Interpretation of Aeromagnetic and Gravity Data sets in EL 52/94 and ML 1M/95 Queenstown Tasmania

Final report

Prepared for:
Copper Mines of Tasmania

by

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1 Introduction

This report was commissioned by Paul Harbon of Copper Mines of Tasmania Ltd. and undertaken in June and July of 1997. The work centres on the processing and interpretation of aeromagnetic and gravity data over ML 1M/95 and El 52/94 near Queenstown, Tasmania (**Figure 1**). The work entailed the following tasks:

- ❑ Process aeromagnetic imagery for ML 1M/95 and EL 52/94 (Linda) to reveal any geological/structural associations.
- ❑ Produce hardcopy imagery.
- ❑ Register raster images in Mapinfo
- ❑ Image process regional gravity data and produce hardcopy imagery for ML 1M/95 and EL 52/94. Register images in Mapinfo.
- ❑ Contour gravity data.
- ❑ Import geology files for ML 1M/95 into Mapinfo and tag tables appropriately.
- ❑ Import geology files for the Queenstown 1:25,000 geology sheet into Mapinfo and tag appropriately.
- ❑ Create faults for Queenstown 1:25,000 geology sheet and tag appropriately.
- ❑ Import topographic contour data into Mapinfo and splice areas together.
- ❑ Produce infrastructure and topographic overlay for aeromagnetic imagery covering ML 1M/95.
- ❑ Produce geological overlays for aeromagnetic imagery covering ML 1M/95 and EL 52/94.
- ❑ Interpret aeromagnetic images to assess any controls on known mineralisation, lithological associations and define structural zones in ML 1M/95 and EL 52/94.
- ❑ Digitise the magnetic interpretations and compile tagged maps in Mapinfo. Produce hardcopy maps of the interpretations.
- ❑ Identify areas of interest for further investigation.
- ❑ Write a report with relevant diagrams describing the above work elements.

Data Sources

Various data sources were available to the project including:

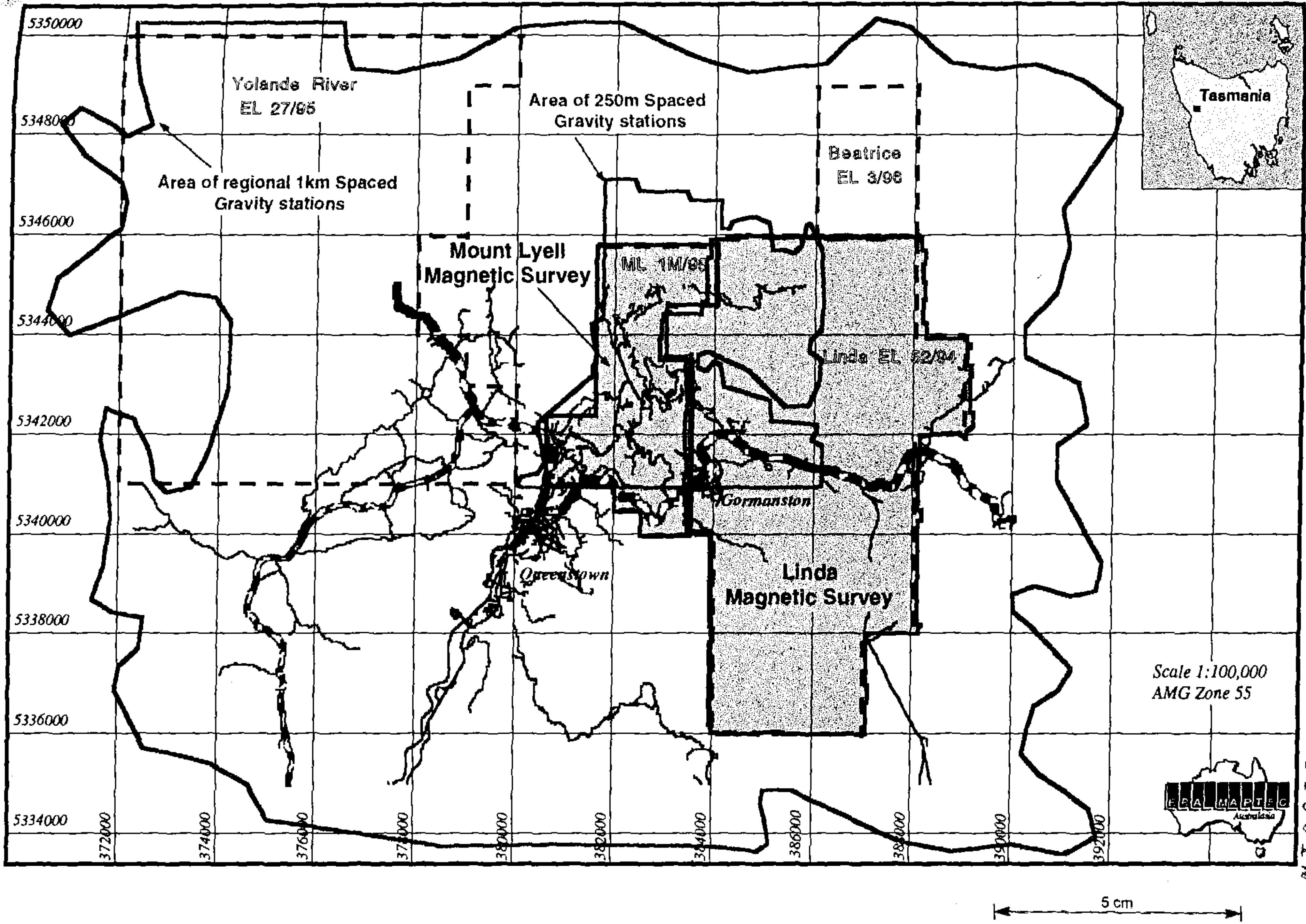

Figure No. 1 Location map for data sets

- Gridded (25m cell size) aeromagnetic data for two separate surveys over ML 1M/95 and EL 52/94. Both surveys were flown at 100m line spacing.
- A digital Mapinfo file of regional gravity station data.
- Digital files for topographic and infrastructure data.
- Unpublished reports on previous geophysical exploration in the study area.
- Mapinfo tables for the local 1:5,000 scale geological mapping covering ML 1M/95. These were translated from a Microstation .dgn file by Encom Technology Ltd. in Melbourne.
- Mapinfo tables for 1:25,000 Queenstown geology sheet. These only comprised lithology polygons which were not coloured but were tagged with a lithological code. Fault data was not included, however, lithology polygons outlined the positions of faults.

Aims and Objectives

The aims and objectives of the study are:

- Image process aeromagnetic and gravity data to reveal any geological associations and features which may be of exploration significance in the data.
- Provide an interpretation of the helimag and gravity data, incorporating current geological and structural interpretation, using signatures over known deposits to interpret anomalous areas.

2. Geological Setting and Background

The major stratigraphic and structural components are outlined below to set the geological framework for the interpretation of the aeromagnetic data sets. This provides a template for the subsequent aeromagnetic interpretations of the region and of the mineralisation in the Mount Lyell area.

2.1 Stratigraphy

The stratigraphic framework (**Figure 2**) follows that erected by the Geological Survey of Tasmania and shown on the 1:25,000 scale maps. The diversity of stratigraphic units reflects partly the fault bounded nature of the sequences and the difficulty in correlating units across strike. This is especially so for the largely Cambrian sequences that make up the Mount Read belt of volcanics and sediments which stretch almost the length of western Tasmanian. The

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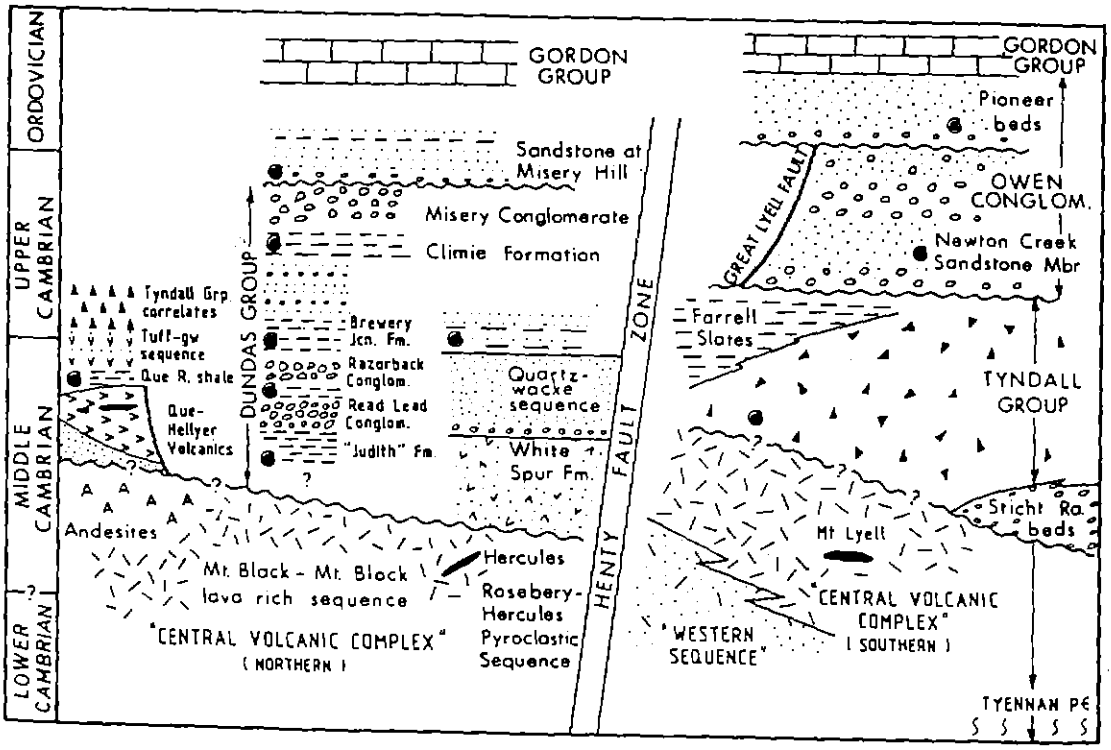


Regional stratigraphy after Burrett & Martin 1989 stratigraphy can be described in 4 general categories of Precambrian/Proterozoic, Cambrian, Cambro-Ordovician and Late Ordovician/Silurian/Devonian. The study area contains the latter three categories.

Cambrian

Regionally within the Mount Read Volcanics, the distribution of major stratigraphic units is strongly controlled by their disposition relative to the major, approximately strike parallel fault zones (**Figure 3**). The Mount Lyell deposits lie within the Cambrian Mount Read Volcanics which are divided by the Henty Fault into northwestern and southeastern sequences, the latter containing the deposits. The SE province is further divided into three main units:

The Yolande River Sequence

Acid to intermediate tuff and agglomerate with interbedded shale and greywacke sandstone and some feldsparphyric lavas of intermediate composition. This sequence contains only minor mineralisation.

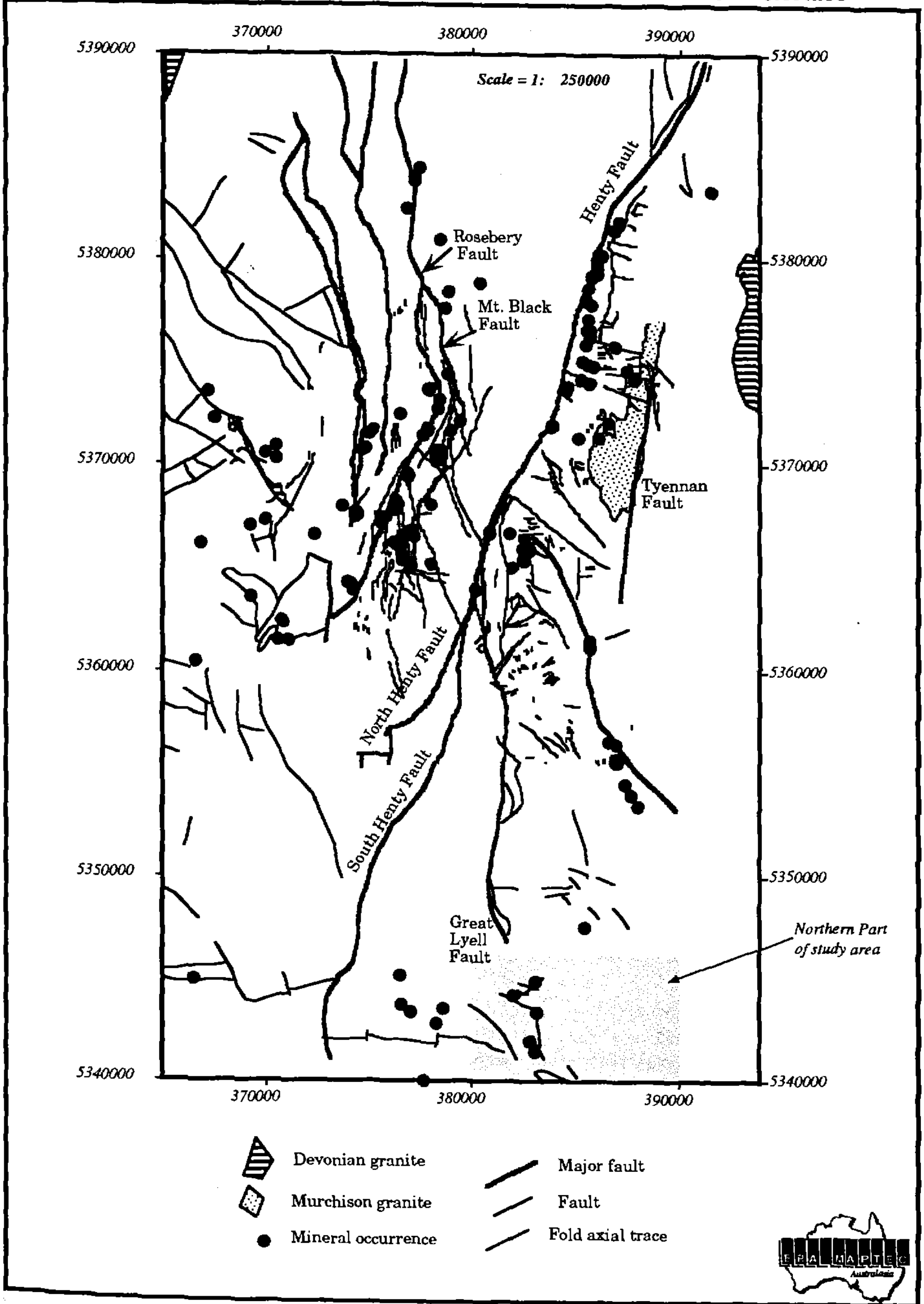
The Central Volcanic Complex (CVC)

Within the study area the Central Volcanic Complex comprises:

- ❑ The Lyell Schists which are host to much of the mineralisation at Mount Lyell:
  - Chloritic Lyell Schist (Lsc) (possibly after mafic intrusives);
  - Sericitic Lyell Schist (Lss) (Zone of feldspar destruction);
  - Pyritic (over 5%) Lyell Schist (Lsp);
  - Siliceous schist grading to massive chert.
- ❑ Mineralisation of various styles including;
  - Bornite-chalcopyrite rich ores (Mmb);
  - Massive pyrite-chalcopyrite ores (Mmp);
  - Disseminated cores of pyrite-chalcopyrite (Mdc);
  - Disseminated haloes of pyrite-chalcopyrite (Mdh);
  - Copper-clay ores (Mcc);
  - Stratiform lead-zinc rich ores (Mlz);
  - Hematite-barite-silica-sericite-rich lithologies at the Owen conglomerate - Lyell Schist contact (Mhb).
- ❑ Basaltic to andesitic intrusives (Eci);
- ❑ Pyroclastics (Ecp);
- ❑ Sediments and interbedded pyroclastics (Ecs);
- ❑ Lavas with columnar jointing (Ecl).

The CVC overlies and partly interfingers with the Yolande River Sequence.

Figure No. 3 Major Faults and mineral occurrences in the Mount Read Volcanics



Tyndall Group

The Tyndall Group (unconformably) overlies the above units and comprises a sequence of quartz-feldspar-phyric volcanic flows, tuffs and volcaniclastic breccias and conglomerate with subordinate shale, siltstone and sandstone and in the mine area (from previous 1:5,000 compilation map with revisions from current mapping) comprises:

- Volcaniclastic conglomerate and conglomerate - Jukes Formation (Etj) (Revised to Zig-Zag Hill Formation (Ytc) during current mapping);
- Pyroclastics (Etp) (Revised to Crystal-rich sandstones of the Julia Member (Ytt) during current mapping);
- Sediments and fine tuffs with some limestone (Ets) (Revised to Basal volcaniclastic breccias, sandstones of the Lynchford Member during current mapping);
- Lavas with columnar jointing (Etl) (Not recognised during current mapping).

Cambro-Ordovician

The Mount Read Volcanics are overlain to the east by the Late Cambrian-Early Ordovician Owen Conglomerate, Pioneer Beds and Gordon Group.

Owen Group - Owen Conglomerate

The Late Cambrian to Ordovician Owen Group is dominated by conglomerate and sandstones with subordinate siltstones. The extensive sequence of conglomerates form a molasse style of deposit.

To the north of the study area there are abrupt thickness and facies changes within the Owen Conglomerate, suggesting strong structural control on the basin topography. The Owen Conglomerate is interpreted (in the Tasmanian Survey maps) as lying with angular unconformity on the Tyndall Group and on the Murchison Granite.

Ordovician/Silurian/Devonian

The Ordovician Gordon Limestone sequence conformably overlies the Owen Group in most areas.

Above the Gordon Limestone, the Eldon Group Silurian-Devonian rocks comprise an alternating sequence of quartz rich sandstones, calcareous sandstones mudstones and minor limestones. Deposition on a shallow shelf is indicated, continuing upwards into the early Devonian.

Intrusive History

A range of feldspar and quartz-feldspar-phyric porphyries occur in the Central Volcanic Complex and in the Tyndall Group. Many are probable sub-volcanic equivalents to the extrusive rocks. To the north of the study area Devonian

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granites have been interpreted at depth from gravity data.

2.2. Structure

Major faults, folds and cleavage are developed on a regional scale. Major faults (**Figure 3**), such as the Henty and Tyennan Faults, are NNE trending whereas the regional cleavage (S1) and folds (F1) are generally NNW trending. As a general observation, the overall pattern is similar to a transpression zone with an ENE regional compression, to generate the cleavage and folds, and resultant oblique dextral shear along the NNE boundary faults. There is a close spatial association of mineral occurrences with the major fault zones which derives from fundamental structural controls on deposition and mineralisation.

Cleavage

The regional ~~S1~~ S2 cleavage is steeply inclined to the SSW or NNE. The age of the cleavage forming event(s), within the CVC in particular, is important to constrain, i.e. whether to ascribe all of the deformation to the Devonian Tabberabberan Orogeny or place much of the ductile deformation as pre-Devonian, developing in the Late Cambrian through to Ordovician.

A complex cleavage chronology within the CVC Rosebery Mine Sequence is described by Aerden (1991). While composite fabrics are observed in places, the regional deformation has formed a single cleavage which is superimposed on a bedding fabric enhanced by compactional strains.

Folds

The major regional folds are NNW and WNW trending, with variable plunges to the SSE and NNW and the regional cleavage is apparently axial planar to these. The dominant cleavage (S2) is parallel to the WNW folds

Faults and Shear Zones

The major fault and shear zones (**Figure 3**) in the region are NNE and NNW trending and generally have a long strike length. The Rosebery, Henty, Great Lyell and Tyennan Faults in particular are boundaries to distinct tectonostratigraphic domains, across which correlation of Cambrian stratigraphic units is poorly constrained.

- **Henty Fault**: This fault zone has a strike length of *ca* 55 km and dips west, reportedly at up to 60°. The southern part of the zone splits into two well defined strands termed the North and South Henty Faults. The North Henty Fault appears to terminate in the south along a north trending zone of faults that enclose an area of mafic and ultramafic rocks. The tectonostratigraphic contrasts across the fault (e.g. no Owen Conglomerate or Tyndall Group identified west of the fault) suggest that it had a Cambrian precursor. As such, it is expected to have undergone reactivation during the Palaeozoic evolution of the region.

- **Great Lyell Fault:** This extends NNW from Queenstown and intersects the Henty Fault in the SE of the project area. It is recognised as a growth fault during the Late Cambrian and Early Ordovician and has been subsequently inverted as a thrust during regional compression.

2.3 Previous Research

Mineralization

The distribution of mineral occurrences in the region (**Figure 3**) are clearly related to some of the major faults. It is generally believed (e.g. Leaman 1987) that the orientation and intersections of major faults, together with the age of fault movements relative to the ingress of mineralising fluids, provide important controls on the genesis and/or geometry of ore deposits within the western Tasmanian mineral province.

Mount Lyell Cu-Au-Ag Deposits (Hills 1990)

Two types of model have been previously proposed for the genesis of the Mount Lyell orebodies:

- As primary VMS deposits in the Cambrian Mount Read Volcanics
- Devonian age hydrothermal replacement.

Generally, the volcanogenic model of formation is accepted, although there is local replacement and enrichment.

Structural History

Three major episodes have been recognised:

- The 'Haulage deformation' - early Ordovician, prior to deposition of the Pioneer Beds. This was a local event related to movement on the Great Lyell Fault. Localised recumbent folds were formed and deposition of the Owen Conglomerate interrupted.
- Two stages associated with the Devonian Tabberabberan Orogeny:
    - The first led to the development of N-S folds and cleavage which affect the Owen Conglomerate.
    - The second created NW trending structures and was responsible for the NW trending cleavage in the volcanics as well as a sequence of cross-faults which off-set the Great Lyell Fault.

Alteration

The mine sequence has undergone pervasive feldspar-destructive hydrothermal alteration. Much of the alteration is closely related to and possibly contemporaneous with mineralisation. Outliers of Owen Conglomerate and the volcanics have suffered chertification, reinforcing models of Devonian hydrothermal replacement. ?

Mineralisation

Three main types of mineralisation are recognised:

- Massive pyrite-chalcopyrite
- Disseminated pyrite-chalcopyrite
- Chalcopyrite-bornite.

The orebodies dip 70-75°SW and strike 330° with the exception of Cape Horn (N strike) and the Comstock lodes (030° strike). Most of the orebodies occur close to the Great Lyell Fault and are truncated by it at depth.

The deposits are modelled as a combination of Cambrian VMS lenses and later structurally controlled, Devonian hydrothermal bodies which may have derived their metal content from the earlier lenses.

Geology of the Study Area

The Mount Lyell area is strongly affected by a 6km wide deformation zone containing NW to W trending folds, thrusts and normal faults formed as part of a later event in the Tabberabberan Orogeny. This was called the Linda Disturbance (Solomon 1962) and extends 10's of kilometres to the east and west. This zone affects basement blocks.

Comments on the 1:25,000 Queenstown Geology Sheet

The following observations are made from the 1:25,000 Queenstown Geology sheet:

- There is a relatively low density of faults within the CVC sequence as compared to the Ordovician rocks to the east. This is most likely a consequence of lack of marker horizons with which to recognise offsets. A similar or more intense system of faults is likely to be present.
- There is a much stronger NNW structural grain within the CVC and to some extent the Tyndall Group to the west than in the Ordovician sediments to the east. Mapped rock units commonly have elongate or attenuated shapes. The Ordovician rocks are dominated by more NW trends and outcrop patterns which are mostly fault controlled and much more open folding styles. There are a number of possibilities to explain this geometry:
    - The Ordovician sequence is unconformable on the CVC and post-dates a strong brittle-ductile deformation.

- The CVC sequence has been thrust on top of the Ordovician sequence from a different structural terrane.
- The CVC is deformed by a broad NNW trending brittle-ductile shear zone which hosts much higher strains and deformation levels (evidenced by tighter folding and multiple cleavages and steeper bedding dips). The WNW trending fault system to the east may splay out of the NNW shear zone as a possible termination array in a regime with a dextral shear component. The cross-section drawn through the WNW trending faults affecting the Ordovician rocks suggests an imbricate sequence in a high angle reverse or thrust duplex system. This scenario is consistent with the regional fault geometry shown in **Figure 3** which shows the Great Lyell Fault to the north of the study area as a planar structure which terminates within the study area.

  From the map sheet it is also apparent that the system of WNW faults affecting the Ordovician rocks does not extend to the east past the strong NNE trending structural break defined by the King River. The faults seem to be an interaction and transfer of shear as the intersection zone between the Glen Lyell Fault and the King River structure is approached. Foliation and bedding trends are also rotated into this WNW orientation.

Comments on Detailed Mapping in ML 1M/95

The following observations are made from the detailed mapping of ML 1M/95 compiled by K. Wills in 1995:

- Zones of mineralisation occur at varying distances from the Great Lyell Fault.
- The North Lyell Fault has a large dip-slip component with a slip vector whose pitch lies close to the intersection of the Lss - Ecp boundary and the fault plane as the boundary is only slightly offset.
- The Lyell Comstock ore system is discordant to stratigraphic boundaries and likely to be structurally controlled. The widening of the ore zone at an anticlockwise swing in strike of the mineralisation and enrichment of grades suggest that a component of sinistral shearing and fault bend dilation was involved in their genesis.
- Orebodies are frequently oblique to the Great Lyell Fault. The Cape Horn, Green Horn, Green Queen, and Queen Lyell zones of mineralisation may be en echelon and part of the same sinistral shear system suggested as controlling the Comstock mineralisation.
- Cleavage to the west of the Comstock ore system seems to be folded on a regional scale with cleavage strikes swinging from NE trending to NW trending. The outcrop pattern of the pyritic Lyell Schists (Lsp) also seems to be folded with a wider zone of pyritic schist in the core of the fold which has a sub-vertical fold axis. This change in strike could be rotation into shearing controlling the mineralisation.

- Foliation trends are oblique to the boundary between the Lyell Schist (Lss) and Ecp to the west. Stratigraphy to the west is also oblique to the boundary. The boundary is mapped as conformable and if it is not structural the geometry, suggests that the Lyell Schist lies unconformably on the stratigraphy to the west. However, bedding measurements to the east within the Lyell Schist are also oblique to boundary which strongly suggests that this is a structural contact.
- Mapped bedding and cleavage data indicate that the Western Tharsis and Crown mineralisation lie in the cores of synclines which are overturned to the east and a repetition of the same mineralisation by folding. The folding is approximately axial planar to the cleavage.
- The zone of mineralisation extending north from West Lyell through Royal Tharsis is oblique to foliation trends with ore lenses lying en echelon within this zone and sub-parallel to cleavage. These are likely to be fold cores. The folds are doubly plunging and suggest dextral shearing in the N-S zone defined by the interpreted geometry of the Lyell Schist and Pyritic Lyell Schist.
- The asymmetric geometry of the Pyritic Lyell Schist either side of the mineralised zone indicates that the apparent thickening is due to folding.
- In the south of the mapped area foliation trends swing to WNW orientations in association with later faulting.
- The Great Lyell Fault is mapped as folded and would originally have to have had a relatively low angle dip. It seems likely that many of the convolutions in the fault trace can be explained by unmapped WNW trending structure.
- There is an increasing strain gradient approaching the Great Lyell Fault from the east as Ordovician rocks become more steeply dipping and deformed.

3 Geological Data Sets

Two digital geological data sets were available for the project:

- 1:5,000 scale geological mapping over ML 1M/95 supplied as Mapinfo tables by Encom Technologies Ltd. after translation from Microstation .dgn format.
- Mapinfo tables for lithology polygons for the 1:25,000 Queenstown geology sheet.

Both of these data sets required additional work before they could be used effectively for the interpretation of aeromagnetic images. The data have been tagged for use with Geobasemap, a set of geological software tools for Mapinfo, but the tags are valid and useful if Geobasemap is not available. As with other data sets in this project, the tables are in an AGD84 zone 55 projection.

