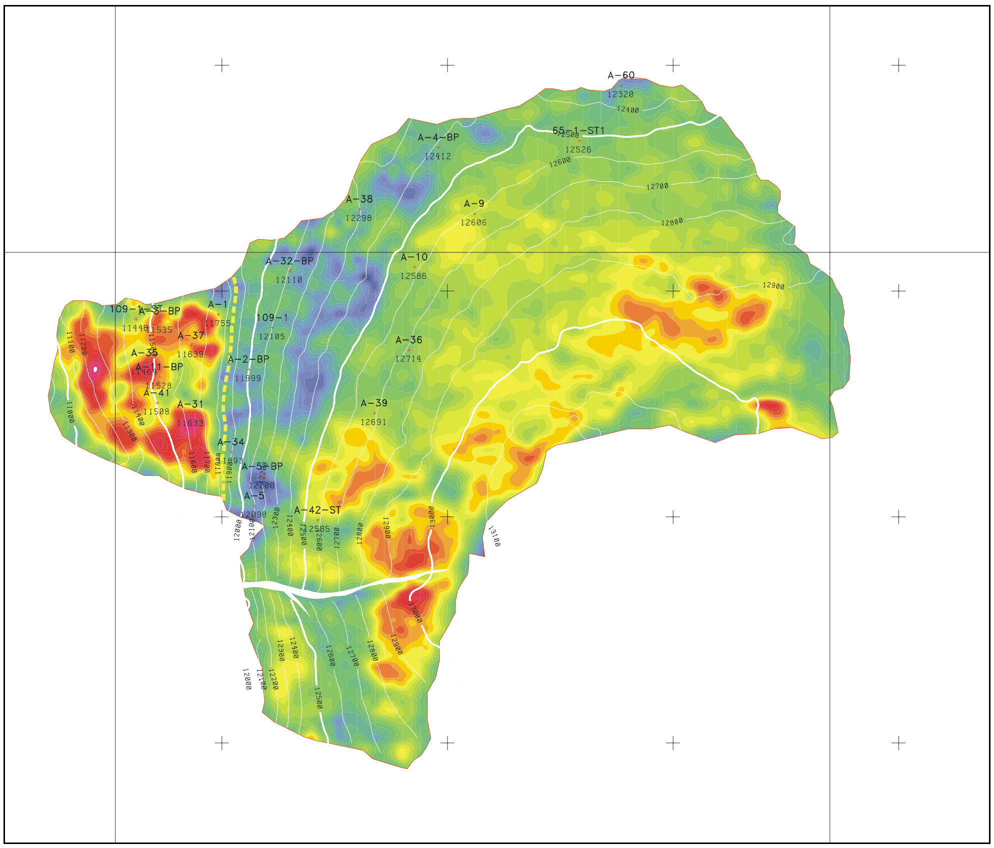
Bullwinkle J-Sand Maps

V2.0



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Summary

This report presents the results of my effort to produce depth converted seismic amplitude maps of the main pay sands in the Bullwinkle Field, Green Canyon 65, using both the "Bull34" and the Geco-Prakla surveys. Five horizons were mapped: the I10 and the J1 through J4. The report also includes a basemap of the field, showing the well locations, the spatial extent of the horizons, and the location of a characteristic dip-section though the reservoir region of the sands. This dip-section is discussed in *Section 2*. Digital file locations are listed in *Appendix 4.1* and instructions for producing the depth-converted maps in Z-map are included in *Appendix 4.2.*

It is anticipated that future versions of the report will be produced when refinements are made to the maps and more horizons in other surveys are considered.

Contents

1. Preliminaries

1.1 Basemap

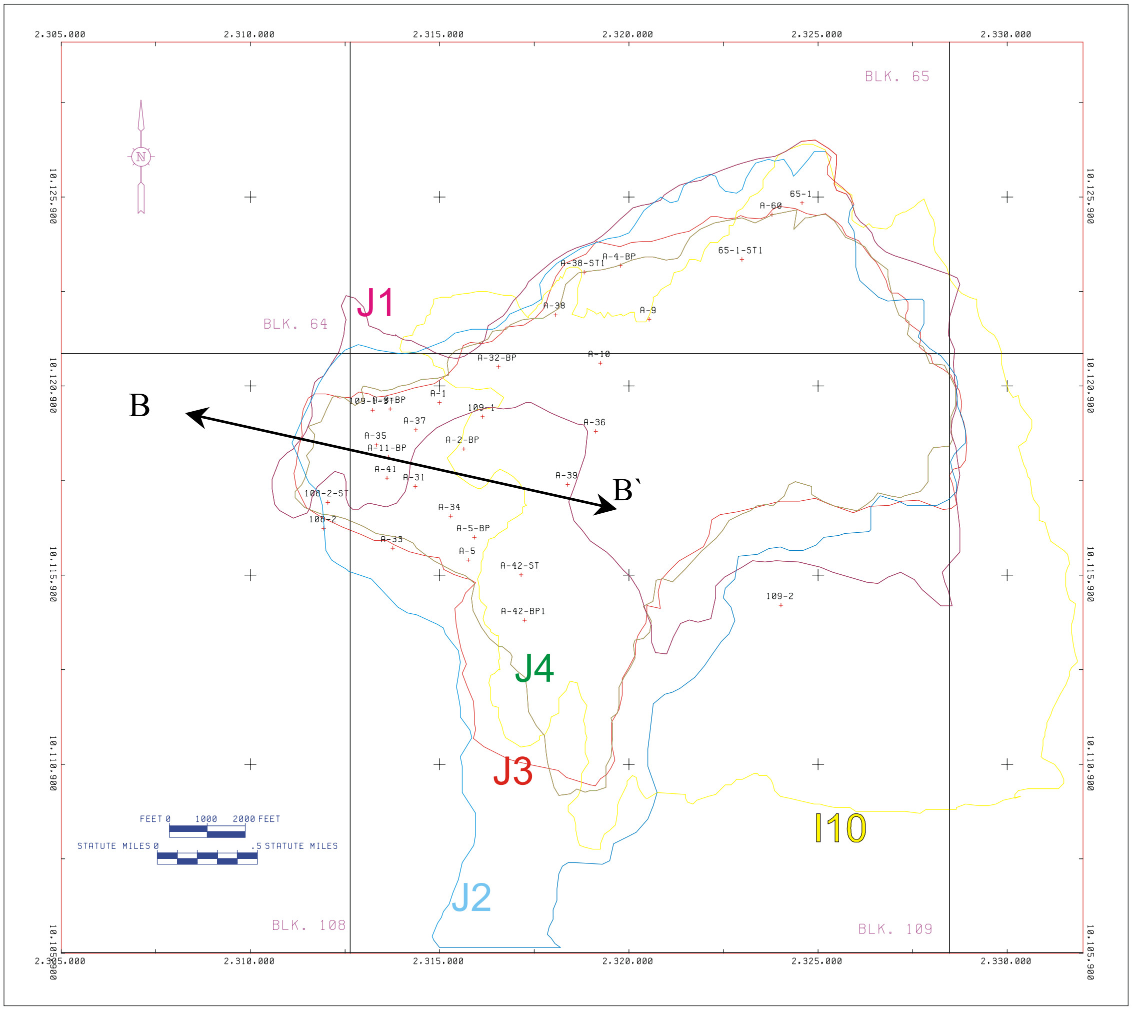


Figure 1: Basemap showing the location of the Bullwinkle wells in the J2 Horizon. Bounding polygons of the horizons from Bull34 are also included for reference. The line B-B` corresponds to the seismic sections shown in *Section 2*.

2. Dip-Sections

The image below is a *Seisworks* arbitrary line from Bull34, illustrating a dip-section through the J-sands. Its location (B-B`) is shown on the basemap on *page 3*. Note the polarity reversal in the J3 and J4 horizons in the region of Well A-5-BP. The section is repeated on the following page in variable density format. The polarity reversal is also evident in the zero-phase reflection coefficient Geco-Prakla survey (*Figure 2.3*).

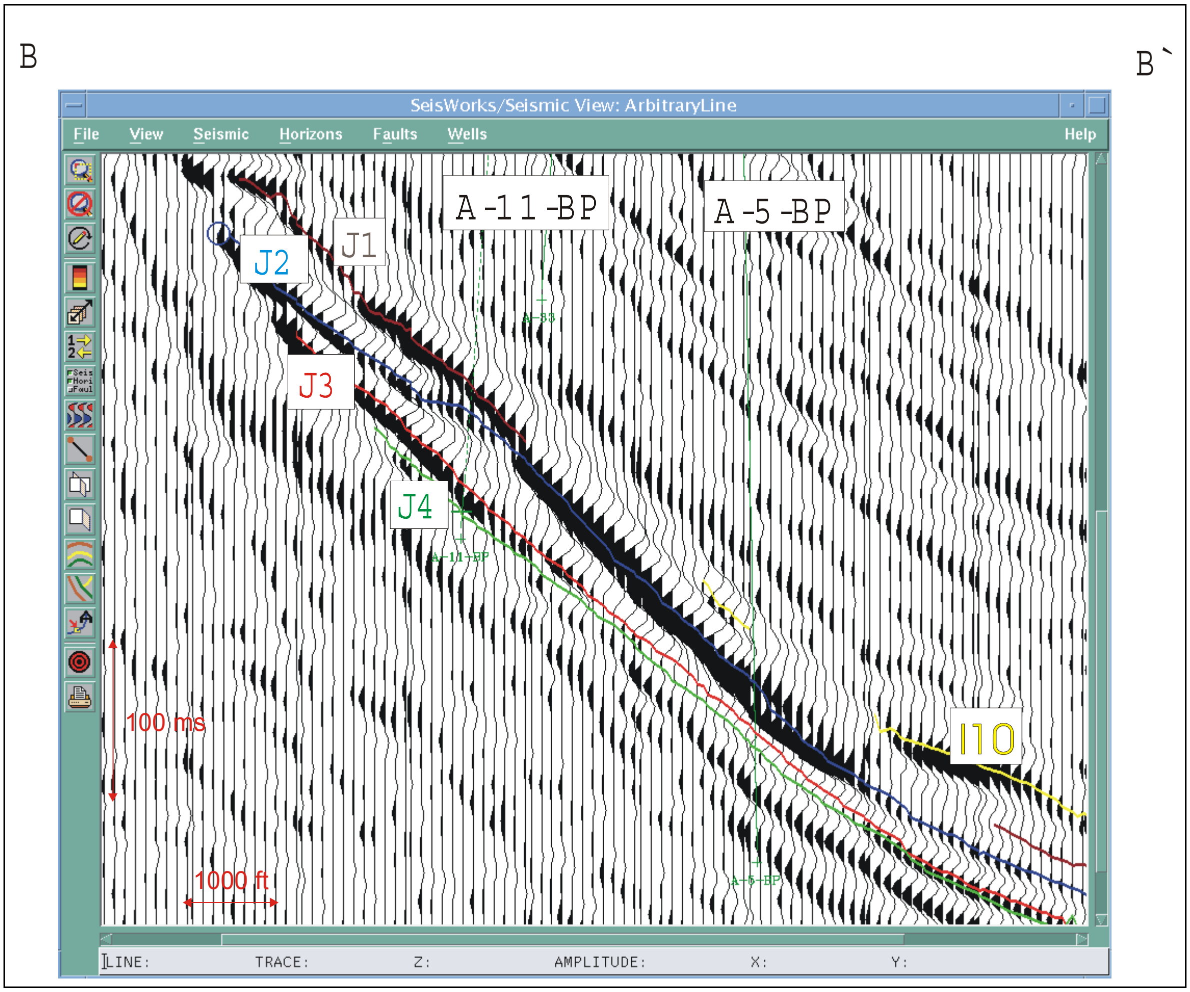


Figure 2.1: Bull34 wiggle trace J-Sand dip-section B-B`. The data is reverse polarity, but displayed such that it appears to be normal polarity survey.

