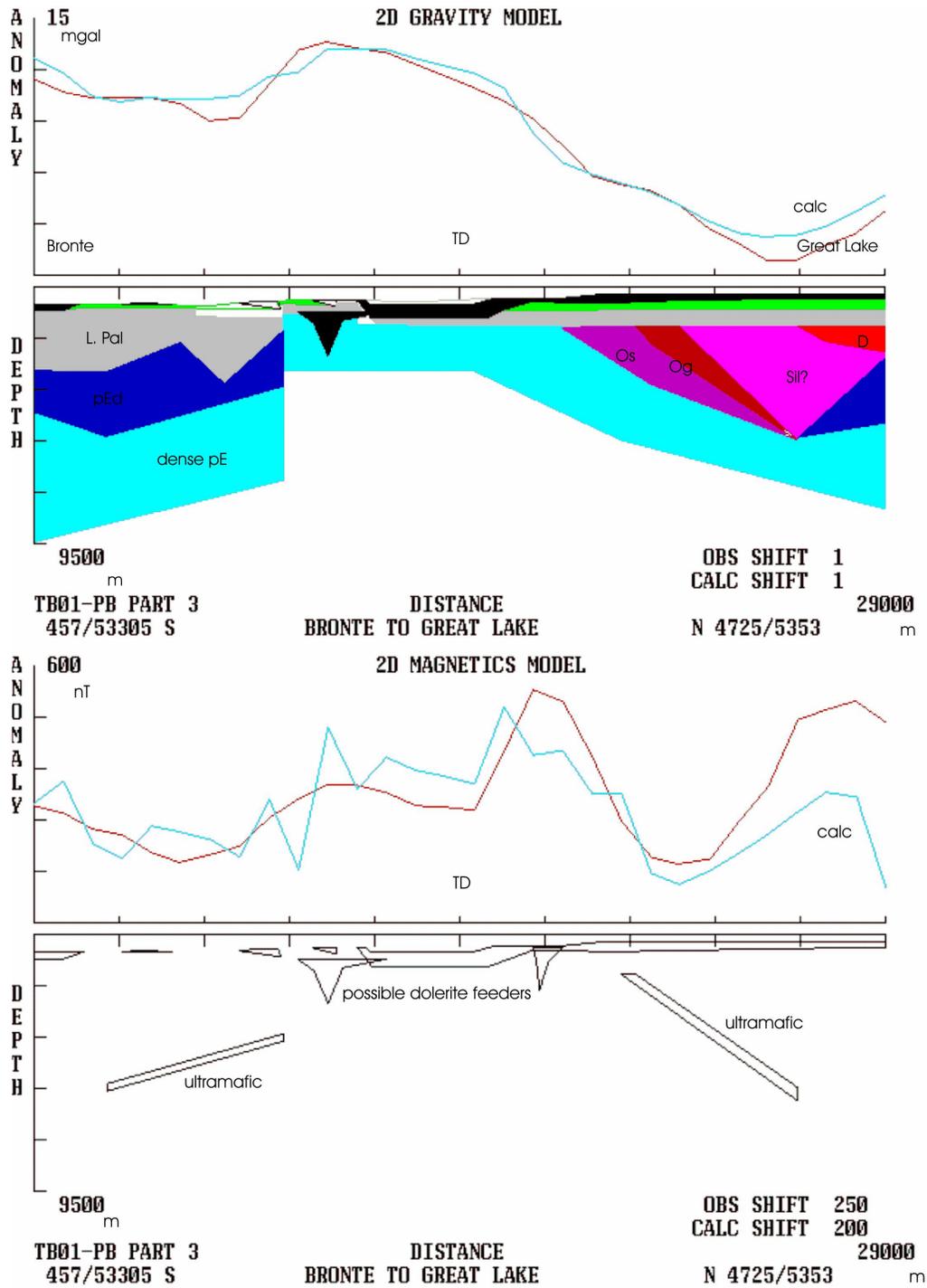


Figure 18. Interpretation of line TB01-PB, segment from Bronte to Great Lake.

### **Seismic LINE TB01-TD (2001).**

Line TD provides a useful cross line for the structure at Bellevue (Line PB part 3) and shows that all reflectors can be linked. Parts of them can be traced laterally but dislocations are evident, just as noted in the above discussion.

The modelled line extends from Great Pine Tier (457/53477) to Bellevue Tier (466/53385) and the mid point is on the Marlborough Highway and a tie with Line PB, part 3. This short line confirms the many distinctive reflectors observed on Line PB and shows that one dips to the northeast, and the others dip to the west. A crude time map is offered in Figure 20. The map is based on the direct implications of this line and PB with inferences and limitations based on TB/TL (below). No part of the seismic surveys yet undertaken by Great South Land Minerals in central Tasmania provide a satisfactory grid and any time maps must be very sketchy. If the structures mapped have any closure it is somewhere near Lake Echo. Line TD simply shows that the major reflections dip west and that some sources reach up to the base Parmeener unconformity.

Major traverse PB has been interpreted without any Palaeozoic content in mid section in the location of the apparent antiform but there are some relatively shallow reflections on this line which indicate a more complex folded environment beneath the unconformity. Further, the gravity data – which are poor and must be confirmed – imply a positive crestal anomaly and which, if real, cannot be explained by a simple slab of denser Precambrian rocks. This situation is also constrained by the dips of major blocks or units and a structural crest in the region of Lake Echo at line end, not line centre. Lower density rocks must be present at the western end of the profile and the rollover of anomaly then becomes a natural result of the gross dips. The magnitude of the gravity anomaly also indicates that the thickness of Precambrian rocks inferred on line PB is an absolute minimum and, further, that denser units must be present. This suggests that line PB samples a portion of the area in which a dolomite sequence is present only as a thin cap on the more normal basement. The three dimensional nature of the structure and its contents may be demonstrated by comparison of the two profiles.

Magnetic data are distinctive and imply the presence of ultramafics near the contact between dolomite and the lower basement rocks. The extent of this material and the depth at which it could be emplaced has been examined and it has been found that the most likely location is shown in Figure 19. It is most unlikely that the ultramafics are present at the base of the denser Precambrian segment.

Figure 20 presents a crude summary of time events in the Bellevue region. Structures run up to the base Parmeener unconformity and the importance of review of possible sources, migration paths and seals becomes evident.