ML 1M/95 1:5,000 scale geology

This data set was supplied as four Mapinfo tables:

- ❑ A "text" table containing some map labels and fault names - this table was incomplete with much of the text information missing.
- ❑ A "lines" table which included faults, tracks, topographic highs, grid lines.
- ❑ A "Shapes " table containing lithological boundaries.
- ❑ A "Solids" table also containing lithological boundaries.

These tables were created from a Microstation format file from which a hardcopy map had been plotted and supplied. There were a number of problems and inconsistencies with these tables and they still need significant work for them to accurately reflect the data as portrayed in the Microstation plot. For the purposes of this study the following objectives for the data set were achieved in the form of Mapinfo tables:

- ❑ A complete architecture of tagged faults .
- ❑ A complete set of lithological polygons in two tables:
  - A table of boundaries that can be overlain on a raster image.
  - A table of solid fills which are tagged with lithological codes and coloured to reflect the Microstation map as closely as possible.

These tables enabled aeromagnetic signatures to be evaluated and interpreted.

There were a number of problems with the data set as supplied including:

- ❑ None of the structural information or bedding trends were included in the translation and need to be added.
- ❑ The fault system was incomplete and had to be checked and amended. Sections from the middle of some faults were missing whilst others did not appear at all.
- ❑ Only a small proportion of the topographic information depicting waste heaps and open cuts and tracks is present. No attempt has been made to complete this data.
- ❑ Several lithological polygons were missing and had to be re digitised. Several polygons were duplicated and had to be removed.
- ❑ Colour codes were provided as tags for the lithology polygons however, some of the colours in the original map were incorrectly assigned (subtle differences in shades of yellow for example) which meant they could not be easily selected.
- ❑ There are gaps in lithological boundaries and faults where text on the original map was present.
- ❑ Colour codes in the shapes table sometimes differed for the same lithology in the solids table.

The final map had to be plotted and closely examined for missing information and polygons and then amended. The Geobasemap codes used are prefixed by "L_" for polylines such as faults and boundaries and "R_" for regions. The codes assigned are shown in **Figure 4**. The geology polygons have been compiled in a map (**Map 20**) at 1:10,000 scale to cover the aeromagnetic image of ML 1M/95.

Queenstown 1:25,000 Geology Sheet

This data set was supplied as a Mapinfo table of lithological boundaries. The boundaries were probably scanned from hardcopy information. No faults were included in the data but the lithology polygons include elongate shapes which surround the positions the faults occupy. The fault system was added to the data set using these elongate features. The boundary layer was duplicated and the copy used to created a solid fills table. When the polygons were assigned solid fills to closely reflect those of the Queenstown Sheet, many irregular holes were created by the fault induced boundaries. The worst of these imperfections have been cleaned up but many still remain beneath the faults. Some of the faults have irregular zig-zag segments which are not present on the hardcopy map. These reflect the scanned boundary shapes between two lithologies which are not as planar as they should be. No attempt has been made to remedy this situation as it is more of an aesthetic problem.

Colours were assigned to the map using Geobasemap. This entailed adding an "Object type" field to the table. Lithology codes were already present in the table but needed to be prefixed with "R_" in order for Geobasemap to recognise them as regions and to assign the correct colours to match those of the published sheet as closely as possible. The tags used for the data in this table are shown in **Figure 5**. The geology has been compiled in a map to cover the Linda EL at 1:10,000 scale (**Map 34**).

4 Infrastructure data sets

As an aid to interpretation of the aeromagnetic images some cultural and topographic data were supplied:

- Topographic contours were supplied in Mapinfo format. Unfortunately the contour labels have not been preserved in the import into Mapinfo and so the contours on the maps accompanying this report are unlabelled. The information was in 5 separate files which in combination cover ML 1M/95. The area covered by the five files is shown in **Figure 6**. Contours are at 2m intervals for two of the files and 10m intervals for the others. The data in the files overlapped by varying degrees. Where 2m contour data overlaps 10m data, the redundant broader spaced information has been removed. The final Mapinfo table contains contour data to cover ML 1M/95 without overlapping contours, however the individual contours have not been joined as this would involve considerable effort. There is a degree of mismatch of the contours at the file boundaries.
- A Mapinfo table of power line positions was also supplied to assess their impact on the aeromagnetic images. This data set may not be

Figure No. 4 Mapinfo tags for ML 1M/95 geology

	Mapinfo Code (object_type field)	
	L_Litho	*Litho Boundary*
Gordon Group	**R_MOgc**	*Ogc mine area*
	R_MOgl	*Ogl mine area*
	R_MOgs	*Ogs mine area*
Owen Group	**R_MOus**	*Ous mine area*
	R_MOmc	*Omc mine area*
	R_MOms	*Oms mine area*
	R_MOlc	*Olc mine area*
Mineralisation	**R_Mhb**	*Mhb mine area*
	R_Mdh	*Mdh mine area*
	R_Mmb	*Mmb mine area*
	R_MMlz	*Mlz mine area*
	R_MMdc	*Mdc mine area*
	R_MMcc	*Mcc mine area*
	R_MMmp	*Mmp mine area*
Host Schists	**R_MLss**	*Lss mine area*
	R_MLsp	*Lsp mine area*
	R_MLsc	*Lsc mine area*
Tyndall Group	**R_MEtp**	*Etp mine area*
	R_MEtl	*Etl mine area*
	R_MEtj	*Etj mine area*
	R_MEts	*Ets mine area*
Central Volcanic Complex	**R_MEci**	*Eci mine area*
	R_MEcp	*Ecp mine area*
	R_MEcs	*Ecs mine area*
	R_MEcl	*Ecl mine area*

Figure No. 5 Mapinfo tags for Queenstown 1:25,000 Geology Sheet

Mapinfo Code (object_type field)

L_InfFaul	Inferred fault
L_Fault	Mapped Fault

Quaternary

R_Qha?	Qha?
R_Qt	Qt
R_Qpm	Qpm
R_Qpl	Qpl
R_Qph	Qph
R_Qpg	Qpg
R_Qmd	Qmd
R_Qmc	Qmc
R_Qhd	Qhd
R_Qhc	Qhc
R_Qhb	Qhb
R_Qha	Qha
R_Qc	Qc
R_Qb	Qb

Tertiary

R_Ts	Ts

Jurassic

R_Jdl	Jdl

Permian - Carboniferous

R_Plu	Plu

Devonian

R_Dl	Dl
R_Df	Df
R_Db	Db

Silurian

R_Scs	Scs
R_Scc	Scc
R_Sca	Sca

Ordovician

R_Ogs	Ogs	Gordon Group
R_Ogl	Ogl	Gordon Group
R_Oous	Oous	Owen Group
R_Oou	Oou	Owen Group
R_Oop	Oop	Owen Group

Cambrian

R_YOon	YOon	Owen Group
R_YOom	YOom	Owen Group
R_YOolv	YOolv	Owen Group
R_YOols	YOols	Owen Group
R_YOolg	YOolg	Owen Group
R_YOolc	YOolc	Owen Group
R_YOol	YOol	Owen Group
R_YOo	YOo	Owen Group
R_YOmu	YOmu	Owen Group
R_YOj	YOj	Owen Group
R_YOch	YOch	Owen Group

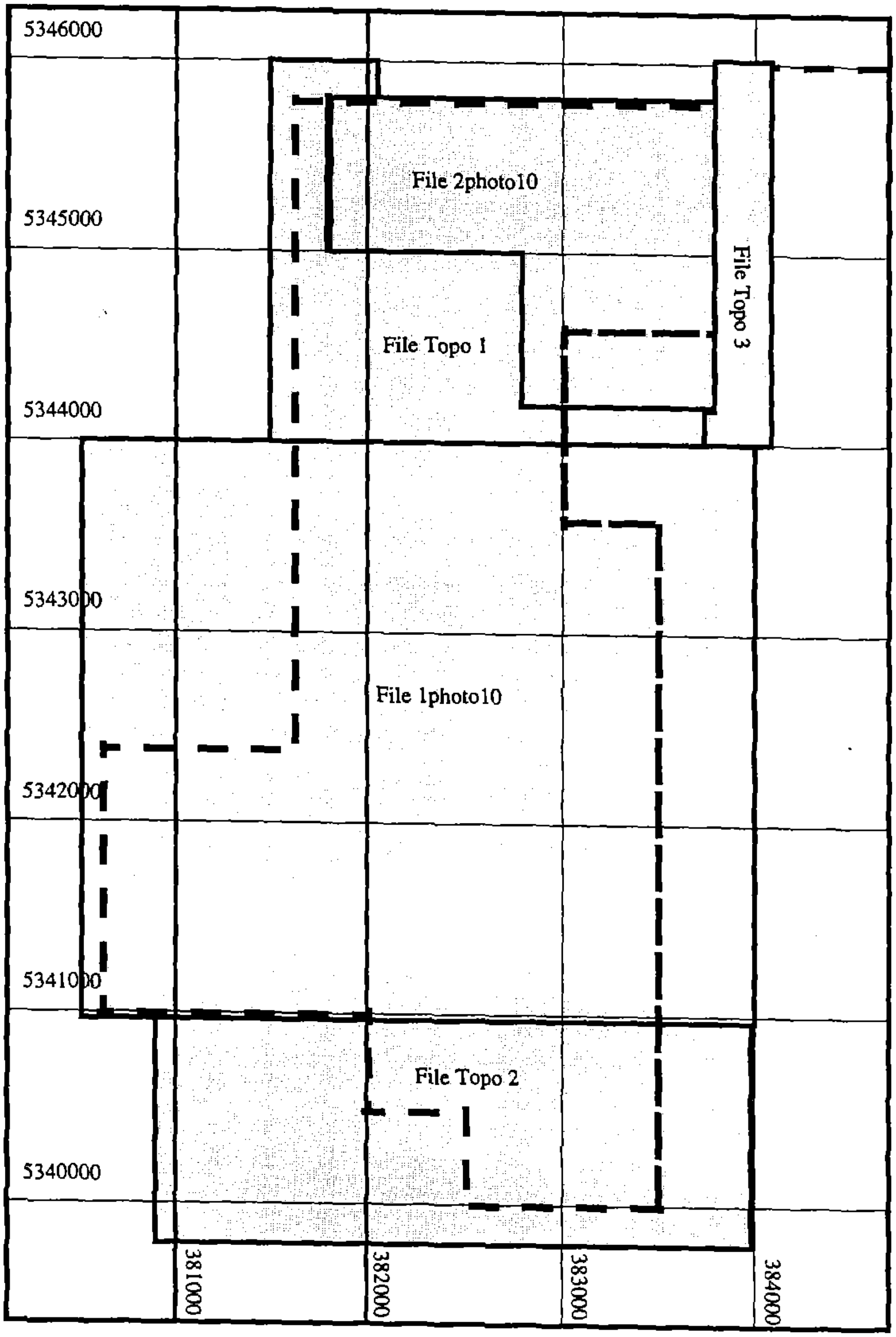
R_Yqfp	Yqfp	
R_Ytval	Ytval	Tyndall Group
R_Ytva?	Ytva?	Tyndall Group
R_Ytva?	Ytva	Tyndall Group
R_Ytv	Ytv	Tyndall Group
R_Ytt	Ytt	Tyndall Group
R_Yts	Yts	Tyndall Group
R_Ytc	Ytc	Tyndall Group
R_Ytb	Ytb	Tyndall Group
R_Yt?	Yt?	Tyndall Group
R_Yt?	Yt	Tyndall Group
R_Ybp	Ybp	Tyndall Group
R_Ysrb	Ysrb	Tyndall Group
R_Yab	Yab	Central Volcanic Complex
R_Ycvt	Ycvt	Central Volcanic Complex
R_Ycvs	Ycvs	Central Volcanic Complex
R_Ycvq	Ycvq	Central Volcanic Complex
R_Ycvl	Ycvl	Central Volcanic Complex
R_Ore	Ore	Central Volcanic Complex
R_Ycvf	Ycvf	Central Volcanic Complex
R_Ycvag	Ycvag	Central Volcanic Complex
R_Ycv	Ycv	Central Volcanic Complex
R_Yfqpp	Yfqpp	Yolande River Sequence
R_Yfqhp	Yfqhp	Yolande River Sequence
R_Yyxt	Yyxt	Yolande River Sequence
R_Yyt	Yyt	Yolande River Sequence
R_Yys	Yys	Yolande River Sequence
R_Yymr	Yymr	Yolande River Sequence
R_Yymb	Yymb	Yolande River Sequence

Precambrian

R_Zs	Zs
R_Zq	Zq
R_Zp	Zp

R_Water	Water

Figure No. 6 Topographic data file coverage



Coverage of topographic contour files within ML 1M/95

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complete as the lines do not form a coherent network.

- A Mapinfo table of major buildings was also supplied.
- The main roads and tracks were available for part of the study area and used for location purposes.

These data sets provide good coverage for ML 1M/95 but not the Linda EL. A map containing the above data (**Map 19 (1:10,000) or Map 19b (1:5,000)**) has been prepared to overlay the magnetic images of the mine lease.

5 Aeromagnetics

Previous Work

As background to this study, a number of reports on previous geophysical exploration in the area were supplied by CMT. Much of that work focuses on electrical methods which have been successful in delineating ore bodies. The following comments and observations have been made by previous workers on the application of gravity and aeromagnetic methods in the region.

Leaman (1987)

- Strongly defined magnetic anomalies are unlikely to be associated with mineralisation. Most known mineralisation is associated with subtle anomalies in depressed backgrounds.
- On a regional scale, major mineralised sites appear to lie at the intersection of NW-SE and E-W magnetically defined corridors.
- There is a gross E-W gravity trend through the Mt. Lyell site.
- Strong magnetic anomalies are associated with the Tyndall Group, basic volcanics or gabbros.
- Higher anomalies, but still regionally low, in a low background can be associated with the mineralised zone.
- A strong Bouger gravity gradient is associated with the Great Lyell Fault.
- In the gravity data, ore bodies lie on the maximum gradient between local anomaly pairs. Anomaly heights generally exceed 3 mGals.
- Alteration zones create negative gravity anomalies.
- Alteration of the Mount Read Volcanics is confined to the south of an E-W cross structure at around 5346000N.

Bishop and Lewis (1988)

These authors conclude that most of the successful geophysical work in the Mt. Lyell area has been derived from electrical methods. They make the following comments on the use of magnetics and gravity:

- They report that the BMR found the magnetic technique was not diagnostic for locating ore.
- Early gravity work shows a strong gravity low associated with Ordovician sediments. When this regional effect is removed, a positive residual is coincident with mineralisation.
- Alteration zones in the Mount Read Volcanics are often coincident with magnetic lows.
- Massive sulphide deposits in Tasmania are not magnetic and this technique cannot be expected to lead directly to targets. However, some of the Cu mineralisation at Mt. Lyell is weakly magnetic and contains magnetite.

RGC Report on exploration activities (1990)

This report outlines exploration activities utilising airborne and ground magnetics.

- Ground magnetics over Little Owen indicated a strong correlation between the alteration zone and a series of ground magnetic highs.
- There is a high degree of correlation between magnetic highs and rocks of the Tyndall Group.

Digital Aeromagnetic Data sets

Digital data for two helimag surveys (see **Figure 1** for coverage) were supplied by Tesla-10 Ltd. The surveys were flown by UTS Geophysics.

- The mine lease 1M/95 was covered by Area 1 of Job A059 in February 1995.
- The Linda EL 52/94 was covered by Job A062 also in February 1995.

The surveys have the same specifications:

Flight line spacing:	100m
Flight line direction:	090°-270°
Aircraft Type:	AS350B Helicopter
Sensor height:	20-30m
Sample rate:	0.1 sec / 4-5m
Tie line spacing:	1000m
Tie line direction:	0° - 180°

As the variation in topographic relief in the area is quite dramatic, a helicopter borne instrument was used to minimise the variation in sensor height.

The data for both surveys were gridded to 25m by Tesla-10 Ltd. These grids were supplied to the project and regridding was deemed unnecessary by CMT. As the final images were to be produced at 1:10,000 and 1:5,000 for the ML 1M/95 survey, that grid was resampled to a 2.5m cell size to avoid excessive pixelation. Images for the survey over EL 52/94 were to be produced at 1:10,000 and 1:25,000 and the cell size was therefore interpolated to 6.25m. The following points are noted on the resulting images:

- Some of the filtering and shading algorithms used enhance the original 25m cell boundaries, resulting in a regular grid pattern on some parts of some images.
- Ideally, the first vertical derivative and first vertical derivative with AGC should be calculated on the original flight line data and then re-gridded to form an image. This retains more detail of the smaller scale anomalies. The flight line data was not available to the study and for this reason the first vertical derivative images supplied by Tesla-10 have been used as they are likely to have been calculated in this way.

The surveys were processed separately so as to retain detail within each of the survey areas and maximise the variation in total magnetic intensity displayed.

A series of images were produced for each of the survey areas and interpreted using available geological and infrastructure data sets to constrain the signatures. The images have been provided digitally in TIFF format as Mapinfo tables, to be used as raster backdrops to linear data. The interpretations have been digitised and tagged with suitable identifiers as outlined in **Figure 7**. This enables particular features to be selected and displayed.

ML 1M/95 Magnetic Interpretation

Several images have been produced for this survey and reveal different aspects of the data. The interpretation derived from all images is shown in **Map 35 (1:10,000 scale)** and **Map 35b (1:5,000 scale)** and **Figure 8**. The raster images have been registered as tables in Mapinfo. The images have the following co-ordinates:

- SW corner 380600E, 5339975N
- SE corner 384025E, 5339975N
- NE corner 384025E, 5345800N
- NW corner 380600E, 5345800N

The images are 2330 pixels N-S by 1370 pixels E-W

Only the maximum gradient image is a slightly different size and is 25m shorter E-W but with the same NW and SW co-ordinates. This image is 1360 pixels by 2330 (2.5m pixel size).

Maps 19, 19b (same data as Map 19 but at 1:5,000 scale) & 20 have been produced as topographic/cultural and geological overlays to the images.

During the course of the interpretation a number of new fault zones have been

Figure No. 7 Mapinfo tags for aeromagnatic interpretation

Mapinfo Code (object_type field)

L_Magsurv	*Magnetic survey boundary*
L_magmajft	*Major fault from magnetics*
L_magfault	*Fault interpreted from magnetics*
L_Gorm	*Disturbance related to Gormanston*

RTP TMI Images

L_maghigh	*Boundary to RTP TMI magnetic high*
L_maglow	*Boundary to RTP TMI low*
L_shadlith	*Possible bedding trends from shadowed RTP image*
R_Maghigh	*RTP magnetic High*
R_magvhigh	*Very High RTP TMI*
R_maglow	*RTP mag low*
R_magmhigh	*Medium high RTP TMI*

Maximum Gradient Images

L_Maxgrad	*Boundary to maximum gradient signature*
R_maxvar	*Variable maximum gradient signature*
R_maxflat	*Smooth maximum gradient area*

1st VD Images

L_1VDbound	*Boundary to 1st VD signatures*
L_1VDtrend	*Linear highs in 1st VD*
R_1vdanom	*Anomalous 1VD highs*
R_1VDSmed	*Smooth medium intensity areas in 1VD*
R_1VDmlow	*Low 1st VD signature*
R_1VDLOW	*Very low1ST VD signature*
R_1VDnoise	*Noisy signature in 1st VD*
R_1VDhilo	*Variable high/low unit in 1st VD*
R_1VDfuzzy	*Fuzzy masking signature in 1st VD*
R_1VDmed	*1st VD medium anomalies*
R_1vdhigh	*1st VD high*

1st VD with AGC Images

L_AGCzone	*Large scale boundaries in 1stVDAGC*
L_1VDAGC	*Boundary to 1st VD AGC signatures*
L_AGCtrend	*Linear highs and trends in 1st VD with AGC*
R_AGChilo	*Noisy high-low signature in 1st VD with AGC*
R_AGCNlow	*Noisy low in 1st VD with AGC*
R_AGCVlow	*Very low 1st VD with AGC*
R_AGCLhigh	*High with strong trends in 1st VD with AGC*
R_AGCFhigh	*Fuzzy high in 1st VD with AGC*
R_LSPlo	*Low coincident with Lsp in 1st VD with AGC*
R_1VDAGC	*High zones in 1st VD with AGC*

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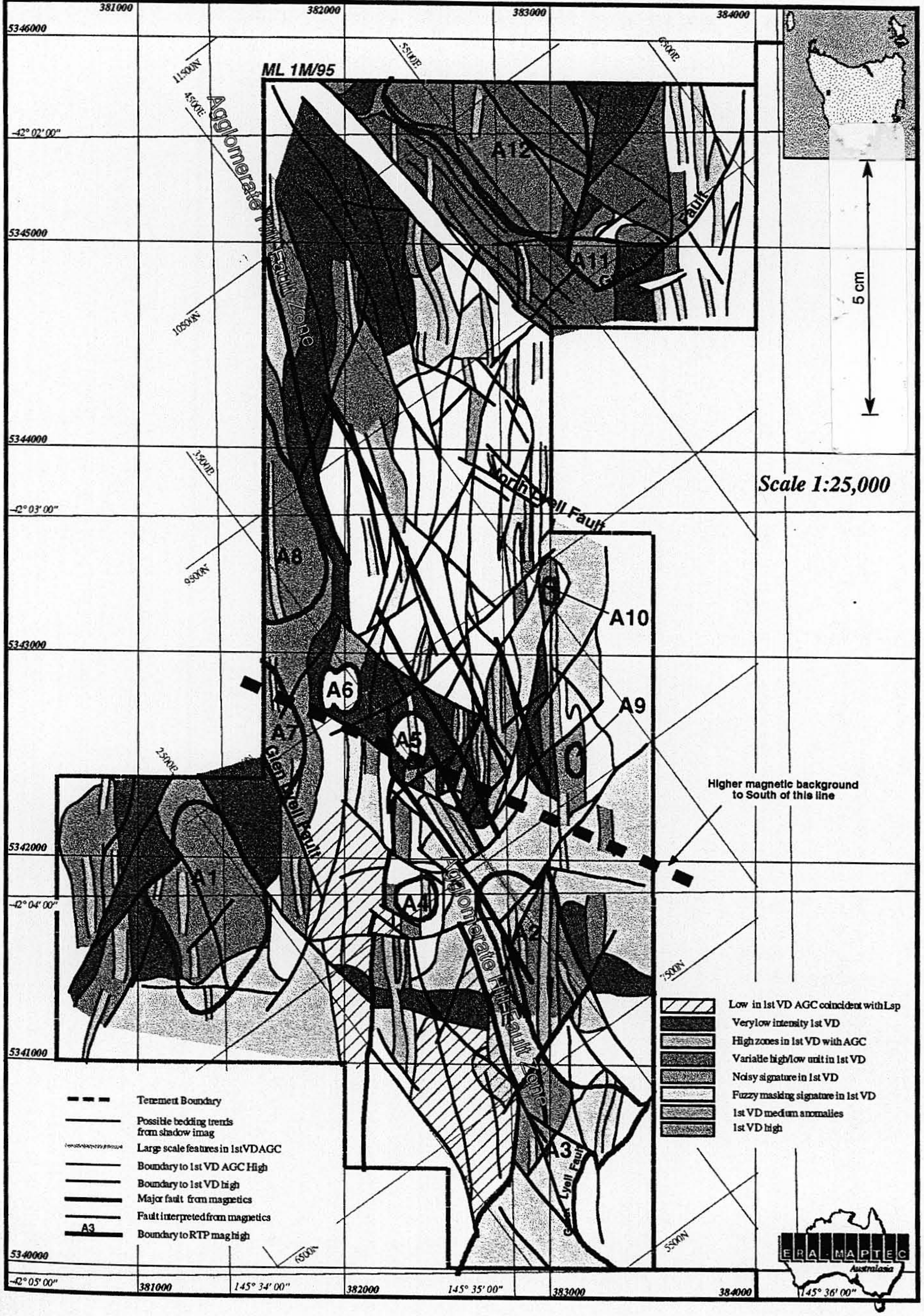
Figure No. 8 Aeromagnetic interpretation for ML 1M/95



recognised. For ease of reference these have been named after features or areas on the 1:25,000 geology sheet which lie on or close to the trace of the zones. The new zones are:

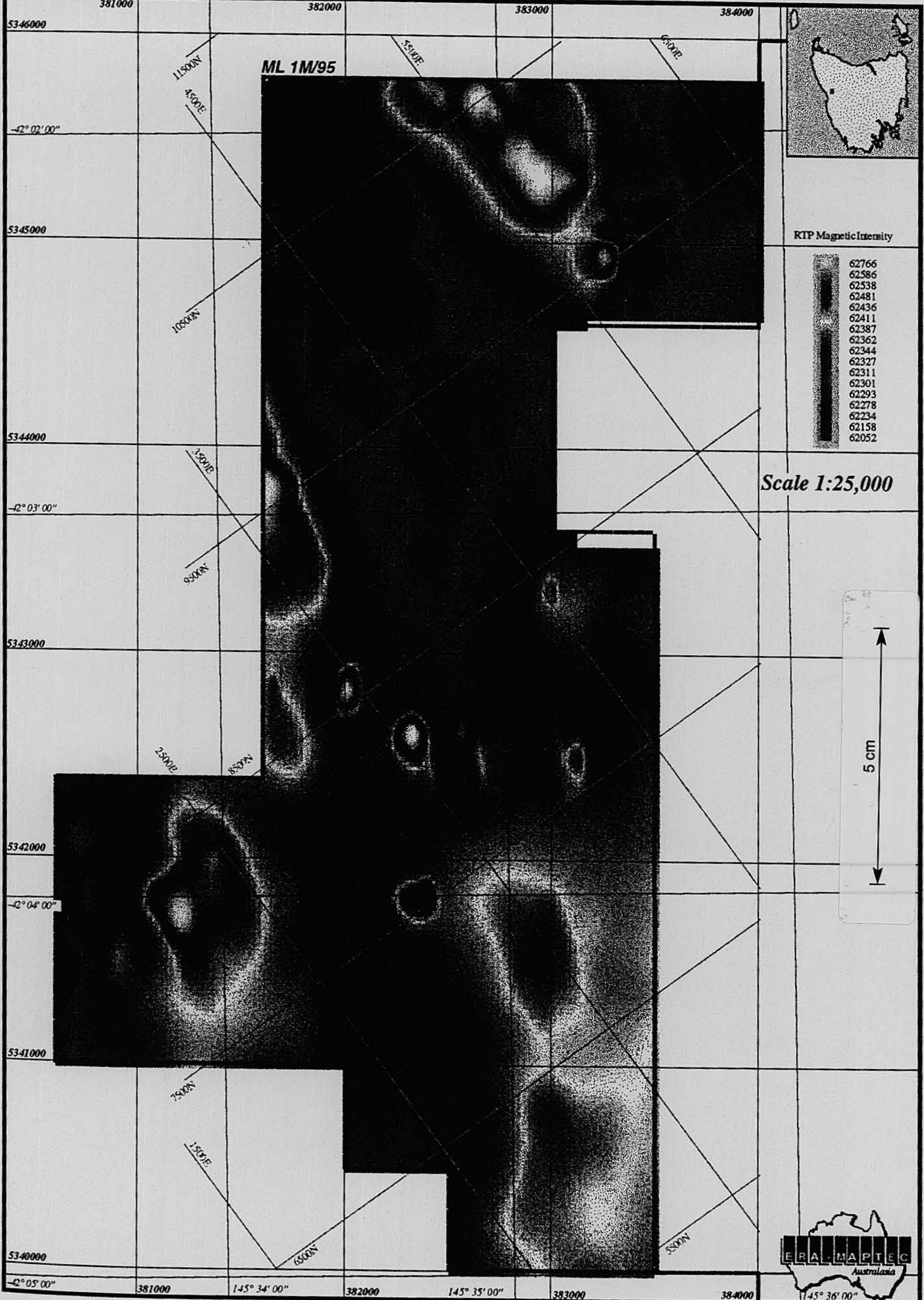
- The Agglomerate Hill Fault Zone
- The Owen Spur Fault Zone
- The Tofft Fault Zone
- The McDowells Fault Zone
- The Comstock Valley Fault Zone
- The King River Fault Zone
- The East King River Fault Zone

Reduced to pole Total Magnetic intensity (Map 1 (1:10,000), Map 1b (1:5,000) & Figure 9)

This image has been enhanced with a vertical shade to emphasise the anomaly shapes (in some areas it also emphasises the original cell boundaries prior to interpolation). As the data are reduced to pole the anomalies should lie directly over the causative bodies. The anomalies are fairly broad and there are twelve significant highs of varying sizes and intensities. These highs have been labelled A1 - A12 (see **Figure 8** and **Map 35 or 35b**). Powerlines could not be detected as affecting the signatures in any of the images:

- **Anomaly A1** is in the SW of the survey area and is coincident with columnar jointed lavas (Etl on the mine geology and Etva on the Queenstown sheet) of the Tyndall Group. The Tyndall Group is often the cause of extensive highs in both surveys. The extent of the outcrop pattern and the anomaly shape are quite a close match.
- **Anomaly A2** - lies to the east and is coincident with part of the Lyell Schist (Lsc and Lss). The lithological correlation does not hold along strike and this must be some feature at depth.
- **Anomaly A3** - is probably part of the same causative body as A2, both are oblique to surface bedding and foliation trends. They may reflect a change in basement at around 5342000N across an E-W zone. The Prince Lyell deposit lies at this easting and the Gormanston Fault contains an E-W segment. The eastern margin of this high mirrors the trace of the Great Lyell Fault.
- **Anomaly A4** - This is an isolated, subrounded high with no obvious geological association. None of the infrastructure in the supplied data sets is coincident with it although power lines run close by suggesting a cultural cause.
- **Anomaly A5** - This is coincident with the Prince Lyell Shaft and is probably created by the head frame.
- **Anomaly A6** - This is a dipole anomaly (dipoles should not be present in an RTP data set) suggesting that this is a cultural anomaly generated by some active source such as a generator. CMT report that it is caused by a bulk emulsion tank.
- **Anomaly A7** - This is coincident with lithology Ecl (lavas with

Figure No. 9 Total Magnetic Intensity Reduced to Pole with Vertical Shade



columnar jointing) which is mapped as part of the Central Volcanic sequence. Only the western portion of this lithological block is magnetic. This suggests that the affiliation of part of it needs to be reassigned to the Tyndall Group (Etl) as for Anomaly 1.

