TASMANIA
DEVELOPMENT
AND RESOURCES

**Tasmanian Geological Survey**
**Record 1996/16**

# *Combined interpretation of new aerial-survey geophysical datasets for northwestern Tasmania*

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**Figures**



## INTRODUCTION

New datasets, including magnetic, radiometric (K, U, Th and total counts) and digital terrain coverages, were collected in an aerial survey, with a line spacing of 200 m, flown over a 3560 km$^2$ area of north- western Tasmania in April 1996. The primary reason for the survey was to assist in the assessment of the mineral potential of the Northwest Forests Area as part of the Mineral Resources Tasmania (MRT) report for the Regional Forest Agreement. The approach used to interpret the new data was to construct a separate interpretation layer for each of the three main coverages (magnetic, radiometric, digital terrain combined with pre-existing LANDSAT coverage) using a non-genetic style of annotation, then use these to produce a combined interpretation with as much geological identification of features as possible. Identification of linear features was assisted by examination of the first vertical derivative of the total magnetic intensity and total radiometric counts coverages, with separate images illuminated from the northeast and from the southeast. In outlining and classifying anomalies, the contrast of an anomaly with its immediate surroundings was, in many cases, given as much priority as its absolute amplitude.

Much of the central part of the survey area has never been subject to systematic geological mapping at any scale, and it was known that the compilation of existing regional geological coverages (in particular the MRT 1:250 000 scale digital coverage) relied significantly on interpretation of less-detailed geophysical datasets in existence prior to this new survey. Therefore, in order to avoid circular reasoning, the interpretation avoided undue reference to the existing 1:250 000 scale geological coverage (which is included as Figure 1 herein), except in areas where known ground geological mapping could help identify rock types responsible for geophysical anomalies. Existing MRT published and unpublished systematic 1:50 000 and 1:25 000 scale geological mapping in the northern and southern marginal parts of the survey area provided similar ground control in these areas, and is referred to where appropriate. However, polygon boundaries are presented as they were drawn from the survey data only, and have not been modified based on ground geological information. Discussion of the interpretation is based mainly on the combined interpretation layer, on which most of the geological inferences are made. Reference is made to the four other intermediate layers where appropriate.

The enhanced images of the original datasets were produced by Dr Robert Richardson. Production of the geological map and interpretation diagrams was by the Data Management Group of MRT.

## INTERPRETATION

### *Major faults*

The most obvious feature of the interpretation is the identification of a number of regional-scale major faults, which separate large domains with either differing magnetic signatures or differing structural trends, or both.

In the central north of the survey area, the NNE-trending Roger River Fault (fig. 1, 9), a previously known structure, is prominent on both the aeromagnetic and topographic coverages (fig. 2, 3, 6, 7, 8). In this interpretation, the splay pattern at the fault's southern end differs from that shown on the existing 1:250 000 scale geological coverage.

In the southeastern part of the survey area a pair of NE-trending major faults extend from the Pieman River at the west coast through the Arthur Metamorphic Complex (see below), offsetting both the western boundary and internal structural trends (fig. 9). These two faults correspond to the Pieman and Donaldson Faults, which are known from existing 1:50 000 scale mapping (Turner *et al.*, 1991) (fig. 1).

Two newly-recognised major faults appear to connect the southern end of the Roger River Fault with the Pieman Fault in the southeast of the survey area. The easternmost of these is an arcuate structure commencing near the southern end of the main trace of the Roger River Fault, from where it trends eastward then southward to join the Pieman Fault, finally intersecting the west coast near the mouth of the Pieman River (fig. 9). Expressions of this fault were visible on both the aeromagnetic and radiometric coverages (fig. 2, 3, 4, 5). The very arcuate shape of this structure suggests that it may be an east to northeast-directed thrust fault, an idea supported by the manner in which it terminates the pattern of structural trends in the block to the northeast. Furthermore, the way the fault appears to offset magnetic anomalies attributed to Proterozoic basalts (see below) suggests that the horizontal offset could be in the order of 7 to 12 kilometres. The other major fault also commences near the southern end of the Roger River Fault, and trends mostly SSE along the western side of the Norfolk Range, finally curving to a southwest trend to intersect the west coast just north of the Pieman River (fig. 9). This fault was identified mainly on the basis of discontinuities between the magnetic signatures and structural trend patterns in the blocks to the east and west. Together, the two newly-recognised major faults outline a large D-shaped domain (see further discussion below) which has distinctive magnetic and structural signatures compared with adjoining domains.

### *Arthur Metamorphic Complex (AMC)*

In the southeastern part of the survey area an eight kilometre wide NNE-trending belt of very strong linear magnetic anomalies and associated topographic linears is due to strongly magnetic rock units (amphibolite and metabasalt) in the Arthur Metamorphic Complex (fig. 9), a correlation based on available 1:50 000 scale geological mapping in the southern part of the survey area (Turner *et al.*, 1991). The pronounced pinch and swell in the width of this belt is due to the Pieman and Donaldson Faults, which cross-cut it obliquely.

### *Neoproterozoic sequences*

In the central northern part of the survey area, a four to seven kilometre wide zone of strong magnetic anomalies immediately east of the Roger River Fault (fig. 2, 3, 9) is known, from available 1:50 000 scale mapping (Everard *et al.*, 1996), to be due to strongly magnetic Neoproterozoic basalt of the Togari Group, the main unit forming the Smithton Synclinorium. Other units in the Togari Group are mainly shelf-facies siliciclastic and carbonate rocks which are essentially non-magnetic. The aeromagnetic coverage shows that basalt is much less significant west of the Roger River Fault, but is still present as at least one thin, northwest-trending unit (shown mainly as a lithological trend line on the combined interpretation, fig. 9), which according to recent 1:25 000 scale mapping is close to the base of the Togari Group (Everard *et al.*, in press). A small but strong magnetic anomaly in the same area is due to a gabbroic intrusive rock low in the Togari Group (fig. 2, 3, 9). An elongate ESE-trending narrow magnetic anomaly nine kilometres ESE of Balfour corresponds with a mapped outlier of Togari Group basalt (unpublished MRT mapping). This outlier is believed to represent a fault offset of a similar unit immediately west of the southern end of the main trace of the Roger River Fault (fig. 1, 9).

There are other, mostly unexplained, weak to moderate magnetic anomalies in the Togari Group north of the thin basalt-gabbro units west of the Roger River Fault. Some of these are in localities known, from existing ground information, to be underlain by Neoproterozoic shelf carbonate sequences. Because carbonate sequences have potential for replacement mineralisation, such anomalies are of particular interest. One such anomaly is a diffuse elliptical feature just west of the Roger River Fault, about nine kilometres WSW of Trowutta (fig. 2, 3, 9), and which is partially coincident with or transected by a WNW-trending linear magnetic anomaly. The latter is parallel to another longer linear magnetic anomaly further south (just north of the lower Arthur River, fig. 2, 3, 9), which transects both Togari Group sequences and a significant part of the underlying Rocky Cape Group. Apart from these magnetic anomalies, the distinction shown on the datasets across the immediate boundary of the Rocky Cape and Togari Groups west of the Roger River Fault is subtle, and mainly expressed as a difference in density of structural trend lines discernible on the aeromagnetic and topographic coverages (fig. 2, 6 and 7).