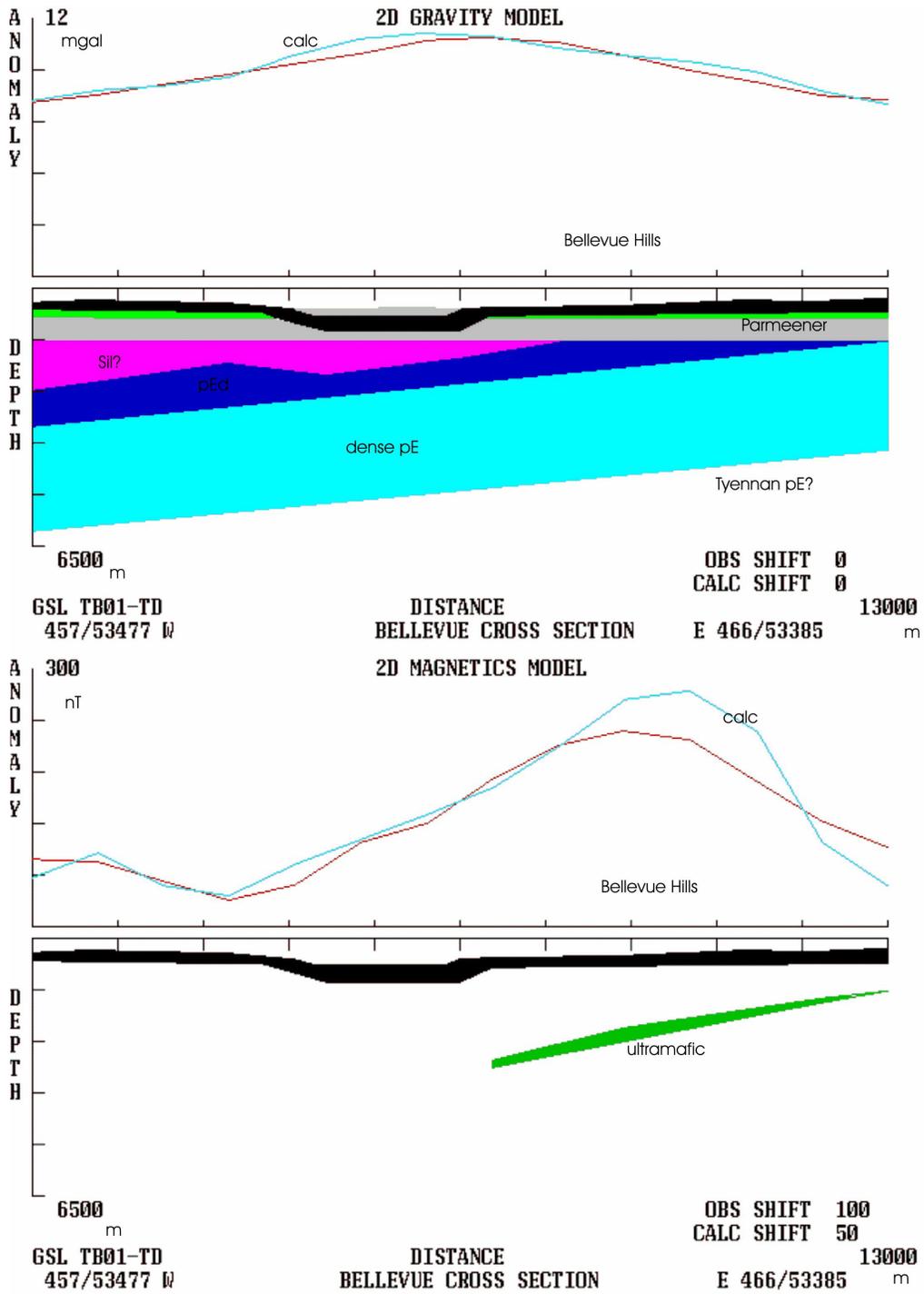


Figure 19: Gravity and magnetic models for seismic line TB01-TD, Bellevue.



### **Seismic LINE TB01-TB and LINE TL (2001).**

The two lines TB and TL form a natural extension and extend from King William Saddle (426/5326) along the Lyell Highway through Derwent Bridge (436/5334) to Bronte junction (Marlborough Highway, 458/53323) and on to a point above Lake Echo (4678/53316). The segment from Bronte to Lake Echo is Line TL.

The problem of tying lines (PB and TB) is evident and the two solutions offered in this report can be considered as limiting possibilities. Orientation with respect to major structures is a further issue. Line PB offers a thick Palaeozoic sequence, dolomite and dense Precambrian beneath the Bronte road junction. This could be arranged in the model for line TB-TL (Figure 21) by inserting a wedge of lower density material above the Precambrian variations. However, the seismic character of Line TB is most distinctive and emphatic: there are several west-dipping structures beneath the region extending from Lake Echo toward Derwent Bridge. If these structures are accepted then a simple pattern such as shown in Figure 18 is not credible when seen in east-west alignment. It should be noted that both solutions could be correct and that Figure 18 presents the strike orientation, Figure 21 the dip orientation.

There is no doubt that the gravity field demands the presence of more than normal density Precambrian rocks and blocks of dolomite have been included in the model. These have been located consistently with seismic character.

Note the multiple reflector nature of seismic data at Bronte below the unconformity: this could be sheared Precambrian or the layered variations in the lithology of younger Silurian – Devonian rocks. The west-dipping character of the basement is demonstrated on line segment TL east of Bronte (see also Figure 20).

Very different conditions apply at the western end of the traverse, beneath Mt King William. In this zone there are arcuate reflections which are synformal and within this package there are east-dipping elements. Few of these features have any continuity and the entire suite is bounded by a large east-dipping structure or unit. The gravity model is defined by these features and scaled by them. When this is done it may be inferred that nearly all parts of the west Tasmanian sequence are present in a large fold with offsets and onlaps.

Magnetic data, although at the edge of reliable coverage, offer some important constraints and generally confirm the gravity picture. A slab of slightly magnetic material is present in the gross fold and can be presumed to be Cambrian volcanics. An alternate view would be a segment of metamorphosed Precambrian but this would not be easily fitted into the density profile required to balance the gravity field. Ultramafics are also present, partly as a slice between Precambrian blocks and partly within the main fold – at the base of the inferred volcanics. This is a pattern commonly observed in western Tasmania.

Although the location of anomalies is a little vague, and the disposition of sources producing them necessarily uncertain as a result, each west-dipping boundary to the dolomitic blocks would appear to be picked out by slices of ultramafics. This conclusion supports the general view of the interpretation that the modelled aspects of the structure, as seen near Bronte, are determined by line orientation across a complex dipping environment full of detachments.

