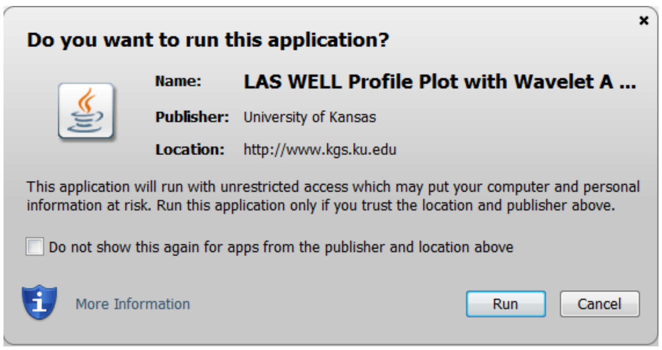
LAS File Viewer with Wavelet Analysis Java Applet

by John R. Victorine

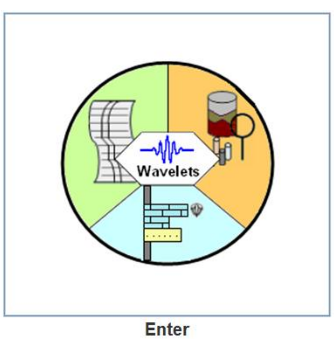
Introduction

The Wavelet web app has 2 sources for importing well data, 1) the user's PC or 2) the Kansas Geological Survey (KGS) Server & ORACLE Database. This program allows the user to import Log and Tops Data.

There will be occasions when the user would like to inspect the contents of a LAS file. So, for example, the user may wish to find the identity of the well, the types of logs, depth range, well or log parameters. Alternatively, the user can suspect that the file is not coded correctly in LAS format if the Import LAS function fails, and wishes to examine the file to troubleshoot the problem. The LAS file is an ASCII file and can be read by any text editor, i.e. Notepad, WordPad, TextPad, etc. The CSV (Comma Separated Values) files are also ASCII and can be edited in the same way or with Microsoft Excel.



To access Wavelet web app go to http://www.kgs.ku.edu/stratigraphic/WAVELET/. At the top of the web page there is a menu "Main Page|Description|Applet|Help|Copyright & Disclaimer|". Select the "Applet" menu option a "Warning - Security" Dialog will appear. The program has to be able to read and write to the user's PC and access the Kansas Geological Survey (KGS) Database and File Server, ORACLE requires this dialog. The program does not save your files to KGS, but allows you to access the KGS for well information that may be missing in your Kansas logs. The program does not use Cookies or any hidden software it only reads the LAS and CSV files for the Wavelet Session. The blue shield on the warning dialog is a symbol that the Java web app is created by a trusted source, which is the University of Kansas. Select the "Run" Button, which will show the Wavelets "Enter" Panel illustrated below,



Contents

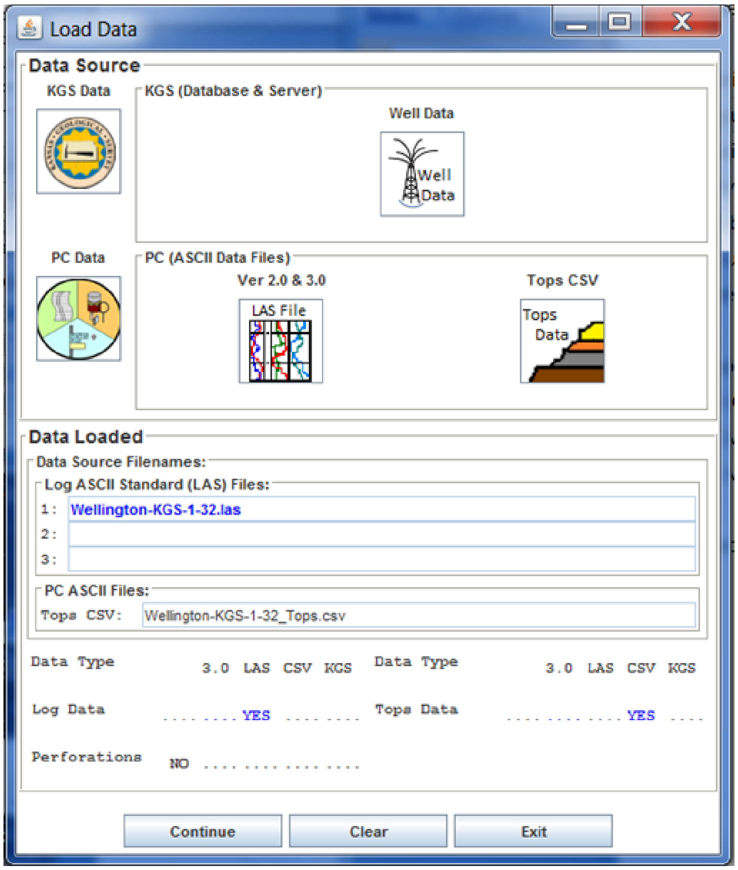
Loading Well Data

Click the "Wavelet Web App Enter” Icon Button, which will show the "Load Data" Dialog. The dialog below displays an example of the Wellington KGS 1-32 well data loaded from the PC Data icon buttons with the data in the tables above. The icon buttons in the Data Source Panel assists the user in loading well data into the LAS File Viewer with Wavelet Analysis Applet.

Data Source Panel
Load existing well data. User can load from multiple sources.

Data Loaded Panel
Positive feedback to user to verify what source data was loaded and location of the source.

Dialog Buttons:
Continue – Build LAS File Viewer Plot
Clear – Clear loaded data from this dialog.
Exit – Exit Program



Load data from Kansas Geological Survey (KGS) Database and Server.

Load ASCII Delimited Data Files from PC.

Displays the filename of files loaded.

Show the source of the data and type.

Data Source Panel

The Data Source Panel provides two methods of importing data into the Wavelet Web App. The Kansas Geological Survey (KGS) Database & File Server and the user’s PC. A number of icon buttons are provided to assist the user in importing the specific data type of interest. When the user selects the icon button a search dialog is provided specific to the data type. The CSV (Comma Separated Values) icon buttons under the “PC ASCII Delimited Data Files” Panel are expecting a general type of data presentation. Although the order of the specific data columns is not important, the “Mnemonics” of the data column is. Each data type in GEMINI Tools web apps have a data mnemonic list that will be presented later as each icon search dialog is presented. The CSV Search Dialog will use the first two lines of the CSV file to automatically match the file column data mnemonics with the web app curve mnemonics, but if the program does not recognize the file data mnemonic then it will leave it blank and expect the user to match the file data mnemonic to the web app curve mnemonics, this will be explained later.

Kansas Geological Survey (KGS) Database & Server Data

Kansas Well Data
This button allows the user to access well data stored in the Kansas database & Server. LAS ASCII Standard (LAS) version 2.0 Files & Core Images JPEG Files (Boxes, Core Slab, Thin Sections) Database Data: Perforations Depth Data, Formation Tops (Stratigraphic Units), Measured Core Data

PC ASCII Delimited Data Files

Log ASCII Standard (LAS) File Read
This version will read up to 3 Log ASCII Standard (LAS) Files, versions 2.0 & 3.0. This read process does not necessarily distinguish between the two versions. The LAS Java Read classes follow the rules set up by the Canadian Well Logging Society for both versions.

Tops CSV (comma separated values) ASCII File Read
This version will allow the user to map a comma delimited ASCII file data columns to the tops data variables in the Profile Web Application.

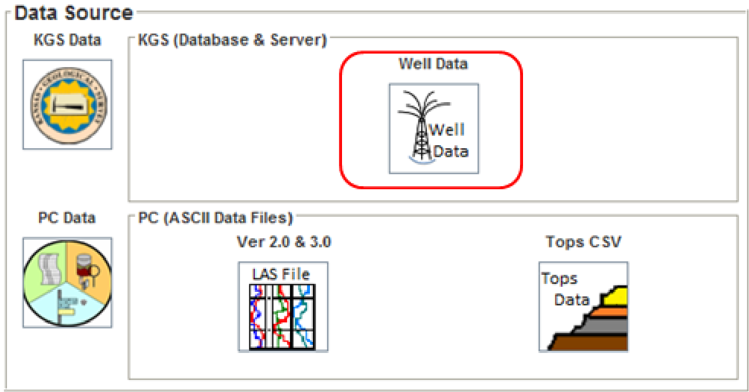
Data Loaded Panel

The Data Loaded Panel provides a visual feedback that the data type was loaded, by the file names of the files that were accessed to load the data and by the data type that is loaded. The data type is important in that it shows where the data came from. The KGS data has the ORACLE Database from which the Tops Data is retrieved from a XML (Extensible Markup Language) data stream that is constructed using the ORACLE PL/SQL for each data type. The user's PC will load the data from CSV (Comma Delimited Values) files or a delimited file for the Geologist Report. The LAS File can be downloaded automatically from the KGS Server in the program or from the user's PC. This program allows the user to import up to 3 Log ASCII Standard (LAS) version 2.0 or 3.0 files. The LAS version 3.0 file can hold all the well data, but if the user wishes to add log curves from a LAS version 2.0 File it is advised that the LAS version 3.0 file be loaded last. In most cases the user is importing multiple LAS version 2.0 files, which can be saved into a single LAS version 3.0 file.

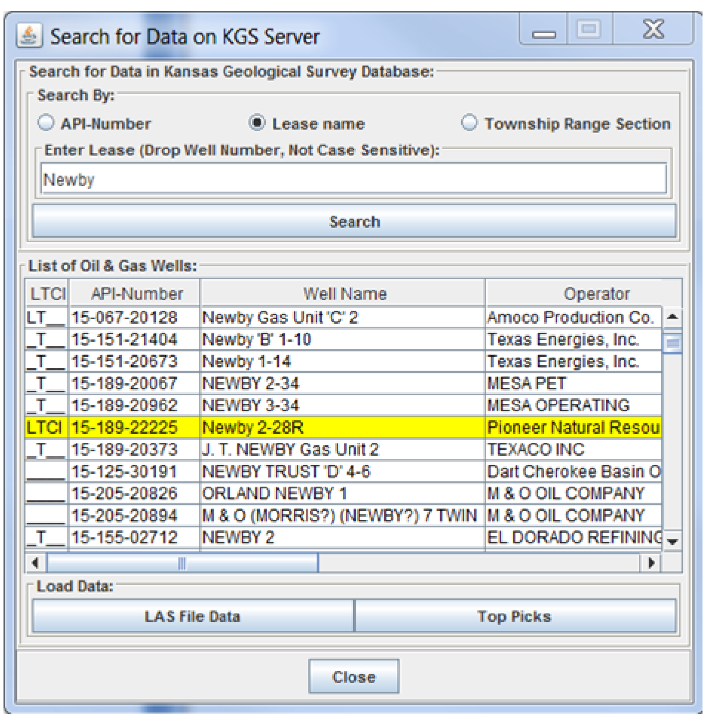
Importing KGS (Database & Server) Data

KGS (Database & Server) - Importing Well Data

The Kansas Geological Survey (KGS) has a good collection of well data stored in the ORACLE Database and File Server as Files Log ASCII Standard (LAS) version 3.0 Files. In this example the user will download the well data available from the KGS, Log data (LAS version 2.0 File), Tops Data, Measured Core Data, and Perforation Data. The ORACLE Database is accessed by making Stored Procedure PL/SQL calls to the ORACLE Database from which an Extensible Markup Language (XML) data stream is created containing the well data that is passed back to the web app making the request.



Left Click on the "Well Data" Icon Button in the Data Source Panel of the Load Data Dialog.



Search for Well Data in KGS Database Search By:

- **API-Number** – The user can search the KGS Database for well data by API-Number. The Format for the API is SS-CCC-99999 where
  - SS – Two Digit State Code
  - CCC – Three Digit County Code
  - 99999 – 5 Digit Well Number
- **Lease Name** – The user can search for well data by lease partial phrase, i.e. "Newby", which will look for all wells with the phrase "Newby" in the lease name.
- **Township-Range-Section** – Search for a list of Wells by a specific area.

List of Kansas wells that match the search criteria

Load Well Data Buttons

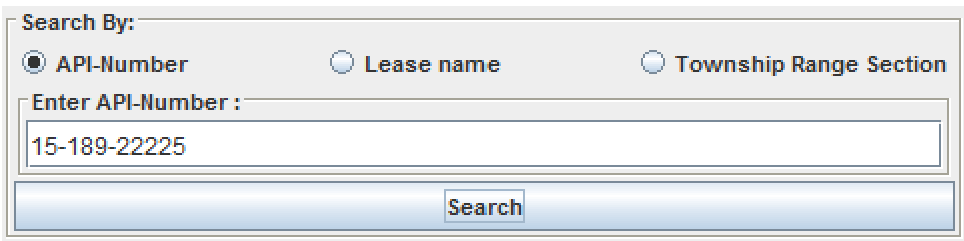
- LAS File Data – Load Log ASCII Standard (LAS) Files
- Tops Picks – Load Formation Tops Picks

NOTE: LTCI Column in Table: L-LAS Files; T-Formation Tops; C-Measured Core Data; I-Core Images

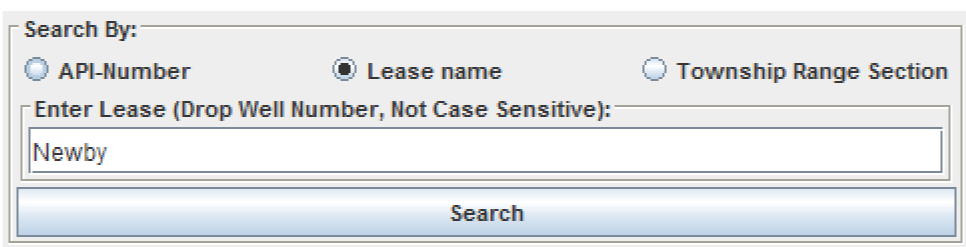
This will display the “Search for Data on KGS Server” Dialog, see above image. This dialog allows the user to search the KGS database for well data. In this example, the well of interest will be the Newby 2-28R, this well contains all the well data that can be retrieved from the KGS Database, i.e. Log Data (LAS version 3.0 File), Tops Data, Core Data, and Perforations.

As the Summary image suggests there are 3 methods for searching for the well data within this dialog,

- By API-Number – KGS has a specific format for the API-Number, i.e.SS-CCC-99999 where SS is the state code for Kansas 15, CCC is the county code for Newby 2-28R it is 189 for Stevens County and the 5-Digit Well Number for Newby 2-28R it is 22225.

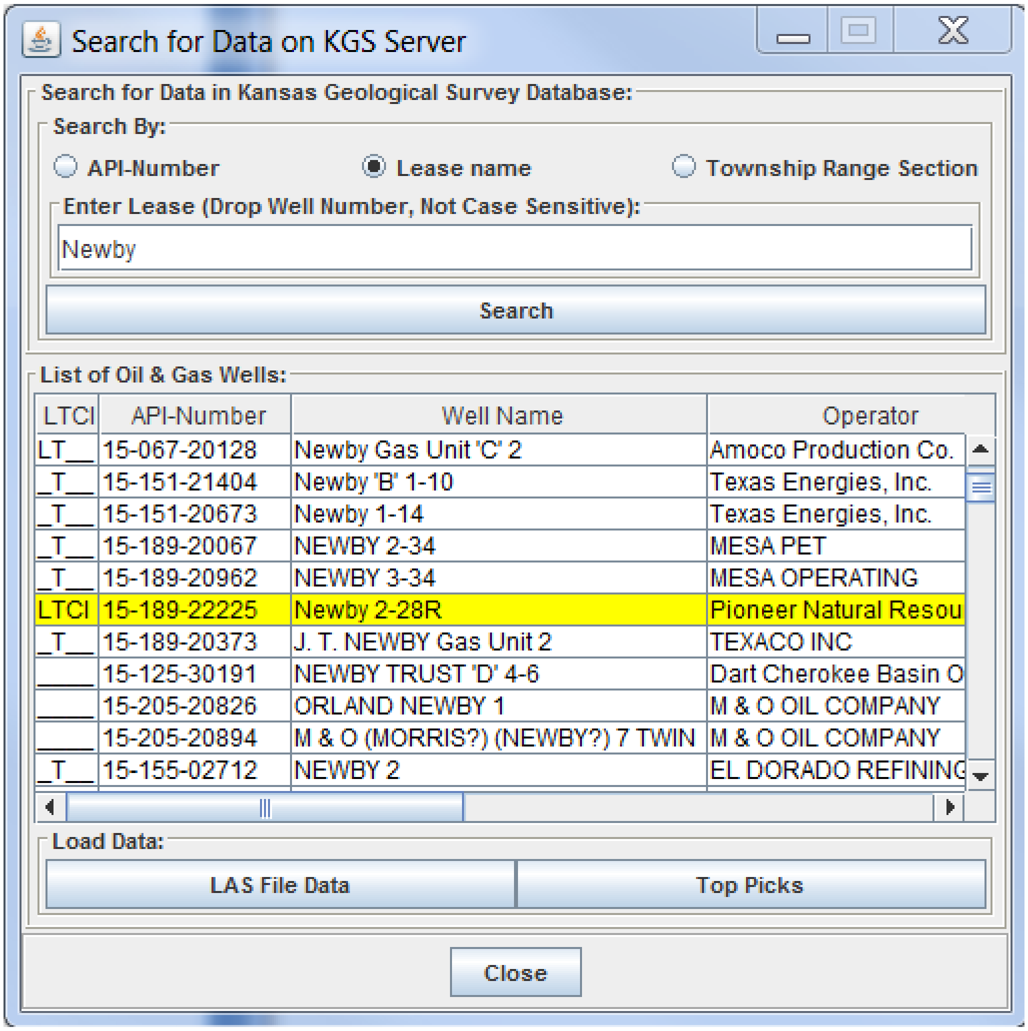


- By Partial Lease Name – The stored procedure used to retrieve the well header information allows the user to enter a partial phrase, in this example Newby. The program places a ‘%’ in front and back of the phrase and sends the request to the Database, i.e. “%Newby%”.