- **Anomaly A8** - can be grouped with Anomaly A7 as part of the Tyndall group. The Columnar jointed lavas need to be sub-divided. The lower signature between A7 and A8 may be related to demagnetisation in association with faulting.
- **Anomaly A9** - is a small anomaly within lithology Lss. It has no direct geological association but is coincident with a mapped hill (slag heap?). A power line runs through the anomaly suggesting a cultural cause.
- **Anomaly A10** - Lies just to the west of the Crown deposit with the Lyell Schist. It is probably associated with infrastructure as a power line terminates at the anomaly.
- **Anomaly A11** - lies just to the east of the Lyell Comstock deposit and appears to form a dipole with the low to the east. As with anomaly A6 this suggests a cultural cause. However, it lies along strike from Anomaly A12 and could have a geological association.
- **Anomaly A12** - is a broad NW trending feature which can be directly attributed to lithology Etl of the Tyndall Group as for anomalies A1, A7 & A8. However, the outcrop pattern of the lithology trends significantly anticlockwise of the anomaly axis. The high portions of the anomaly have sharp margins suggesting fault control. Some low zones traverse the anomaly and are probably associated with faults.

None of the known mineral deposits can be identified as affecting the magnetic signature in this image and are coincident with a broad range of intensities. Other comments on the image are:

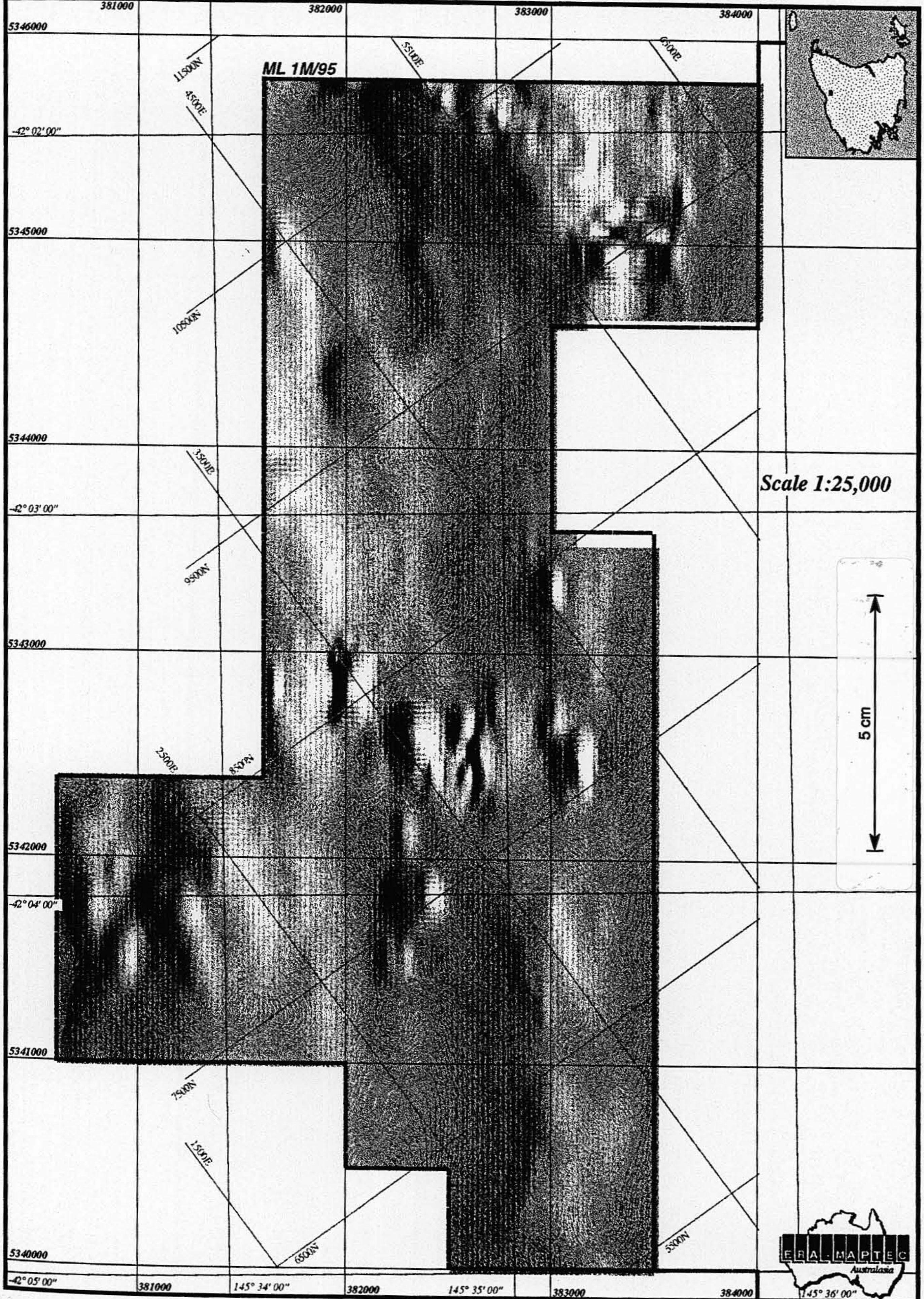
- Ordovician sediments appear to have little or no affect on the signatures and are coincident with a range of intensities. Anomalies may reflect basement to these gently dipping rocks.
- Lithology Ecp (pyroclastics) is generally coincident with lower magnetic signatures, especially in the NW of the survey area to the NW of the Great Lyell Fault.
- In general, direct geological correlations for the signatures are infrequent both lithologically and structurally.

Shadowed Images (Maps 2, 3, 4, 5, 5b & 14) and Figures 10, 11, 12, 13

Maps 2, 3, 4 & 5 are grey scale RTP - TMI images shadowed from the east, NE, SE and North respectively. Map 14 combines three of these shadow images as an RGB colour composite (N, NE and SE projected as RGB). They highlight a strong NNW grain in the image within a zone several hundred metres wide and which passes just to the SW of the Prince Lyell deposit and is sub parallel to the Glen Lyell Fault. This zone has been named the Agglomerate Hill Fault Zone and traverses the entire image and is consistent with interpretation as a brittle ductile shear zone. The western boundary of the Lyell Schist rotates to a NNW orientation within this zone suggesting a component of sinistral shear. The images also highlight a noisy group of anomalies in the vicinity of the

446036

Figure No. 10 MI 1M/95 - RTP total magnetic intensity shadowed from east



446037

Figure No. 11 MI 1M/95 - RTP total magnetic intensity shadowed from NE

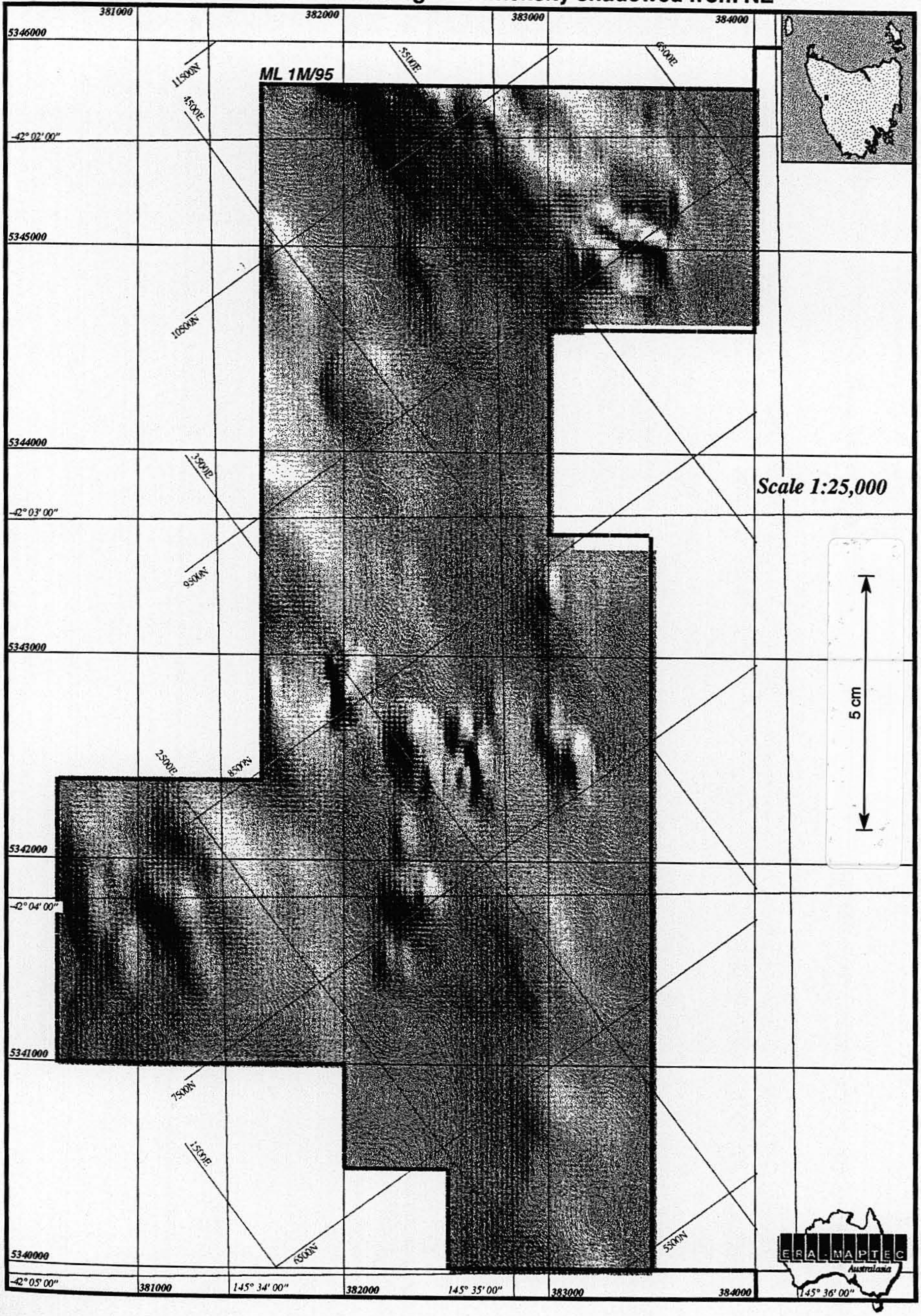


Figure No. 12 MI 1M/95 - RTP total magnetic intensity shadowed from SE

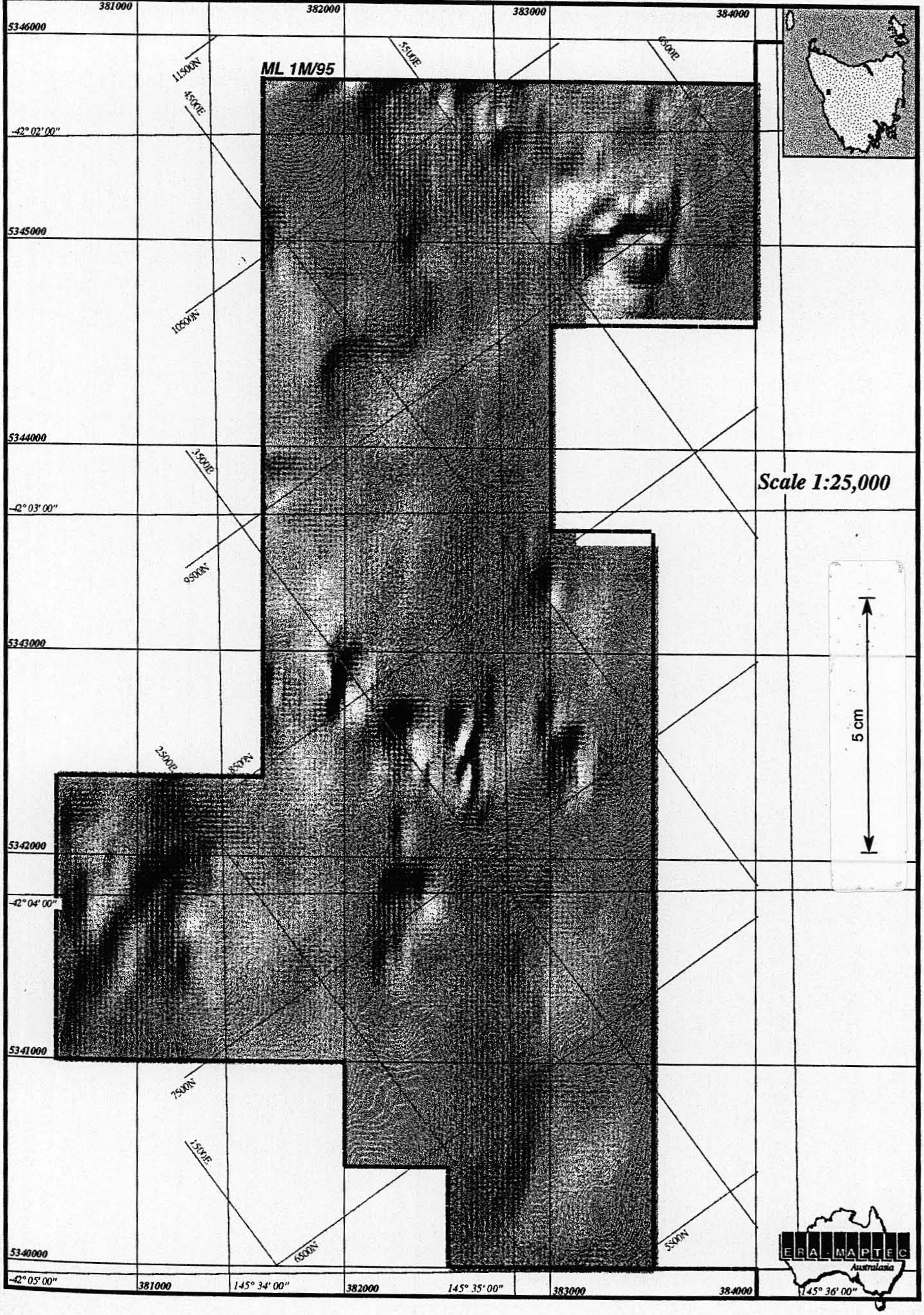
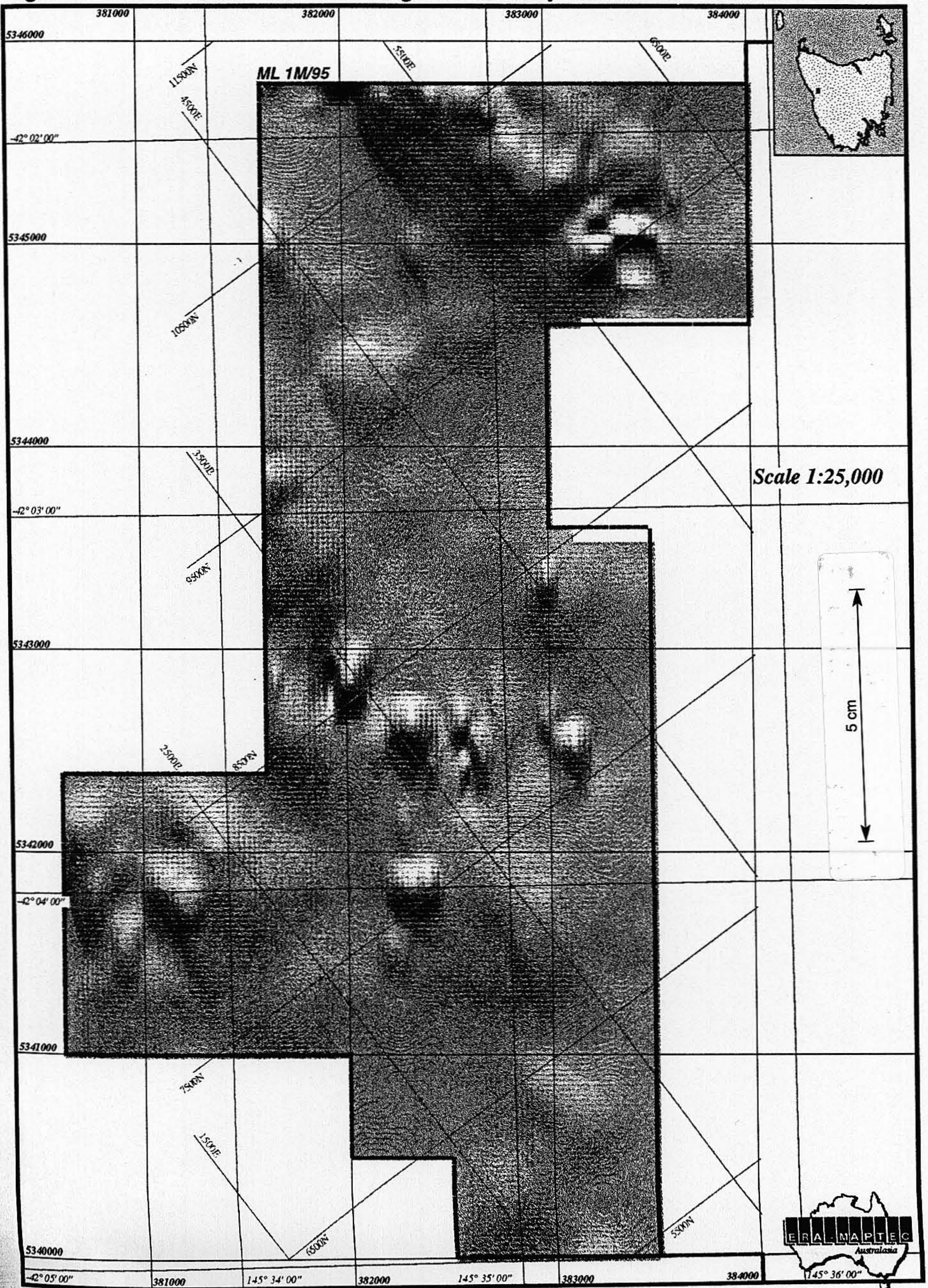


Figure No. 13 MI 1M/95 - RTP total magnetic intensity shadowed from North



Prince Lyell deposit. The zones of mineralisation and Pyritic Lyell Schist (Lsp) seem to suppress and mask this signature and form a bland flat area which fairly closely matches its outcrop extent. There is also a banding developed around the SW margin of Anomaly A12. This is sub-parallel to bedding in the area but may be an artefact in the shadowing and application of the vertical shade filter. The signature to the east of the Great Lyell Fault is flat and featureless.

First Vertical Derivative (Maps 6 & 13 and Figures 14 & 15)

The first vertical derivative calculates how rapidly the magnetic field is dying out upwards. Near surface features which die away rapidly have high vertical derivatives whilst deeper features have low vertical derivatives. **Map 13** and **Figure 15** show the first vertical derivative with a total magnetic intensity colour drape. The following observations were made on the first vertical derivative image:

- There is quite a strong N-S grain to the smaller anomalies in the image. This is partly a consequence of the interpolation process. Minor anomalies which are much smaller than the flight line spacing will be interpolated with a long axis perpendicular to the flight line direction. In the 1:10,000 images there is 1 centimetre between flight lines.
- A slightly higher first derivative signature is present to the north of the Great Lyell Fault where it trends ENE in the N of the area.
- Lithology Ecp is coincident with a low, flat signature in the north of the area and this can be followed to the south. The Lyell Schist to the east has a slightly higher, but discernible, intensity.
- This data set provides good constraints on the boundary to the magnetic Etl lavas in the west and are defined by a broad first derivative high.
- Power lines seem to have no effect on the signatures. This image should pick them up if they are at all significant.
- A high first derivative unit passes N-S through the Prince Lyell shaft. and lies within the Lyell Schist. This unit seems to be truncated by the Agglomerate Hill Fault Zone which passes just SW of the Prince Lyell deposit (the unit is coincident with the western margin of the waste dump and links two cultural RTP-TMI anomalies but is thought to be related to geology). It is affected by the Glen Lyell Fault and has a much more diffuse signature to the south of it.
- The mineralisation at Royal Tharsis passes through a N-S low in higher signatures suggesting magnetic destruction by alteration processes.
- Iron Blow open cut also lies close to a low 1st derivative signature in a higher background.
- There is an intense NW trending low corridor containing RTP anomalies A5 & A6, which are coincident with high 1st derivative anomalies. This corridor may be an artefact of these surface cultural features. However, it has been shown in Map 35 as a geological features for ground truthing. These data also indicate that RTP

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Figure No. 14 MI 1M/95 - Grey scale first vertical derivative image

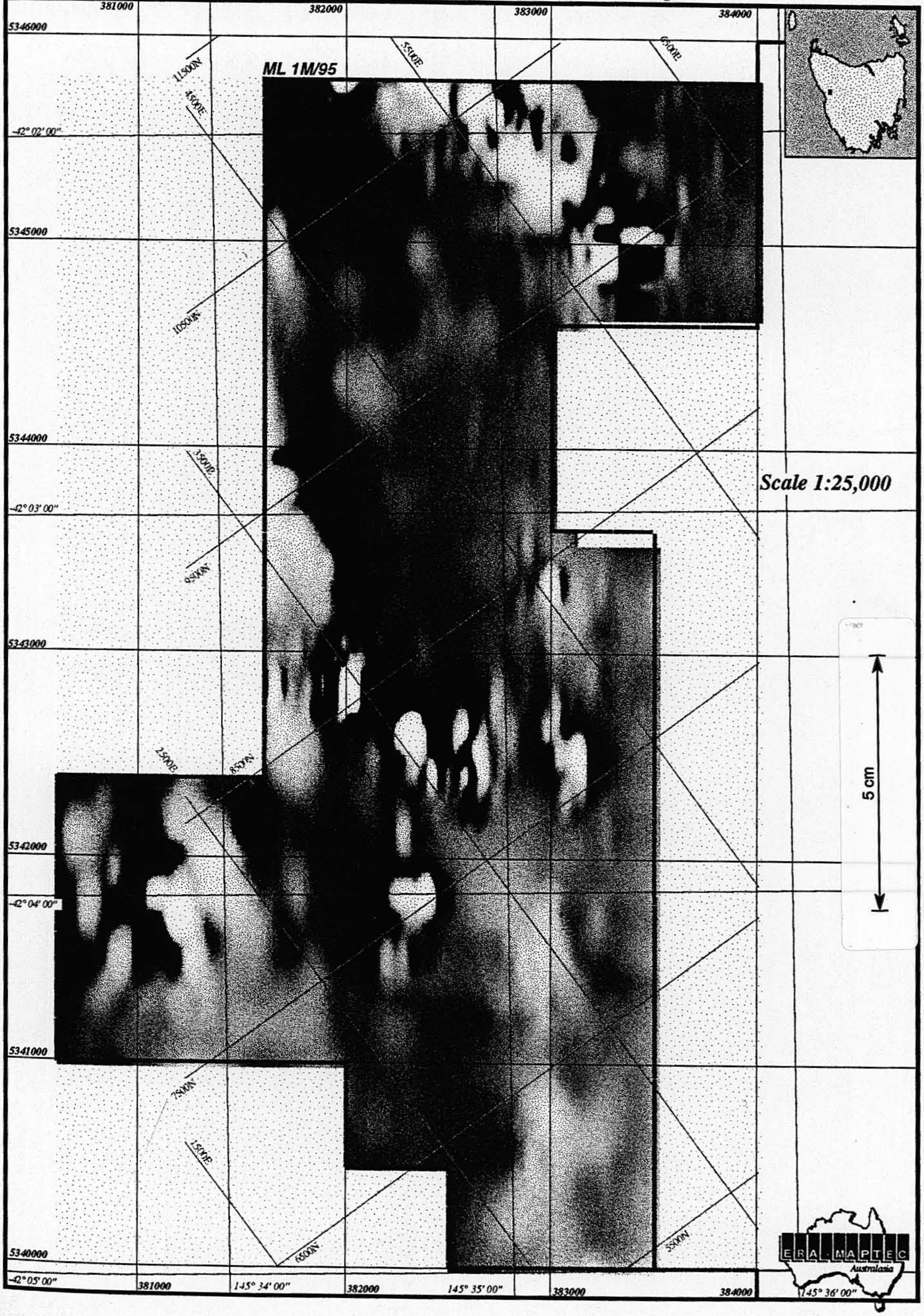
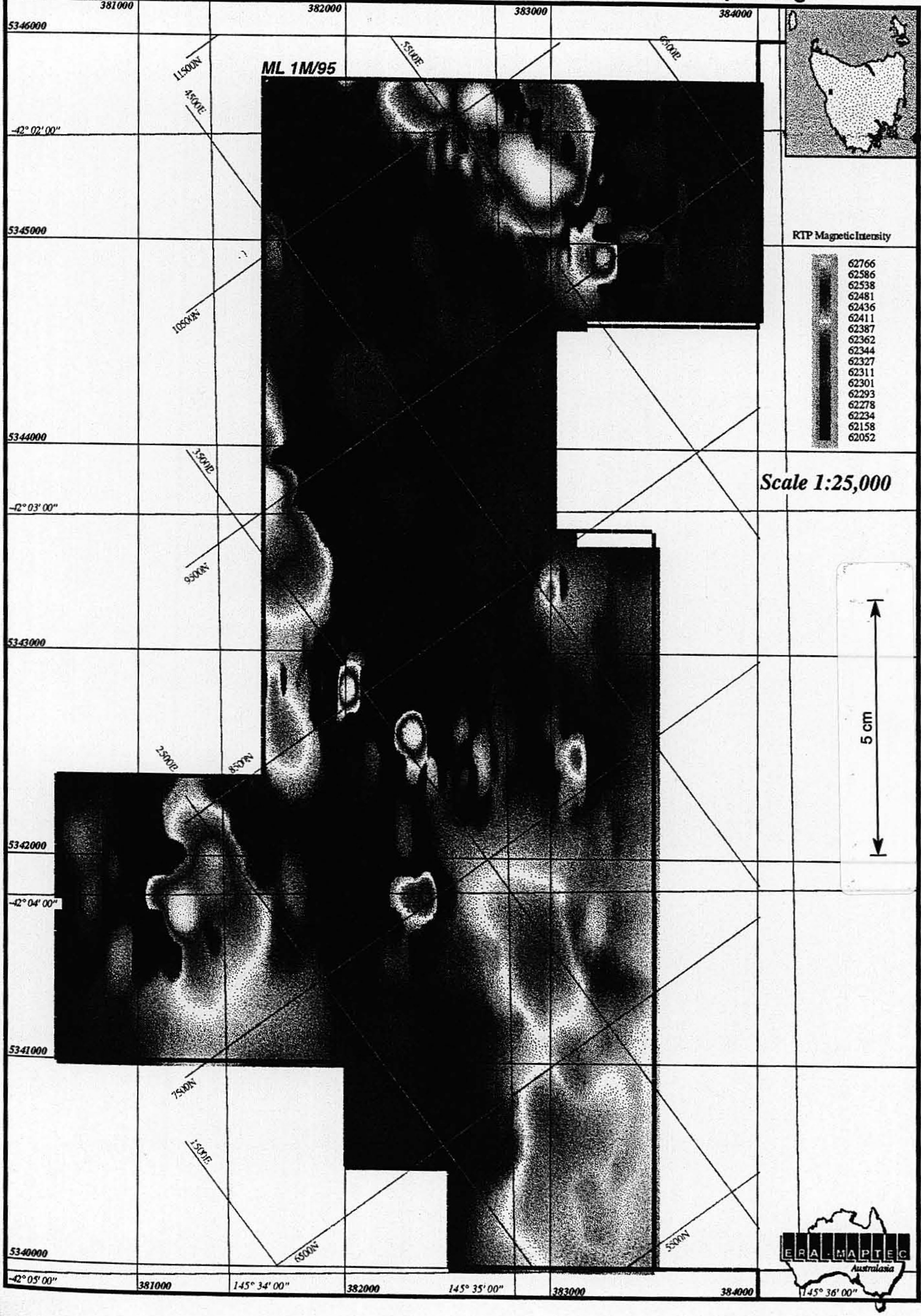


Figure No. 15 MI 1M/95 - First vertical derivative with TMI colour drape image



anomaly A4 is also a surface cultural feature. Structures extending from this corridor to the ESE can be traced across the Linda survey image.