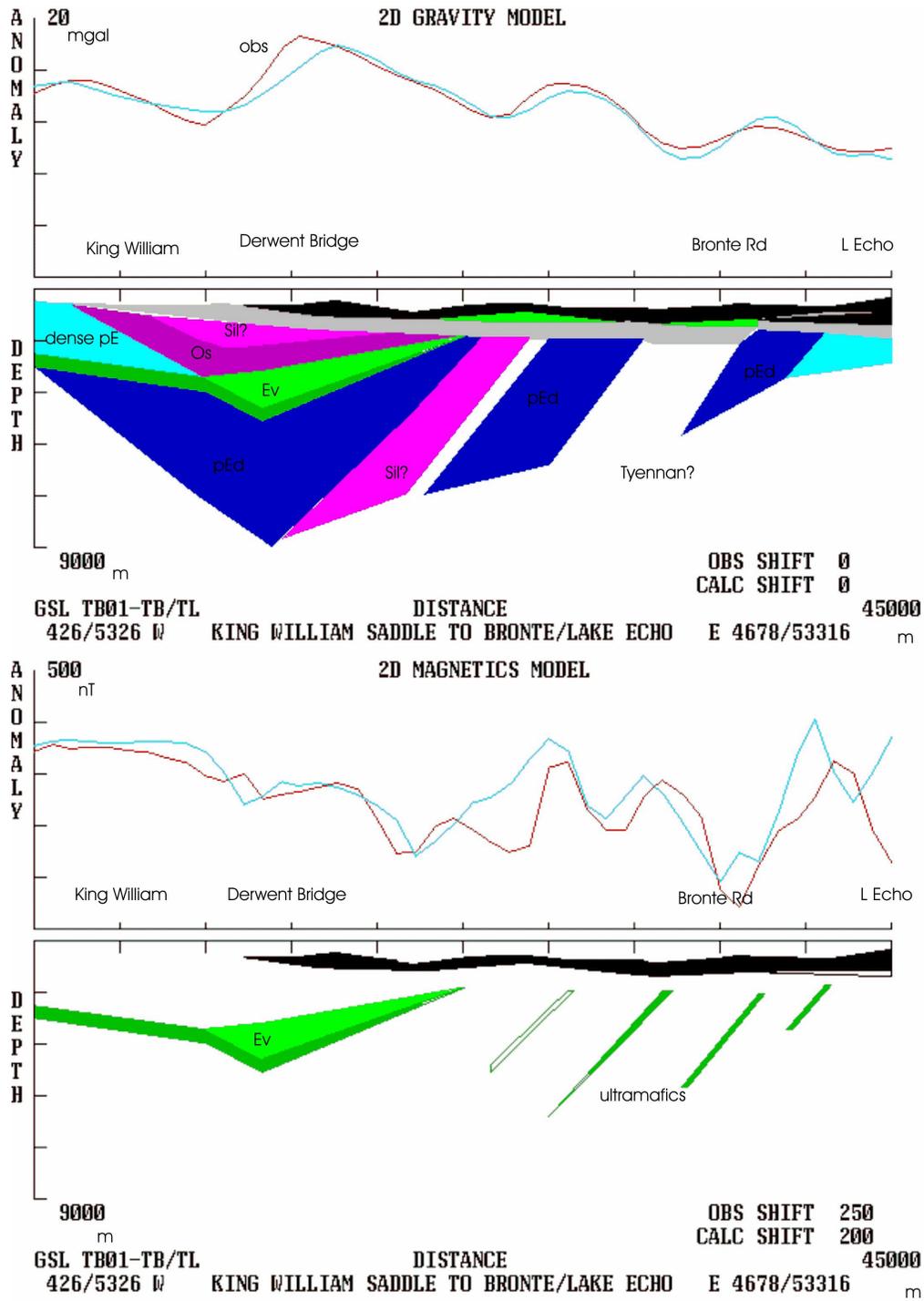


Figure 21: An interpretation of seismic lines TB and TL, Mt King William to Lake Echo.

## DISCUSSION

The analysis reported above is almost wholly consistent with previous work, with some significant variations, in terms of the general structural content, gross lithology of basement, and structural style of the rocks deep beneath central Tasmania.

The use of the limited seismic coverage available has removed many interpretation options and clearly demonstrated the presence of two families of thrusts: east and west dipping.

Comparison of many modelled lines, in the few places that they overlap or intersect, will show some minor deviations or alternatives. As noted earlier this may be due to orientation and observation issues, but is generally due to incorporation of slightly different concepts where the seismic data allows or is silent. Thus, Line PB (central part) and Line ST, at Steppes (Figures 15 and 16) for example, present similar materials or sequences but a different balance of them. Much depends on the data control in each segment, the change in line orientation, and the feasible combinations of units and physical properties.

In the context of central Tasmania the cover of post Carboniferous rocks (Parmeener Supergroup and dolerite) is almost irrelevant. It is a relatively thin veneer with regional dip and distortion. Any structures within it have origins and associations in the underlying complex. This means that the Hunterston structure, as seen in the Permian rocks, is related to rejuvenation of the underlying thrusts, some of which involve Cambrian and Devonian activation and creation. Several Jurassic dolerite structures are also related to these sites and changes in sheet form seem linked. Many feeders, most of which are not accurately located by gravity or magnetic data as yet, may also be associated.

There are enough magnetic data to demonstrate that a number of structures include, or are defined by, material with ultramafic properties. This material is Cambrian in age but has been relocated structurally. Many of these structures are seismically defined due to the different properties of the ultramafics, and the sheared and fractured nature of the zones in which they now occur. The broad spread of reflections in some regions indicates highly sheared, structurally layered rocks. Few of these zones are extensive.

Precambrian rocks are, in general, at non commercial or non productive depths although a number of blocks crest to, and are overlain by, the Parmeener cover – as at Hunterston and Bellevue. Various dipping blocks have been identified which are thrust-bounded.

On the presumption that rocks younger than Cambrian are of most interest to the exploration program Figure 22 has been prepared to suggest their location and any inferred structuring. This diagram is focussed on the Central Plateau region since this is the current location of most of the seismic network. Other seismic lines straggle to the west or south and lead to Palaeozoic rocks but, until there are tie and cross lines – and more potential field data – it is not possible to infer much about the possible structures (see Recommendations).