- By Township Range Section – This search is by location in Kansas, this search also allows the user to enter just the Township and Range to search for wells, e.g. to look for the Newby 2-28R, enter Township as 31 set the S (South) Radio button and Range as 37 set the W (West) Radio button.

The user only needs to enter the above data and select the “Search” Button to display the list of Wells in the Kansas Database that match the search criteria. In the image below the Lease Name “Newby” was entered to search for all wells in Kansas with the Phrase Newby in it. The user searches through the list until they find the well of interest. In this example it is the Newby 2-28R, which is highlighted.



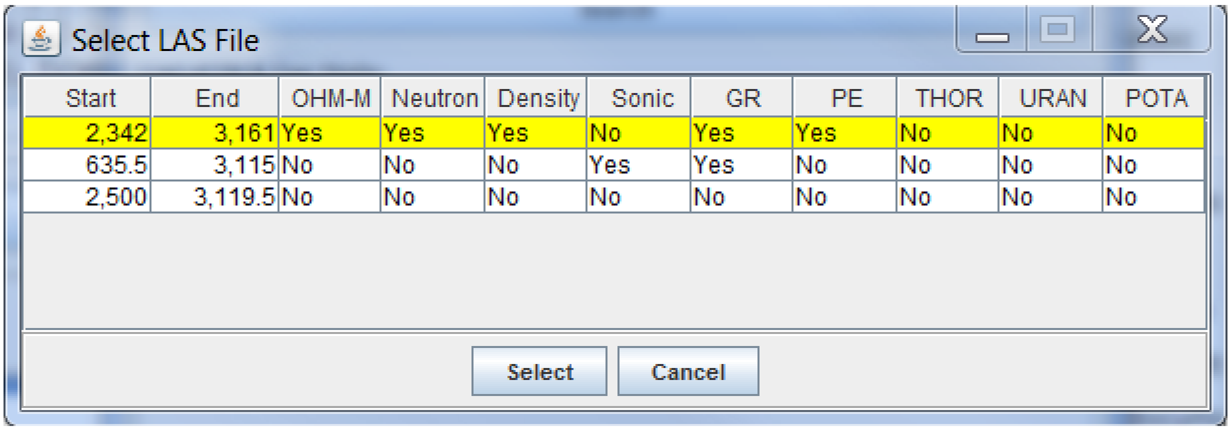
Notice that the LTCI represents the type of data that the well contains. It is a visual aid that lets the user see what is available before trying to download the data. If you require a LAS file you would want to see an L in that column. The LTCI labels stand for the following,

- L – Log ASCII Standard (LAS) version 2.0 Files
- T – Tops Data (Stratigraphic Unit Horizons)
- C – Measured Core Data
- I – Core Joint Photographic Experts Group (JPEG) Image Files

This dialog allows the user to now download each of the data types that are available.

Load KGS Well Data – LAS File Data

The “Search for Data on KGS Server” Dialog allows the user to download data from the KGS Database & Server to the web app. The “LAS File Data” Button will display the “Select LAS File” Dialog with a list of LAS version 2.0 Files that are available.

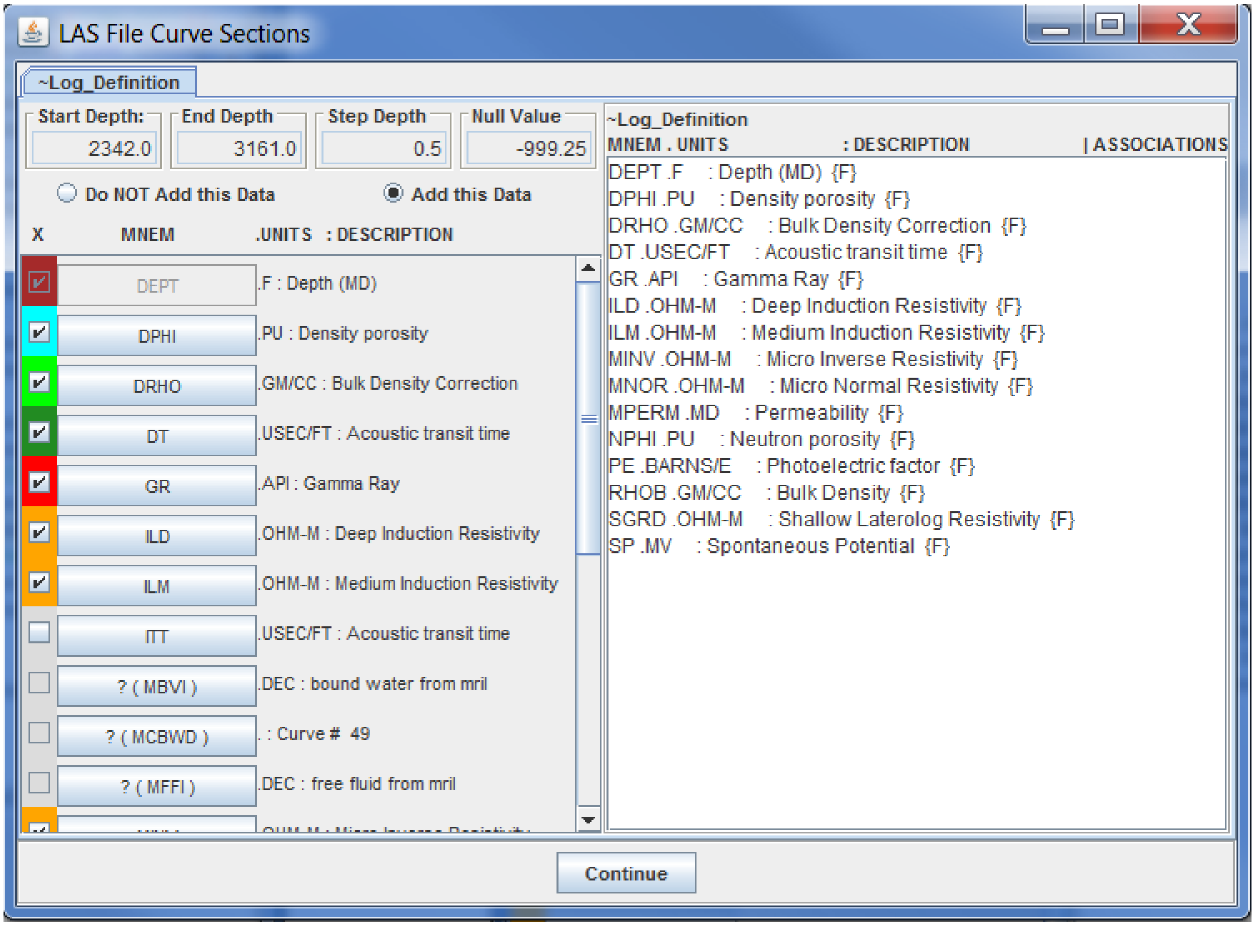


Start	End	OHM-M	Neutron	Density	Sonic	GR	PE	THOR	URAN	POTA
2,342	3,161	Yes	Yes	Yes	No	Yes	Yes	No	No	No
635.5	3,115	No	No	No	Yes	Yes	No	No	No	No
2,500	3,119.5	No	No	No	No	No	No	No	No	No

In this example there are three LAS files available, with a table suggesting the log data type in the file. In the beginning of the GEMINI Project (2000-2003) a precursor to the GEMINI Tools the KGS populated the Tool Types from every log that was in the KGS Server at that time. Unfortunately KGS has not maintain that table for wells uploaded after 2003 so the LAS File may have “No” for all the log types, which is not accurate. The user will need to open or download the file or search for the Well on the KGS Master List of Oil and Gas Wells in Kansas Web Page (http://www.kgs.ku.edu/Magellan/Qualified/index.html) to see what is in the File Header before deciding to download data from this program. For this example the first log has most of the data necessary except the Spectral Gamma Ray Logs. The Table above identifies the following log types,

- OHM-M – Resistivity Logs
- Neutron – Neutron Porosity Log
- Density – Bulk Density and/or Density Porosity Log
- Sonic – Acoustic Transit Time and/or Sonic Porosity Log
- GR – Gamma Ray (API units) Log
- PE – Photoelectric Factor Log
- THOR – Thorium Concentration
- URAN – Uranium Concentration
- POTA – Potassium Concentration)

In this example the first log contains the data needed, highlight the first log and click on the “Select” Button to display the “LAS File Curve Sections” Dialog. The “LAS File Curve Sections” Dialog allows the user to map unknown LAS Curve Mnemonics to the KGS “Standard” Curve Mnemonics so they will be plotted in the Wavelet Web App Plot. This program reads the “LAS Tool Curve Mnemonics map to KGS Standard Mnemonics” XML File (http://www.kgs.ku.edu/software/gemini/data/las_standard_tools.xml), which will automatically maps the Curve Mnemonics from the LAS file to one of 31 KGS “Standard“ Curve Mnemonics.



As you can see this log has all the log types of interest, Gamma Ray API, Resistivity, Neutron/Density, Photoelectric Factor, Sonic and Permeability. If a curve Mnemonic is not recognized the program will place a "?" in front of the Mnemonic, e.g. "?(MPERM16)" for the ". : Curve # 51" Log Curve. If the user is satisfied with the automatic curve selections, which are checked and color coded, they only need to select the "Continue" Button at the bottom of the Dialog to import the file. The next section will take the user through a series of examples in changing the curve selections and mapping unknown curve mnemonics.

Notice that some of the check boxes are colored with different colors, which shows that the curves were automatically selected, but also to represent the curve type by color.The Curves are colored by type (data units) as follows,

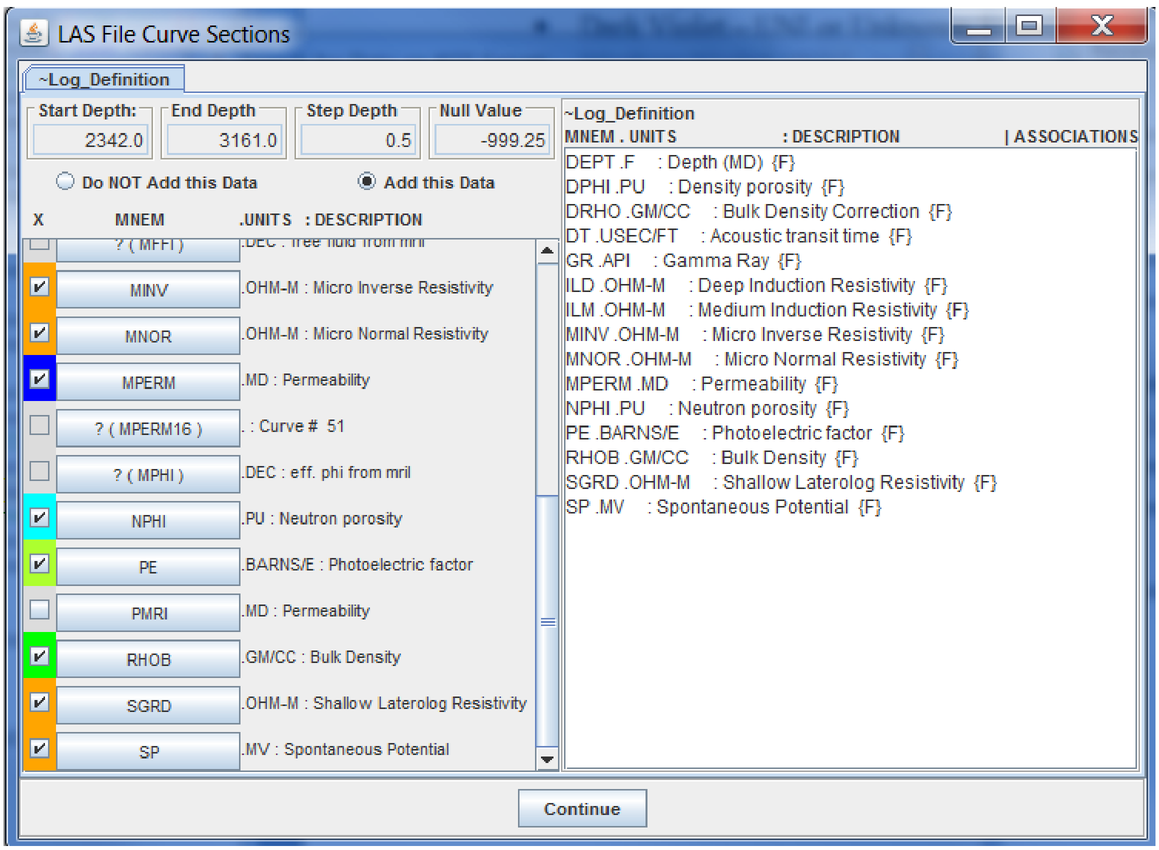
- Orange - OHM-M or Resistivity Logs
- Cyan – PU or porosity Logs, Neutron Porosity, Density Porosity, etc.
- Greenish yellow – BARNS/E or Photoelectric Factor Logs
- Green – GM/CC or Bulk Density Log
- Forest Green – USEC/FT or the Acoustic Transit Time Log
- Red – API, PPM or "%" as Radioactive logs, Gamma Ray, Spectral Gamma Ray, etc.
- Blue – MD or Permeability Logs
- Brown – F, FT or IN or Depth

- Middle yellow – FRAC, or other log curve types.
- Dark Violet – UNI or Unknown Linear Curves
- Medium Violet – UNL or Unknown Logrithum Curves

The color coding of the selected curves were added to also help the user visually recognize that a curve was selected or not.

Map Curves & Change Curve Selections

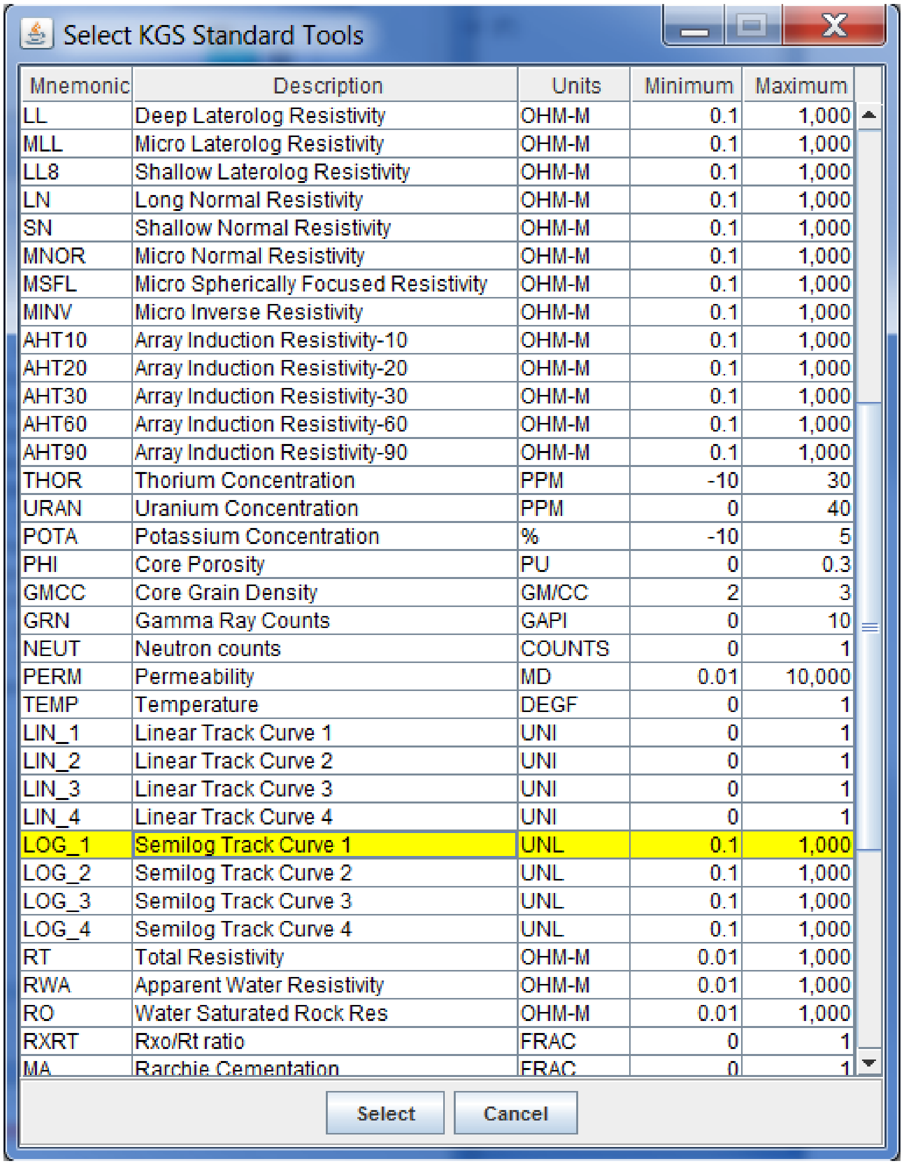
Some logs will have curve mnemonics that are not recognized as one of the KGS "Standard" Curve Mnemonics. The user will need to map the log curve to one of the KGS standard curves if they want to display the curve. Slide the scroll bar down to the Permeability Curves MPERM and ?(MPERM16).



