



Zonge Engineering and Research Organization (Australia) Pty Ltd

2021
CSAMT Survey
Logistics Summary

January 2021
for
Copper Mines of Tasmania

Compiled by:

P. Soeffky

Report No: 200047

Date: April 2021

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1. SUMMARY

In January 2021, Zonge Engineering and Research Organization Australia (Zonge) conducted a field survey for Copper Mines of Tasmania, at Mt Lyell, Tasmania. Fifteen lines of Controlled Source Audio-Frequency Magneto Telluric (CSAMT) data were collected. A total of 182 stations and 8350-line metres of data were collected over 15 days of data acquisition, mobilisation and rostered days off led to a total program duration of 20 days.

Presurvey information provided to Zonge prior to the survey starting is contained within Appendix II.

2. INSTRUMENTATION

A Zonge multipurpose GDP-32/24 receiver was used to collect all of the CSAMT data for this project. Transmitted fields were generated with a Zonge GGT-10 geophysical transmitter which was powered by a ZMG-10 generator system. Signal frequency and synchronisation was controlled by an XMT-32 controller; the receiver and controller were synchronised daily. For all surveys transmitter electrode pits were dug and prepared by the crew.

Grounded, porous ceramic pots filled with copper sulphate were used to collect electric field data. CSAMT magnetic-field data were sensed using EMI ANT-6 coils. Receiver and transmitter arrays were constructed using 2.5mm² insulated copper wires.

The raw data from each day were downloaded each evening from the receiver's internal memory to a laptop computer before being sent to Zonge's Adelaide office. Final processing, plotting and modelling were completed in Zonge Engineering's Adelaide office.

3. SURVEY PARAMETERS

Each CSAMT receiver array consisted of four 50 meter long E-field dipoles (i.e. collecting Ex component data) and one central H-field antenna (i.e. collecting Hy component data). Data from each channel were recorded simultaneously to provide scalar coverage along each line. Line orientation and length varied on each grid; line specifications are shown in Table 1. Note that the midpoint of start and ending receiver dipoles is recorded in Table 1, actual start and end electrodes lie 25m outside these locations. All CSAMT data were

processed as harmonic data to provide additional impedance estimates over frequency for each sounding. While data were collected for up to 9 odd harmonics, due to relatively weak signal, only 1st and 3rd harmonics were used for the data collected over both grids. CSAMT data were recorded over the frequency range from 4 to 8192 Hz.

The position of the CSAMT transmitter dipoles used for these surveys are shown in Table 2. Distance between receiving lines and transmitter dipole varied however, ranged from 6.9 to 10.8 km for the grid. To aid planning and permissions, the transmitter dipoles occupied the same sites as previous surveys.

All coordinates presented here are in GDA94 Zone 55S. GPS coordinates and tracks collected in the execution of this project are recorded in the Survey_Info\GPS director accompanying this report.

Table 1: Summary of CSAMT 2021 data.

<i>Line</i>	<i>Survey</i>	<i>Start Station Local</i>	<i>Finish Station Local</i>	<i>Start Station UTM mE/mN</i>	<i>Finish Station UTM mE/mN</i>	<i>Number of Stations</i>	<i>Line Length (m)</i>
5700E	CSAMT	10625	11775	382711 / 5345998	382027 / 5346923	24	1150
6100E-NC	CSAMT	11025	10375	383389 / 5345754	383181 / 5346035	8	350
6100E-TC	CSAMT	9125	9475	383924 / 5345030	383716 / 5345312	8	350
6200E-NC	CSAMT	10025	10375	383469 / 5345814	383261 / 5346095	8	350
6200E-TC	CSAMT	9125	9475	384004 / 5345090	383797 / 5345371	8	350
9400N	CSAMT	6025	6375	383700 / 5345207	383982 / 5345415	8	350
10125N	CSAMT	5925	6275	383189 / 5345730	383470 / 5345939	8	350
10400N	CSAMT	5525	6075	382704 / 5345714	383146 / 5346041	12	550
10600N	CSAMT	5625	6075	382665 / 5345934	383027 / 5346201	10	450
10800N	CSAMT	5525	6075	382466 / 5346035	382908 / 5346362	12	550
11000N	CSAMT	5325	6075	382186 / 5346077	382789 / 5346523	16	750
11200N	CSAMT	5325	6075	382067 / 5346238	382970 / 5346684	16	750
11400N	CSAMT	5325	6075	381948 / 5346398	382551 / 5346845	16	750
11600N	CSAMT	5325	6075	381829 / 5346559	382432 / 5347005	16	750
11800N	CSAMT	5325	5875	381710 / 5346720	382152 / 5347047	12	550
Total # of stations and line m						182	8350

Table 2: Transmitter Location

Tx Centre (mE)	Tx Centre (mN)	Orientation (°T)	Length (m)	Lines
375657	5338426	324	1735	5700E, 6100E-TC, 6100E-NC, 6200E-TC, 6200E-NC
376306	5350900	36	1650	9400N, 10125N, 10400N, 10600N, 10800N, 11000N, 11200N, 11400N, 11600N, 11800N

4. PRODUCTION ISSUES

No incidents were reported during this job. Safety documentation completed by Zonge's crew during this project is contained within the Safety_Documentation directory accompanying this report.

Detailed information on daily production may be found in Appendix I and in the accompanying digital data set under "*Production Summary*" and "*Production Reports*".

5. DATA PROCESSING

Processed data presented in this report and in the accompanying digital data set only reflects reliable data with all suspect data removed in editing. All raw data collected during this survey are included in the accompanying data set so that all of these data may be edited and re-averaged if desired.

The quality of each block of raw CSAMT data was examined using Zonge's CSAVGW software before being averaged to create a single record for each receiving station. Blocks or channels that were considered of poor quality were skipped before averaging each station's data. Where harmonic data were recorded only harmonic data that were deemed to be clean were used. The 1st and 3rd harmonic data for each transmitted frequency were used for each station.

Averaged data files were then reviewed using ASTATIC software where each sounding was reviewed and outlying points removed. Data are also inspected for internal consistency between apparent resistivity and phase soundings and static effects. Static correction were applied to this data using a trimmed moving average filter at 4096Hz. Resulting averaged (.avg) files contain both non-corrected and static corrected apparent resistivities.

Final average files were then input into Zonge SCS2D inversion modelling software. Modelling parameters were designed to mimic the modelling methodology used on data from previous surveys in this region for CMT. Modelling parameters included a 1D start model to improve model sensitivity to deeper structures and to utilise near and transition zone frequencies in modelling. 2D modelling were then carried out using this 1D seed model. Results of inversion modelling for each line are presented in Appendix III.

6. EXPLANATION OF FILES

A digital data copy of all of the data and processing accompanies this report; printed plots of the data are provided in appendices at the end of the report as well. Data from each surveyed line are placed in the following directory structure on the accompanying digital data set: *Processed_Data\line#*. File formats are explained below:

CSAMT data files

*.CAC (binary)	Binary raw time series files downloaded from the GDP3224 receiver each day
*.MDE	File used to control/processing variables for Zonge data processing programs
*.AVG¹	Files created by Zonge's CSAVGW program containing averaged CSAMT data
*.ZDB	Zonge International CSAVGW software database containing raw and edited impedance data
*.STN	Text files containing station number, easting, northing and elevation information for each line
*.KML	Google Earth files showing line electrode positions
.MTD,.MTM	Observed, calculated and inversion model result files created by SCS2D
*.PNG	Plot files containing modelled, observed and calculated Cagniard resistivity and phase data

¹ AVG files are averaged data files created by various Zonge processing programs. In initial processing these are often organised by individual station number. A number of these are then combined into the averaged data set for a line, and this Line.AVG is then used as an input to most Zonge inversion routines.

APPENDIX I

Job Summary

Zonge Engineering & Research Organization (Australia) Pty Ltd

39 Raglan Avenue Edwardstown SA 5039

Tel +61 8 83710020 Fax +61 8 83710080



Zonge Engineering & Research Organization (Aust) Pty Ltd

JOB HOURS SUMMARY

Job No.: 200047
 Client: Copper Mines Tasmania
 Project Name: Mt Lyell
 Summary Sheet: 1 of 1

Date: 11/01/2021
 By: Mark Reed

DATE	Production Hours			Misc Hours			Comments
	Mobe 4-person	4-person	3-person	Standby 4-person	Standby 3-person	Weather 4-person	
11-Jan-2021	12.5						Mobilisation from Adelaide to Melbourne - Load vehicles on Spirit of Tasmania
12-Jan-2021	6.25				3.5		Continue Mobilisation from Devonport to Queenstown - Inductions + Job Prep
13-Jan-2021			9.75				Build Tx site and Setup repeater station
14-Jan-2021			2.5				Drive to site - Put out pot wires + Pots - Setup first spread - Rx failure
15-Jan-2021			10.5				Line 10600N complete, setup on 10400N
16-Jan-2021			11				Line 10400N completed and Line 10125N Completed
17-Jan-2021			8.5				Line 10800N completed - 3 Readings
18-Jan-2021					10		RDO
19-Jan-2021		10					Finish line 11000N - 4 Readings
20-Jan-2021		10					Finish line 11200N - 4 Readings
21-Jan-2021		10.75					Finish line 11400N - 4 x Readings
22-Jan-2021		11.5					Finished lines 11600N and 11800N - 7 Readings
23-Jan-2021		1					Finish Repeat lines 10400N and 10600N - 6 Readings
24-Jan-2021		3					Finish Repeat lines 10800N - 3 repeats, 10125N - 2 repeats + Line 9400N - 2 Reads
25-Jan-2021		10				0.5	Flip transmitter to the west (N-S Tx), Line 6100E complete
26-Jan-2021				10			RDO
27-Jan-2021		11.75					Lines: Tasman Crown Line 6200E, Comstock 6100E and 6200E
28-Jan-2021		10.75					Line: West Comstock 5700E, Tx#2 picked up and Tx#1 resetup.
29-Jan-2021	8.5						Job Complete. Repeat of 5800E done on 11200N , DEMOBE to Devonport + board Ferry
30-Jan-2021	9.5						Continue Demobe from Melbourne to Adelaide - Unload vehicles
TOTALS	TOTAL HOURS						
	Mobe 4-person	4-person	3-person	Standby 4-person	Standby 3-person	Weather 4-person	
Sub Totals	36.75	78.75	42.25	10	13.5	0.5	
Totals	36.75	78.75	42.25	10	13.5	0.5	
Rate p/hr	200	400	350	300	262.5	300	
Billable Total	\$7,350.00	\$31,500.00	\$14,787.50	\$3,000.00	\$3,543.75	\$150.00	

APPENDIX II
Pre Survey Client Checklist



PRE SURVEY CLIENT CHECKLIST

Date last modified: _____

Survey Details (Please attach maps or relevant documents)

1.	Zonge Job Number:	200047
2.	Zonge Representative Managing Survey:	Simon Mann
3.	Client Company:	Copper Mines of Tasmania
4.	Client Representative Planning Survey: Crew Leader:	main : Phil Muir, 0417 942 729, phil.muir@bigpond.com alt: Ken Morrison, 0419 873 702, ken.morrison@inet.net.au
5.	Survey / Project Name:	CSAMT 2021
6.	Exploration License Number:	EL_13-2016, ML_9M-2013, ML_10M-2013
7.	Coordinate Datum / Zone to be used:	GDA94 / MGA zone 55
8.	Survey Type:	CSAMT
9.	Survey area or line priority:	Shorter SW-NE oriented cross lines 1 st priority
10.	Station / Dipole Spacing:	As for previous surveys: 50m
11.	Frequency:	As for previous surveys (Simon to confirm): 16 Hz
12.	Data coverage required for IP:	n/a
13.	Can the crew contact the client representative out of hours (weekends) if necessary?	Yes



PRE SURVEY CLIENT CHECKLIST

14.	Will Zonge be required to perform specific processing or inversion modeling on the data acquired?	Yes, 1D and 2D inversion
15.	Will the client require a hardcopy of the logistics report as well as digital?	No
16.	Will the client require a hardcopy of safety documents and or MSDS?	No

Site Details (please provide information where possible)

17.	Crew Accommodation:	Arranged by ZERO
18.	Client contact for crew (<i>name, phone and email</i>):	main : Phil Muir, 0417 942 729, phil.muir@bigpond.com alt: Ken Morrison, 0419 873 702, ken.morrison@iinet.net.au
19.	Relevant site liaison contacts (<i>name, phone and email</i>):	General, and especially for anything needing immediate on-site attention : Geoff Cordery, 0407 040 387, Geoff.Cordery@cmt.com.au CMT Safety/emergency : 0419 877 639
20.	Will Zonge crew be required to contact landowners or other external interested parties?	No
21.	Have all stakeholders been made aware of hazards relating to our operations? (<i>please distribute Form 82 as required</i>)	Please advise hazards from survey. Include in RA / JHA
22.	Level of mobile phone coverage at accommodation or survey area:	Good (in Queenstown). Limited on job field site.
23.	Please describe level of vehicle access along survey lines and expected topography (<i>attach photos or maps if possible</i>):	Vehicle access to baseline road intersection only. No vehicle access along grid lines. Topography on lines towards north is steep.
24.	Known obstacles along lines (<i>fences, roads etc</i>):	Lines cleared, but in some locations there are sapling tree stump "stakes" remaining in the ground where vegetation has been cleared. Typical PPE required (see Q32 below).
25.	Are cultural noise sources present (<i>power lines, fences, houses etc</i>)?	None in immediate survey area.



PRE SURVEY CLIENT CHECKLIST

26.	Please describe access to nearest water source, both potable and non potable:	Potable water in Queenstown accommodation and / or boxed water from CMT site. Process water available from local streams. Will require small pump and tank.
27.	Are large volumes of water available for grounded electrodes (<i>up to ~2000L/day</i>)?	Yes
28.	Are there specific cultural or environmental requirements for work within the survey area? Please advise of sensitive areas or specific cultural clearances obtained for this work to proceed.	No cultural or environmental constraints. Include bushfire prevention / precautions in RA / JHA, main likely to be no spark generation during high fire danger periods. Mines Dept approval has been obtained for work along grid lines.
29.	Please describe nearest refueling location (<i>diesel and petrol</i>):	Commercial fuel station in Queenstown. CMT can provide diesel if required.
30.	Do you require daily or scheduled contact with crew?	Just a brief email at end of day advising how far survey has progressed, or comment in a little more detail if something has unexpectedly slowed progress. Send email to Phil, Ken, Geoff.
31.	Will the crew be required to work around other personnel?	Yes – some assistance from local personnel available for wire work
32.	Please describe requirements (if any) for crew to work on site (<i>restricted work hours, induction, drug test, PPE etc</i>):	Personnel will require site contractors induction (to be delivered by CMT on arrival, allow max 3 hours); Minimum PPE requirements high viz, long sleeve and long trousers, lace boots with ankle protection, (gaiters recommended) safety glasses, hat (hard hat not required for bush work). Remote area process - tag on and off site, record on remote area board expected work location, contact details and expected return time, have coms (phone and / or radio) plus CMT provided "SPOT" EPIRB, make contact that safe when leaving site. Every morning pre start alcohol test plus random drug tests are possible. Working hours, no longer than 7 days without a break.
33.	Have the lines been flagged prior to crew arrival?	Yes
34.	What level of rehabilitation of transmitter electrodes is required?	Refill pits to original ground level
35.	Will a client based Emergency Response Plan be available? (<i>If so please attach copy</i>)	To be prepared as part of RA / JHA. CMT has a remote area process as described in 32 above. CMT has a formal emergency response plan and during care and maintenance has limited emergency response capability on site.



PRE SURVEY CLIENT CHECKLIST

36.	Will there be stock or animals in the survey area?	No
37.	Please describe vehicle requirements and site inspection checklist (where relevant): <i>e.g. no split rims, flashing lights etc.</i>	Flashing lights, first aid kit, fire extinguisher, UHF radio, no split rims. Clean of soil and vegetation (to be inspected before entering site). Require recorded pre start checks (use own or CMT pre start check book)