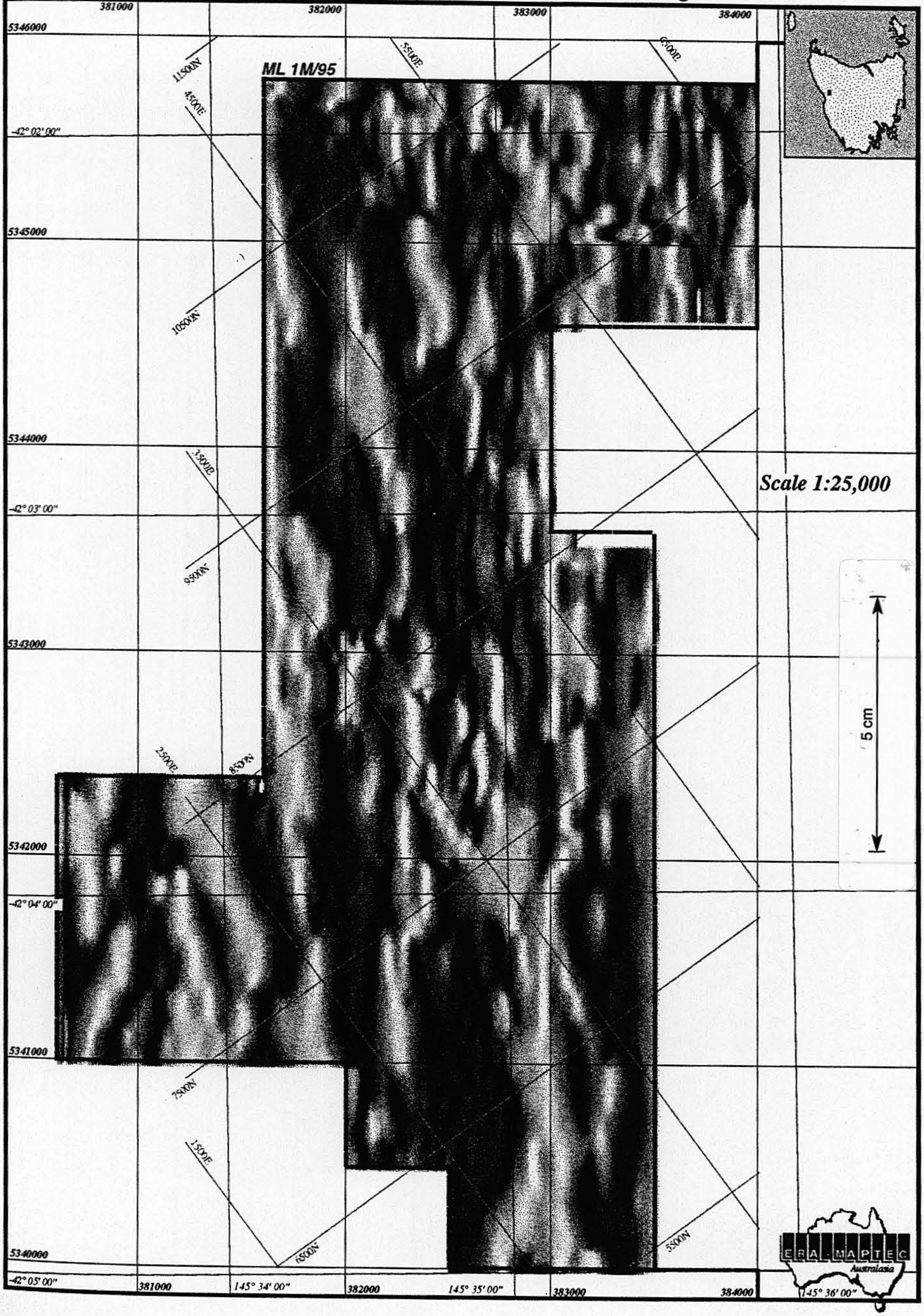
- At the northern end of the Lyell Schist outcrop a NW trending fault zone is interpreted as a boundary to a noisy high and low signature which is partly contained within the mapped Lyell Schist. The N-S linear highs within this unit are probably interpolation artefacts.
- Mapped faults are generally very poorly represented in the data and could not be interpreted in the vast majority of cases. There are no obvious characteristic signatures for mineralisation but they do generally coincide with smoother, lower areas.
- The mapped foliation and bedding trends are generally oblique to anomalies.

First Vertical Derivative with Automatic Gain (AGC) (Map 8 and Figure 16)

This image type enhances structural features and subtle anomalies in the data set. The automatic gain control essentially reduces all anomalies to the same amplitude producing a residual image. This image type can also enhance artefacts and noise and needs to be interpreted with care. There are common E-W trending discontinuities which are simply interpolation boundaries between flight lines. If there are any lithologically controlled trends they will appear in this image. The following observations were made:

- The mapped swarm of WNW trending faults are very poorly represented and for the most part cannot be detected. This is partly because they are at low angles to the flight line direction. More northerly trending structures will be better enhanced.
- The broad Agglomerate Hill Fault Zone which was noted in the shadowed images and which passes just to the west of the Prince Lyell deposits is enhanced in this AGC image. It is parallel to the Glen Lyell Fault and is consistent with the regionally extensive NNW and NNE shear zones which are important controls on mineralisation within the Central Volcanic Complex (See **Figure 3**). Other, sub parallel faults have also been interpreted.
- The Sericitic Lyell Schist (Lss) is generally coincident with a variable signature but which contains strong linear highs, the cause of which is unclear. The Pyritic Lyell Schist (Lsp) in the south of the area has an associated signature which is much more subdued than for Lss. A similar signature is present just to the west. The Lsp signature seems to be bounded to the north by the NNW trending shear zone.
- There are areas with "fuzzy" signatures which seem to mask sharper anomalies. Such a feature is coincident with the Prince Lyell mineralisation and could be associated with alteration processes.
- The magnetic trends and "units" generally cut across mapped foliation and bedding trends. The trends may be biased by the flight line direction.

Figure No. 16 MI 1M/95 - First vertical derivative with automatic gain control



Shadowed First Vertical Derivative With AGC (Maps 9, 10, 11, 12 & 15, and Figures 17, 18, 19, 20 & 21)

The vertical derivative with AGC has been shadowed from 4 different directions in an effort to enhances different structural orientations. This can also enhance spurious data trends and needs to be interpreted with caution:

- ❑ **SE Shadow (Map 9 and Figure 17)**
- ❑ **E Shadow (Map 10 and Figure 18)**
- ❑ **NE Shadow (Map 11 and Figure 19)**
- ❑ **N Shadow (Map 12 and Figure 20)** - This image tends to enhance flight line discontinuities.

In order to combine some of the structural information from three of the shadowed images they have been combined in a colour image (**Map 15** and **Figure 21**) with the N shadow projected in red, NE shadow in green and SE shadow in blue. This image depicts the major structural orientations in the area but also contains many spurious zones. A strong fault system has been interpreted trending N-S just east of the western Lyell Schist boundary. Again the majority of mapped faults do not affect the signatures. The magnetics may reflect earlier ductile deformation. An extensive, NNW trending structure passes through the Western Tharsis deposit and extends south through Royal Tharsis. This zone may be reflecting the fold core which contains the mineralisation. It is perhaps best seen in the image shadowed from the north. The image shadowed from the north does not enhance the more E-W trending structures as had been hoped.

Maximum Gradient Images (Maps 7 &16 or 16b and Figures 22 & 23)

The maximum gradient filter has some advantages in that it is non-directional and does not induce spurious trends on the data. High areas in this image are the areas where the magnetic gradients are highest. This is often used to define the margins to lithological blocks or the positions of faults bounding areas with differing magnetic characteristics. Again the mapped faults are poorly represented in this image. Some indications of some structures can be seen. The Gormanston Fault, for instance, lies close to a sub-parallel maximum gradient zone. The general signature associated with the Lyell Schists is higher to the south of the major NNW trending structural zone which passes just west of Prince Lyell mineralisation (although this zone cannot be detected in its own right). In addition the mineralisation around Prince Lyell superimposes a lower, flat signature on this higher background.

The shadowed and colour draped maximum gradient image (**Map 16 or 16b** and **Figure 23**) emphasises those features outlined above, especially the Agglomerate Hill Fault Zone. The ENE trending portion of the Great Lyell Fault also becomes clearer in this image which also illustrates the change in magnetic intensity to higher in the south across a WNW trending zone.

Interpretation Map (Map 35 or 35b & Figure 8)

This map summarises the features interpreted from the magnetic images. The interpretation of the data is not straight forward as there is limited direct

Figure No. 17 MI 1M/95 - First VD with AGC shadowed from SE

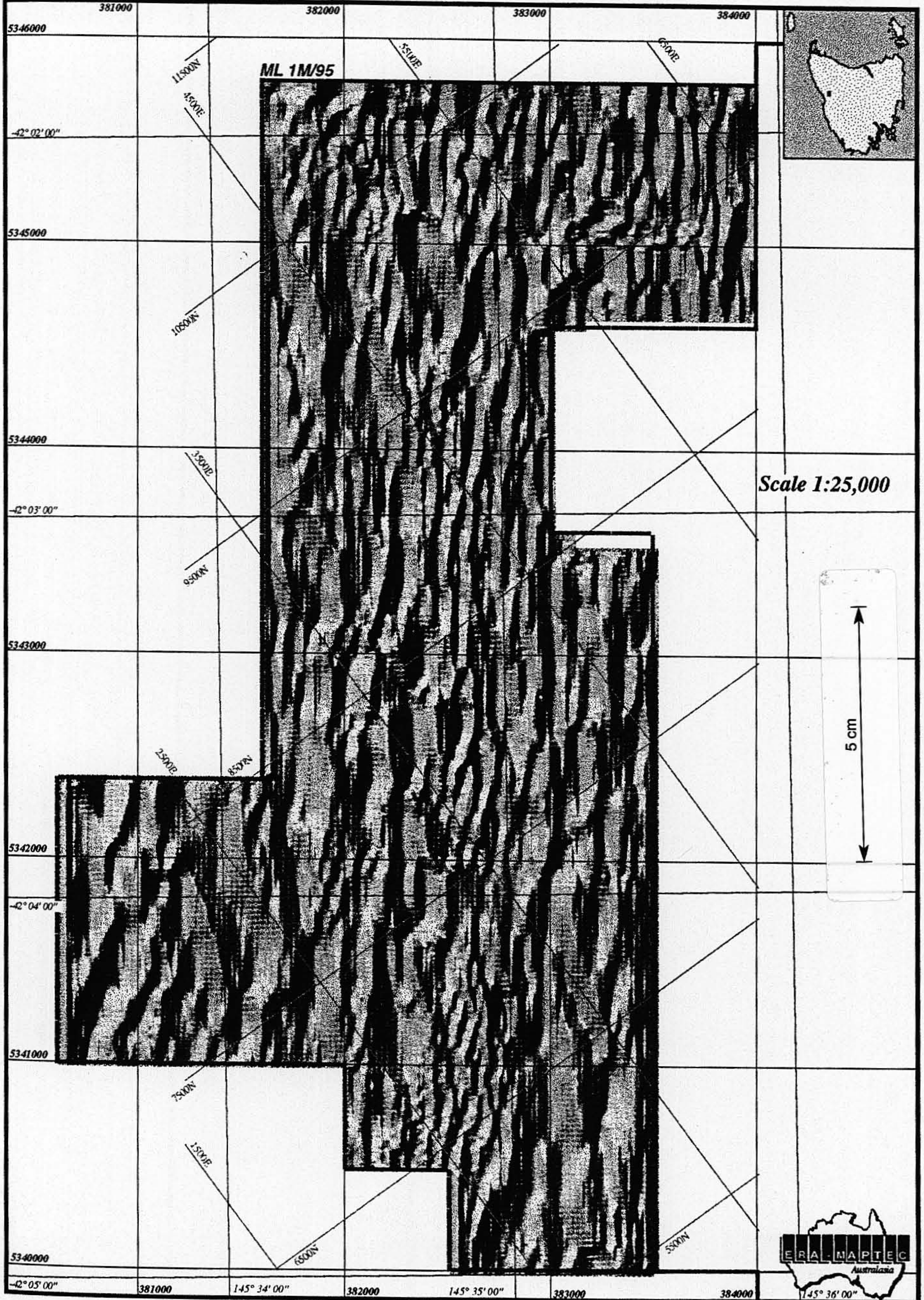


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Figure No. 18 MI 1M/95 - First VD with AGC shadowed from east

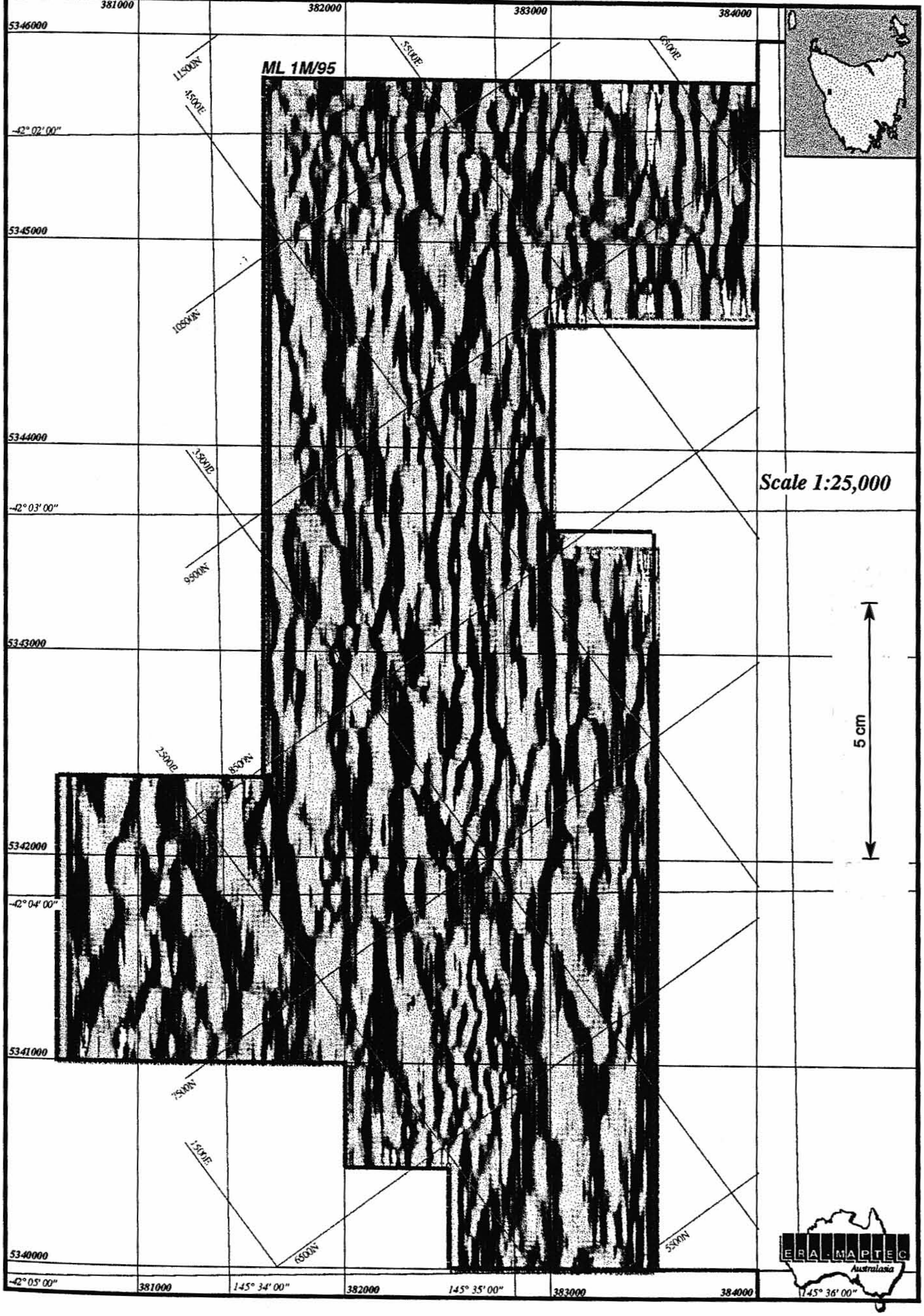
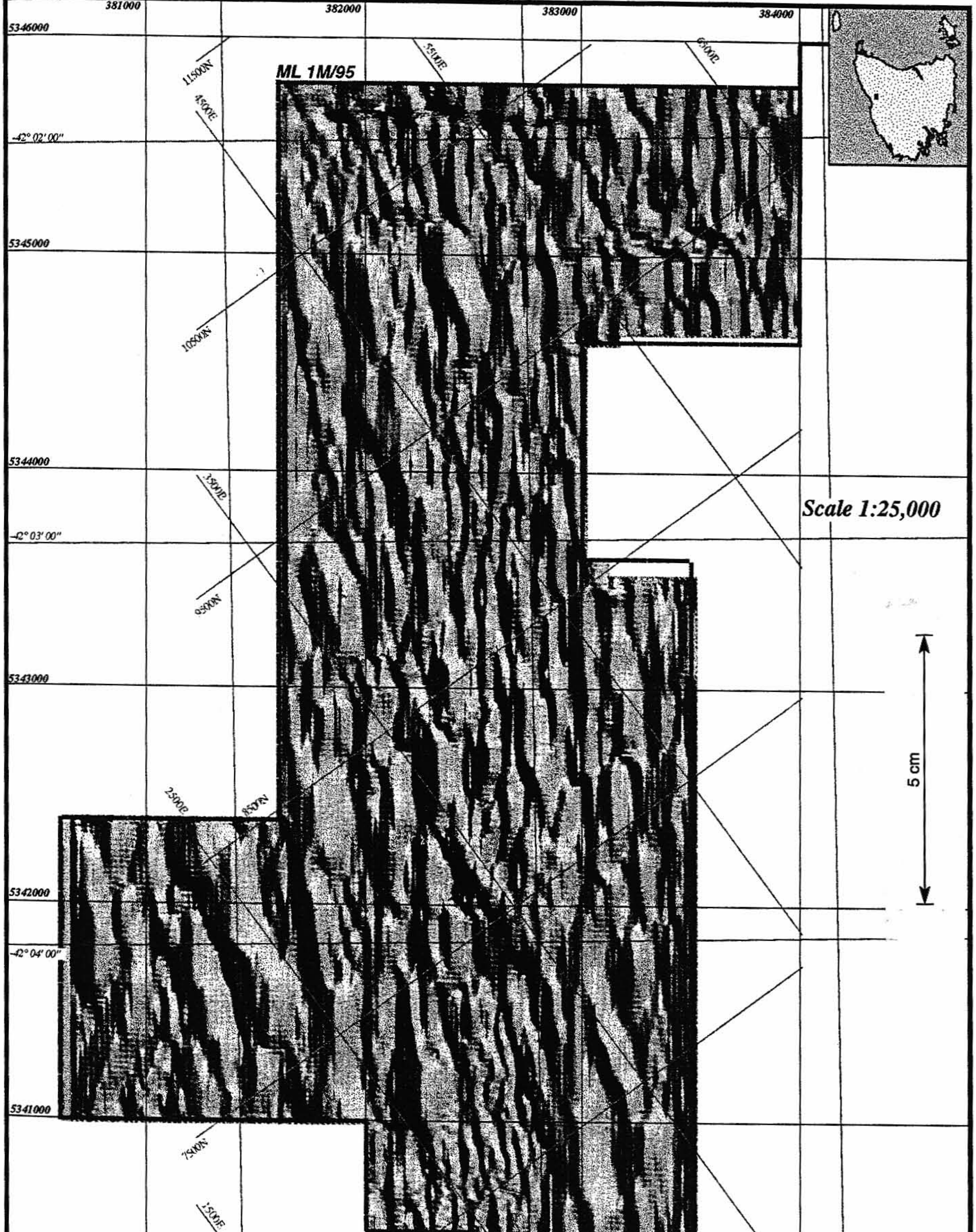
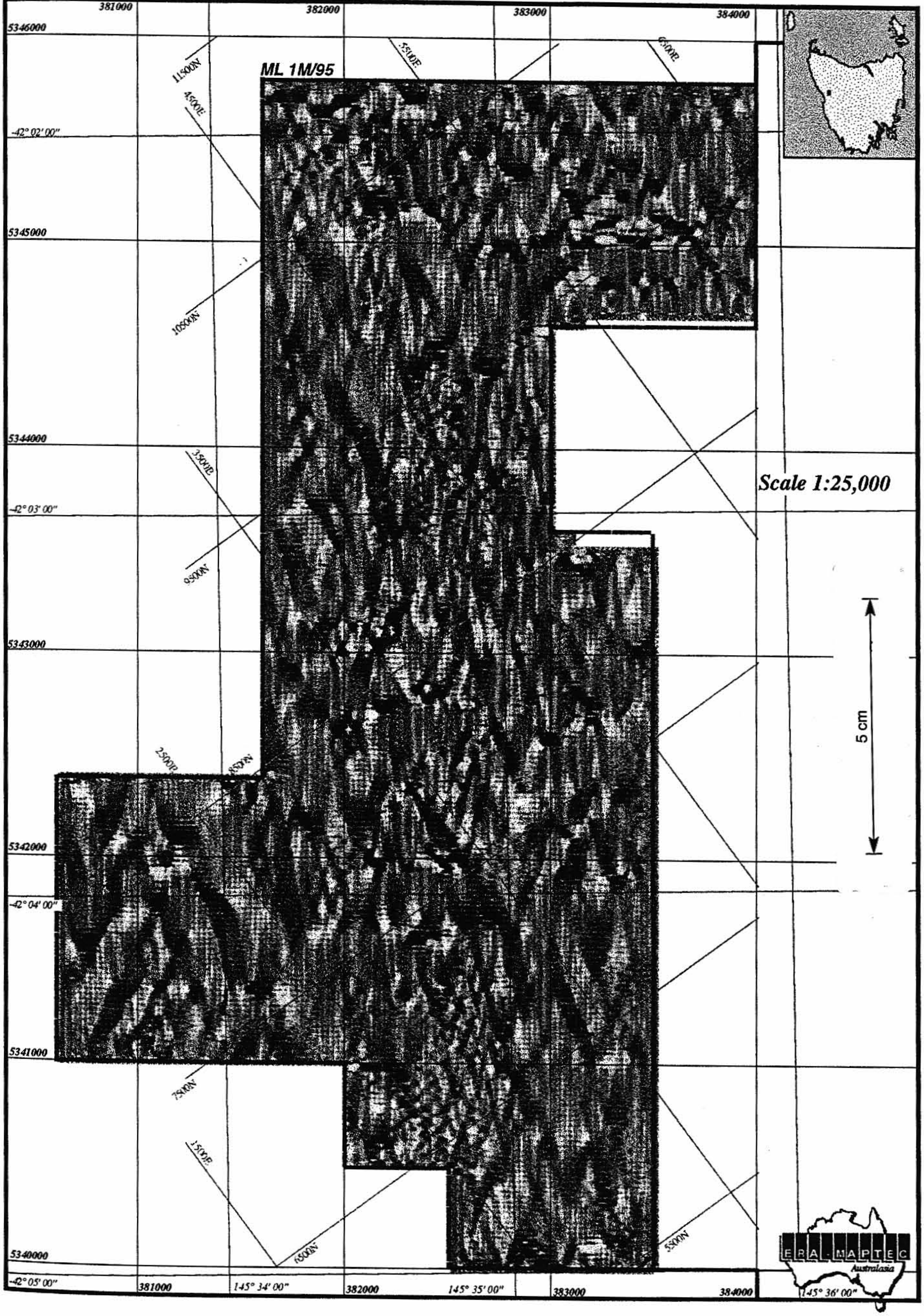