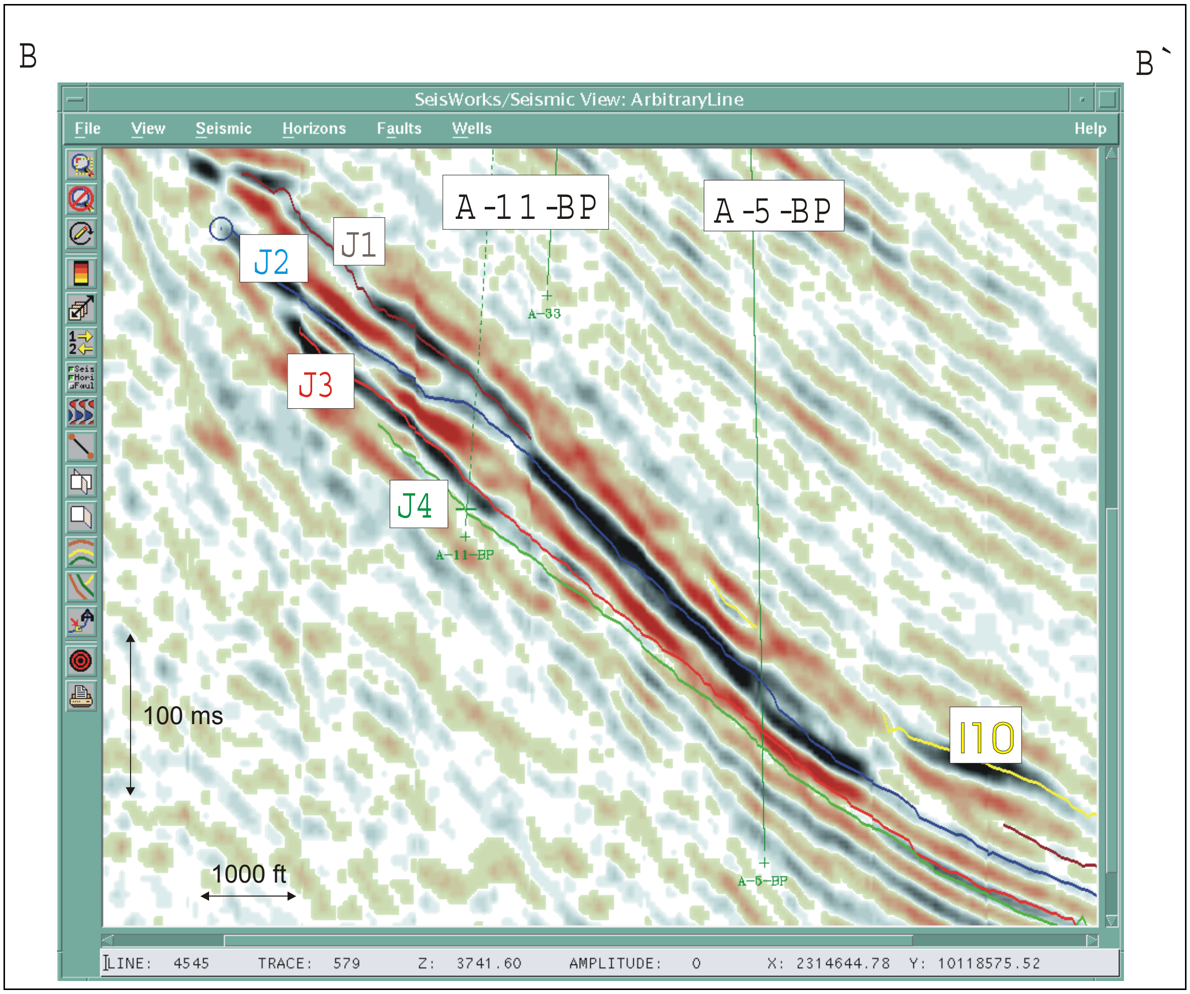


Figure 2.2: Variable density J-Sand dip-section B-B`. Black represents a peak in this reverse polarity dataset, corresponding to a negative reflection coefficient. Red colors are troughs.

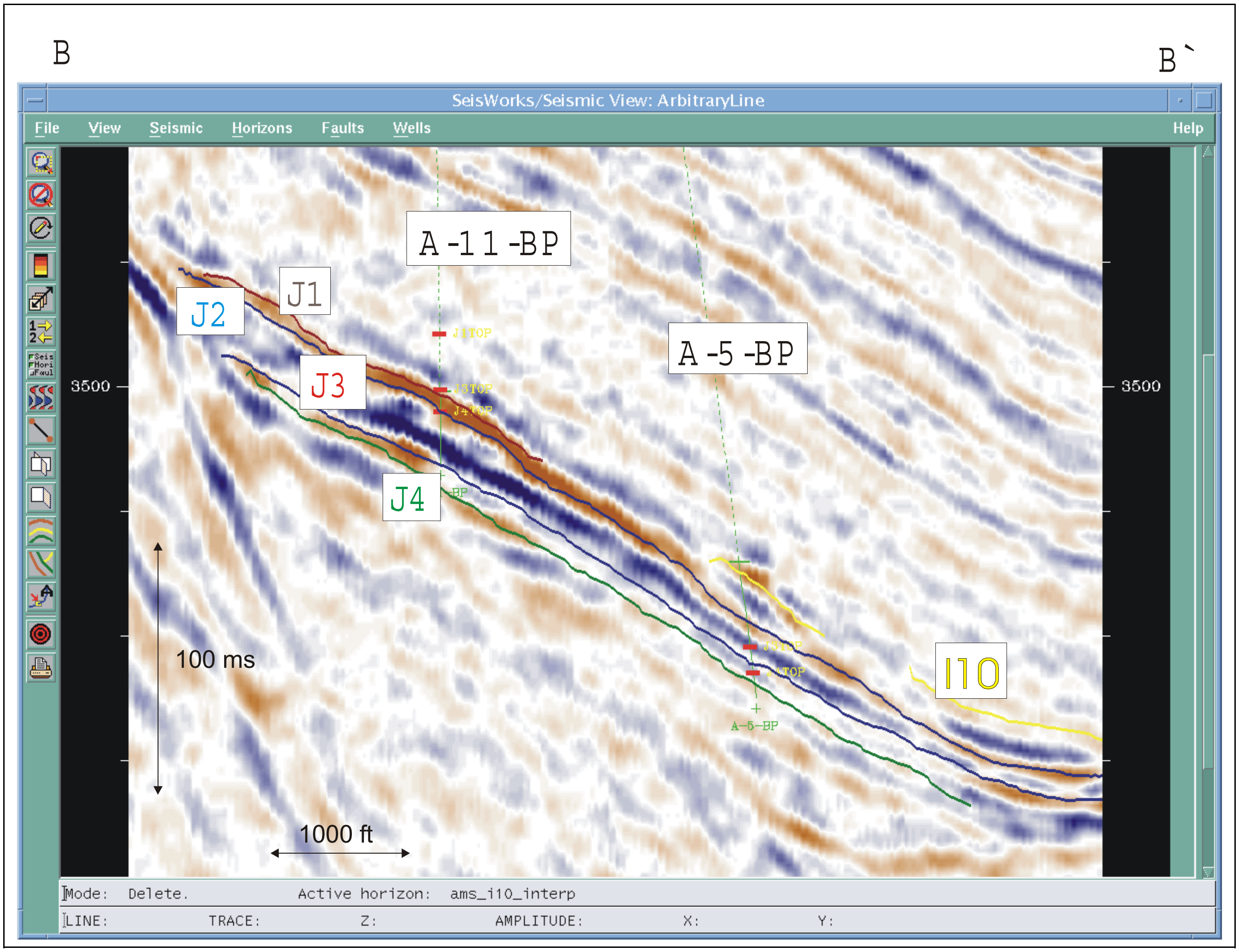


Figure 2.3: Geco-Prakla variable density J-Sand dip-section B-B`. Red represents a trough, corresponding to a negative reflection coefficient. Blue colors are peaks. Note the much reduced amplitude of the I10 horizon in comparison to the pre-production Bull34 survey.

3. The Maps

The following fifteen pages contain reduced size printouts of the J-sand maps. Combined amplitude and structure maps from both the Bull34 and the Geco-Prakla survey are presented for each horizon, as well as a structure only map. The yellow dashed lines represent the original oil-water contacts. Full size plots can be found in 20 Hosler.

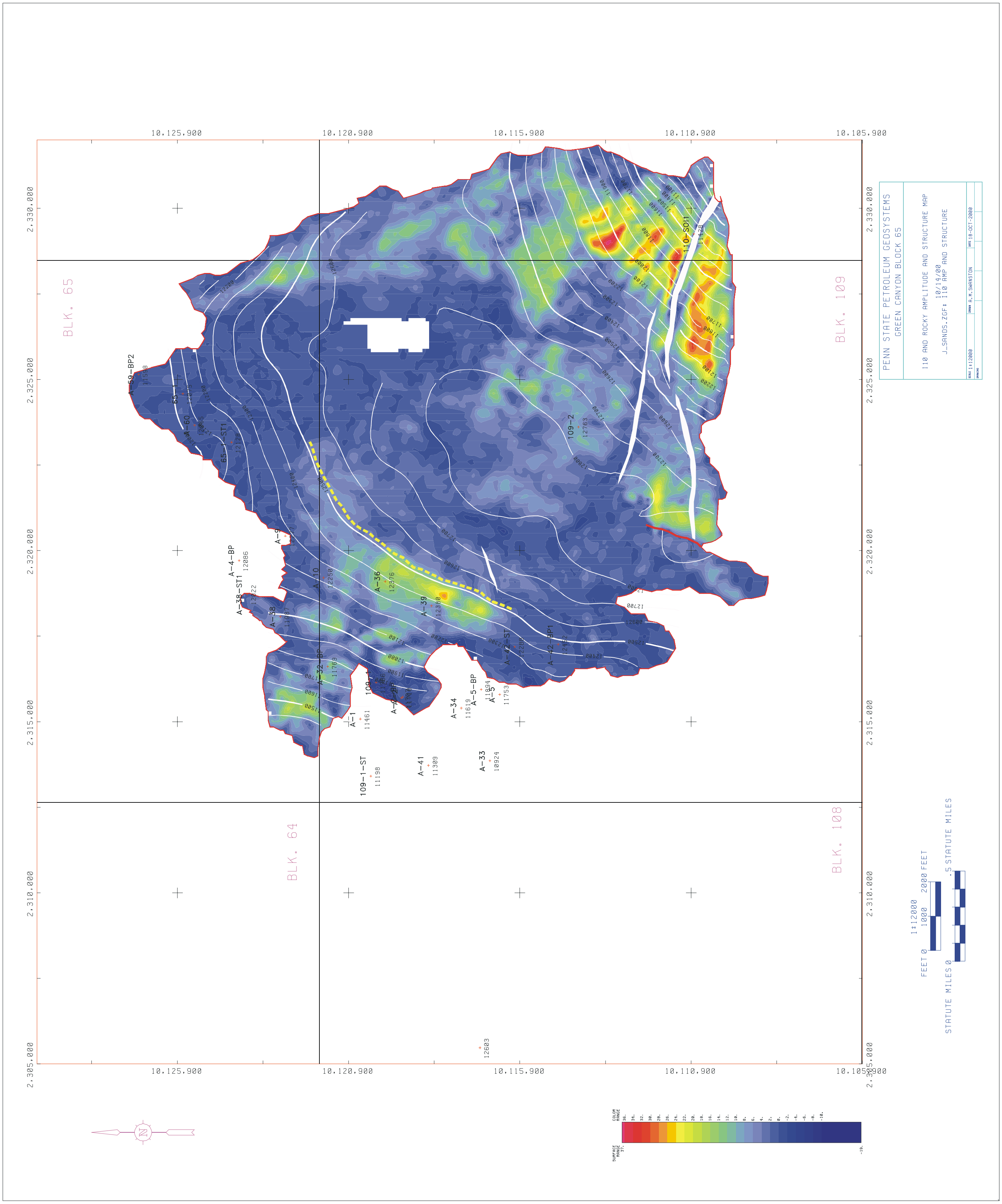


Figure 3.1.1: Bull 34 I10 and Rocky amplitude and structure map.

