

Comparison of MultiLoop III's Geotem/Megatem Responses for a Thin Plate

In this review, MultiLoop III is used to calculate the response of a thin plate to a Geotem/Megatem system operating at 90 Hz. The results are compared with results from programs PLATE and EMIGMA which were provided by Richard Smith of Fugro Airborne Surveys, and are gratefully acknowledged. The MultiLoop III files used in this comparison are in the MultiLoop III distribution folder Demos/MlpIII Comparison/Geotem-Megatem.

The responses of two plates were modeled for a 90 Hz waveform and a 2 msec pulse. The plates were at depths of 0 and 100 meters respectively, were 500 meters square with a strike perpendicular to the line and a dip of 90 degrees. The MultiLoop III model consisted of a mesh with 511 nodes.

Figure 1 illustrates the basic modeling setup used in the deeper PLATE simulation; the depth of 220 meters refers to the depth of the deeper plate below the transmitter. Since the Geotem/Megatem plot point is at the receiver, in the MultiLoop III model, reference to the line is made with respect to the receiver point. Hence, the line is at an altitude equal to the receiver, or 70 meters high, and the assembly (the plate) is at a depth of either 0 or 100 meters.

The screenshot shows a dialog box titled "PLATE PARAMETERS GEOTEM/MEGATEM". The parameters are organized into several sections:

- Polynomial degree:** 4
- Time Gate File:** C:\Documents and Settings\smith\My Documents\wor (with a BROWSE button)
- Plate Orientation:** Strike: 90, Dip: 90, Plunge: 0
- Plate Dimensions:** Strike length: 500, Width: 500
- Output Units:** Normalisation to Primary Field (ppm), Physical Units (pT/s or nT/m)
- Transmitter:** Moment (Am²): 1000000
- Transmitter-Receiver Geometry:** Horizontal separation: 125, Vertical separation: 50
- Profile:** Plate located at x = 0, Xo: -300, Profile offset: 0, Dx: 20, Depth: 220, Npts: 31

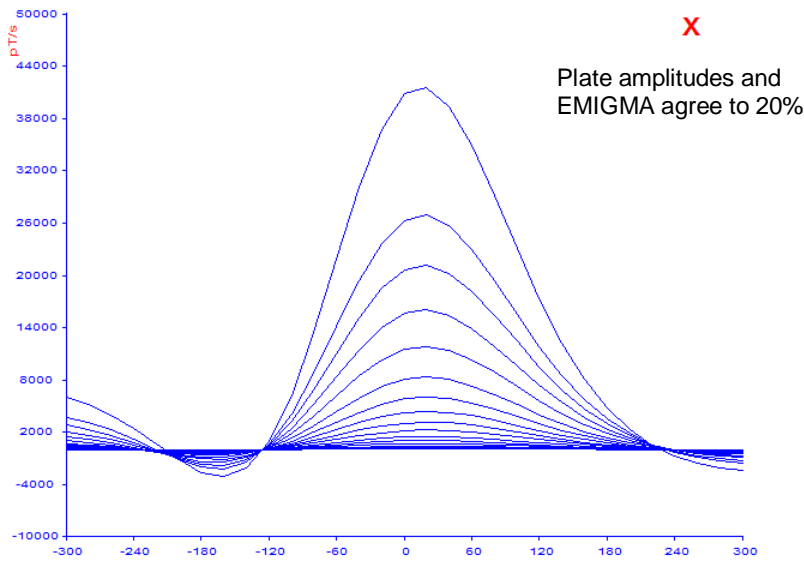
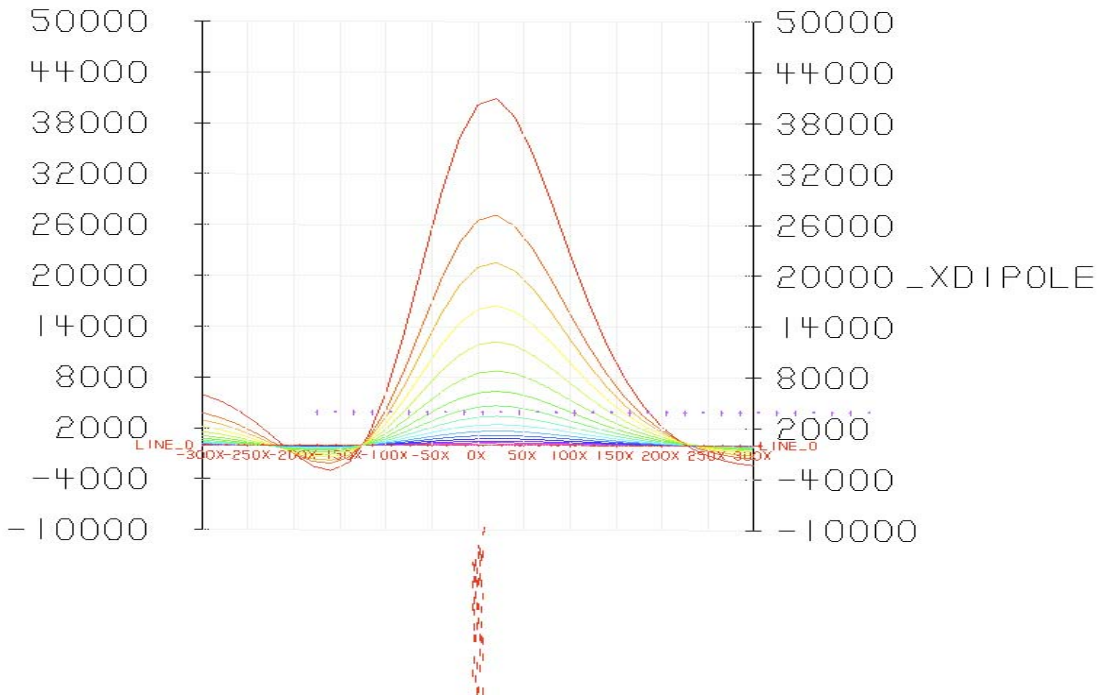
At the bottom left, there are two checkboxes: Nomogram and Display all views. At the bottom right, there are OK and CANCEL buttons. At the bottom center, the copyright notice reads: (c) 2003 University of Toronto - École Polytechnique de Montréal.