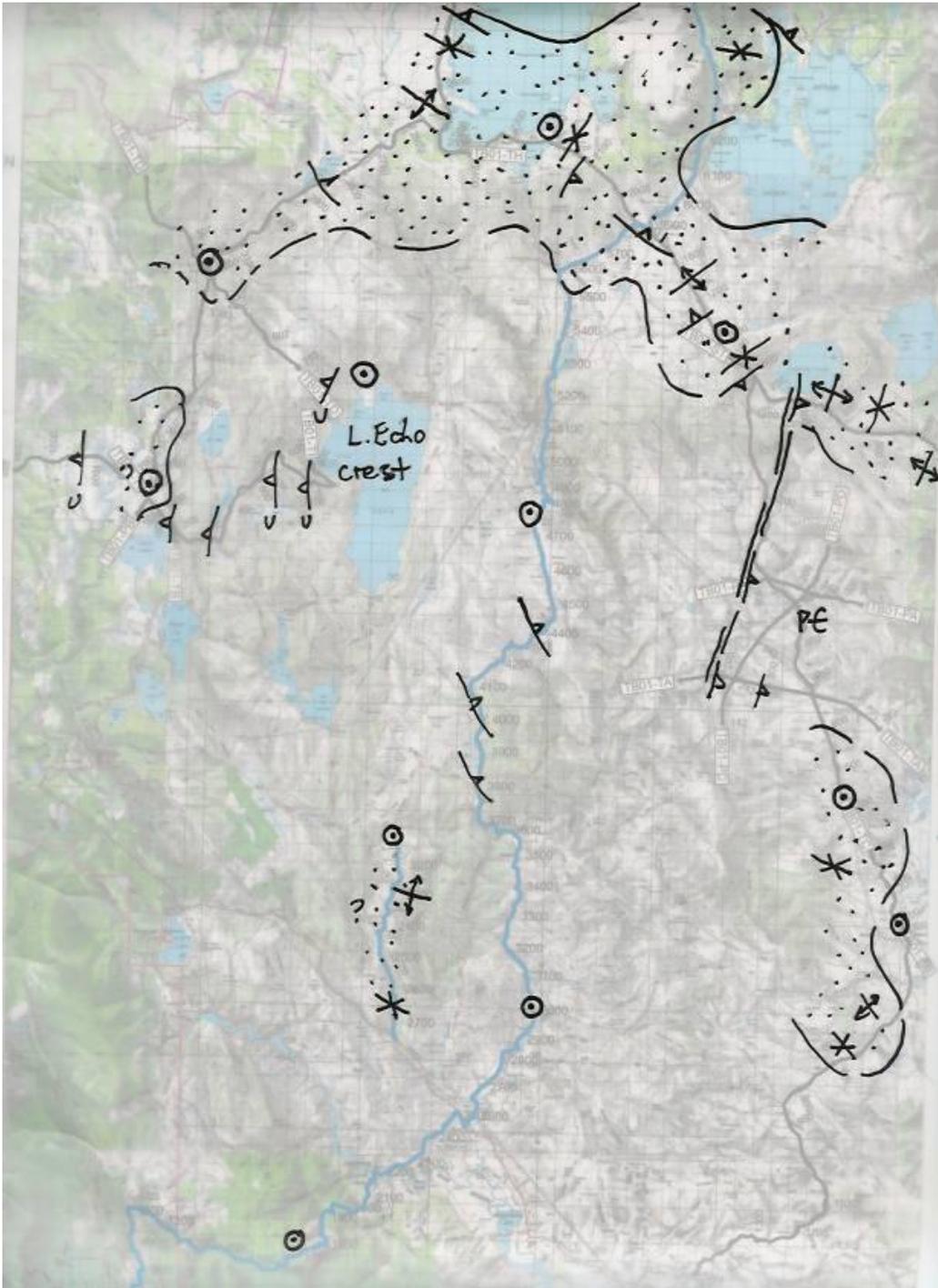


Figure 22: Inferred location of mid Palaeozoic suites.

The diagram also shows the location of major thrusts but few of these can be oriented nor connected with the present information. Dotted areas indicate inferred presence of Ordovician-Devonian rocks directly beneath the base Parmeener unconformity. Fold symbols are also marked. Circle symbols locate nominal positions of recommended control bores on the basis of present work. Basemap shows location of existing seismic traverses as heavy, coloured lines.

Figure 22 also does not consider the situation in the south-eastern part of the licence area where it is thought that the Mathinna Beds sequence predominates. This region is not adequately surveyed by any means as yet and no conclusions can be drawn. There is clear evidence of a large fold and possibly monocline at the foot of the Great Western Tiers. This structure probably involves Mathinna Beds and is also broken by a series of faults and thrusts in possible flower and rift margin structures. Such a zone may not be prospective in any event due to clear leakage possibilities and broken seals.

There are a number of other locations where ambiguity requires either more data, more analysis or review. For example:

What happens at the edge of the inferred Palaeozoic sequence which dips west from the unconformity beneath the segment Bronte to Derwent Bridge? Could traps exist in this region?

More control is needed near Bellevue. Where exactly does the shallow cover inferred to be mid Palaeozoic rocks become truncated by the unconformity? Could traps exist? Gezer-1 will answer some of these questions.

The situation near the highway junction at Bronte must be resolved. Are Palaeozoic rocks present, and what are they?

More detail is needed on the underlying section north of Breona and south of Miena. Are Palaeozoic rocks present, and what are they? Similar comments apply to the sequence between Steppes and Woods Lake.

Is there a structural closure north of Hunterston? There does not appear to be one in the post unconformity rocks but the identification or demonstration of mid Palaeozoic rocks to the north may prove important.

The situation involving possible mid Palaeozoic rocks in the region north of Ouse must be resolved: does the succession extend east of the Derwent axis?

It must be stressed that this interpretation is essentially uncontrolled and based on insufficient data for acceptable reliability risk. It must be regarded as preliminary and indicative only.

The seismic coverage, with its awkward line orientation and terrain changes, generally lacks ties and does not allow proper definition or mapping of any unit or structure over worthwhile distances (except for some parts of the Permian rocks and some dolerite sheets). The gravity coverage ranges from excellent to terrible and much weight has been placed on too few observations. The magnetic coverage is uniform but coarse and, ironically, turns out to be the best regional data set, as a data set, at the time of writing. It is simply a pity that the wide line spacing leads to limited resolution of features and locations.

This interpretation amounts to an over-interpretation in many regions and the Recommendations (below) are designed to solve this problem and advance the exploration effort.

This study includes no evaluation of the seismic or other data coverage northeast of the Great Western Tiers. A comprehensive view of that region, a view consonant with new data, was provided by Leaman (1991, 1992) and Leaman & Webster (2002). It may be commented, however, that the seismic net for that region is the minimum standard for useful judgments and the new program for the southeast is compatible.

## OTHER OBSERVATIONS

The above discussion and interpretation, with its emphasis on old rocks and complex structural relationships, would seem to offer little for a petroleum exploration program. The sequences, and lithologies, inferred are of high velocity and structured. It is a thrust terrane. All formations in these circumstances are likely to be of low porosity but may be locally fractured. In such fractured zones they may form adequate reservoirs for gas or fluid and the same zones would also be critical for any fluid migration, or escape.

It is often assumed by “soft rock” explorers that hard rock terranes carry little potential for petroleum – but this is clearly not the case in some Asian provinces. The same principles, involving source, migration and storage apply: is it possible?

Various theories for potential source rocks have been presented for the Tasmania Basin – a term which might itself be of little value. This, and previous, regional interpretation indicates that the post Carboniferous rocks of the “basin” are but a veneer with very modest variation in thickness and which have been largely removed as a cover. Migration is clearly possible per the net of thrusts, faults and fractured zones and, perhaps, near unconformities.

