# **1D CSEM INVERSION TUTORIAL**

created December, 2017

Steps:	Page
1. Data organization and import	2
2. Examine data through plots and Survey Editor	7
3. Perform initial modeling	15
4. Perform controlled inversions	17
5. Inversion evaluation	25



CSEM Inverse

1

- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation

# The data in EMIGMA is organized into Projects, Surveys and Data Sets.

	ata Sets in Survey	Copy Paste	Survey Comments Add Survey	BackUP Delete Survey
	ata Sets in Survey			
Project ID: 2 Date Created: [3/10/2017 2:16:26 PM Project Name: [suit Sixs Change Name Delete Project Create Project	Agyers2. shallow 1200 Jayers2 shallow 1200 2 Jayers2 shallow 1200 3 JS3DInv. Born, 3333 S3DInv. Born, 3333 Layer shallow 1200 Layer S3DInv. Born, 1863 S3DInv. Born, 1863 ▼ ata File Name: S2EM_examples_9.dat 	Data Set Simulated Domain Type: Frequency Data Set Name: Silayers2 shallow 1200 Model Name: Silayers2 shallow 1200 Model Gild Gild Gild Gild Gild Gild Gild Gild	Data Set ID: Date Created: Change Change	9 8/10/2017 2:16:371 Responses: Incident Scattered Total Delete Data Set Data Set Info

Across the top, there are four tabs, *Database* (view shown above), *Survey Review*, *Data Correction* and *Data Reduction*, as discussed on the next page.



1. Data organization and import	CSEM Inverse
2. Examine data	3
3. Perform initial modeling	5
4. Perform controlled inversions	
5. Inversion evaluation	

*Database* – Organizes the data into Projects, Surveys and Data Sets. For each data set, any corresponding models and grids are also shown (if the appropriate 'model' or 'grid' button is checked)

*Survey Review* - Allows the user to review the lines and data points. Data sorting, filtering and profile name modification options are available.

Data Correction – Enables the user to delete points and components. The user can also modify values in a number of ways such as applying a shift, multiplication by a factor, inverting the sign, etc.

*Data Reduction* – Allows the user to reduce entire data sets (measured or simulated) in a single operation

For a detailed description of each feature, please refer to the EMIGMA Manual.

- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation

CSEM data must be imported through a .qct file. Column organized data in ascii format can be imported to QCTool for organization and processing prior to import.

#### / DATA

/ Li	he Easting	Northing	Depth(m)	GPS_Z	FREQ()	Curr(A)	Orient(deg)	Aspace	(m) Vx.I(nV)	Vx.O(nV)	Vy.I(nV)	Vy.O(nV)
L1	169142.20	226561.80	-0.10	*	0.5000	1.00	20	100.0	-4.68112e-07	-6.33771e-07	-2.72988e-06	-3.93512e-06
L1	166547.80	228066.00	-0.10	*	0.5000	1.00	300	100.0	-6.09049e-07	-2.45836e-06	-5.08496e-06	-3.58344e-06
L1	168131.20	227146.40	-0.10	*	0.5000	1.00	20	100.0	-2.08049e-05	-1.68325e-05	-4.10244e-06	6.43980e-06
L1	163874.20	229619.00	-0.10	*	0.5000	1.00	20	100.0	-5.27675e-05	1.71213e-05	4.44177e-05	6.22607e-05
L2	165804.80	229679.90	-0.10	*	0.5000	1.00	20	100.0	-1.84041e-04	-6.95028e-05	5.34330e-05	9.89392e-05
L3	166614.80	229819.90	-0.10	*	0.5000	1.00	20	100.0	-3.00521e-05	-1.57039e-05	4.26581e-05	4.09867e-05

-data is usually organized by line with the line column selectable in the import to EMIGMA -coordinates of receivers are given in 2 columns for easting and northing

- depth of electrodes can be set
- GPS-Z elevation can also be imported
- the frequency of each set of data is given. the order is not important as it will be re-ordered during import
- the current for each measurement is provided
- the length of the voltage receivers are given through the Aspace channel
- if 2 voltages are provided they must be orthogonal measurements as should magnetic measurements
- voltages are normally provided in nVolts and magnetic fields in nTelsa but these units can be calculated from other units once imported to QCTool
- -voltages channels should be labelled Vx and/or Vy and magnetic channels Hx, Hy and/or Hz
- voltages and magnetic fields should be measured parallel and perpendicular to the lines
- rotation to these orientations can be done in QCTool

2. Examine data

Raw Data Formats

- 3. Perform initial modeling
- Perform controlled inversions 4
- 5. Inversion evaluation

CSEM data must be imported through a .qct file. Column organized data in ascii format can be imported to QCTool for organization and processing prior to import.

