
Part 3: Regional interpretation, Meredith Granite

Introduction

This survey covers the margins of the Devonian Meredith Granite. The survey area contains some significant granite-related mineralisation, including the carbonate replacement Sn deposits at Mt Bischoff and Cleveland, polymetallic skarns at Whyte River and Mt Youngbuck, vein Pb-Zn-Ag at Magnet, and alluvial tin, gold and platinoids (e.g. Castray River Au). Regional geology of the survey area is shown in Figure 3.1 (Brown *et al.*, 1995).

Interpretation

A detailed regional interpretation of the Meredith HEM, magnetic and radiometric data was the subject of a recent Honours thesis at the University of Tasmania (Griggs, 2002). This report is largely based on his work. Quantitative interpretation of magnetic data from parts of the Meredith HEM survey area has been performed by Webster (2002) and Leaman (2002).

Apparent resistivity maps

Figures 3.2 and 3.3 show the 980 Hz VCX apparent resistivity and HCP ternary conductivity maps derived from the HEM data. TMI and ternary radiometric images are shown in Figures 3.4 and 3.5. Geological boundaries (1:250 000 scale, Brown *et al.*, 1995) have been superimposed on these figures. A digital elevation model derived from the HEM radar and GPS altimeter data is shown in Figure 3.6. The HEM data generally show good correspondence with the mapped geology. As discussed below, HEM data have been particularly successful at detecting a number of concealed major faults, some of which may have implications for future exploration.

A number of major power transmission lines transect the survey area, and are shown superimposed on the 980 Hz apparent resistivity map in Figure 3.7. In contrast to the Dolcoath and Mount Read Volcanics survey areas, the transmission lines appear to have had little influence on the HEM data – possibly because they are largely orientated sub-parallel to the flight lines.

Major features of the HEM data are indicated by the letters A to M on Figure 3.8, and are discussed individually below. An HEM interpretation for the Meredith survey is shown in Figure 3.9.

A. Areas of thick Tertiary basalt cover in the northeast of the survey area (A) may be heavily-jointed (Brown, 1986), and are typically electrically conductive (40–200 ohm-m). Bishop and Lewis (1988) have noted that Tertiary basalts east of Waratah are composed of multiple flows with interbedded lake sediments, and that the lower sequences of the basalt pile are more conductive.

The maximum basalt thickness which can be determined from Hummingbird HEM data is dependent on the basalt conductivity and magnetic susceptibility, and on the conductivity of the basement rocks. Layered-earth calculations using typical conductivities and susceptibilities (≈ 0.03 SI), and assuming a resistive (1000 ohm-m) basement indicate a maximum depth of investigation of around 50 metres. Drilling results and CSAMT interpretations reported by Bishop and Lewis (1988) have indicated basalt thicknesses east of Waratah of up to 500 m, well beyond the depth of investigation of the HEM system.

An area of mapped basalt around A1 (380 000 mE, 5 412 000 mN) shows relatively high apparent resistivities in comparison with the surrounding basalts. This may indicate a region of thin, or less heavily fractured, basalt cover. An apparent conductivity-depth section for Line 10252, which crosses this basalt, is shown in Figure 3.10. Tertiary basalt near the granite margin at A2 (374 000 mE, 5 404 000 mN) also displays anomalously high apparent resistivities (≈ 1000 ohm-m), indicating that the basalt here is likely to be very thin.

- B. A strong apparent resistivity low is associated with the pyrrhotite-rich Mt Bischoff carbonate-replacement Sn deposit (see also the following discussion of Line 10252).
- C. The outcropping Meredith Granite generally shows very high apparent resistivities (>1000 ohm-m). High resistivities extend more than 1 km from the mapped granite boundary near 372 500 mE, 5 405 000 mN. Shallow ground electromagnetic and DC resistivity measurements by Griggs (2002) have shown that there is no conductivity contrast between the granite and adjacent contact-metamorphosed volcanoclastic rocks of the Cleveland-Waratah Association. Highly-resistive zones corresponding to mapped Cleveland-Waratah Association rocks are considered to be due to a reduction in porosity as a result of contact metamorphism.

North-south and northeast-trending conductive zones within the Meredith Granite and surrounding resistive Cleveland-Waratah Association at C are interpreted as faults or fracture zones. A number of small Sn deposits (371 950 mE, 5 406 700 mN; 371 900 mE, 5 404 350 mN; 372 300 mE, 5 403 000 mN) are located on these interpreted fractures.

- D. A north-south trending linear conductor with a strike extent of ≈ 7.5 km cuts a number of mapped geological contacts, and is interpreted as a

concealed fault. The Pb-Zn-Ag vein deposits of Magnet lie immediately to the north of this fault, and have a similar trend. The fault may therefore represent a feeder for the Magnet mineralisation (Griggs, 2002), and may warrant further exploration. The Matthews Pb-Zn mineralisation (369 000 mE, 5 407 500 mN) is also situated close to this fault.

- E. Small isolated conductors at E have coincident magnetic responses, and show low radiometric responses. Ground truthing of the magnetic and radiometric data has shown these features to be outliers of Tertiary basalt (J. Everard, pers. comm.). The HEM conductors are likely to indicate the thickest areas of basalt.
- F. A prominent northeast-trending conductive zone has no magnetic expression, and corresponds closely to mapped outcrop of the Whyte River Mafic-Ultramafic complex. The conductor is clearly associated with the Whyte River Complex, and is not due to conductive alluvium within the river valley. HEM data indicate that the Whyte River Complex extends almost a kilometre further to the northeast than is shown on existing 1:250 000 scale geological maps, and that it extends west of its mapped position within its northern half. Griggs (2002) has postulated further extensions of the Whyte River complex to the south and southwest of its mapped location.
- G. The Mount Stewart Ultramafic complex is weakly defined in the HEM data. The unit boundaries are most clearly seen in the ternary conductivity image (fig. 3.3), and are closely coincident with the mapped boundaries.
- H. This pronounced linear conductor (extending from 353 050 mE, 5 398 700 mN to 354 000 mE, 5 404 450 mN) is interpreted as a fault boundary within the Oonah formation, separating quartzwacke (Loq) to the east from slaty to massive siltstone/mudstone (Lo) to the west. Conductivity-depth slices (fig. 3.14–3.16) suggest that the position of the conductor changes with depth, suggesting that the fault plane dips shallowly to the east (at $\approx 12^\circ$).
- I. HEM data indicate a strong northeast-trending geological contact within the Bell Formation, extending from 365 650 mE, 5 385 450 mN to 368 800 mE, 5 389 163 mN. This contact has a very strong radiometric expression and a close correlation with the digital elevation model, but is only weakly indicated in the magnetic data. The contact does not extend beyond the Bell Formation, and is therefore unlikely to be faulted.
- J. The boundaries of the Wilson River Ultramafic complex are quite well-resolved in the HEM data, particularly in the ternary conductivity image (fig. 3.3). High conductivities in the southwest of

the Wilson River Ultramafic Complex (363 000 mE, 5 383 500 mN) correspond to a mapped fault boundary with the Crimson Creek Formation. High conductivities may be related to alluvium in the Harman River, which is partly coincident with this contact.

- K. A zone of anomalously-high conductivities (extending from 356 800 mE, 5 381 800 mN to 358 300 mE, 5 380 000 mN) has a coincident magnetic response, and corresponds closely in position with a mapped fault within the Oonah Formation (fig. 3.1).
- L. Numerous north and northwest-trending conductors have a similar orientation to extensive linear magnetic anomalies within the Meredith Granite (e.g. between 355 600 mE, 5 385 000 mN and 354 900 mE, 5 397 900 mN; fig. 3.4), which are interpreted as dykes. These conductors have no apparent magnetic expression, and are hence interpreted as fractures within the Meredith granite.

Oonah Formation rocks which abut the granite near L have unusually high apparent resistivity in comparison to other exposures of this unit in the southwest and northwest of the survey area. This high resistivity zone either indicates contact metamorphism of the Oonah Formation (as for the Cleveland–Waratah Association at C), or the presence of granite at very shallow depth. The regional potential field interpretation of Leaman and Richardson (1989) suggests the granite shelves quite steeply at this location, and the former interpretation is considered more likely.

- M. An extensive, north-south trending conductor (373 400 mE, 5 398 750 mN–372 650 mE, 5 394 900 mN) is situated at the contact between the Cleveland–Waratah Association and the Oonah Formation to the west. The large strike extent of this conductor suggests that it is fault-related, although it could also be due to carbonaceous shales.

Responses of known mineralisation

The Mt Bischoff carbonate-replacement Sn deposit (see discussion of Line 10252 in conductivity-depth section) and the Mt Youngbuck tungsten skarn, both of which are pyrrhotite-rich, have a strong EM and magnetic response. A number of other skarns, such as Laurel Creek East Sn-W (369 700 mE, 5 392 600 mN) are magnetic but non-conductive.

Other mineralisation appears to be associated with structures or trends interpreted from the HEM data. Examples include the Magnet Pb-Zn-Ag deposits ($\approx 370 000$ mE, 5 410 700 mN), which occur along strike of an interpreted major fault (D in fig. 3.8), and the Godkin Pb-Zn-Ag deposits (362 500 mE, 5 405 500 mN), which occur along a conductive trend. Further

exploration along these faults or trends may be warranted.

Bedrock conductors within the part of the Meredith survey north of 5 394 000 mN have been picked by Griggs (2002) from the raw HEM profile data.

EMFlow and Sengpiel conductivity-depth sections

Conductivity-depth sections for four profiles within the survey area are shown in Figures 3.10 to 3.13.

Line 10252 (fig. 3.10)

This survey line crosses from Tertiary basalt at the eastern end of the line (378 300 mE–382 500 mE), Oonah Formation rocks of the Mt Bischoff Inlier (372 500 mE–378300 mE), and the Whyte River Complex near the western end of the line (368 700 mE–369 700 mE). A smaller outcrop of Tertiary basalt is present between 370 000 mE–371 600 mE. The very strong HEM and magnetic response of the Mt Bischoff mineralisation at 376 500 mE is the dominant feature. Conductive zones around 377 600 mE, 372 150 mE, 372 400 mE, 372 600 mE and 372 800 mE are related to the presence of alluvium in modern drainages, and high conductivities at around 369 200 mE are due to the Whyte River Complex. A weak anomalous conductor at 375 600 mE is likely to be of stratigraphic origin.