Form populated by Geoff Cordery & Phil Muir

Date: __4th January 2021__

Form reviewed by _____ **(if applicable)**

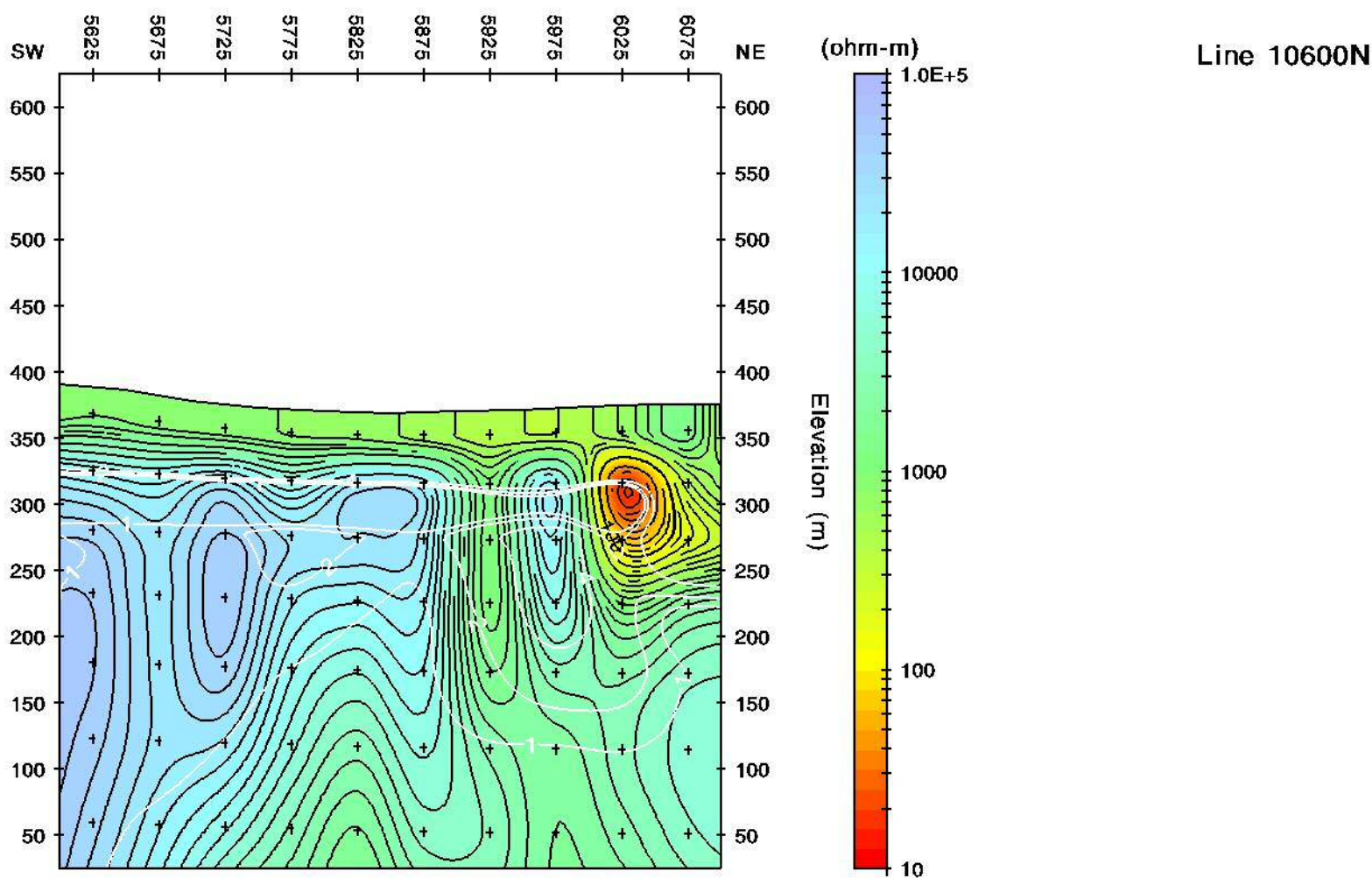
Date: _____

Form reviewed by _____ **(if applicable)**

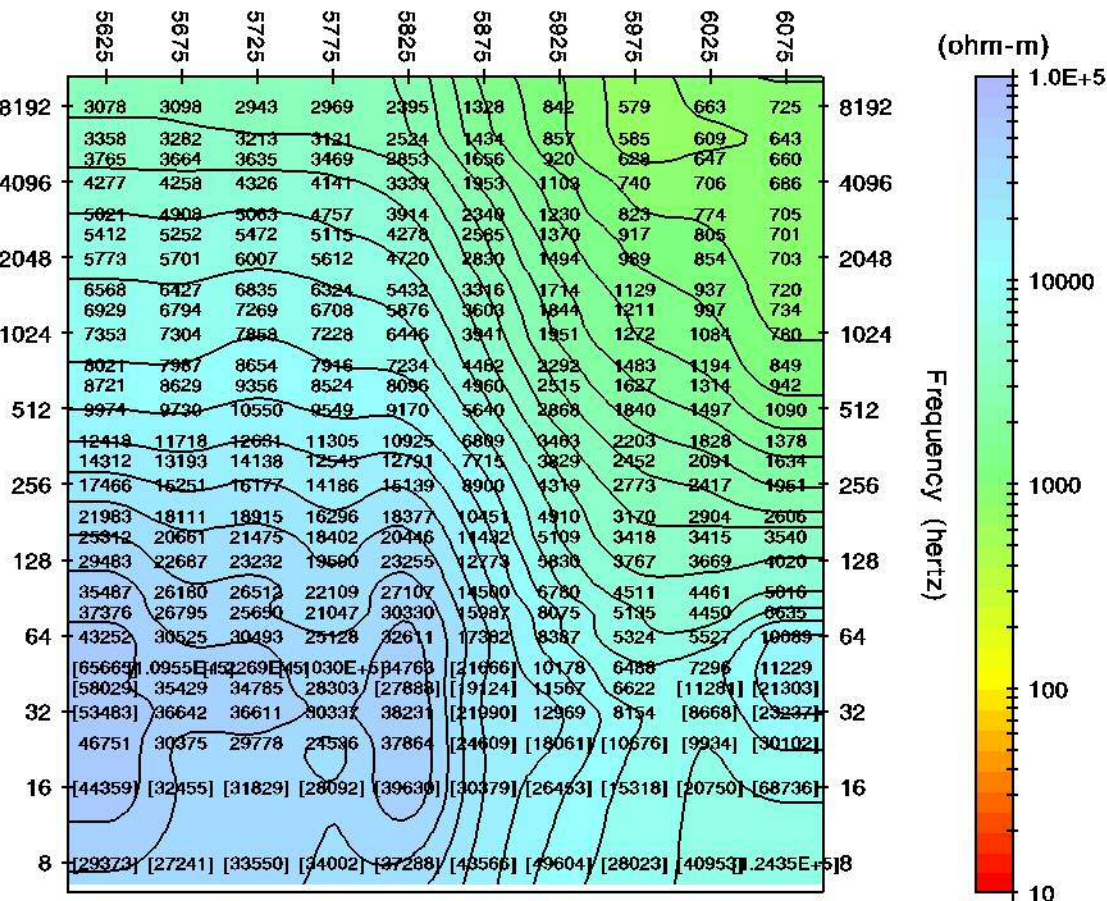
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APPENDIX III
Inversion Model Results

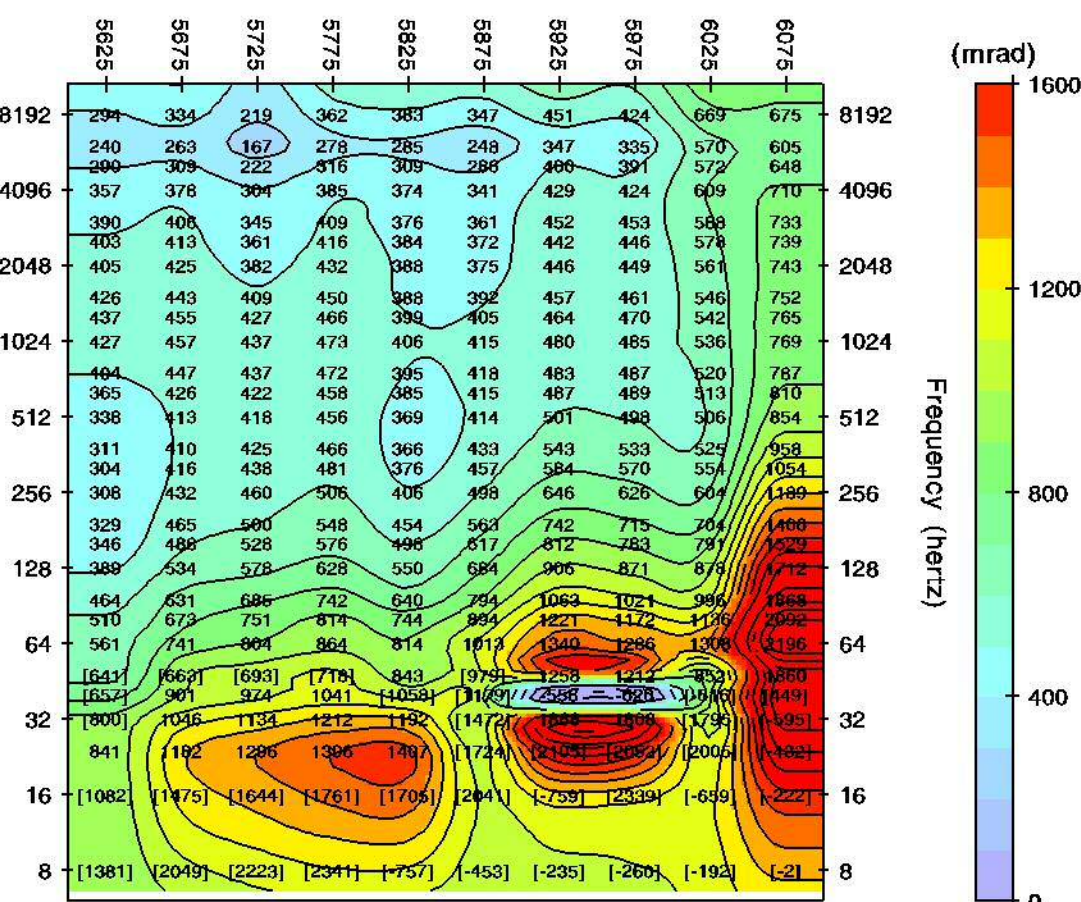
Model Resistivity Inversion Model



TM App. Res. Observed Data



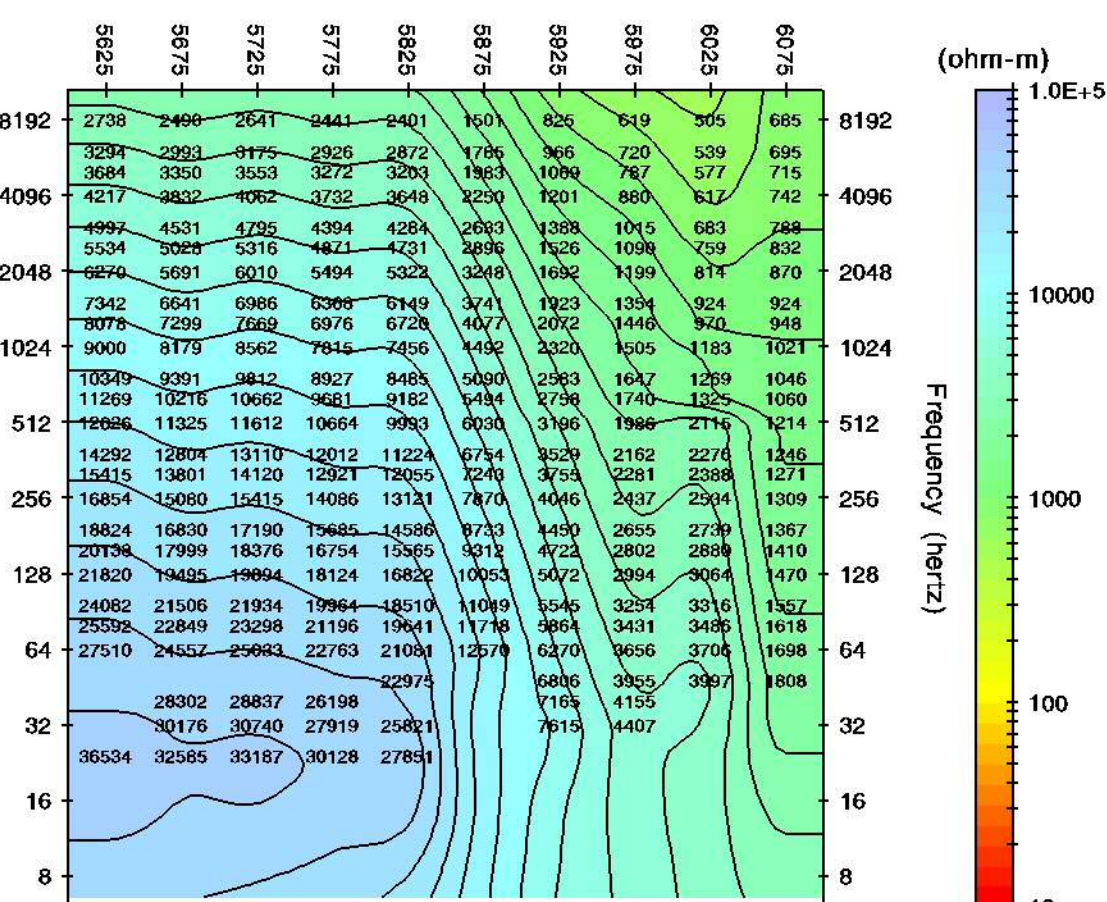
TM Phase(Z) Observed Data



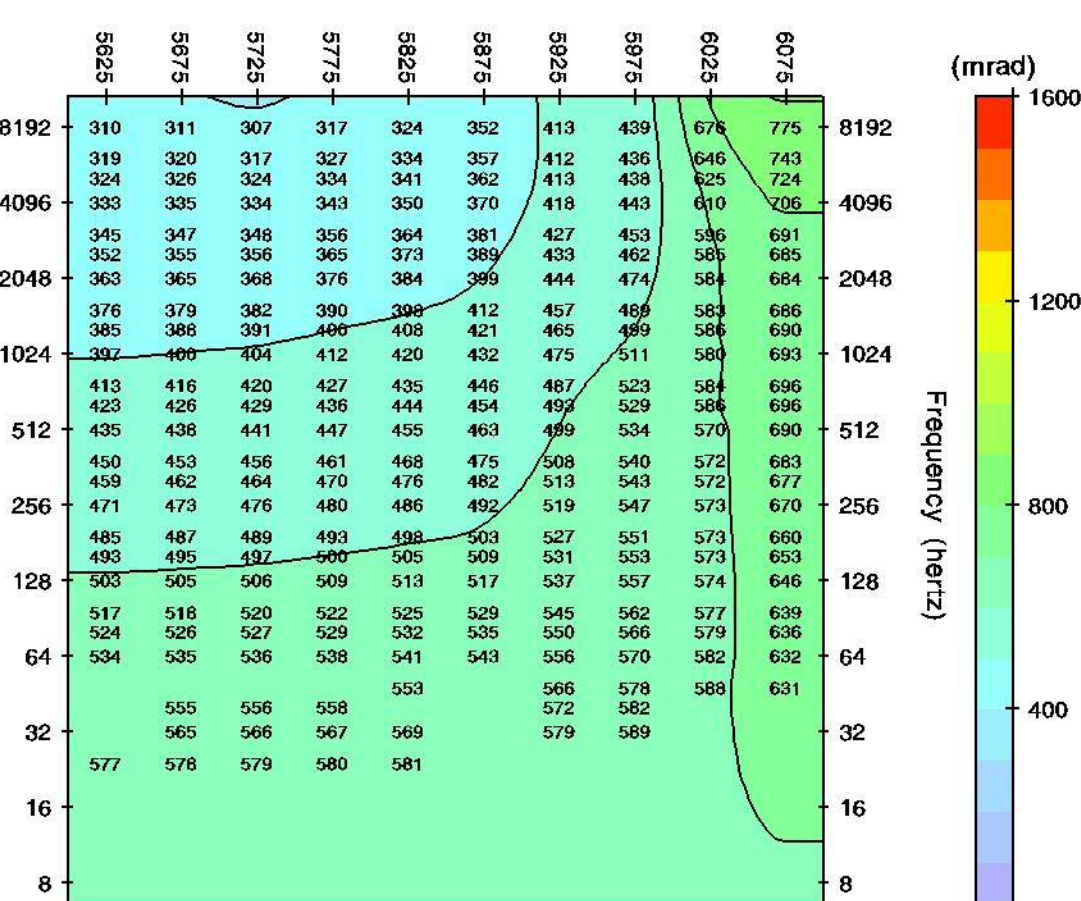
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Bipole Source Scalar AMT data
Tx length = 1354 m, azimuth = -51
Tx center easting=374513, northing=5340109

Rx dipole length = 50 m
Inversion control parameters:
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White contours show Sensitivity