# Browse and select data file for import

**CSEM** Inverse

5



- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation





Click "Next" to proceed to the next step

CSEM Inverse 6

- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation





Click "Next" to proceed to the next step

### CSEM Inverse

- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation





- 1. Data organization and import
- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation

In this tutorial, we will be working with the *CSAMT demo database* available through our website.

We will start by examining a synthetic data set in a project titled CSAMT Theory.

Select the survey and data sets as shown (on the right) in the database:

	$\sim$	
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		-

CSAMT	Inverse
7	

Database Survey Review D	ata Correction Data Reduction
Projects in Database	Surveys in Project
Costa Rica CSAMT Theory HudsonsBay USGS Cominco Spokane new synthetic CSAMT synthetic 1 CSAMT synthetic 2 CSAMT synthetic 3 china US Europe Finland	CSAMT Survey CSAMT Survey grid impedances CSAMT Survey grid impedances_edit MT Survey grid impedances_edit CSAMT Survey grid impedances_edit MT Survey line impedances_edit MT Survey line impedances_HighFreq
Project ID: 12 Date Created: 6/27/2014 10:00:04 PM Project Name: CSAMT Theory	fields impedances t1 impedances t2 impedances t3 dipping impedances back

Click the *Plotter* button on the toolbar to load the 'Fields' and 'impedances t1' data sets.

With the *Plotter*, the user can display not only the electric field and magnetic field data but also the impedance data (with the respective real and imaginary components).



- 1. Data organization and import
- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation

CSAMT Inverse 9

The figure below shows the *Hy* component with the real component (in red), the imaginary component (in blue) and the amplitude (green) -- all on the same plot. The plot is shown in Spectrum mode on the next page.



- 1. Data organization and import
- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation

CSAMT Inverse 10

The plot below shows the *Hy* component in Spectrum mode. Here, the response is shown as a function of frequency. The Real component is shown in **red**, the imaginary component in **blue** and the amplitude in **green** – as indicated on the previous page. The Fields/Component dialog is discussed on the next page.



- 1. Data organization and import
- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation

Click "Channels" button on the toolbar and select "Field" in the popup dialog (as shown)

Check "Phase" option, and click "OK" to display the phase

Phase (degrees)



# CSAMT Inverse 11



- 1. Data organization and import
- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation

You can also switch between electric field and magnetic fields. Click the domain 🕎 button on the toolbar to view the following dialog:



- 1. Data organization and import
- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation

You can also plot the impedance data using the *Plotter*.

Select the 'Impedance/Magnetic Ratio' data sets in the same survey after selecting the *Plotter* button to load the data set.

Double-click the white background on the plotter window to access the *Channel Selection* dialog.

Then click the 'Field' button to access the '*MT/CSAMT/VLF Tensor Selection*' window, shown on the right.

Check 'Real' and 'Imaginary' components and the impedance tensors, Zxy, Zyx, to display the data.

You can also switch between 'Apparent Resistivity' and 'Phase' by checking the appropriate boxes.

An example plot is shown on the next page.

#### CSAMT Inverse 13

Data Sets in Survey:		6		Selected Data Se	ts to load:	p
Name	Model Name	Type	Data Units:	Name	Model Name	Ty
line1 X4209 Imped Marq4_Zxy Marq4 Zxy	line1 X4209 Marq4_Zxy Marq4_Zxy	S S S	Ohms	CSAMT_		h
Marq5_Zxy Marq4_Zxy CS3DInv_SupLN	Marq5_Zxy Marq4_Zxy CS3DInv_SupLN	S S	Add to>	1		
			Add All to>	1		-
			< Remove from	1		
	<b>N</b>	Show IMPED	ANCE / MAGNETIC RATIO	Data Sets in Survey		
Loading						