The CDI and Sengpiel sections do not clearly indicate the presence of resistive basement beneath the eastern basalt, and it seems likely that the basalt thickness is greater than the depth of investigation of the Hummingbird system. Basalt east of 381 300 mE is more conductive, and is likely to be thicker and/or more heavily fractured.

Line 10511 (fig. 3.11)

This flight line crosses conductive Tertiary basalt between 373 800 mE and 379 500 mE, the Cleveland–Waratah Association between 370 100 mE–373 800 mE and 364 800 mE–367 900 mE, Cambrian mafic rocks between 367 900 mE–370 100 mE, and the Whyte River Complex between 364 000 mE–364 800 mE. Areas of no data in the Sengpiel section indicate resistive terrain with HEM responses below the nominal noise level. Very deep conductors in the EMFlow CDI corresponding to these areas of low signal (e.g. 370 200 mE–371 600 mE; 365 000 mE–368 000 mE; 362 600 mE–364 000 mE; 359 000 mE–360 500 mE) are processing artifacts, and have no geological significance.

The uniform basalt thickness implied by the CDI and Sengpiel sections again suggests that the basalt thickness generally exceeds the depth of investigation. However, a resistor within the basalt at 376 400 mE denotes a window to underlying basement. The more conductive zones around 373 800 mE–375 000 mE may indicate the thickest basalts.

An anomalous conductor within the Cleveland–Waratah association (372 300 mE) has a coincident 400 nT magnetic anomaly, and may be due to pyrrhotite-rich mineralisation. A stronger conductor within the Whyte River Complex (364 500 mE) also has a coincident 400 nT magnetic anomaly, and is most likely to be related to pyrrhotite mineralisation near the former Cleveland mine.

A resistive hill at 360 150 mE corresponds to outcropping Crotty Quartzite.

Line 11341 (fig. 3.12)

This short flight line crosses a series of generally-resistive lithologies, including Owen Group (east of 375 750 mE), Oonah Formation (373 000 mE–375 750 mE), Cleveland–Waratah Association (370 400 mE–373 000 mE), Crotty Formation (369 400 mE–365 950 mE) and the Meredith Granite (west of 365 950 mE). High near-surface conductivities between 369 400 mE and 370 400 mE are associated with Quaternary sediments. Minor conductors at 373 300 mE, 367 300 mE, 366 700 mE and 366 000 mE correspond to modern drainages, and are probably due to unconsolidated Quaternary sediments. Gaps in the Sengpiel section indicate resistive areas, and corresponding deep conductors in the EMFlow CDI are processing artifacts.

Line 11681 (fig. 3.13)

High resistivities on this survey line are mainly due to the Meredith Granite, which crops out between 353 700 mE and 361 000 mE. The conductive zone on the extreme western end of the survey line corresponds to outcropping rocks of the Arthur Metamorphic Complex. Conductors on the eastern third of the line are associated with the Bell Formation (east of 365 500 mE), Quaternary sediments (364 800 mE and 364 000 mE), and the Wilson River Ultramafic Complex (361 600 mE–363 600 mE).

EMFlow conductivity-depth slices

Conductivity-depth slices from EMFlow data at 20 m, 70 m, and 120 m below surface are shown in Figures 3.14 to 3.16. Interpretation of the deeper slices is complicated by processing artifacts. Both the 70 m and 120 m slices contain a number of features which clearly have a geological origin.

The dominant features of the 20 m depth slice are high conductivities associated with the widespread Tertiary basalt in the east and northeast of the survey area, and the Whyte River complex (364 400 mE, 5 406 600 mN–369 600 mE, 5 413 700 mN). A weakly-conductive zone around 368 000 mE, 5 403 000 mN is roughly coincident with outcropping Cambrian high magnesian andesite. Faults within the Cambrian andesite (D in fig. 3.8) and the Oonah Formation (H in fig. 3.8) are well-defined in this shallow slice. The fault boundary within the Oonah

Formation can be seen to migrate to the east on the 70 m and 120 m slices, indicating a shallow easterly dip for this contact.

A faint northeast-trending conductor extending from 369 500 mE, 5 405 700 mN to 372 000 mE, 5 408 600 mN is evident on the 70 m and 120 m depth slices. This conductor cannot be seen on the 20 m depth slice, and may represent a deep concealed fault within the Cleveland–Waratah Association. The minor mineralisation at Arthur River Vein (372 400 mE, 5 409 300 mN) lies immediately along strike of the northeastern end of this interpreted fault.

Areas of apparent low conductivity on the 70 m depth slice corresponding to Tertiary basalts and the Whyte

River Complex are artifacts caused by the limited depth of investigation in these conductive lithologies. A conductive zone in the east of the survey area (5 393 500 mN–5 397 000 mN) partly coincides with a block of flight lines flown with Bird 3 (5 395 000 mN–5 397 600 mN, see Figure 1.2), and could indicate a problem associated with merging data acquired using Birds 2 and 3. This artifact is also strongly evident on the 120 m depth slice.

High conductivities within the Meredith Granite on the 70 m and 120 m slices are most likely to be EMFlow processing artifacts commonly seen in resistive lithologies (see the preceding discussion of Figure 3.11).