TM App. Res. Calculated Data



TM Phase(Z) Calculated Data



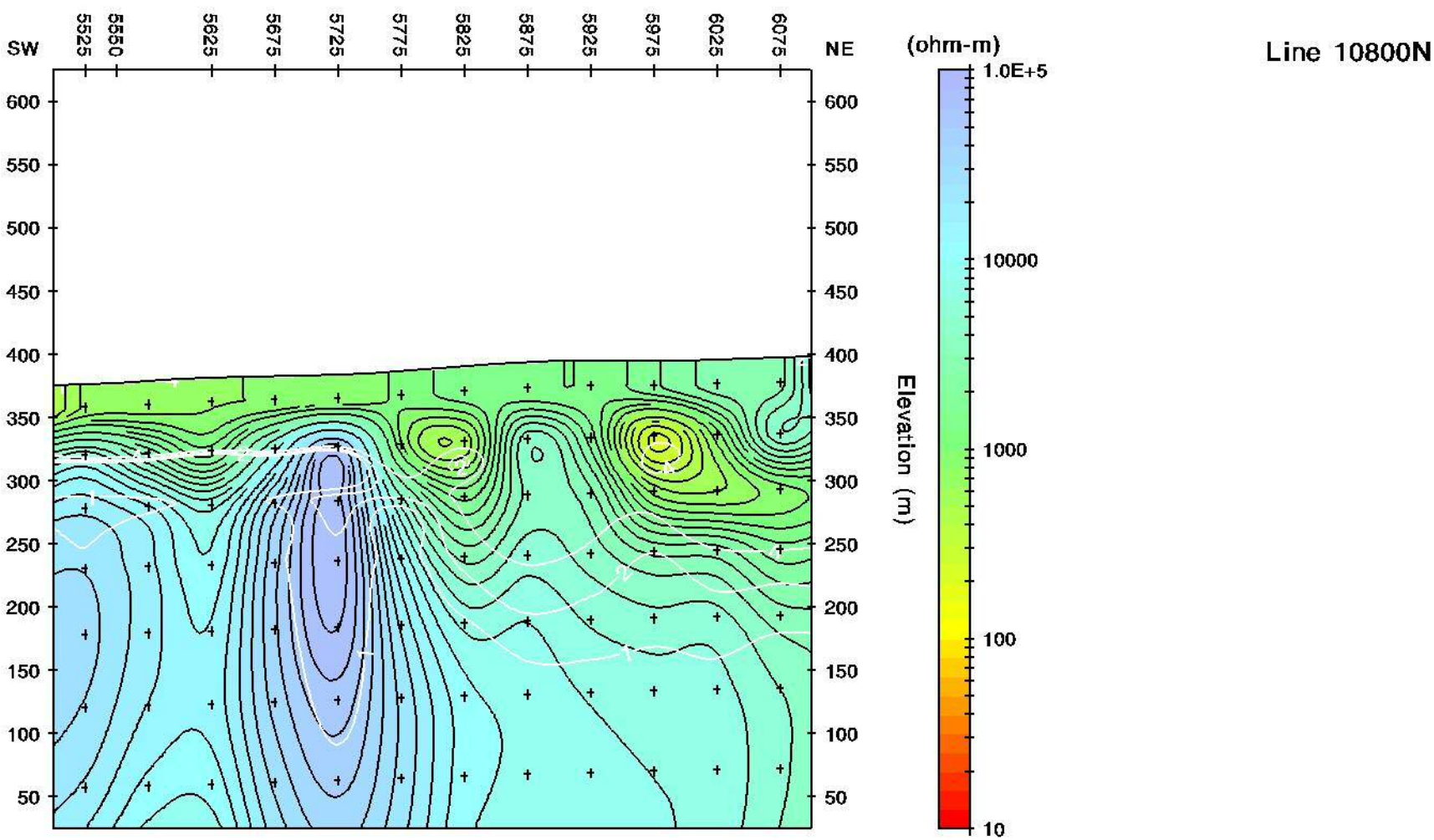
300 m

Copper Mines of Tasmania
10600N

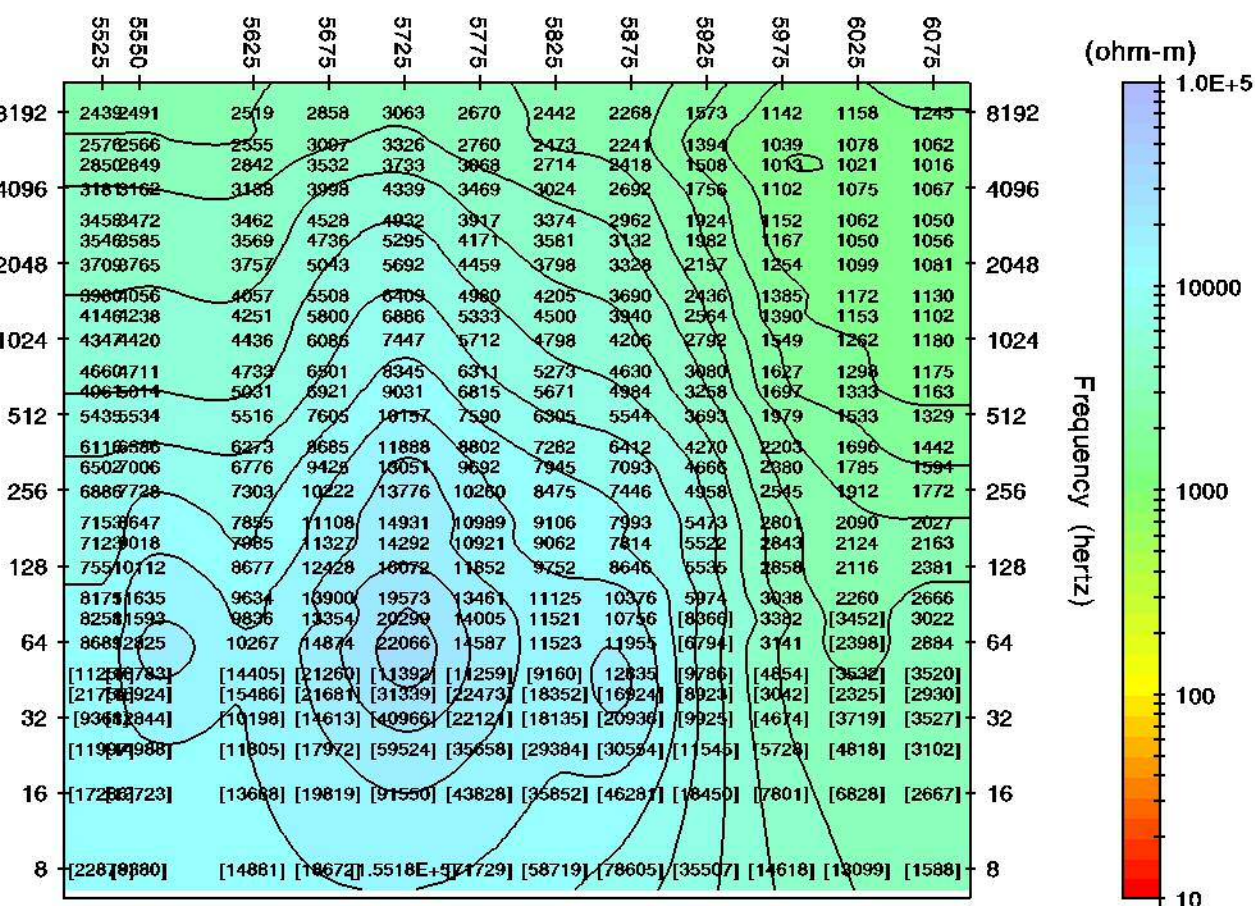
2D Smooth-Model Inversion
Scalar CSAMT/NSAMT Data

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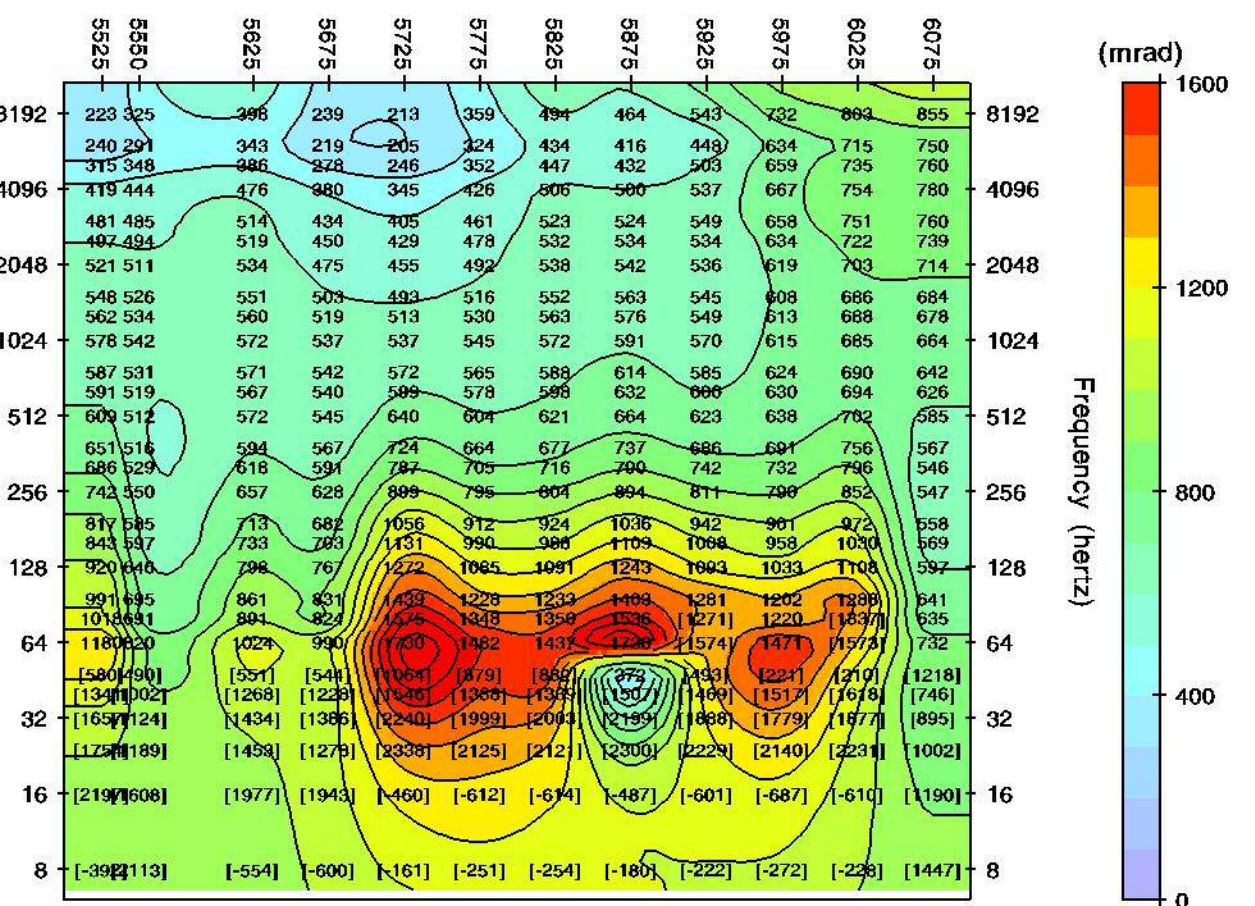
Model Resistivity Inversion Model



TM App. Res. Observed Data



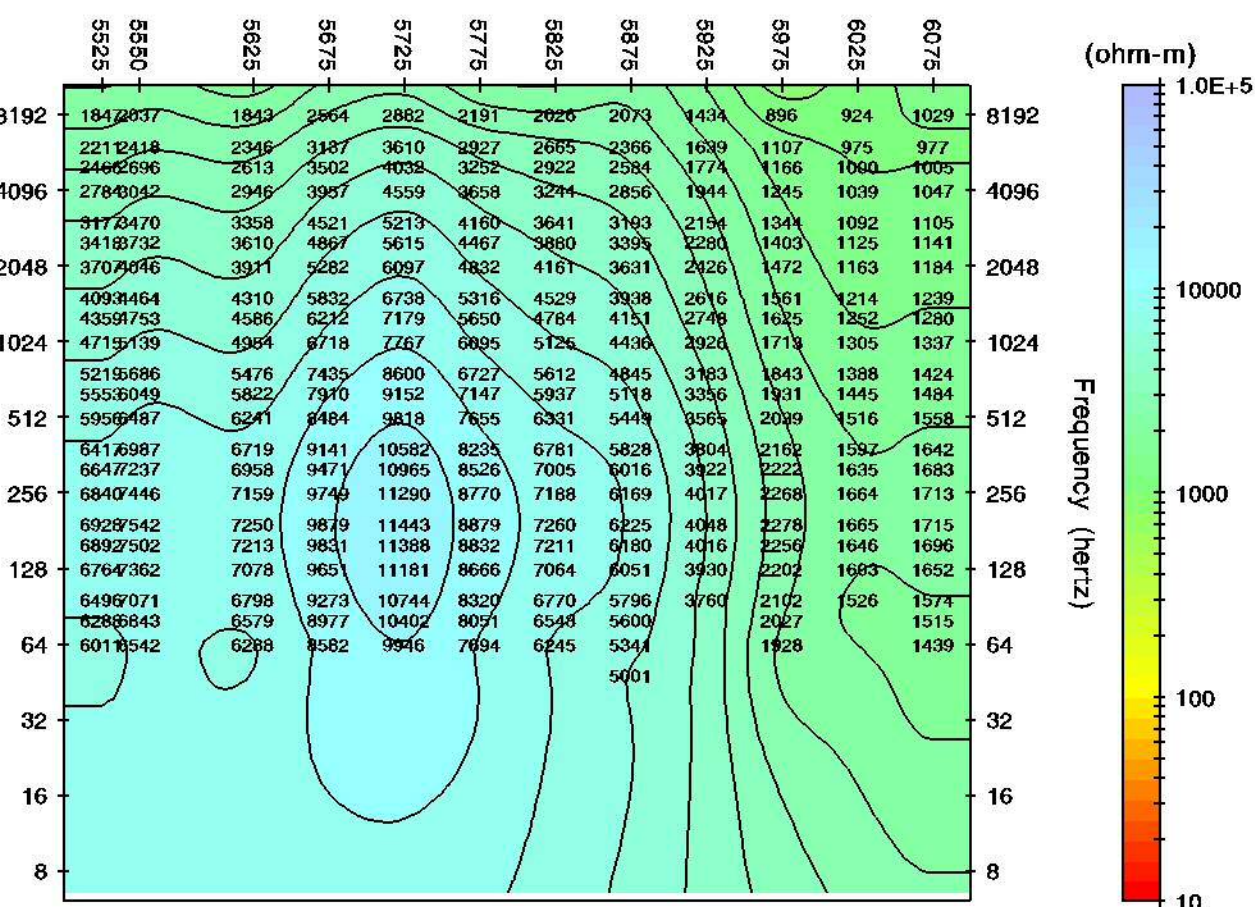
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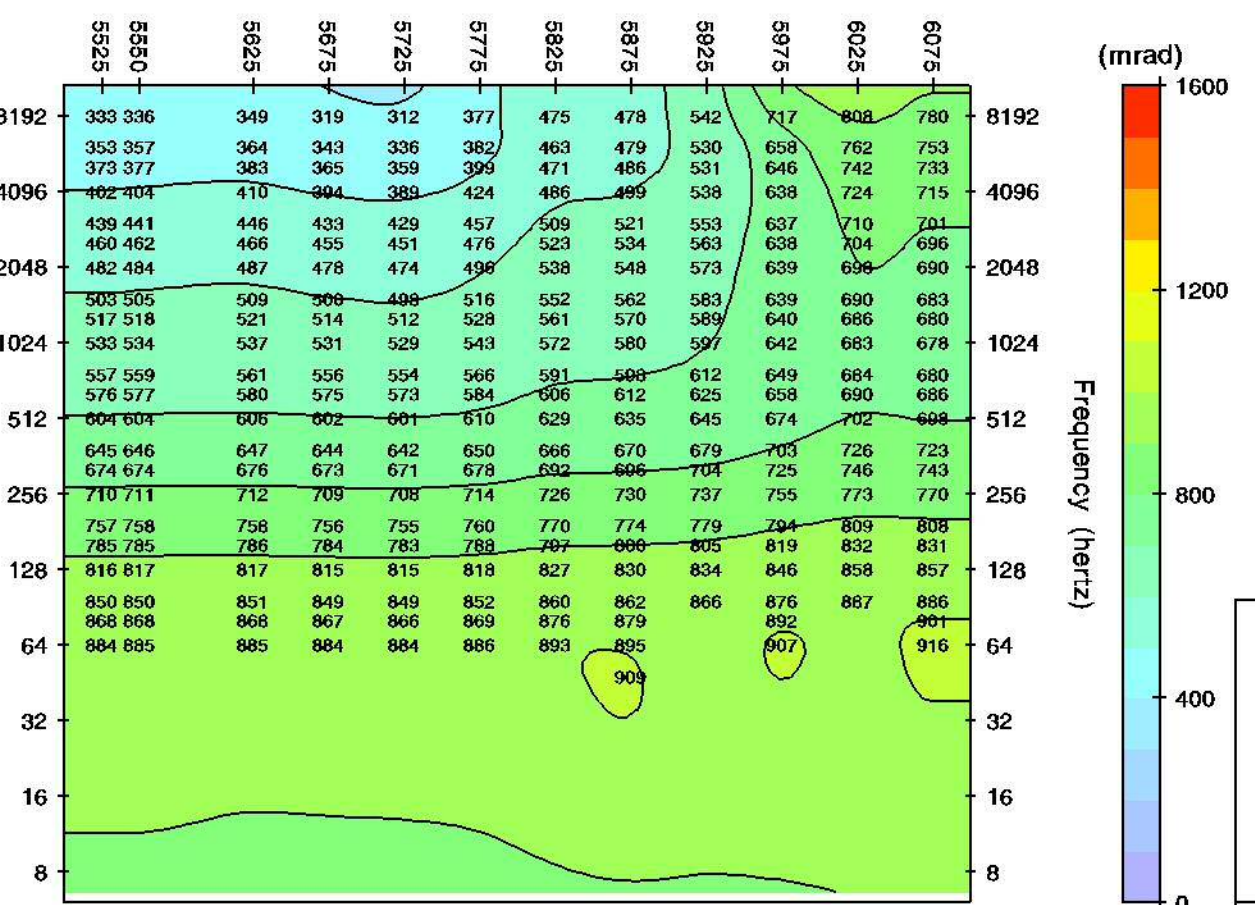
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Rx dipole length = 50 m
Inversion control parameters:
ResSmth=0.5, dpW=0.1, dxW=1, dzW=1
White contours show Sensitivity