In such situations the matter of seals becomes paramount since many fracture systems have been rejuvenated and extend to surface. The potential for leakage is high and this pattern probably accounts for the Lonnvale observations of escaping oil through dolerite. Set against this negative view is the fact that nearly all media encountered in central Tasmania, and implied in the above interpretation, including Permian rocks at depths greater than 100-200 m, have velocities in excess of 5000 m/s; most in excess of 6000 m/s. It is known, for example for Permian rocks and dolerite, that this translates into a tightly sealed rock mass in which joints are filled and effectively impermeable. There is an observed velocity profile in such rocks as surface is approached representing first an opening of joints (due to unloading) and then due to increasing effect of weathering. For the dolerite the critical change occurs at depths of 40-80 m below surface. Below such depths the rock is a seal. Thus for dolerite, within section as a complete sheet, the intrusion itself represents a seal.

It might be expected that many other, older high velocity lithologies would act in a similar manner. In these terms, Lower Permian rocks deeply buried (depths > 200-500 m) would also act as seals – regardless of lithology. No such assumptions should be made for Triassic or younger sedimentary materials.

These comments mean that many units, viewed stratigraphically or as structural members, could act as seals. The issue for exploration is, could reservoir settings be developed and recognised in such situations, or with less than excellent data. In normal situations dipping reservoirs, whether structural or stratigraphic, may well display anomalous reflections: direct hydrocarbon indicators (DHIs) in which a strong horizontal reflection can be contrasted against its dipping setting. Using the currently available data, with all its limitations, there are few unambiguous stratigraphic

reflectors defining units but many structural reflectors (thrusts and fracture zones of lower velocity), and few such patterns might be identifiable.

Two possible DHIs have been observed, and each involves an association with a lower density medium, presumed to be mid Palaeozoic rocks.

These are located at SP 3380-3420, Line TB01-PB and SP 1540-1760, Line TB02-BA.

The possible feature on Line PB is illustrated in Figure 23.

There are several, horizontal high amplitude responses on the structural crest and these show slight dip contrasts to all surrounding features. Given the three dimensional nature of the structures involved (Figure 20) this character is quite unexpected.

The responses are associated with the intermediate level structure which may involve ultramafics and these materials may be implicated in the generation of the seismic changes.

The possible features on Line BA are much less definite but there are several possibilities in the particular short line section. All lie in the 0.6 to 1.3 seconds range. The sites lie south of Mt Thunderbolt near the edge of the Florentine Valley structures. All responses are relatively subtle but oppose the grain of other reflections. All effects lie within the modelled Palaeozoic section which is considered to dip up to the east toward the base Parmeener unconformity.

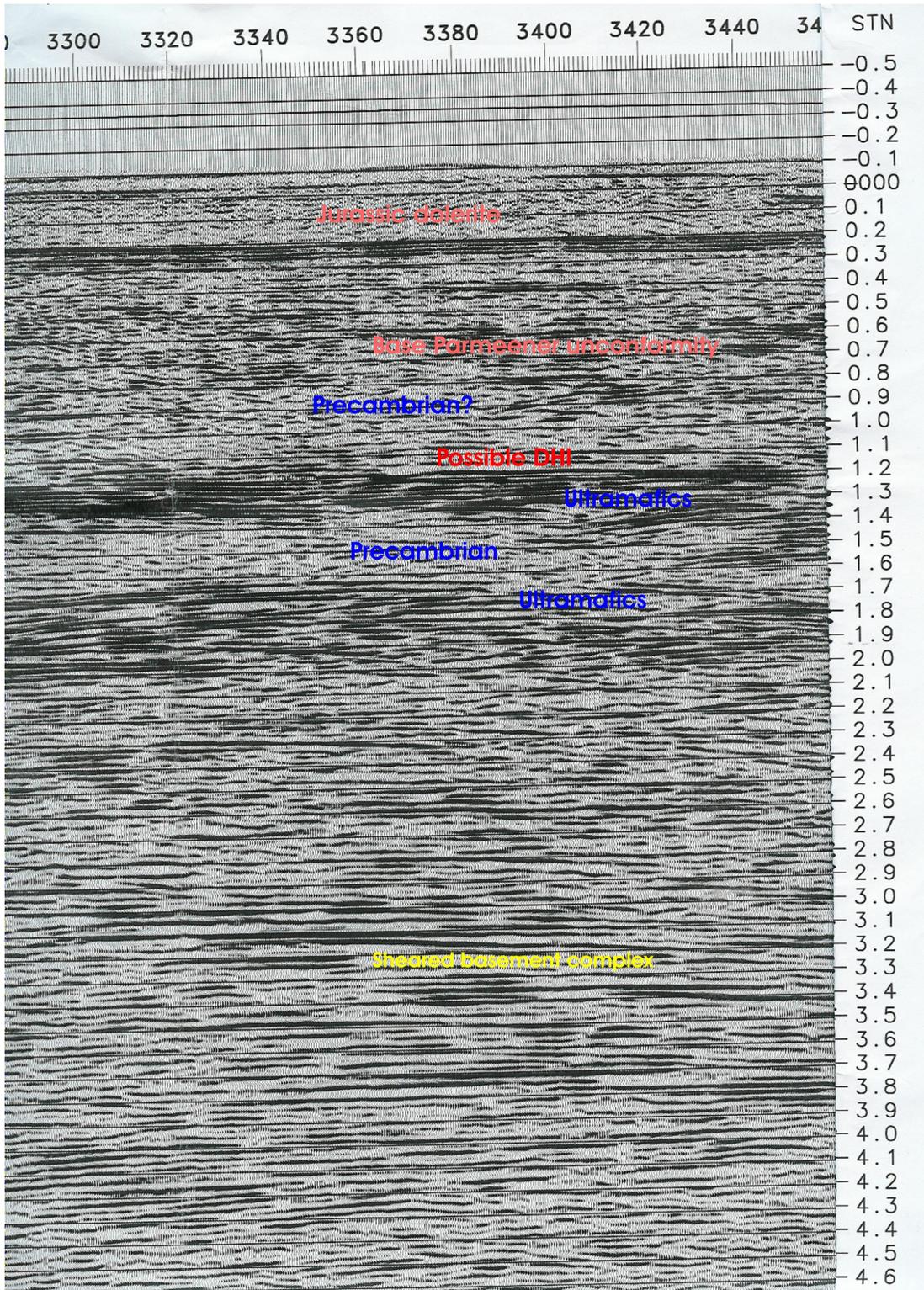


Figure 23: Portion of Line TB01-PB near Bellevue.