Click on the "?(MPERM16)" Button to display the "Select KGS Standard Tools" Dialog. This dialog provides a list of the KGS "Standard" Curve Mnemonics, from which the user can map an unrecognized log curve to one of the KGS standard curve mnemonics. The KGS "Standard" Curve Mnemonics List was created as a way to standardize the alpha bit soup of Log Mnemonics. Each logging company has their own curve mnemonics to represent similar tools. The Wavelet Web App program is a later version of code from the GEMINI Project Wavelet Web App Module, which needed to standardize the log curves so the curves could be automatically read and assigned a plot track. The "LAS Tool Curve Mnemonics map to KGS

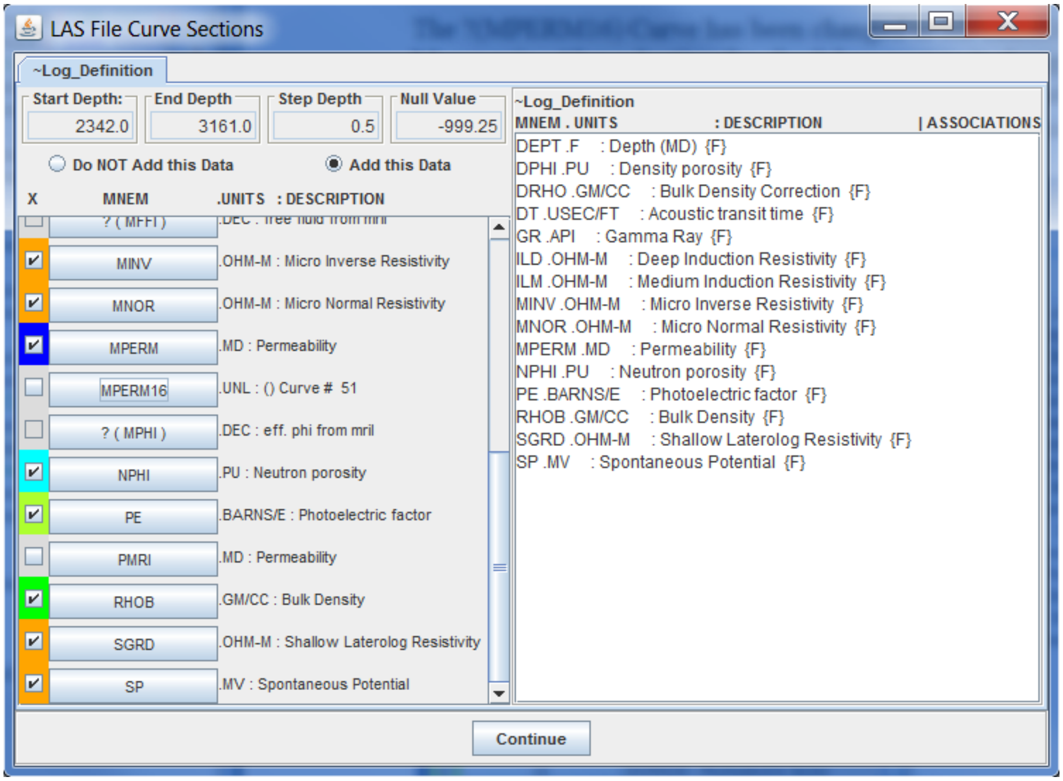
Standard Mnemonics" XML File was created to map the log curves from logs that were part of the KGS LAS File Collection which is not a complete list of possible curve mnemonics.

To map the unknown curve mnemonic "?(MPERM16)" you first notice that it similar to the MPERM curve above, which is a permeability curve. In this example both curves will be plotted together, but the Permeability Plot Track can only plot one curve. The web app has the ability to allow the user to plot up to 4 unknown logrithum curves and 4 unknown linear curves. The permeability is usually plotted as logrithmic. Click on the "?(MPERM16)" Button to display the

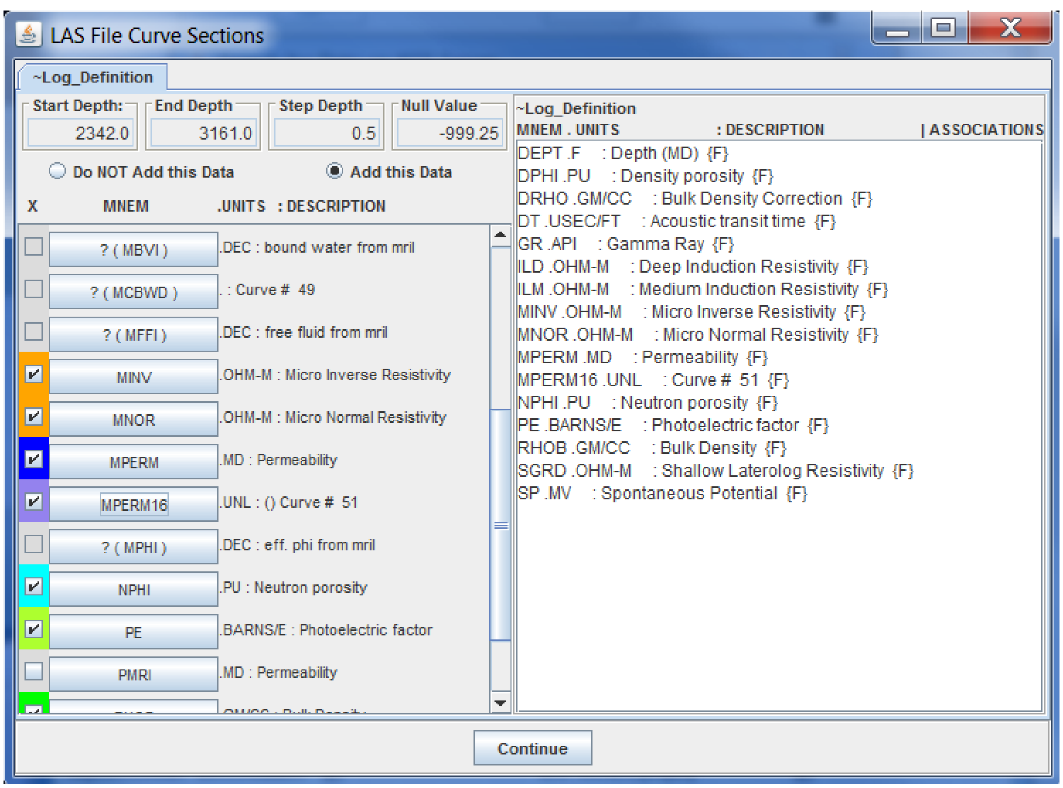


Mnemonic	Description	Units	Minimum	Maximum
LL	Deep Laterolog Resistivity	OHM-M	0.1	1,000
MLL	Micro Laterolog Resistivity	OHM-M	0.1	1,000
LL8	Shallow Laterolog Resistivity	OHM-M	0.1	1,000
LN	Long Normal Resistivity	OHM-M	0.1	1,000
SN	Shallow Normal Resistivity	OHM-M	0.1	1,000
MNOR	Micro Normal Resistivity	OHM-M	0.1	1,000
MSFL	Micro Spherically Focused Resistivity	OHM-M	0.1	1,000
MINV	Micro Inverse Resistivity	OHM-M	0.1	1,000
AHT10	Array Induction Resistivity-10	OHM-M	0.1	1,000
AHT20	Array Induction Resistivity-20	OHM-M	0.1	1,000
AHT30	Array Induction Resistivity-30	OHM-M	0.1	1,000
AHT60	Array Induction Resistivity-60	OHM-M	0.1	1,000
AHT90	Array Induction Resistivity-90	OHM-M	0.1	1,000
THOR	Thorium Concentration	PPM	-10	30
URAN	Uranium Concentration	PPM	0	40
POTA	Potassium Concentration	%	-10	5
PHI	Core Porosity	PU	0	0.3
GMCC	Core Grain Density	GM/CC	2	3
GRN	Gamma Ray Counts	GAPI	0	10
NEUT	Neutron counts	COUNTS	0	1
PERM	Permeability	MD	0.01	10,000
TEMP	Temperature	DEGF	0	1
LIN_1	Linear Track Curve 1	UNI	0	1
LIN_2	Linear Track Curve 2	UNI	0	1
LIN_3	Linear Track Curve 3	UNI	0	1
LIN_4	Linear Track Curve 4	UNI	0	1
LOG_1	Semilog Track Curve 1	UNL	0.1	1,000
LOG_2	Semilog Track Curve 2	UNL	0.1	1,000
LOG_3	Semilog Track Curve 3	UNL	0.1	1,000
LOG_4	Semilog Track Curve 4	UNL	0.1	1,000
RT	Total Resistivity	OHM-M	0.01	1,000
RWA	Apparent Water Resistivity	OHM-M	0.01	1,000
RO	Water Saturated Rock Res	OHM-M	0.01	1,000
RXRT	Rxo/Rt ratio	FRAC	0	1
MA	Rarchie Cementation	FRAC	0	1

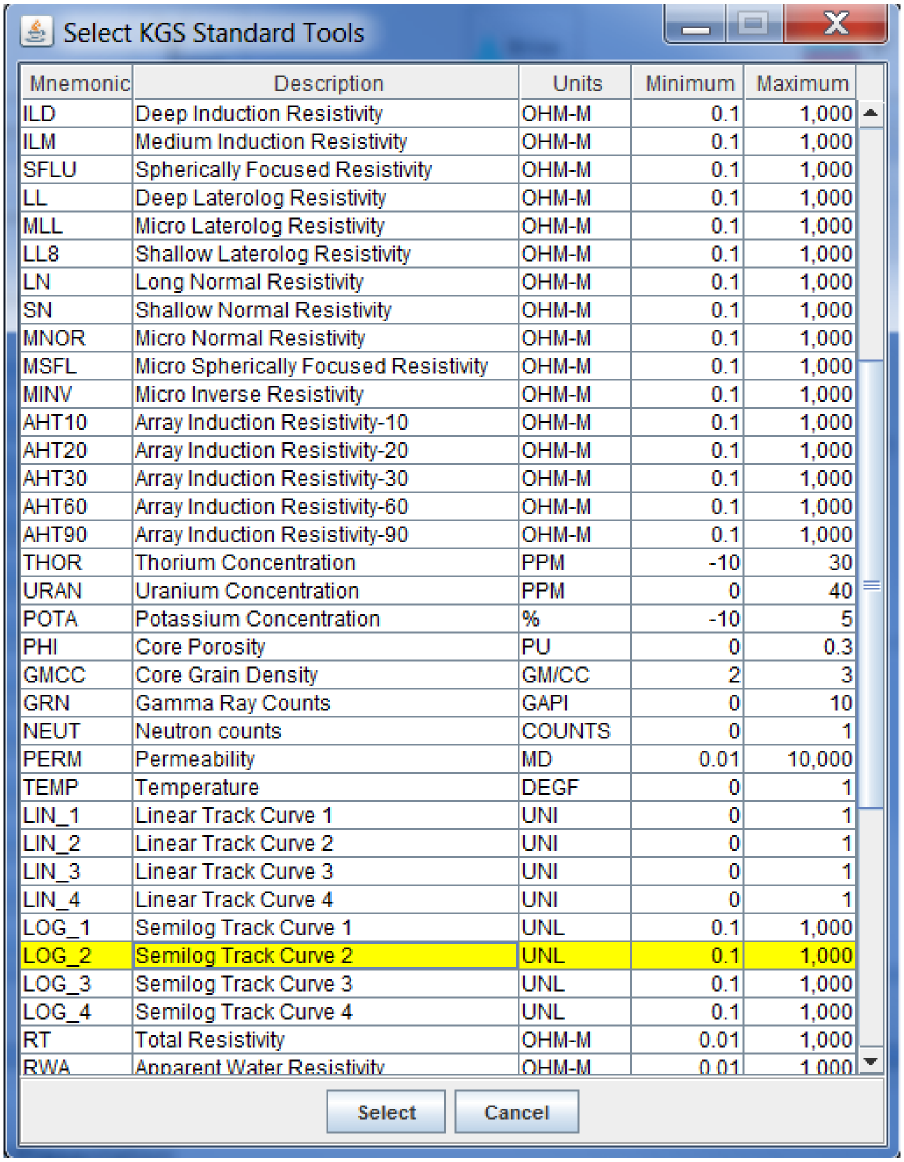
"Select KGS Standard Tools" Dialog. Slide the scroll bar down to the "LOG_1" Mnemonic – Semilog Track Curve 1 and highlight that curve. Click on the "Select" Button to map the "?(MPERM16) to the Semilog Track Curve 1.



The ?(MPERM16) Curve has been changed to MPERM16 removing the ?() around the Curve Mnemonic. Also select the check box next to it, which changes to a dark violet.

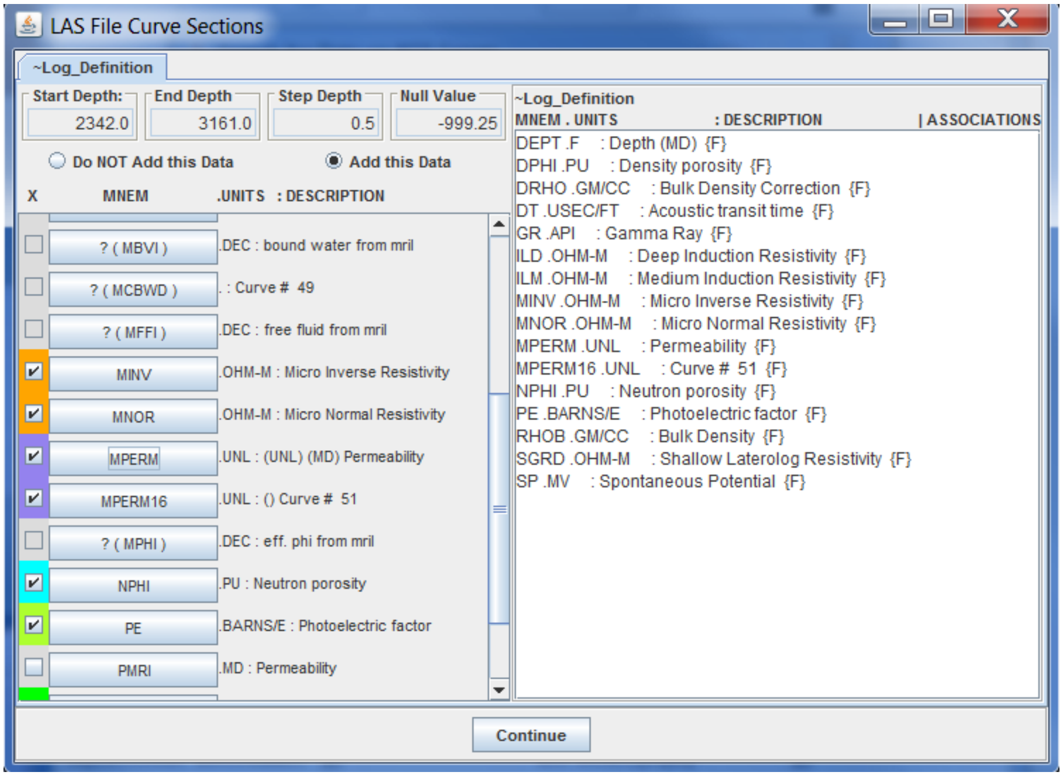


In order to plot both Permeability Curves on the same track, the MPERM must be assigned to the unknown Log Curves with MPERM16. Click on the MPERM Mnemonic Button to display the