As noted above, the newly-inferred major arcuate fault trending ESE from near Balfour (fig. 9) may be an east to northeast-directed thrust which may have over-ridden southward extensions, at depth, of Togari Group carbonate sequences. Such extensions, if they existed, would place these carbonate rocks in proximity to inferred Devonian granitoid at depths of less than two kilometres (Leaman and Richardson, 1992), with the consequent possibility of concealed replacement mineralisation.

Immediately west of the AMC, close to the southern margin of the area, a single strong northeast-trending linear magnetic anomaly is embedded in a similarly-trending four kilometre wide magnetically low area (fig. 2, 3). This corresponds to another Neoproterozoic basalt sequence enclosed by carbonate sequences in the Ahrberg Group, a correlate of the Togari Group (Turner *et al.*, 1991).

## *Rocky Cape Group*

With the exception of the southeastern corner, most of the remainder of the survey area is either known or assumed to be underlain by correlates of the Rocky Cape Group, a ?Mesoproterozoic, largely shelf-facies clastic sedimentary sequence with minor carbonate rocks. These rocks are considered to be prospective for Proterozoic sedimentary-exhalative base-metal mineralisation and Devonian base-metal vein mineralisation.

The interpretation presented here enables subdivision of the area of known or assumed Rocky Cape Group rocks into a number of large domains. These show considerable variation in characteristics and are separated by the major faults which have been identified.

Between the Norfolk Range and the west coast, and running parallel to the coast between Sundown Point and just north of the Pieman River, is a $55 \times 15$ km domain of Rocky Cape Group rocks characterised by a noisy magnetic signature with many small to medium-sized moderate to strong anomalies. A general NNW-trending structural grain is visible in the aeromagnetic and topographic coverages (fig. 2, 3, 6, 7, 8, 9). This domain is bounded immediately east of the Norfolk Range by one of the inferred major faults (fig. 9). A discontinuous line of narrow NNW-trending strong magnetic anomalies immediately west of this fault (fig. 2, 3, 9) has, in recent mineral exploration, been interpreted as being due to pyrrhotitic siltstone in the Rocky Cape Group. However the proximity to an inferred major fault perhaps raises the possibility of fault-related mineralisation, as gravity interpretation (Leaman and Richardson, 1992) suggests that the anomalies partially overlie inferred Devonian granitoid at depths of less than two kilometres. This line of anomalies appears to have a somewhat more discontinuous extension into the northwestern corner of the survey area (fig. 2, 3, 9).

North of the Sundown Point–Norfolk Range domain, between the west coast and the edge of the Smithton Synclinorium (defined by the base of the Togari Group), the magnetic character of the Rocky Cape Group is much less noisy, except for the northwesterly extension of the line of anomalies adjacent to the eastern bounding fault of the domain. Some eight kilometres inland from the coast, in the vicinity of the lower Arthur River, there is an interesting (and unexplained) rectilinear pattern of intersecting narrow linear magnetic anomalies, consisting of a WNW-trending set obviously overprinted by a later, almost north-trending set (fig. 2, 3, 9). The former continues into the Smithton Synclinorium (see above) and may be partially fault-related, but the latter has the appearance of a set of dyke or vein system-related anomalies.

Inland from the Sundown Point–Norfolk Range domain is a $40 \times 14$ km D-shaped area of Rocky Cape Group rocks lying between the two newly-recognised major faults described earlier (fig. 9). This area (referred to here as the Balfour–Mt Sunday domain) has a noisy magnetic signature similar to that in the Sundown Point–Norfolk Range domain, but shows a pattern of intersecting NNE and WNW structural trends, discernible on the aeromagnetic and topographic data and also, to some extent, in the radiometric data.

Northeast of the Balfour–Mt Sunday domain is a large, 40 × 22 km rectangular area of Rocky Cape Group and lower Togari Group rocks with a quiet overall magnetic signature, referred to here as the Arthur River–Rapid River domain. The eastern half of this area contains fairly subtle, NNE-trending, long narrow linear magnetic anomalies (fig. 2), which according to recent geological mapping (Everard *et al*., 1996) are due to a swarm of dolerite dykes intruding the Rocky Cape Group (fig. 1, 9). The dykes are intruded parallel to the dominant structural trend in the country rocks. The aeromagnetic coverage shows that this dyke-related pattern is abruptly terminated against the arcuate eastern bounding fault of the Balfour–Mt Sunday domain (fig. 2, 3, 9). Apart from the absence of dykes in the Togari Group, the distinction between the Rocky Cape Group and the Togari Group in this domain is not obvious in any of the datasets. West of the dolerite dyke swarm, about eight kilometres southeast of Trowutta, a slightly discontinuous line of narrow, northeast-trending moderate magnetic anomalies in the Rocky Cape Group and lower Togari Group has no proven origin, but recent work on major faults in the Rocky Cape Group north of the area of this study suggests that this anomaly may be fault related (Seymour, 1996). The Rapid River Lineament, a WNW-trending topographic linear defined by the overall trend of the trunk of the Rapid River (fig. 6, 7, 8), appears to have no discernible expression in offsets of structural or lithological trends visible on the geophysical datasets. Sixteen kilometres NNW of Savage River, in the southeastern corner of the Arthur River–Rapid River domain, an 8 × 2 km area of strong magnetic signature in presumed Rocky Cape Group rocks lies adjacent to the arcuate eastern bounding fault of the Balfour–Mt Sunday domain (fig. 2, 3, 9). This area has internal north-south structural trends (visible on the aeromagnetic and topographic coverages), but is of unexplained origin.

Rocky Cape Group rocks also occur between the two major northeast-trending faults in the southeastern part of the survey area, but to the southwest of the AMC rocks within this zone. The Rocky Cape Group rocks here have a moderately noisy magnetic signature, with a dominant northeasterly structural trend visible on the aeromagnetic, topographic and radiometric coverages (fig. 9).

### *Cambrian rock units*

Eight kilometres ENE of Savage River, at the eastern margin of the survey area, a 16 × 5 km area of strong magnetic signature is mainly due to the Cambrian Heazlewood Ultramafic Complex (fig. 1, 2, 3, 9), much of which falls outside the area of the survey.

### *Devonian rock units*

At the southeastern corner of the survey area, a 17 × 8 km area of very low magnetic response corresponds with part of the Late Devonian or Early Carboniferous Meredith Granite (fig. 1, 2, 3, 9), the bulk of which falls outside the survey area. An arcuate 8 × 1.5 km area of strong magnetic anomaly, immediately southwest of the Heazlewood Complex anomaly, appears to correspond with a known area of metamorphosed country rocks developed adjacent to the northwestern margin of the Meredith Granite (Turner *et al*., 1991) (fig. 1, 2, 3, 9). Adjacent to the west coast, near the southwestern margin of the survey area, a 21 × 4 km area of low magnetic response corresponds to the Early Carboniferous Interview Granite (Williams *et al*., 1989; also called the Pieman Granite by Leaman and Richardson, 1989) (fig. 1, 2, 3, 9).