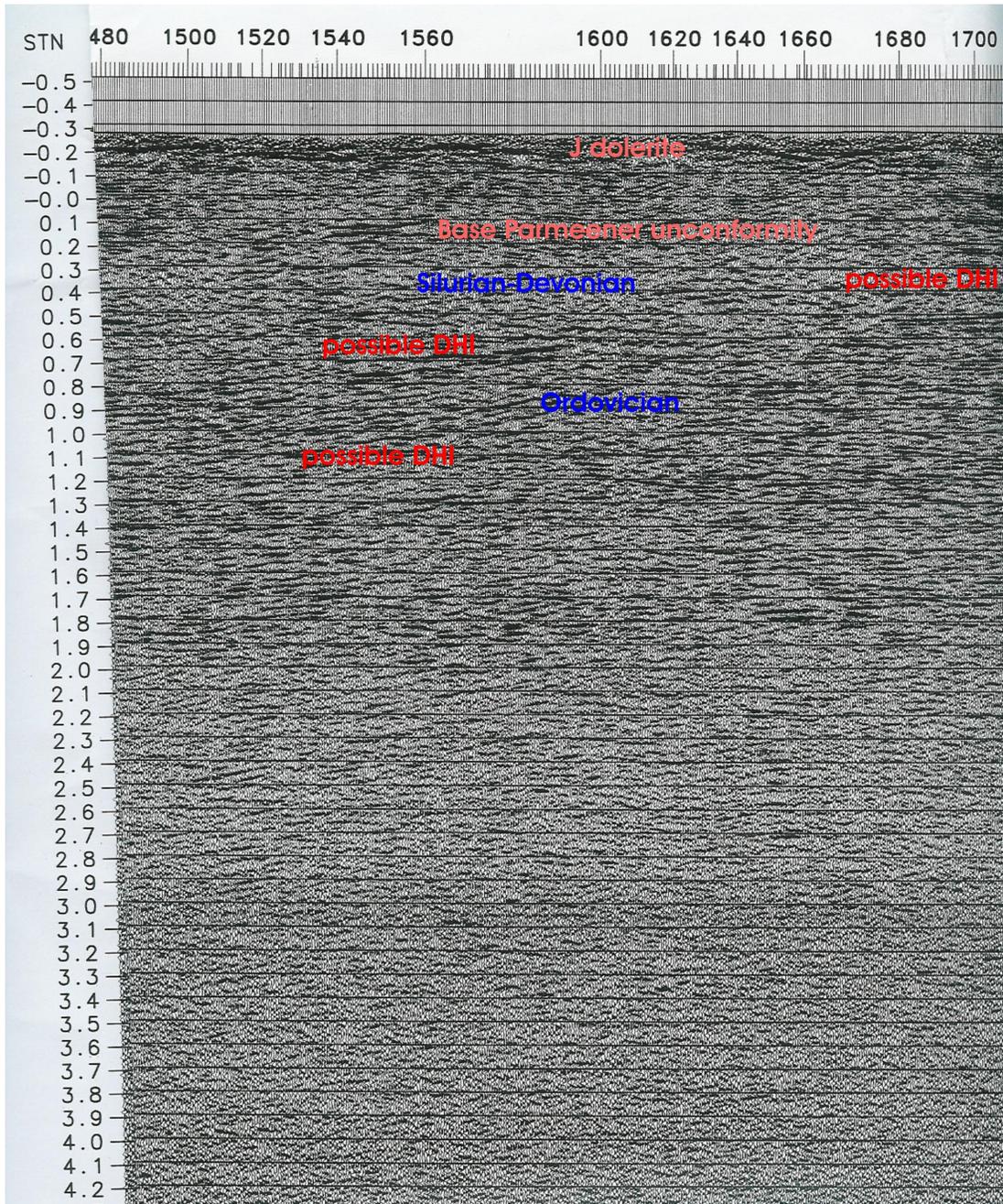


Figure 24: Portion of Line TB02-BA south of Mt Thunderbolt. Note the cross-grained appearance of this record which may reflect hydrocarbon indicators or a combination of off-line, dipping and diffraction events. Short horizontal effects are clearly anomalous in this situation.

## CONCLUSIONS

The principal conclusion drawn from the present study, which represents the most extensive analysis ever undertaken, is that the data available is quite inadequate for the guidance of a substantial exploration program. See Recommendations.

The seismic surveys completed to date are too isolated and unable to provide any comprehensive structural or stratigraphic unity. Segments of these traverses carry interesting suggestions of reflector events but their origin is not identifiable without use of other methods or well control. Most events are thought to be structural boundaries. One well, Hunterston-1, is simply not enough to provide the required control information alone: the area is too large, too complex and too variable for this to be claimed.

Gravity data, which have been used to carry major elements of this interpretation, are variable in quality and coverage and have almost certainly been over-interpreted in western regions. Magnetic data, used to test or verify certain elements of the interpretation, are only able to do so within the constraints of acquisition specifications. This data set is the most consistent regionally and it has been able to allow critical conclusions. These include the deduction that many thrusts and detachments are present and that they involve ultramafics (presumed to be Cambrian in age).

The present integrated interpretation does indicate where data must be acquired, and the nature of that data. If the implications suggested, with respect to mid Palaeozoic rocks, are correct then some useful stratigraphic holes may be drilled. There are other sites, as near Bronte and Steppes, where generally concordant interpretation allows significant variations and such sites should be drilled to establish firm control at clearly anomalous or ambiguous locations.

The interpretation generally confirms earlier views that central Tasmania is underlain by a complex overthrust terrain and that thrusts are both east and west facing. Many include coatings of ultramafics and some arcuate surfaces are completely enclosed with these materials. Precambrian rocks, including dense and dolomitic members, or largely dolomite, dominate the upper crust and siliceous Tyennan style basement is relatively limited in volume. The denser rocks may also be strongly metamorphosed and altered rocks but there is no suggestion of any significant magnetic signature.

Palaeozoic rocks can be traced into the plateau region from the southwest (Florentine valley region), the west (King William) and the north (Golden Valley). Block size, variation and limited lateral extension restricts seismic control and the other data sets can only indicated general presence and basic lithology at present. It is clear, however, that large portions of the included section are relatively low density ( $2.60 \text{ t/m}^3$  +) and indicates the presence of Silurian and Devonian rocks, perhaps with significant elements of non limestone Ordovician. Large accumulations of Cambrian rocks appear to be absent under much of the region.

This interpretation should be reviewed and models recalculated once new potential field data is available and at least some of the control wells have been drilled.

## RECOMMENDATIONS

Some comments were made in Introduction which suggested that the present work would inevitably be limited. Such limitations were directly related to ground inspections of critical structures, and the quality and coverage of gravity and magnetic data. It is also clear that the generally isolated nature of the seismic coverage also retards understanding. The entire interpretation should be reviewed upon completion of these recommendations.

### DRILLING

Some drilling is required regardless of acquisition of any other data, or surface evaluations. Some real control and insight into the construction of the basement is essential – and this control must be widespread.