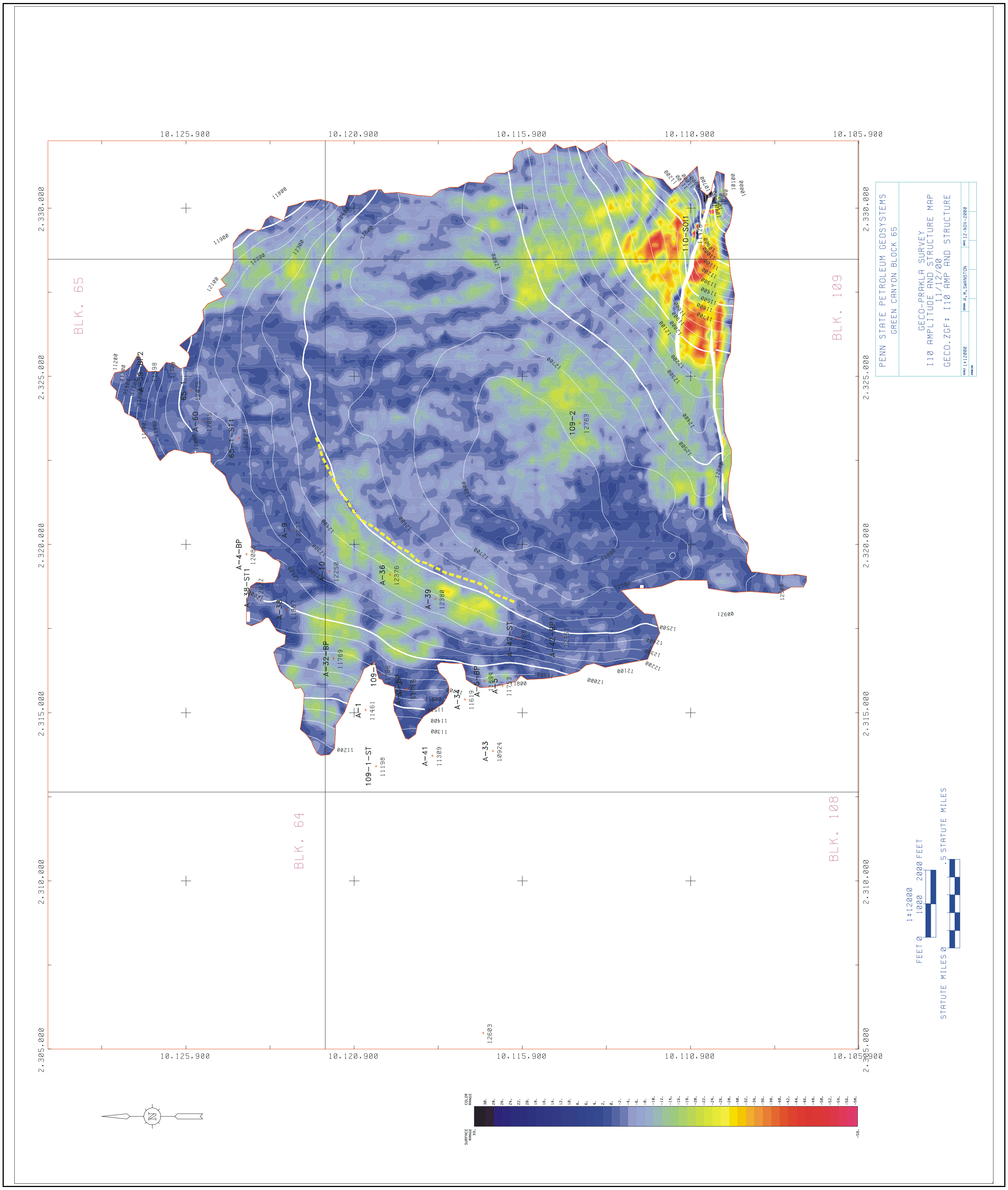


Figure 3.1.2: Geco-Prakla I10 and Rocky amplitude and structure map.

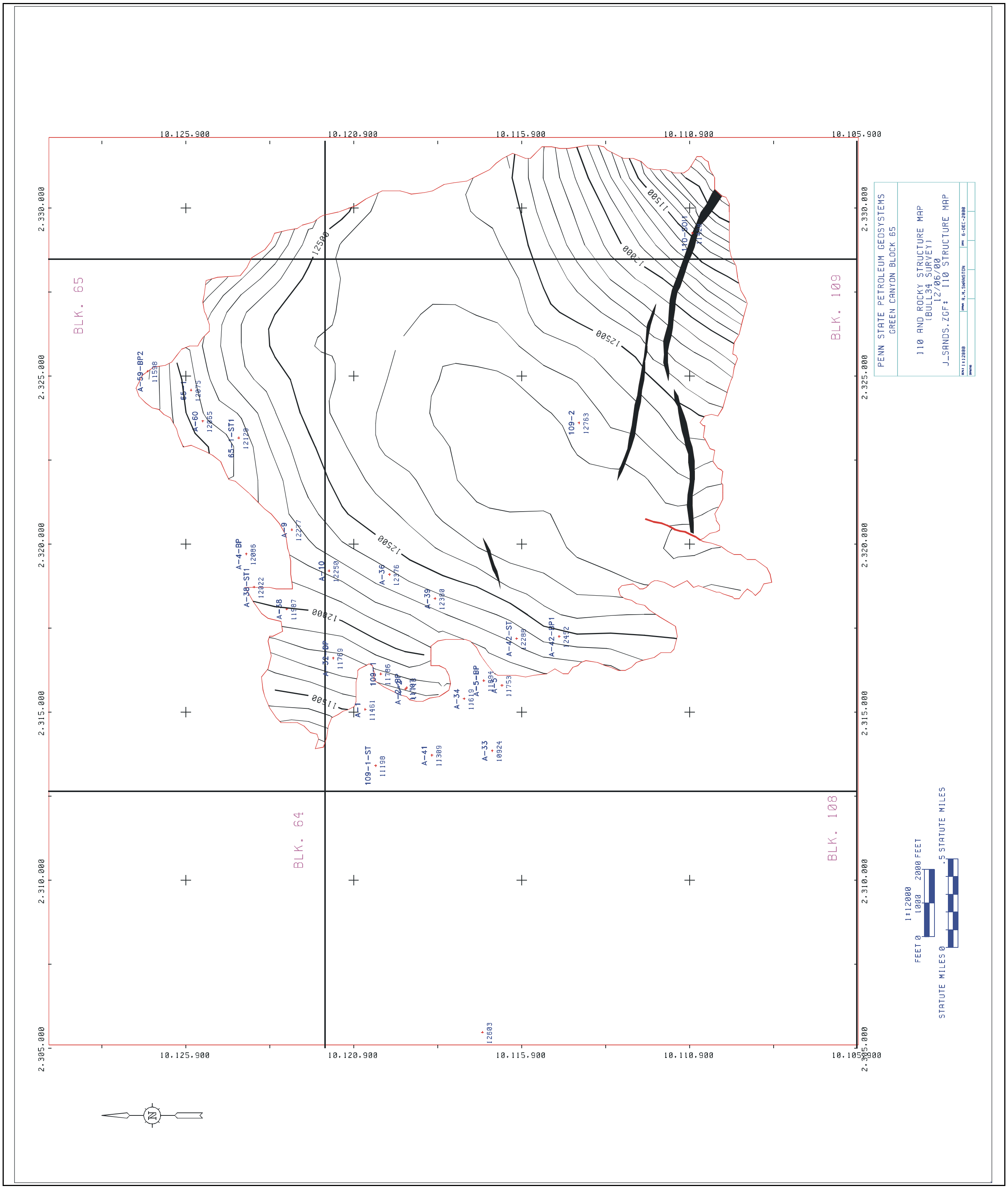


Figure 3.1.3: I10 and Rocky structure map (from the Bull34 Survey).

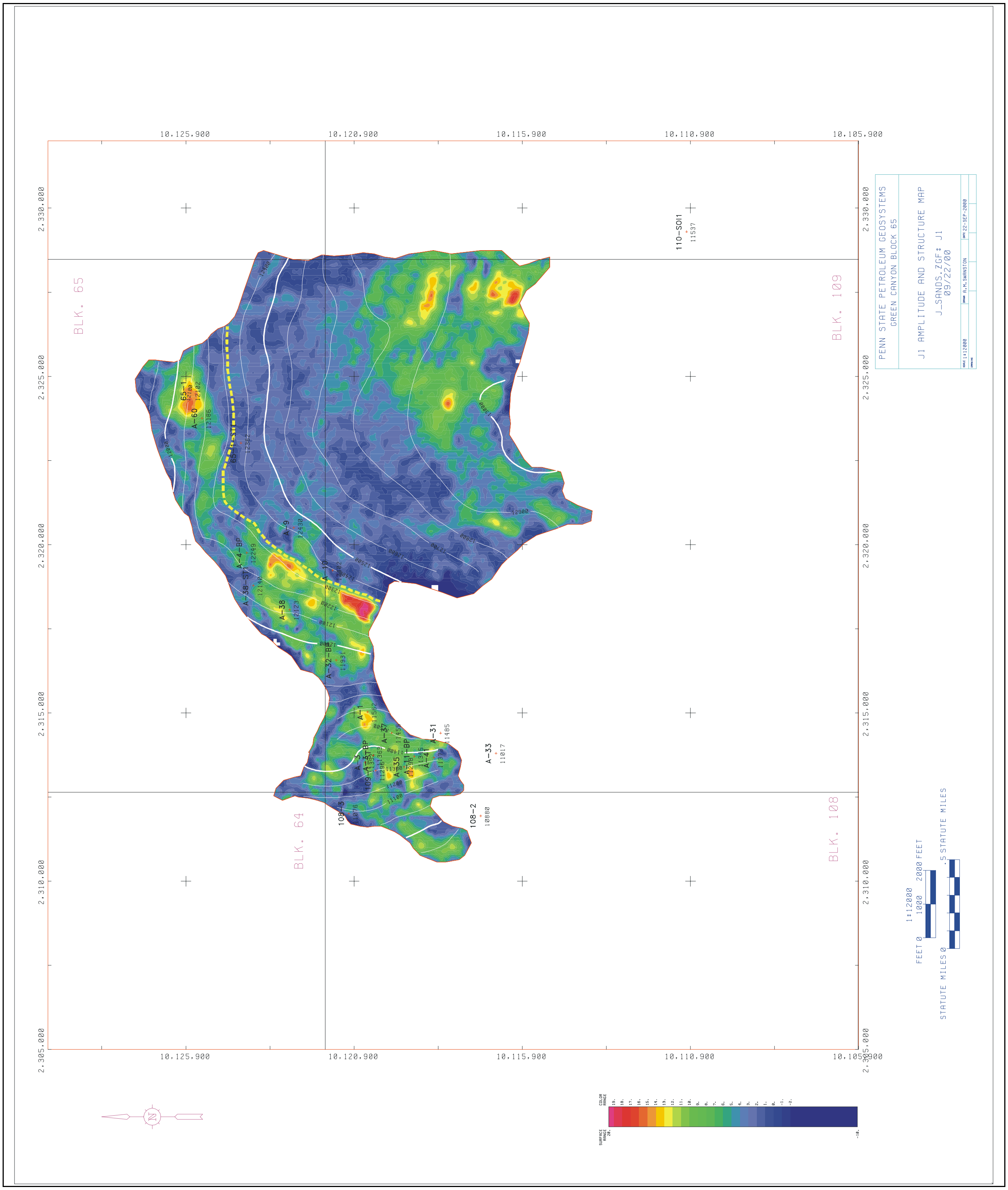


Figure 3.2.1: Bull 34 J1amplitude and structure map.