Figure No. 19 MI 1M/95 - First VD with AGC shadowed from NE



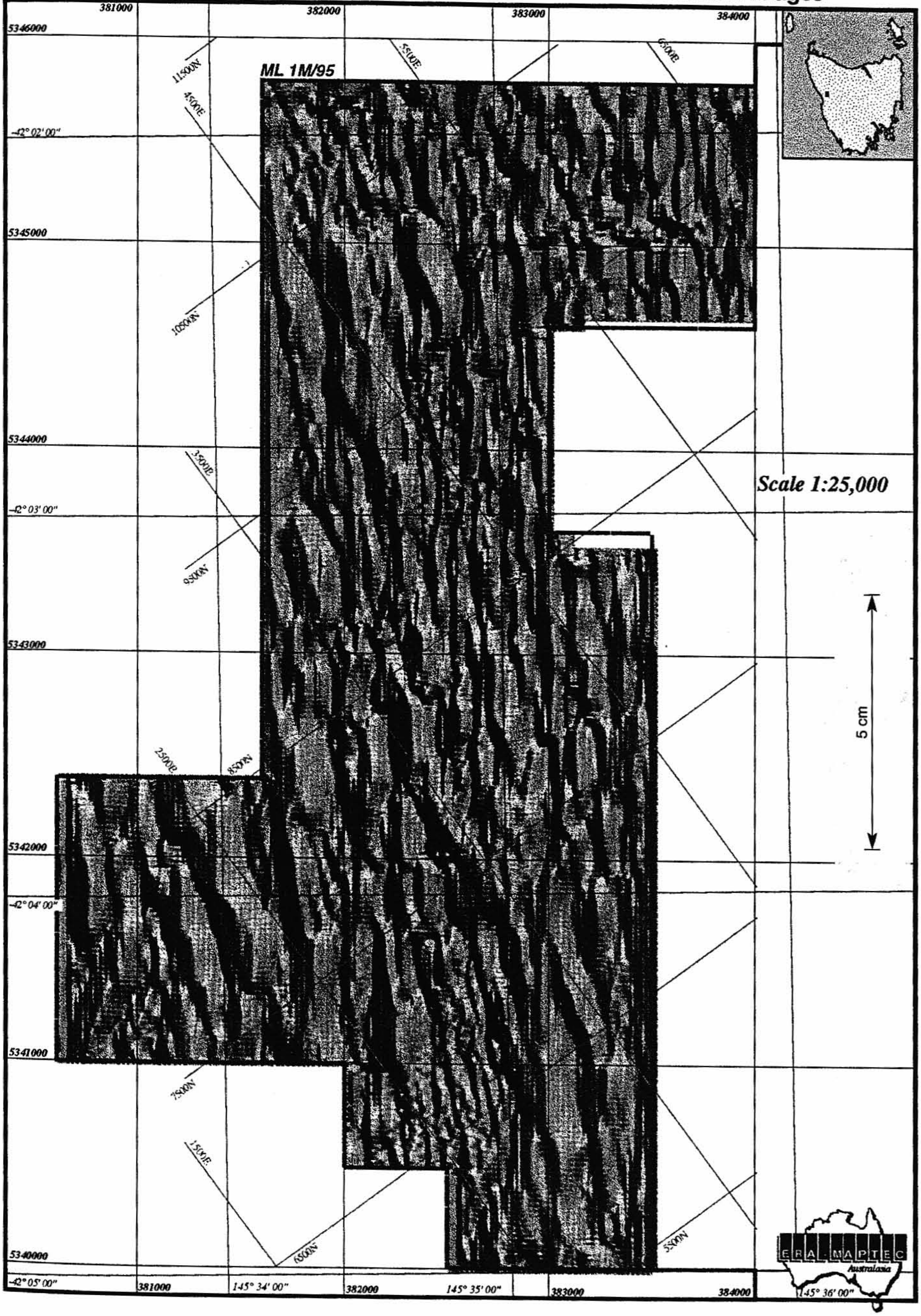
446049

Figure No. 20 MI 1M/95 - First VD with AGC shadowed from north



446050

Figure No. 21 MI 1M/95 - Colour composite of 1st VD with AGC shadow images



446051

Figure No. 22 MI 1M/95 - Grey scale maximum gradient image

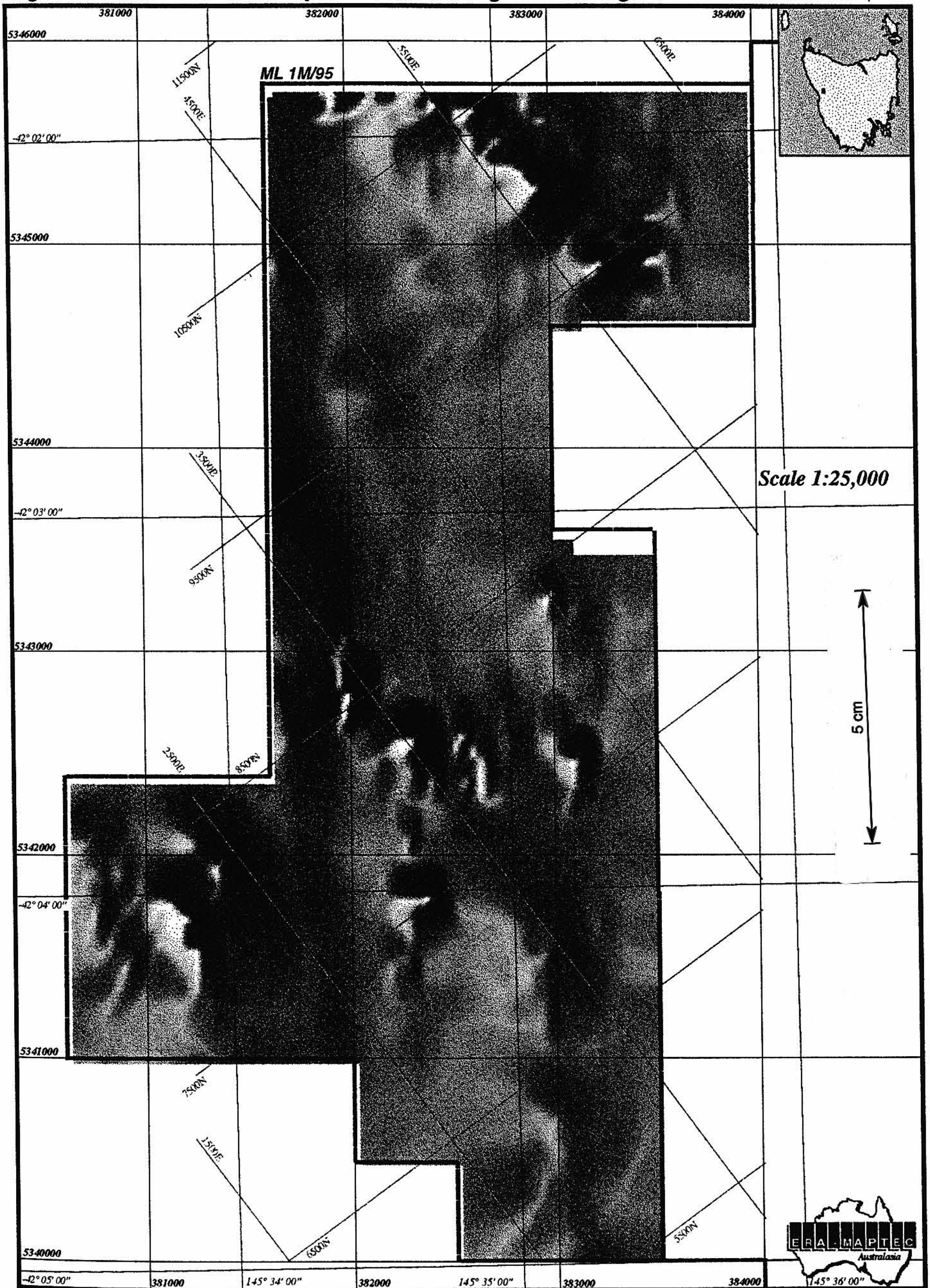
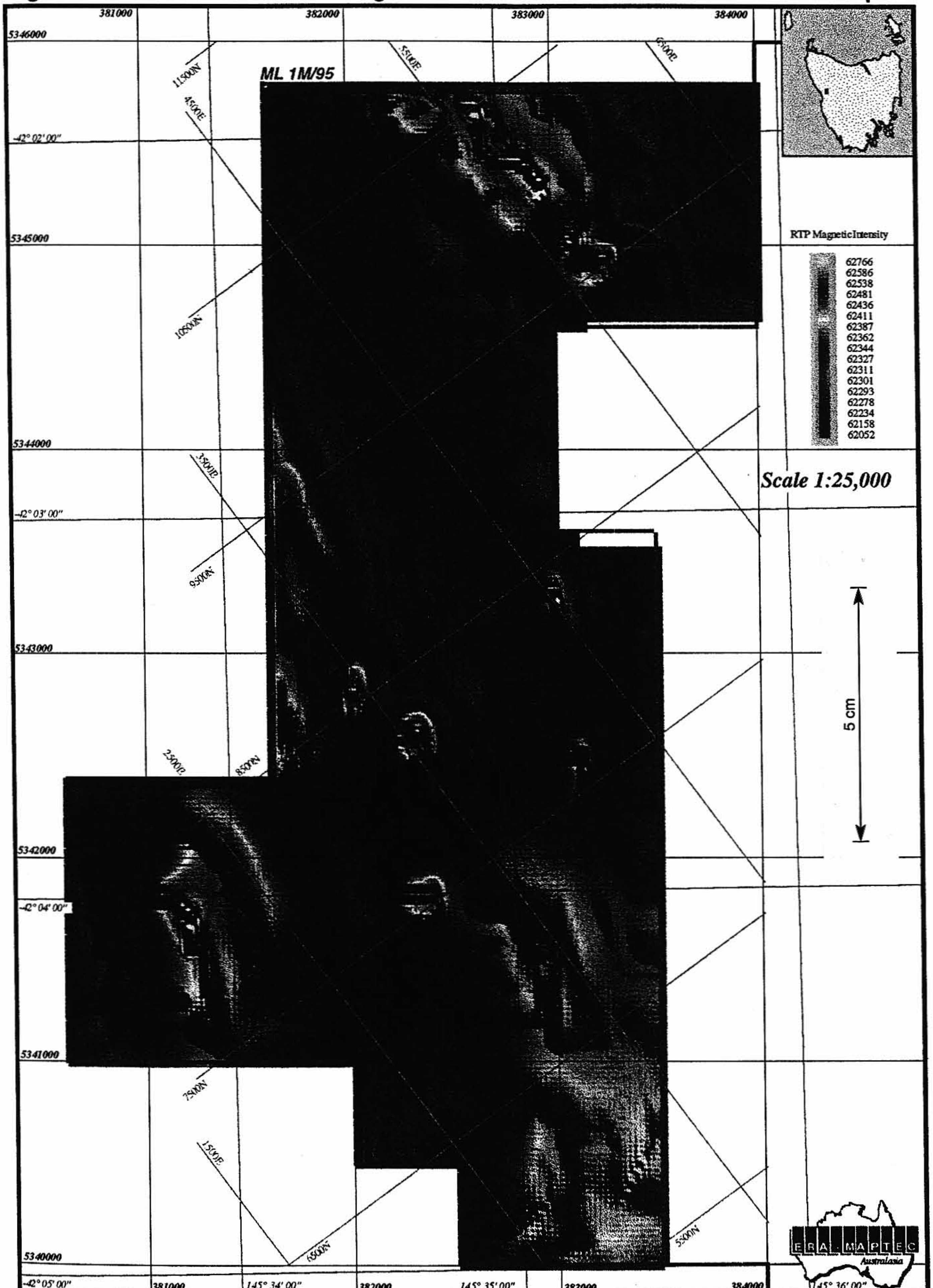


Figure No. 23 MI 1M/95 -Maximum gradient shadowed from NE with TMI colour drape



correlation between signatures and mapped geology. Many of these features are discordant to the geology and the signatures have not been constrained or limited by the known geology. The affiliation of many of them is unclear and will require investigation in the field to ascertain if they are geologically controlled. The following comments are made with regard to the interpretation:

- ❑ The intensity variations in the first vertical derivative could be related to:
  - Secondary weathering process
  - Fault controlled alteration zones. These may be in brittle fault zones that do not appear to be geologically significant in that they do not off-set geology but could be significant fracture zones and fluid pathways.
  - Quaternary cover and alluvium. This does not appear to be the case as the areas of Quaternary within the Linda survey area do not affect magnetic signatures.
  - Primary alteration of the sequence.
- ❑ Some areas of mineralisation do have an effect on the signatures but not one which is itself characteristic. This can be seen, for example, for the Prince Lyell which depresses the magnetic signature. This is most obvious where the background signature is high. This feature can be used as an exploration criteria, however, other mineralised areas do not appear to show this phenomena. It would be difficult to identify potential areas on this criteria alone.
- ❑ There is a change in broad magnetic intensity to the south of the Prince Lyell deposit suggesting a different basement type with a higher magnetic signature. The boundary between these zones appears to be ESE trending and can be traced into the Linda area. This may be a fundamental basement feature with exploration potential.
- ❑ It appears that there may also be a NW trending shear zone forming the northern margin of the Lyell Schist outcrop. Foliation, bedding trends and the Pyritic Schists rotate into this zone.
- ❑ Linear highs in the 1st VD with AGC which can be traced across a few flight lines (longer than 300m) have been included for field checking. Again these zones have no association with any mapped geological feature.
- ❑ The Agglomerate Hill Fault Zone appears to affect basement and as such has exploration potential as it is likely to have been present during deposition and the mineralising event. There is some suggestion that this zone contains a number of en echelon strands.

Linda El 52/94 Magnetic Interpretation

A similar suite of images have been produced for the Linda El as for the mine licence. Two interpretation maps have been produced from the image as there is too much information to combine in one map:

- Interpretation of the 1st vertical derivative image along with features from the maximum gradient image are shown in **Map 36** (and **Map 36b** combined with the interpretation from Ml 1M/95) and **Figure 24**.
- Interpretation of the 1st vertical derivative with automatic gain image are depicted in (**Map 37** and **Figure 25**).

Both of these maps contain the features interpreted from the RTP TMI image.

The raster images have been registered as tables in Mapinfo. The images have the following co-ordinates:

- SW corner 382875E, 5336025N
- SE corner 389175E, 5336025N
- NE corner 389175E, 5345975N
- NW corner 382875E, 5345975N

The images are 1592 pixels N-S by 1008 pixels E-W at 6.25m resolution.

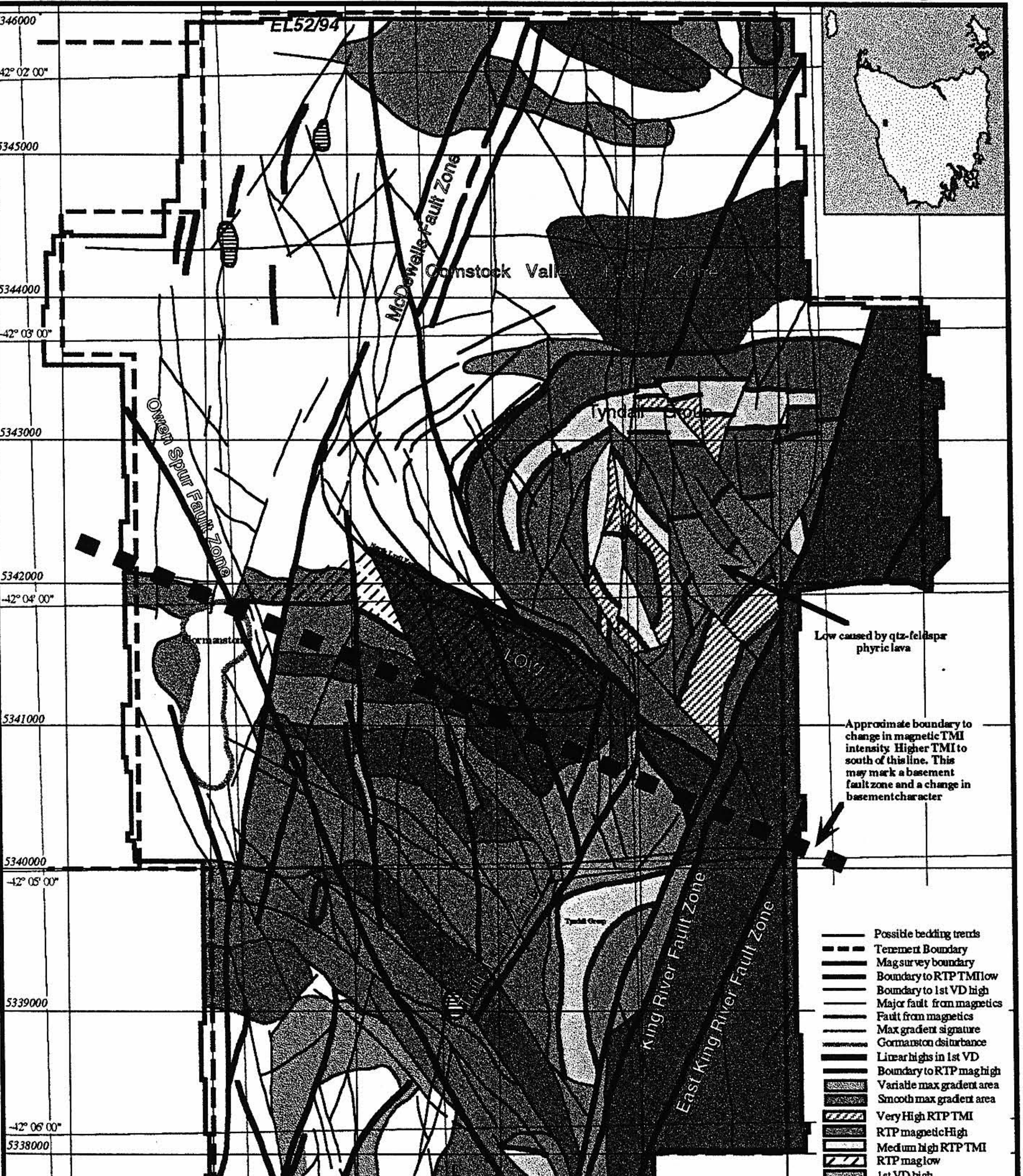
There is no topographic data coverage for this area but a geological overlay has been prepared at 1:10,000 scale to overlay the images (**Map 34**).

Reduced to pole Total Magnetic intensity (Map 21 & Figure 26)

This image has been enhanced with vertical shading which again enhances the original pixel boundaries in places. As with the survey over ML 1M/95 the distribution of the Tyndall Group has a strong influence on RTP-TMI highs. .

- The extensive high area centred at 387000E, 5342500N is controlled by outcropping Tyndall Group rocks. There is a good correspondence between the upper outcrop boundary (Etc - volcaniclastic Cg + sandstone + minor mudstone and tuff) and a TMI value of 6270 nano-tesla (the bright yellow "contour" in the image). This correlation does not hold for the highs to the south of this large triangular shaped area.
- The low area within this triangular Tyndall Group high is created by a quartz- feldspar phyric lava and tuff (Etv). The interpreted area of this low is considerably different to the mapped extent of this lithology. It also seems to be affected by a number of faults.
- The highest signatures are generally coincident with part of unit Etc but there is not a 1:1 relationship with the mapped geology. The aeromagnetics suggest a different distribution of units.
- The central area of the high is coincident with unit Ett (crystal tuff with agglomerate + sandstone + siltstone + rare limestone). This has a variable signature and also contains some of the highest intensity anomalies.
- The Quartz-feldspar porphyry intrusions within the Tyndall Group outcrop area do not have a characteristic signature. They are coincident with medium high areas.
- The undifferentiated Tyndall Group outcrops in the southern half of the EL area are variably magnetic, as was the case for ML 1M/95. The anomalies do not match the mapped outcrops.

Figure No. 24 EL 52/94 - Interpretation of 1st VD, TMI and maximum gradient magnetics



5 cm

Figure No. 25 EL 52/94 - Interpretation of 1st VD with AGC and TMI magnetics

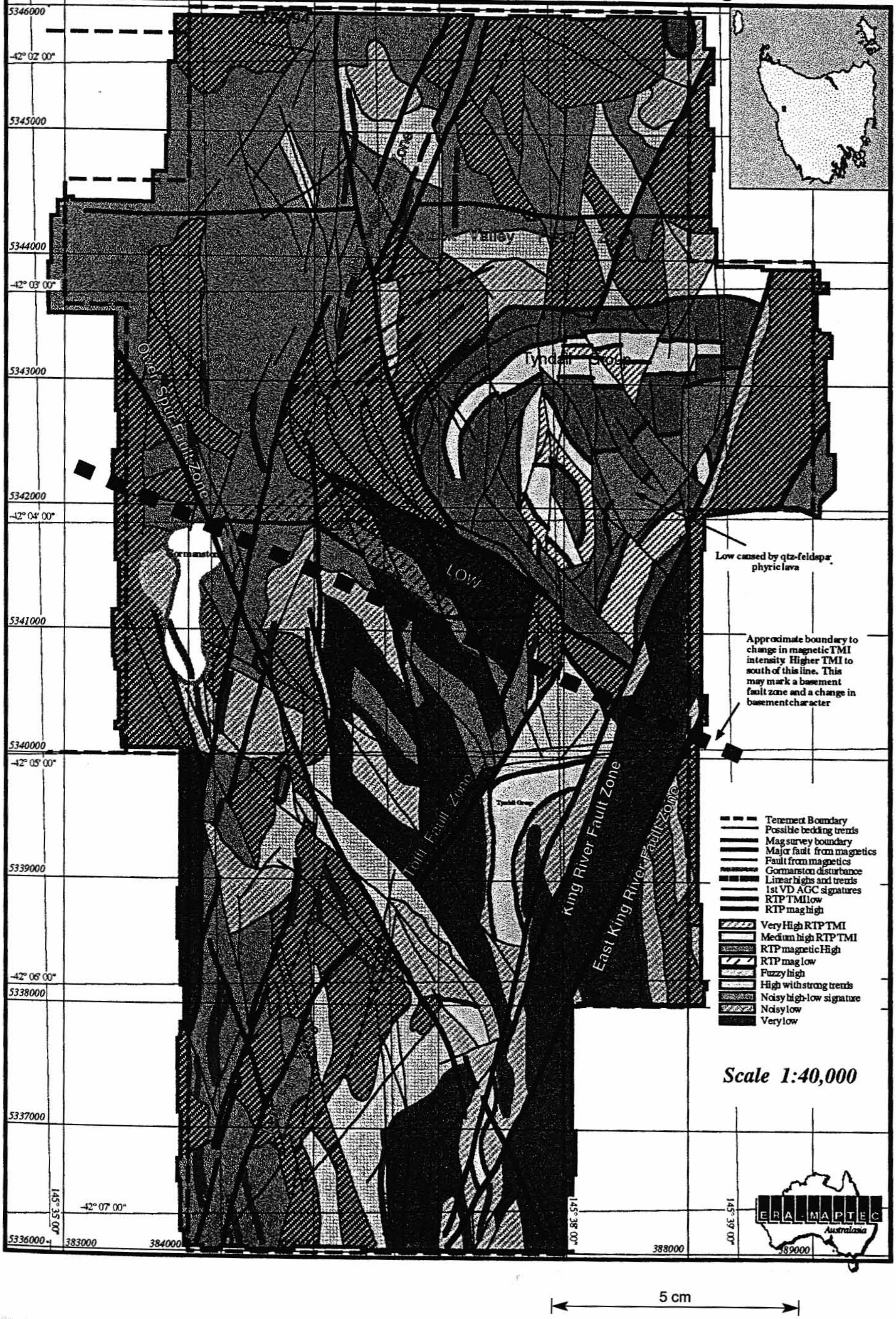
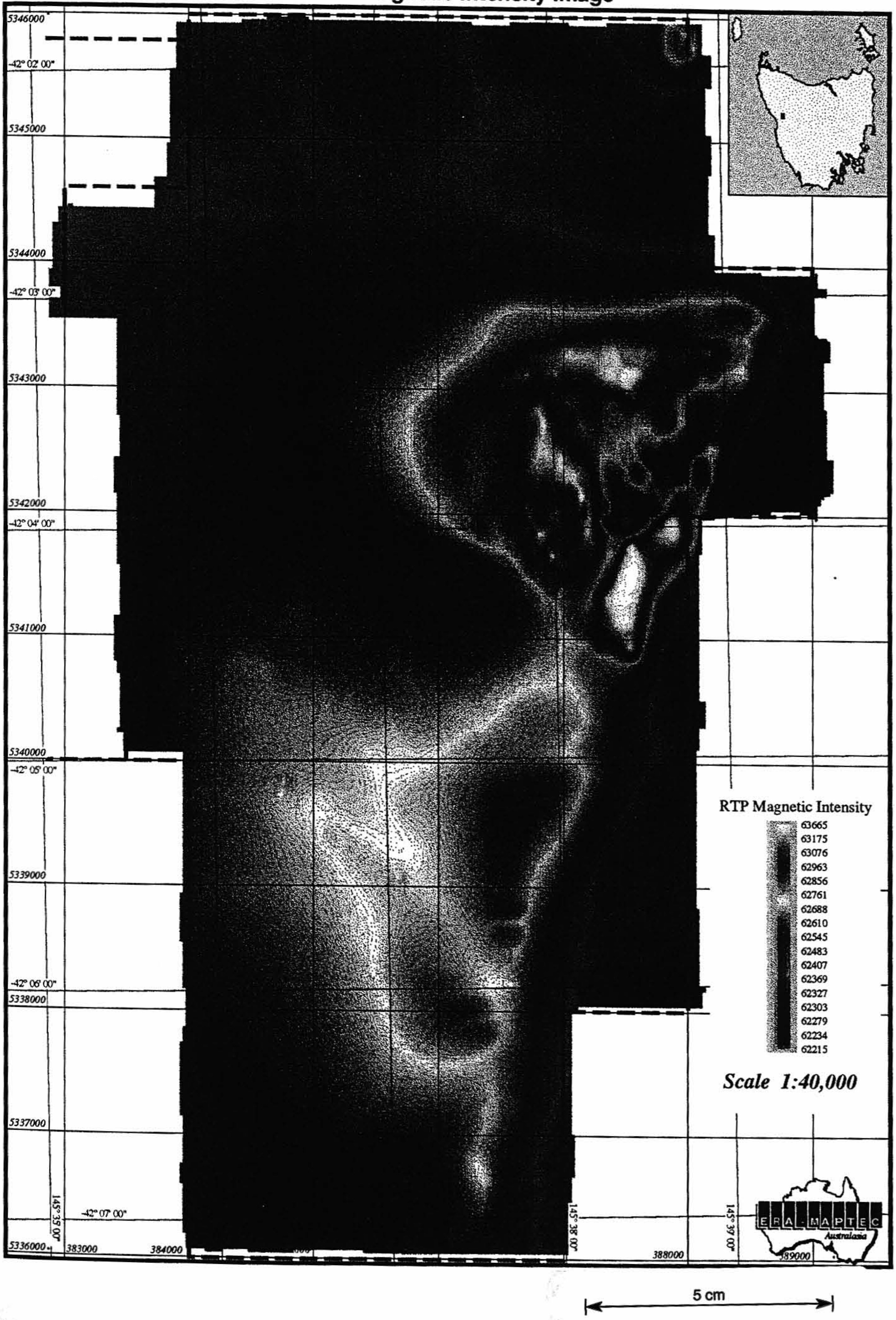


Figure No. 26 EL 52/94 - RTP total magnetic intensity image



- ❑ The anomalies associated with Tyndall Group rocks in the south have much lower gradients which suggest gentler dips but the mapping does not show this to be the case.
- ❑ A WNW trending low is present immediately south of the North Lyell Fault which bounds the Tyndall Group outcrops in the north.
- ❑ There must be a major structure trending NNE through the King River valley sub parallel to the Tyennan Fault (see **Figure 3**). This structure terminates signatures associated with the Tyndall Group which are striking obliquely to it. Very low signatures are present to the east of the structure which are associated with the Siluro-Devonian Eldon Group. These rocks also create the E-W trending low in the north of the tenement area. This indicates that the Owen Conglomerate is missing in this area, possibly removed by an E-W trending structure.
- ❑ The isolated high in the extreme NE of the survey is also controlled by the Tyndall Group.
- ❑ The central area of the survey contains NW to WNW trending contours which is consistent with the fault and bedding strike orientation in that area. Lithologies Oop and Oous of the Owen Group seem to have some control on elevated intensities, especially Oop which is described in the Queenstown Geology Sheet as containing chromite-rich bands. The correlation is not complete though and there must be variation in the lithologies.