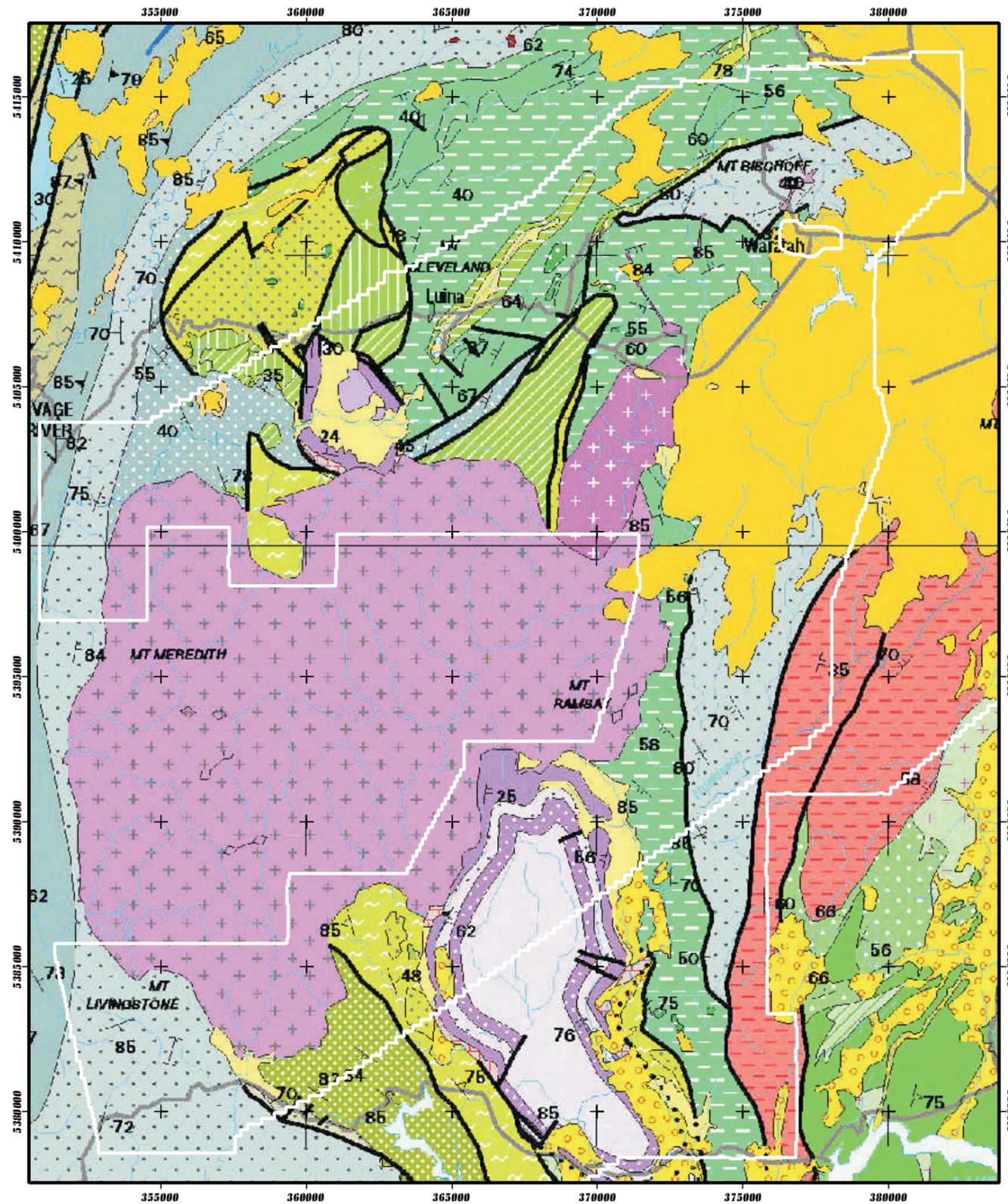


Figure 3.1
Meredith 1:250,000 geology
with EM survey boundary

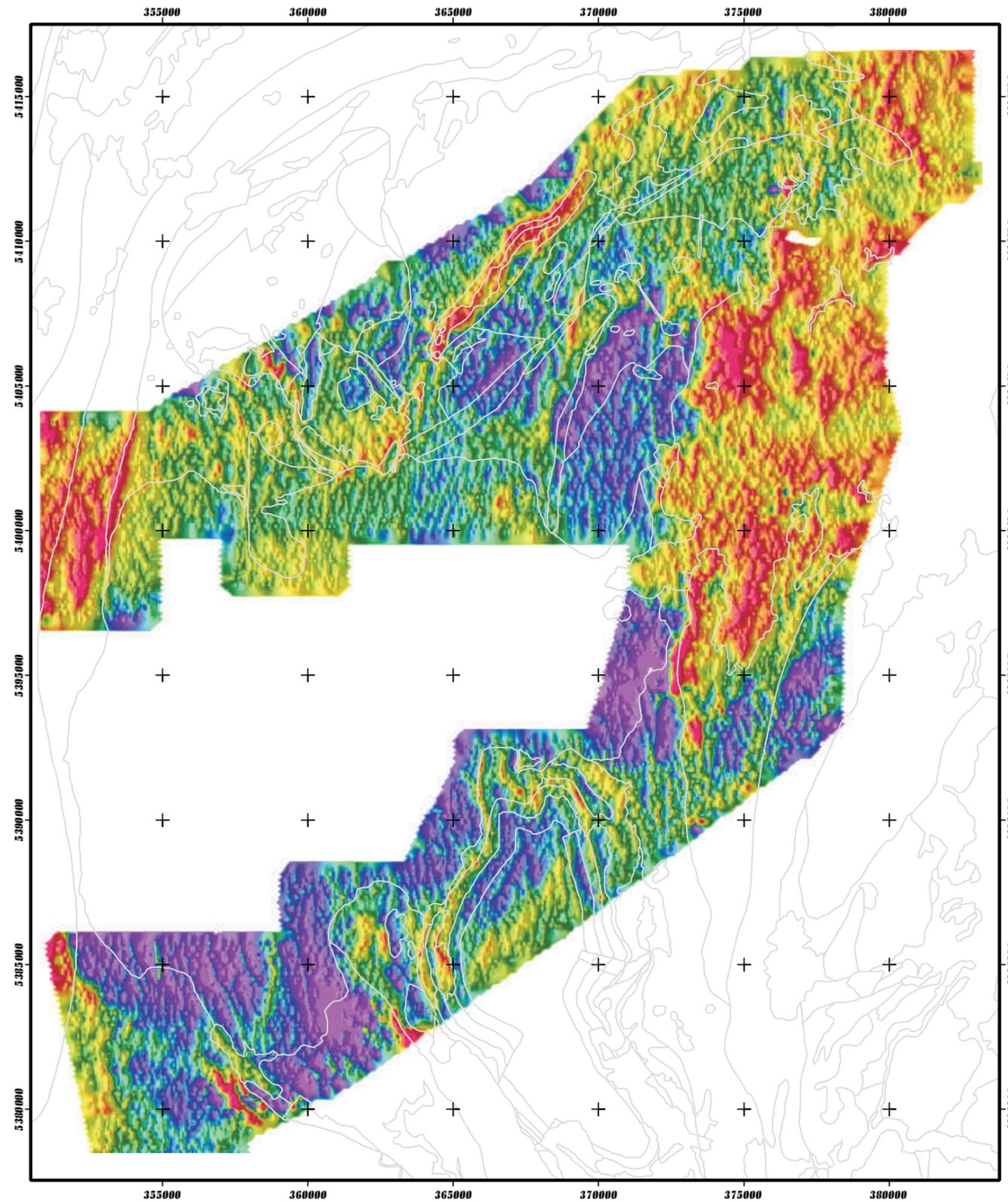
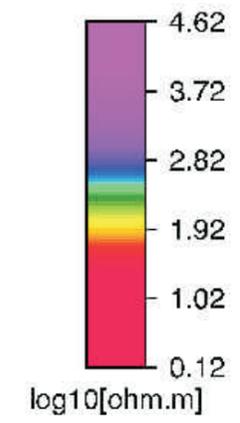


Figure 3.2
Meredith 980 Hz apparent resistivity
with 1:250,000 geology



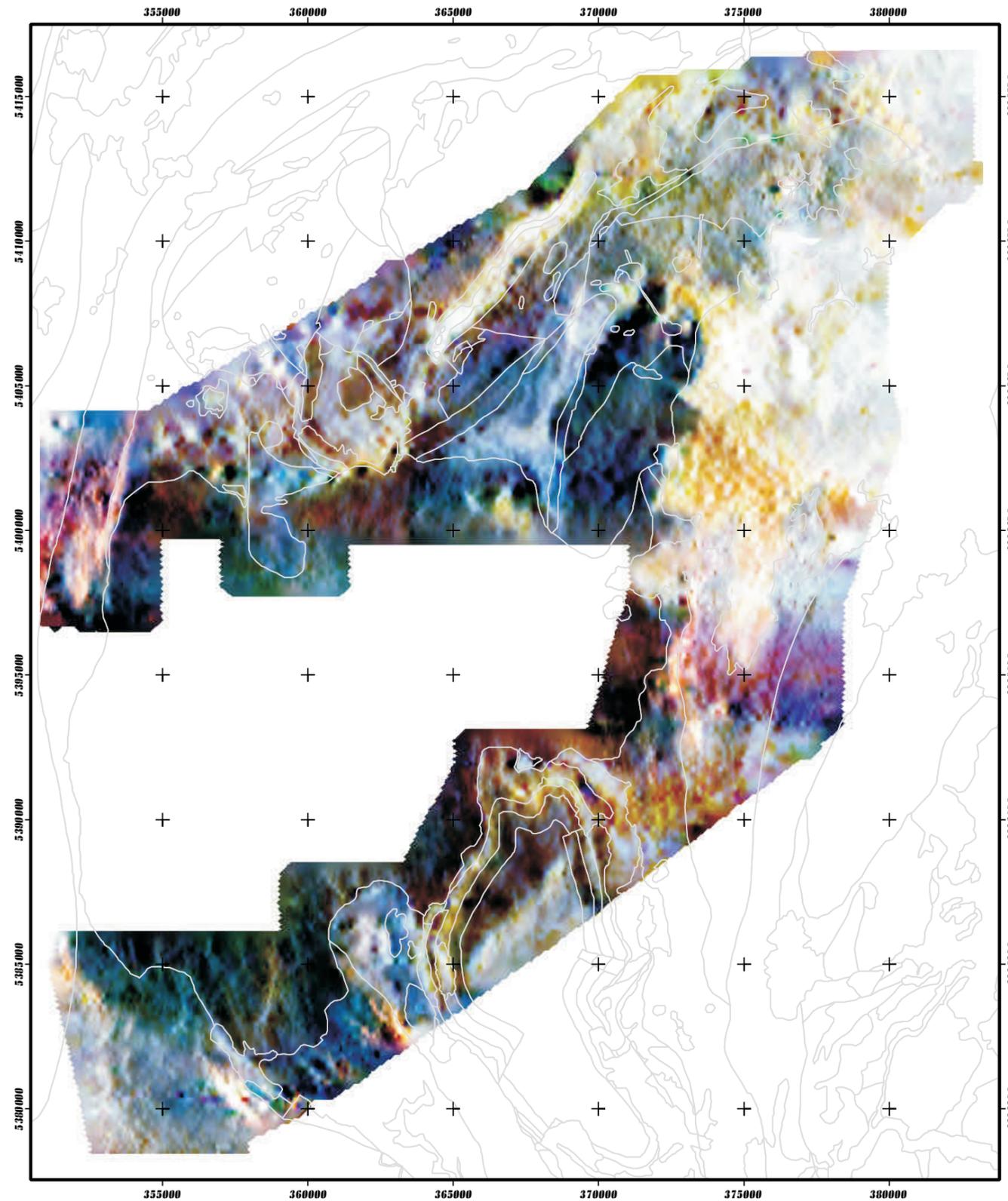
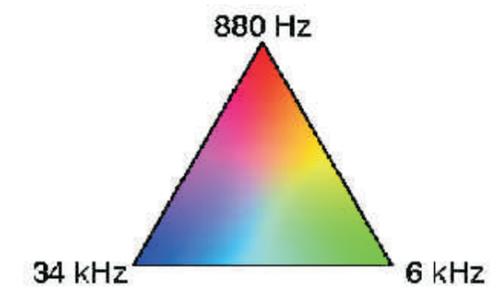


Figure 3.3
Meredith HCP ternary conductivity
with 1:250,000 geology



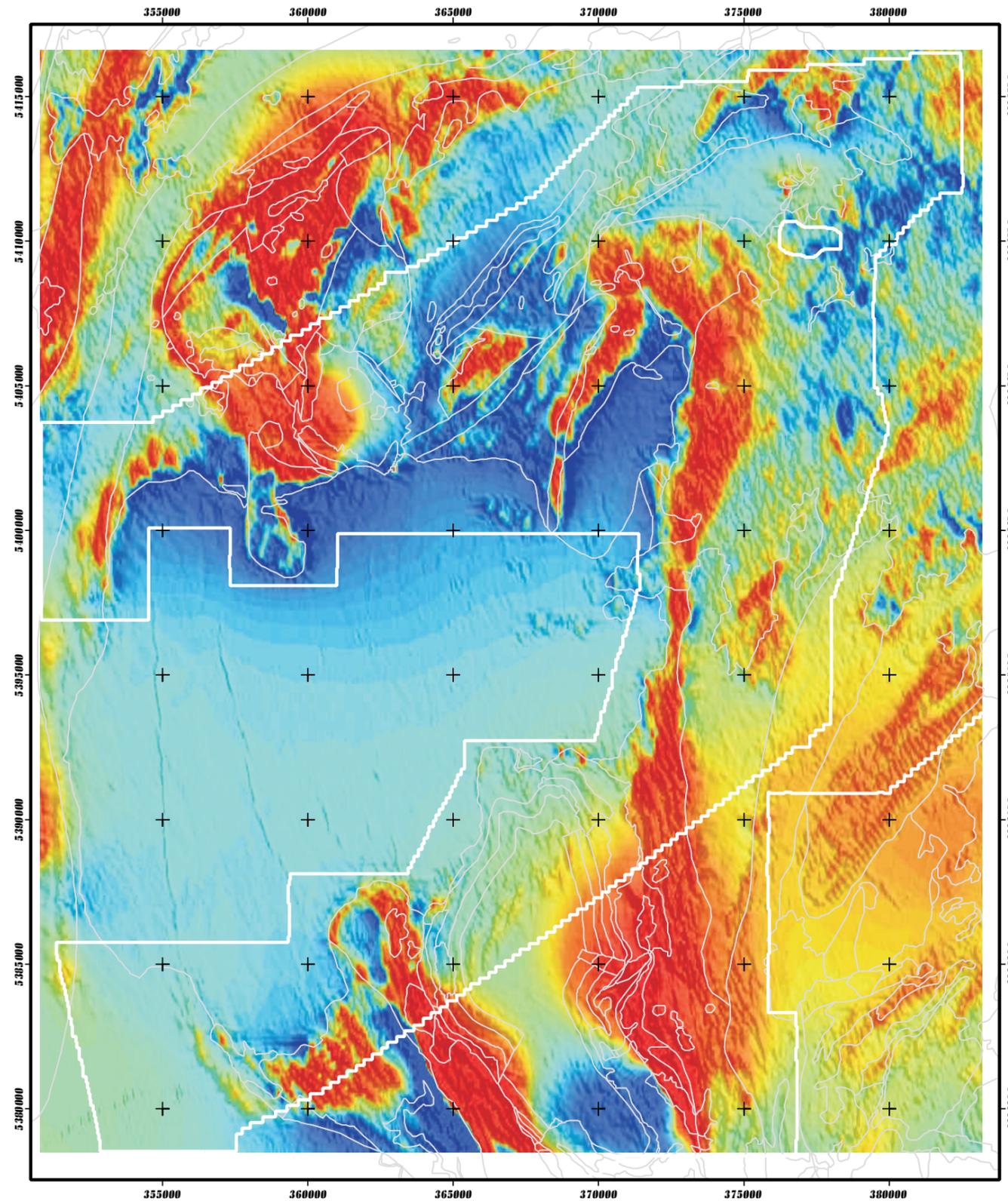
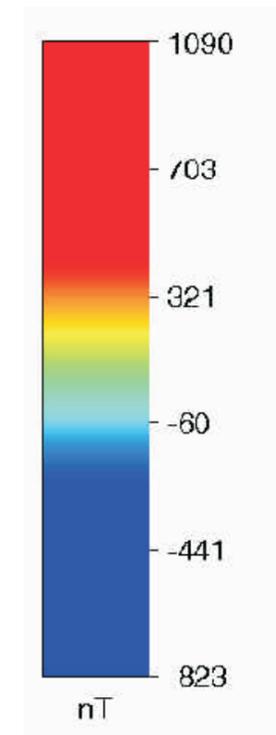