TM App. Res. Calculated Data



TM Phase(Z) Calculated Data



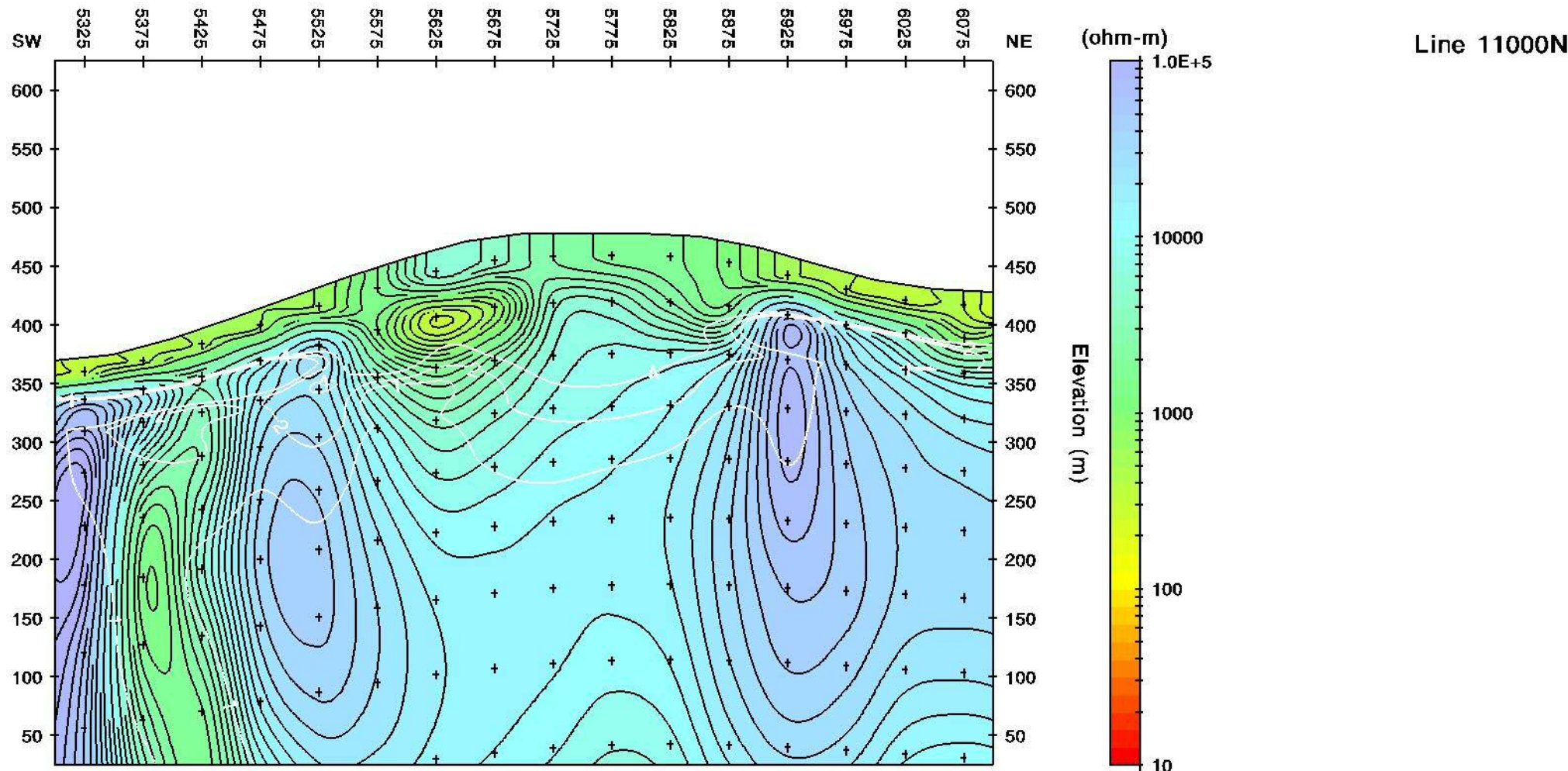
300 m

Copper Mines of Tasmania
10800N

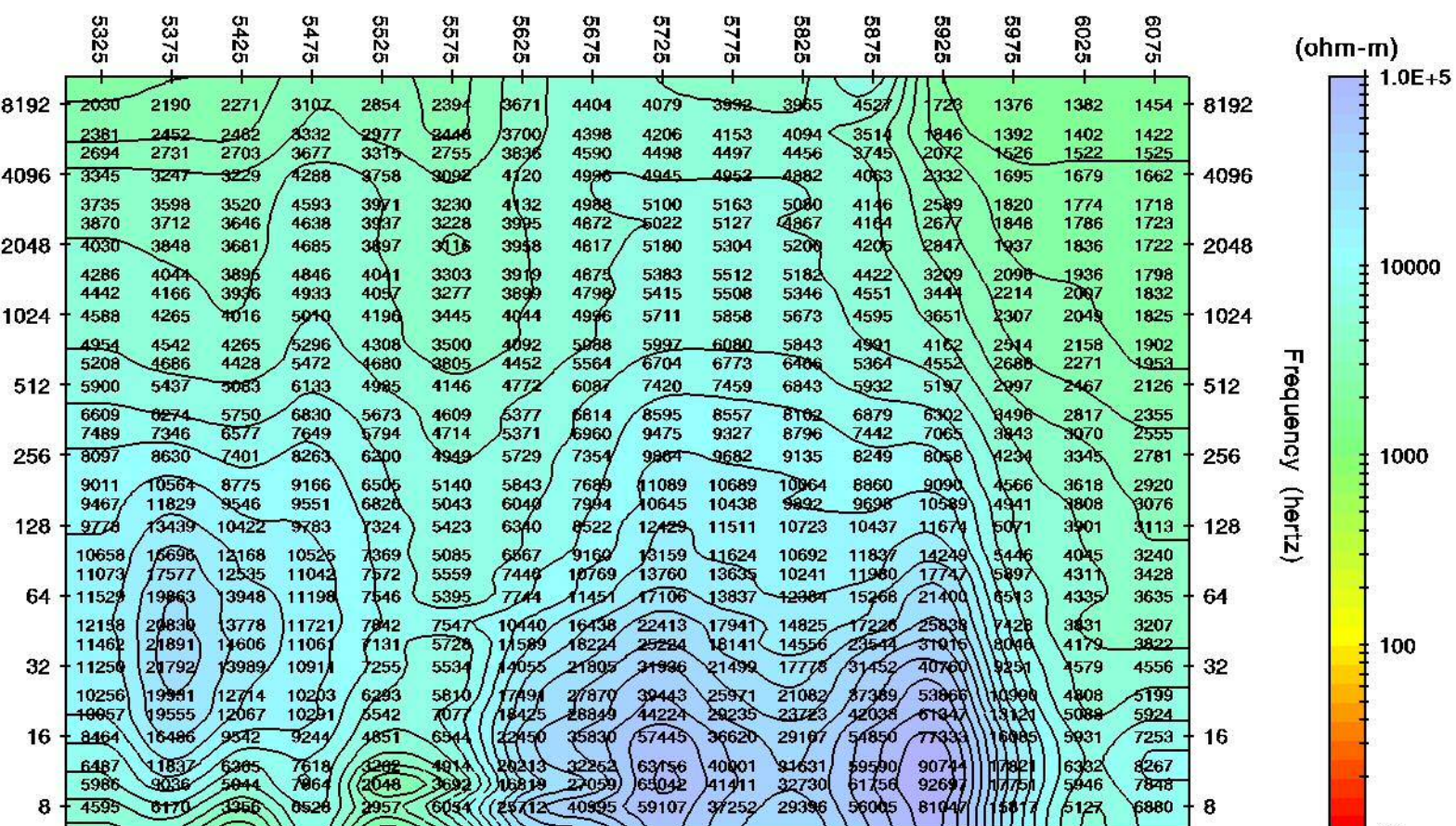
2D Smooth-Model Inversion
Scalar CSAMT/NSAMT Data

AUTHOR	DRAWN	DATE	SCALE	REPORT
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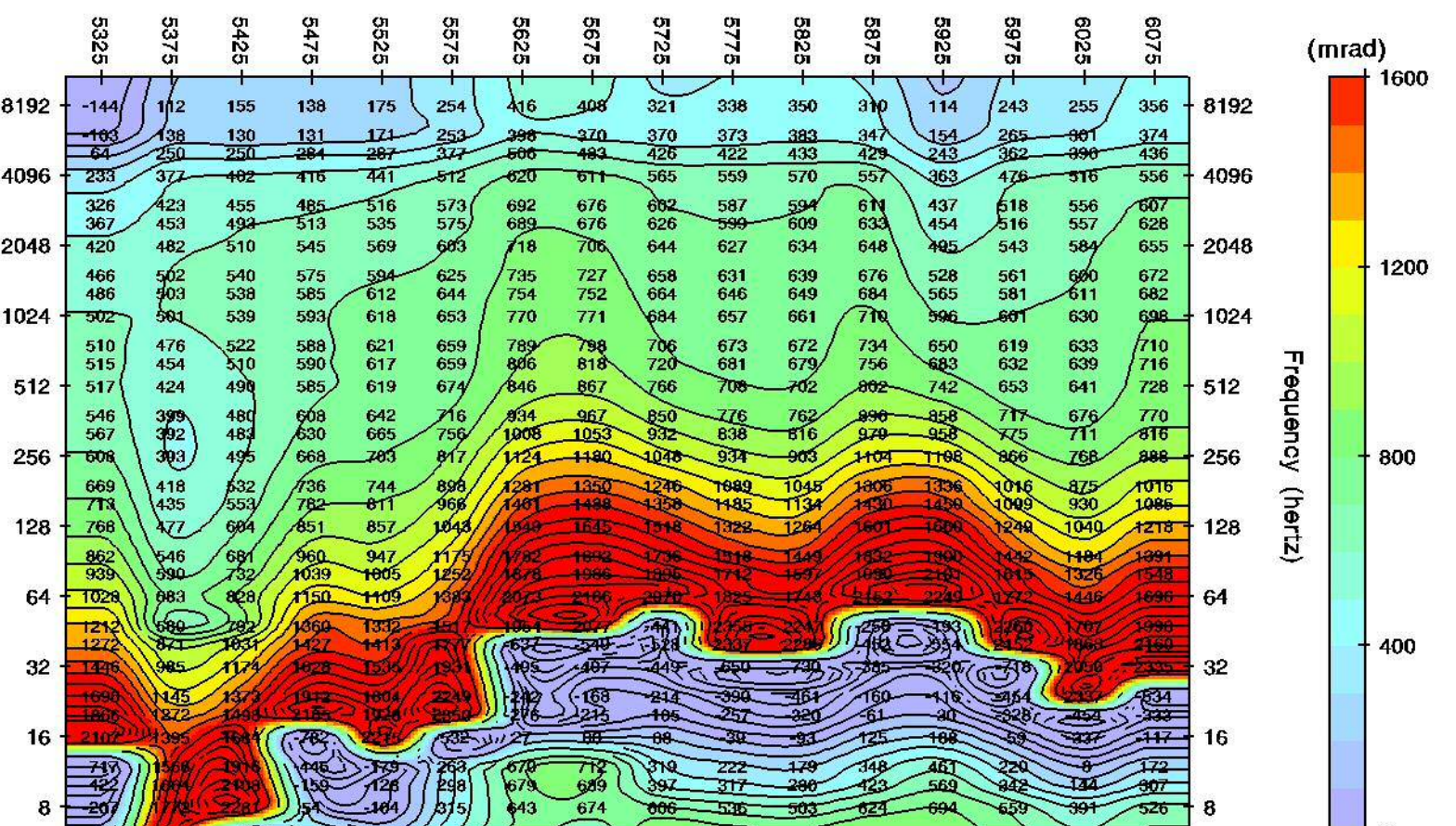
Model Resistivity Inversion Model



TM App. Res. Observed Data



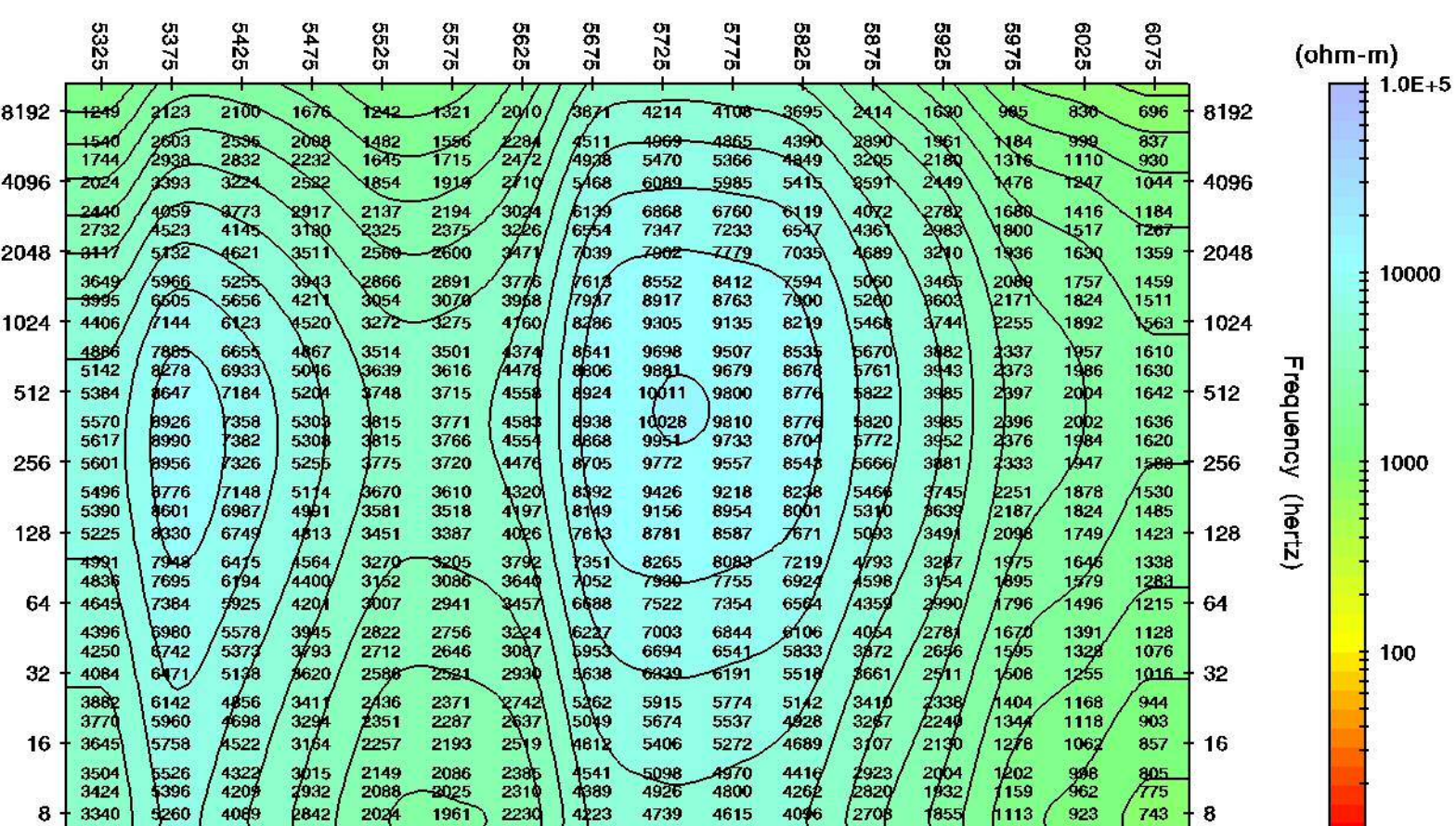
TM Phase(Z) Observed Data



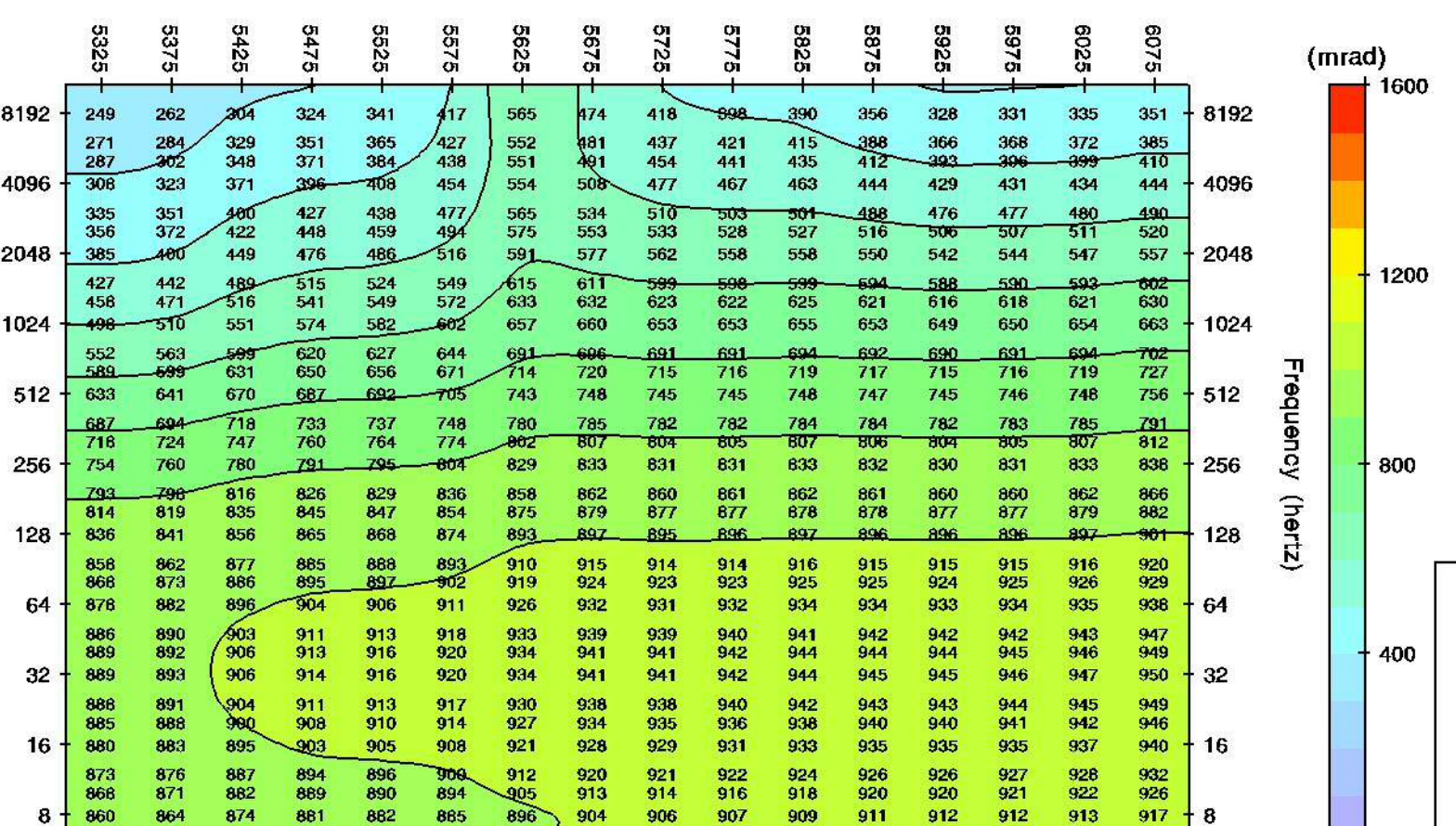
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Tx center easting=374513, northing=5340109

Rx dipole length = 50 m
Inversion control parameters:
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White contours show Sensitivity