Shadowed RTP Image (Map 22 and Figure 27)

Only the colour composite shadowed image has been produced for the Linda survey. This combines E, NE and N shadow directions as red, green and blue respectively in the image. The following points were noted:

- ❑ Pronounced fringes are present around the western margin of the main Tyndall Group outcrop. Similar fringes were present around the Tyndall Group in the north of ML 1M/95. Again these could be coincident with lithological units as the contours are sub parallel to bedding strikes in the area.
- ❑ A dramatic change in signature is present across an E-W trending discontinuity at 5344300N. This is parallel to the flight line direction which suggests it is an artefact, but the discontinuity separates areas with very different magnetic grains. The discontinuity also makes geological sense as an E-W fault would account for the considerable thickness of Owen Conglomerate which must be missing in this vicinity.
- ❑ A number of smaller scale highs are enhanced in this data set but do not have any obvious geological or cultural association. The town of Gormanston creates some disturbance of the magnetic field.

First Vertical Derivative Image (Map 23 & 30 or 30b and Figure 28 & 29)

The interpretation of the first vertical derivative image is shown in **Map 36** and **Figure 24**. The following observations were made:

Figure No. 27 EL 52/94 - Colour composite of TMI shadowed images

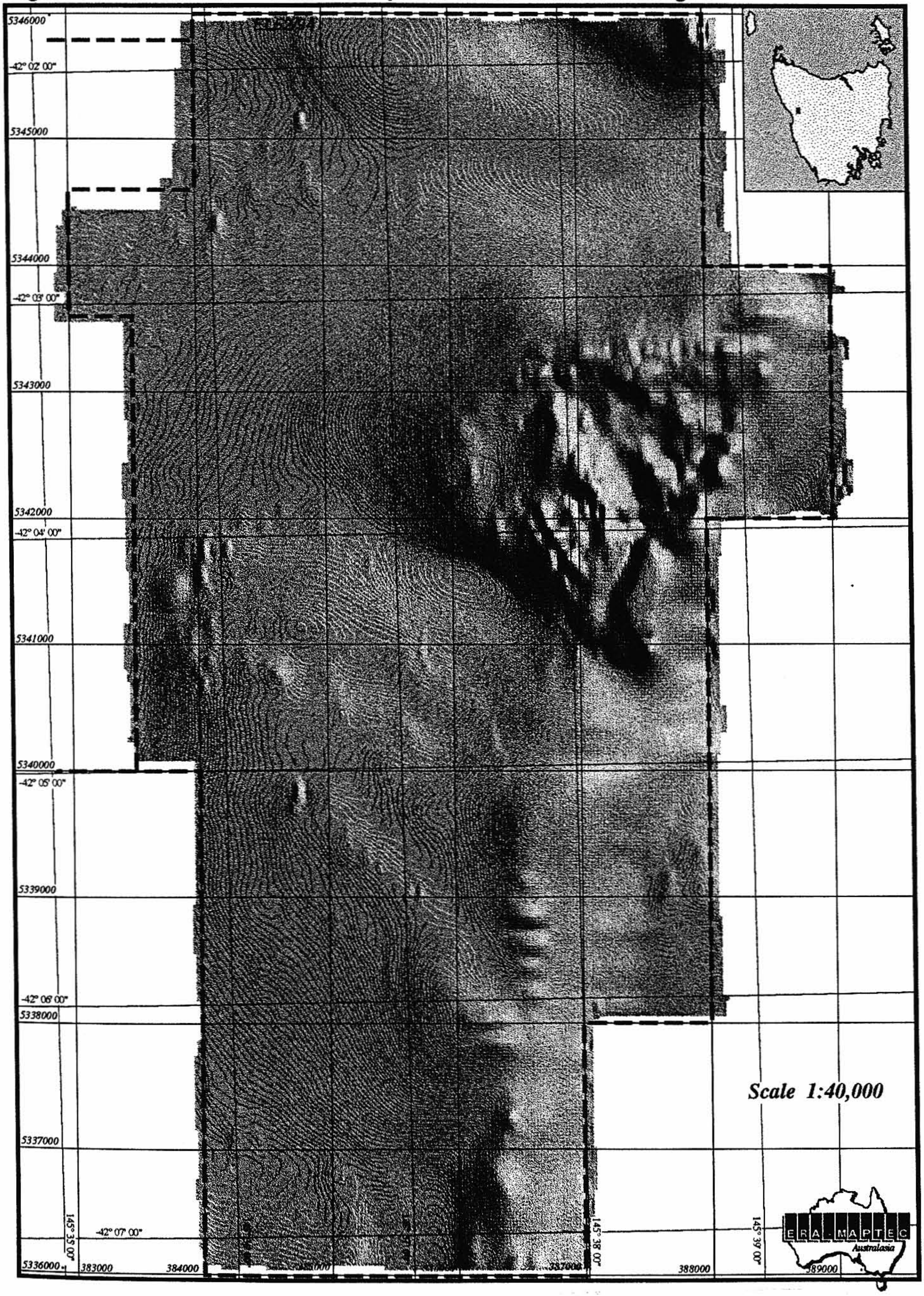
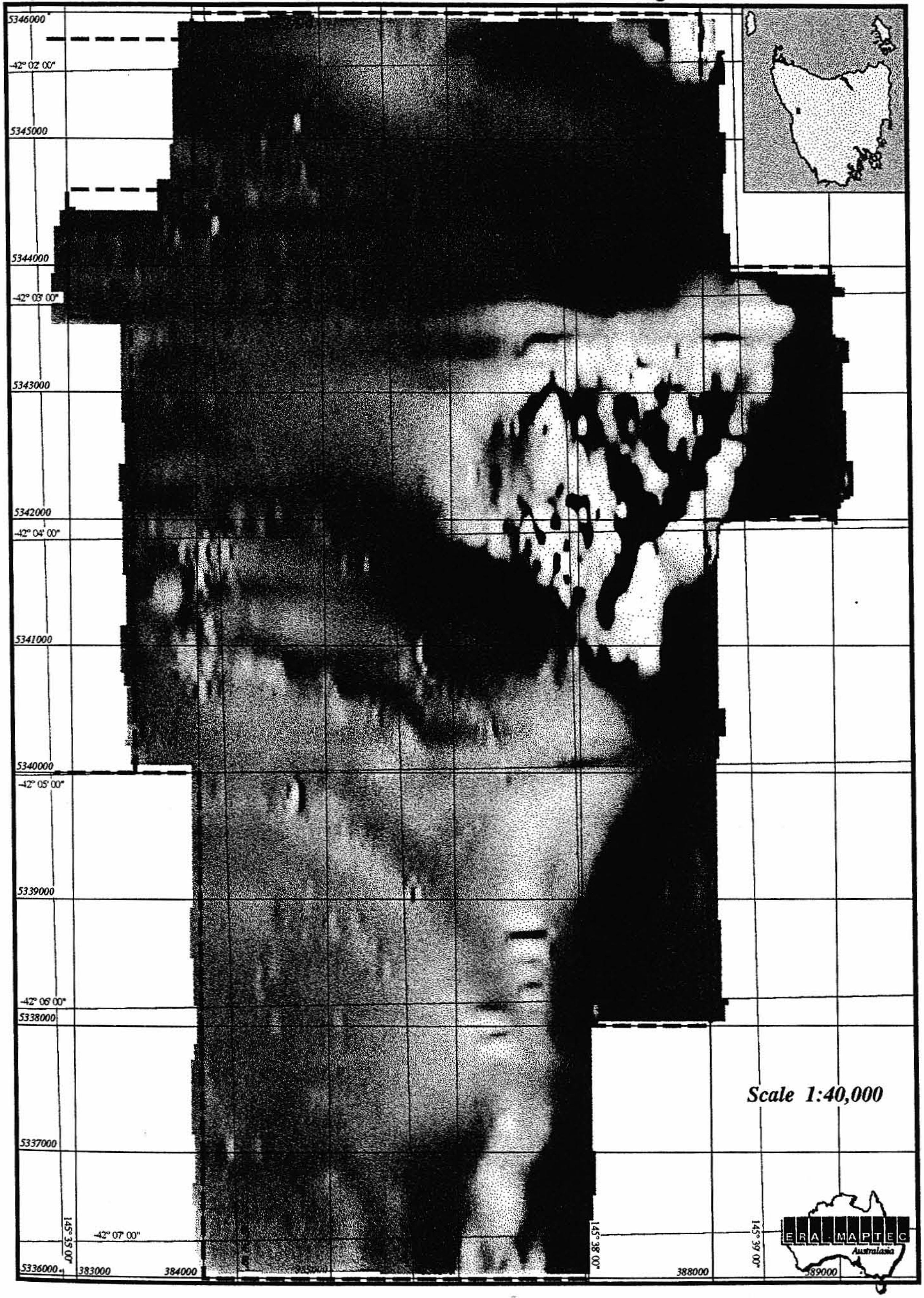


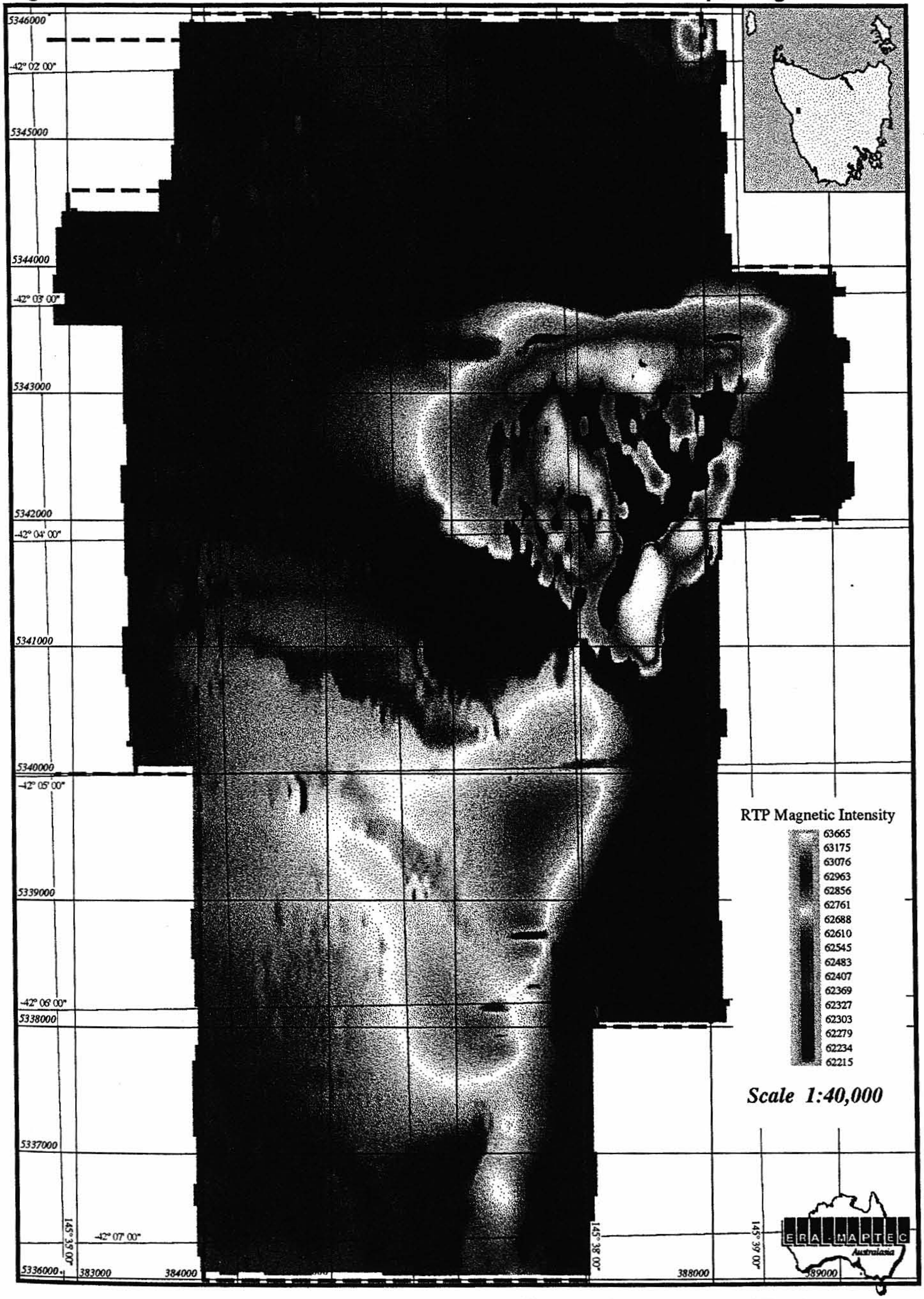
Figure No. 28 EL 52/94 - Grey scale first vertical derivative image



5 cm

446061

Figure No. 29 EL 52/94 - First vertical derivative with TMI colour drape image



5 cm

- The King River Structure is well defined with a very low signature to the east of it associated with the Eldon Group.
- The northern half of the survey has only been partly interpreted due to the lack of variation in the signatures. There is a change across a WNW trending line to a background of higher signatures. This can be traced into the Prince Lyell - Royal Tharsis area of ML 1M/95.
- Parts of lithologies Ous and Oop have higher noisier signatures and together with the Tyndall Group form the higher intensity areas in the southern half of the survey.
- The main mass of Tyndall Group rocks have not been interpreted further from this image as they are best interpreted from the total field image.
- The disturbance associated with the town of Gormanston is best seen in this image.
- Some isolated high anomalies have been identified but have no obvious geological or cultural association and need to be investigated in the field.

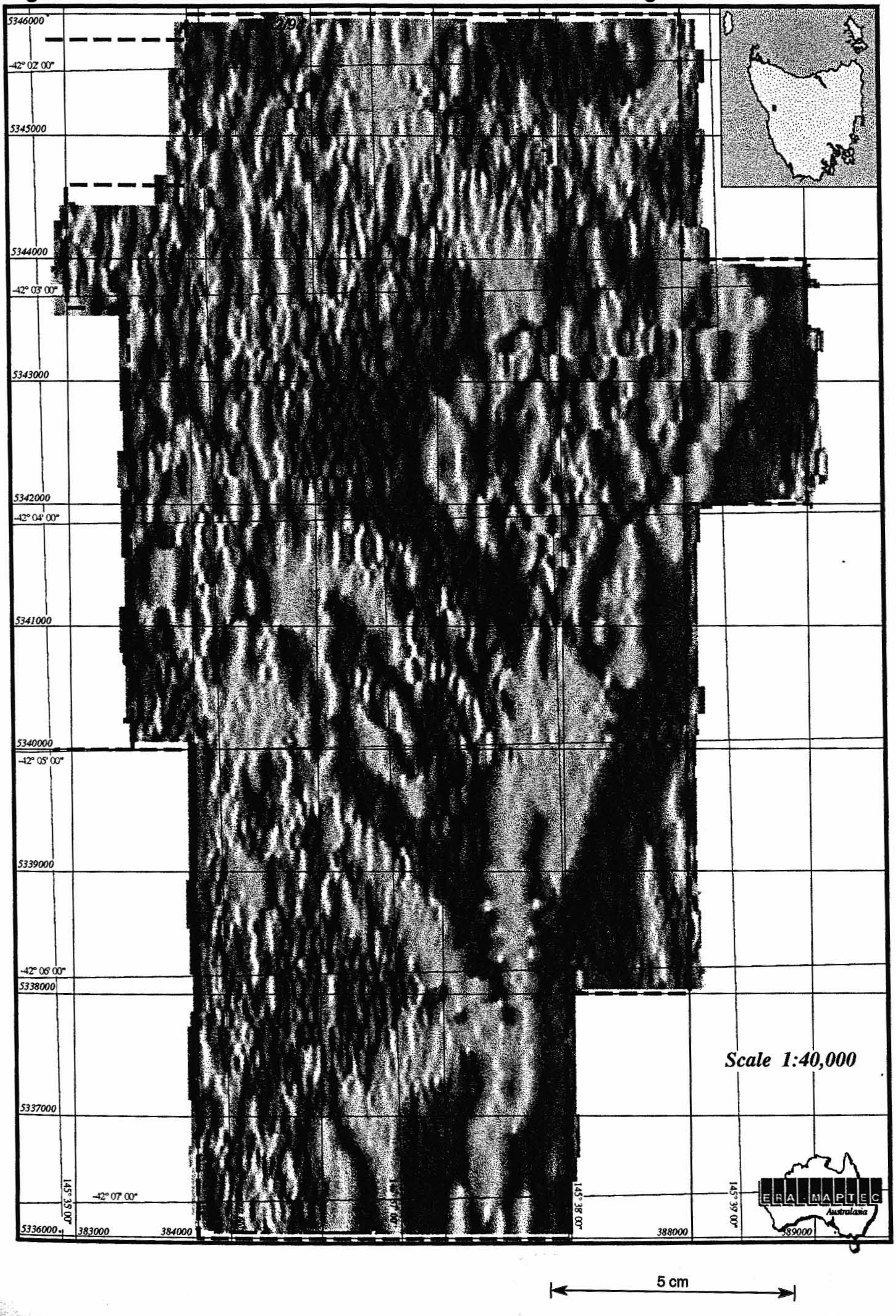
The TMI draped, first vertical derivative images for EL 52/94 and ML 1M/95 have been combined in **Map 30b**

First Vertical Derivative with Automatic Gain (AGC) (Map 25 and Figure 30)

This image shows good variation in signatures in coherent blocks which must have some geological significance although their boundaries do not precisely match the mapped geology.

- Again high areas are controlled by the Tyndall Group and lithologies Oop and Ous. The Tyndall Group rocks in the south are generally associated with the smooth high signature whereas the highs with strong linear highs are partly controlled by Oop.
- The King River Structure is well defined and a second, sub parallel, extensive zone has been revealed around 500m to the east.
- Trends within the image do not reflect foliation or bedding directions but are dominated by N-S orientation suggesting a strong influence by the flight line direction.
- The mapped WNW trending faults generally have no expression in the image. This could indicate that these are lower angle structures than depicted in the cross-section on the Queenstown sheet. However, they are at a far from ideal angle to the flight lines to be readily detected.
- The signature described as "low and noisy" is similar to that associated with part of the Pyritic Lyell Schist (Lsp) of the mine licence. With an extensive area immediately to the west of the Tyndall Group and another at the southern margin of the survey.
- At first sight there appear to be problems with the levelling of the data in the northern portion of the image with E-W trending banding in some images and strong E-W discontinuities in this image. However, the strike of the Tyndall Group in this area is E-W and a major

Figure No. 30 EL 52/94 - First vertical derivative with automatic gain control



structure (the Comstock Valley Fault Zone) is indicated in the geology. The flight lines are in a poor orientation to resolve these details. In addition the topography in this area has a strong E-W grain.

- The high areas in the north of the image trend at a high angle to surface geology strike and have no obvious geological association.
- The North Lyell Fault does not have a direct linear signature along its trace. However, there is a broad, low corridor around 200m wide coincident with the fault trace in the east of the area. There is a rapid change to high, noisy signatures to the south of this. The North Lyell Fault Zone appears to be much wider than specified on the geological map with a large proportion of it under Quaternary cover.
- The major NNE and NNW trending structures interpreted from the images are best seen in this data set (see **Map 37** and **Figure 25**).
  - **The Owen Spur Fault Zone** - trends NNW parallel to the Glen Lyell Fault and traverses the survey area. There is one mapped fault segment coincident with this zone and lithologies rotate clockwise into it. The outcrop pattern of Oop could also be easily modified to accommodate this zone.
  - **The Tofft Fault Zone** - trends NNE but is poorly represented in the geology although bedding strikes are sub parallel in places.
  - **The McDowell's Fault Zone** - passes through the McDowells deposit on the North Lyell Fault. It seems to be continuous across the fault even though the North Lyell Fault is clearly a significant feature. The zone contains extensive linear highs in the AGC image.
  - **The Comstock Valley Fault Zone** - trends E-W to the north of the Tyndall Group mass but is not easily seen in the AGC data. This fault zone is sub-parallel to the North Lyell Fault and passes into the NE corner of ML 1M/95 where it forms the northern margin of the Tyndall Group coincident with anomaly A12. The distribution of lithologies in the Queenstown geology sheet suggests there is significant movement on this structure. It probably links into the Great Lyell Fault and may transfer much of the shearing from it.

Shadowed First Vertical Derivative With AGC (Maps 26, 27, 28, 29 & 31, and Figures 31, 32, 33, 34 & 35)

These images have been shadowed from the SE, E, NE and N and are very difficult to interpret in isolation due to the overwhelming number of possible discontinuities and structures. They have not been considered in detail here for this reason as it would be pointless to record these features as faults as the resulting interpretation would be unusable. These images will prove useful if a prospective zone is identified from other sources and can then be traced using these shadowed images.

The colour composite image of shadow directions (**Map 31** and **Figure 35**) is easier to interpret but still contains too many unexplained discontinuities. The pattern of these features is not compatible with naturally occurring fault

446065

Figure No. 31 EL 52/94 - First VD with AGC shadowed from SE

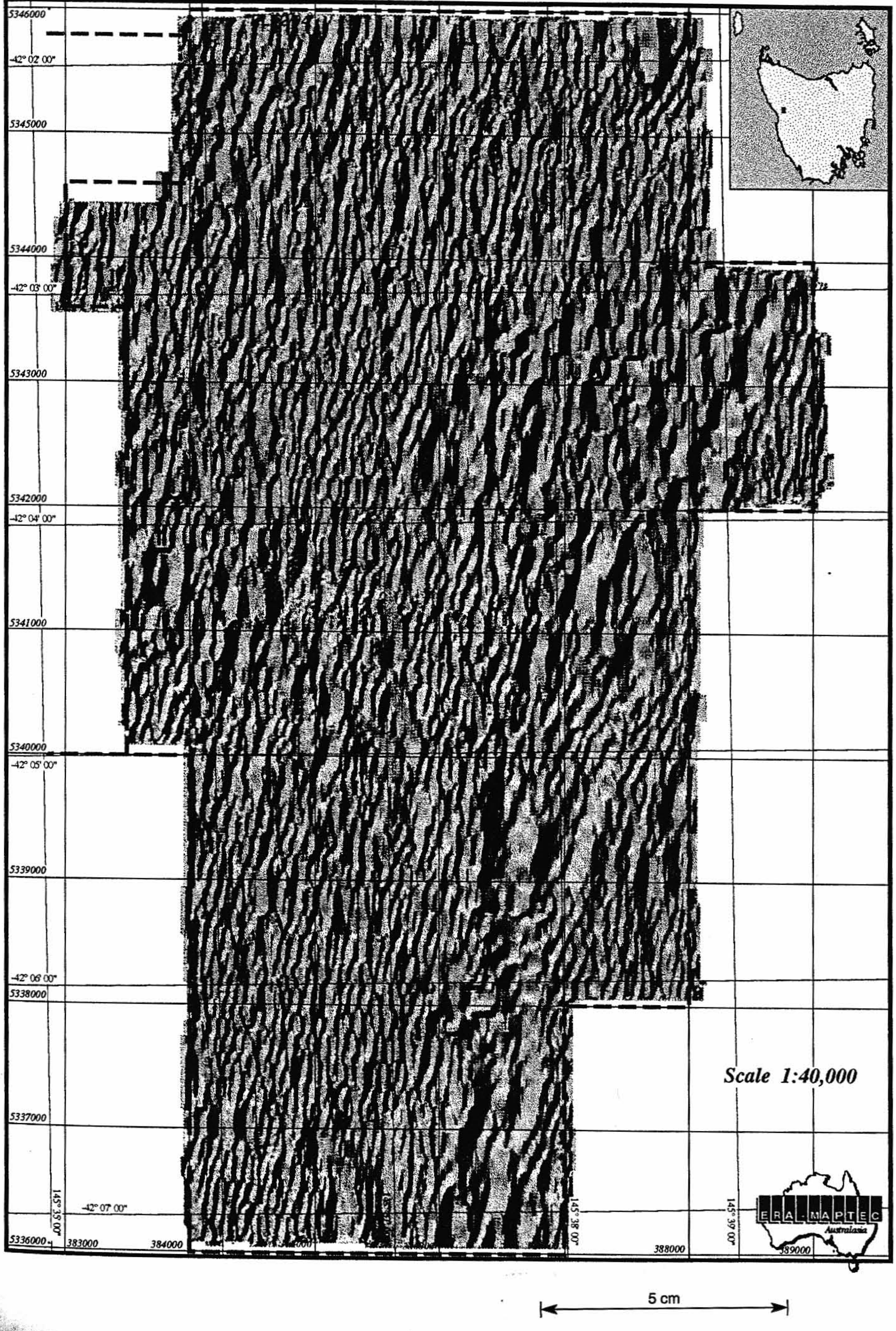
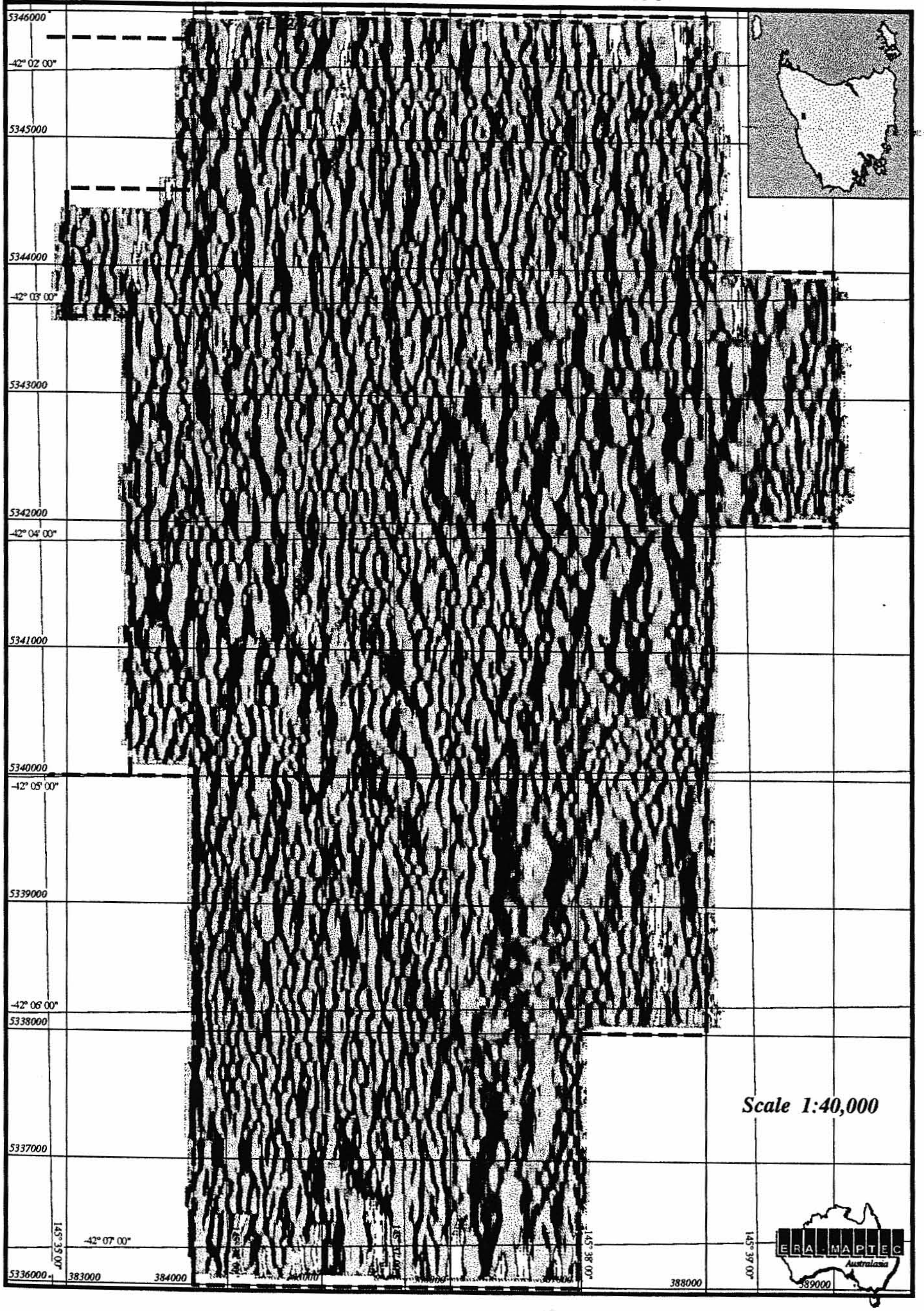
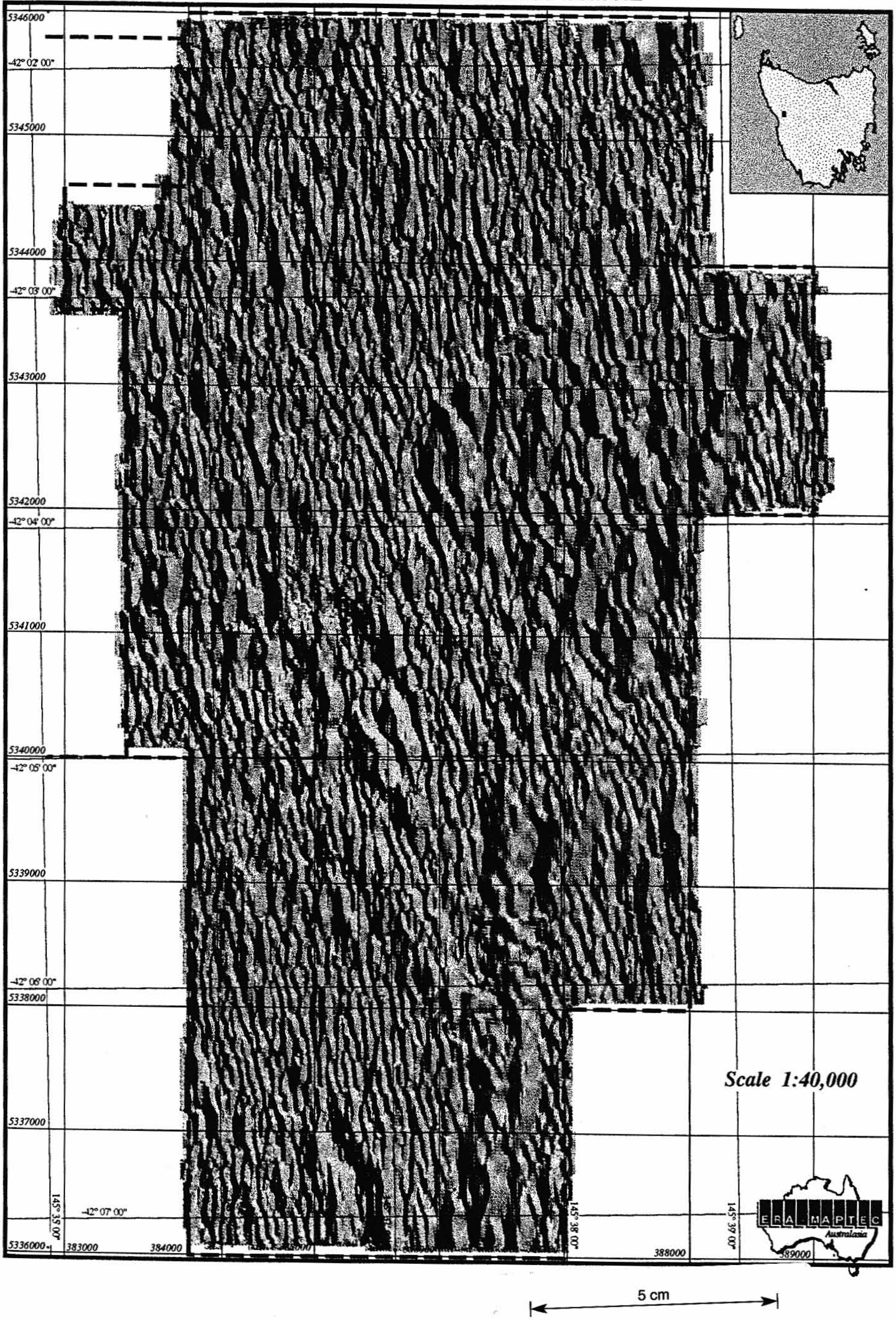