Figure 3.4
 Meredith WTRMP magnetics with 1VD
 enhancement, EM survey boundary
 and 1:250,000 geology



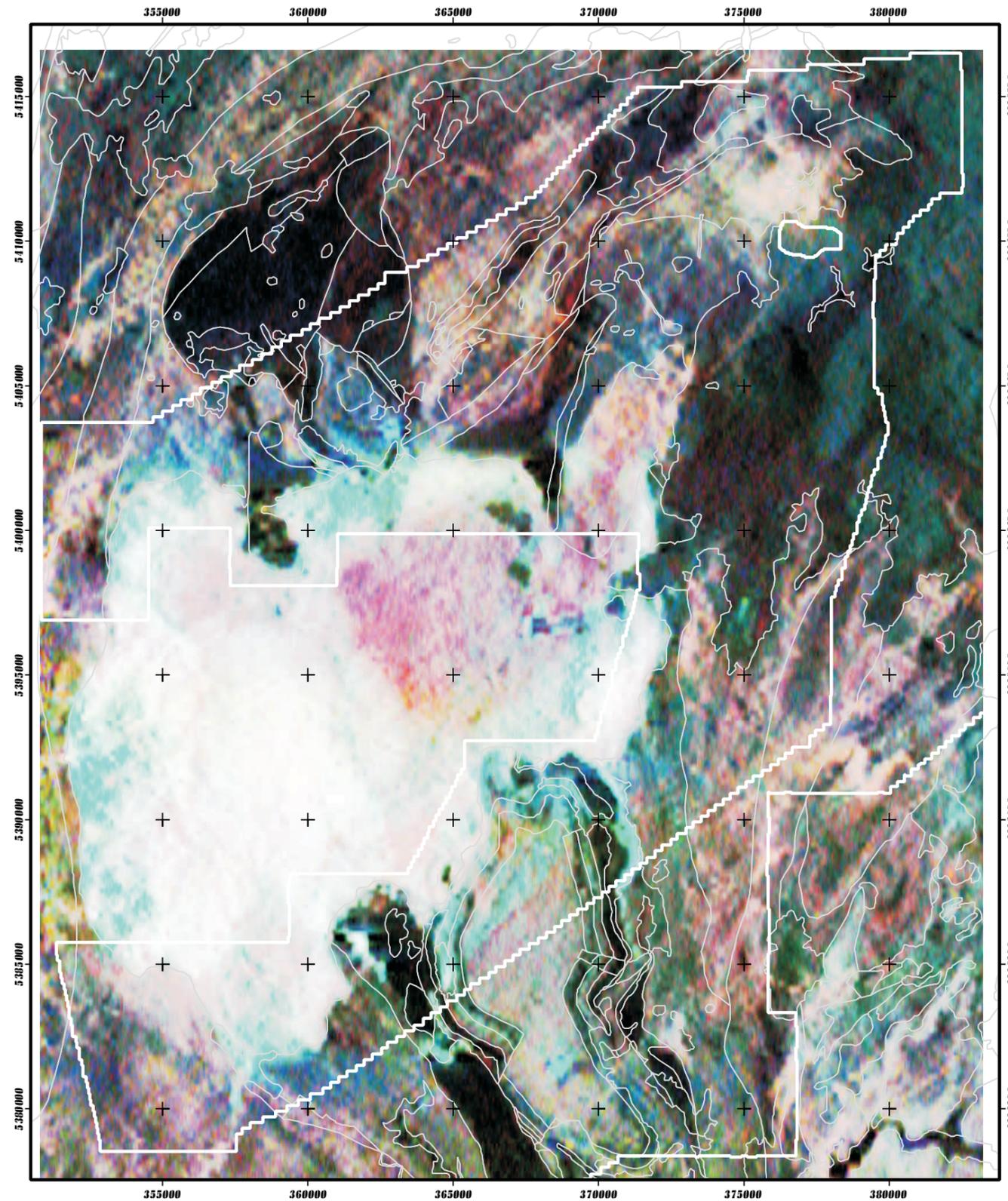
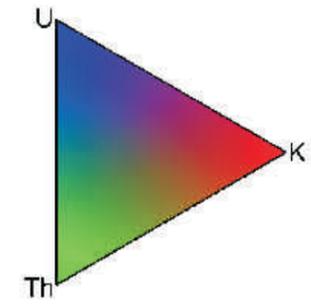


Figure 3.5
Meredith WTRMP ternary radiometrics
with EM survey boundary
and 1:250,000 geology



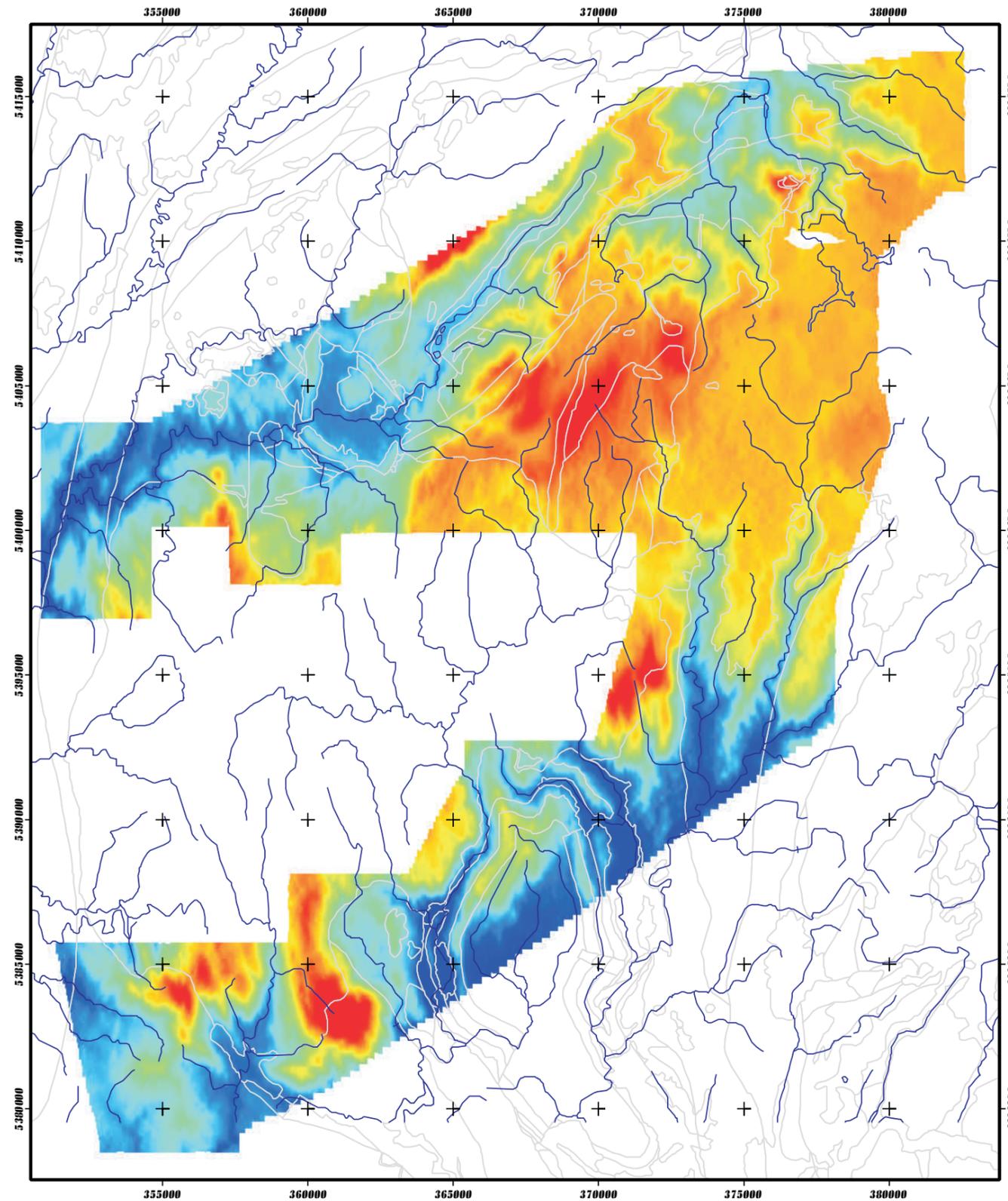
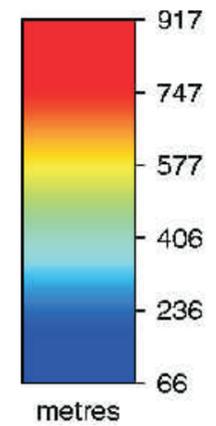