## CONCLUDING COMMENTS

In mainland Australia, geological terrains similar to the little-explored Proterozoic terrain of northwestern Tasmania have been subject to intensive exploration for major ore deposits, with considerable success. When compared to the exploration model parameters used in the equivalent geological environments in mainland Australia, the new geophysical datasets for northwestern Tasmania show a number of positive indicators for mineral prospectivity. These include:

- The inferred presence of major regional-scale faults (including possible thrust faults) which may be big enough to penetrate to mid-crustal levels, and which could have acted as conduits for ore-forming fluids;
- Narrow but strong magnetic anomalies adjacent to some of these inferred faults, which may indicate fault-controlled mineralisation;
- Generally noisy magnetic signatures over large areas of Proterozoic sedimentary sequences which contain no known anomalously magnetic rock types, combined with sufficient proximity to known or inferred Devonian granitoids to allow the possibility that these signatures are due to granitoid-related mineralisation;
- Unexplained linear and 'bulls-eye' magnetic anomalies located in areas known to be immediately underlain by Proterozoic carbonate sequences, suggesting the possibility of replacement mineralisation;
- The possibility that an inferred major east-directed thrust fault may have concealed (possibly at shallow depths) southward extensions of Togari Group carbonate sequences in an area in which they would be more proximal to granitoid rocks, and therefore more likely to host replacement mineralisation.

## REFERENCES


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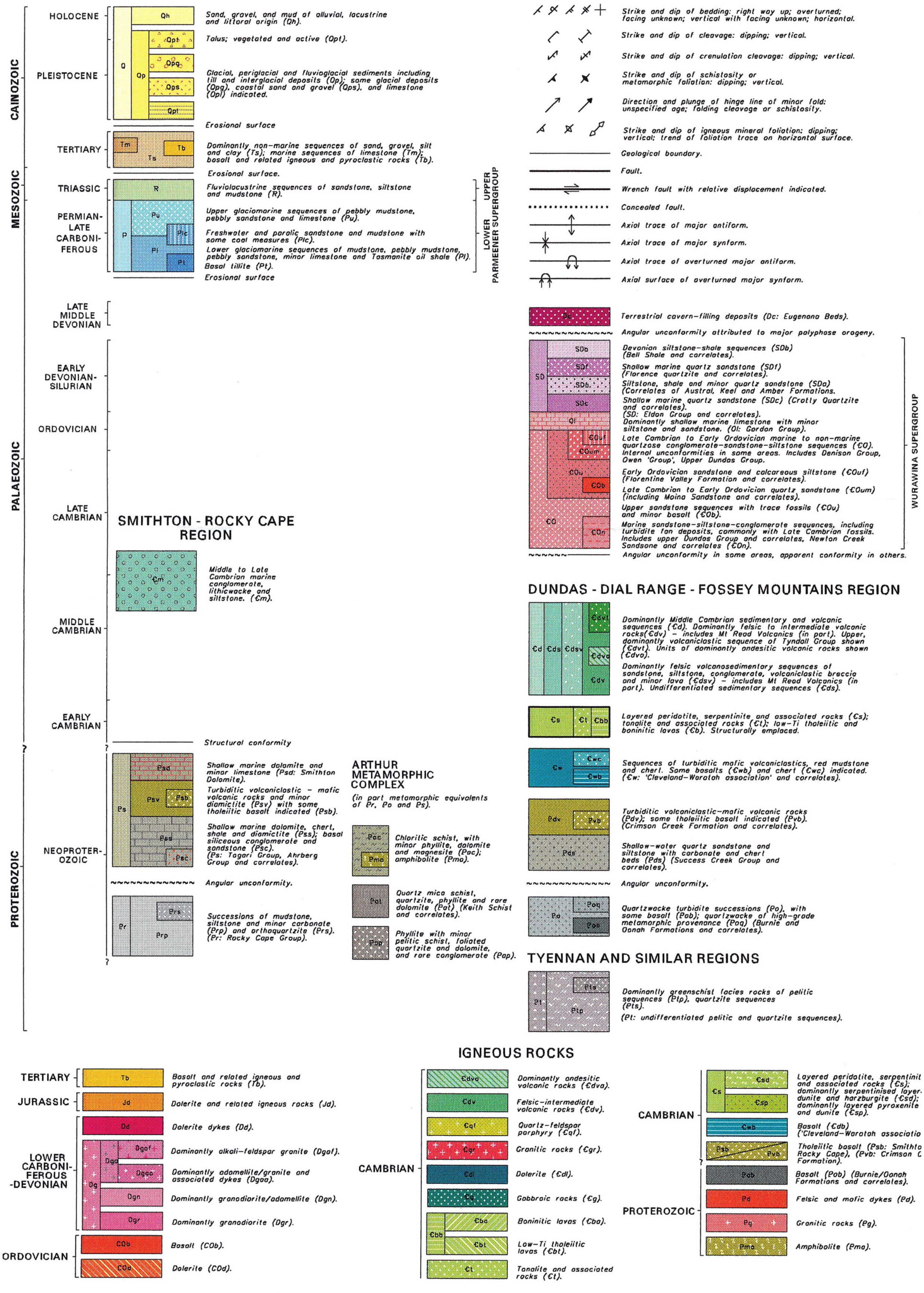
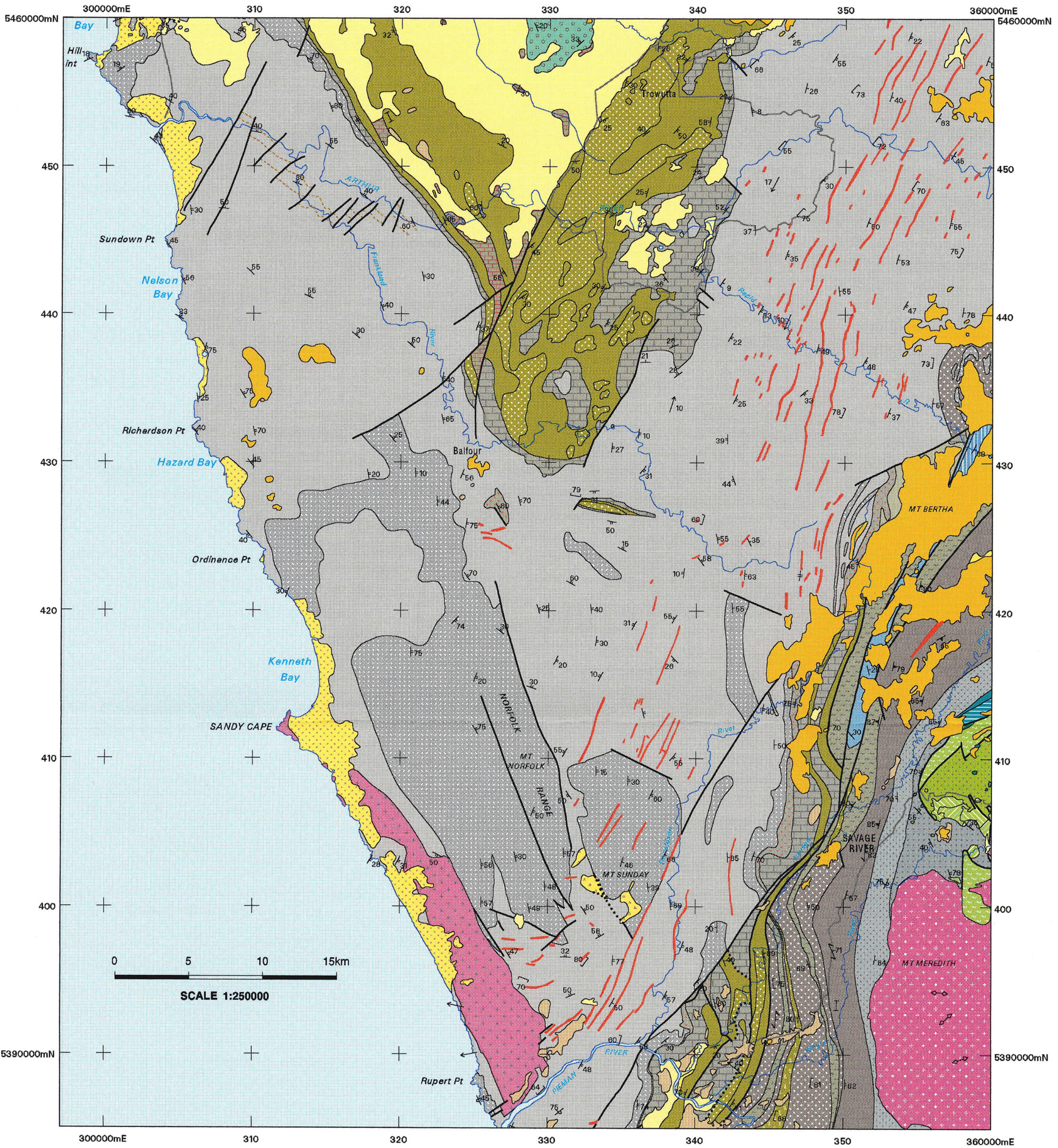
[25 November 1996]