Name	Model Name	Data Type	C Measured
impedances t1_1m	Freq Sim	S	<ul> <li>Simulated</li> <li>Processed</li> </ul>
Phasor			
🔽 Real	Impedan	ce Tensor	┌─ Tipper
Imaginary		☑ Zxv	T Ix
		,,	
	V Zyx	🗖 Zyy 🗖 Z det	ГТу
App Resistivity	0	Rotation (in degree:	5]
Response			
🔽 Total 🔲 Incident	C Decomp	tional Angle	Skew Angle
Phase Unit		al Impedances	
🕫 Degree 🛛 C mrad		Zxy П Zyx	
Profile(s) Available			
1 ON	Apply C	omponents to All Channel	s



#### 2. Examine data

- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation

To illustrate the different plotting capabilities for an impedance data set, an example from the Costa Rica Project is shown below:





Both the 'real' and 'imaginary' components of Zxy are shown in red and blue respectively. The corresponding 'Phase' and 'Apparent Resistivity' plots are shown on the right.

To access the CSAMT Tensor selection options for plotting, double-click the white background on the Plotter window and then click the 'Field' button

#### **CSAMT** Inverse 14

a. 18622 512 Hz Zou Tokline

- 1. Data organization and import
- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation

The object is to perform some initial modeling in order to get a "feel" for the background resistivity and thus estimate the parameters for the 'initial model', which is to be used for inversion.



#### EM Response

- 1. Data organization and import
- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation

You can view existing models for a data set by clicking the *Model* button, as shown:

5AMT_1592	Data Set Sin	N Susceptibility 1 0 2 0 3 0	Resistivity 1e+008 900 250	Density 0 0 0	Thickness 1e+008 135 600	Survey Name         Model_24           Model Name         Model_24
arq_3 z prev larq_3 zxy st24	Domain Type: Fre	4 0	10	0	16+008	Total Number of Layers 4
1arq_3_FarField	Data Set Name:	Edit Mode	Layer Par	rameters		Top Depth 0 Bottom Depth -135
	Model_24 Model Name:	Insert Layer	Layer #	t	900	Cole-Cole Polarization Mode Parameters
ata File Name:	Model_24	Delete Layer	Relative	e Permittivity	1	M parameter (chargeability) dimensionless T (time constant) parameter
SAMT_db_105.dat	Model	Undo Delete	Suscep	otibility	0	Resistivity & Susceptibility Grid Data Files
		Restore	Density	(g/cm^3) [	0	View File
		< Import Layers	Thickne	ess (m)	135	Convert to GPSZ Delete File Layer(s)

You can also create models for a given data set by clicking the 'Model' button and then specifying the parameters for a 1D layered earth model and/or a 3D model.

# To learn more about forward simulation, please refer to the EMIGMA manual or the FORWARD Simulation tutorial.

# CSAMT Inverse 16

- 1. Data organization and import
- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation

#### CSAMT Inverse 17

#### To perform a 1D CSAMT inversion:

2. Click the 1D button on the toolbar to see the following window:





CSEM/CSAMT 1D Inversion				_ 🗆 ×
Database F:\Interp\Ro	ockGeo\Complete Surveys\Sprud	:eMountain\Spruce_DB\Spruce_DB.mdb		
Project terry new csamt project ID: 12	Survey	Dataset 10m_Proc CSAMT ID: 1748		
Frequency 32,000 ▲ 64,000 128,000 128,000 512,000 1024,000 2048,000 4096,000 € 1024,000 512,000 € 1024,000 €	Component Field Impedance 1 Zxy Advanced Selection No. of selected components 1 Multi Locations	Inversion Technique  Trust Region  Occam  (underparameterized)  use Plane Wave method  Initial Model (SI units)  Set Initial Model  Use inversion result of the previous location as initial model	Current Profile Index Total No. of Locations No. of Locations Done Processing Message	
Phasor	Select Locations	🗖 Flip quadrature data sign		
Amplitude App Resist	tivity 🗖 Phase	Get Inversion Settings From a Log File		
Processing progress				
Close application wh	nen inversion completes	<u>R</u> un <u>C</u> ancel		Help

CSEM/CSAMT 1D Inversion

terry new csamt project ID: 12

- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled Trust Region or Occam inversions