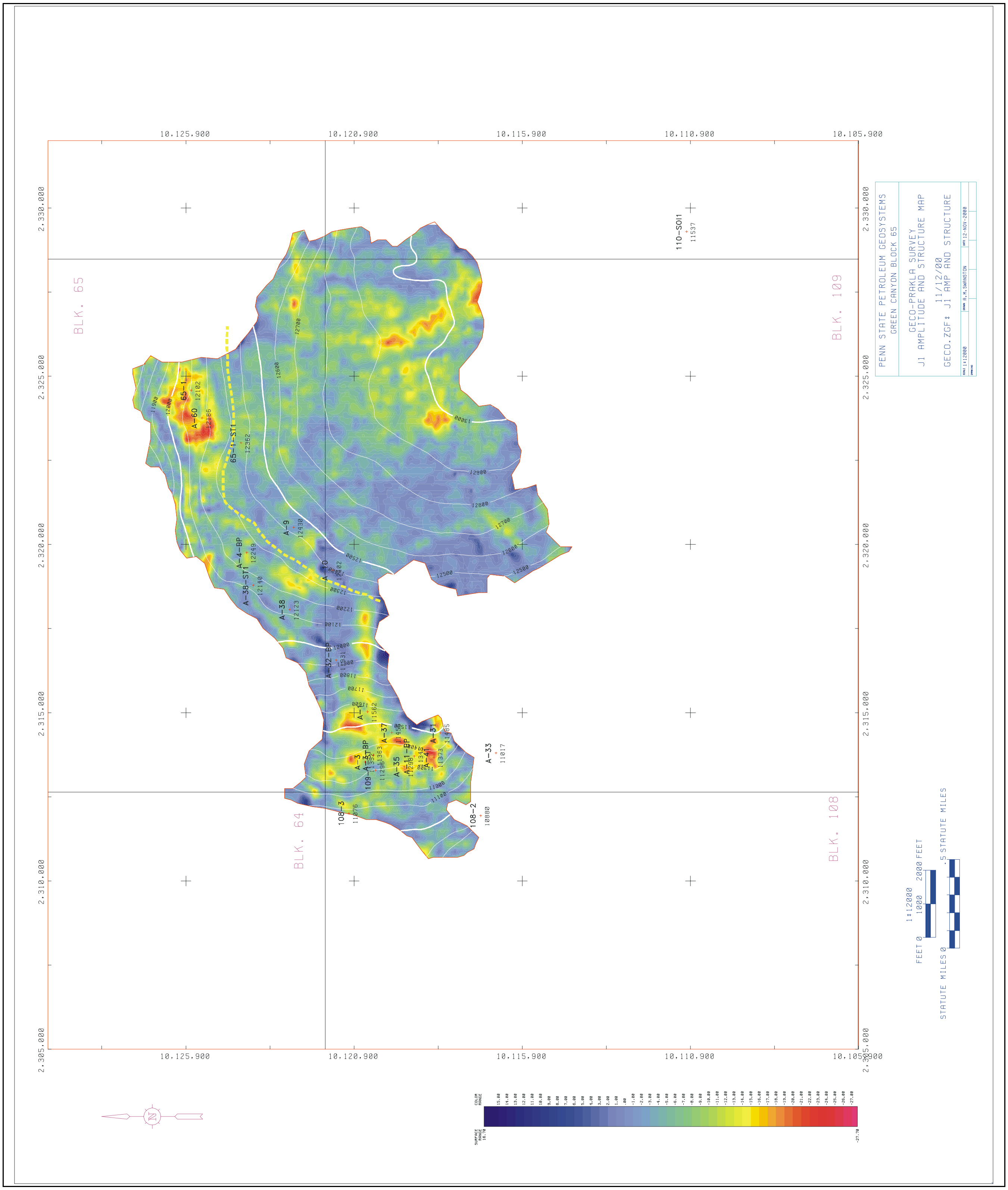


Figure 3.2.2: Geco-Prakla J1amplitude and structure map.

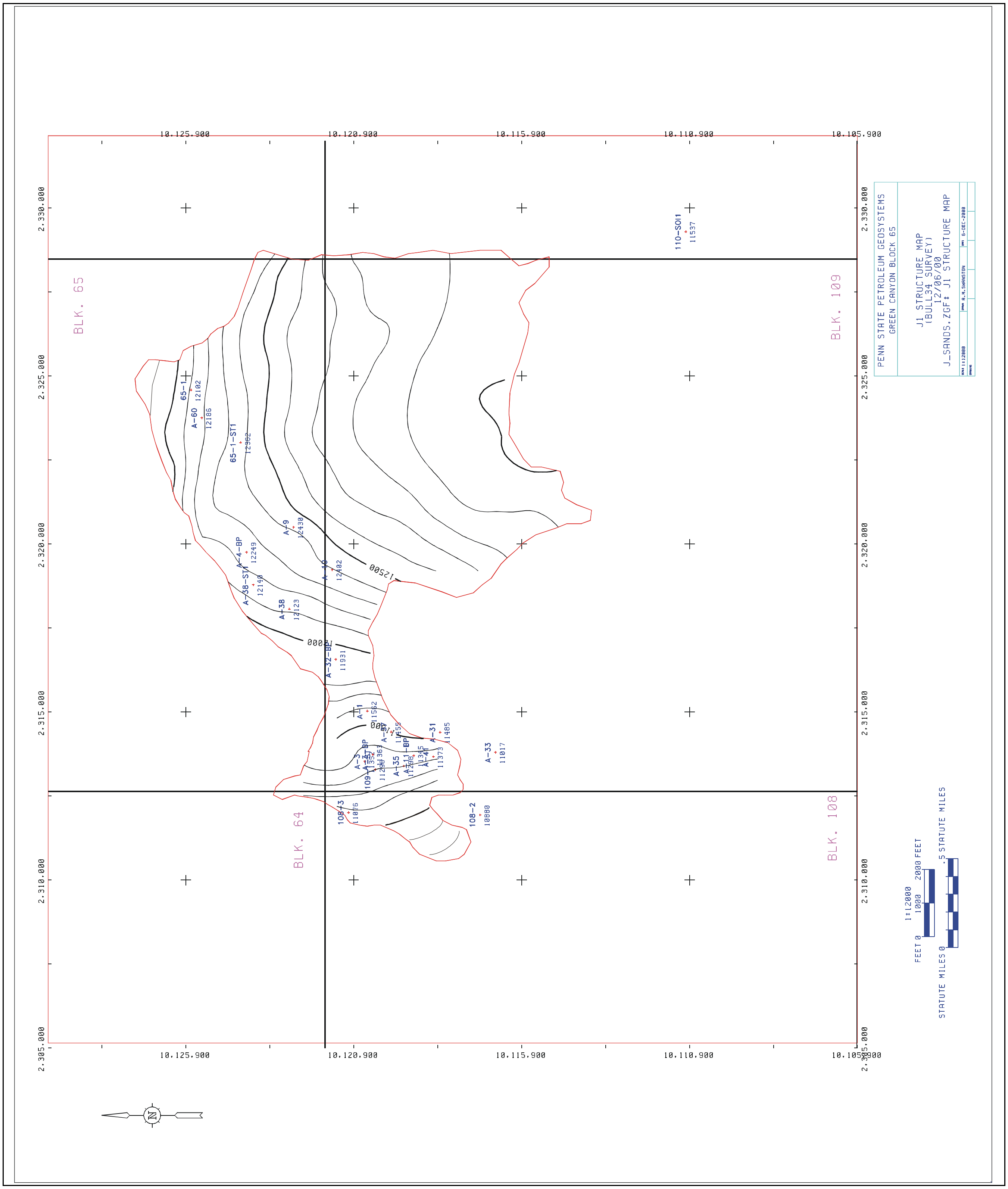


Figure 3.2.3: J1structure map (from the Bull34 Survey).

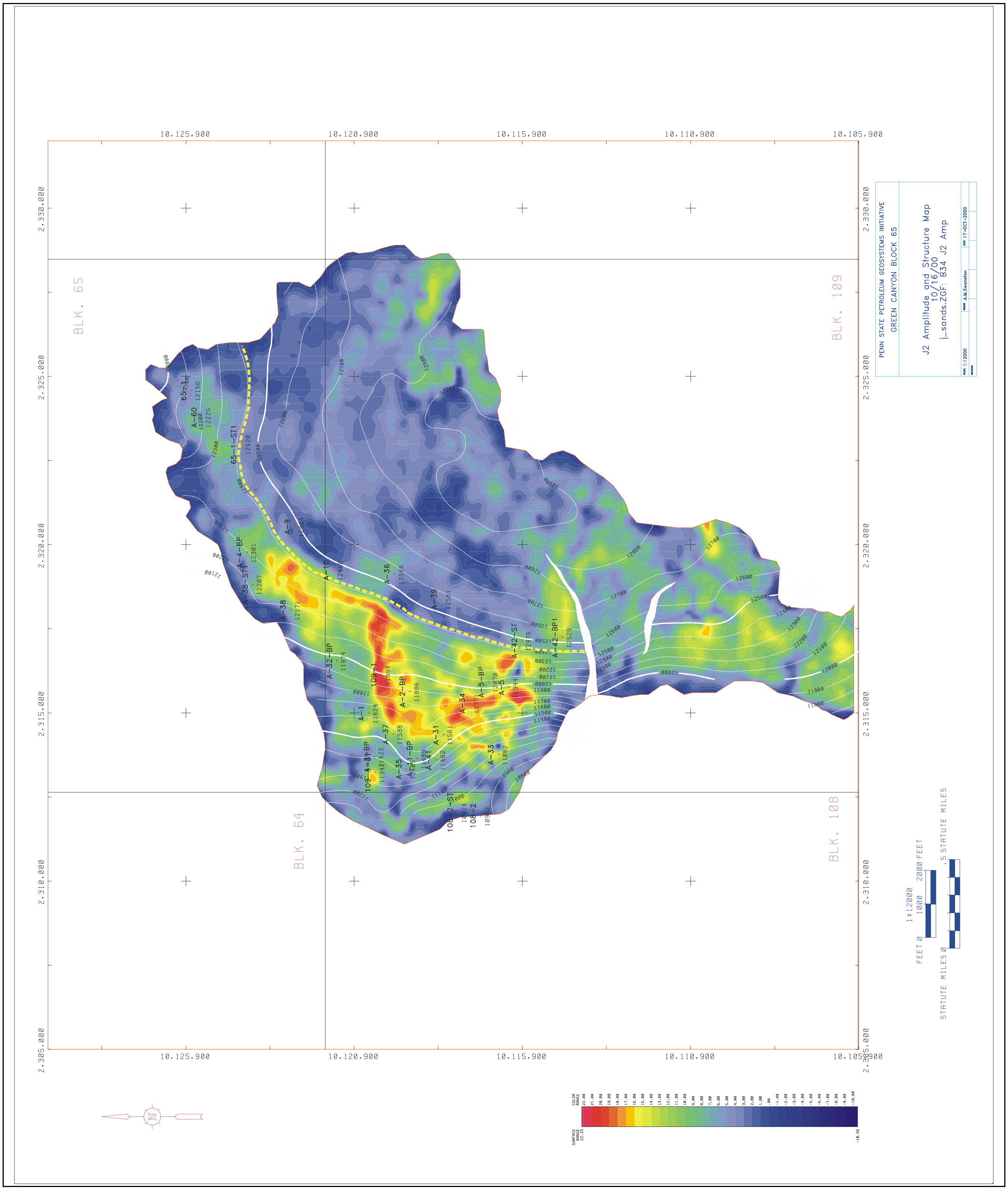


Figure 3.3.2: Bull 34 J2 amplitude and structure map.