Mnemonic	Description	Units	Minimum	Maximum
ILD	Deep Induction Resistivity	OHM-M	0.1	1,000
ILM	Medium Induction Resistivity	OHM-M	0.1	1,000
SFLU	Spherically Focused Resistivity	OHM-M	0.1	1,000
LL	Deep Laterolog Resistivity	OHM-M	0.1	1,000
MLL	Micro Laterolog Resistivity	OHM-M	0.1	1,000
LL8	Shallow Laterolog Resistivity	OHM-M	0.1	1,000
LN	Long Normal Resistivity	OHM-M	0.1	1,000
SN	Shallow Normal Resistivity	OHM-M	0.1	1,000
MNOR	Micro Normal Resistivity	OHM-M	0.1	1,000
MSFL	Micro Spherically Focused Resistivity	OHM-M	0.1	1,000
MINV	Micro Inverse Resistivity	OHM-M	0.1	1,000
AHT10	Array Induction Resistivity-10	OHM-M	0.1	1,000
AHT20	Array Induction Resistivity-20	OHM-M	0.1	1,000
AHT30	Array Induction Resistivity-30	OHM-M	0.1	1,000
AHT60	Array Induction Resistivity-60	OHM-M	0.1	1,000
AHT90	Array Induction Resistivity-90	OHM-M	0.1	1,000
THOR	Thorium Concentration	PPM	-10	30
URAN	Uranium Concentration	PPM	0	40
POTA	Potassium Concentration	%	-10	5
PHI	Core Porosity	PU	0	0.3
GMCC	Core Grain Density	GM/CC	2	3
GRN	Gamma Ray Counts	GAPI	0	10
NEUT	Neutron counts	COUNTS	0	1
PERM	Permeability	MD	0.01	10,000
TEMP	Temperature	DEGF	0	1
LIN_1	Linear Track Curve 1	UNI	0	1
LIN_2	Linear Track Curve 2	UNI	0	1
LIN_3	Linear Track Curve 3	UNI	0	1
LIN_4	Linear Track Curve 4	UNI	0	1
LOG_1	Semilog Track Curve 1	UNL	0.1	1,000
LOG_2	Semilog Track Curve 2	UNL	0.1	1,000
LOG_3	Semilog Track Curve 3	UNL	0.1	1,000
LOG_4	Semilog Track Curve 4	UNL	0.1	1,000
RT	Total Resistivity	OHM-M	0.01	1,000
RWA	Apparent Water Resistivity	OHM-M	0.01	1,000

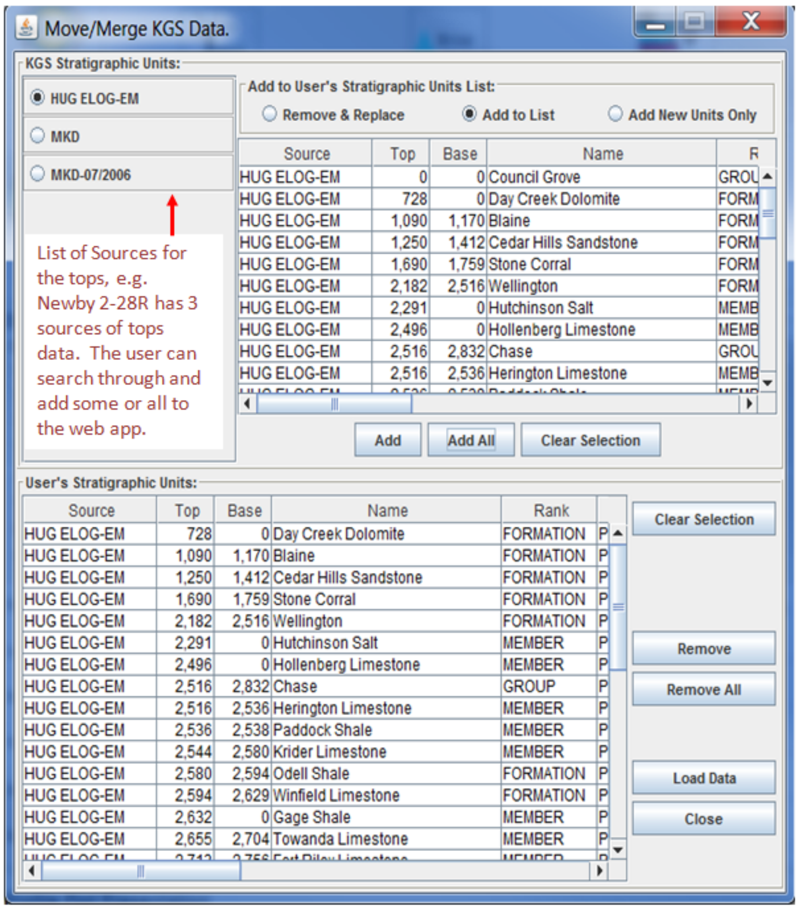
"Select KGS Standard Tools" Dialog. Slide the scroll bar down to the "LOG_2" Mnemonic – Semilog Track Curve 2 and highlight that curve. Click on the "Select" Button to map the "MPERM to the Semilog Track Curve 2.



Click the check box next to the MPERM Mnemonic Button you will notice that it has the same color as MPERM16, which now groups the two curves together. Select the "Continue" Button to load the LAS File into the web app.

Load KGS Well Data – Top Picks

The “Search for Data on KGS Server” Dialog allows the user to download data from the KGS Database & Server to the web app. The “Top Picks” Button will display the “Move/Merge KGS Data” Dialog with available top picks grouped by the sources creating the tops.



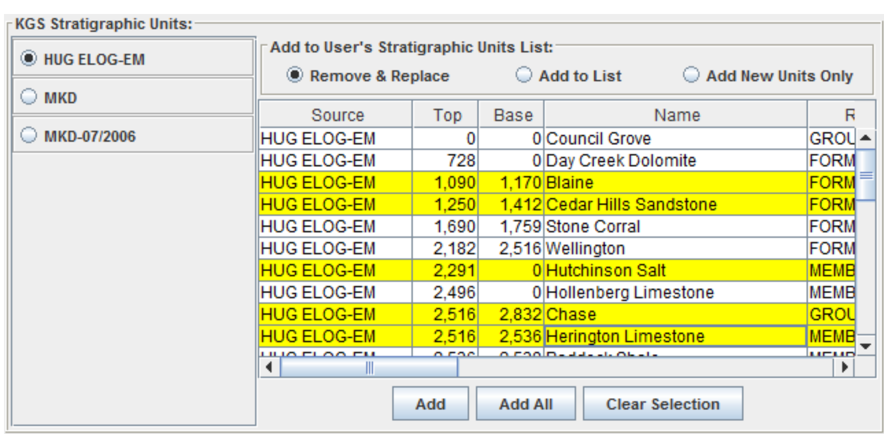
“Add to User’s Stratigraphic Units List” Table shows the tops selected by the source, e.g. “HUG ELOG-EM” Source Tops List.

Radio Buttons
Remove & Replace – move the selected tops and replace any duplicate names
Add to List – move the selected tops to the “User’s Stratigraphic Units” Table
Add New Units Only – move on the selected tops that are not already in the “User’s Stratigraphic Units” Table
Table Buttons
Add – add the highlighted top(s) to the “User’s Stratigraphic Units” Table. Note: this table will allow the user to select multiple wells by using the “Ctrl” Key and the left click of mouse.
Add All – copy the list of tops to the “User’s Stratigraphic Units“ Table.
Clear Selection – remove the highlight on tops selected.

“Add to User’s Stratigraphic Units List” Table. “User’s Stratigraphic Units” Table shows the list of tops that will appear in the web app when the user selects the “Load Data” Button.

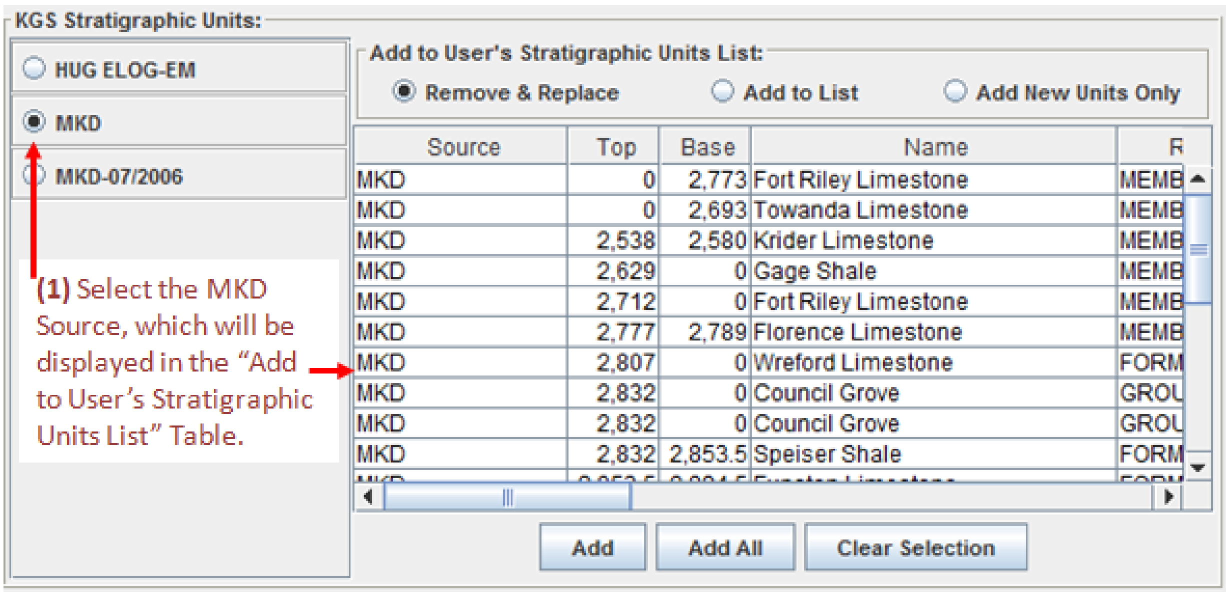
Table Buttons
Clear Selection – remove the highlight on tops selected.
Remove – remove the highlighted top(s) from the table. Note: this table will allow the user to select multiple wells by using the “Ctrl” Key and the left click of mouse.
Remove All – remove all tops from the table.
Load Data – transfer the tops list to the web app calling.
Close – Close this dialog

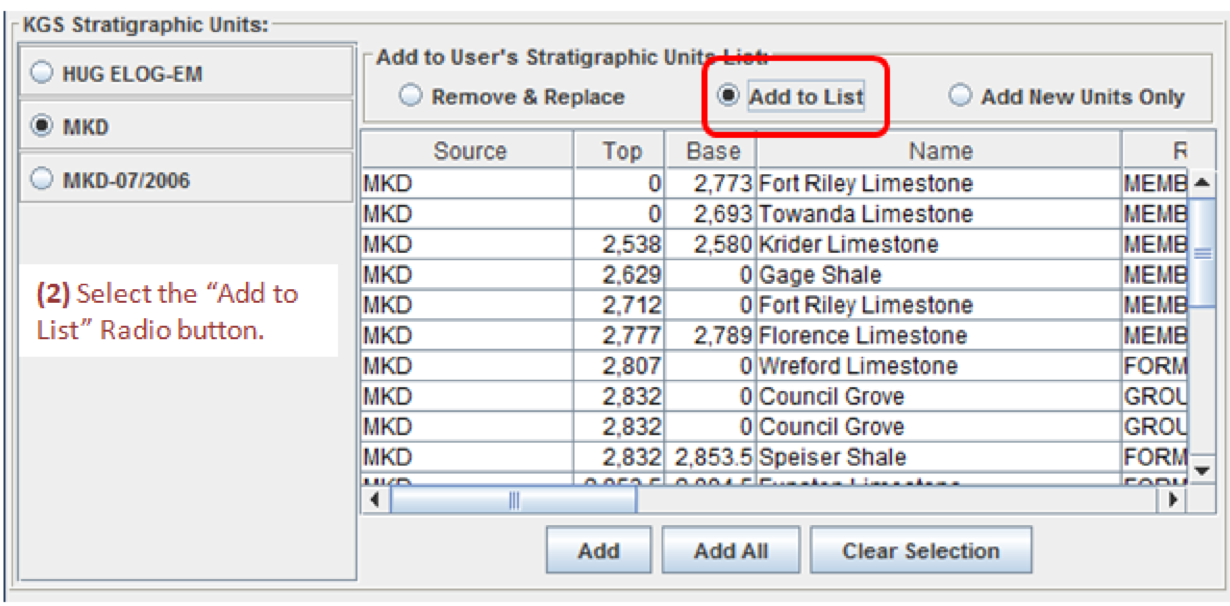
This dialog allows the user to add all or some the tops from each of the sources. Both tables are set up so the user can use the “Ctrl” Key with the left click of mouse to select multiple tops, i.e.

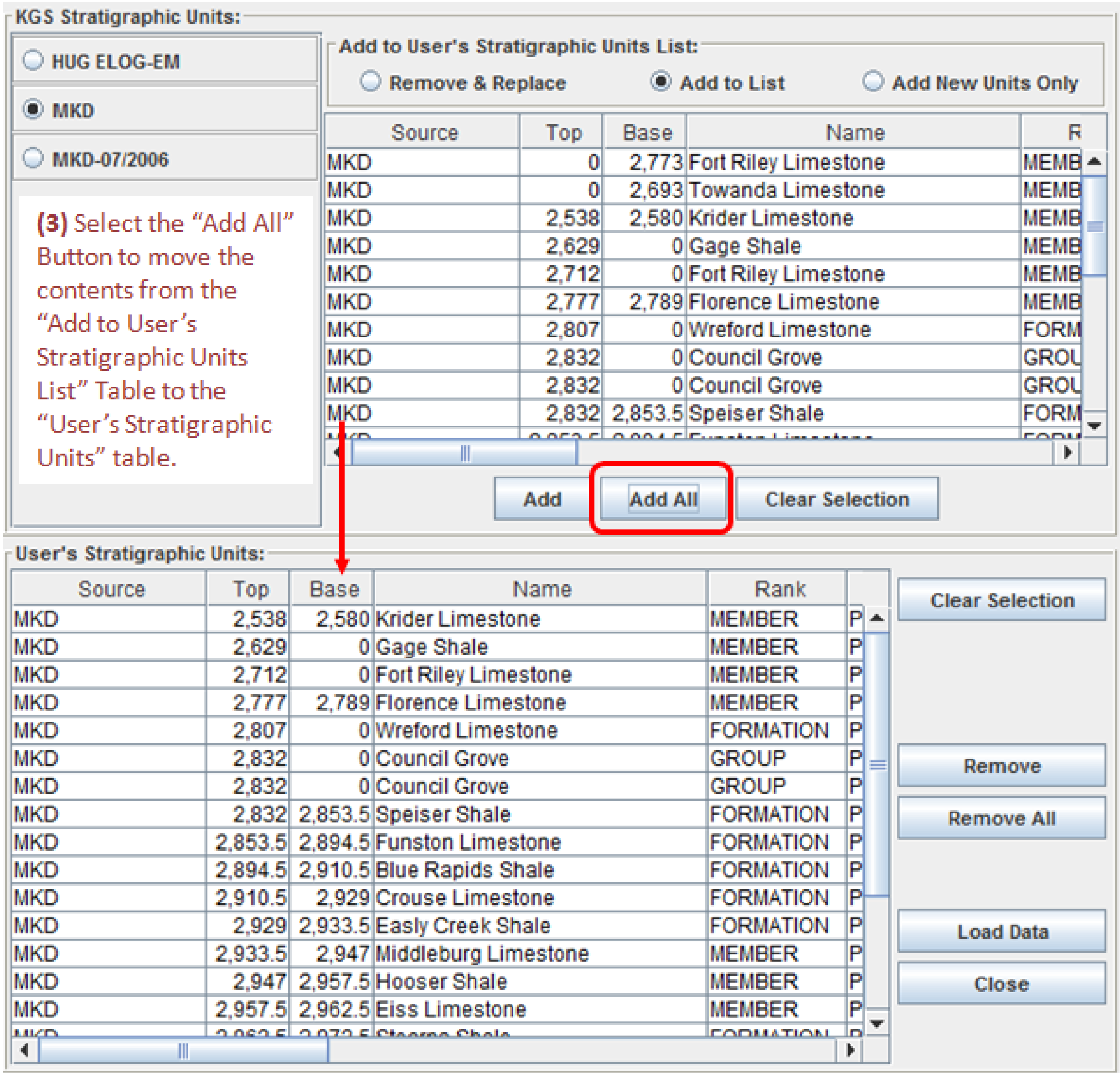


Notice that the only some of the tops are selected. You can then select the Add Button to move only the selected tops to the “User’s Stratigraphic Units” Table.