Figure No. 32 EL 52/94 - First VD with AGC shadowed from east



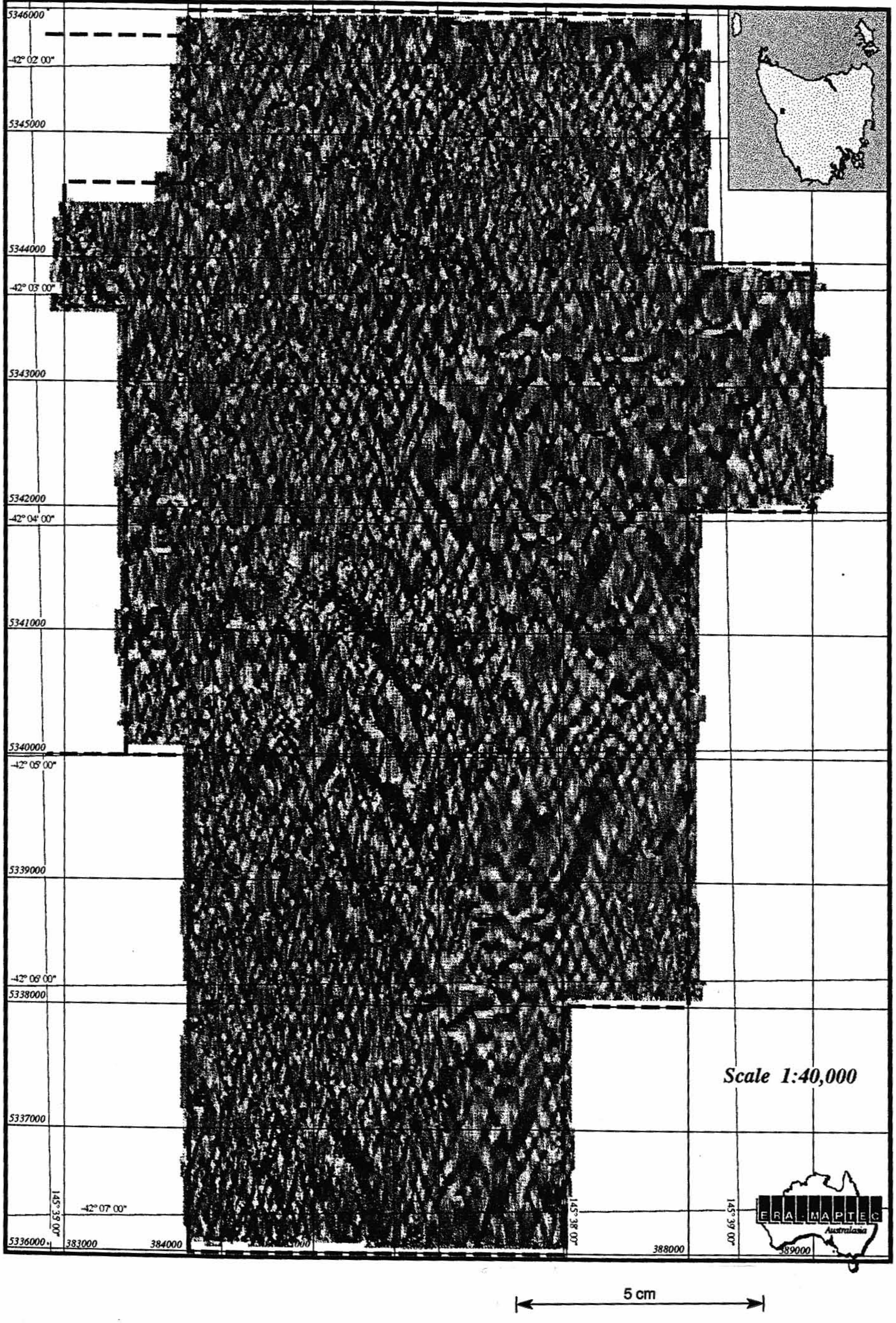
5 cm

Figure No. 33 EL 52/94 - First VD with AGC shadowed from NE



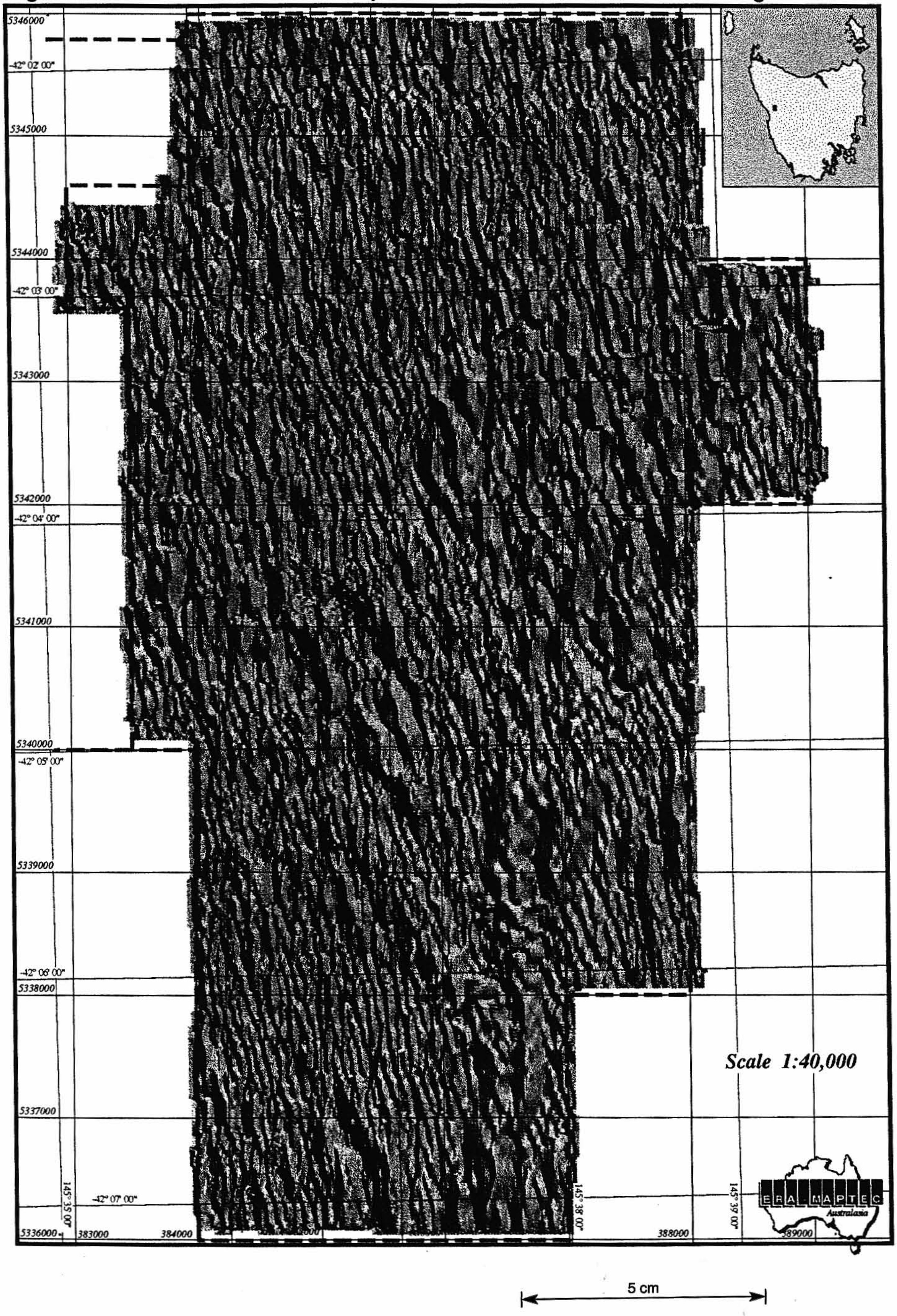
446068

Figure No. 34 EL 52/94 - First VD with AGC shadowed from north



446069

Figure No. 35 EL 52/94 - Colour composite of 1st VD with AGC shadow images



systems and many must be spurious features. At this stage it is more productive to interpret major structural features from the other images.

Maximum Gradient Image (Map 24 and Figure 36)

Highest gradients are associated with the Tyndall Group rocks. Some areas with very flat, featureless signatures have been identified and are sho

wn in **Map 36** and **Figure 24**. They have no obvious geological association. The North Lyell Fault Zone contains a number of WNW trending highs which indicate a broad deformation zone. More variable signatures are present in the south of the area with bland areas in the north. There is an E-W streaking in the image which gradually increases north of about 5340000N. This is most prominent in an E-W trending, 1km wide, low zone in the image centred on 5344000N and coincident with the previously interpreted Comstock Valley Fault Zone. At first sight this feature would appear to result from levelling problems in the data as it is parallel to flight lines. However, as mentioned earlier, stratigraphy and topography are sub parallel to the zone. This may only be resolved by a further survey with N-S directed flight lines.

6 Gravity

Gravity data was supplied to the project as a Mapinfo file of residual values with co-ordinates and station numbers. These data cover a wider area (372500E - 390000E (17.5km), 5332500N - 5352000N (19.5km)) than the magnetic surveys (see **Figure 1**). The northing co-ordinates had been truncated with the leading "5" of the co-ordinate omitted. This has been remedied so that the data can be imported into Mapinfo. There are two resolutions of data:

- The regional data has a station spacing of around 1km.
- Data in the Mount Lyell area has a station spacing of around 250m.

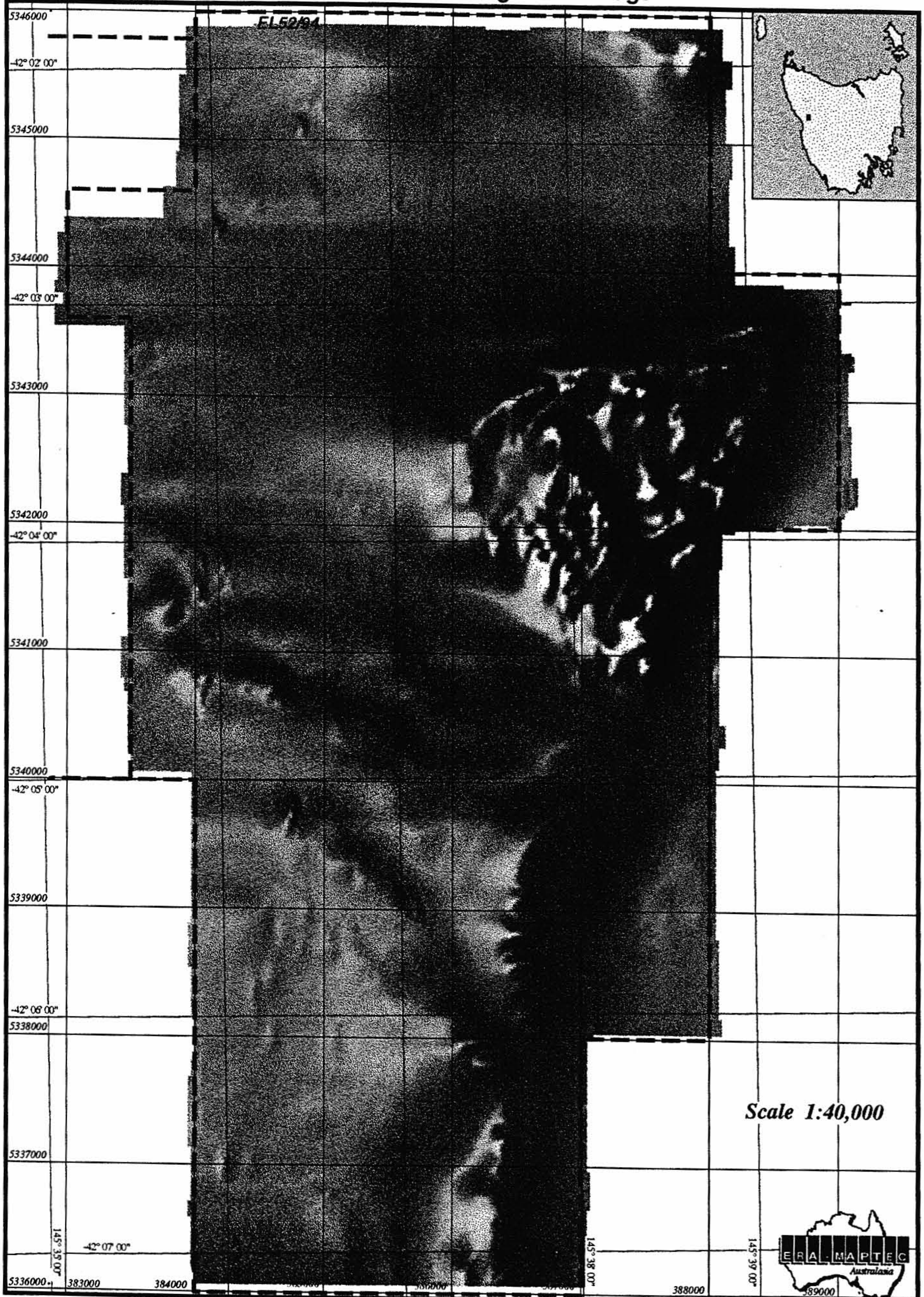
The data has been gridded at two cell sizes. A regional image for the whole data set has been gridded at 250m cell size (**Figure 37**). The more detailed data has been extracted (380600E - 386000E (5400m), 5341000N - 5347000N (6000m)) and image processed separately with a 50m cell size (**Maps 17 & 32b** and **Figure 38**). These data have been contoured at 0.5 mGal intervals and superimposed on the aeromagnetics (TMI colour drape on first vertical derivative) **Maps 18, 33**. The residual data were derived from the file "Tas Res" held by CMT. The residual data have had the following corrections performed:

- Terrain Correction
- Free air Correction
- Bouger Reduction
- Coastal Water Correction
- Mantle Correction

The data were interpolated using a simple spherical weighted fill with a radius of 4. This method was chosen after other interpolation methods and search radii were tested.

The gravity image compiled for the Linda EL 52/94 (**Map 32**) is a composite of

Figure No. 36 EL 52/94 - Grey scale maximum gradient image



5 cm

446072

Figure No. 37 Regional gravity image with geology from Queenstown sheet

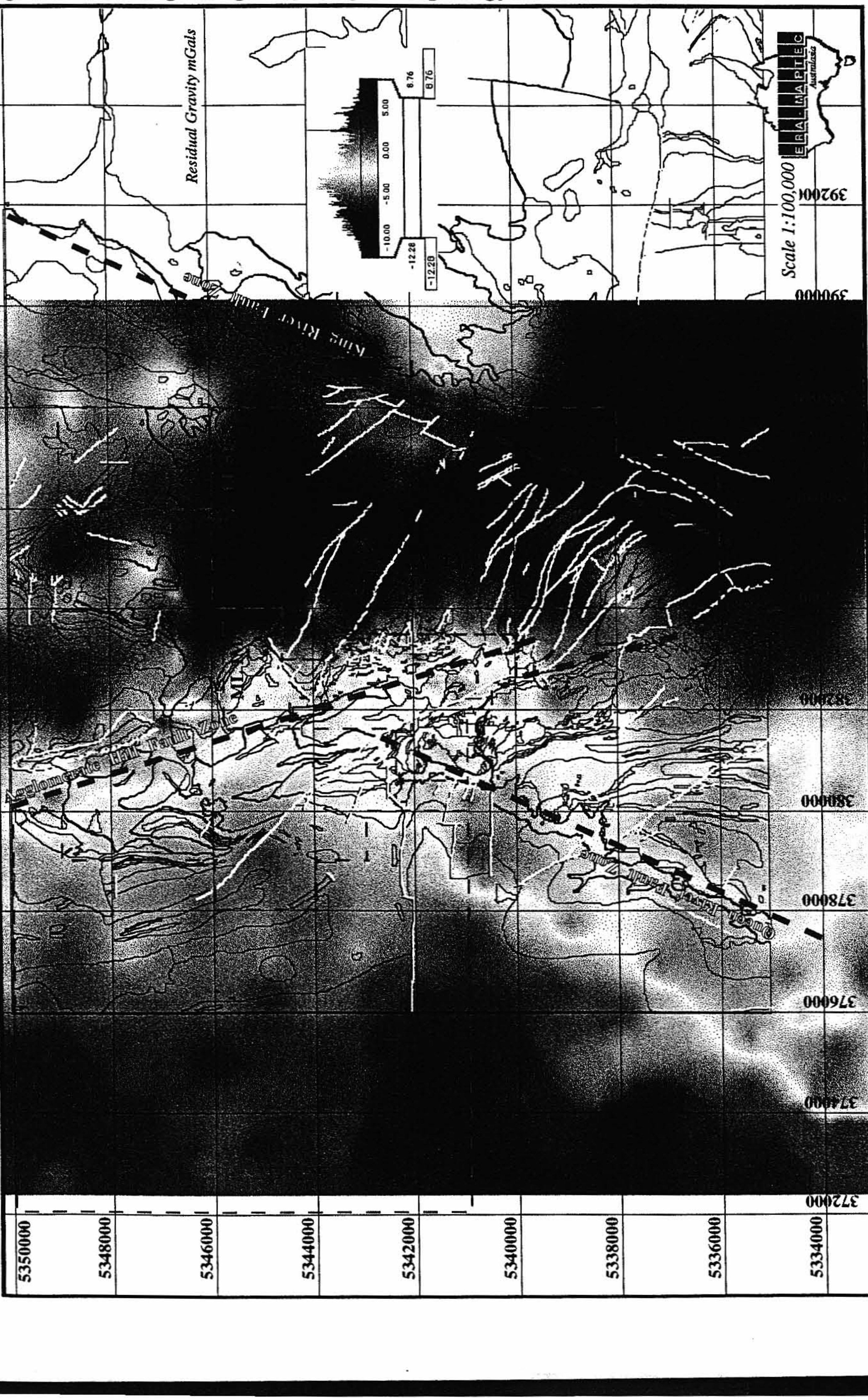
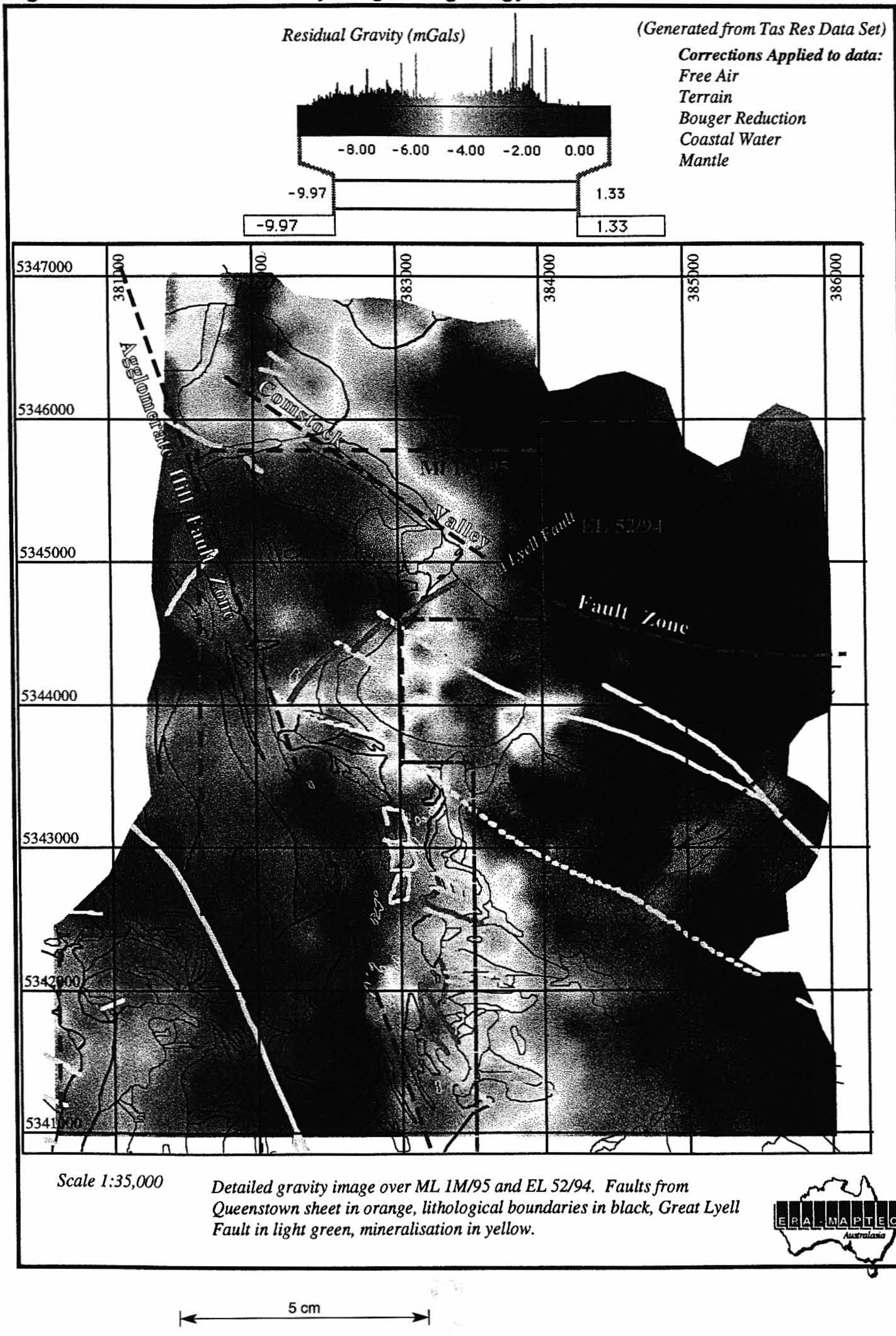


Figure No. 38 Detailed Gravity image and geology



Scale 1:35,000

Detailed gravity image over ML 1M/95 and EL 52/94. Faults from Queenstown sheet in orange, lithological boundaries in black, Great Lyell Fault in light green, mineralisation in yellow.