Figure 1: Summary of model parameters used in PLATE.

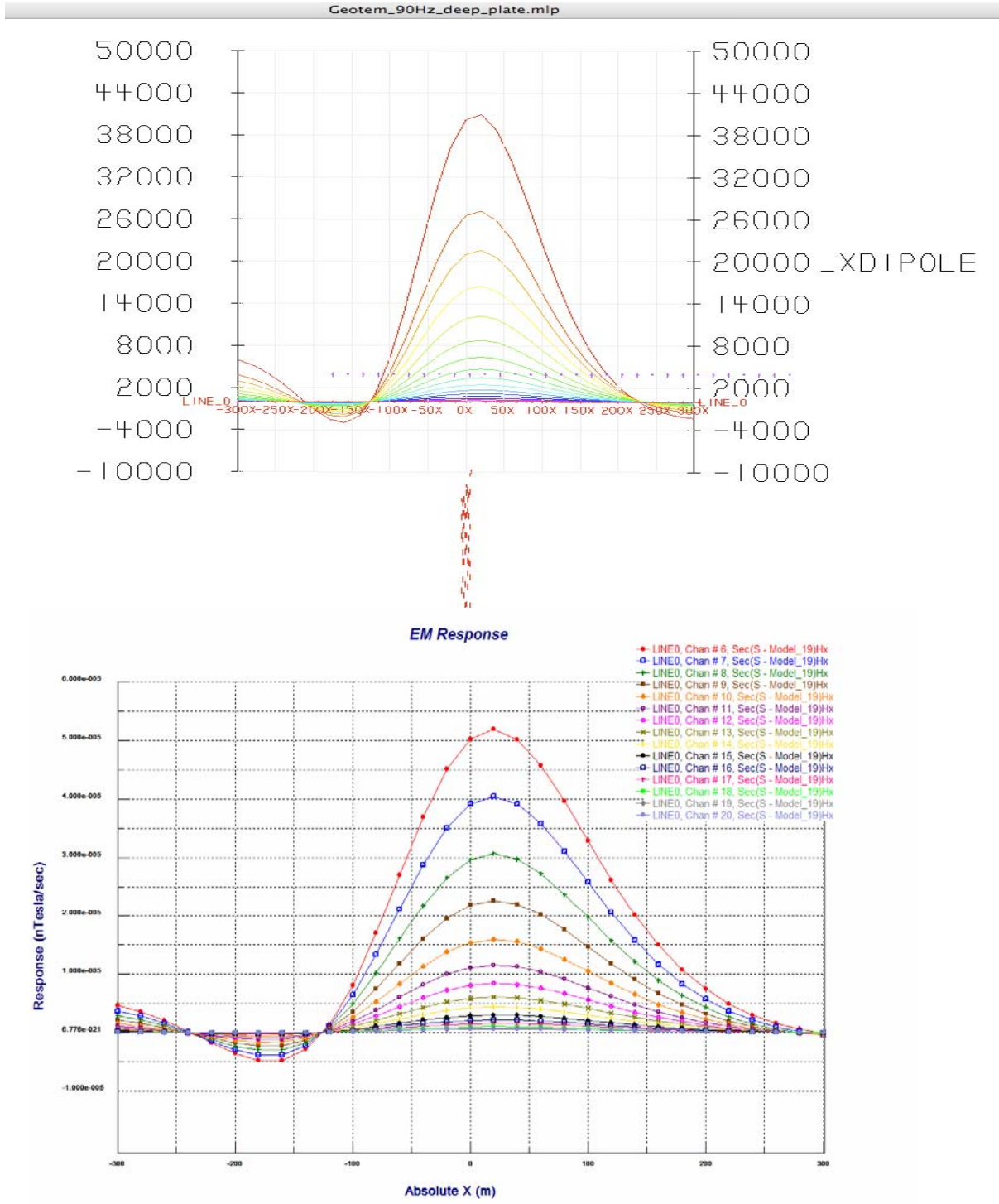
In the MultiLoop III models that follow, the response is calculated in pT/sec using a transmitter with an NIA of 1,000,000 Amps.