Survey

Component

O Field

Zxy

Ln 1-3 tx rev electrodes 10m\_Proc

Impedance

5. Inversion evaluation

Database Project

-Frequency

32.000

64.000

128.000

256.000

512.000

#### **CSAMT** Inverse 18 **1D CSAMT Inversion Interface** Select components used for inversion Z or V/H F:\Interp\RockGeo\Complete Surveys\SpruceMountain\Spruce\_DB\Spruce\_DB.mdb CSAMT ID: 1748 Current Profile Index O Occam Total No. of Locations No. of Locations Done Create a starting Processing Message

1024.000 2048.000 -Initial Model (SI units) 1096.000 model, and constrain Set Initial Model < Select All No. of selected model parameters 1 components Use inversion result of the previous Number of selected location as initial model frequendies Multi Locations For a consistent 14 model, use result of Elio quadrature data sign -Phasor previous point as El Am App Resistivity Phase Get Inversion Settings From a Log File initial model Processing progress Specify multiple locations to be used in Close application when inversion completes <u>R</u>un Cancel Help. inversion, if available Choose frequencies for Flip data sign if it is opposite Load inversion settings inversion to the sign convention from a log file and set Choose real and/or imaginary name for log file

Dataset

Inversion Technique

Trust Region

(underparameterized)

🔲 use Plane Wave method

phasor data for inversion

- 1. Data organization and import
- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled Trust Region or Occam inversions
- 5. Inversion evaluation

CSEM/CSAMT 1D Inversion Database F:\Interp\R	ockGeo\Complete Surveys\Spru	ceMountain\Spruce_DB\Spruce_DB.mdb		
Project terry new csamt project ID: 12	Survey	Dataset s 10m_Proc CSAMT ID: 1748		
Frequency 32,000 64,000 128,000 256,000 512,000 512,000	Component O Field O Impedance	Inversion Technique Trust Region O Occam (underparameterized) use Plane Wave method	Current Profile Index Total No. of Locations No. of Locations Done	
1024.000 20148.000 4096.000 stop.000 Select <u>A</u> ll Number of selected frequencies	Advanced Selection No. of selected Components Multi Locations	Initial Model (SI units) Set Initial Model Use inversion result of the previous location as initial model	Processing Message	
Phasor	Select Locations	Flip quadrature data sign		
Amplitude      App Resis  Processing progress	tivity 🗖 Phase	Get Inversion Settings From a Log File		
Close application w	nen inversion completes	<u>R</u> un <u>C</u> ancel		Help

#### CSAMT Inverse 19

#### Inversion style

#### Inversion style:

There are two distinct inversion techniques that are available:

#### **Trust Region**

An underparametrized technique with a fast rate of convergence. Utilizes (user-defined) simple bound constraints to solve the least-squares minimization problem. Inverts for both resistivity and thickness.

#### Occam

Over-parameterized and smooth inversion. Each layer has a fixed thickness and the inversion only inverts for resistivity.

Please refer to the Help section of EMIGMA or the EMIGMA manual for more details.

- 1. Data organization and import
- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation



# CSAMT Inverse 20

#### Choose frequencies for inversion

After examining your data, choose which frequencies you wish to utilize for inversion. The best model will be computed for all frequencies for comparison.

#### **Inversion Controls**

In CSAMT, *Vx* and *Hy* fields are typically measured, and impedance *Zxy* will then be processed from field data. It is standard to use impedance data for inversion, but using field data would give you information not included in impedance such as, the variation along profile is mainly in current (E-field), or both fields for anomaly.

As this inversion process is suitable when the ground is smoothly varying laterally, you may choose to use the previous data point's final model as the starting model for the next point. This will also speed up the process.

- 1. Data organization and import
- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation

enerate unifo	orm lavers		
ickness (m)	1499.81	Total number of layers 27	Number of Selected Components 2
sistivity (Oh	m*m) 15	Generate Default Settings	Number of Selected Frequency 14
sert a layer			Resistivity and thickness to invert
ickness (m)	31.1953	Insert layer index 1	Allowed number 55
sistivity (Oh	m*m) 6.7013	Insert a layer	Selected number
I	mport Layers	Total thickness 1613.24	Model Constraints
#	Resistivity	Thickness (m)	
1	6.701300	31.195299	
3	20.096001	1441 587891	to invert both resistivity and thickness
4	2123.578613	100000000.000000	without bound limits. To make changes, click "Model Constraints".