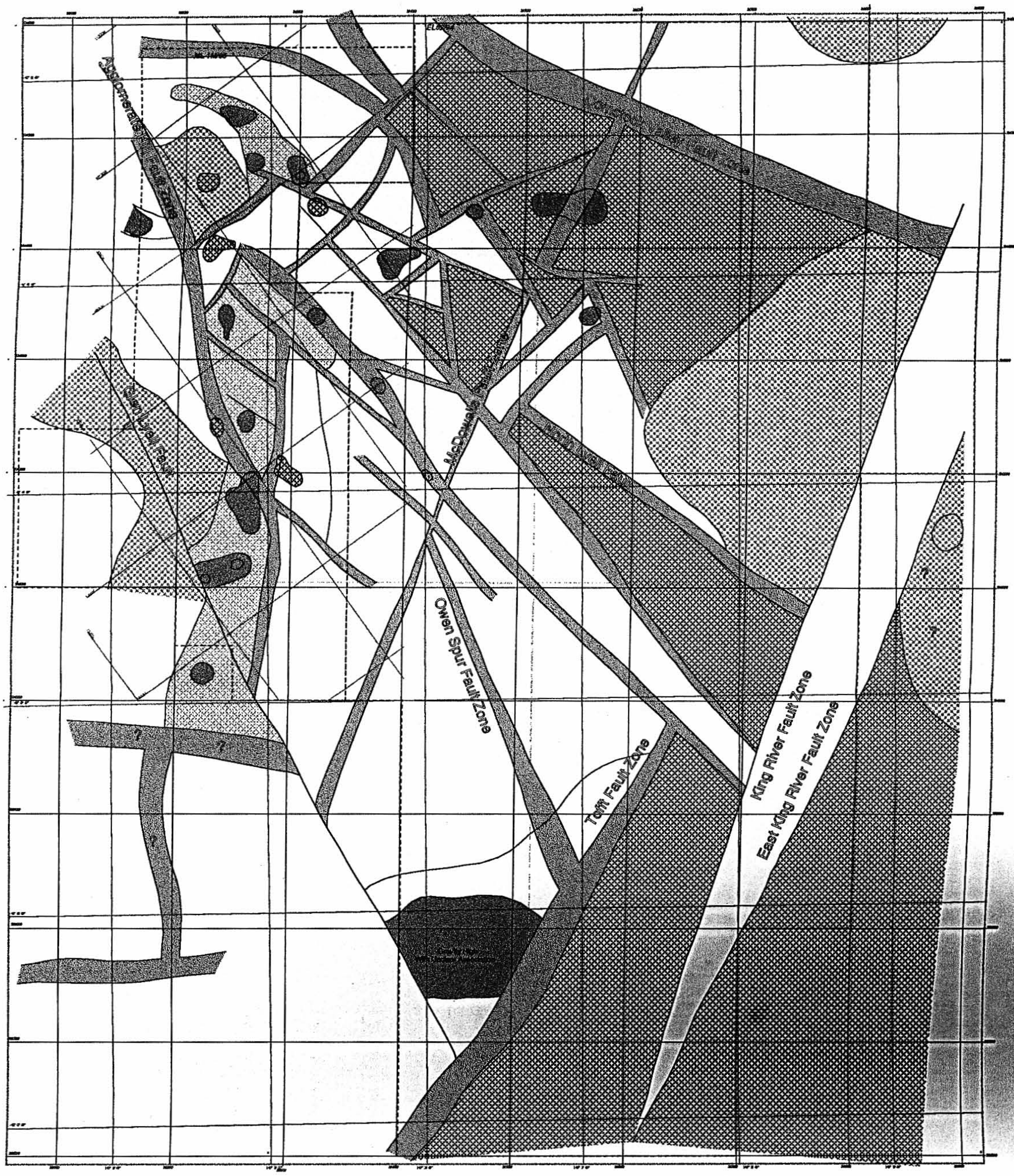
boundary between the data sets on the map in order to preserve the detail in the higher resolution data. Contours have also been generated at 0.5 mGal intervals for the regional data. These have been spliced with detailed contours and superimposed on the magnetic data (TMI colour drape on first vertical derivative) (**Map 33**). There is a degree of mismatch with the detailed contours due to the differing interpolation cell size.

A composite gravity image covering both EL 52/94 and ML 1M/95 has been produced (**Map 32b**) which also contains the contour data and data station locations to aid resolution of anomalies and gradients and to depict the varying degree of interpolation over the map.

The interpretation of the gravity data is shown in **Figure 39** and **Map 39**. The following observations have been made from the gravity images and contour maps.

- There is a general gravity gradient from low in the east to high in the west in association with the exposure of the Tyndall Group.
- The exposed area of Tyndall Group in EL 52/94 also controls a gravity high. The high is poorly constrained by only a few stations in the regional data.
- There are some extensive gradients in the data, some of which are coincident with known structures. The gradients separate blocks with a gravity change of up to 4 mGals.
- There is a very strong N-S gradient coincident with the eastern margin of the projected positions of the Prince Lyell and Royal Tharsis mineralisation and which also forms the western margin of Tharsis Ridge.
- A prominent low is present close to the projected position of the Prince Lyell mineralisation and which coincides with a gap in the mineralisation. The cause of this low is not clear (alteration, development voids?) and is defined by one station. There is a relatively high degree of interpolation in this area due lack of stations.
- There are a series of local gravity highs immediately west of the N-S gradient which correlate well with the distribution of the pyritic Lyell Schist (Lsp).
- Although the Tyndall Group rocks clearly control gravity highs there is a poor correlation between mapped boundaries and lithologies and the gravity signature. This suggests remapping is required.
- The Agglomerate Hill Fault Zone which was prominent in the magnetic data in ML 1M/95 is not so obvious within the gravity data but is consistent with the data and seems to create a low zone.
- The North Lyell Fault does not have a simple gradient associated with it and it appears there is a more complex fault pattern present than is mapped. A strong zone of NW trending structures with linking ESE zones is indicated. The North Lyell Fault, and the NE trending Great Lyell Fault, bound a gravity low are which is consistent with the presence of the Owen Conglomerate.
- The strong gravity gradient on the eastern margin of Prince Lyell

Figure No. 39 Interpretation of Gravity Data



AGD84 Zone 55 Coordinates

Scale 1:40,000

0 400 1200 2000 m

5 cm

Tenement Boundary

Gravity Gradient Zone

Very Low Gravity - Eldon Group?

Local Gravity Lows

Local Gravity Highs

Gravity High Zone Associated with Pyritic Lyell Schist

Gravity High Associated with Tyndal Group

446075

extends to the south and appears to end at around 5335000N in an area of poor data station density. The gradient zone contains patches of Pyritic Lyell Schist. The strength of the gradient and the local highs to the west suggest that either:

- The Pyritic Lyell Schist is strongly developed at depth or
- Tyndall Group rocks are present at depth. The magnetics suggest this is not the case as the gravity highs are coincident with lower magnetic signatures.

- ❑ The surface expression of the Great Lyell Fault east of Prince Lyell controls a very weak gradient.
- ❑ Gravity contours east of the Great Lyell Fault are influenced by the ESE structures associated with the Linda Disturbance. The folding mapped in the Pioneer Beds is also reflected in the gravity data.
- ❑ There is no obvious gravity low connecting Tharsis Ridge and Razorback which could be used to infer Owen Conglomerate at depth.
- ❑ The King River Fault System creates a broad low zone. A gravity high to the east of it suggest Tyndall Group rocks are present in places.
- ❑ There is a NE trending gravity ridge at around 385000E, 5343000N. This has no correlation with magnetics but is defined by a number of stations.
- ❑ The Comstock Valley Fault Zone as interpreted from magnetics is consistent with the gravity data, forming the margin to local highs but is not a prominent gravity feature. A much more significant feature in the detailed data is present to the north but is poorly constrained in the regional data.
- ❑ The Eldon Group creates low signatures and is possibly present south of the North Lyell Fault in EL 52/94.
- ❑ The Owen Spur Fault Zone as interpreted from magnetics is coincident with a saddle in high NE gravity trend in the south of EL 52/94.
- ❑ The McDowells Fault Zone is reflected in the gravity data.
- ❑ The Tofft Fault Zone could form the eastern margin to the southern gravity high in EL 52/94.
- ❑ Copper Estates lies within the broad spaced data and has no characteristic signature.
- ❑ Iron Blow is coincident with a -4 mGal gravity low.
- ❑ Western Tharsis is coincident with a gravity high anomaly (-0.22 mGals). The contours have a similar trend to the deposit strike.
- ❑ North Lyell lies in a lower gravity area but with no characteristic signature.
- ❑ Lyell Tharsis also on the margin of a low (probably associated with the Owen Conglomerate).
- ❑ Cape Horn lies in the NE trending gradient created by the Great Lyell

Fault. This gradient is much stronger than that coincident with the Great Lyell Fault to the south. A prominent gravity low is present just to the south (-4.26 mGals similar in size to that at Prince Lyell) at the junction of the Great Lyell and North Lyell Faults.

- Lyell Comstock is also within the Great Lyell Fault gradient but also lies on a strong N-S gradient created by the eastern margin of the Pyritic Lyell Schist (Lsp). The gravity high in this area indicates that Lsp extends away from the Great Lyell Fault and indicates a significant area of Lsp which contains some prominent local highs. The shape of the anomaly is consistent with foliation trends.
- A high is present at around 381600E, 5344200N which could be bounded by the Agglomerate Hill Fault Zone and the extension of the North Lyell Fault. The cause of this high is not clear although it lies within mapped Tyndall Group. It is possible it could be create by a fault bounded area of Lsp as it is not directly coincident with a magnetic high.

There is a direct association between gravity features and mineralisation and the results of the contouring and image processing of the data can be used as a strong criteria during target generation. The contoured data shown in **Maps 18** and **33** are more useful than the images for accurately positioning faults interpreted from strong gravity gradients, however the images give a better appreciation of the overall geometry of the gravity data. These interpreted features have been compiled in **Figure 39** and **Map 39**.

7 Identification of Target Areas

The major structural features in ML 1M/95 and EL 52/94 have been compiled in **Map 38** and **Figure 40**. This map contains:

- Faults from ML 1M/95 geology map
- Faults from Queenstown 1:25,000 sheet
- Mineralisation polygons from 1M/95.
- Major and minor structures interpreted from aeromagnetic images.
- Features interpreted from regional and detailed gravity data.

Although the aeromagnetic data did not match closely with the mapped geology, many of the features interpreted can be corroborated by reinterpreting the mapped geological boundaries and it is felt that the major fault zones identified in the interpretation will prove to be present when ground truthing is undertaken. The important points to arise from this study are:

- The mineralisation itself has no distinctive magnetic signature but **can be coincident with depressed magnetisation and fuzzy masking signatures probably related to alteration.**
- The Lyell Schists seem to have undergone considerably more

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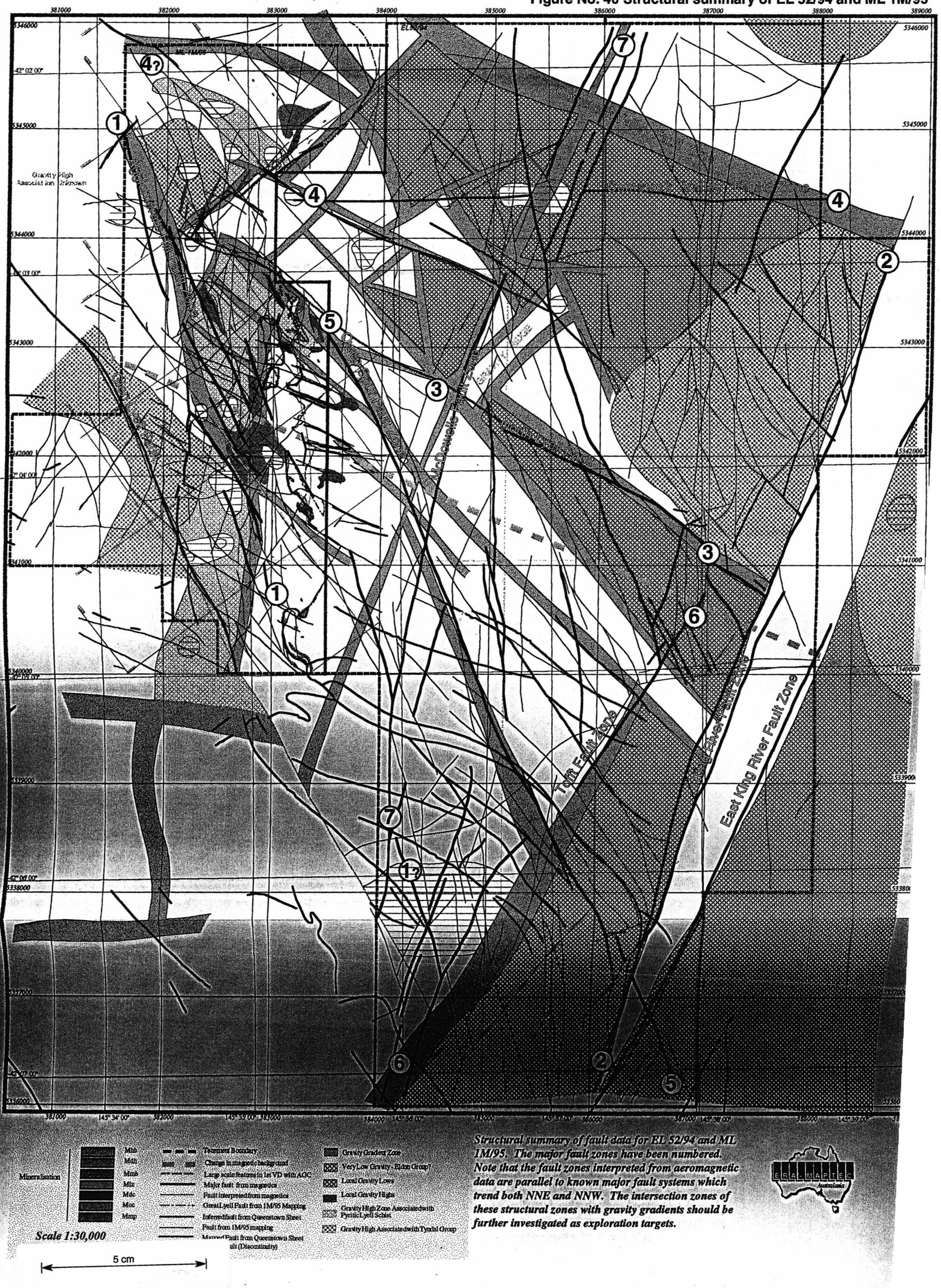
Figure No. 40 Structural summary of EL 52/94 and ML 1M/95



Structural summary of fault data for EL 52/94 and ML 1M/95. The major fault zones have been numbered. Note that the fault zones interpreted from aeromagnetic data are parallel to known major fault systems which trend both NNE and NNW. The intersection zones of these structural zones with gravity gradients should be further investigated as exploration targets.

deformation than the Ordovician rocks. This may be because they are deformed by broad zones of shearing including the Agglomerate Hill Fault Zone which, along with the King River Fault Zone, controls the strongest deformation in the study area.

- The **gravity data has a much more direct association with mineralisation**. The Mount Lyell deposits are coincident with both local high and low gravity signatures within an envelope of higher signatures created by the Pyritic Lyell Schist. A number of the deposits lie on or close to significant gravity gradients which could be the expression of basement fault zones. The Irish base metal deposits have a strong association with SW trending basement high margins which controlled the development of the later basins which contain the mineralisation and also provide the source for mineralising fluids. A similar model is applicable to the Mount Lyell deposits with VMS mineralisation sourced from deep seated basement structures which also had an important control on later deformation.
- The gravity data indicate an extensive development of pyritic Lyell Schist south of the Prince Lyell deposit, much more significant than indicated by mapping. The gravity highs are more intense than those in Lsp to the north.

Criteria for identifying target areas for further exploration include:

- Major fault zones which affect the gravity data. These have been numbered in Figure 40 and include:
  - **1** - The Agglomerate Hill Fault Zone
  - **2** - The King River Fault Zone
  - **3** - The North Lyell Fault
  - **4** - The Comstock Valley Fault Zone

  A number of other gravity gradient structures have also been identified (**Map 39 and Figure 39**) and also provide exploration potential. The largest gradients should be investigated first.
- Local gravity highs and lows are coincident with known deposits. Similar types of anomalies are present within ML 1M/95 and EL 52/94.
- Intersections of gravity gradients with other fault zones identified from the aeromagnetic data which include:
  - **5** - The Owen Spur Fault Zone
  - **6** - The Tofft Fault Zone
  - **7** - The McDowells Fault Zone
- The Agglomerate Hill and King River Fault Zones approach each other in the south of the Linda tenement. Faults also increase in frequency in this area. Enhanced fluid flow may have been generated in this zone. Some exposures of Mount Read Volcanics are mapped in this area on the Queenstown 1:25,000 sheet with potential for more extensive development under Quaternary cover. A gravity high is partly coincident with the volcanics but the high is poorly constrained due to a lack of data.

8 Recommendations

Following the interpretation of the data sets in this project the following recommendations are made:

- If flying further aeromagnetics it would be more useful to fly a symmetrical grid with tie lines at the same spacing as flight lines. There are significant features trending both E-W and N-S. A tighter line spacing would be required of 25 or 50m. Such a survey would also reduce the number of spurious features generated in the interpolation process.
- There are clearly large scale features present which have not been recognised in the mapping to date. A phase of ground truthing and structural mapping of the major zones identified in this project is required. This work would also delineate strain gradients within the area which seem to be closely linked to mineralisation.
- Further infill of the regional gravity survey would better delineate the anomalies in the southern portion of ML 1M/95, especially over the areas interpreted as possible Pyritic Lyell Schist. The southern portion of EL 52/94 and the area of the exposed Tyndall Group would also benefit from close spaced gravity data.

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Wills, K. 1995 Solid Geology Interpretation Map (Scale 1:5,000) Compiled from previous mapping. *CMT proprietary map.*

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INTERPRETATION OF AEROMAGNETIC AND GRAVITY DATA SETS - CMT EL 52/94 AND ML 1M/95 - ERA-MAPTEC

File Name	Description
Aeromagnetic Imagery	
ML 1M/95	
RTPVS.TIF	REDUCED TO POLE WITH VERTICAL SHADE - COLOUR
_1HD.TIF	FIRST HORIZONTAL DERIVATIVE - GREY SCALE
_1VD.TIF	FIRST VERTICAL DERIVATIVE - GREY SCALE
MAXGRAD.TIF	MAXIMUM GRADIENT IMAGE - GREY SCALE
RTP.TIF	REDUCED TO POLE TOTAL MAGNETIC INTENSITY - GREY SCALE
RTP0B.TIF	RTP IMAGE SHADOWED FROM NORTH - GREY SCALE
RTP90B.TIF	RTP IMAGE SHADOWED FROM EAST - GREY SCALE
RTP45B.TIF	RTP IMAGE SHADOWED FROM NE - GREY SCALE
RTP135B.TIF	RTP IMAGE SHADOWED FROM SE - GREY SCALE
RTPBY1VD.TIF	FIRST VERTICAL DERIVATIVE WITH RTP COLOUR DRAPE - COLOUR
RTPCOL.TIF	RTP TOTAL INTENSITY - COLOUR
RTPEW.TIF	RTP TOTAL INTENSITY SHADOWED FROM EAST - COLOUR
SHADECOL.TIF	COMBINATION OF THREE SHADOW DIRECTIONS ON RTP IN RGB IMAGE - COLOUR
VDG.TIF	FIRST VERTICAL DERIVATIVE WITH AUTOMATIC GAIN CONTROL
VDG0B.TIF	FIRST VERTICAL DERIVATIVE WITH AGC SHADOWED FROM SE - GREY SCALE
VDG135B.TIF	FIRST VERTICAL DERIVATIVE WITH AGC SHADOWED FROM NORTH - GREY SCALE
VDG45B.TIF	FIRST VERTICAL DERIVATIVE WITH AGC SHADOWED FROM NE - GREY SCALE
VDG90B.TIF	FIRST VERTICAL DERIVATIVE WITH AGC SHADOWED FROM EAST - GREY SCALE
AGCRGB.TIF	COMBINATION OF THREE 1ST VERTICAL DERIVATIVE WITH AGC SHADOWED IMAGES AS RGB - COLOUR
RTPMAXSH.TIF	MAXIMUM GRADIENT IMAGE SHADOWED FROM NE WITH COLOUR DRAPE OF RTP TOTAL INTENSITY
LEGEND	RASTER IMAGE OF COLOUR MAGNETIC INTENSITY BAR FOR COLOUR IMAGES
EL 52/94	
RTPVS.TIF	REDUCED TO POLE WITH VERTICAL SHADE - COLOUR
_1HD.TIF	FIRST HORIZONTAL DERIVATIVE - GREY SCALE
_1VD.TIF	FIRST VERTICAL DERIVATIVE - GREY SCALE
MAXGRAD.TIF	MAXIMUM GRADIENT IMAGE - GREY SCALE
RTP.TIF	REDUCED TO POLE TOTAL MAGNETIC INTENSITY - GREY SCALE
RTP0B.TIF	RTP IMAGE SHADOWED FROM NORTH - GREY SCALE
RTP90B.TIF	RTP IMAGE SHADOWED FROM EAST - GREY SCALE
RTP45B.TIF	RTP IMAGE SHADOWED FROM NE - GREY SCALE
RTP135B.TIF	RTP IMAGE SHADOWED FROM SE - GREY SCALE
RTPBY1VD.TIF	FIRST VERTICAL DERIVATIVE WITH RTP COLOUR DRAPE - COLOUR
RTPCOL.TIF	RTP TOTAL INTENSITY - COLOUR
RTPEW.TIF	RTP TOTAL INTENSITY SHADOWED FROM EAST - COLOUR
SHADECOL.TIF	COMBINATION OF THREE SHADOW DIRECTIONS ON RTP IN RGB IMAGE - COLOUR
VDG.TIF	FIRST VERTICAL DERIVATIVE WITH AUTOMATIC GAIN CONTROL
VDG0B.TIF	FIRST VERTICAL DERIVATIVE WITH AGC SHADOWED FROM SE - GREY SCALE
VDG135B.TIF	FIRST VERTICAL DERIVATIVE WITH AGC SHADOWED FROM NORTH - GREY SCALE
VDG45B.TIF	FIRST VERTICAL DERIVATIVE WITH AGC SHADOWED FROM NE - GREY SCALE

√DG90B.TIF	FIRST VERTICAL DERIVATIVE WITH AGC SHADOWED FROM EAST - GREY SCALE		
AGCRGB.TIF	COMBINATION OF THREE 1ST VERTICAL DERIVATIVE WITH AGC SHADOWED IMAGES AS RGB - COLOUR		
LEGEND	RASTER IMAGE OF COLOUR MAGNETIC INTENSITY BAR FOR COLOUR IMAGES		
Combined			
RTPEW.tif	COMBINATION OF COLOUR RTP IMAGES SHADOWED FROM EAST FOR ML 1M/95 AND EL 52/94		
RTP1VD.TIF	COMBINATION OF 1ST VERT DERIVATIVE WITH RTP COLOUR DRAPE FOR BOTH ML 1M/95 AND EL 52/94		
LEGEND	COLOUR BAR FOR RTPEW IMAGE IN WHICH MAGNETIC INTENSITIES HAVE BEEN NORMALISED		
TESLA 10 IMAGES			
ML 1m/95			
RTP.TIF	RTP MAGNETIC INTENSITY SUPERIMPOSED ON ENHANCEMENT		
RTP1HD.TIF	FIRST HORIZONTAL DERIVATIVE WITH COLOUR DRAPE		
RTP1VD.TIF	FIRST VERTICAL DERIVATIVE WITH COLOUR DRAPE		
EL 52/94			
LINDA1HD.TIF	FIRST HORIZONTAL DERIVATIVE - GREY SCALE		
LINDA1VD.TIF	FRIST VERTICAL DERIVATIVE - GREY SCALE		
LINDA RTP.TIF	RTP MAGNETIC INTENSITY AS COLOUR DRAPE ON ENHANCEMENT - COLOUR		
GRAVITY DATA			
GRAVSTNS	MAPINFO TABLE OF GRAVITY STATION LOCALITIES AND DATA		
DETGRAV.TAB	IMAGE OF AREA OF DETAILED GRAVITY DATA (NOTE IMAGE MARGINS HAVE INTERPOLATION PROBLEMS)		
REGGRAV.TAB	IMAGE ARE OF REGIONAL AND DETAILED GRAVITY DATA (250M CELL SIZE)		
REGCONT.TAB	MAPINFO TABLE OF 50MGAL CONTORS OF REGIONAL GRAVITY DATA		
DETCONT.TAB	MAPINFO TABLE OF DETAILED GRAVITY CONTOUR (10 MGAL INTERVAL)		
GRAVGRAD.TAB	MAPINFO TABLE OF INTERPRETED GRAVITY GRADIENTS		
GRAVBND.TAB	MAPINFO TABLE OF BOUNDARY TO REGIONAL AND DETAILED GRAVITY AREAS		
INFRASTRUCTURE			
ROADS.TAB	MAPINFO TABLE OF ROADS IN THE REGION		
INFRSRCT.TAB	MAPINFO TABLE OF BUILDINGS		
POWERLIN.TAB	MAPINFO TABLE OF POWERLINES		
TENEMENTS			
TENEMENT.TAB	MAPINFO TABLE OF TAGGED TENEMENTS		
CMT LOGO			
CMTLOGO	TIFF FILE OF CMT LOGO		
MLGEOL			
FILLS.TAB	MAPINFO TABLE OF SOLID COLOURED LITHOLOGY REGIONS FOR ML 1M/95		
GRLGRID.TAB	MAPINFO TABLE OF THE GRL GRID IN ML 1M/95 WITH LINES TAGGED		
LINES.TAB	MAPINFO TABLE OF VAROIUS POLYLINES INCLUDING LITHOLOGY BOUNDARIES, UNCONFORMITIES ETC		

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TEXT.TAB	MAPINFO TABLE OF INCOMPLETE TEXT FROM TRANSFER OF ML 1M/95 GEOLOGY
MIN.TAB	MAPINFO TABLE OF MINERALISATION REGIONS FROM ML 1M/95
MLFAULTS.TAB	MAPINFO TABLE OF FAULTS IN ML 1M/95
MINBOUND.TAB	MAPINFO TABLE OF BOUNDARIES TO MINERALISATION FOR OVERLAY ON RASTER IMAGES
QUEENGEO	
QBOUNDS.TAB	MAPINFO TABLE OF UNFILLED,TAGGED LITHOLOGY BOUNDARIES FOR QUEENSTOWN 1:25000 SHEET
QFAULTS.TAB	MAPINFO TABLE OF FAULTS FOR THE QUEENSTOWN 1:25,000 SHETT
QFILLS.TAB	MAPINFO TABLE OF FILLED AND TAGGED LITHOLOGY REGIONS FOR QUEENSTOWN 1:25,000 GEOLOGY SHEET
MLTOPO	
MLTOPO.TAB	MAPINFO TABLE OF SPLICED TOPOGRAPHIC CONTOURS FOR ML 1M/95
MAGINTERP	
_1STVD.TAB	MAPINFO TABLE OF INTERPRETATION OF 1ST VD SIGNATURES FOR ML 1M/95 AND EL 52/94
_1VDAGC.TAB	MAPINFO TABLE OF INTERPRETATION OF 1ST VD WITH AGC SIGNATURES FOR ML 1M/95 AND EL 52/94
_1VDBND.TAB	MAPINFO TABLE OF POLYLINES FORMING BOUNDARIES TO 1ST VD SIGNATURES FOR ML 1M/95 AND EL 52/94
_1VDGBND.TAB	MAPINFO TABLE OF POLYLINES FORMING BOUNDARIES TO 1ST VD WITH AGC SIGNATURES FOR ML 1M/95 AND EL 52/94
AGCZONE.TAB	MAPINFO TABLE OF PROMINENT BOUNDING STRUCTURES IN 1ST VD WITH AGC FOR ML 1M/95
GORMASTO.TAB	MAPINFO TABLE OF BOUNDARY TO MAGNETIC DISTURBANCE CAUSED BY GORMANSTON
LSPLOAGC.TAB	MAPINFO TABLE OF AREAS OF LOW SIGNATURE IN THE 1ST VD WITH AGC IMAGE FOR ML 1M/95 PARTLY COINCIDENT WITH LITHOLOGY
MAGFAULT.TAB	MAPINFO TABLE OF FAULTS INTERPRETED FROM MAGNETICS
MAGMAJFT.TAB	MAPINFO TABLE OF MAJOR FAULTS INTERPRETED FROM MAGNETICS
MAGSURV.TAB	MAPINFO TABLE OF MAGNETIC SURVEY BOUNDARIES TAGGED WITH SURVEY SPECS
MAXGBND.TAB	MAPINFO TABLE OF BOUNDARIES TO SIGNATURES FROM MAXIMUM GRADIENT IMAGES
MAXGRAD.TAB	MAPINFO TABLE OF SIGNATURES INTERPRETED FROM MAXIMUM GRADIENT IMAGES
RTPHIBND.TAB	MAPINFO TABLE OF BOUNDARIES TI RTP HIGHS IN MAGNETICS
SHADLITH.TAB	MAPINFO TABLE OF POSSBLE BEDDING TRENDS INTERPRETED FROM SHADOWED RTP IMAGES
MAGCHANG.TAB	MAPINFO TABLE OF SE TRENDING BOUNDARY ACROSS WHICH BACGROUND MAGNETIC INTENSITIES CHANGE
RTPVSMAG.TAB	MAPINFO TABLE OF SIGNATURES INTERPRETED FROM RTP TOTAL INTENSITY IMAGES.

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