Deep Plate Comparison (1): Top: MultiLoop III, Bottom: PLATE. The two solutions compare well. The y-axis is labelled in pT/sec.

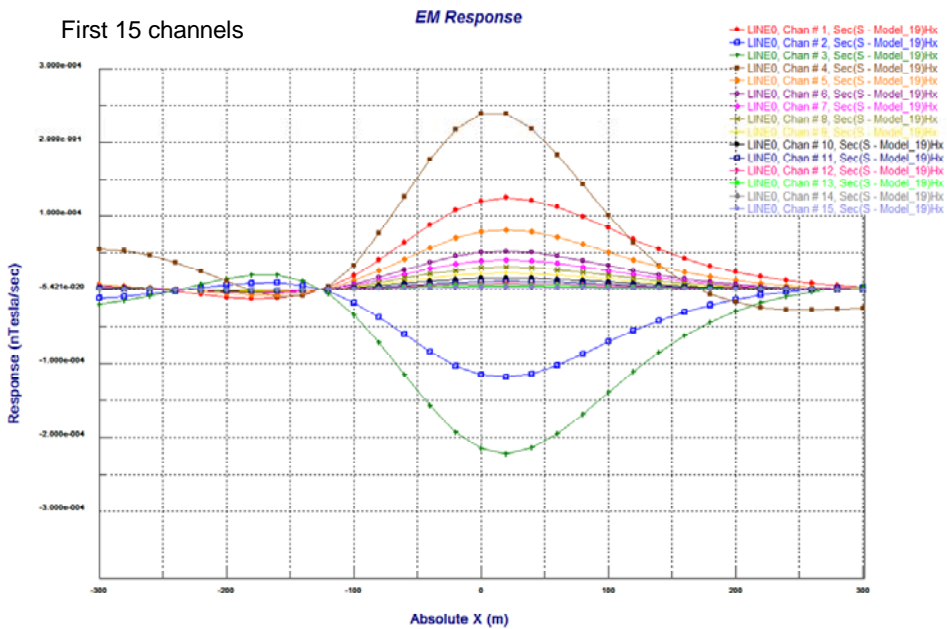
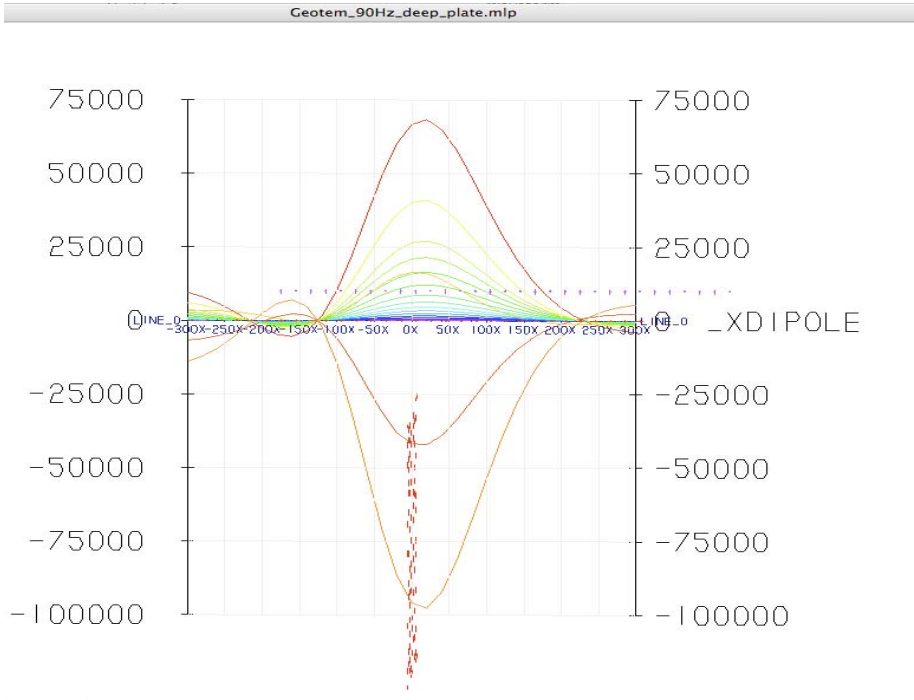
Geotem_90Hz_deep_plate.mip