# Create a Starting Model

**Import Layers**: If you have created a forward model that you like, you may import it as a starting model or if you have a previous inversion that you like, you may import it as a starting model.

**CSAMT** Inverse

21

**Insert a layer:** You may insert additional layers at any stage.

#### Generate a Starting model:

First select how many layers in total that you would like in the model, set the initial resistivity and thickness. Then click "Generate Uniform Layers".

#### **Modify Starting model**:

After making a starting model (whether by importing or generating), you may edit the resistivity and the thickness of the layer by simply double-clicking on the parameter (value).

- 1. Data organization and import
- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation



# CSAMT Inverse 22

#### **Constrain Model Parameters**

### **Resistivity Constraints**:

It is useful to constrain the layer resistivities to ranges that are possible in the geological environment.

#### **Thickness Constraints**:

This option is only available under the *Trust Region* technique.

Constraining the thickness not be too large helps gain resolution. Constraining the thinness of the layer is a question of geological meaningfulness.

**Note**: You do not have to invert every parameter.

- 1. Data organization and import
- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation

# Executing the Inversion

CSEM/CSAMT 1D Inversion				_ 🗆 🗙
Database F:\Interp\Rc Project terry new csamt project ID: 12	ckGeo\Complete Surveys\Spru Survey Ln 1-3 tx rev electrodes	ceMountain\Spruce_DB\Spruce_DB.mdb Dataset s 10m_Proc CSAMT ID: 1748		
Frequency         32.000         64.000         128.000         256.000         512.000         1024.000         2048.000         4096.000         \$102.000         Select All         Number of selected         frequencies         14	Component  Field C Impedance  Vx Hy Advanced Selection No. of selected components  Multi Locations Select Locations	Inversion Technique  Trust Region Occam (underparameterized)  use Plane Wave method  Initial Model Set Initial Model Use inversion result of the previous location as initial model  Ein quadrature data sign	Current Profile Index Total No. of Locations No. of Locations Done Processing Message	
Phasor Amplitude Processing progress Close application wh	✓ Imaginary en inversion completes	Get Inversion Settings From a Log File     Run   Cancel		Help

#### Finally, click the "Run" button.

The total number of data points in all the profiles will be shown as well as the number of data points completed to the right.

The right corner of the window (white area) shows each data point's progress.

- 1. Data organization and import
- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation

Patabase F:\Interp\Rd	ockGeo\Complete Surveys\Spru	ceMountain\Spruc	e_DB\Spruce_DB.mdb		
Project	Survey		Dataset		1
terry new csamt project ID: 12	Ln 1-3 tx rev electrodes	10m_Proc	CSAMT ID: 1748		
32.000       ▲         54.000       ▲         128.000       256.000         512.000       ↓         2048.000       ↓         4096.000       ▼         Select All       ↓         Number of selected       ↓         frequencies       ↓	Component Field C Impedance 1 VX 2 Hy Advanced Selection No. of selected components 2 Multi Locations	Inversion Teu Trust Re (underparat use Plan Initial Model ( Use inve location	chnique egion C Occam meterized) re Wave method (SI units) Set Initial Model rsion result of the previous as initial model	Current Profile Index	
Phasor	Select Locations	🗖 Flip quadra	ture data sign	Parameters for inversion	
🗖 Amplitude 🔽 Real	🔽 Imaginary	Get Inversio	on Settings From a Log File	Max number of iteration	100
Processing progress				Target fit (%)	0.01
Close application wh	en inversion completes	Run	Cance	Model epsilon	0.0001
				Min tolerance	0.01
				Fit tolerance	0.001
				OK	Cancel

**Note**: The inversion will stop for either 1) target fit is satisfied, or 2) the maximum number of iterations is reached

#### CSAMT Inverse

# Executing the Inversion

24

Upon clicking **Run**, a window will pop-up. Unless the user is familiar with these items then it is suggested that the defaults be maintained.

> Number of Iterations: A higher value will help ensure accuracy but execution time increases

Target Fit: The residual between the estimated data under the best model and the measured data.