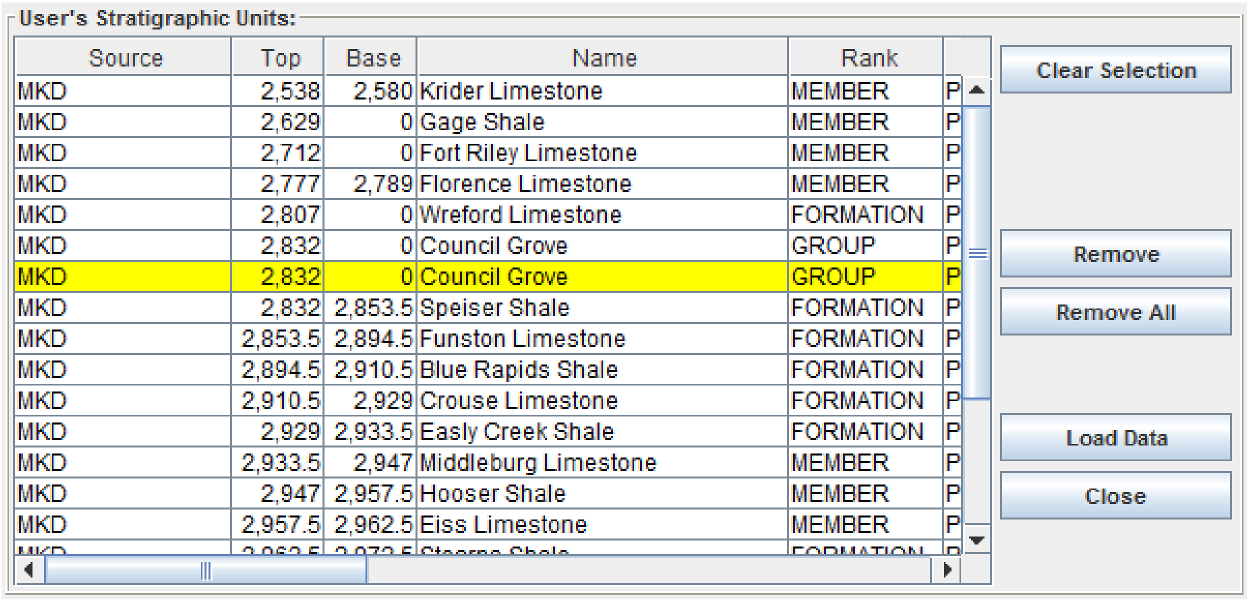
MKD Source Example:







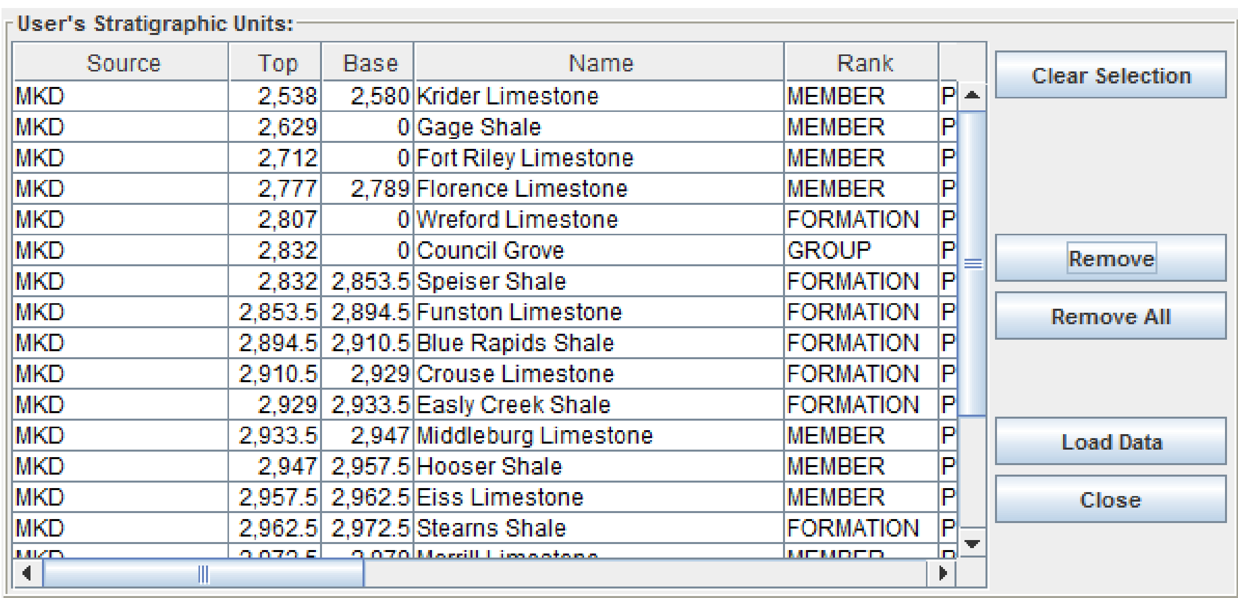
Once the list of tops are in the "User's Stratigraphic Units" Table the user can edit the list by removing any duplicate or invalid tops. Notice that the "Council Grove" Top occurs 2 times in the list. Highlight the one of the "Council Grove" tops.



User's Stratigraphic Units:

Source	Top	Base	Name	Rank	
MKD	2,538	2,580	Krider Limestone	MEMBER	P
MKD	2,629	0	Gage Shale	MEMBER	P
MKD	2,712	0	Fort Riley Limestone	MEMBER	P
MKD	2,777	2,789	Florence Limestone	MEMBER	P
MKD	2,807	0	Wreford Limestone	FORMATION	P
MKD	2,832	0	Council Grove	GROUP	P
MKD	2,832	0	Council Grove	GROUP	P
MKD	2,832	2,853.5	Speiser Shale	FORMATION	P
MKD	2,853.5	2,894.5	Funston Limestone	FORMATION	P
MKD	2,894.5	2,910.5	Blue Rapids Shale	FORMATION	P
MKD	2,910.5	2,929	Crouse Limestone	FORMATION	P
MKD	2,929	2,933.5	Easly Creek Shale	FORMATION	P
MKD	2,933.5	2,947	Middleburg Limestone	MEMBER	P
MKD	2,947	2,957.5	Hooser Shale	MEMBER	P
MKD	2,957.5	2,962.5	Eiss Limestone	MEMBER	P
MKD	2,962.5	2,972.5	Stearns Shale	FORMATION	P

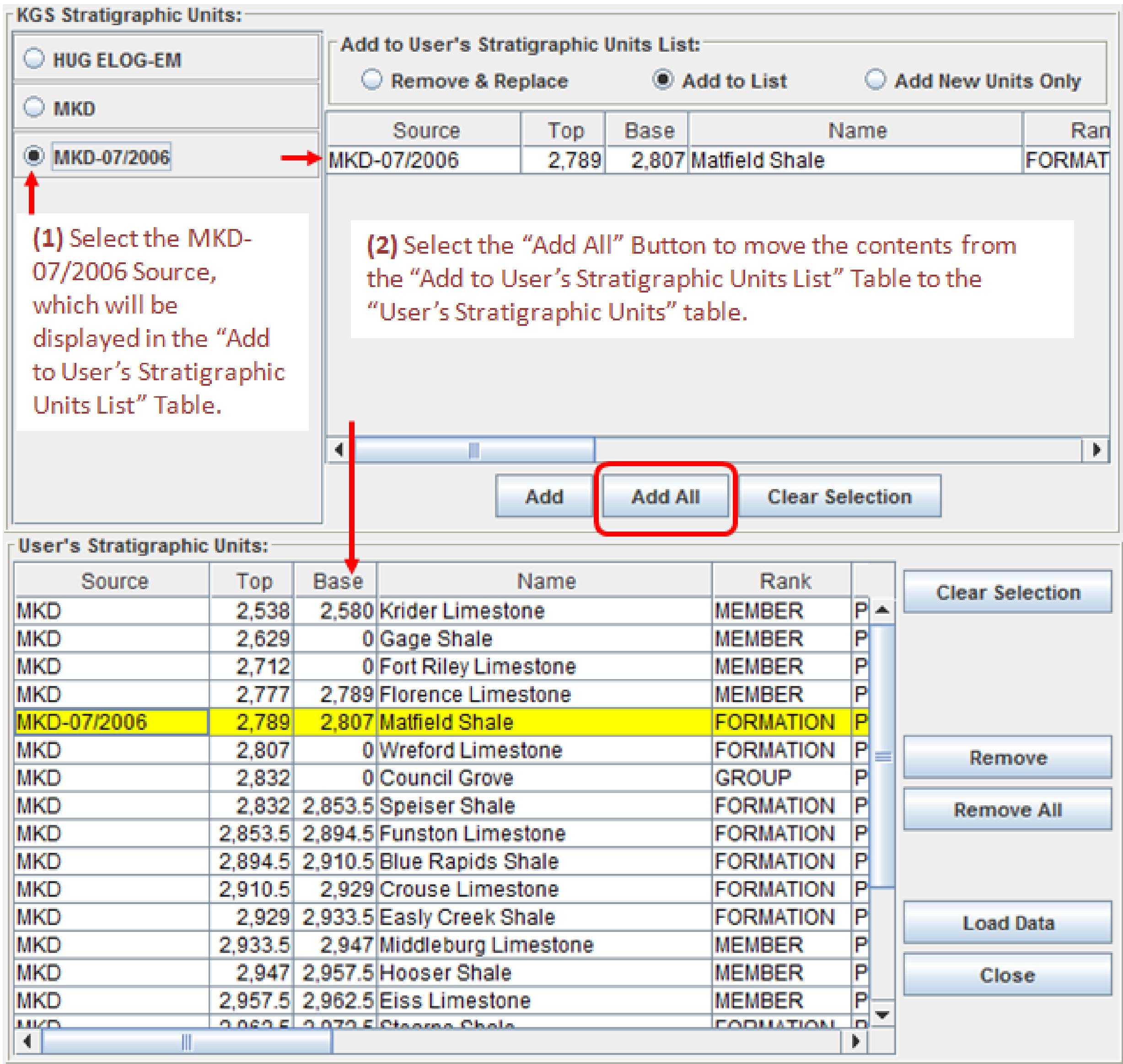
Now select the “Remove” Button.



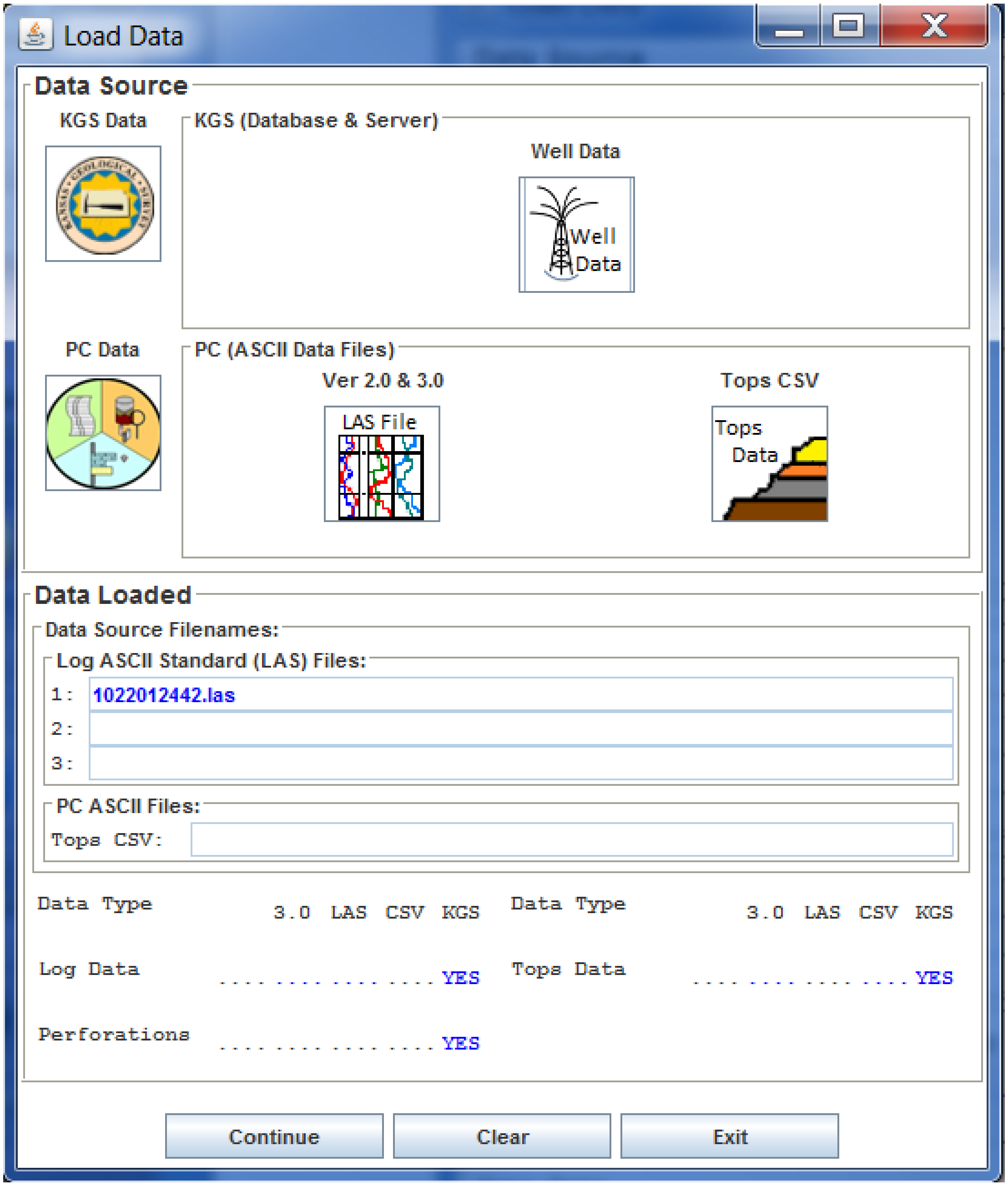
User's Stratigraphic Units:

Source	Top	Base	Name	Rank	
MKD	2,538	2,580	Krider Limestone	MEMBER	P
MKD	2,629	0	Gage Shale	MEMBER	P
MKD	2,712	0	Fort Riley Limestone	MEMBER	P
MKD	2,777	2,789	Florence Limestone	MEMBER	P
MKD	2,807	0	Wreford Limestone	FORMATION	P
MKD	2,832	0	Council Grove	GROUP	P
MKD	2,832	2,853.5	Speiser Shale	FORMATION	P
MKD	2,853.5	2,894.5	Funston Limestone	FORMATION	P
MKD	2,894.5	2,910.5	Blue Rapids Shale	FORMATION	P
MKD	2,910.5	2,929	Crouse Limestone	FORMATION	P
MKD	2,929	2,933.5	Easly Creek Shale	FORMATION	P
MKD	2,933.5	2,947	Middleburg Limestone	MEMBER	P
MKD	2,947	2,957.5	Hooser Shale	MEMBER	P
MKD	2,957.5	2,962.5	Eiss Limestone	MEMBER	P
MKD	2,962.5	2,972.5	Stearns Shale	FORMATION	P
MKD	2,972.5	2,979	Morrill Limestone	MEMBER	P

The MKD-07/2006 has only one top, so this dialog allows the user to add that top to the “User’s Stratigraphic Units” Table. The MKD does not have this top and this is an extra top missing from the MKD data set.



Now with the data set complete select the "Load Data" Button to import the Tops data into the web app.