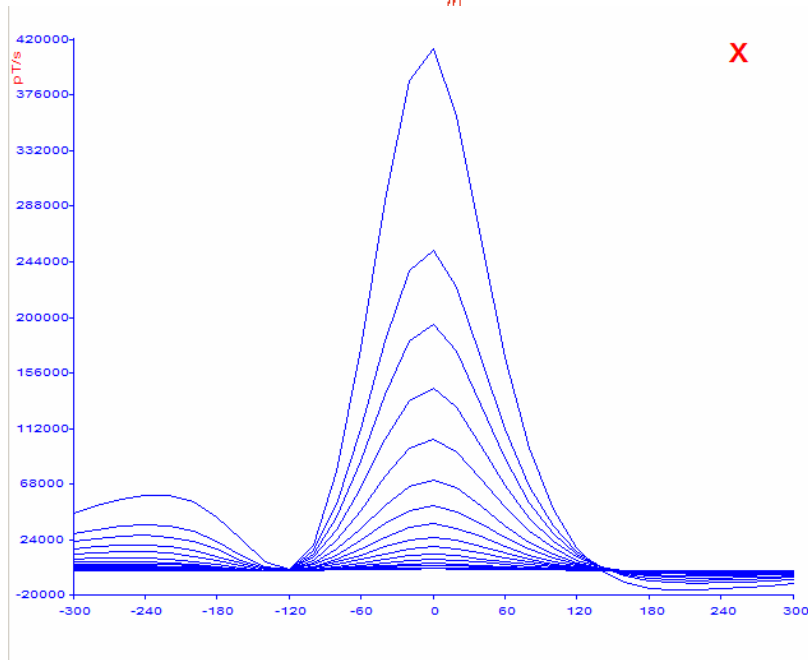
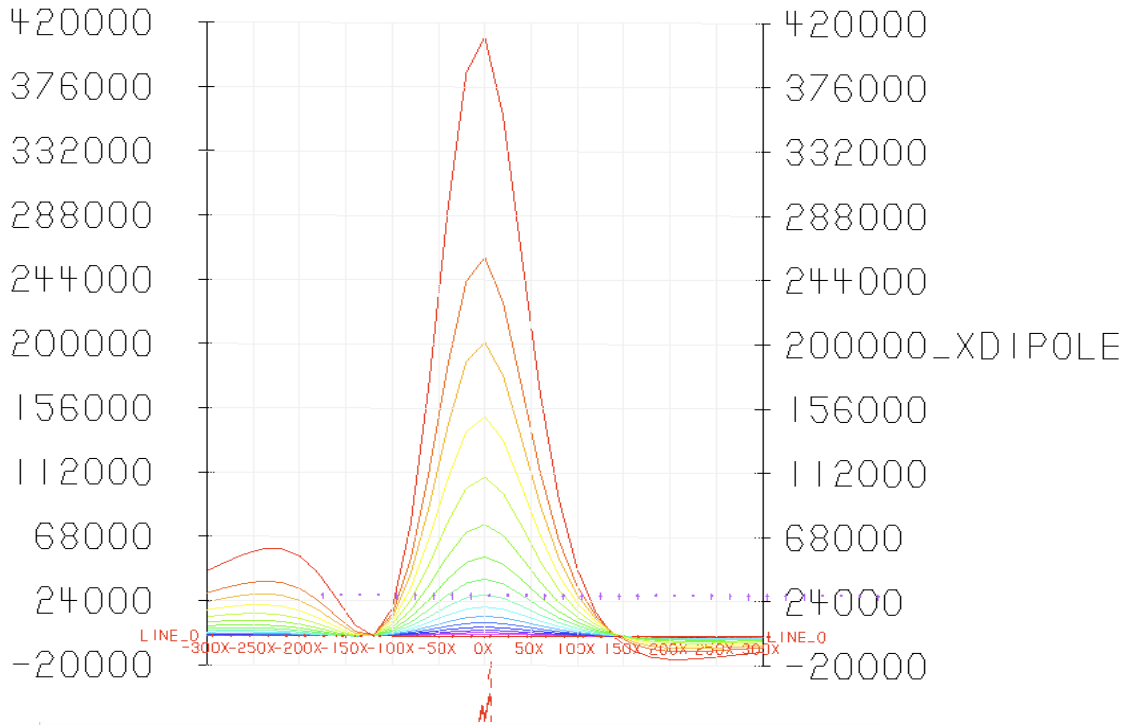
Deep Plate Comparison (2): Top: MultiLoop III, Bottom: EMIGMA (last 15 channels) in nT/sec. The two solutions compare less favourably than the MultiLoop III – PLATE comparison. The Emigma plot uses a label interval of $1e-5$ nT/sec, with a maximum of $6e-5$. Emigma calculations are in nT/sec with a unit NIA, and require multiplication by $1e9$ to convert to the illustrated PLATE / MultiLoop III results.