TM App. Res. Calculated Data



TM Phase(Z) Calculated Data

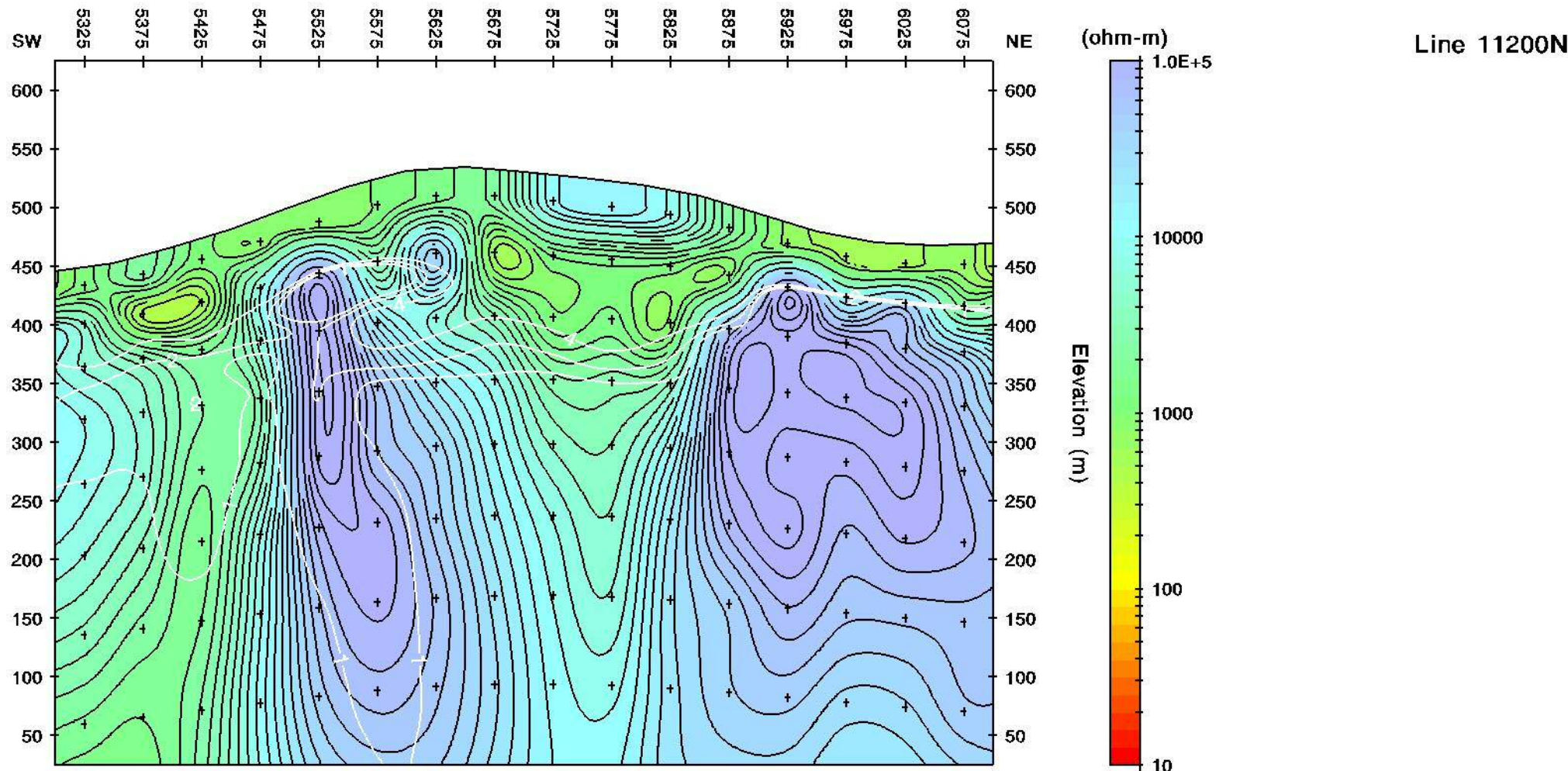


Copper Mines of Tasmania
11000N

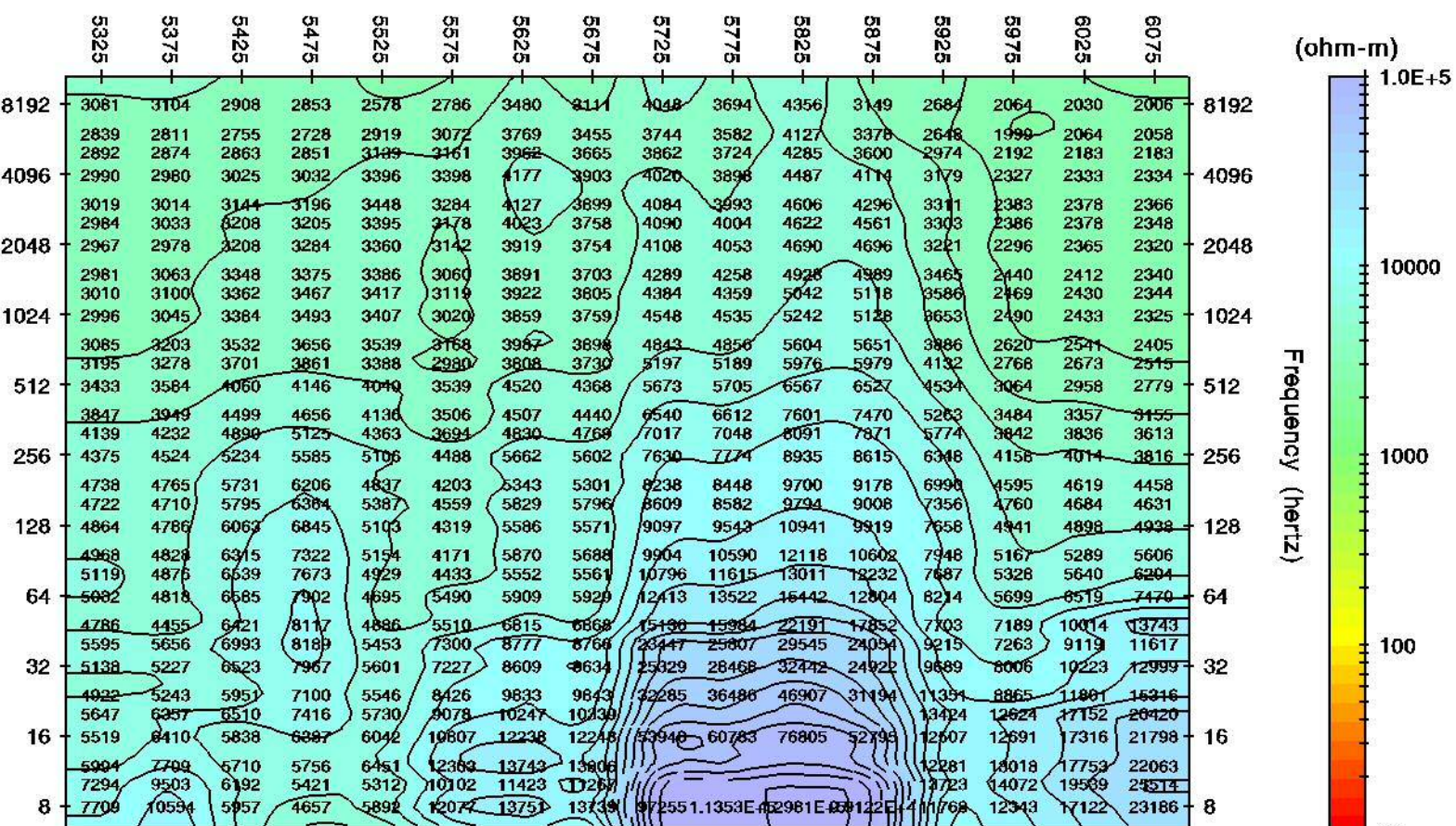
2D Smooth-Model Inversion
Scalar CSAMT/NSAMT Data

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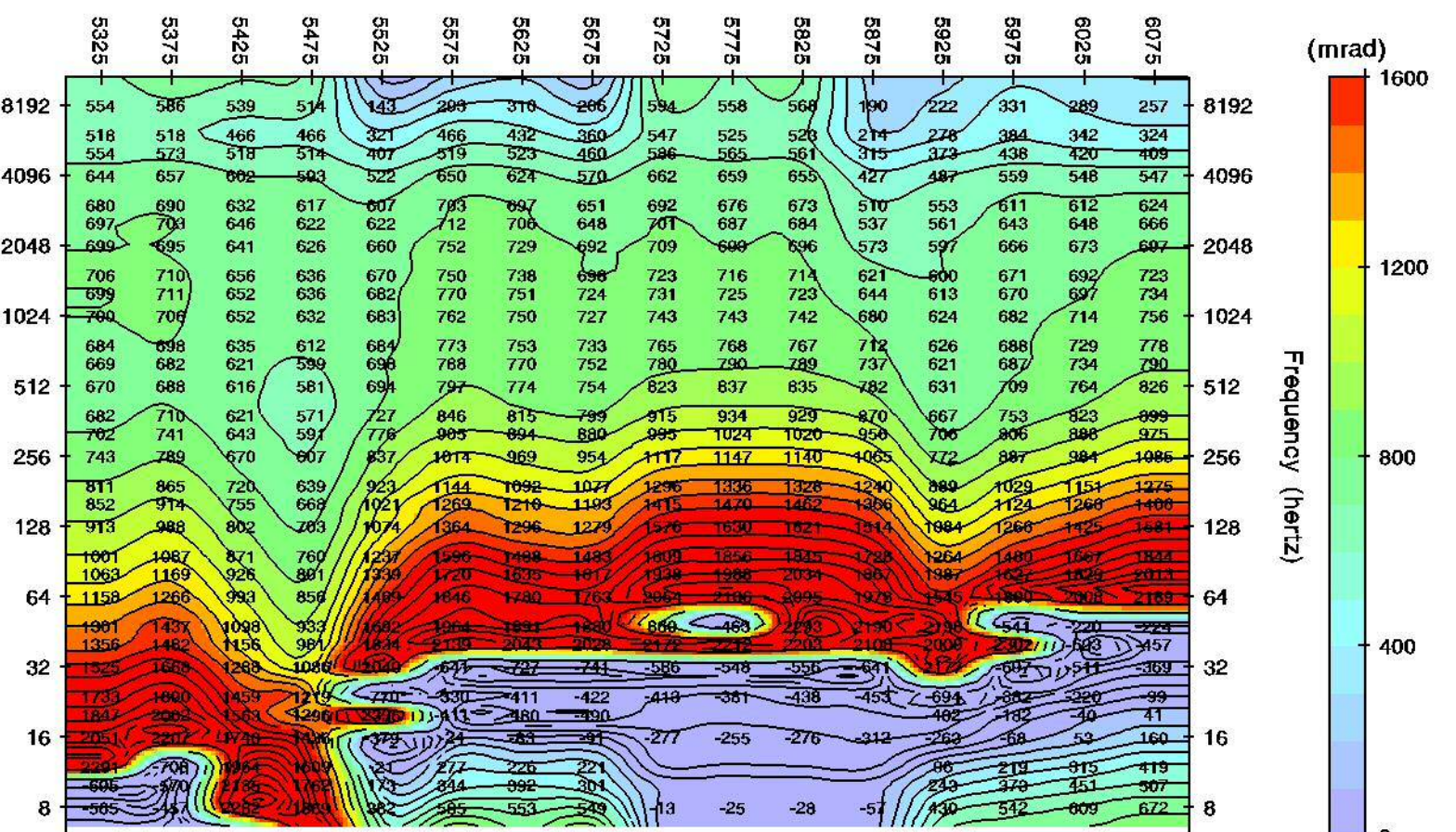
Model Resistivity Inversion Model



TM App. Res. Observed Data



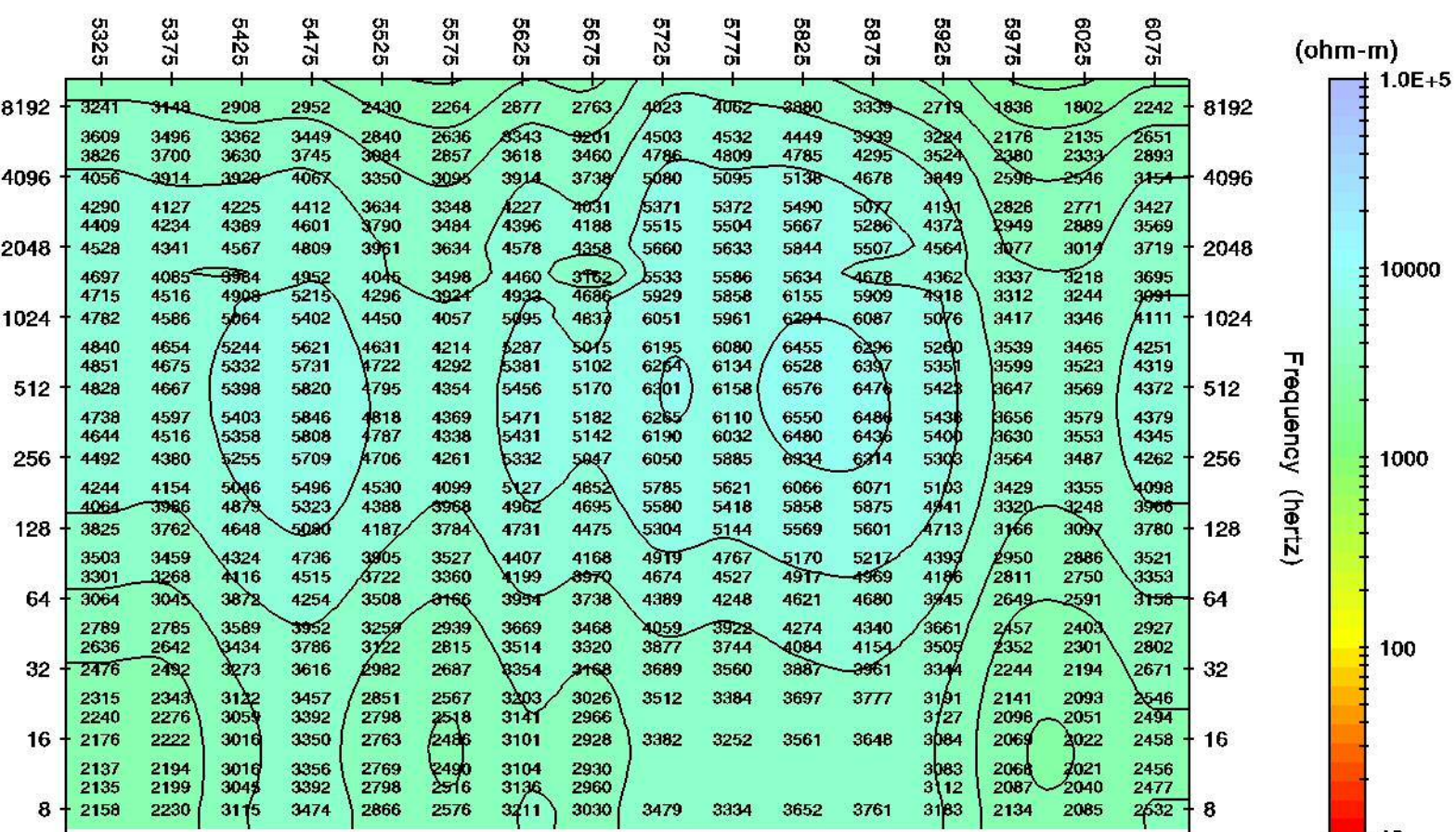
TM Phase(Z) Observed Data



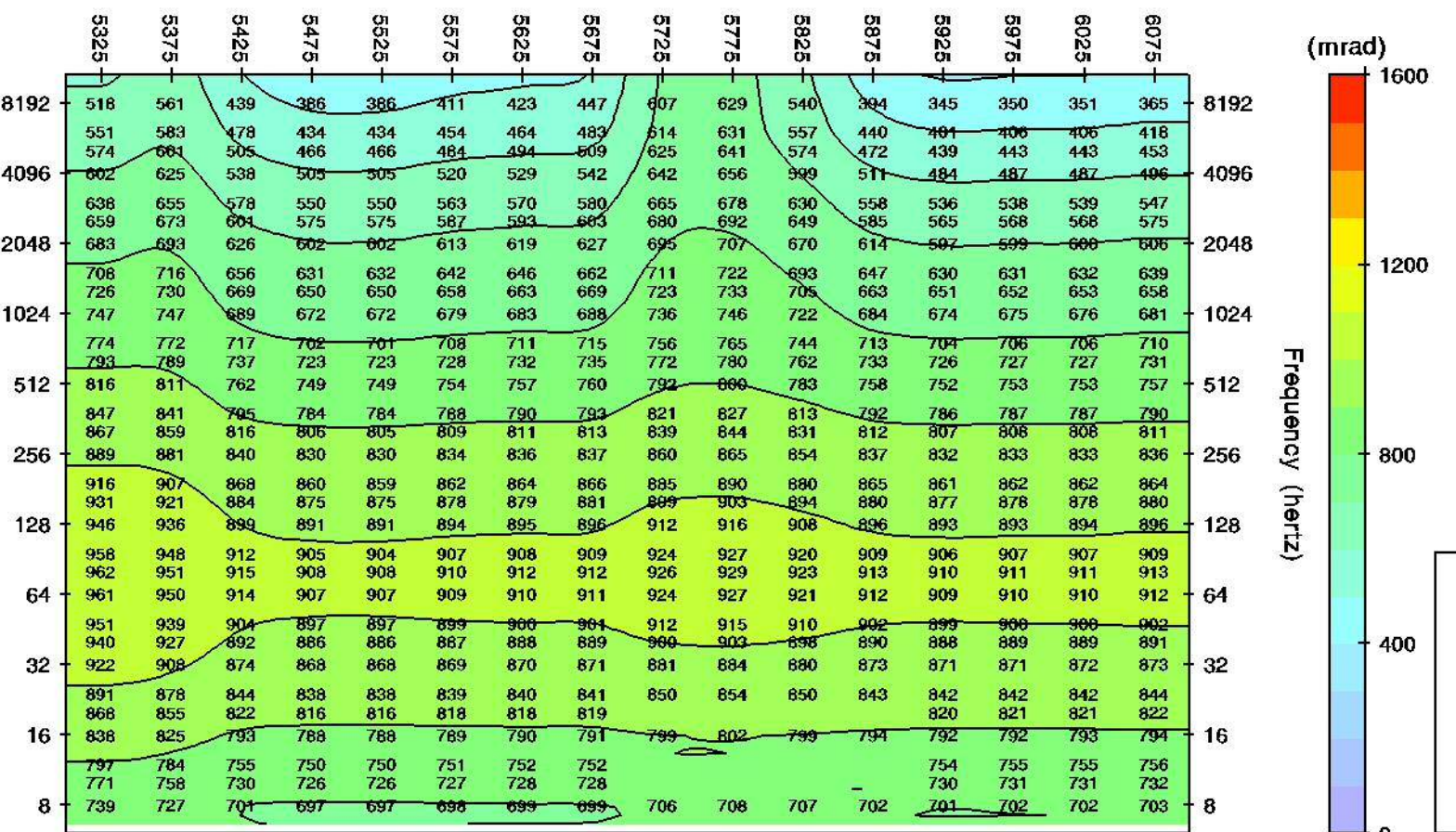
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Tx center easting=374513, northing=5340109

Rx dipole length = 50 m
Inversion control parameters:
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White contours show Sensitivity