# The settings below are generally not changed by the user:

Model epsilon: Occam is a smooth inversion and the model epsilon controls the smoothness.

Min tolerance: Specifies how accurately the search algorithms determine minima in the fit.

Fit tolerance: Specifies how close to determine the final fit.

- 1. Data organization and import
- 2. Examine data
- 3. Perform initial modeling
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In each survey, there will be several data sets after modeling, inversion and processing. In this case, we have one 1D model and 3 inversions. The forward model has a new data set containing the simulated data under the model. Similarly, each inversion contains a new dataset containing the simulated data set under the inversion model (for each point) and attached to that data set is the inversion model.

- 1. Data organization and import
- 2. Examine data

-

- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation

# Inversion Evaluation

An inversion is selected. You will note the "Model" button is checked.

Database: C:\Program Files (x86)\EmigmaV8.6\Demo Databases\CSAMT database\CSAMT db.mdb Database Survey Review Data Correction Data Reduction - Projects in Database -- Surveys in Project-Survey Name: CSAMT 0.2A CSAMT Theory CSAMT 0.2A Costa Rica 8 Survey ID: HudsonsBay USGS If the model button is clicked... Cominco Spokane Сору Surv new synthetic CSAMT synthetic 1 Paste CSAMT synthetic 2 А CSAMT synthetic 3 US Europe Finland - Data Sets in Survey-Simulated Data Set CSAMT 1592 Model\_24 3 Project ID: Marq\_3 z prev Domain Type: Frequency Marg 3 zxv st24 Date Created: Marg 3 FarField 10/9/2009 5:24:48 PM Data Set Name: Marq\_3 zxy st24 Project Name: Model Name: china Marq\_3 zxy st24 Change Name Data File Name: Model CSAMT db 127.dat Delete Project Configuration Grid(s) Create Project

CSAMT Inverse 26

- 1. Data organization and import
- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation

Susceptibility	Resistivity	Density	Thickness	Configuration	
0	1e+008	0	1e+008	Survey Name Marq_3 zxy st24	
0	403.932	Ō	208.103		8
0	141.241	0	177.727	Model Name Marq_3 zxy st24	
0	33.7009	0	1e+008		_
				Total Number of Layers 4	
				Depth	_
				Top Docth	
				Top Deput	
lode	Layer P	arameters		Bottom Depth -208.103	
for each for each			2		1
Inselt Layer	Layer	Ħ	2	- Cole Cole Polarization Mode Parameters	
	- Resist	ivity (Uhm.m)	403.932	C (exponent) parameter	
Heplace Layer				dimensioniess	
	Relati	ve Permittivity	1	M parameter (chargeability)	$\checkmark$
Delete Laver			· · · · · ·	dimensioniess	
	Relati	ve Permeability	1	T (time constant) parameter	
	-1		I.	seconas	
Undo Delete	Super	etibilitu	0	Barlinkinki (Conservitilika Cold Data Film	_ /
		publiky		Hesistivity & Susceptibility and Data Files	
	Densi	hu (a/cm^3)	0	Models\CSAMT_db_127_36.pex	
Hestore		y (grom o)	0		6
			000 100	View File	
·	Thick	ness (m)	208.103		
< Import Layers				Convert to GP52 Delete File Layer(s)	

A new window will appear:

Attached to the database in a subdirectory called "Models" are the inversion results in a simple ASCII XYZ file (\*.pex) which may be viewed here. This file may easily be imported to another application although graphical viewing tools are provided within EMIGMA.

The 1D model for the final data point is also included.

Click "View File" button to view the data file of the saved 1D layered model.

CSAMT Inverse 27





If there is more than one line then **other lines** may be selected.

Note: If multi-lines are available the 3D Contour may be used to provide an interpolated 3D volume





Equal Range: assign different colors to different ranges which are equal independently of the number of data falling within these ranges. Sequence of the colours cannot be changed.Equal Weight: assign colors to different ranges which are unequal but covering the same number of data Min: Any data values below Min will be displayed as the color to the right of the edit fieldMax: Any data values above Max will be displayed as the color to the right of the edit field

- 1. Data organization and import
- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation

# **Inversion Displays**

# F 🔽 Viz 🔳 🖼 🖙 📰 🔊 ጅ

Choose CDI viewer to graphically view the results

**CSAMT** Inverse

31



Axes may be edited by double-clicking on it, and you can change Max, Min, Labels and Titles etc. on the popup dialog Depth and location interpolated may be repeated (note: the results of previous interpolations are used in the next interpolation so use with care)

- 1. Data organization and import
- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation



To assess how well the inversion model fits the data at each station, select the measured data and then select the

plotter.