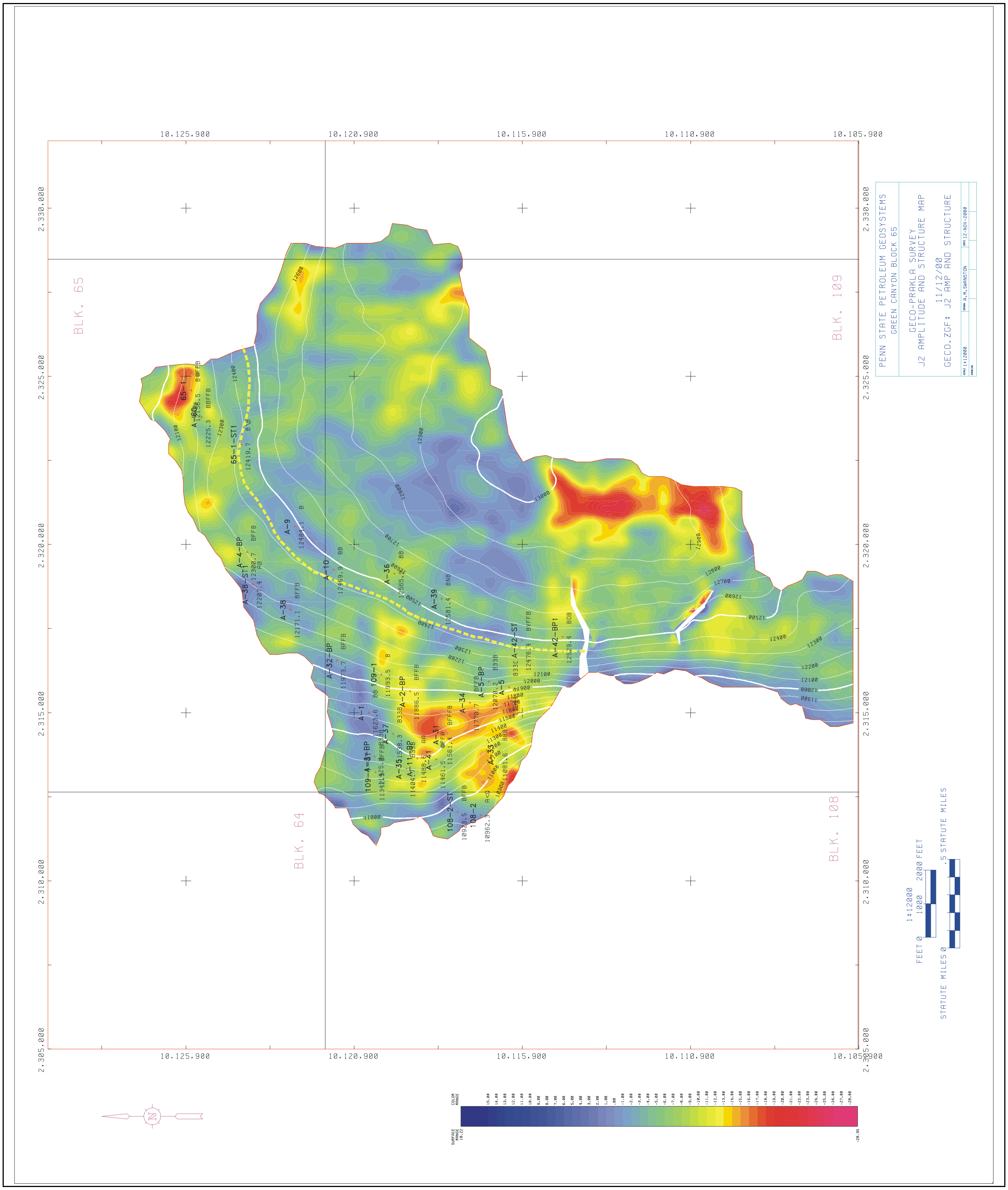


Figure 3.3.2: Geco-Prakla J2amplitude and structure map.

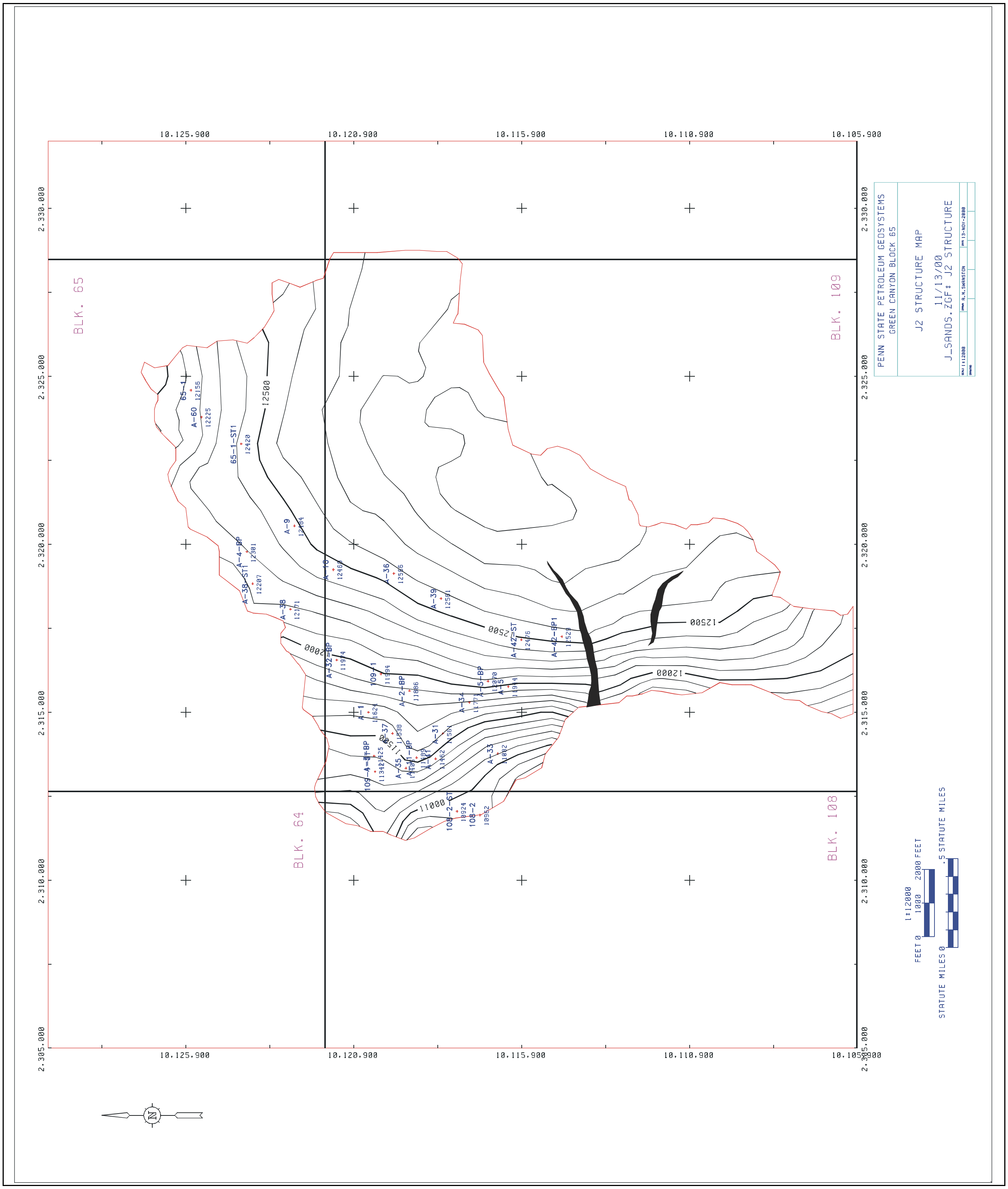


Figure 3.3.3: J2 structure map (from the Bull34 Survey).

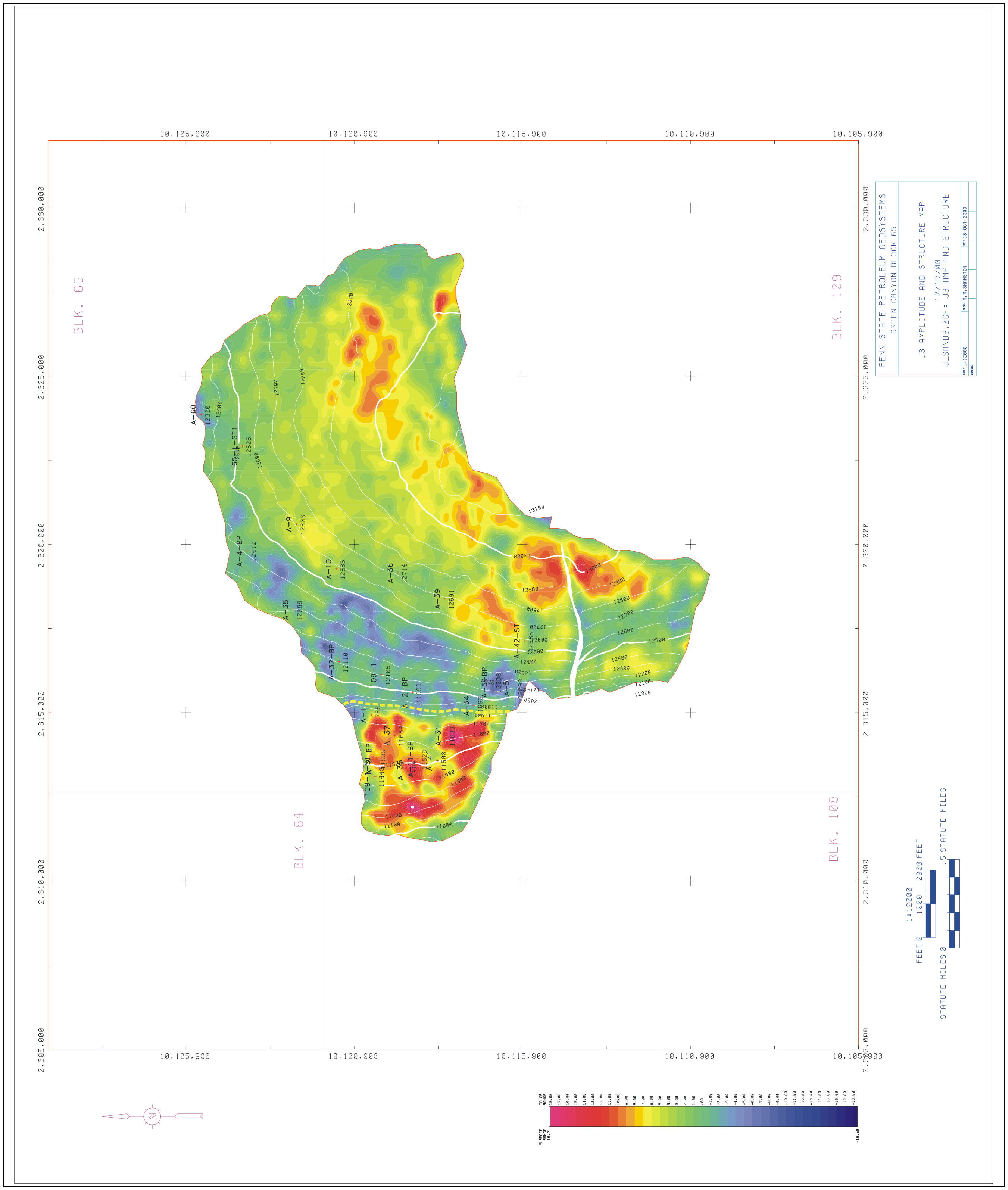


Figure 3.4.1: Bull 34 J3 amplitude and structure map.