Load Data
Data Source
KGS Data
KGS (Database & Server)
Well Data
Well Data
PC Data
PC (ASCII Data Files)
Ver 2.0 & 3.0
LAS File
Tops CSV
Tops Data
Data Loaded
Data Source Filenames:
Log ASCII Standard (LAS) Files:
1: 1022012442.las
2:
3:
PC ASCII Files:
Tops CSV:
Data Type 3.0 LAS CSV KGS
Log Data .... YES
Perforations .... YES
Data Type 3.0 LAS CSV KGS
Tops Data .... YES
Continue
Clear
Exit

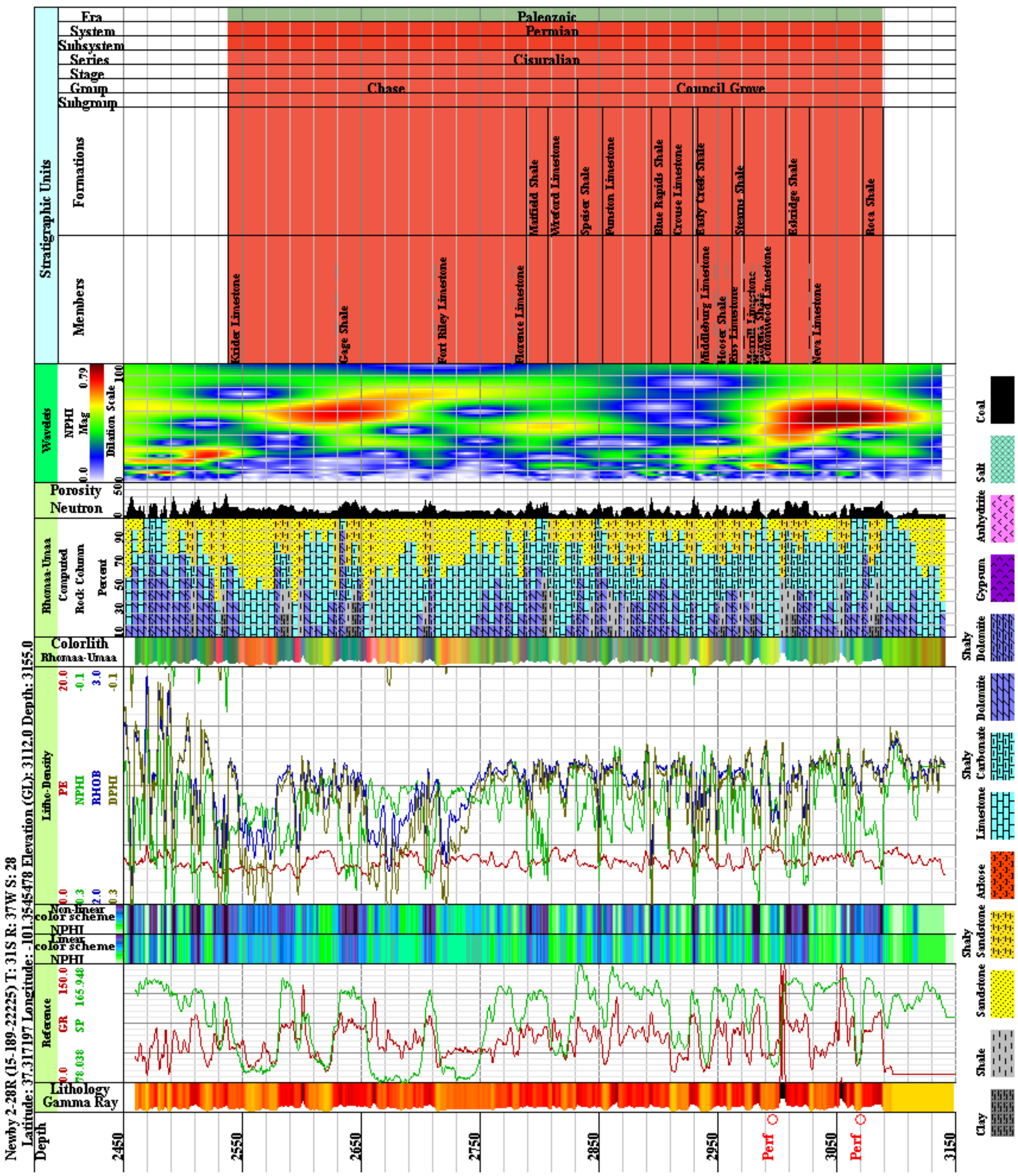


Figure: Example Wavelet Plot of Newby 2-28R well data downloaded from the KGS Database and Server, which includes Log Data, Perforations and Tops Data.

Importing PC Data - Download Well Data to PC

Download either the ASCII Text Files directly or the Zip files extracting the contents into a directory. The problem with the ASCII Text Files being downloaded directly from a web page is that the web page will alter the contents so it does not retain the basic structure and add HTML text to the file. The preferred method if you have Zip or WinZip is to download the zip files to your PC and extract.

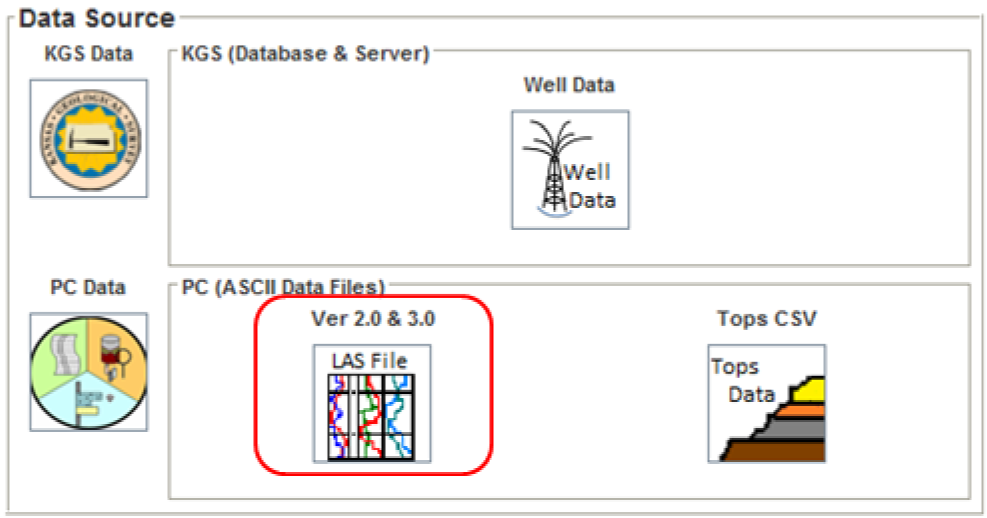
Well Data: Wellington KGS 1-32, Sumner County, Kansas

Type	**ASCII Text Files**
LAS 2.0	http://www.kgs.ku.edu/Gemini/Tools/documentation/Wellington-KGS-1-32.las
Tops	http://www.kgs.ku.edu/Gemini/Tools/documentation/Wellington-KGS-1-32_Tops.csv

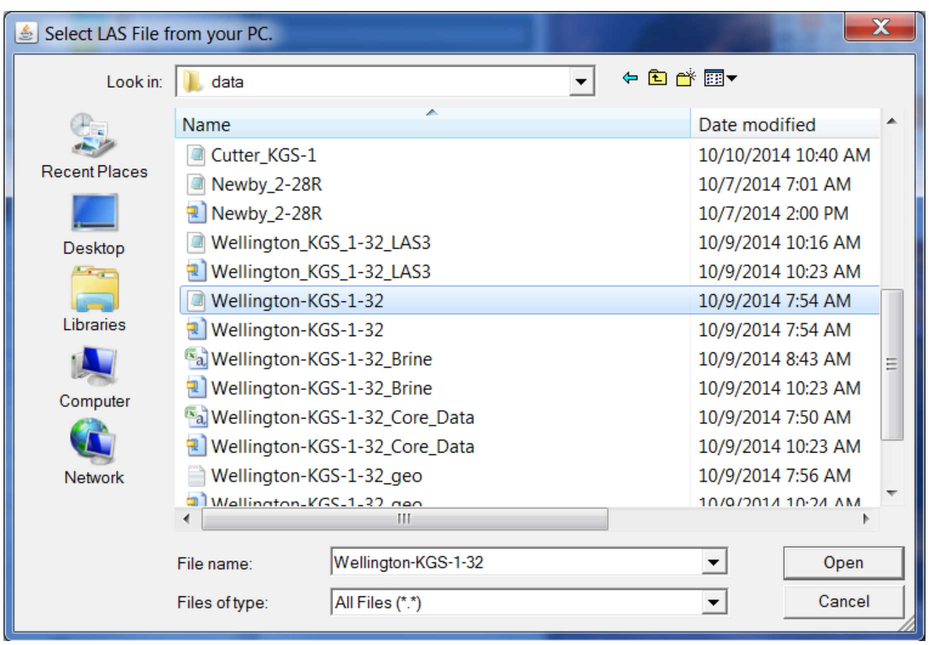
Type	**Zip Files**
LAS 2.0	http://www.kgs.ku.edu/Gemini/Tools/documentation/Wellington-KGS-1-32.zip
Tops	http://www.kgs.ku.edu/Gemini/Tools/documentation/Wellington-KGS-1-32_Tops.zip

Importing PC Data – Log ASCII Standard (LAS) version 2.0 File

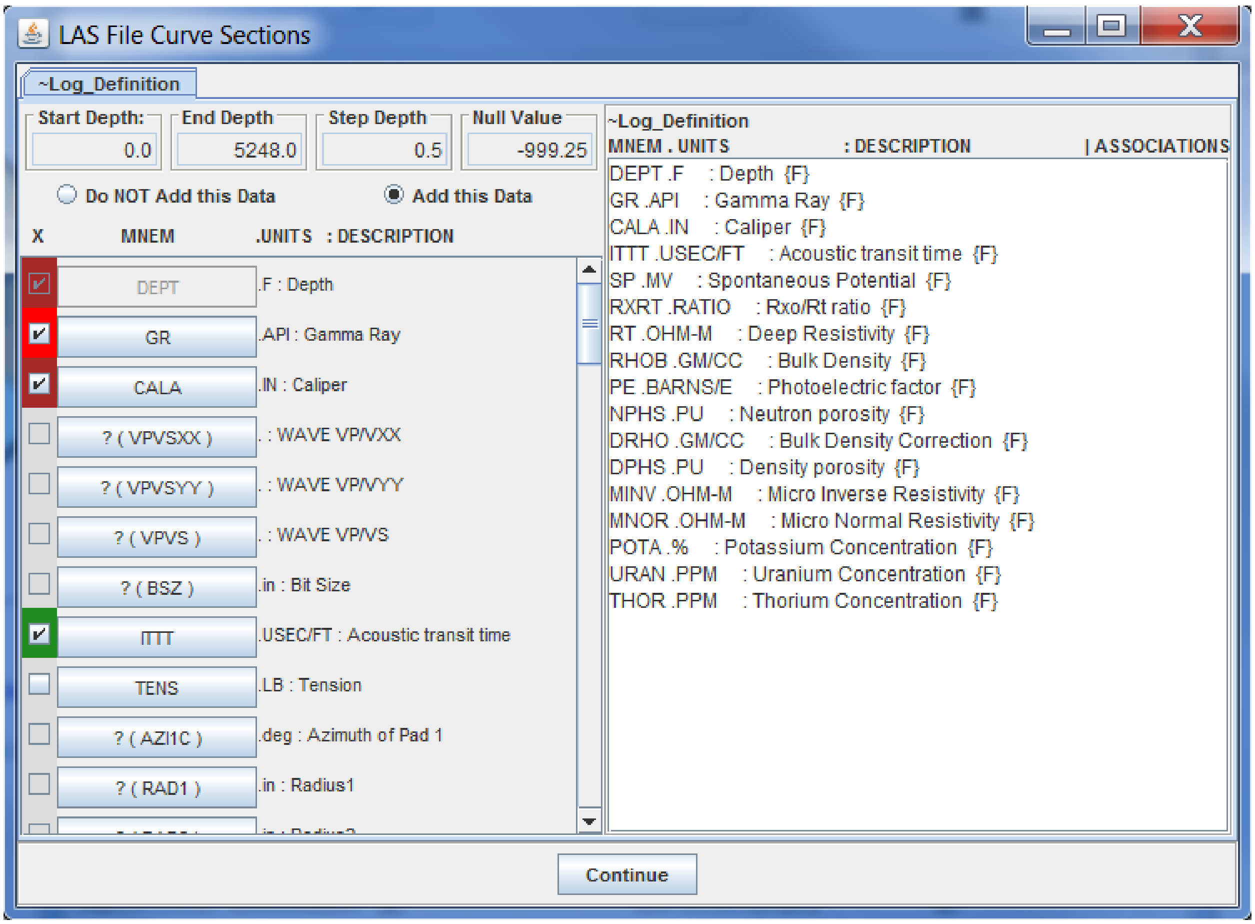
Most of the web apps will use the same input dialogs to import Log ASCII Standard (LAS) version 2.0 or 3.0 files. The Load Data Dialog is basically the same for most of the Web Apps, except they only load a subset of the total data types. In this example a LAS version 2.0 file is being imported into the web app.



Left Click on the "LAS File" Icon Button in the Data Source Panel of the Load Data Dialog. This will display the "Select LAS File from your PC" Dialog. This dialog allows the user to search their PC for the file of interest. In this example it is the LAS version 2.0 file Wellington-KGS-1-32.las, highlighted below. Select the Open button to display the "LAS File Curve Sections" Dialog.



The “LAS File Curve Sections” Dialog allows the user to map unknown LAS Curve Mnemonics to the KGS “Standard” Curve Mnemonics so they will be plotted in the Wavelet Web App Plot. This program reads the “LAS Tool Curve Mnemonics map to KGS Standard Mnemonics” XML File (http://www.kgs.ku.edu/software/gemini/data/las_standard_tools.xml), which will automatically maps the Curve Mnemonics from the LAS file to one of 31 KGS “Standard“ Curve Mnemonics. If a curve Mnemonic is not recognized the program will place a “?” in front of the Mnemonic, e.g. “?(BSZ)” for the “.in : Bit Size” Log Curve. If the user is satisfied with the automatic curve selections, which are checked and color coded, they only need to select the “Continue” Button at the bottom of the Dialog to import the file. The next section will take the user through a series of examples in changing the curve selections and mapping unknown curve mnemonics.



Notice that some of the check boxes are colored with different colors, which shows that the curves were automatically selected, but also to represent the curve type by color.The Curves are colored by type (data units) as follows,

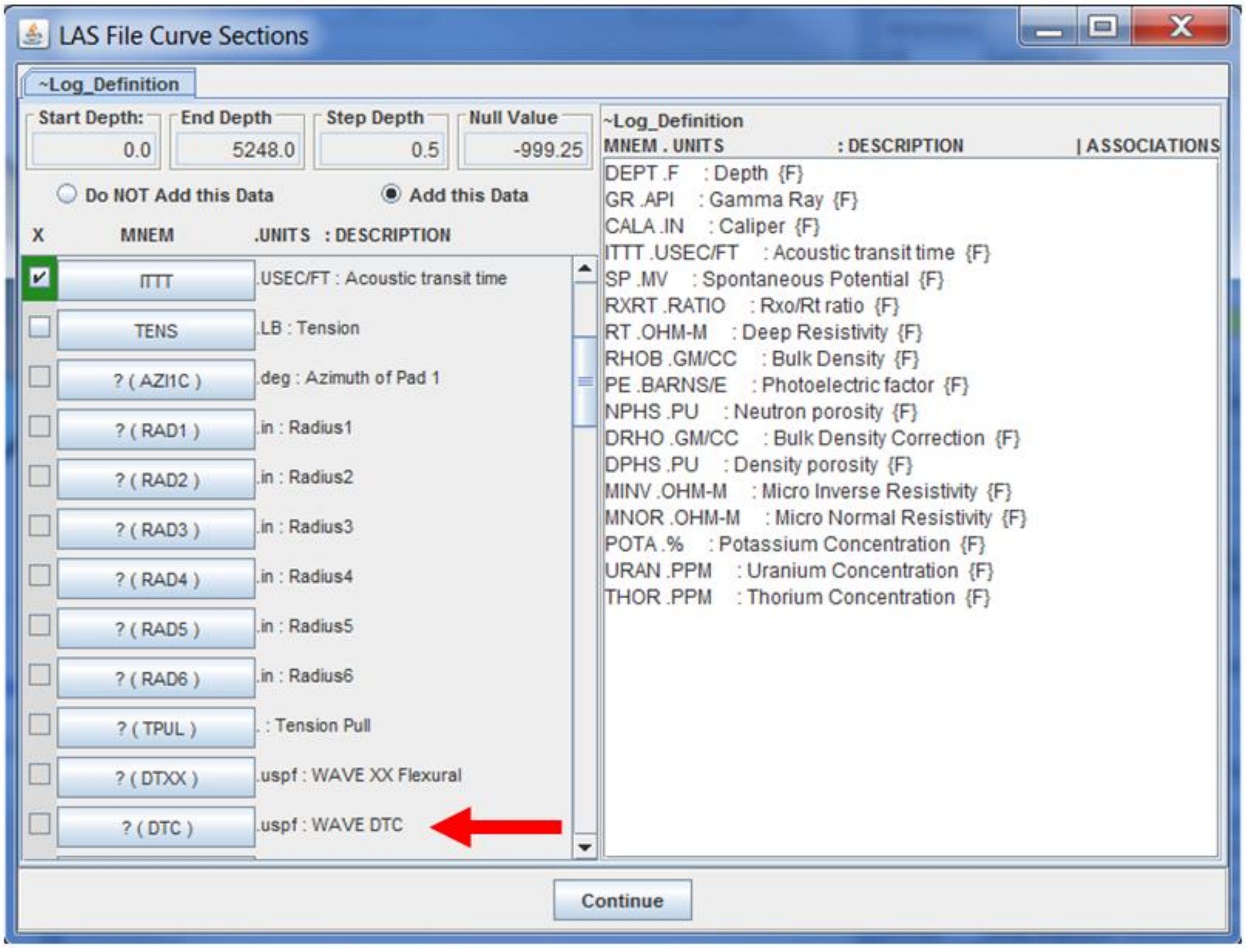
- Orange - OHM-M or Resistivity Logs
- Cyan – PU or porosity Logs, Neutron Porosity, Density Porosity, etc.