TM Res. Calculated Data



TM Phase(Z) Calculated Data

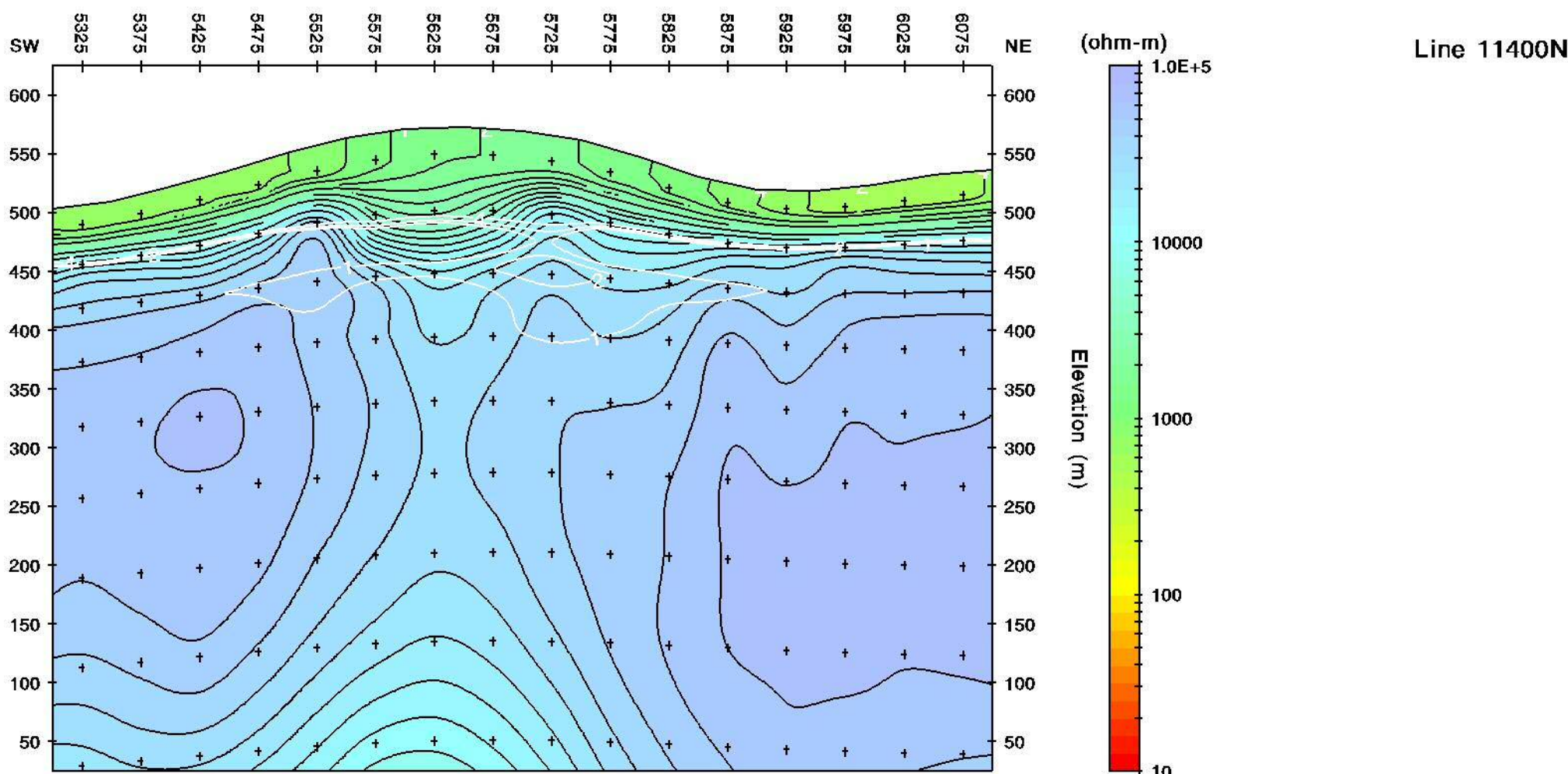


Copper Mines of Tasmania
11200N

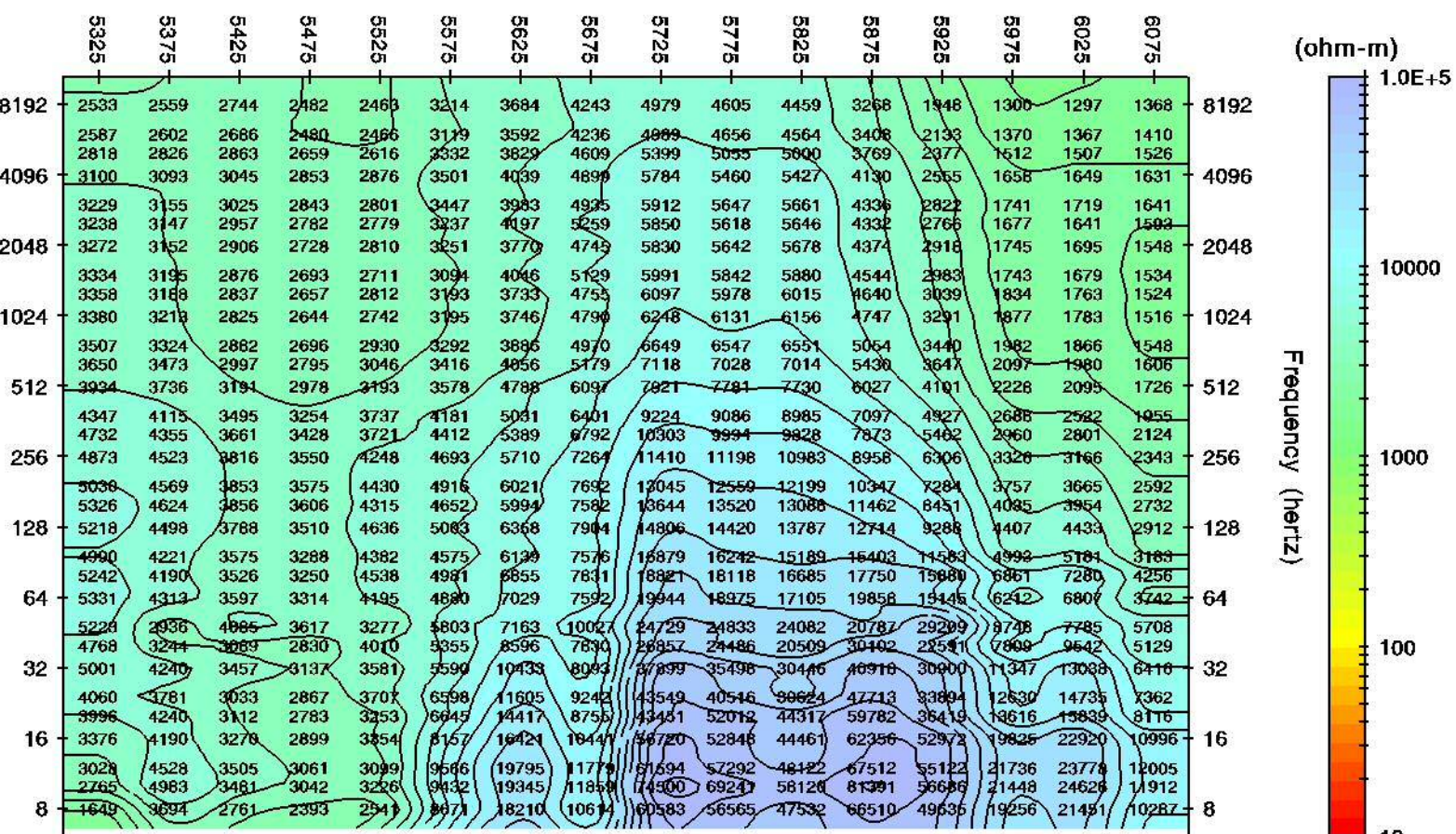
2D Smooth-Model Inversion
Scalar CSAMT/NSAMT Data

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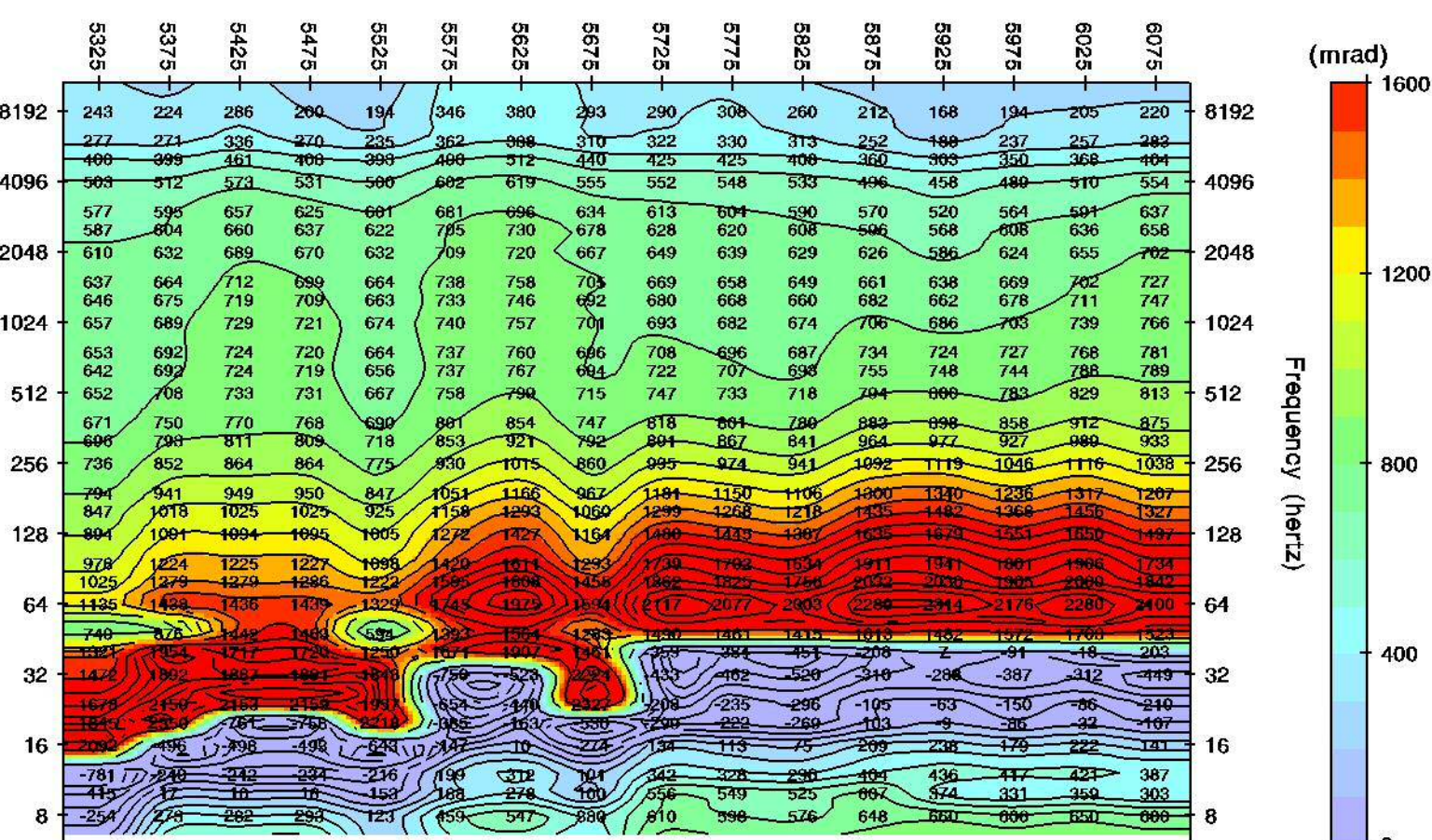
Model Resistivity Inversion Model



TM App. Res. Observed Data



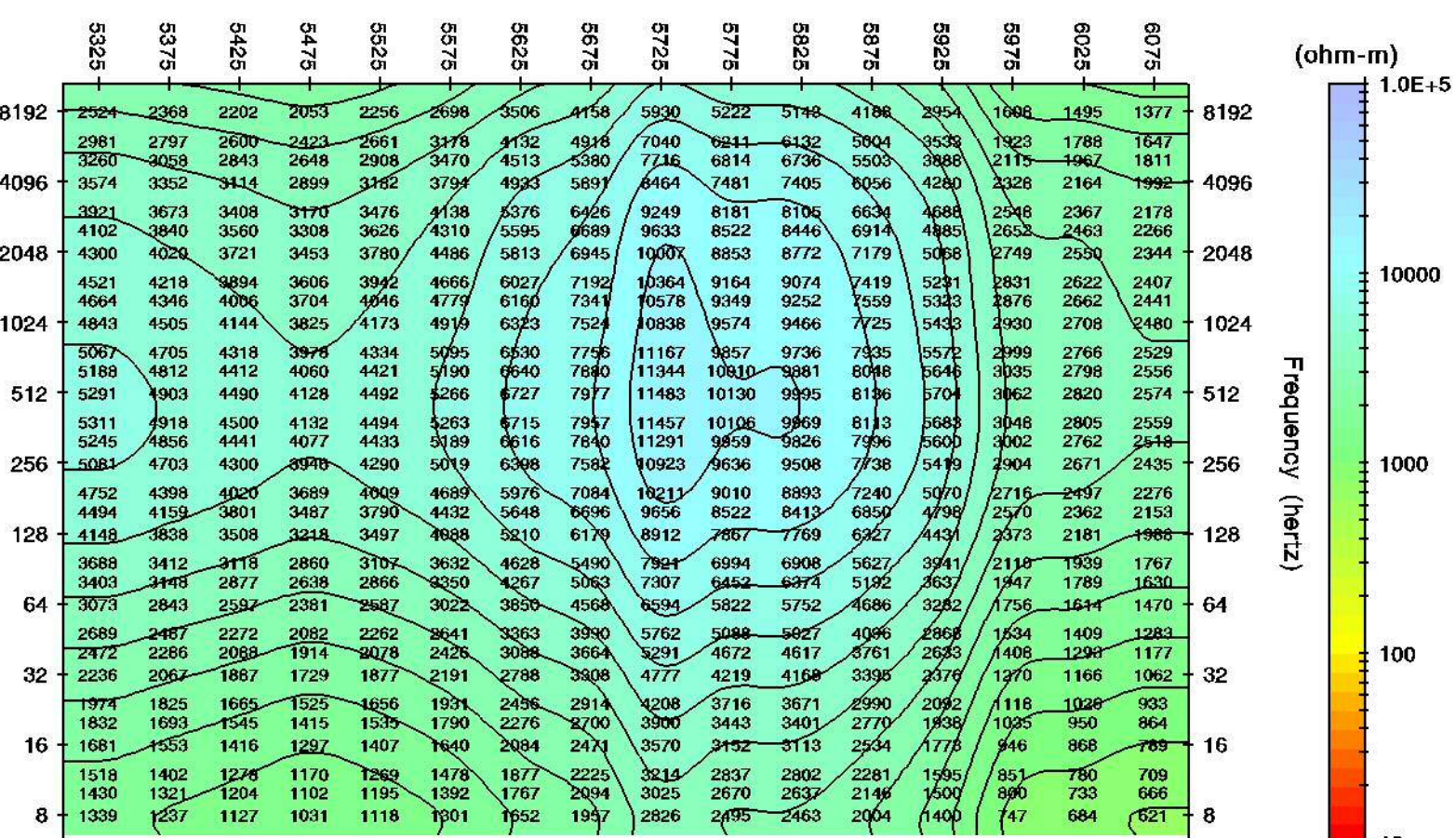
TM Phase(Z) Observed Data



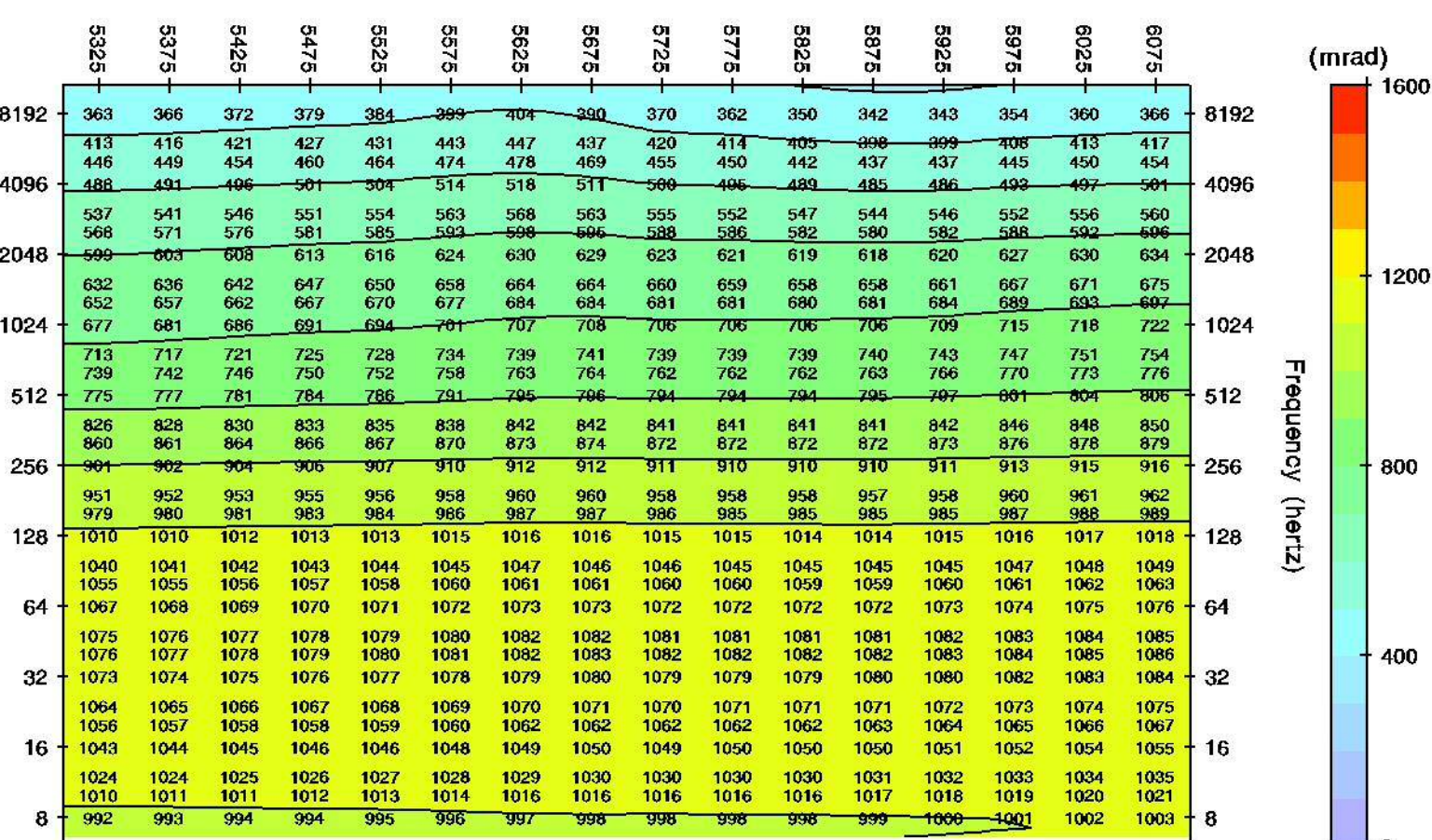
Survey Parameters:
Bipole Source Scalar AMT data
Tx length = 1354 m, azimuth = -51
Tx center easting=374513, northing=5340109

Rx dipole length = 50 m
Inversion control parameters:
ResSmth=0.5, dpW=0.1, dxW=1, dzW=1
White contours show Sensitivity