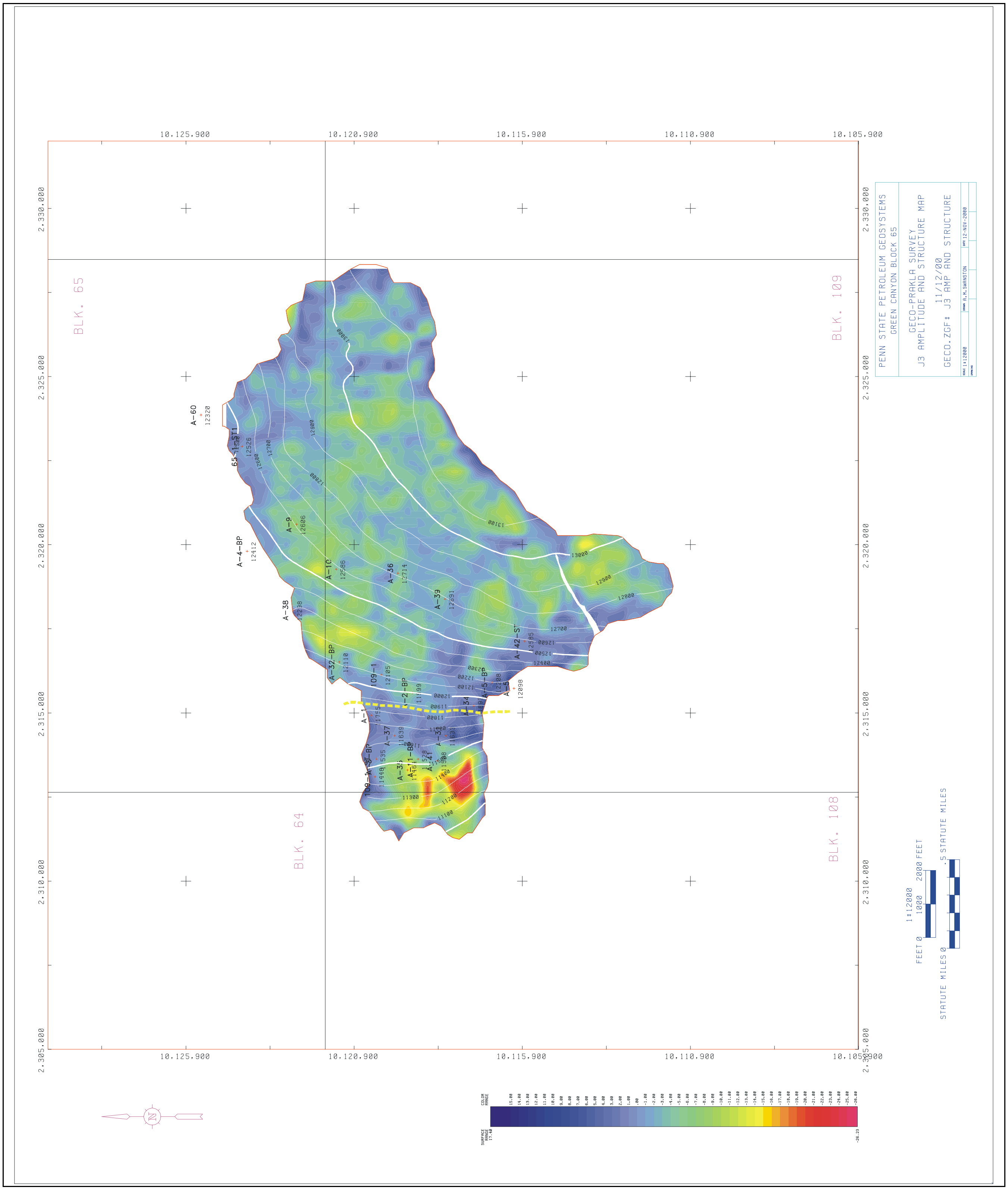


Figure 3.4.2: Geco-Prakla J3 amplitude and structure map.

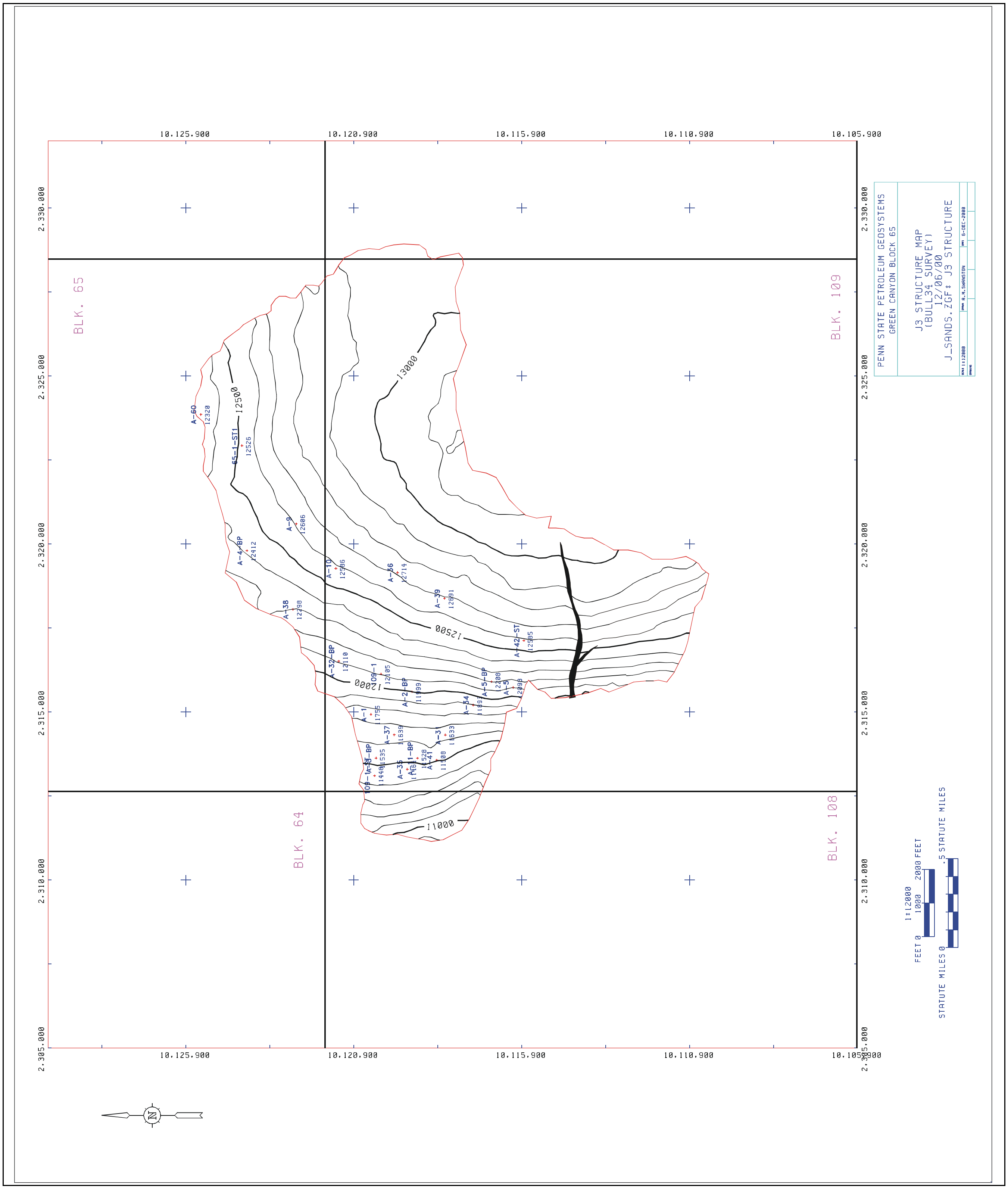


Figure 3.4.3: J3 structure map (from the Bull34 Survey).

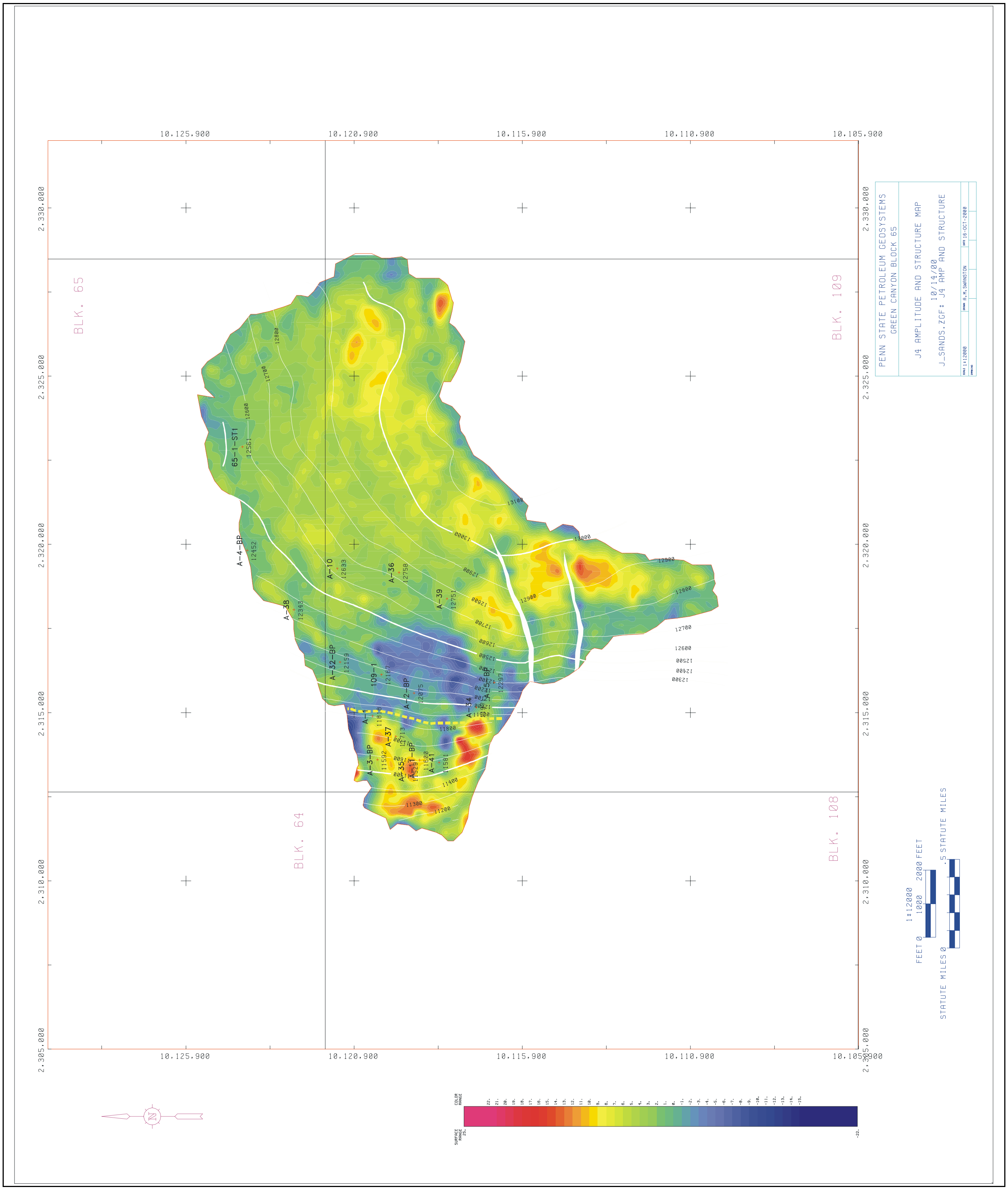


Figure 3.5.1: Bull 34 J4 amplitude and structure map.

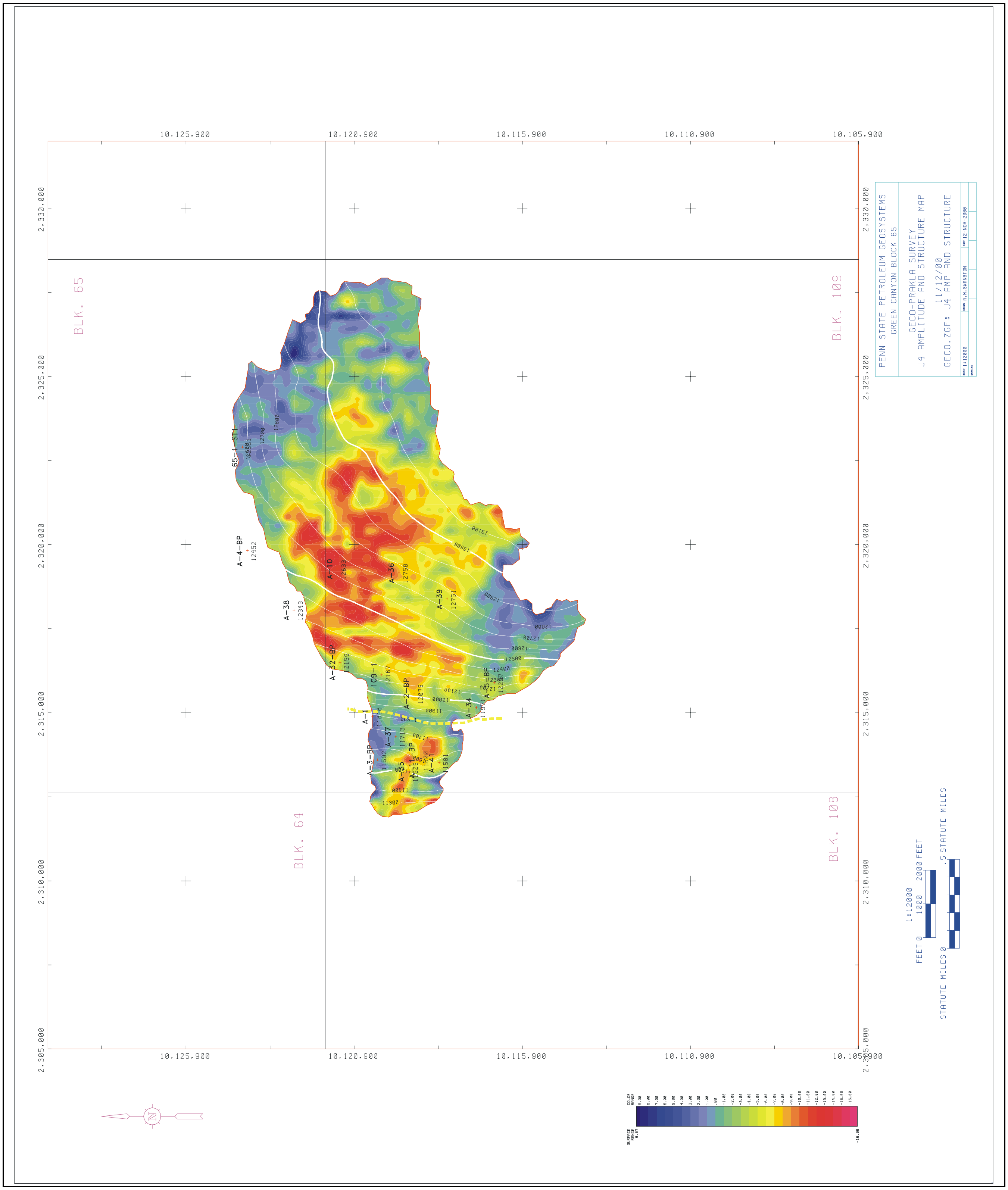


Figure 3.5.2: Geco-Prakla J4 amplitude and structure map.