Figure 3.6
Meredith digital elevation model
with drainage and 1:250,000 geology



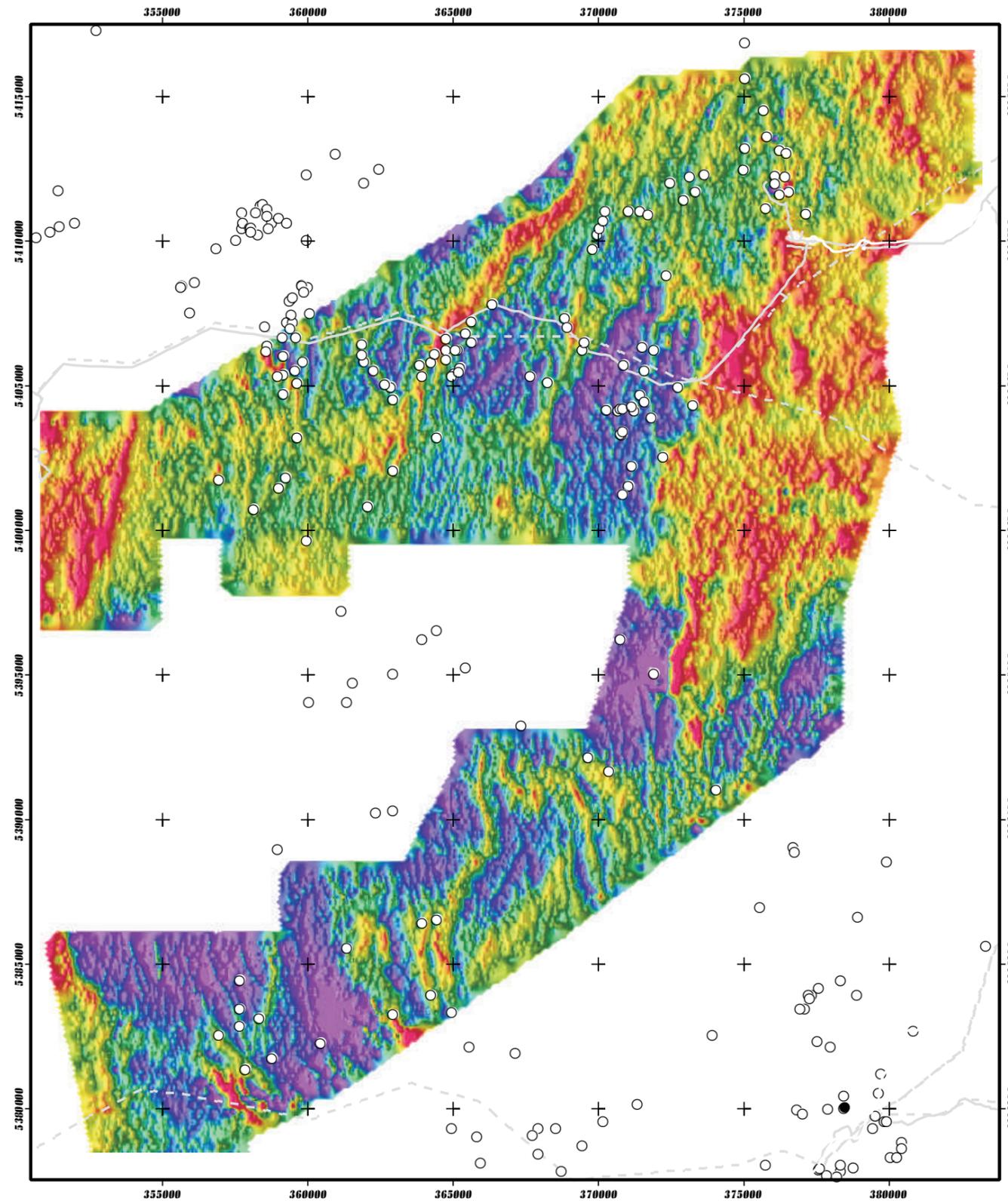
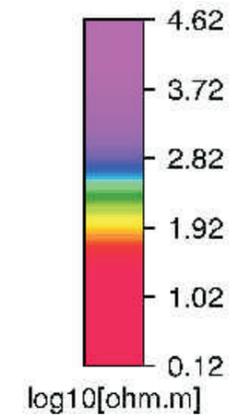


Figure 3.7
Meredith 980 Hz apparent resistivity
with culture and mineral deposits



- Railway lines
- Mineral deposits
- High voltage lines
- - - Extra high voltage lines