# FIGURE 1A - COMPREHENSIVE LEGEND FOR 1:250,000 GEOLOGY OF NORTHWEST TASMANIA

**(From Calver et al 1995)**






# FIGURE 1B - 1:250,000 GEOLOGY

**(From Calver et al 1995; see Figure 1A for legend)**

NORTHWEST FORESTS AIRBORNE GEOPHYSICAL SURVEY TASMANIA - APRIL 1996

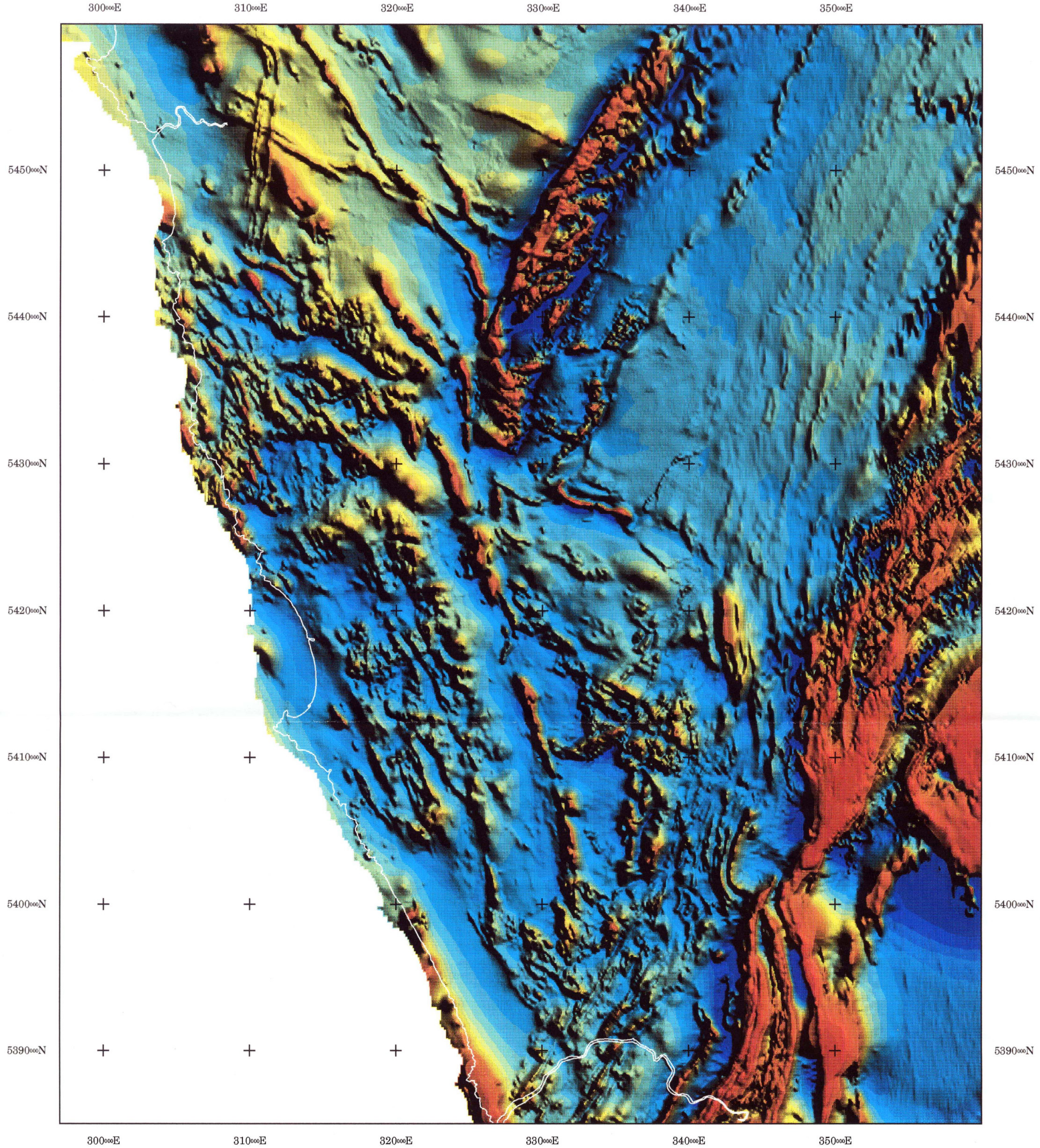



FIGURE 2 - PSEUDO COLOUR TOTAL MAGNETIC INTENSITY IMAGE, APRIL 1996 NORTHWEST FORESTS AIRBORNE GEOPHYSICAL SURVEY, TASMANIA