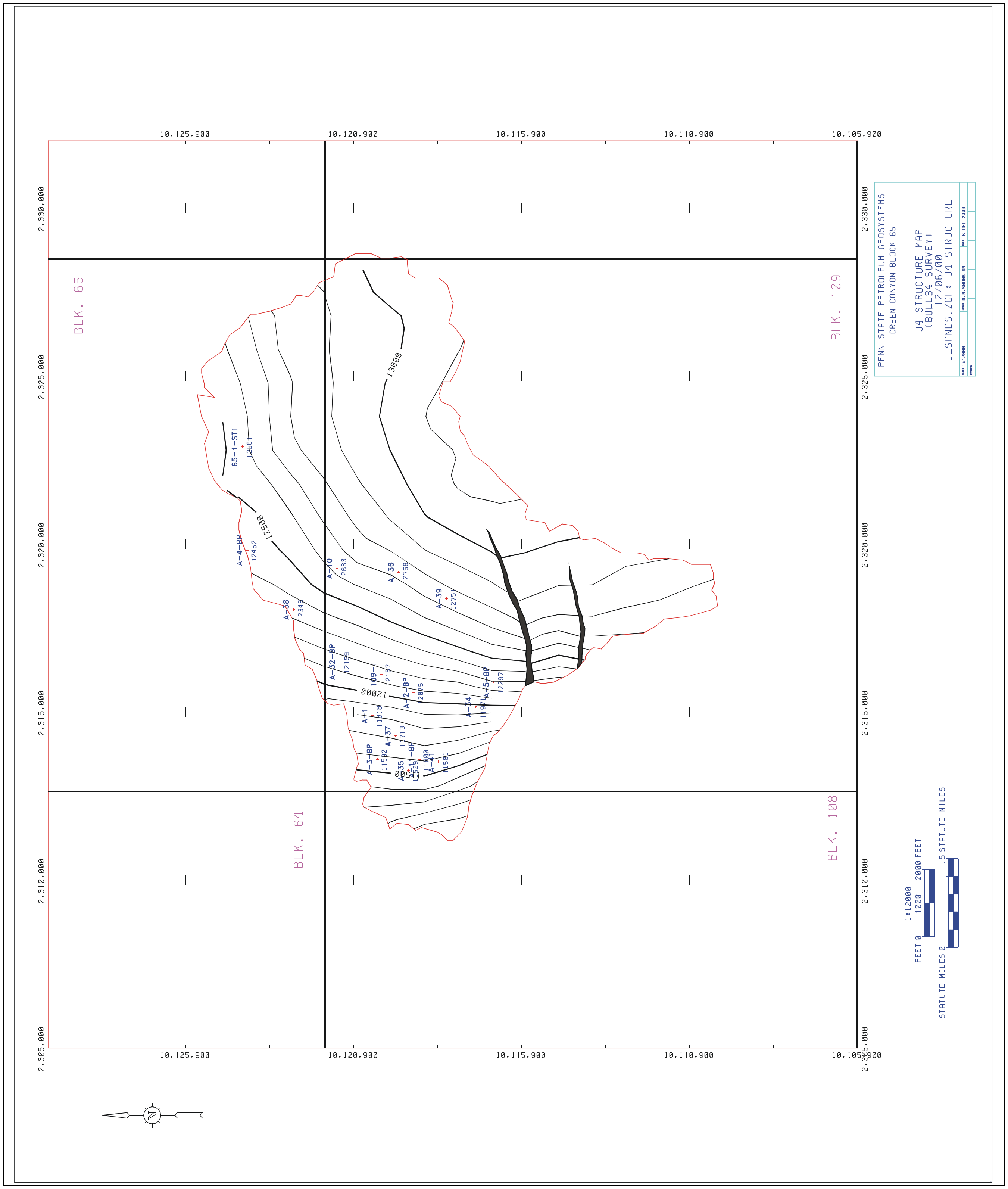


Figure 3.5.3: J4 structure map (from the Bull34 Survey).

4. Appendix

4.1 File Listings

- All of the Bull34 maps can be found in Z-map ZGF format in:

`/shannon/d3/Projects/Zmap/Ams/Bull34/j_sands.ZGF`

They have the following picture names:

I10	`I10 Amp and Structure` `I10 Structure Map`
J1	`J1` `J1 Structure Map`
J2	`B34 J2 Amp` `J2 Structure`
J3	`J3 Amp and Structure` `J3 Structure`
J4	`J4 Amp and Structure` `J4 Structure`

The data used to construct the maps is located in the following files:

```
/shannon/d3/Projects/Zmap/Ams/Bull34/i10.mfd
/shannon/d3/Projects/Zmap/Ams/Bull34/j_sands.mfd
/shannon/d3/Projects/Zmap/Ams/Bull34/j2.mfd
/shannon/d3/Projects/Zmap/Ams/Bull34/j3.mfd
/shannon/d3/Projects/Zmap/Ams/Bull34/j4.mfd
```

- All of the Geco-Prakla maps can be found in Z-map ZGF format in:

`/shannon/d3/Projects/Zmap/Ams/geco.ZGF`

They have the following picture names:

I10	`I10 Amp and Structure`
J1	`J1 Amp and Structure`
J2	`J2 Amp and Structure`
J3	`J3 Amp and Structure`
J4	`J4 Amp and Structure`

The data used to construct the maps is located in the following file:

/shannon/d3/Projects/Zmap/Ams/Bull34/gecojs.mfd/

4.2 Producing a Depth-Converted Seismic Horizon in Z-map

Summary

This is a reference guide to creating a depth-converted seismic horizon in LGC's Z-Map Plus ™. The procedure followed is:

1. Approximately depth-convert a Seisworks time horizon using TDQ
2. Export an amplitude and depth horizon to Z-map
3. Grid both of these horizons
4. Apply a back interpolation procedure to adjust the depth grid
5. Contour the amplitude (using color filled contours) and the adjusted depth grid
6. Make refinements and add features to the map

Detailed instructions are not given on how to produce the initial amplitude and time horizons in Seisworks, or on how to create Z-map pictures and the features within them, other than the amplitude and depth contours and the well postings created in the work flow. If aid is required in these topics, then the reader should consult the appropriate reference manuals.

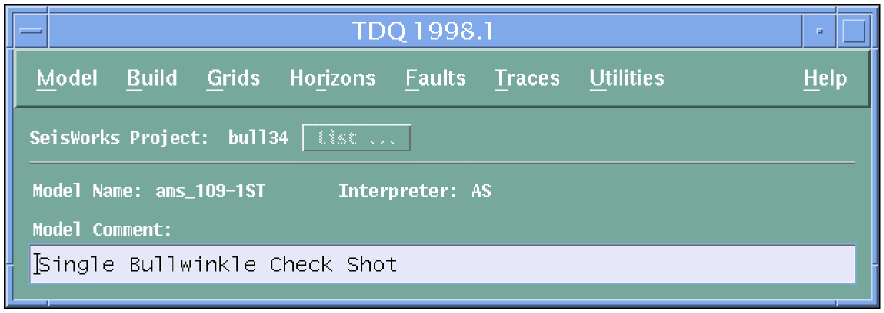
1. TDQ

Open TDQ from Open works Applications menu
Model
  New

Build
  From time-depth tables
Select a good checkshot well or well list that includes one.
Highlight the well in the well list
Select the time-depth table to be used
OK

Horizons
  Convert time to depth
Select survey
Select time horizon to be converted
The given default name is fine
OK
An approximate Seisworks depth horizon is now made.

To save the model (so that it can be opened for future depth conversions):
Model
Save As
Give it a name (identifying it as yours) and a comment if you desire
OK



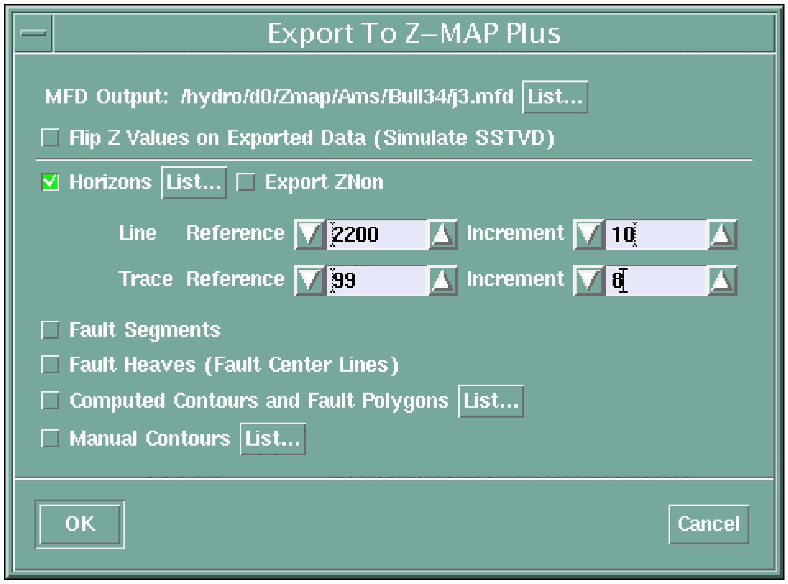
2. Export to Zmap

Open Seisworks
It is a good idea to check that your new depth horizon has been created and looks approximately correct in Map View before continuing.

From the Seisworks main menu, select
Interpret
  Export to Z-MAP Plus

Click the MFD Output – List button:
Create an appropriately named mfd file in your Z-map directory (If you don't have one, then you can add one in /Shannon/d3/Projects/Zmap).
It is best to create a new Z-map mfd rather than adding the exported horizons to an existing one.

Do not select Flip Values on export
Click the Horizons box.
Select the horizons that you wish to export (amplitude and depth), and deselect any that may be highlighted that you do not want to export.
Do not export Znons
You can leave the line and trace values as defaults (the fist in the survey), but change the *Increment* to a sensible value, since this determines the density of the exported data. The information at the base of Seisworks Map View will tell you the line and trace increments in the survey. It is best to pick increments that correspond to 100 - 300 feet. Taking every other line and trace will usually accomplish this.
Select export fault heaves. Fault polygons may also be exported if they have been produced, but Z-map can reconstruct them from the heave information. If faults have not been interpreted, then leave the faults and contours buttons unselected.
OK



3. Z-Map

This paper does not give instructions on how to create basemaps and features such as title blocks, map borders etc., but concentrates on how to produce an amplitude map of a seismic horizon with depth converted structure contours.