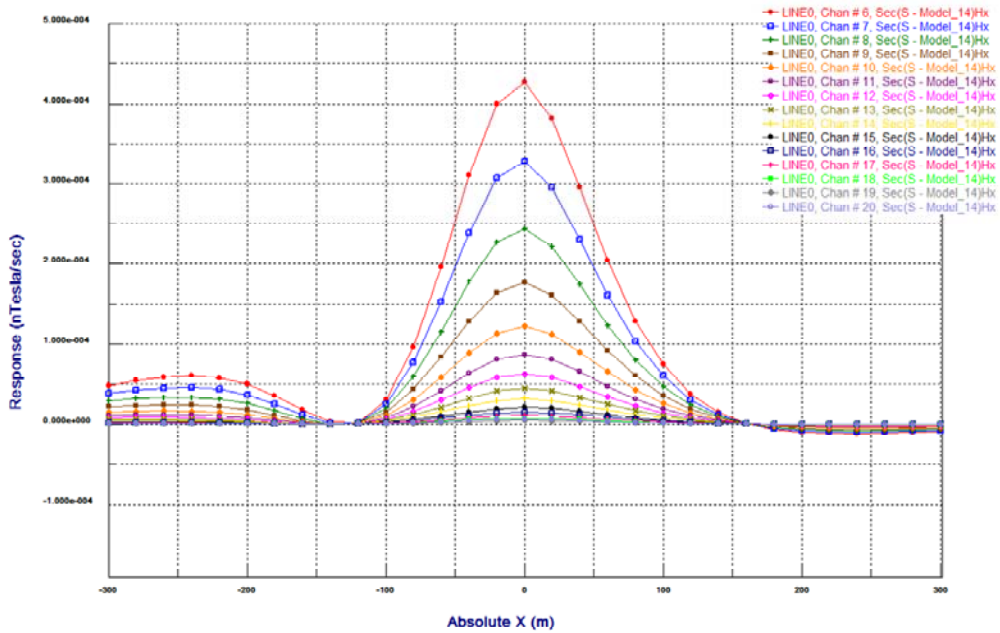
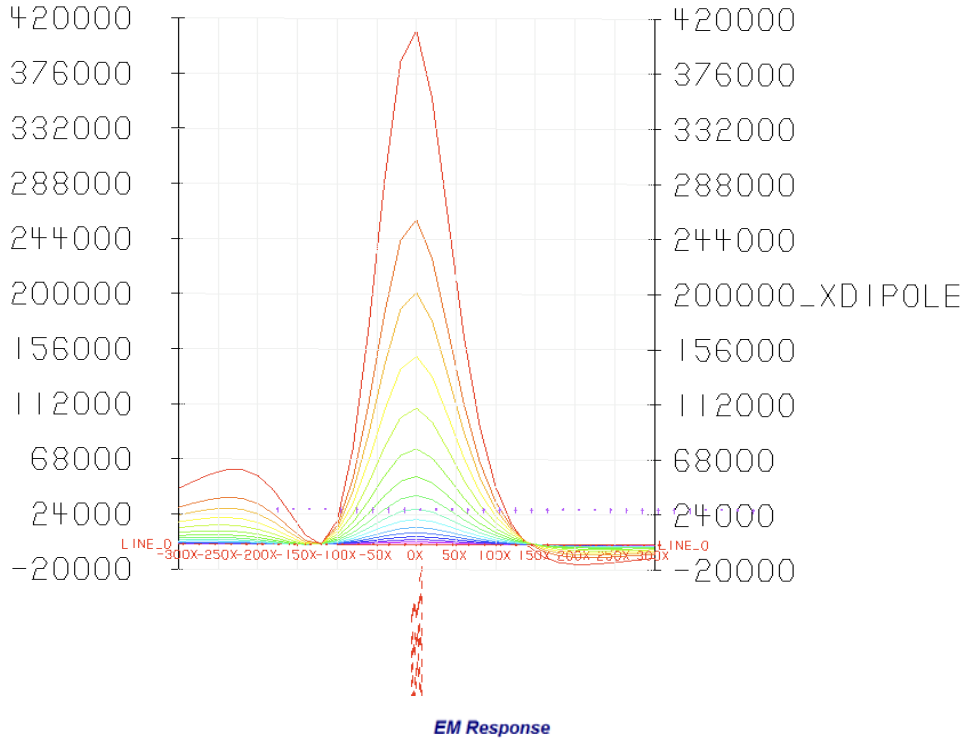
Deep Plate Comparison (3): Comparison of the computed on-time channels. Top: MultiLoop III, Bottom: Emigma. Emigma y-axis is labelled in intervals of $1e-4$ nT/sec with a maximum of $3e-4$ nT/sec. When converted to equivalent scales used in the PLATE/MultiLoop III plots, Emigma's on-time channels have approximately twice the amplitude of MultiLoop III's.