ILLUMINATION FROM THE NORTHEAST
RED=HIGH BLUE=LOW

0 5 10 15 km

SCALE 1:250000

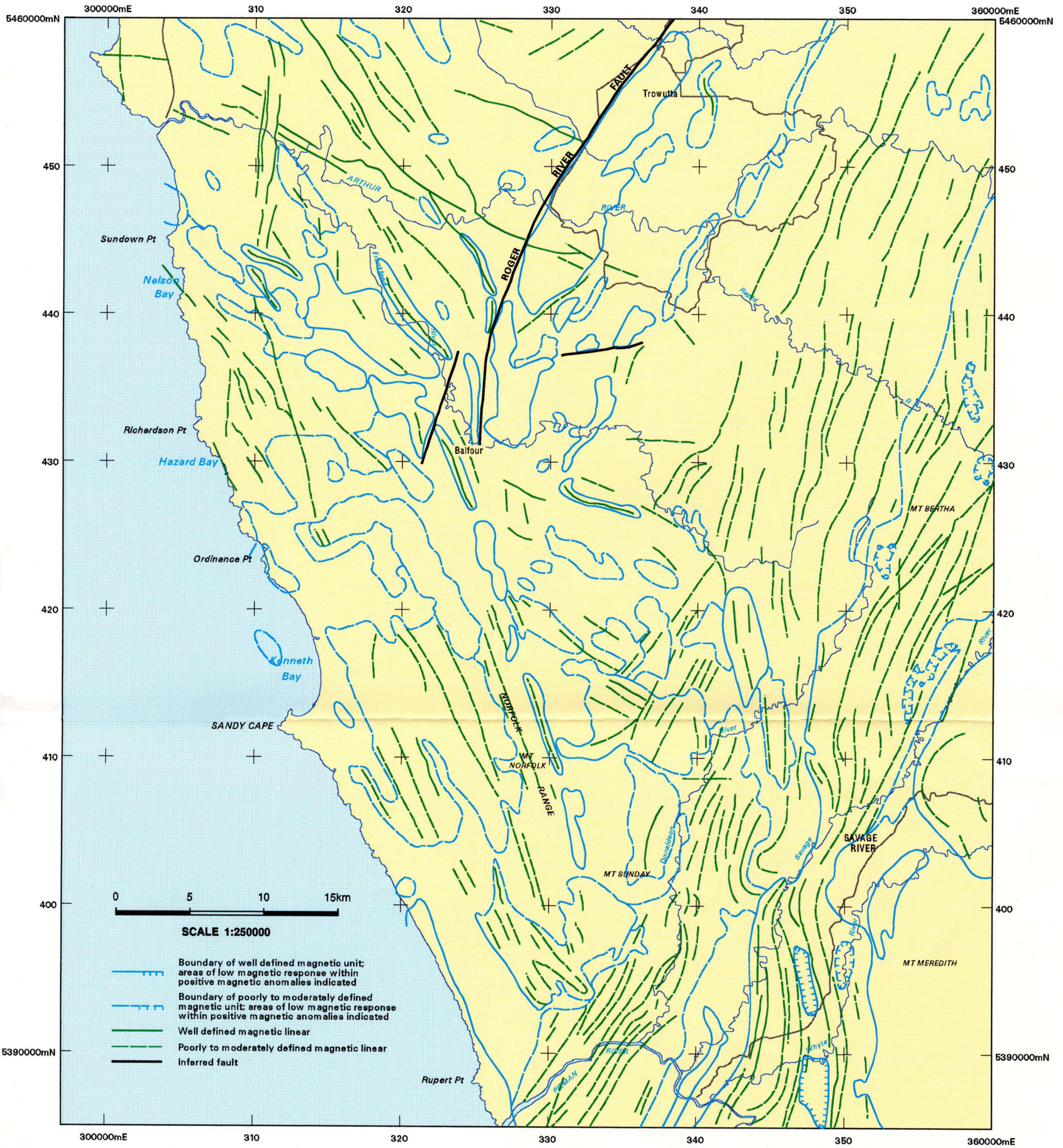



**FIGURE 3 - INTERPRETATION OF MAGNETIC INTENSITY COVERAGE**

NORTHWEST FORESTS AIRBORNE GEOPHYSICAL SURVEY TASMANIA - APRIL 1996

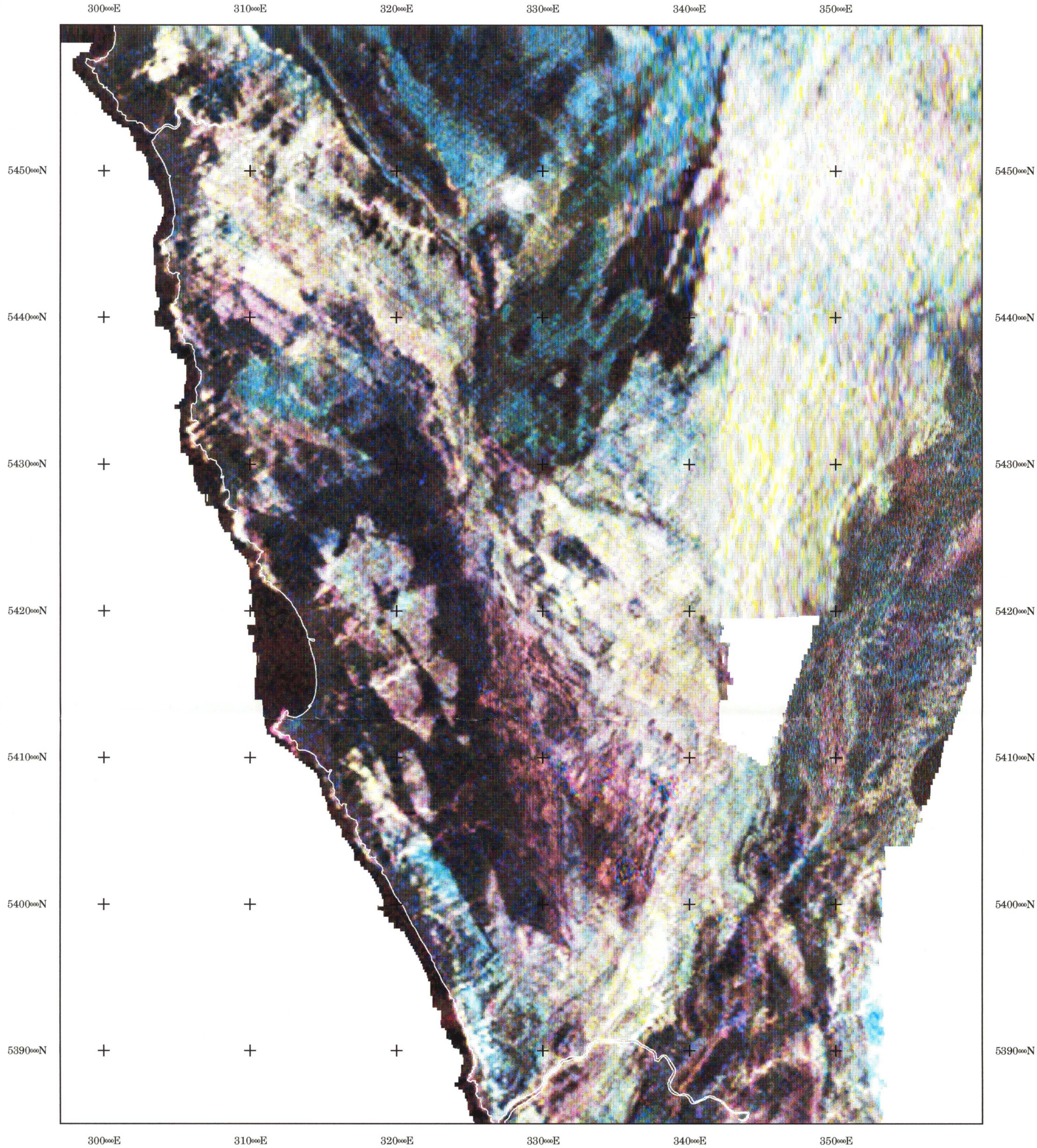
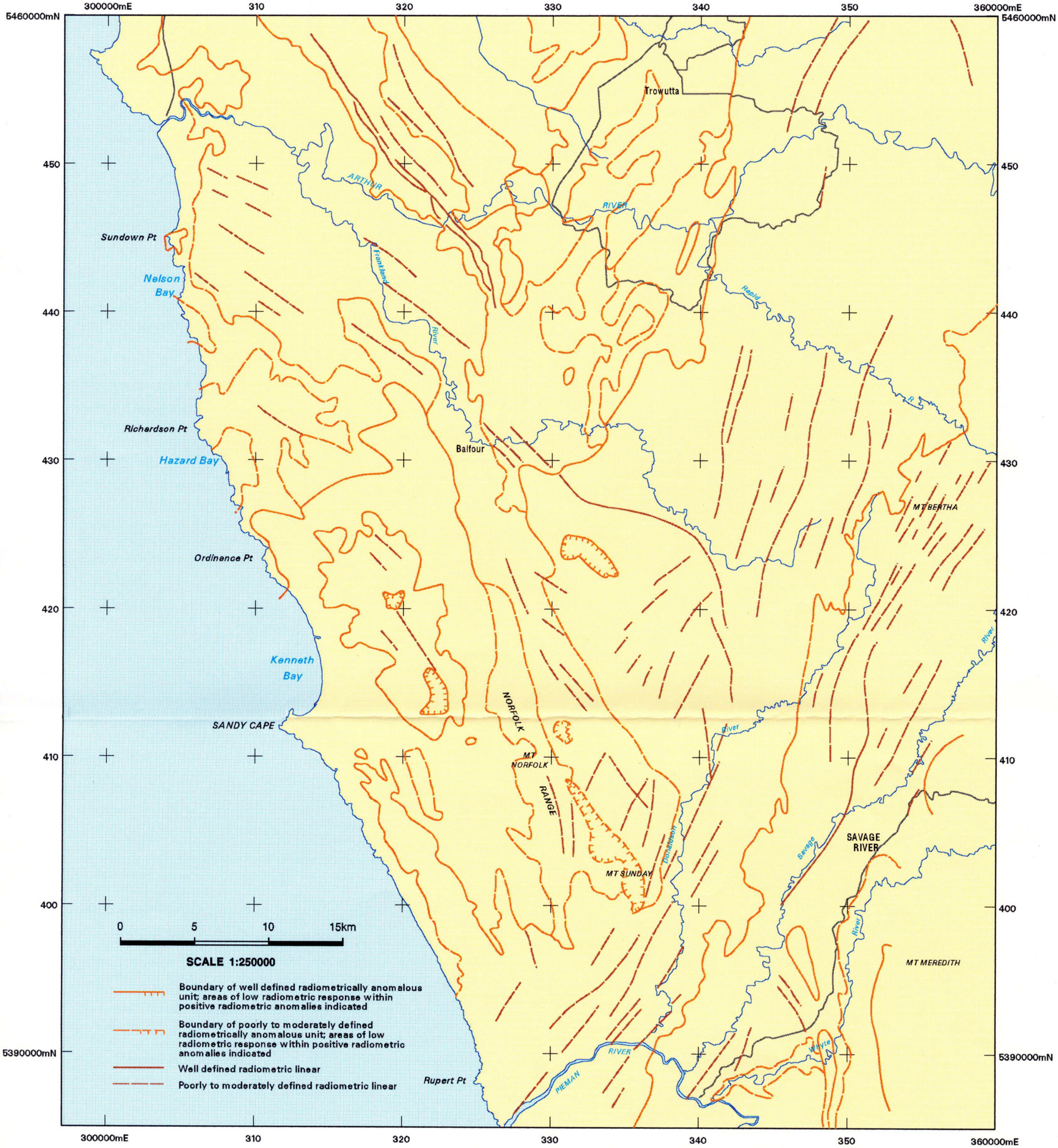