Open Z-map from the OpenWorks menu
Create or open the picture that will contain the amplitude and structure map of your horizon. Note, there should be sufficient space outside the map border for the amplitude color bar that will be created in this procedure (4 inches is a good value).
Make sure that there is a directory path to the newly created mfd file.
Open the mfd using:
File
  MFD Open/Close

3.1 Create a bounding Polygon for the Event

Post either the exported amplitude or depth data from Seisworks using:
View
  (X,Y,Z)Point data
    Select Data - select your data file
OK (you don't need to alter the other parameters)

The location of all the exported points should be posted on your map. Trace around the edge to make the polygon by:

Edit
  Edit/Create Data

Create Data
Polyline
Give it a filename e.g. *horizon_name polygon*
Save it in the mfd that you created
OK
OK

Create the line by clicking with the left mouse button and then trace around the outline with the middle mouse button.

Click End And Close to complete the polygon, and then OK.

Delete the posted values using
Edit
Edit Picture
Delete Features
Posted contol points and values
OK

You can check that the polygon was created successfully by

View
Features
Lines
File
Select Data
Click on your polygon
OK (the other parameters are fine)

You may need to refresh the screen to see it.

3.2 Grid the Amplitude Data

Gridding
Point Gridding Plus

(It is usually good practice to click Unlock parameters on all of these types of Z-map menus, since unwanted parameters may remain from previous work.)

Changing the gridding parameters greatly affects the gridding procedure and result. The following parameters work well for seismic data, but you may wish to experiment or refer to the Z-map manual for more information.

Contol points - select your amplitude data
Select a fault set if you have one
Output file names - enter a suitable name e.g. *horizon_name amplitude grid.*

Enter a name for the expanded fault file if you used a fault file with heaves *e.g. horizon_name expanded fault file.*

Save it in the same mfd

Primary parameters - **Change the search radius to something only slightly larger than the X and Y increments.**

Secondary Parameters - Change weighting to Smooth

Flexing Parameters - Change Smoothness modulus to about 0.8

Number of Refinements : 2

Number of Flex Passes: 7

Other parameters can be left as default

Apply

Gridding should take a couple of minutes.

Click Save when it's done.

Make a note of the Z-Value range in the grid, which can be found with

File
  Info
    Grid Statistics

Click the newly created grid

The information is displayed in the Z-Map system window.

Click Cancel when done.

3.3 Color Contour Amplitude Map

The easiest way to make a color contour amplitude map with a scale bar is to use the Color-filled Contour Macro, located in

Macros
  Graphics
    Color-filled Contours

Click Fill in Macro Parameters Defaults

View Parameter Panels...

Select your amplitude grid

Use a fault file (preferably an expanded fault file) if you have one, otherwise click None - use no file

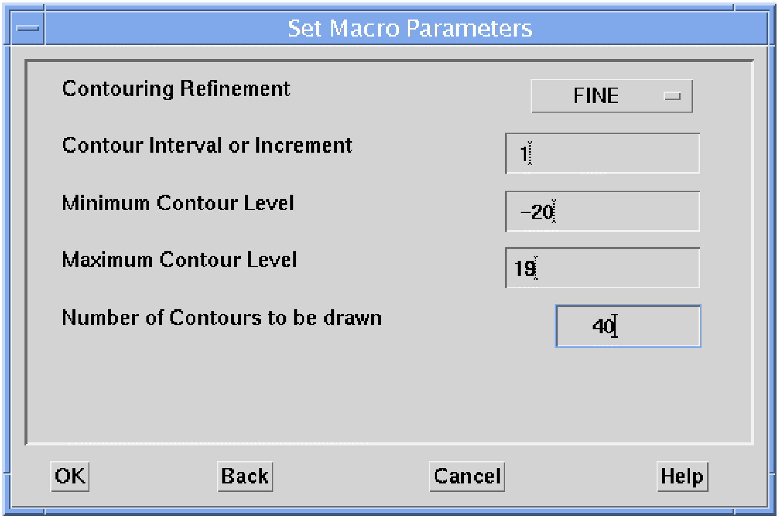
Set Contour Refinement: Fine

Enter the maximum and minimum contour values that you found from the grid statistics

You want to have about 30 - 50 contours, so set the contours interval accordingly

Number of contours = Max - Min + 1

OK



The next 2 boxes of parameters are not needed, so click
OK
OK

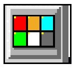
Change Draw Contour Lines on Picture to OMIT
Colorbar location: Left (or wherever you want it)
OK

Select the polygon that you created

OK for the next box
Apply
The procedure should again take a couple of minutes

Click Save
Redraw your Map in the main window.
You should now have a color contour map with a color scale.

Edit the colors to make a suitable scale using the color table button on the left of the main window



Click on the color squares to edit them. Interpolate is a very useful option. A "spectrum" type color scheme usually works well.

(At this stage, faults can be interpreted in Z-map, using the amplitudes as a guide. This is done using a similar procedure to how the polygon was created previously.)

3.4 Gridding the Depth Data

Grid the depth horizon using exactly the same procedure and changes from the defaults as was done for the amplitude horizon. Name the grid something like *horizon_name TDQ depth grid*. Make sure that you reduce the search radius.

4. Back Interpolation

The next stage is to adjust the crude depth conversion that TDQ produces to fit the well data for the horizon. The back interpolation method finds the depth in the TDQ grid at the position of each well. This is then subtracted from the well depth, then this "error" data is gridded and then added to the original TDQ grid to produce a corrected depth grid.

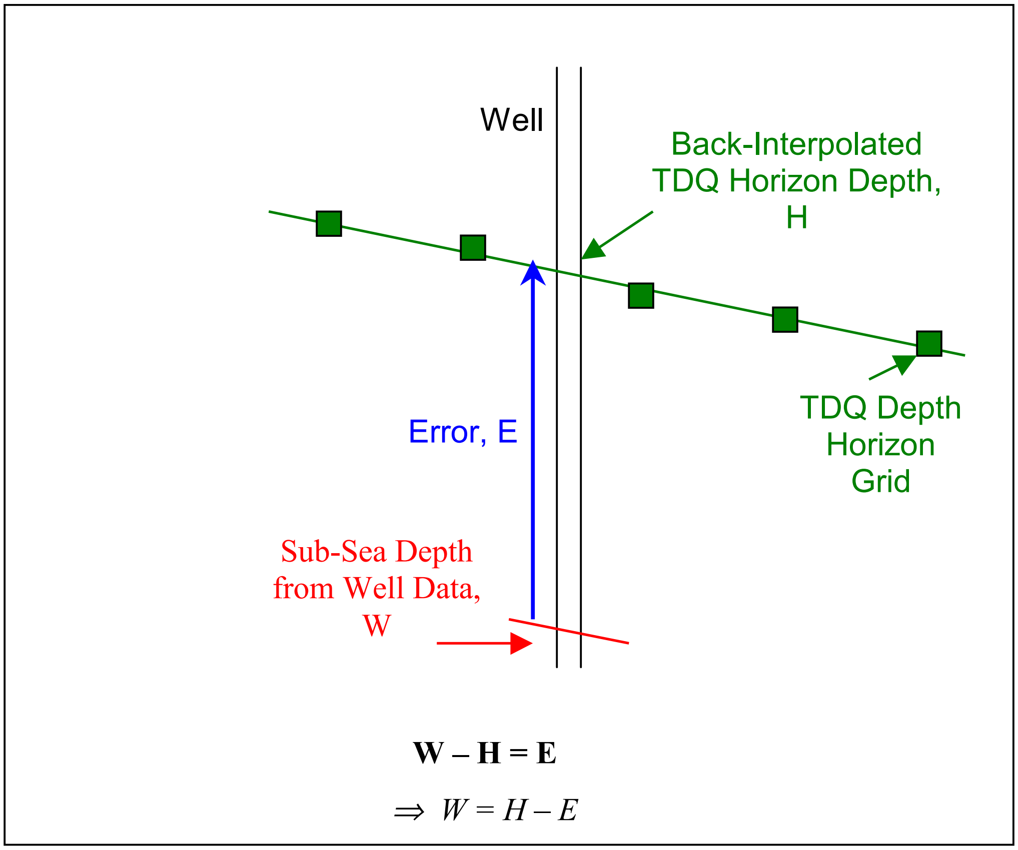


Figure 4.1: Diagram illustrating the theory behind the back-interpolation method.

A data file of horizon depth (True vertical, Sub-sea) and well names is needed for this operation. If one does not exist, then you can create a text file in Z-map friendly format and import it (see the reference manual).

4.1 Post the well information on the map

View
(X,Y,Z)Point Data
Select Data: The well data file
Fields to post: The well name and SSTV Depth
Labelling parameters
Field Parameters
Well Name
Choose a color
Font: Duplex
Height: 0.14

SS Depth:
Font: Duplex
Height: 0.12
Location: Below
OK
Save
OK

Operations
Back Interpolation
Select input grid - the TDQ depth grid
Select a fault file if you have one
Select Input Data - the well data file.
Output Z-field:
New Field - Give it a name (e.g. *BI depth data*)
Output Name..
Call it *horizon_name BI depth data*
Apply
Save

4.2 Find the difference between the TDQ depth and the well Depth

Operations
Data Operations
Dual Data Operations
Input data: The data file that you just created
Input A: The back interpolated data
Input B: The well data
Operation: Subtract (This is A-B)
Output Field: New Field e.g. *Depth error*
Field Type: Z-Value
Output Data: Name - e.g. *horizon_name Depth error data*
OK
Apply
Save

The data statistics can be found in the System Window. The values typically range from ± several hundred feet.

4.3 Grid the Error Data

Gridding
Point Gridding Plus
(Unlock Parameters)
Control points: Your error data set
Z-field: Use the Depth error field that you created
Use a fault file if you have one
Output filename: E.g. *horizon_name depth error grid*

Primary parameters: It is important to alter the X, Y and Z bounding values such that the grid will extend over the whole horizon, and not just where the wells are (the Z maximum and minimum should be increased so that the grid values can increase/decrease beyond the region of the wells - increasing their magnitude by 500 feet should suffice).
Set the X and Y increments to about 400 feet
Leave the Search Radius as the default value
OK
Secondary parameters: Leave as defaults
Flexing parameters: Set Number of Refinements to 2
OK
Apply
Save

4.4 Subtract the error Grid from the TDQ grid

Operations
Grid Operations
Dual Grid Operations
Grid A: The TDQ grid
Grid B: The error depth grid
Operation: Subtract
Output Grid Name: E.g. *Horizon_name Depth Grid*
Source for area of interest: Intersection
OK
Set X and Y increments to 400 ft
OK
Apply
Save

4.5 Contour the New Depth Grid

View
  Contouring
    Contour
      Input file: The new adjusted depth grid
      Constraint: Use a fault file if you have one, otherwise the horizon polygon
      Contouring Parameters…
        Change the minimum to the nearest multiple of 500 below the value given
        100 ft is a good contour interval
        Curve Sampling Density: Fine
        OK
      Curve Drawing and Labeling Parameters:
        Contour Labels: 5
        Reference Contours: 5
        Distance to first label: 3
        Character Height: 0.15
        Change the Starting Color index for Contour Lines to an unused color, e.g. 23
        OK
      OK

Refresh the Main Window if necessary. Zoom in to verify that the Depth contours honor the well data.

If you did not use a polygon in the contouring (you had a fault file), then the contours will extend beyond the horizon for a short distance. A simple way to deal with this is to make them the same color as the background. Since the map will often be plotted, it is advisable to change to background color from black to white. Then, alter the contour color to white using the color table.

Tip: Z-map often gets confused when using pure black or white because they can alter when the background color is changed. This can be avoided by using a non-pure color i.e. for white, make one of the red, blue or green percentages 99% rather than 100%, and similarly for black.

5. Final Edits

The map can be refined by altering the widths of the lines etc. using:

Edit
  Edit/Create Data
    Contours, Faults, Lines
      Display parameters
        By line
          Click on the line you wish to change
          Make whatever changes are necessary

Click OK when you have finished.

You can also make small hand alterations to the contours using:

Edit
  Edit/Create Data
    Contours, Faults, Lines