- Greenish yellow – BARNS/E or Photoelectric Factor Logs
- Green – GM/CC or Bulk Density Log
- Forest Green – USEC/FT or the Acoustic Transit Time Log
- Red – API, PPM or "%" as Radioactive logs, Gamma Ray, Spectral Gamma Ray, etc.
- Blue – MD or Permeability Logs
- Brown – F, FT or IN or Depth
- Middle yellow – FRAC, or other log curve types.
- Dark Violet – UNI or Unknown Linear Curves
- Medium Violet – UNL or Unknown Logrithum Curves

The color coding of the selected curves were added to also help the user visually recognize that a curve was selected or not.

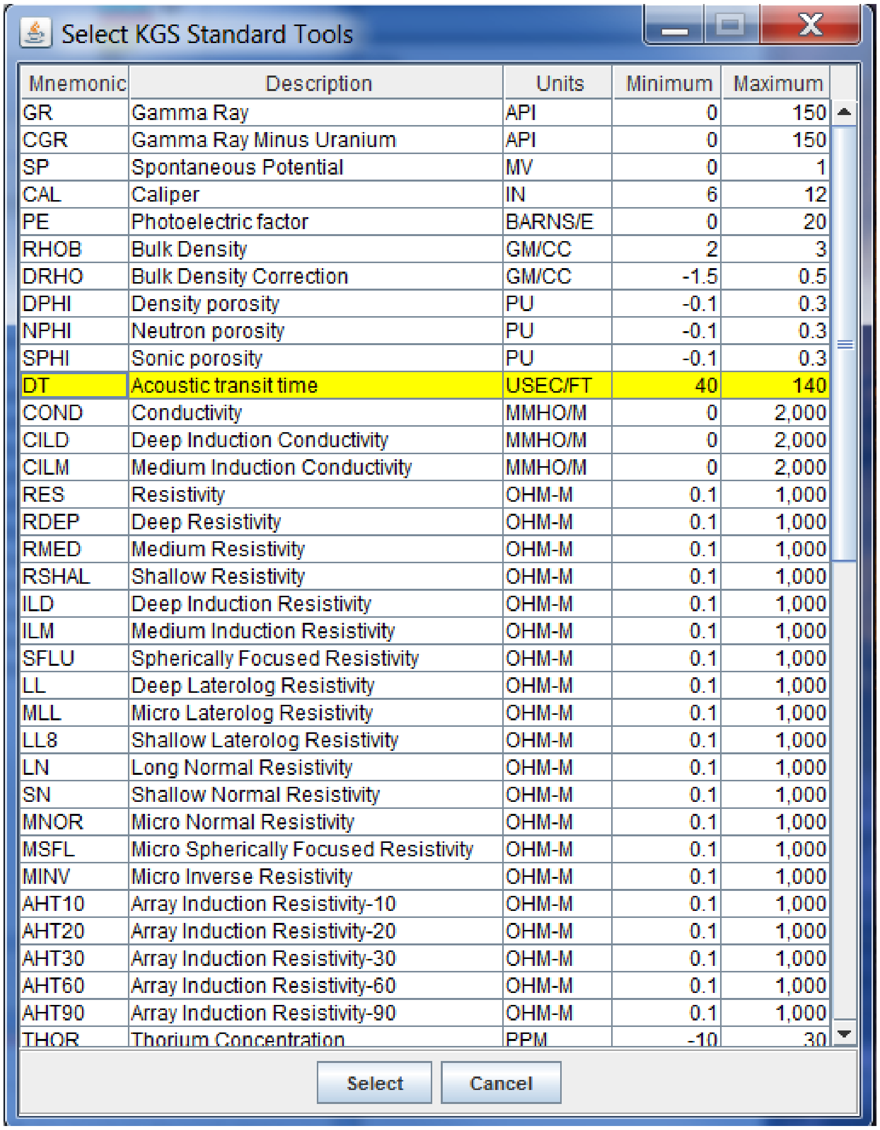
Map Curves & Change Curve Selections

Some logs will have curve mnemonics that are not recognized as one of the KGS "Standard" Curve Mnemonics. The user will need to map the log curve to one of the KGS standard curves if they want to display the curve. The first example is to map the Acoustic Transit Time (DT),which is labeled as ".uspf : WAVE DTC" log curve in the LAS File. Also notice that the button label "?(DTC)" is not recognized by the Wavelet web app.



Click on the “?(DTC)” Button to display the “Select KGS Standard Tools” Dialog. This dialog provides a list of the KGS “Standard” Curve Mnemonics, from which the user can map an unrecognized log curve to one of the KGS standard curve mnemonics. The KGS “Standard” Curve Mnemonics List was created as a way to standardize the alpha bit soup of Log Mnemonics. Each logging company has their own curve mnemonics to represent similar tools. The Wavelet Web App program is a later version of code from the GEMINI Project Wavelet Web App Module, which needed to standardize the log curves so the curves could be automatically read and assigned a plot track. The “LAS Tool Curve Mnemonics map to KGS Standard Mnemonics” XML File was created to map the log curves from logs that were part of the KGS LAS File Collection which is not a complete list of possible curve mnemonics.

To map the unknown curve mnemonic “?(DTC)” you first notice that the unit is “uspf” (micro seconds per foot) a unit of time. Also the Acoustic Transit Time Curve Mnemonic is similar to the KGS “Standard” Curve Mnemonic “DT”. By selecting the “?(DTC)” Button you will display the “Select KGS Standard Tools” Dialog.

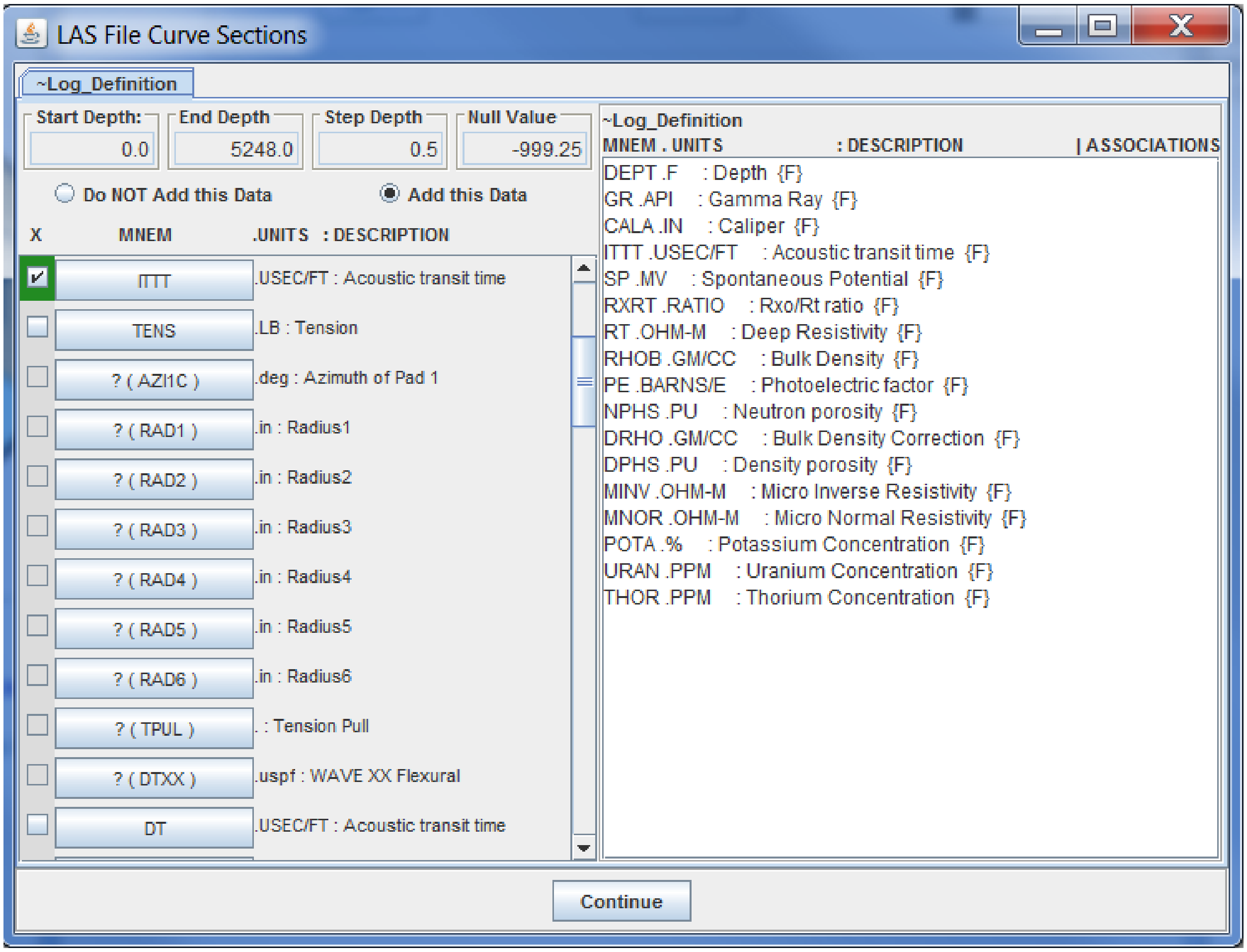


Select KGS Standard Tools

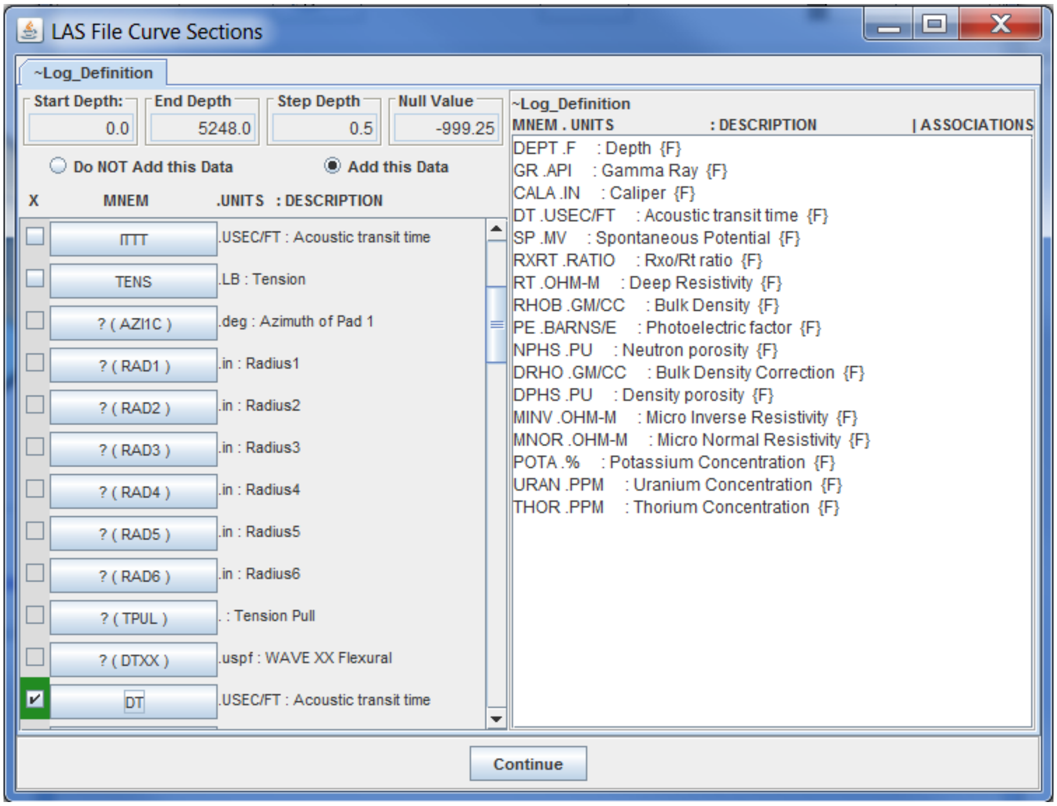
Mnemonic	Description	Units	Minimum	Maximum
GR	Gamma Ray	API	0	150
CGR	Gamma Ray Minus Uranium	API	0	150
SP	Spontaneous Potential	MV	0	1
CAL	Caliper	IN	6	12
PE	Photoelectric factor	BARNS/E	0	20
RHOB	Bulk Density	GM/CC	2	3
DRHO	Bulk Density Correction	GM/CC	-1.5	0.5
DPHI	Density porosity	PU	-0.1	0.3
NPHI	Neutron porosity	PU	-0.1	0.3
SPHI	Sonic porosity	PU	-0.1	0.3
DT	Acoustic transit time	USEC/FT	40	140
COND	Conductivity	MMHO/M	0	2,000
CILD	Deep Induction Conductivity	MMHO/M	0	2,000
CILM	Medium Induction Conductivity	MMHO/M	0	2,000
RES	Resistivity	OHM-M	0.1	1,000
RDEP	Deep Resistivity	OHM-M	0.1	1,000
RMED	Medium Resistivity	OHM-M	0.1	1,000
RSHAL	Shallow Resistivity	OHM-M	0.1	1,000
ILD	Deep Induction Resistivity	OHM-M	0.1	1,000
ILM	Medium Induction Resistivity	OHM-M	0.1	1,000
SFLU	Spherically Focused Resistivity	OHM-M	0.1	1,000
LL	Deep Laterolog Resistivity	OHM-M	0.1	1,000
MLL	Micro Laterolog Resistivity	OHM-M	0.1	1,000
LL8	Shallow Laterolog Resistivity	OHM-M	0.1	1,000
LN	Long Normal Resistivity	OHM-M	0.1	1,000
SN	Shallow Normal Resistivity	OHM-M	0.1	1,000
MNOR	Micro Normal Resistivity	OHM-M	0.1	1,000
MSFL	Micro Spherically Focused Resistivity	OHM-M	0.1	1,000
MINV	Micro Inverse Resistivity	OHM-M	0.1	1,000
AHT10	Array Induction Resistivity-10	OHM-M	0.1	1,000
AHT20	Array Induction Resistivity-20	OHM-M	0.1	1,000
AHT30	Array Induction Resistivity-30	OHM-M	0.1	1,000
AHT60	Array Induction Resistivity-60	OHM-M	0.1	1,000
AHT90	Array Induction Resistivity-90	OHM-M	0.1	1,000
THOR	Thorium Concentration	PPM	-10	30

Select Cancel

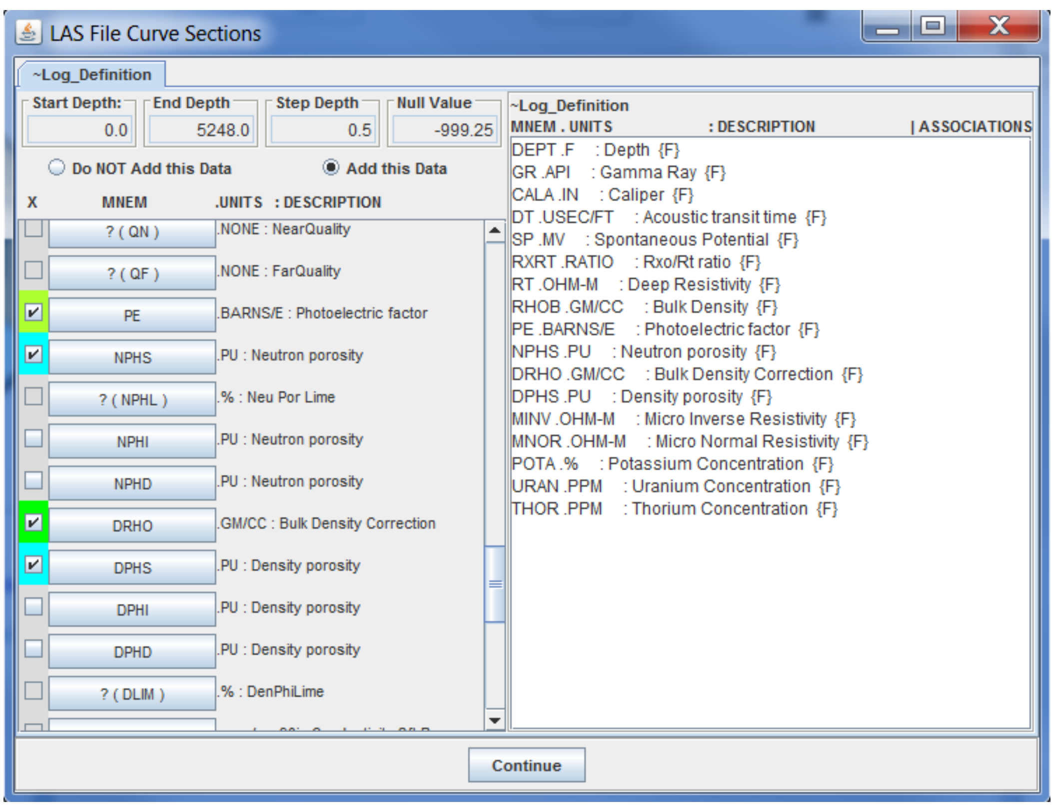
Highlight the “DT” Mnemonic Row and click on the “Select” Button to map the “?(DTC)” Curve Mnemonic to “DT” KGS Standard Curve Mnemonic.