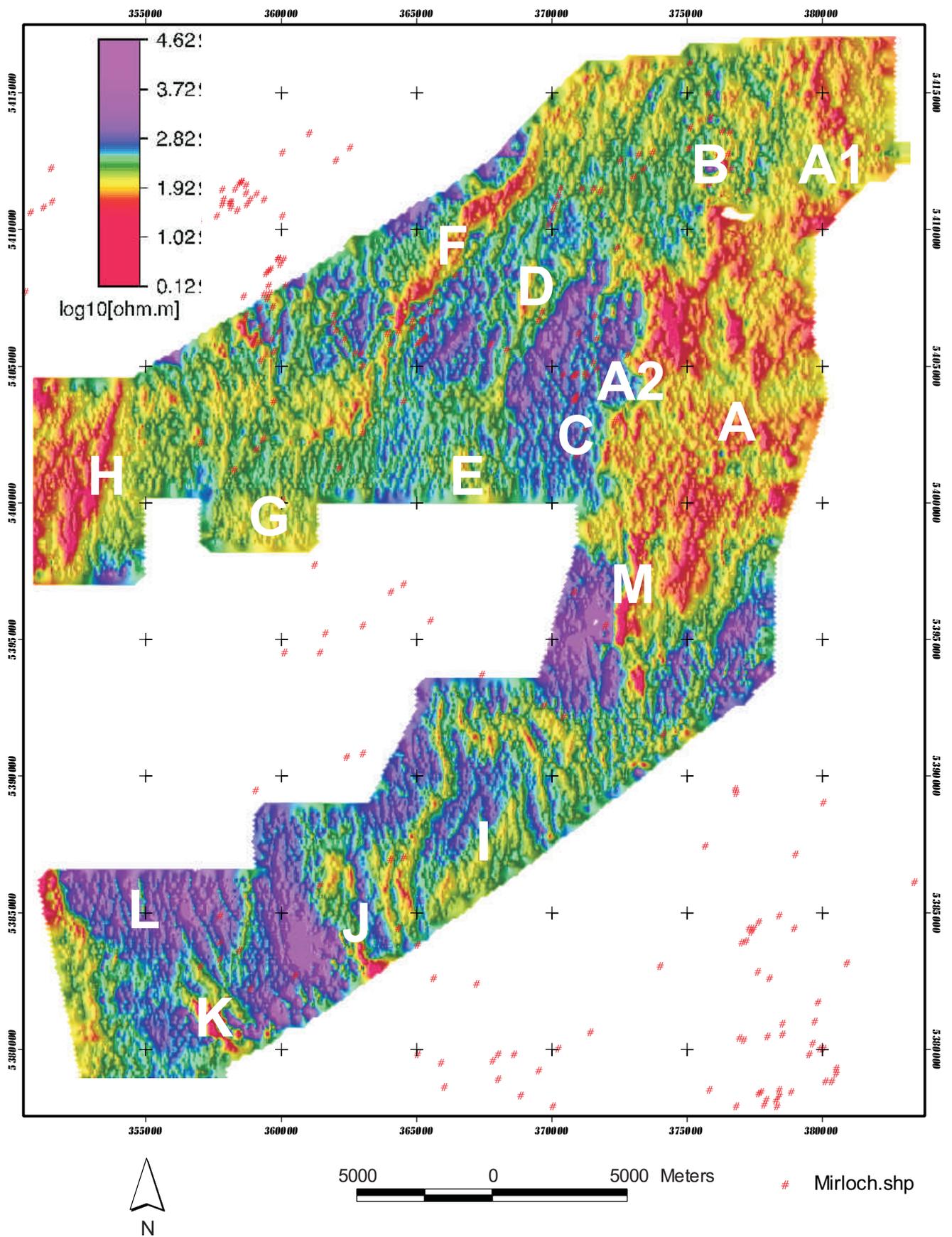


Figure 3.8
Meredith Interpretation Key

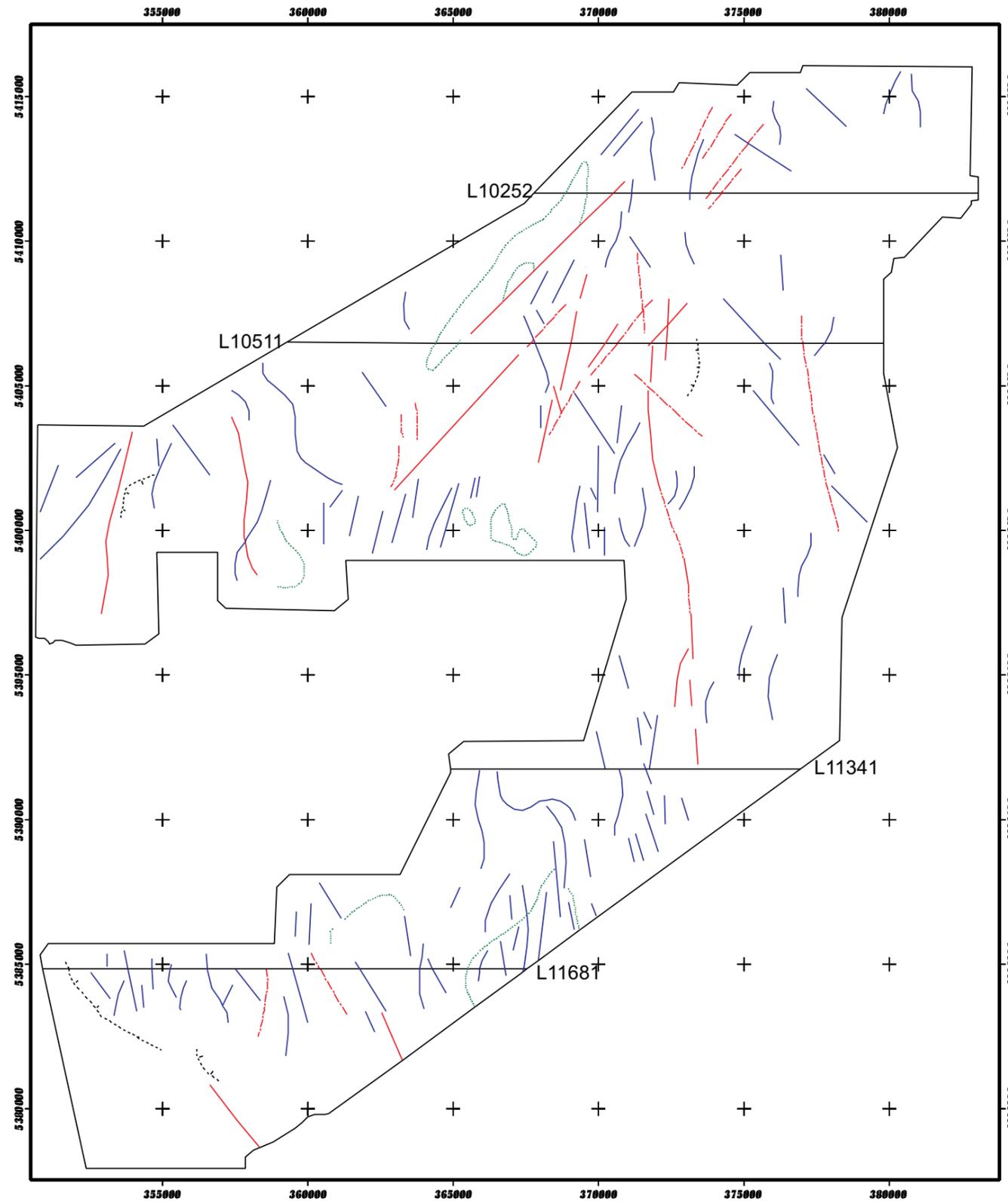


Figure 3.9
Meredith HEM interpretation

- Interpretation key
-  Fault
 -  Possible fault
 -  EM trend
 -  EM contact
 -  Extent of shallow granite (tics show direction to granite)
 -  Survey boundary and flight lines

5000 0 5000 Meters



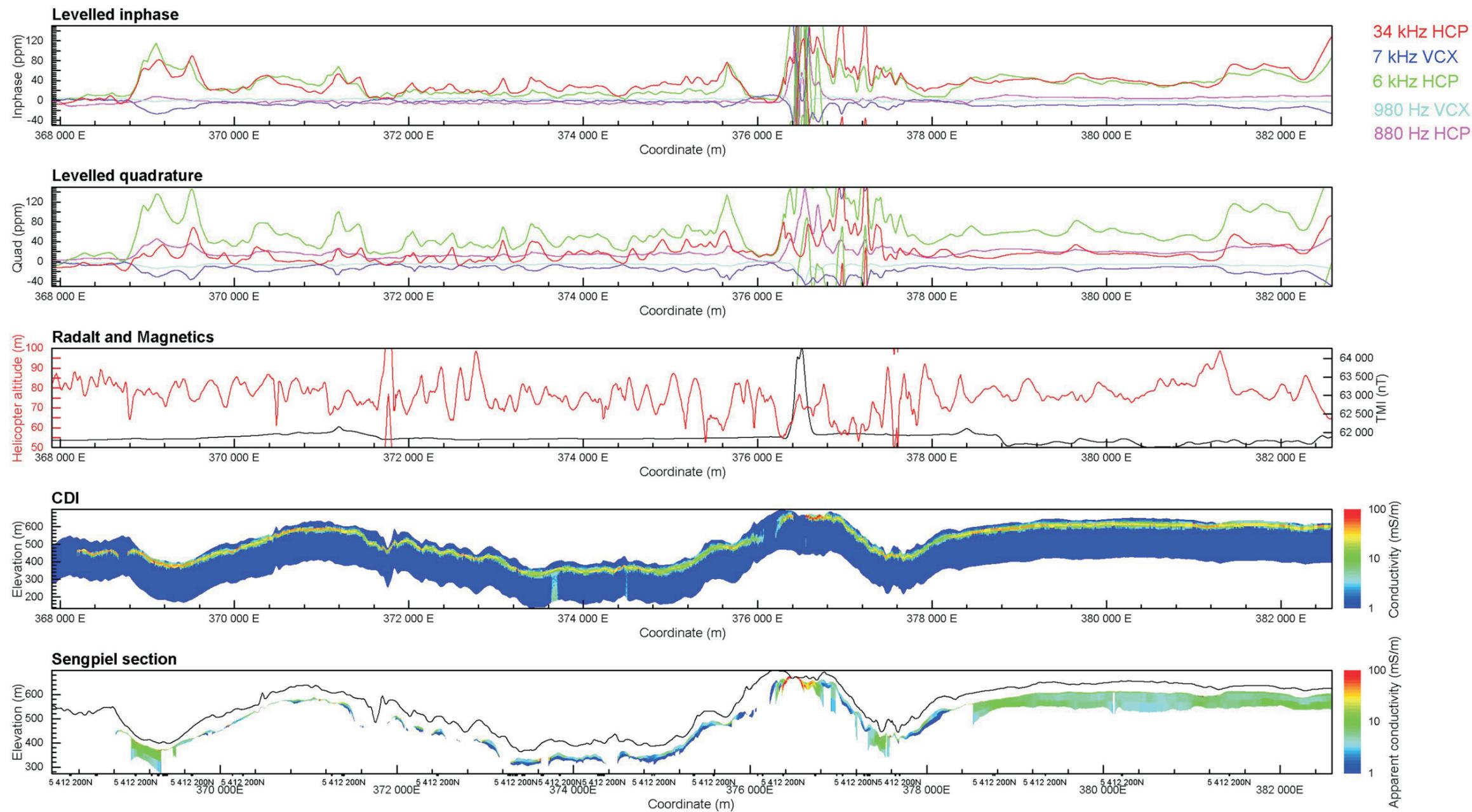



Figure 3.10
Meredith Granite, W Tasmania
Line D10252

Levelled inphase and quadrature data
Radar altimeter and TMI
EMFlow v3.2 conductivity-depth image
Sengpiel section

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An electromagnetic interpretation of west
and northwest Tasmania

March 2003

Coordinates: AGD66/TMAMG 55



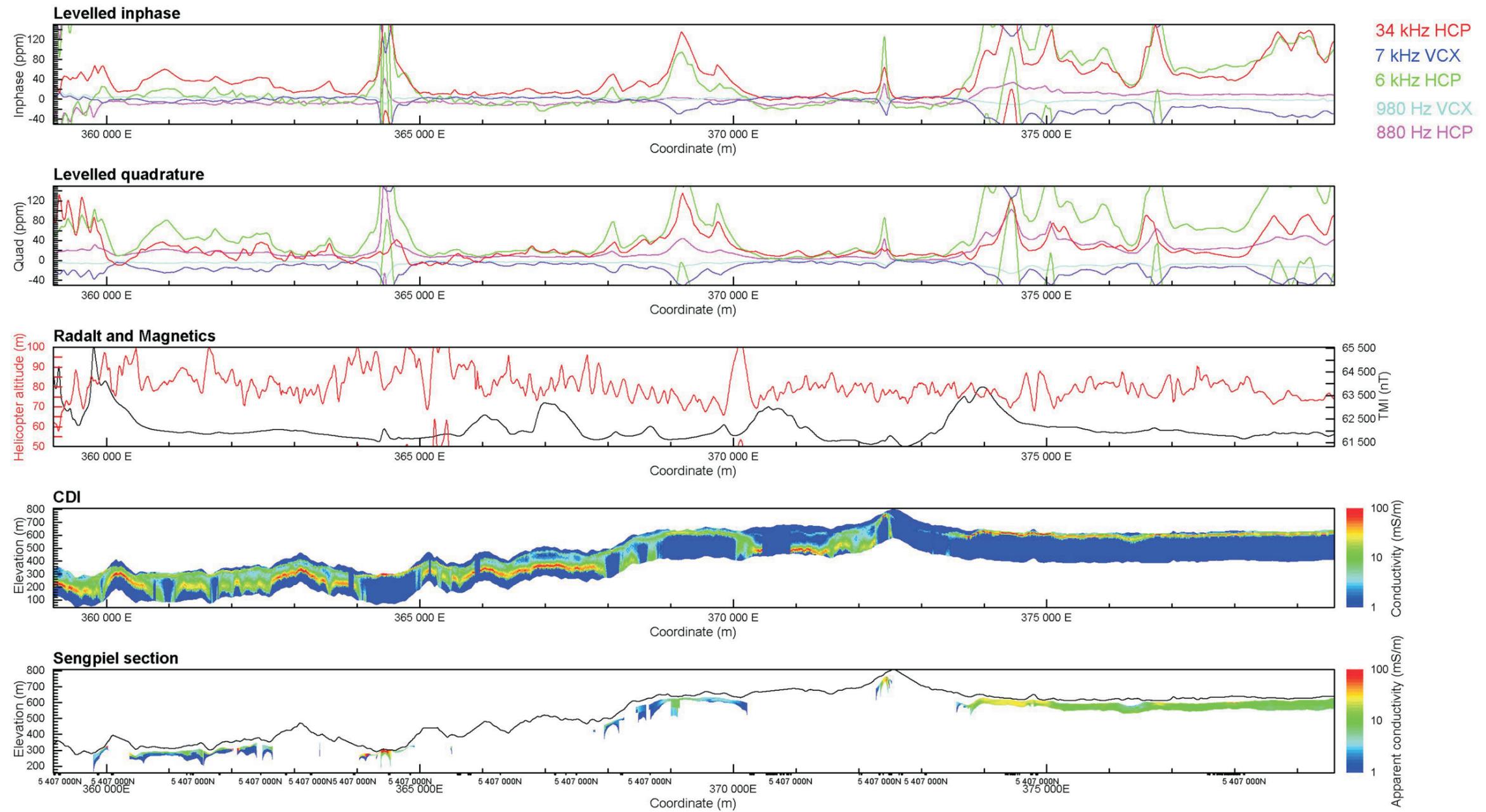


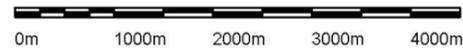
Figure 3.11
Meredith Granite, W Tasmania
Line D10511