Load Data Set				X
?	Do you want to	compare with oth	er Data Sets?	
Yes	No	Load Settings	Cancel	Help

Select "Yes", if this dialog is appeared and select the inversion dataset in the next dialog to open both datasets or multiple datasets to the plotter

Survey Selection							
Project terry new csa	amt project		Surv	vey: Ln 1-3 tx rev electro	odes 10m_Proc		
Data Sets in Survey:		6		Selected Data Sets t	o load:	1	
Name	Model Name	Type	Data Units:	Name	Model Name	Type	
line1 X4209 Imped Marg4 Zxv	line1 X4209 Marg4 Zxy	S S	Ohms	CSAMT_		м	
Marq4_Zxy Marq5_Zxy Marq4_Zxy CS3DInv_SupLN	Marq4_Zxy Marq5_Zxy Marq4_Zxy CS3DInv_SupLN	S S S	Add to>				
			< Remove from				
	<b>v</b>	Show IMPE	DANCE / MAGNETIC RATIO D	ata Sets in Survey			
Loading Load Loading 0 of 1 Cancel							

# CSAMT Inverse 32

- 1. Data organization and import
- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation

CSAMT Inverse 33

Select the data sets required for comparison and then "Load"

All selected data sets are then loaded to the plotter application and the plot appears showing the first frequency of the measured data which by default is the impedance represented as an MT apparent resistivity.



- 1. Data organization and import
- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation

CSAMT Inverse 34

The user may select other data sets to plot by simply double clicking on the plot



Select for the 2<sup>nd</sup> plot, the same / frequency and then measured data and further datasets if required.

- 1. Data organization and import
- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation

CSAMT Inverse 35

Multiple plots can be shown for various inversions and models in "Profile" mode. The user may step through different frequencies by simply clicking the 'arrows'.

||||||♥ů 聞Q@@≤ XIX || ≥ B || ≥ 90♥ 1| > 10 + 1 > M + 1 > M +



- 1. Data organization and import
- 2. Examine data
- 3. Perform initial modeling
- 4. Perform controlled inversions
- 5. Inversion evaluation

CSAMT Inverse 36

Here, spectrums are compared for a single data point in linear-linear mode. The user may move to other data points by simply clicking the arrows.



is accessed by doubleclicking either axis.

- 1. Data organization and import
- 2. Examine data

cale Settings

- 3. Perform initial modeling
- 4. Perform controlled inversions

X

5. Inversion evaluation

# Inversion Evaluation

CSAMT Inverse 37

Here, we select log(time) vs log(amplitude)



Double-click axis to bring up the "Scale Setting" dialog

- 1. Data organization and import
- 2. Examine data

Scaling For Plot

Data Min

Data Max

Min X:

Max X:

X-Axis Incremen

N of SubTicks

Auto Scaling

Auto Increment

Log(10) Scaling

Descending

Decimal Digits

Fixed

Font

(After Decimal Poin

12

Format

8192

0

9000

1000

 $\Box 1/x$ 

C Exponential

- 3. Perform initial modeling
- 4. Perform controlled inversions

Y-AXIS

Data Min

Data Max

Min Y:

Max Y:

Y-Axis Increment

N of SubTicks

Auto Scaling
Auto Increment

Log(10) Scaling

Descending

Decimal Digits

Fixed

Cancel

fter Decimal Point)

12

Formal

1.72270023822784

6453.7998046875

7000

0

C Exponential

Help

1000

5. Inversion evaluation

# Inversion Evaluation

CSAMT Inverse 38

Here, we select log(time) vs log(amplitude)



In CSAMT/MT, it is common to observe data in **Descending** order of frequencies (from high to low)

**Note**: based on results of inversion, you may run additional inversions with different settings, and compare the resulting sections in the CDI viewer and the fit in the plotter.

for assistance please email

support@petroseikon.com