Great South Land Minerals has nominated a number of drilling targets, mainly for stratigraphic purposes. These must be drilled, and to depths of at least 3000 m. This depth is required to ensure that the target zone thickness is properly appraised for future interpretation revision. Besides, the content of the basement to such depths may offer clues as to the source and movement of any hydrocarbons present. The already-drilled deep hole at Hunterston is not deep enough to answer some of the questions which arise from existing seismic data: hence any holes should be drilled to rig capacity and not less than 3000 m (economic depth limit?).

This study suggests that some of the current, nominated well sites are not ideally located. An example of this is offered by Gezer 1. This is clearly off structure, whatever that actually is, and would require greater depth to reach any of the primary reflectors. This site should be shifted several kilometres to the southeast, to Lake Echo. Figure 22, however, shows both sites – and both should be drilled. The nominal Gezer location would establish something of the lithology above the first major reflector and confirm or deny the absence of Palaeozoic rocks near Marlborough. The Lake Echo site is probably close to the crest of reflectors (Figure 20) and would test both the prospectivity and stratigraphy of the region.

Some other suggested sites, which would provide regional control and resolve some ambiguities, are also shown on Figure 22. These are considered the minimum necessary sites to provide appreciation of existing data and support analysis of new data infills.

An additional site near Tarraleah or Wayatinah might also prove of use.

### POTENTIAL FIELD DATA

The coverage and quality of magnetic data must be improved. The only practical way to do this is to survey the entire licence area with consistent specification which allow resolution of both shallow source features and basement effects. Such a survey should have a line spacing of the order of 200-400 m maximum (closer is better) and a nominal terrain elevation clearance of 100-150 m. Significant deviations up to 300-400 m are not significant if very local, provided instrumentation fully records clearances. Tie lines of 10-20 km are advised as minimum specification. The higher range of terrain clearance tolerated means that towns and cities can be overflowed leading to a seamless final presentation. The specifications also mean that the data can be presented as a detailed map and in continued form at some fixed height, say 1300 m asl. The

upward-continued format would be used for basement interpretation and the detailed low level form for Parmeener interpretation.

The coverage and quality of gravity data must also be improved but this is an easier and less costly exercise. Some parts of the area already possess a nominal 1 km observation spacing although the reliability of anomaly values may leave something to be desired. Many regions have a station spacing of more than 7 km, including the zone south of Bellevue, around Thunderbolt, and near Lake Echo. This explains the comments given in Conclusions: some traverses are almost certainly over-interpreted. It is recommended that every track of access which can be driven with a 4WD vehicle in these areas be traversed and observed at 500 m nominal spacing with a modern gravimeter and GPS support. This method will rapidly improve gravity coverage and reliability.

#### SEISMIC DATA

The present study indicates the problems with existing coverage and also suggests that the seismic coverage planned for 2007 is imperfect. Important structures and stratigraphic sections have been missed, and tie sections not considered. It is important that a net of seismic profiles be acquired since much of the difficulty with the present coverage lies with the isolation of individual traverses and the lack of cross ties. These are especially necessary in the Lake Echo region on the basis of present inferences.

Recommended coverage for the plateau region is suggested on Figure 25.

The data should be acquired using a wide frequency response and should not be filtered or altered in any way prior to processing. All traverses should be acquired with the straightest orientation and should exclude major doglegs wherever possible. Use of roads means that some orientation and elevation problems are inevitable but the proposed continuation of Line AA2, for example, is not advised. This line, essentially north-south, includes an east-west segment of some kilometres. This will degrade results. An alternative arrangement has been suggested in Figure 25 and it involves acquiring the north-south segments as proposed but using a cross traverse to acquire the other portion. This has the advantage of providing a proper and continuous setting for all segments.

Traverse planning must be carefully thought through in order to optimise results. Any seismic survey in Tasmania is very expensive and anything which diminishes the chance of good results should be avoided. Line PB, for example, is little short of a disaster for this reason. This line should have traversed from Bronte to Deloraine, not Bronte to Great Lake to Bothwell. TH should have been Great Lake to Bothwell.

Several other lines have waste segments which add nothing to the data set. It is not an advantage to use every bit of road or road curl just to advance a few hundred metres on orientation. This is evident for lines BA and TL where nothing is gained by taking a hairpin bend and following a different orientation.

Seismic presentations should be labelled for orientation and should be organised in the same way (looking north for east-west lines, and looking west for north-south lines) and shot points should be systematically laid out to achieve this. This is a planning issue but reduces confusion and rotation of data in order to put it in the manner of normal inspection. Part of this problem has arisen at the processing centre which has not been concerned with the finer points of useful, and non confusing, presentation.