Levelled inphase and quadrature data
Radar altimeter and TMI
EMFlow v3.2 conductivity-depth image
Sengpiel section

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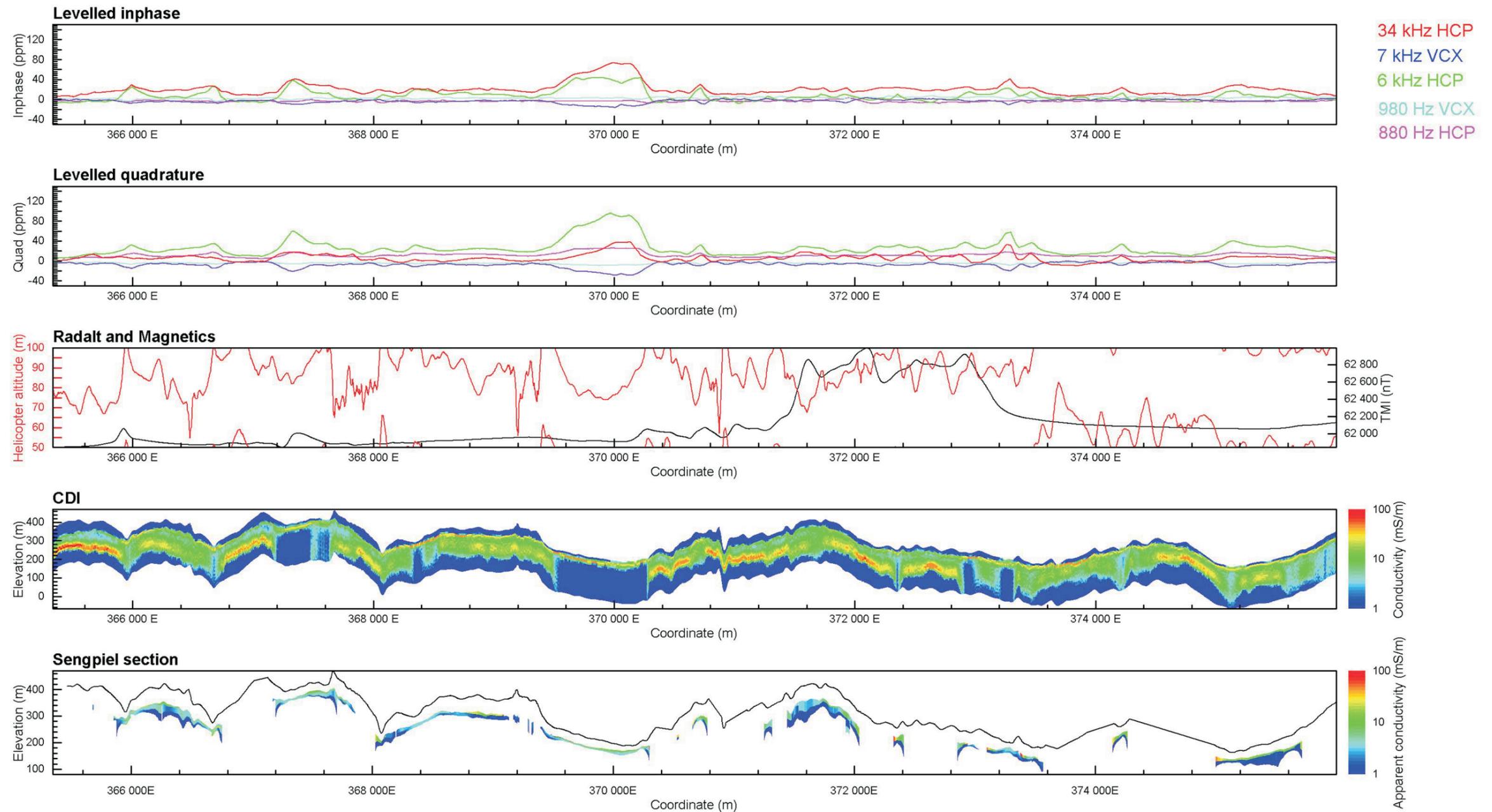


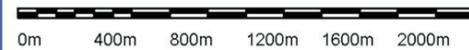
Figure 3.12
Meredith Granite, W Tasmania
Line D11341

Levelled inphase and quadrature data
Radalt altimeter and TMI
EMFlow v3.2 conductivity-depth image
Sengpiel section

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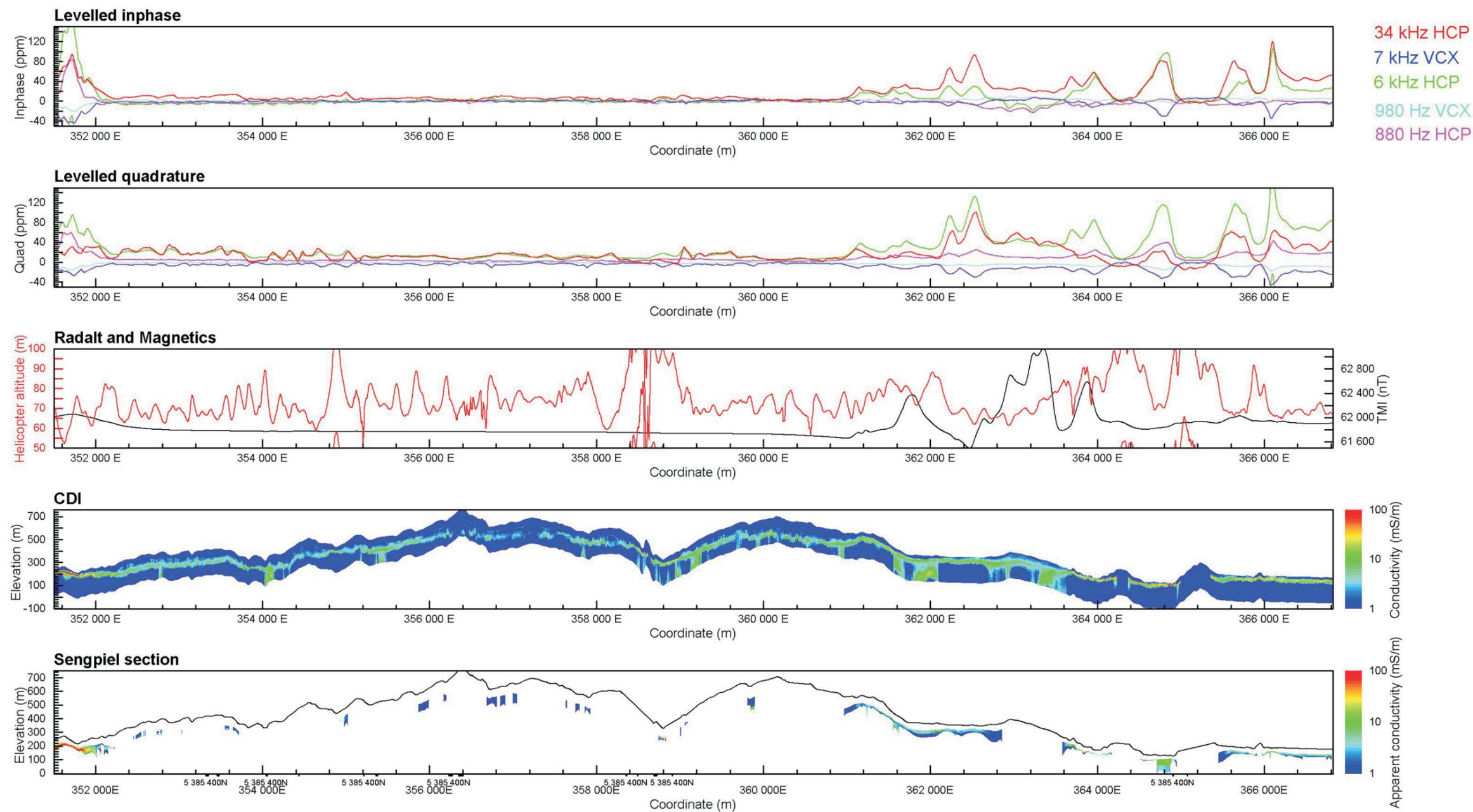


Figure 3.13
Meredith Granite, W Tasmania
Line D11681

Levelled inphase and quadrature data
Radalt altimeter and TMI
EMFlow v3.2 conductivity-depth image
Sengpiel section