TM Res. Calculated Data



TM Phase(Z) Calculated Data



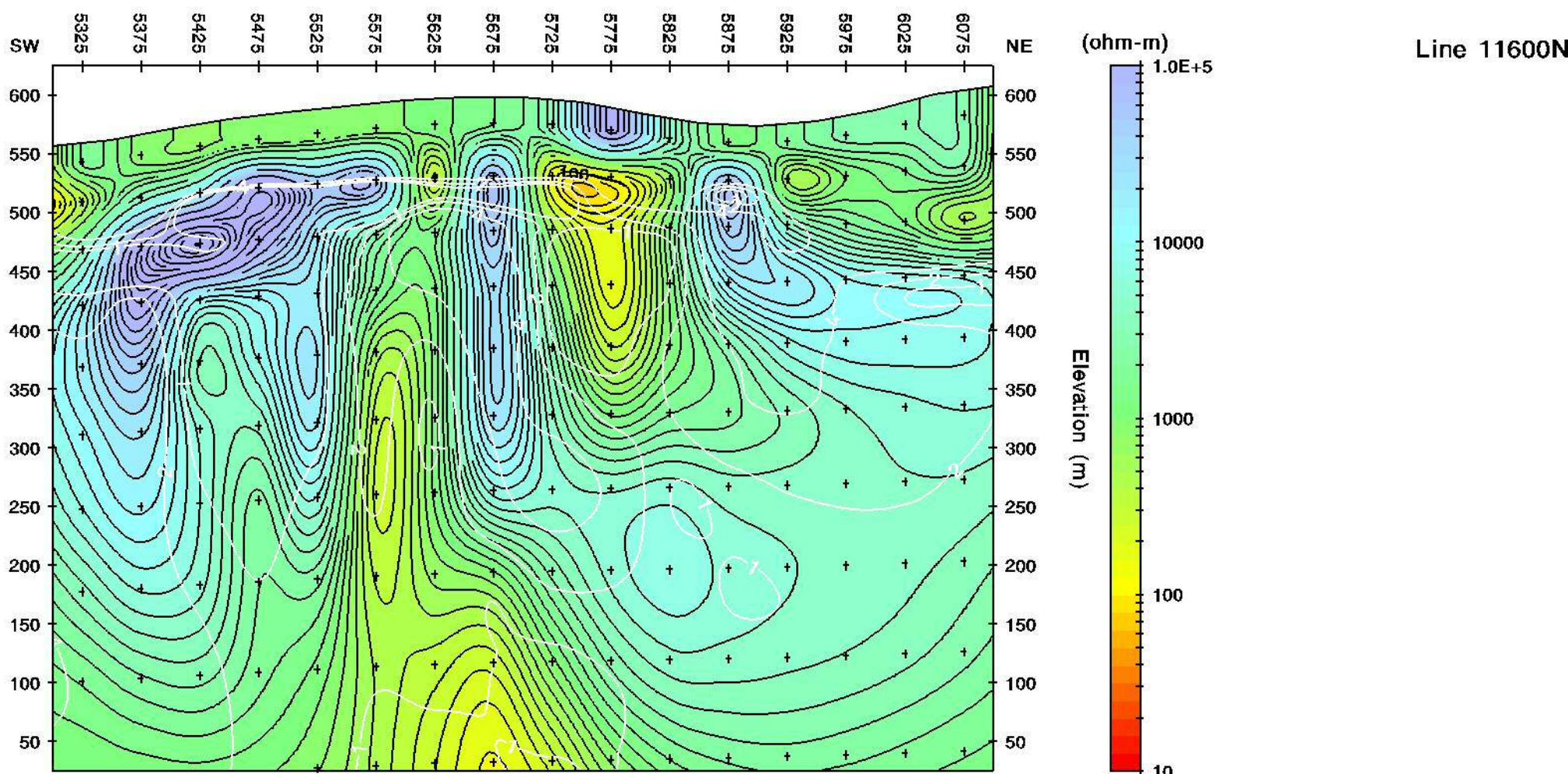
300 m

Copper Mines of Tasmania
11400N

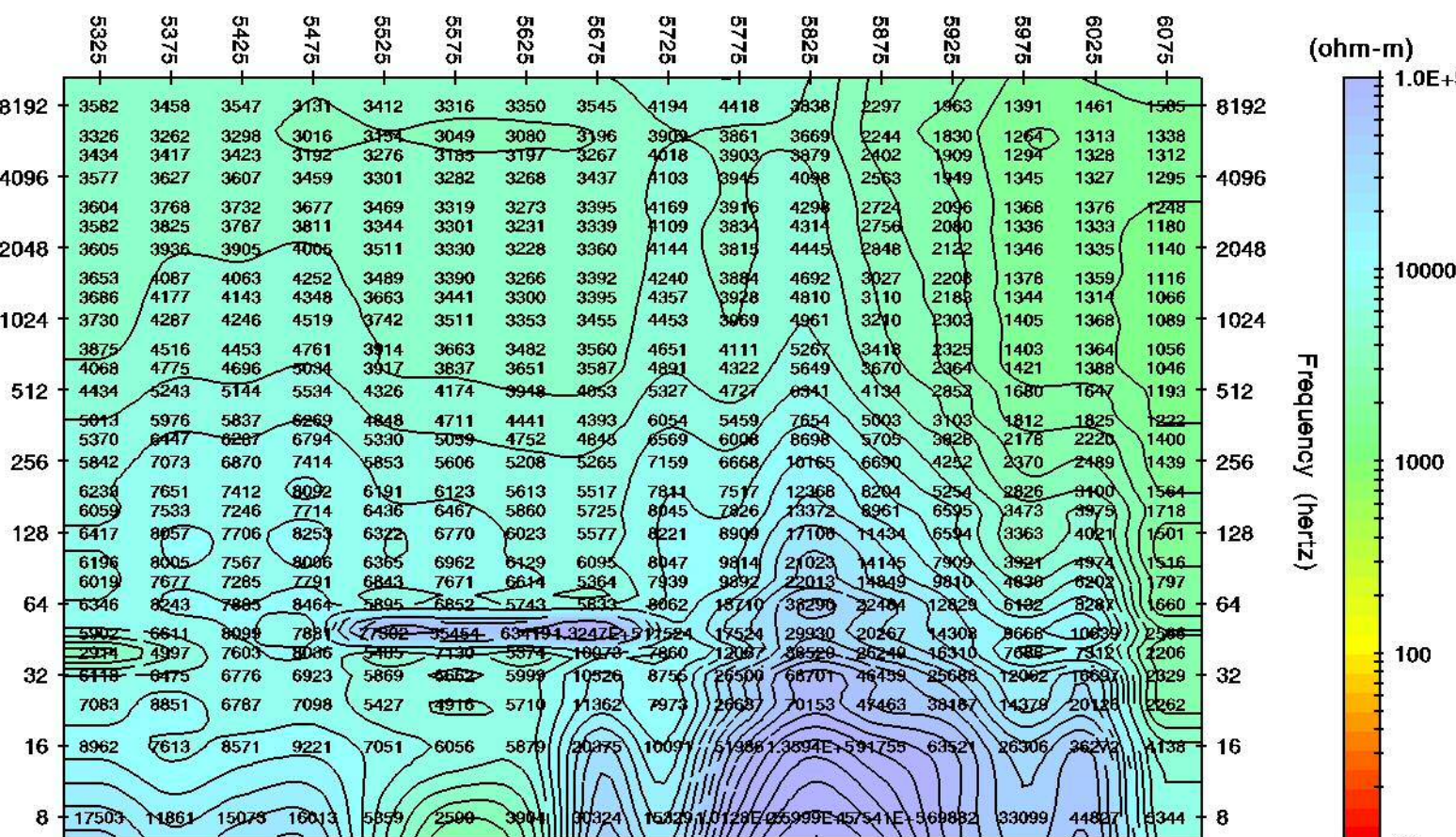
2D Smooth-Model Inversion
Scalar CSAMT/NSAMT Data

AUTHOR	DRAWN	DATE	SCALE	REPORT
Zonge	Zonge	18/02/21	1:5000	200047
SCS2D v3.40i: 11400N-1D2D.mtm				

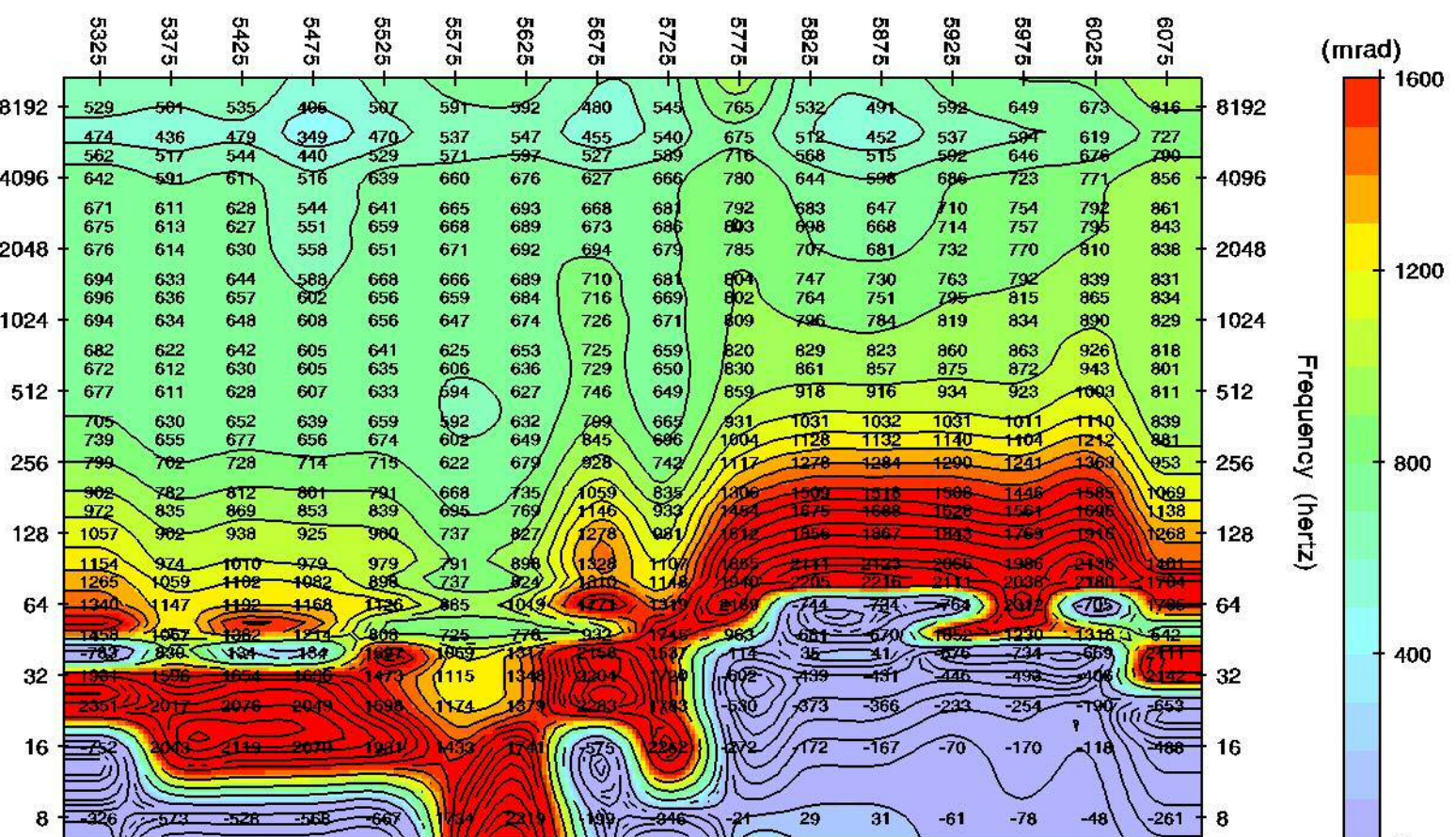
Model Resistivity Inversion Model



TM App. Res. Observed Data



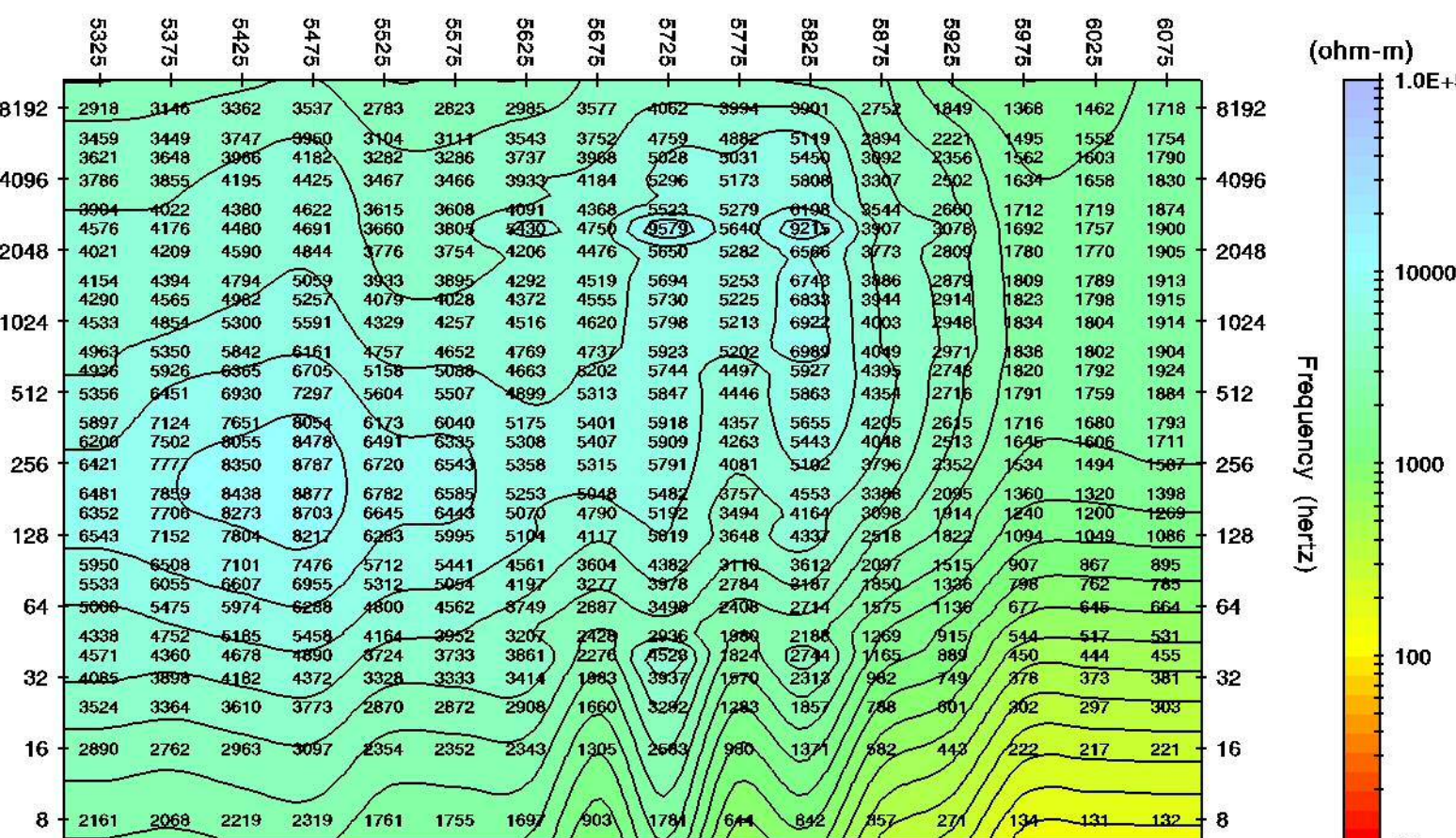
TM Phase(Z) Observed Data



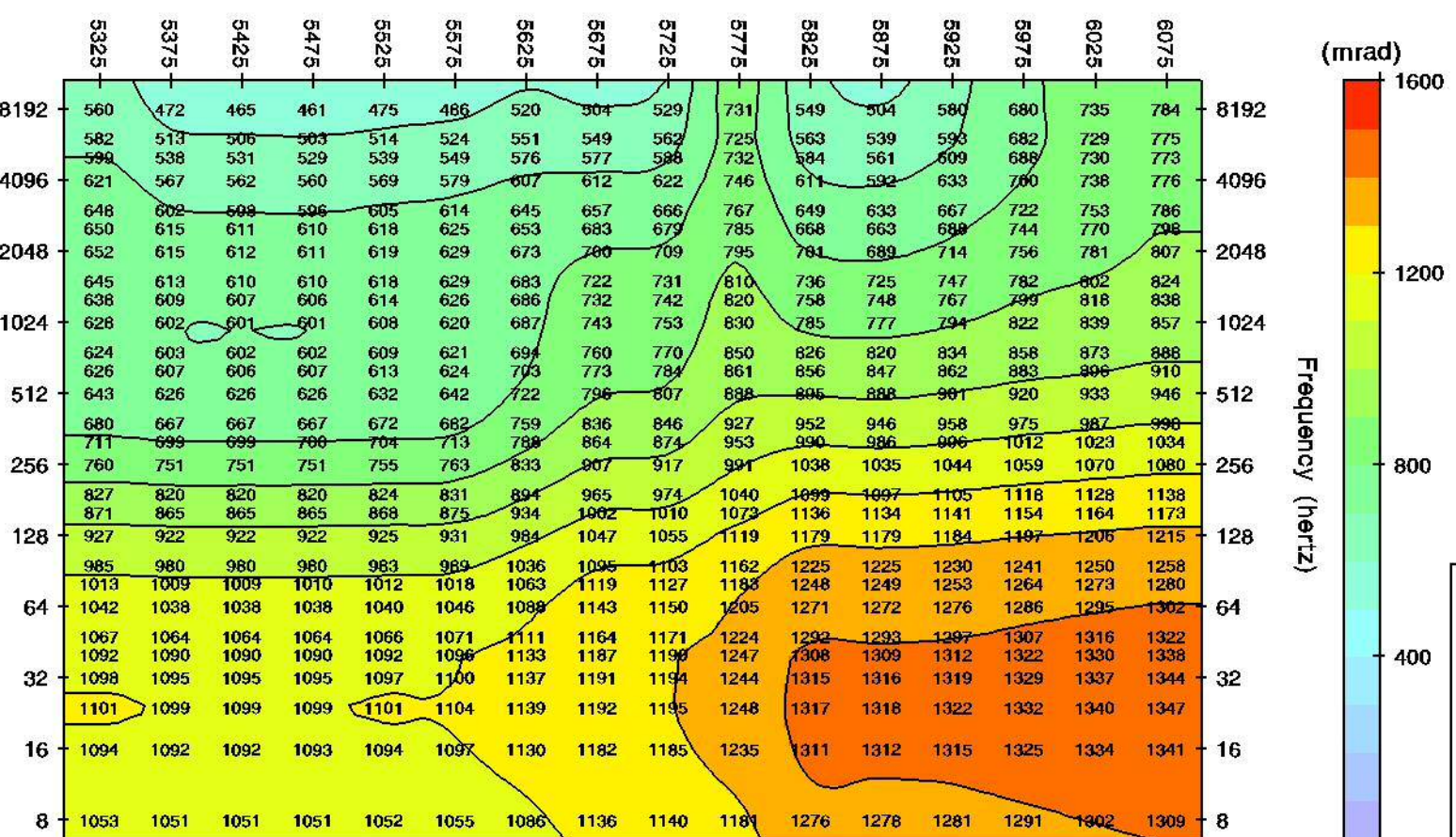
Survey Parameters:
Bipole Source Scalar AMT data
Tx length = 1354 m, azimuth = -51
Tx center easting=374513, northing=5340109

Rx dipole length = 50 m
Inversion control parameters:
ResSmth=0.5, dpW=0.1, dxW=1, dzW=1
White contours show Sensitivity