FIGURE 4 - TERNARY IMAGE OF RADIOMETRIC COUNTS, APRIL 1996 NORTHWEST FORESTS AIRBORNE GEOPHYSICAL SURVEY, TASMANIA

RED=POTASSIUM
GREEN=THORIUM
BLUE=URANIUM

0 5 10 15 km

SCALE 1:250000




# FIGURE 5 - INTERPRETATION OF RADIOMETRIC COUNTS COVERAGES

NORTHWEST FORESTS AIRBORNE GEOPHYSICAL SURVEY TASMANIA - APRIL 1996

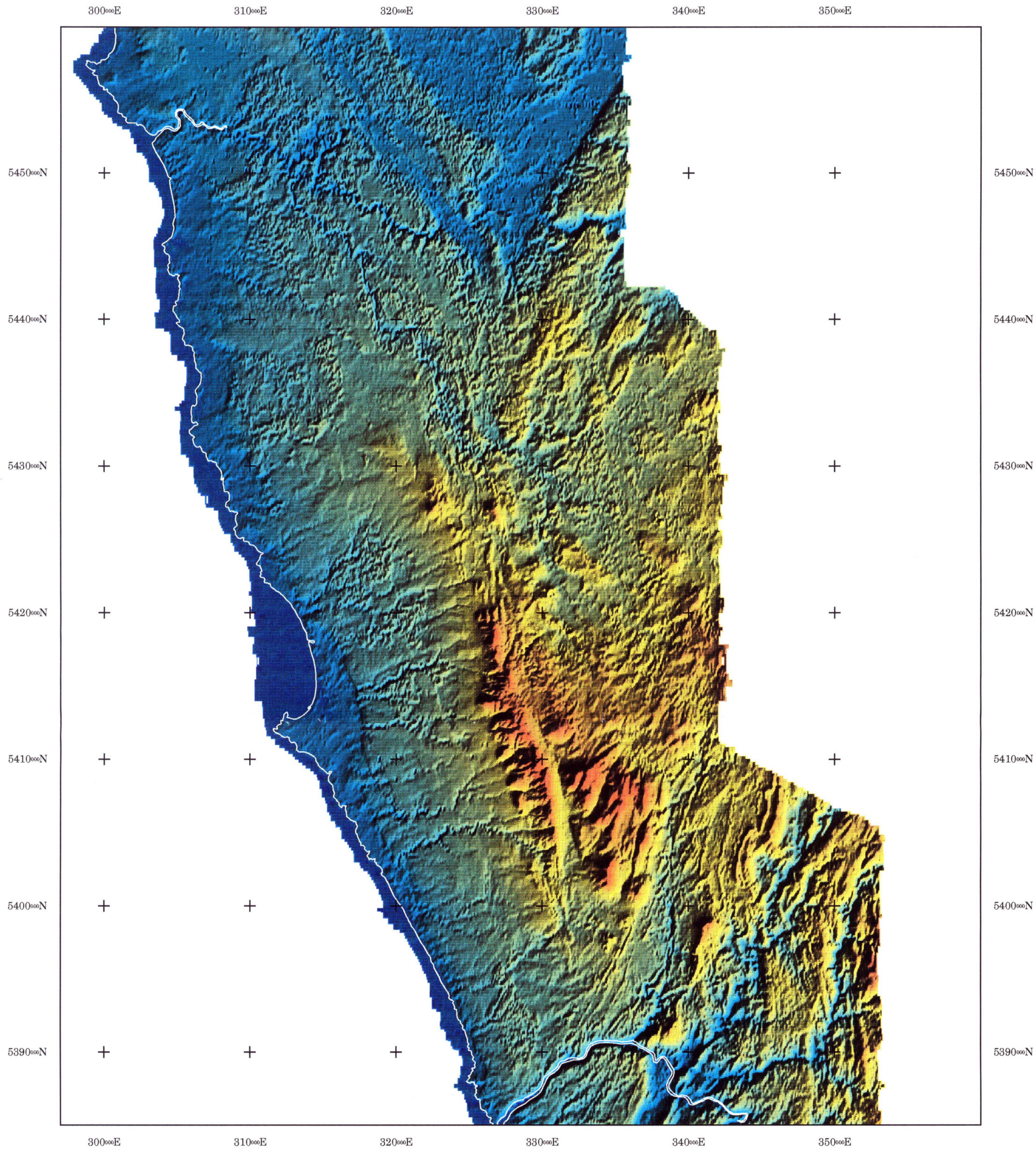
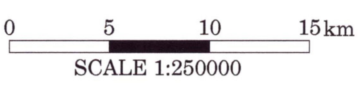