Shallow Plate Comparison (1): Top: MultiLoop III, Bottom: PLATE. The two solutions compare well (y-axis units in pT/sec).



Shallow Plate Comparison (2): Top: MultiLoop III, Bottom: PLATE. In the shallow case, all three solutions compare well. Emigma's y-axis label interval is $1.0e-4$ nT/sec. When converted to common units, the peak Emigma response is approximately 42,000, while the peaks of PLATE and MultiLoop III are closer, and under 42,000.



This is the emigma case at surface, which has the same amplitudes as PLATE.

MultiLoop III Modelling Setups:

1. Traverse Lines: When using the receiver as the plotting location, ensure that the line is at the elevation of the receiver.

Edit Traverse Lines

Line_0

No file

Determine Heading:

By End Point

By clockwise azimuth: 0

Line length: 600

Dip (down): -0

Set Station Separation:

Explicitly By Distance = 20

By No. of Stations = 31

Start and End Points:

	Start Point:	End Point:
X:	-300.00	300.00
Y:	0.00	0.00
Z:	70.00	70.00

New From Scratch Rename Refresh Apply Changes

New From File Save: Traverse File To BH Hide

Delete Save: Borehole File Plotting

Calc profile Calc vector Cancel OK

2. Antennae: A z-dipole is used for the transmitter, and an x-dipole is used for the receiver. The receiver lags the transmitter by 125 m and is 50 meters below it.

Select Antennae

UniformField
_XDipole
_YDipole
_ZDipole

Rx offset from the tx (in station coordinates)

Transmitter	<input checked="" type="radio"/>	_ZDipole	X	Y	Z
Receiver 1	<input type="radio"/>	<input checked="" type="checkbox"/> _XDipole	<input type="text" value="-125"/>	<input type="text" value="0"/>	<input type="text" value="-50"/>
Receiver 2	<input type="radio"/>	<input type="checkbox"/> Unassigned	<input type="text" value="-125"/>	<input type="text" value="0"/>	<input type="text" value="-50"/>
Receiver 3	<input type="radio"/>	<input type="checkbox"/> Unassigned	<input type="text" value="-125"/>	<input type="text" value="0"/>	<input type="text" value="-50"/>
Receiver 4	<input type="radio"/>	<input type="checkbox"/> Unassigned	<input type="text" value="-125"/>	<input type="text" value="0"/>	<input type="text" value="-50"/>
Receiver 5	<input type="radio"/>	<input type="checkbox"/> Unassigned	<input type="text" value="-125"/>	<input type="text" value="0"/>	<input type="text" value="-50"/>
Receiver 6	<input type="radio"/>	<input type="checkbox"/> Unassigned	<input type="text" value="-125"/>	<input type="text" value="0"/>	<input type="text" value="-50"/>

3. Presentation: No waveform or field normalization is used. Results are converted from nT/sec to pT/sec by multiplying by 1000.

Set Default Presentation

Method of Normalization

Continuous

Point Automatic Point Selection

Not Normalized (nT/sec) – unit area sensor

Normalize By

Primary Field Magnitude (All Components)

Absolute Primary Field (Rx Component)

Primary Field (Rx Component)

Select Point Norm Location (X,Y,Z)

Select PNorm Direction Cosine (X,Y,Z)

Normalization Units Multiplier

Ratio PPK

Percent (%) PPM

Numerator:

Denominator:

Waveform Normalization

% of peak primary current

% of average absolute current

% of RMS primary current

No Waveform Normalization

Select Transform:

4. Waveform Shape: The 2msec half-pulse is defined by the function in the edit box below. The sin function is multiplied by 1,000,000 to generate the required dipole moment for Megatem. Event 0 corresponds to the start of the waveform, and pulse. Event 1 occurs at 0.002 seconds and corresponds to the end of the pulse. The off-time is defined by a function 0 and runs from events 1 to 2. There are 3 events (function discontinuities) defining the waveform, and the sin function is digitized into 102 intervals to represent the waveform.

Pulse:

Digitize Waveform

Interval Number	Sample Range Disabled	1024
1	Interval Start Time (Ev=0)	0
2	Start Value	0
	Interval End Time (Ev=1)	0.002
	End Value	-0.149218
	Number of Interior Samples	101

Time Units: sec. msec. usec.

Interval Definition: Function End Points

1000000*sin(2*pi*t/0.004)

Buttons: Append, Remove, Rename, Parse Definition into RPN:, Digitize Waveform, Save To File, Cancel, OK

Digitized time is absolute: will be not be scaled

Offtime:

Digitize Waveform

Interval Number	Sample Range Disabled	1024
1	Interval Start Time (Ev=1)	0.002
2	Start Value	-0.149218
	Interval End Time (Ev=2)	0.00555555
	End Value	0
	Number of Interior Samples	0

Time Units: sec. msec. usec.

Interval Definition: Function End Points

0

Buttons: Append, Remove, Rename, Parse Definition into RPN:, Digitize Waveform, Save To File, Cancel, OK

Digitized time is absolute: will be not be scaled

5. Waveform: The Megatem waveform is a custom waveform defined by piecewise functions (see item 4 above). Here, the piecewise functions are defined in absolute time; alternately, the waveform can be defined in terms of the number intervals the half-period is divided into.