TM App. Res. Calculated Data



TM Phase(Z) Calculated Data



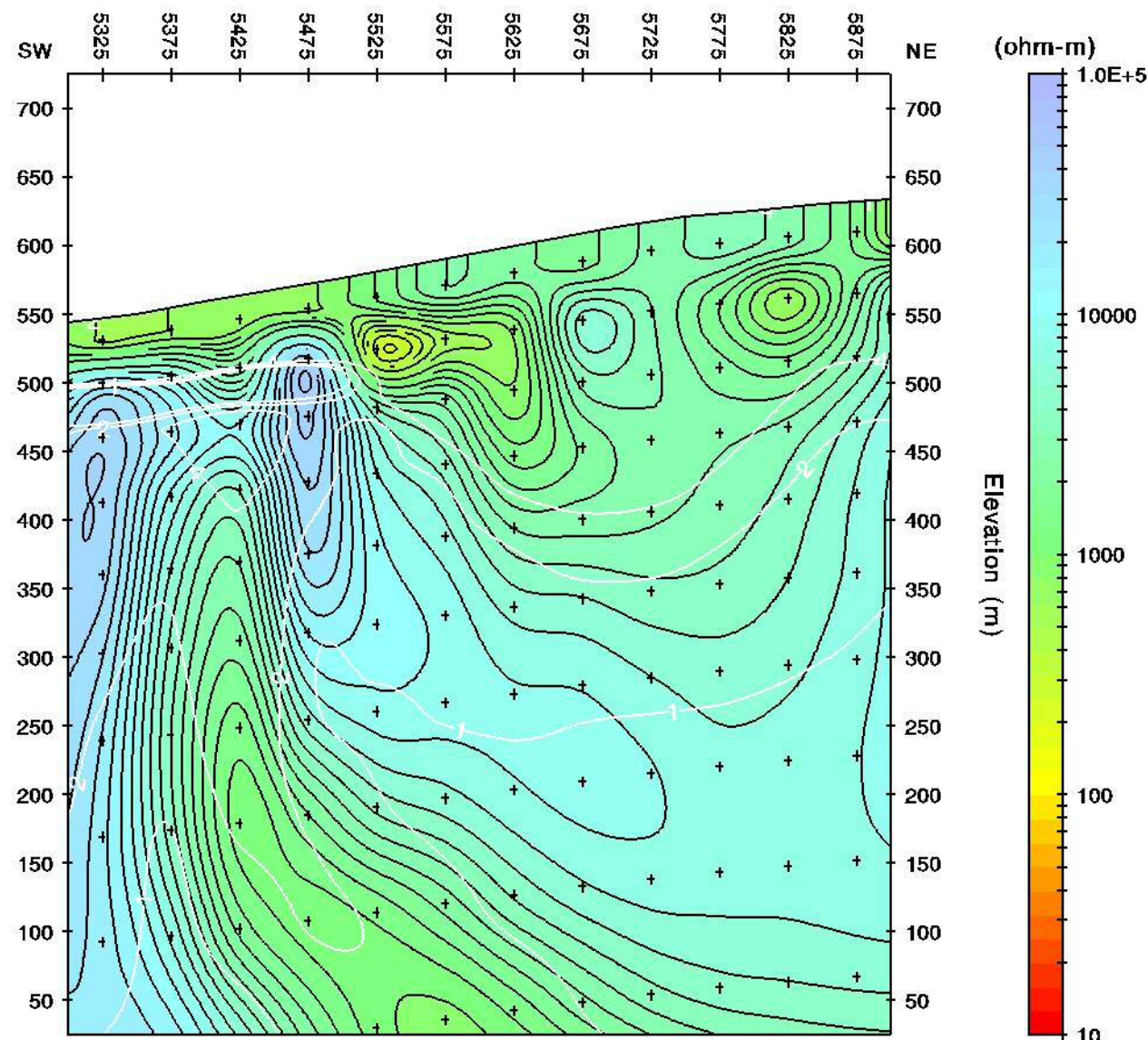
300 m

Copper Mines of Tasmania
11600N

2D Smooth-Model Inversion
Scalar CSAMT/NSAMT Data

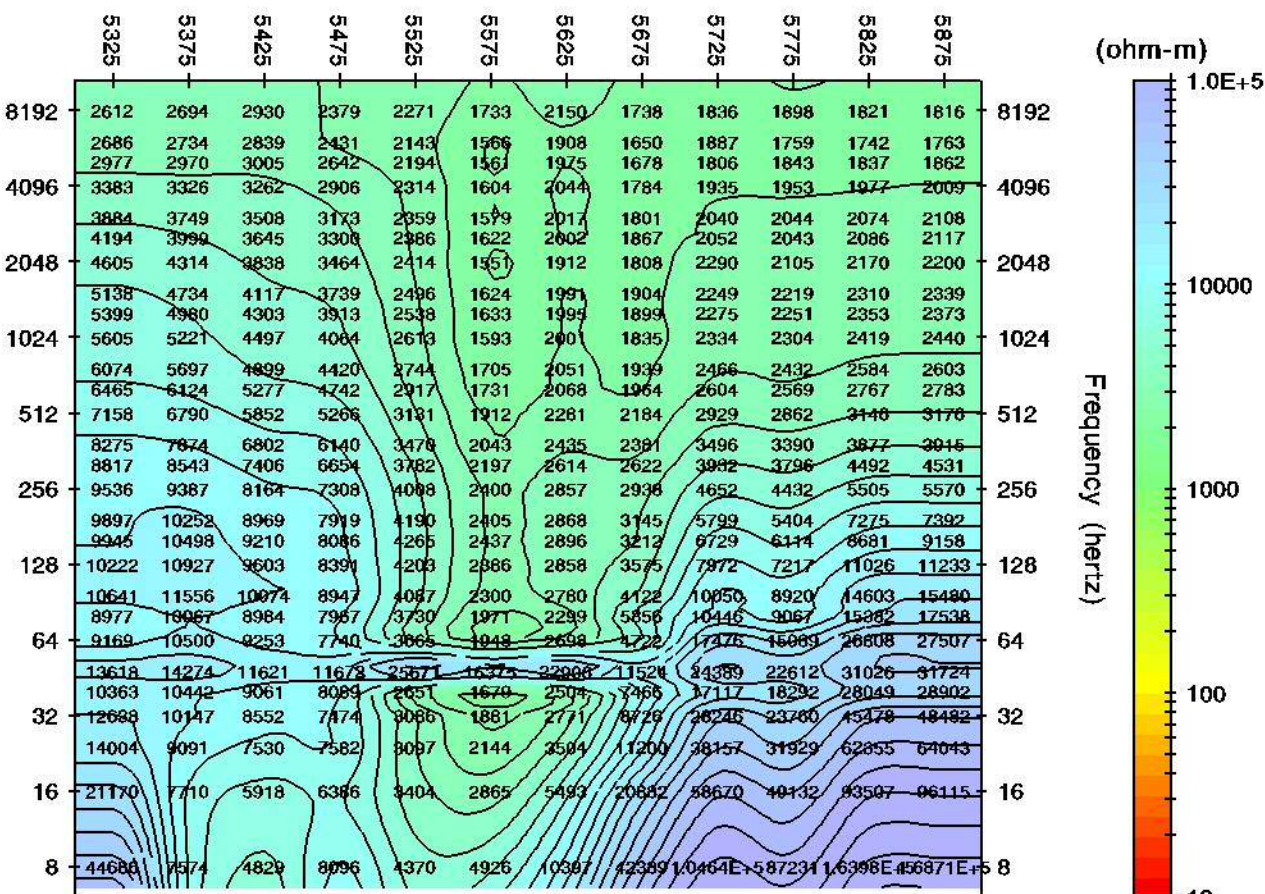
AUTHOR	DRAWN	DATE	SCALE	REPORT
Zonge	Zonge	18/02/21	1:5000	200047
SCS2D v3.40i: 11600N-1D2D.mtm				

Model Resistivity Inversion Model

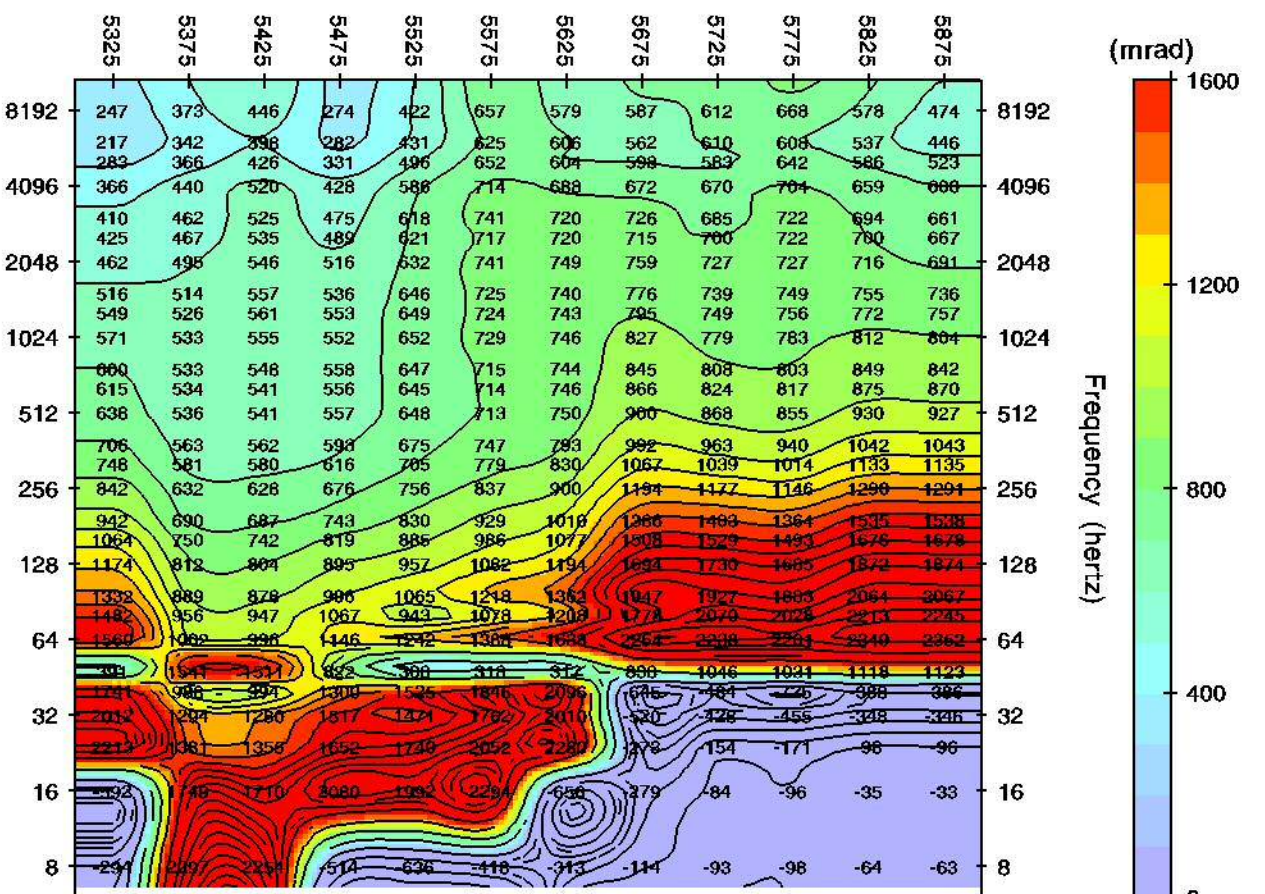


Line 11800N

TM App. Res. Observed Data



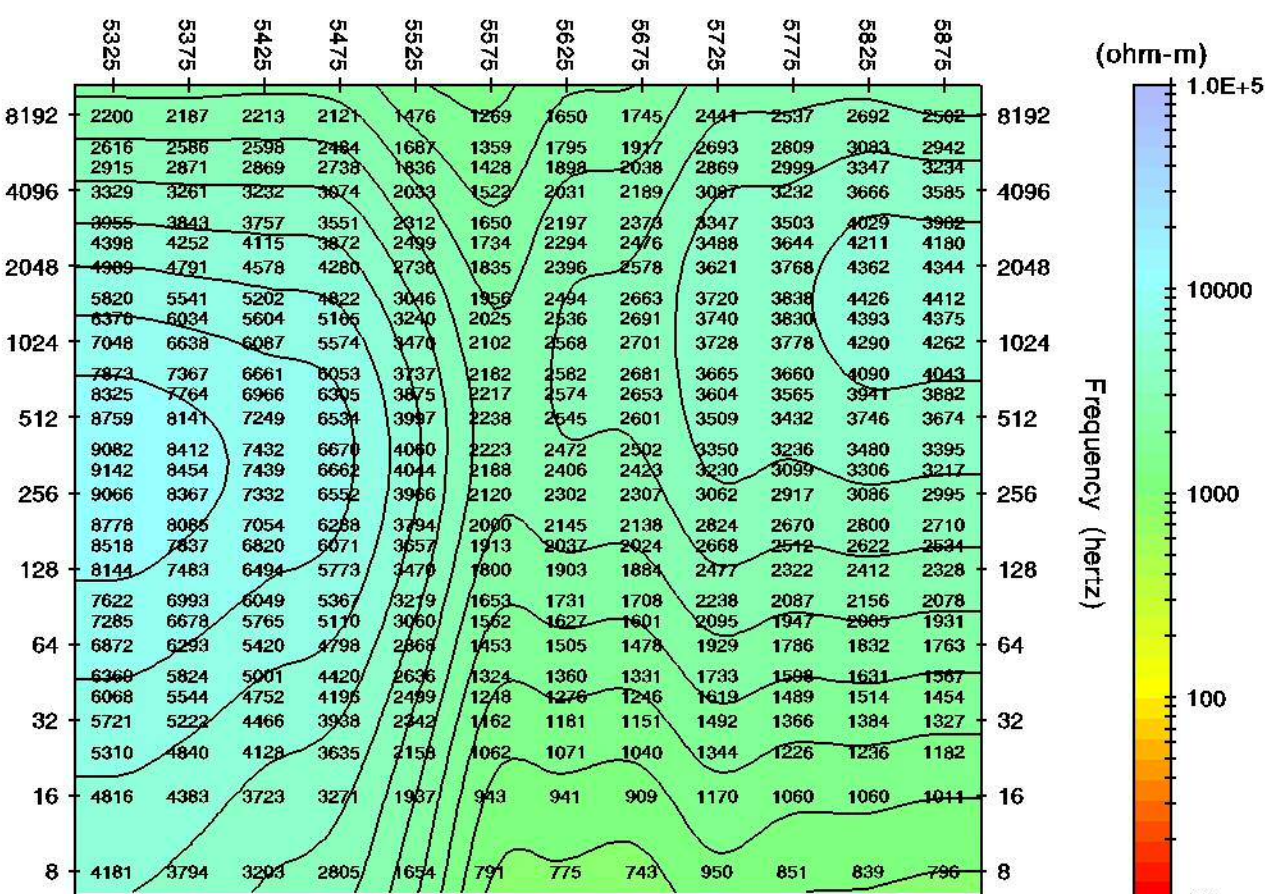
TM Phase(Z) Observed Data



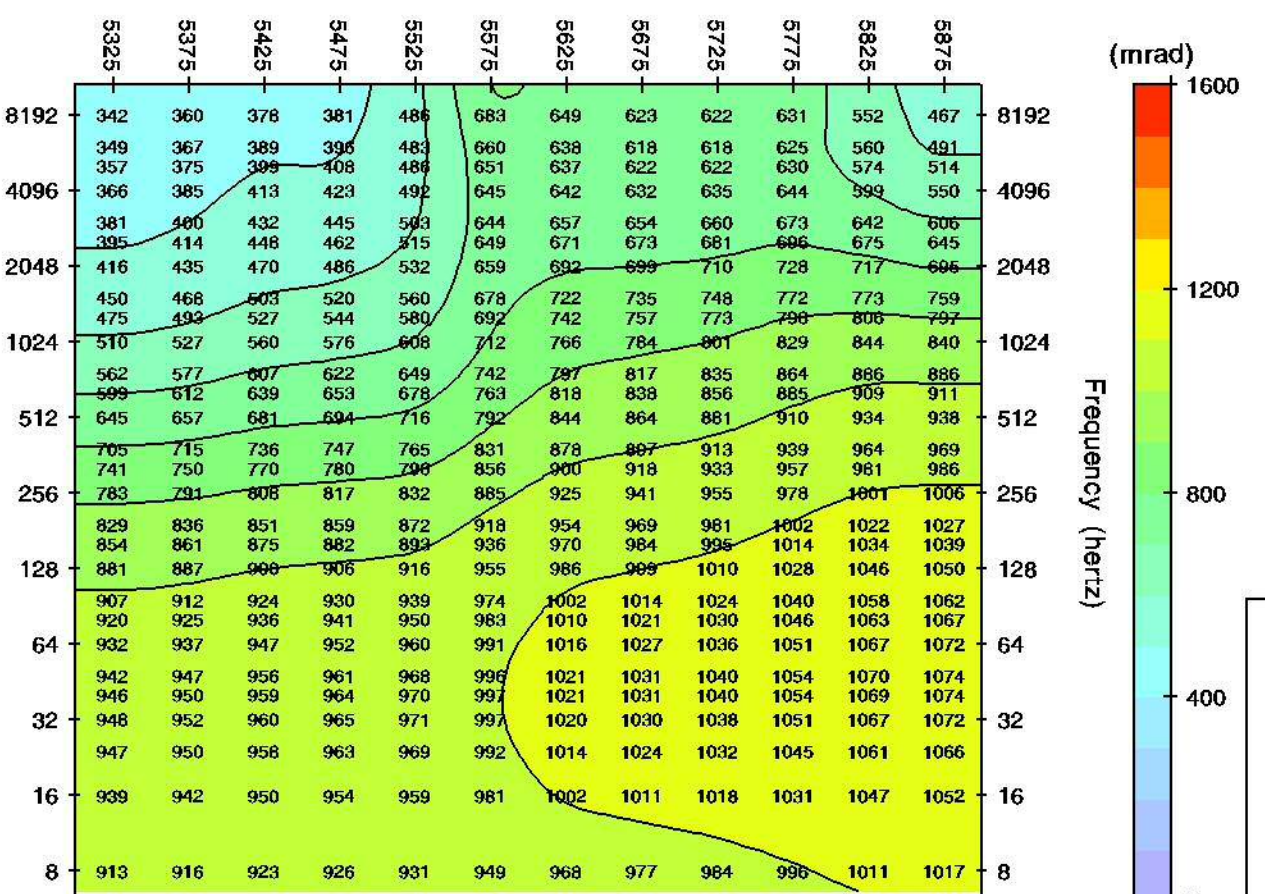
Survey Parameters:
Bipole Source Scalar AMT data
Tx length = 1354 m, azimuth = -51
Tx center easting=374513, northing=5340109

Rx dipole length = 50 m
Inversion control parameters:
ResSmth=0.5, dpW=0.1, dxW=1, dzW=1
White contours show Sensitivity

TM App. Res. Calculated Data



TM Phase(Z) Calculated Data



Copper Mines of Tasmania
11800N

2D Smooth-Model Inversion
Scalar CSAMT/NSAMT Data

AUTHOR	DRAWN	DATE	SCALE	REPORT
Zonge	Zonge	18/02/21	1:5000	200047
SCS2D v3.40I: 11800N-1D2D.mtm				