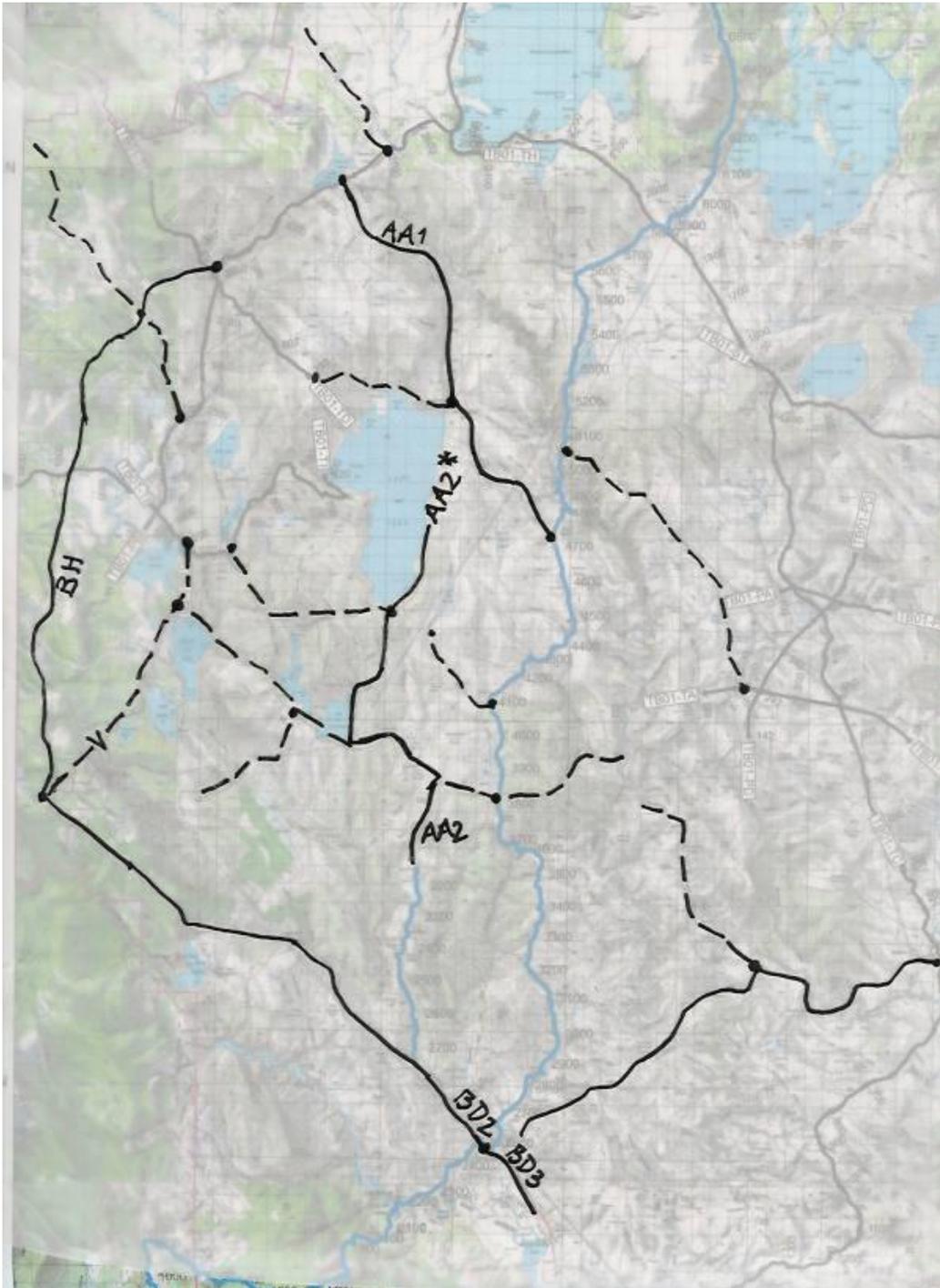


Figure 25: Recommended seismic coverage, central Tasmania.

Existing traverses are shown as coloured, heavy lines on the base map (black = survey TB01, blue = survey TB02). Firm lines on overlay are planned lines for next survey. Broken lines are the minimum recommended coverage required to provide cross ties and basic time maps.

Note AA2 has been planned with a major dogleg. This line should either be acquired in segments or as two parts and much longer cross line as shown.

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## APPENDIX 1

## TABLE OF ROCK PROPERTIES

Density is expressed as contrast with background and reduction density of 2.67 gm/cc

Age and unit	Density gm/cc, t/cu m	Susceptibility cgs	SI
Quaternary	-1.2	0	
Tertiary sediments	-0.7	0	
basalt	0.23	>0.001	>0.01
Jurassic dolerite	0.23	>0.004	>0.05
Triassic	-0.22	0	
Permian	-0.1 to -.13	0	
Siluro-Devonian	-0.1	0	
Mathinna Beds	-0.06 to 0.04	0	
Devonian granite	-0.05-0.07	0	
granodiorite	0.03	~0.0002	~0.0025
Ordovician Gordon Gp	0.07	0	
Denison Gp	-0.07	0	
Cambrian Tyndall/Yolande Gps	0.05-0.07	0.0002	0.0025
Dundas Gp style	0.05-0.07	<0.0002	<0.0025
sundry variations	var	var	
andesites	0.1-0.15	>0.0002	>0.0025
central volcanics	0.06-0.08	~0.0002	~0.0025
porphyry	-0.03<0.05	<0.0002	<0.0025
granite	-0.05/0.02	>0.0005	>0.006
ultramafic	var	>0.01	>0.12
Que style basalts	0.1-0.2	>0.0003	>0.0035
(note many Cambrian units exhibit variations in properties locally when altered)			
Precambrian/Eocambrian			
Crimson Creek Fm	>0.1	>0.001	>0.01
Success Creek Fm	>0.07	0	
Lineament rocks	>0.1	>0.0002	>0.0025
Oonah/Burnie Fm	0.08	<0.0005	<0.006
Forth Complex	0.1	0 var	
Tyennan/Badger/Rocky Cape	0	0	
Cradle Block var	0.1	0	
sundries/amphibolites	0.15	0.0003	0.0035
Massive dolomites	0.17	0	

## APPENDIX 2

### READING THE MODEL DIAGRAMS

All models have been constructed using the criteria and methodology of Leaman (1994, 1995, 1997b). This means that a family of rock units (see Appendix 1) has been consistently engaged and in ways that are known to occur.

Property ranges lie close to those observed and quoted in Appendix 1 and inferences have been used to deduce which combinations of units may actually be present, and where.

The diagrams themselves are in two parts: gravity and magnetics. The separation has been made for clarity and to indicate which units contribute to the observed or modelled effect. This is rarely apparent in compound plots which attempt to label units with properties used.

In so far as it has been possible, and hardware and software have allowed (there were some curious transformations!), the sections are colour coded and labelled in various sections so that the reader may gain a feel for what is included.

Dark blue = Precambrian dolomite, light blue = relatively dense occasionally dolomitic Precambrian, white = siliceous, possibly Tyennan Precambrian or neutral lithology ( $2.67 \text{ t/m}^3$ ). Dark green = Cambrian ultramafics, light green = other Cambrian rocks (volcanic or sedimentary). Red or black have been used for Devonian formations, magenta for Silurian, red for siliceous Ordovician and light red for Gordon Limestone. Devonian granitoids are shown in red.

Undifferentiated Parmeener cover or Permian is usually shown in light grey (occasionally blue), Triassic in green and dolerite in black. Tertiary rocks are not visible (but included in the models) at the scales plotted.

Observed data profiles are the red lines in each case. The blue profile is the calculated (modelled) profile.

The anomaly scale (top left in each diagram) shows the range of scale. Thus 20 mgal represents the entire scale, each tick is then 4 mgal.

The depth scale (bottom left) is scaled in the same way. Thus 9000 m represents the full scale, each tick is 1800 m.

The horizontal scale (bottom right, below "calc shift") is the full range of the diagram. Thus 45000 m represents the length of the section presented, although at least 15000 m more will have been included in calculation to avoid large end effects (but not displayed), and each tick will then represent 4500 m.

The values of "obs shift" and "calc shift" are important since these confirm the consistency of the modelling. The differences between the two numbers should match the base shifts or base levels of the data set. For residual gravity data, assuming the residual separation to be valid, this difference should be zero. For residual magnetic data it will depend on what base value was chosen by the contractor of the survey and its difference from the true IGRF related value at the site. Since the magnetic field is a

variable function this number can vary and must be assessed for the survey and data set. The residual field offered on magnetic maps is rarely true, since this subtlety is not appreciated by many, but it is important that it be determined and recovered consistently in modelling or magnetic interpretations become nonsense and ill-determined. In this case an assessment of the data set suggested that the true base value for the survey was 50 to 60 nT higher than the values presented. This difference should, therefore, appear in the shift values. A difference of 50 nT has been considered an adequate match.

Details of the line appear in the lower left corner of each sub plot and the title line of each plot includes some end point detail in the form of shortened AMG coordinates and some description.