FIGURE 6 - PSEUDO COLOUR DIGITAL TERRAIN IMAGE, APRIL 1996 NORTHWEST FORESTS AIRBORNE GEOPHYSICAL SURVEY, TASMANIA

ILLUMINATION FROM THE SOUTHEAST
RED=HIGH BLUE=LOW



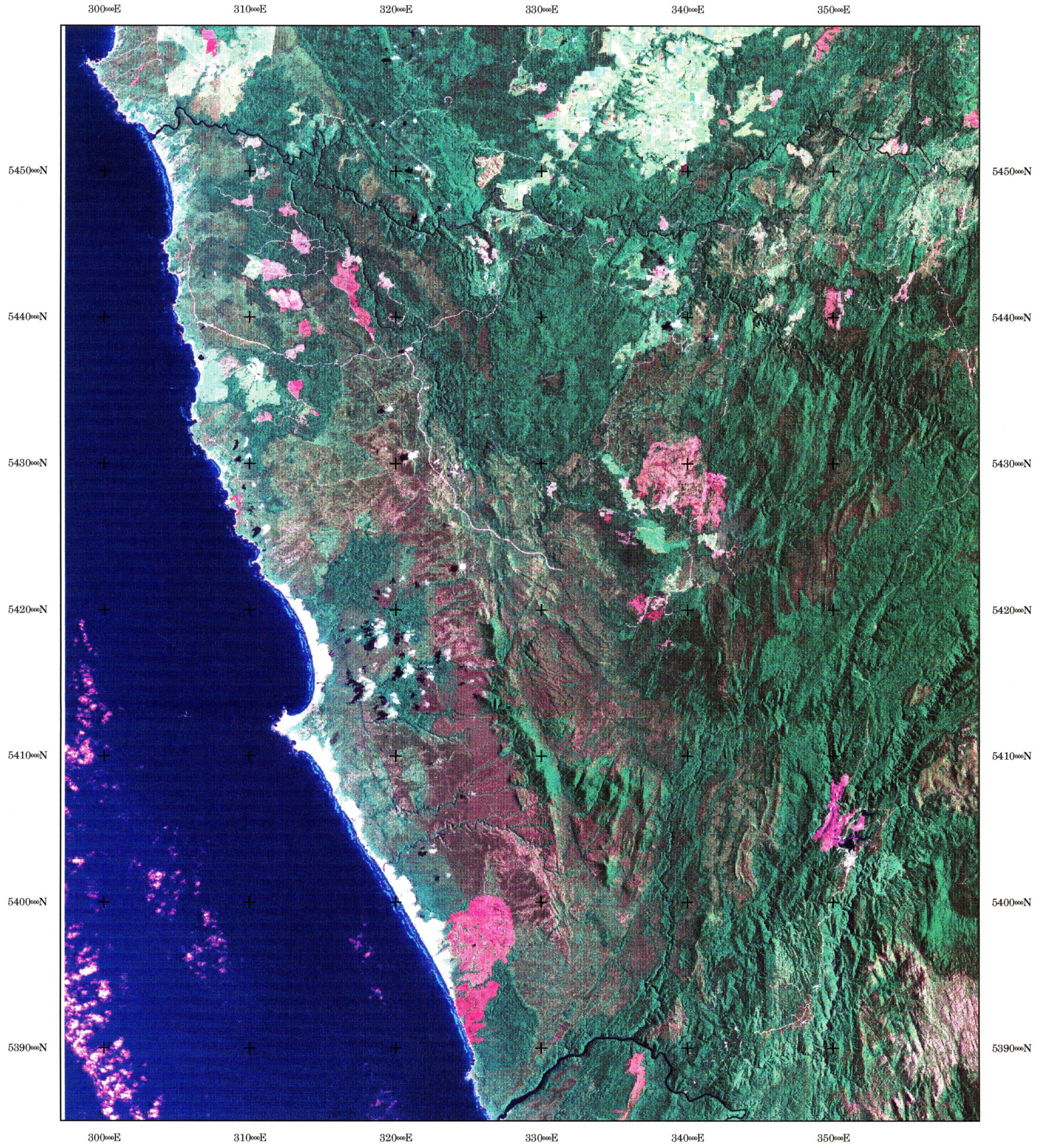
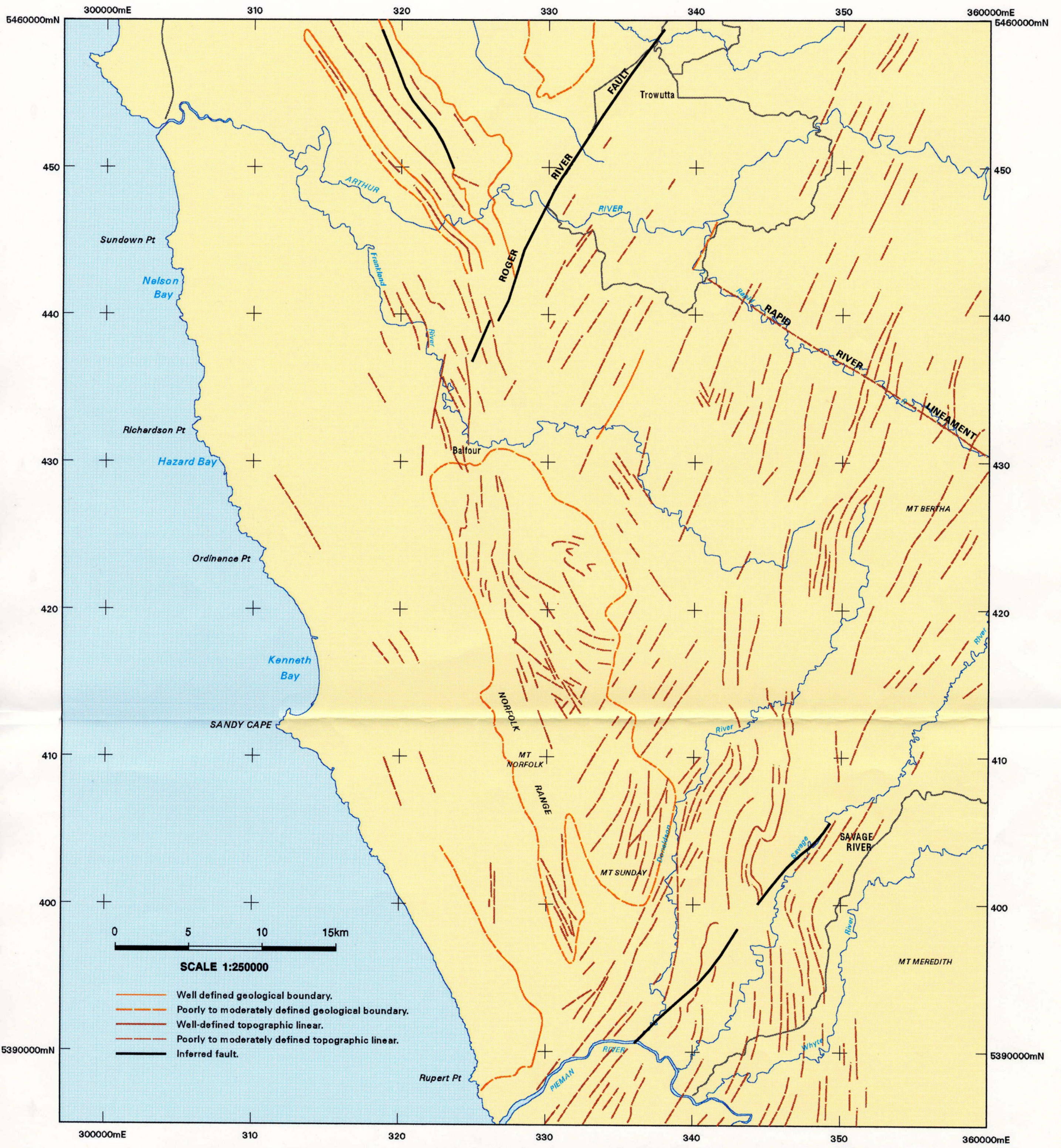