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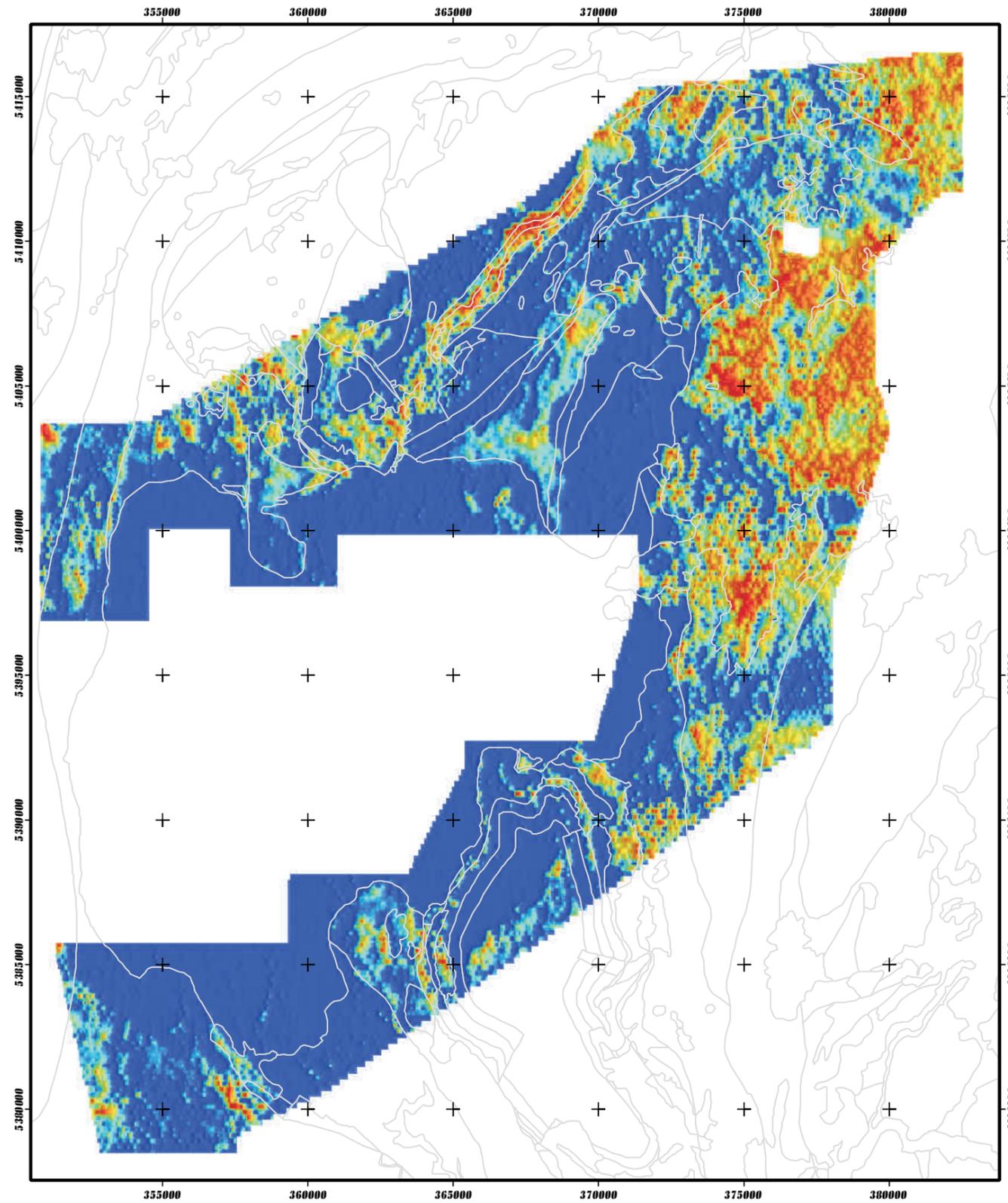
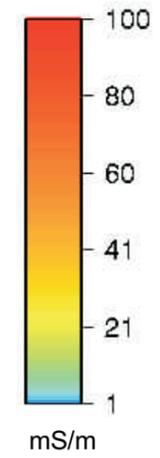


Figure 3.14
Meredith EMFlow 20 m depth slice
with 1:250,000 geology



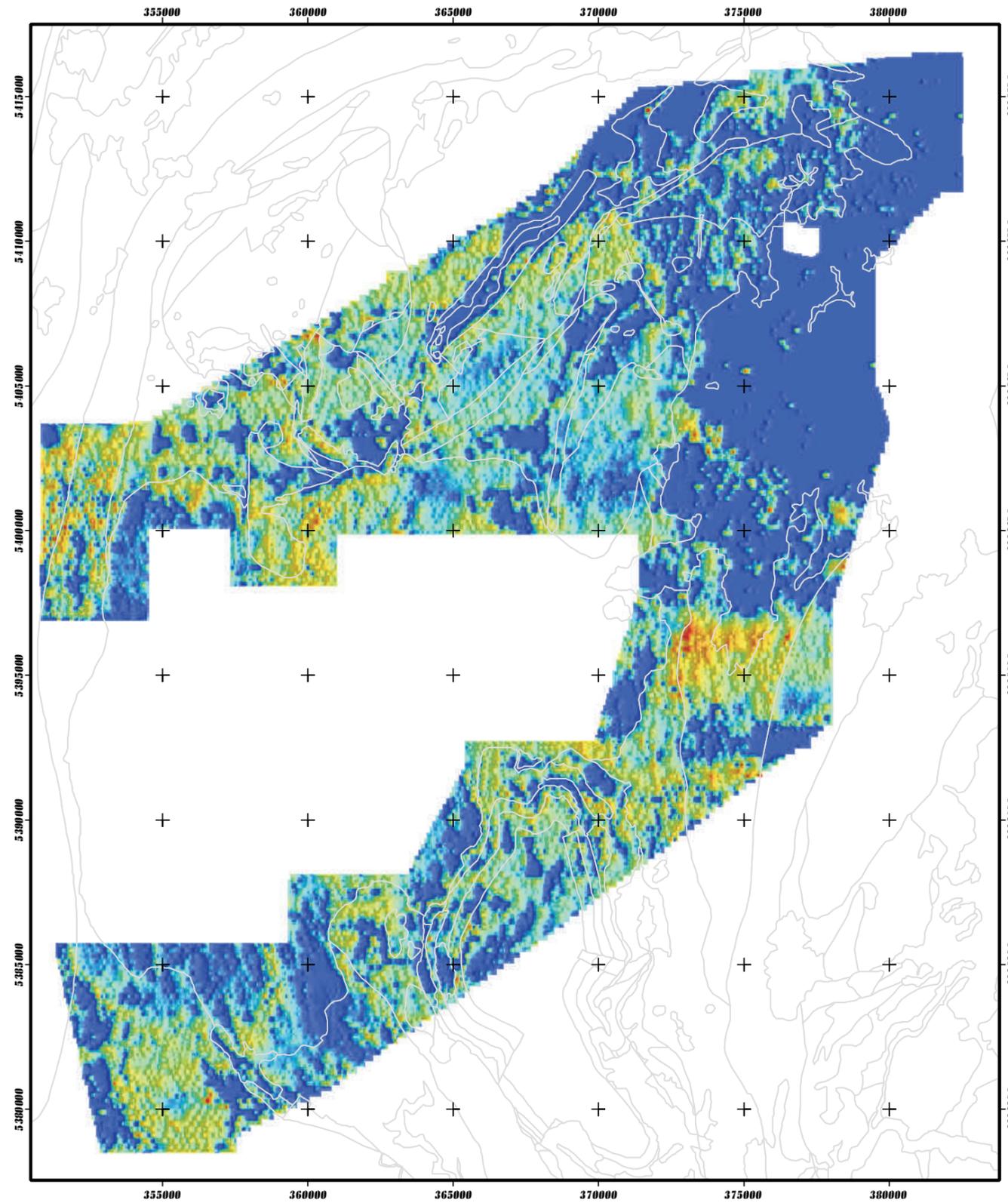
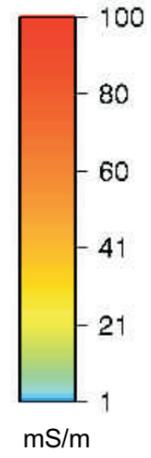


Figure 3.15
Meredith EMFlow 70 m depth slice
with 1:250,000 geology



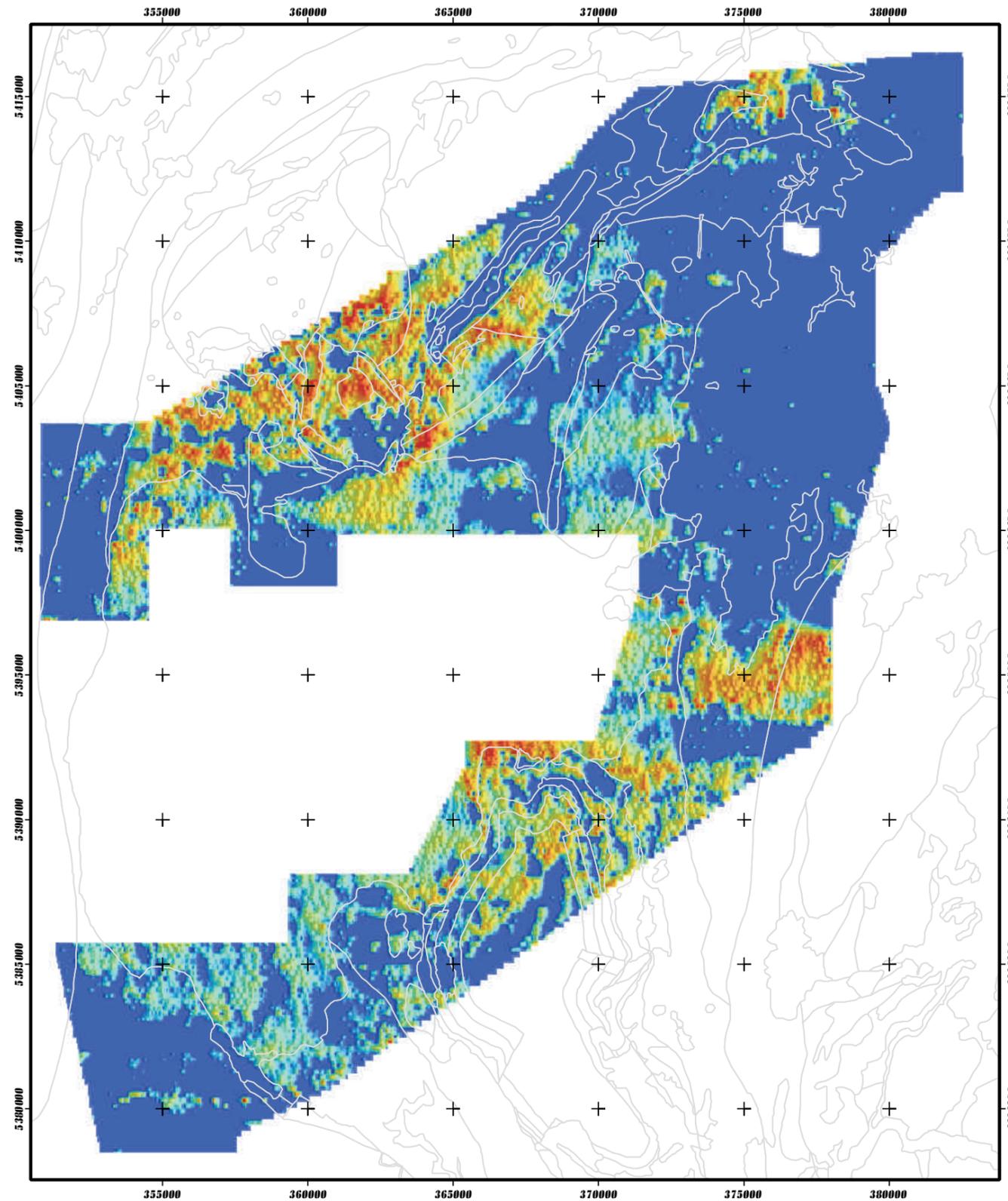


Figure 3.16
Meredith EMFlow 120 m depth slice
with 1:250,000 geology