The waveform is reversing periodic, meaning that the polarity of the current is reversed each half cycle.

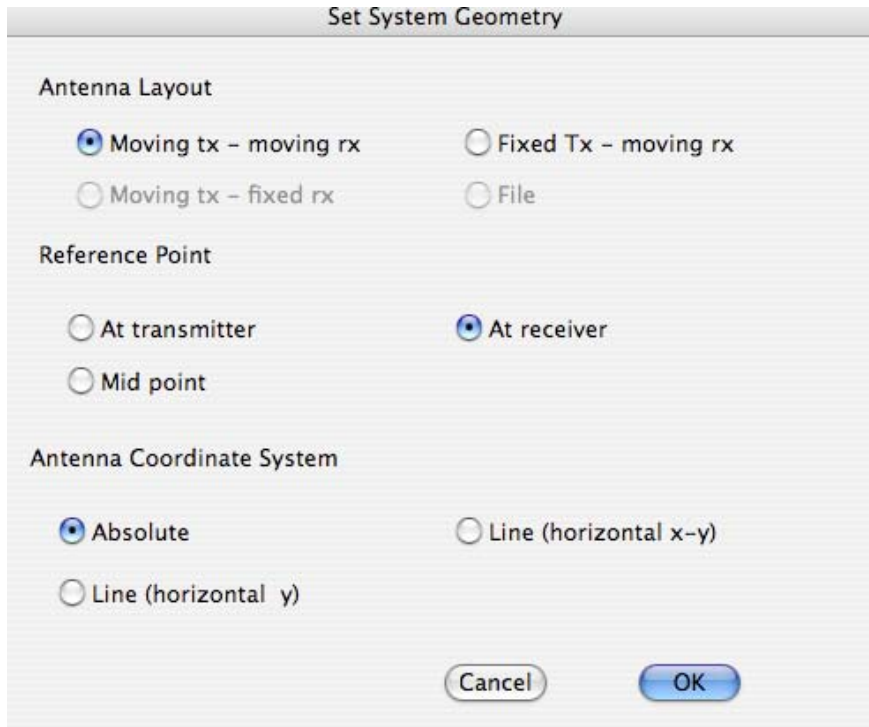
The base frequency used was 90 Hz.

The image shows a software dialog box titled "Waveform". It is divided into three main sections:

- Define Shape:** This section contains radio buttons for "Step", "Impulse", "Frequency Domain", and "Custom - piecewise" (which is selected). There are also checkboxes for "+/- 1 Amp Current Ramp (UTEM)" and "Ramp Start Time (secs before zero):" with a text input field containing "0.002". Under "Frequency Domain", there are input fields for "Num. of Freq's:" (value: 1) and "Ratio:" (value: 2), along with "Load List" and "Edit List" buttons. Under "Custom - piecewise", there are "Import" and "Digitize" buttons.
- Define Repetition:** This section contains radio buttons for "Single Sweep", "Periodic", and "Reversing Periodic" (which is selected).
- Define Base Frequency:** This section contains radio buttons for "Frequency:" (selected, with a text input field containing "89.9999") and "Reference Time: Half-Period" (with a text input field containing "0.00555556").

At the bottom right of the dialog, there are "Cancel" and "OK" buttons.

6. System Geometry: The Megatem system consists of a moving transmitter and receiver pair. The reference point for plotting is at the receiver.



The image shows a dialog box titled "Set System Geometry" with three sections of radio button options. The "Antenna Layout" section has four options: "Moving tx - moving rx" (selected), "Fixed Tx - moving rx", "Moving tx - fixed rx", and "File". The "Reference Point" section has three options: "At transmitter", "At receiver" (selected), and "Mid point". The "Antenna Coordinate System" section has three options: "Absolute" (selected), "Line (horizontal x-y)", and "Line (horizontal y)". At the bottom right are "Cancel" and "OK" buttons.

Set System Geometry

Antenna Layout

Moving tx - moving rx Fixed Tx - moving rx

Moving tx - fixed rx File

Reference Point

At transmitter At receiver

Mid point

Antenna Coordinate System

Absolute Line (horizontal x-y)

Line (horizontal y)

Cancel OK