FIGURE 7 - TERNARY IMAGE OF LANDSAT BANDS 7-4-1 OVER AREA OF APRIL 1996 NORTHWEST FORESTS AIRBORNE GEOPHYSICAL SURVEY, TASMANIA

RED=BAND 7
GREEN=BAND 4
BLUE=BAND 1

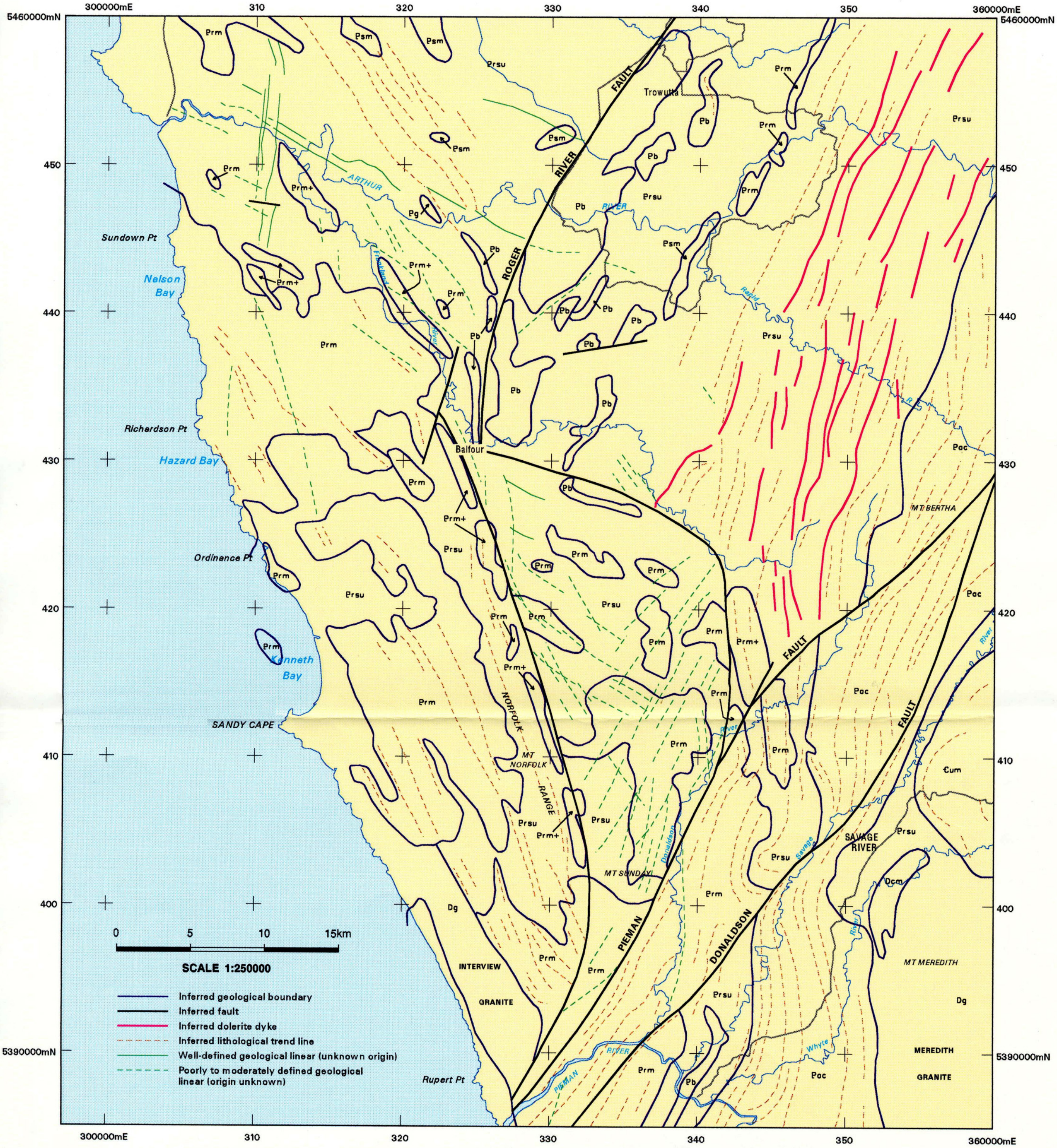
0 5 10 15 km

SCALE 1:250000




# FIGURE 8 - DIGITAL TOPOGRAPHY/LANDSAT INTERPRETATION

NORTHWEST FORESTS AIRBORNE GEOPHYSICAL SURVEY TASMANIA - APRIL 1996




# FIGURE 9 - COMPOSITE GEOLOGICAL INTERPRETATION

## NORTHWEST FORESTS AIRBORNE GEOPHYSICAL SURVEY TASMANIA - APRIL 1996

**LATE DEVONIAN - EARLY CARBONIFEROUS**

| | |
|---|---|
| Dcm | Contact metamorphic rocks (strongly magnetic). |
| Dg | Granitoid (non - magnetic). |

**CAMBRIAN**

| | |
|---|---|
| Cum | Dominantly ultramafic rocks (strongly magnetic). |

**NEOPROTEROZOIC**

| | |
|---|---|
| Pb | Basalt (strongly magnetic). |
| Pg | Gabbro (strongly magnetic). |
| Psm | Areas of moderate magnetic anomalies sourced in or beneath Neoproterozoic sedimentary rocks. |

**MESOPROTEROZOIC - NEOPROTEROZOIC**

| | |
|---|---|
| Pac | Strongly magnetic rock units of the Arthur Metamorphic Complex. |
| Prsu | Undifferentiated non-magnetic to weakly magnetic Proterozoic sedimentary rocks. |

**MESOPROTEROZOIC**

| | |
|---|---|
| Prm | Areas of mostly moderate magnetic anomalies sourced in or beneath Rocky Cape Group sedimentary rocks. |
| Prm+ | Areas of strong magnetic anomalies sourced in or beneath Rocky Cape Group sedimentary rocks. |