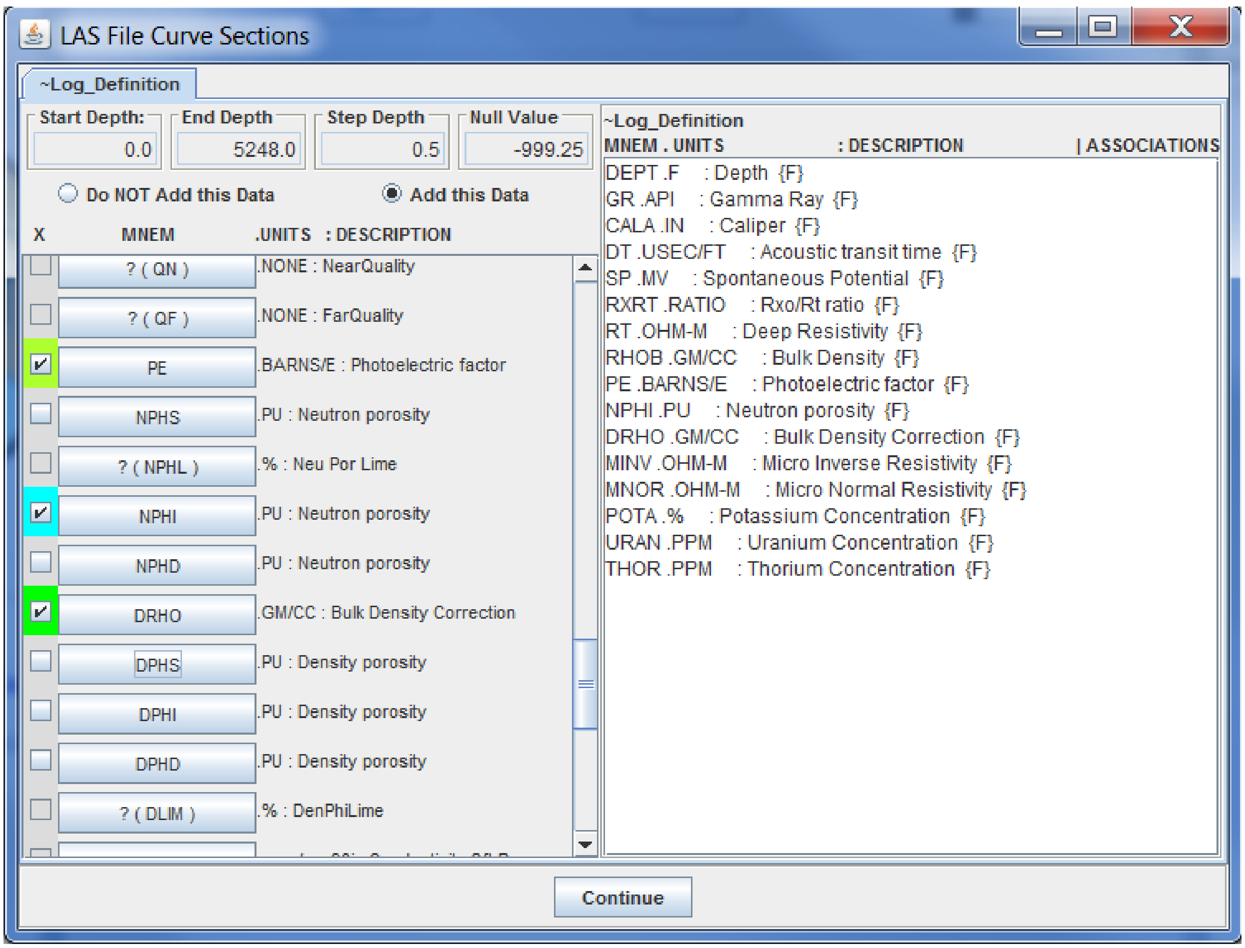
The “?(DTC). .uspf : WAVE DTC” has changed to “DT.usec/ft : Acoustic transit time”. We want to change the selected “ITTT” Log Curve to “DT” Log Curve. The reason is that “ITTT” is the wrong curve type for the Acoustic Transit Time. The program found the curve mnemonic as similar to the “DT” Standard Curve Mnemonic, but this curve will not plot correctly in the Wavelet Web App Plot. Just click on the green check box in front of the “ITTT” Mnemonic Button to deselect the curve and then click on the check box in front of the “DT” Mnemonic Button to select it. Also notice that the ~Log_Definition Text Area was modified to show the change.



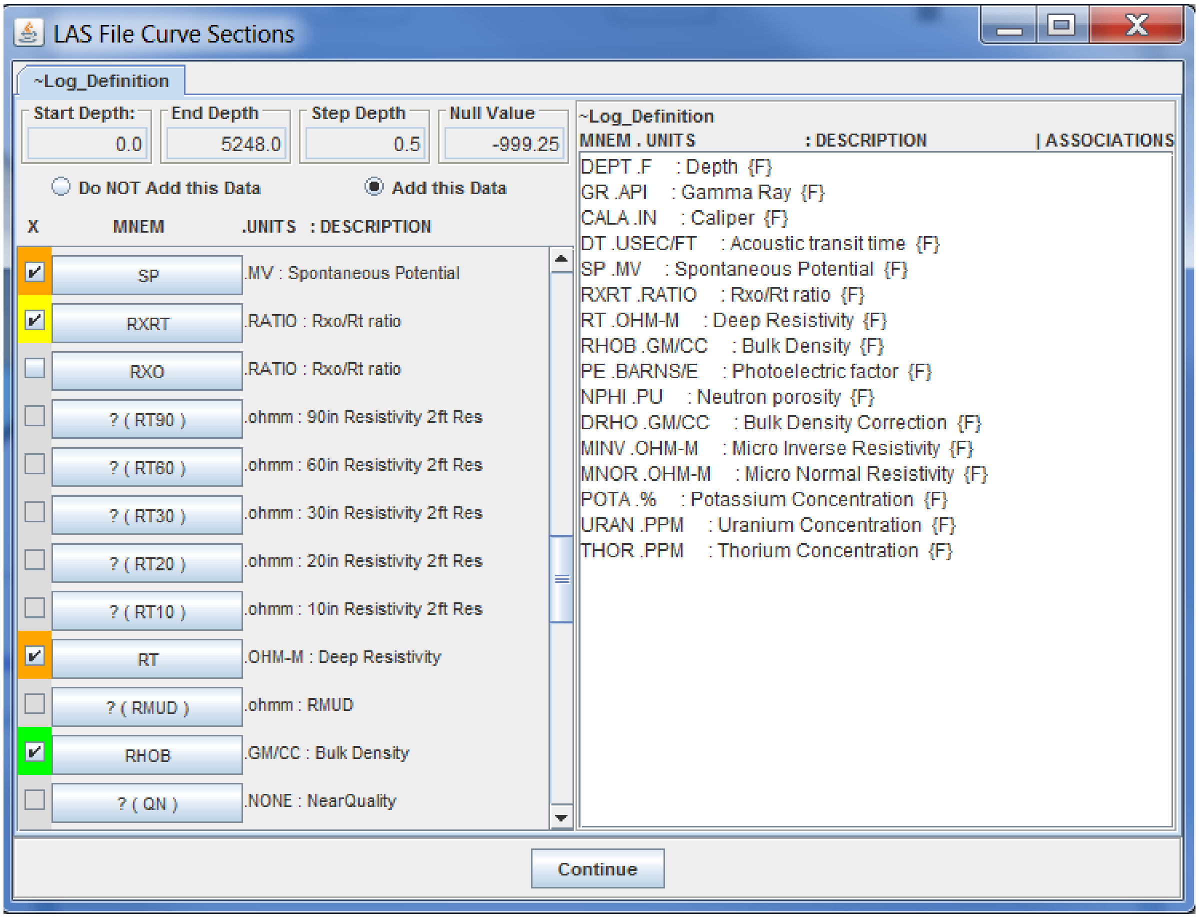
Moving the scroll bar down to the porosity curves, Neutron Porosity, and Density Porosity.



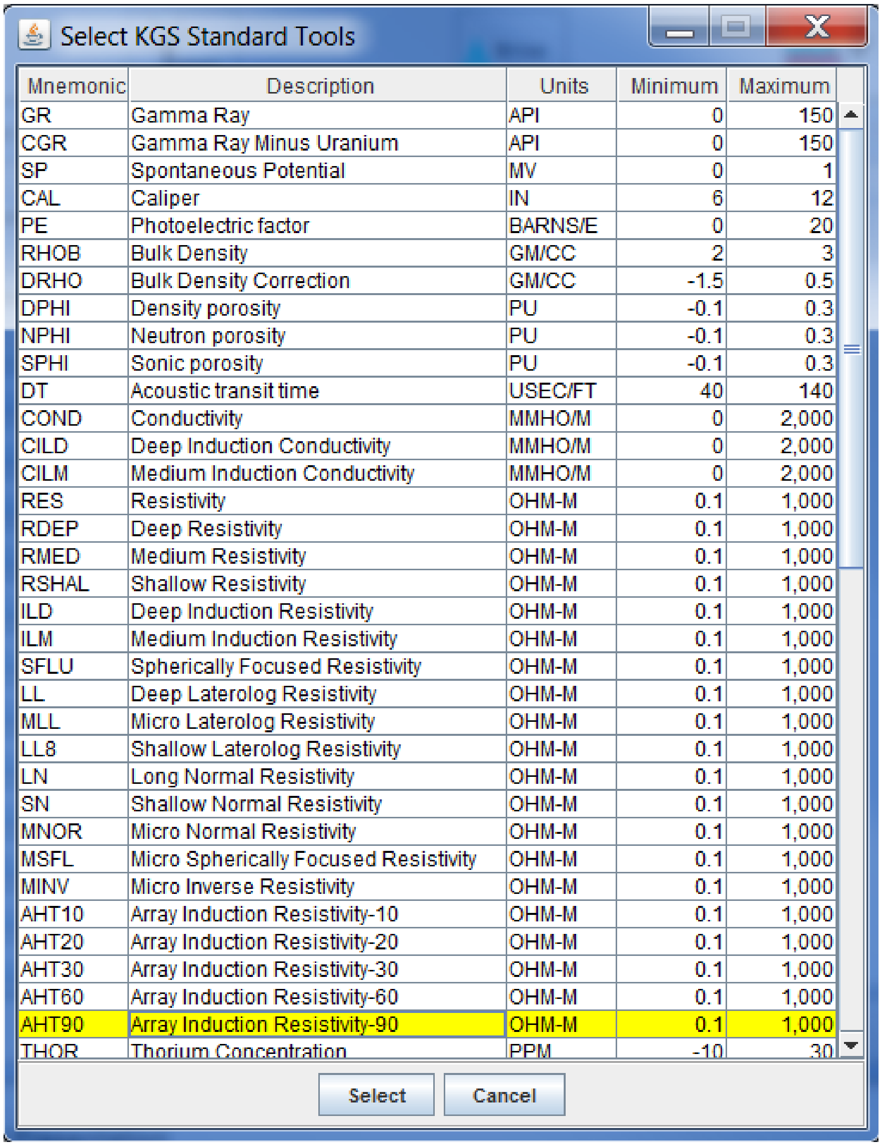
The LAS File Read will select the first curve that it recognizes and selects and color codes the curve. In this case the Neutron porosity mnemonic selected is “NPHS”, which is a valid curve, but the “NPHI” curve is desired so like the Acoustic Transit Time, you can deselect the “NPHS” and then select the “NPHI” Curve. Also the “DPHS” Density Porosity Curve can be deselected since the “RHOB” Bulk Density Curve has been selected. The reason for deselecting the Density Porosity Curve, if the Bulk Density Curve is present, is to force the Wavelet Web App program to recompute the Density Porosity using a Limestone Matrix. If the Neutron Porosity, Bulk Density, Gamma Ray with/without a Photoelectric Factor Logs are present then the program will automatically compute a Lithology Composition Plot, but the Density Porosity has to be computed with a Limestone Matrix or the Lithology Composition Plot will not be computed corectly.



The above dialog represents the changes made for the neutron/density porosity logs. The last curves to be modified are the Array Induction Logs. Haliburton uses a different curve mnemonic for these logs. Move the scroll bar up to find the Array Induction Logs, RT90, RT60, etc.

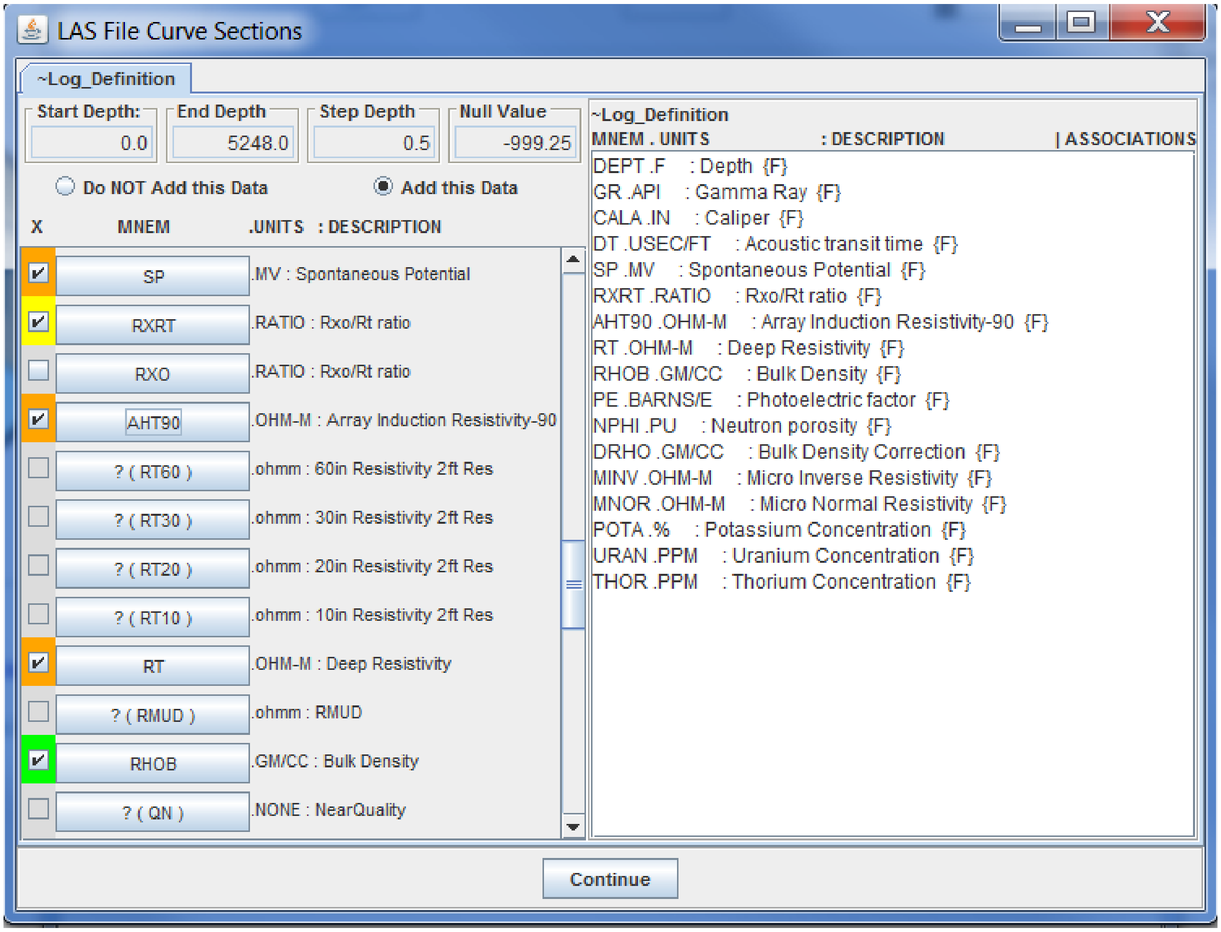


Like the Acoustic Transit Time the "?(RT90).ohmm: 90in Resistivity 2ft Res" through "?(RT10).ohmm : 10in Resistivity 2ft Res" are not recognized. These curves can be map to the "AHT90 Array Induction Resistivity-90" to "AHT10 Array Induction Resistivity-10" KGS Curves Respectively. Click on the "?(RT90)" Mnemonic Button to display the "Select KGS Standard Tools" Dialog.



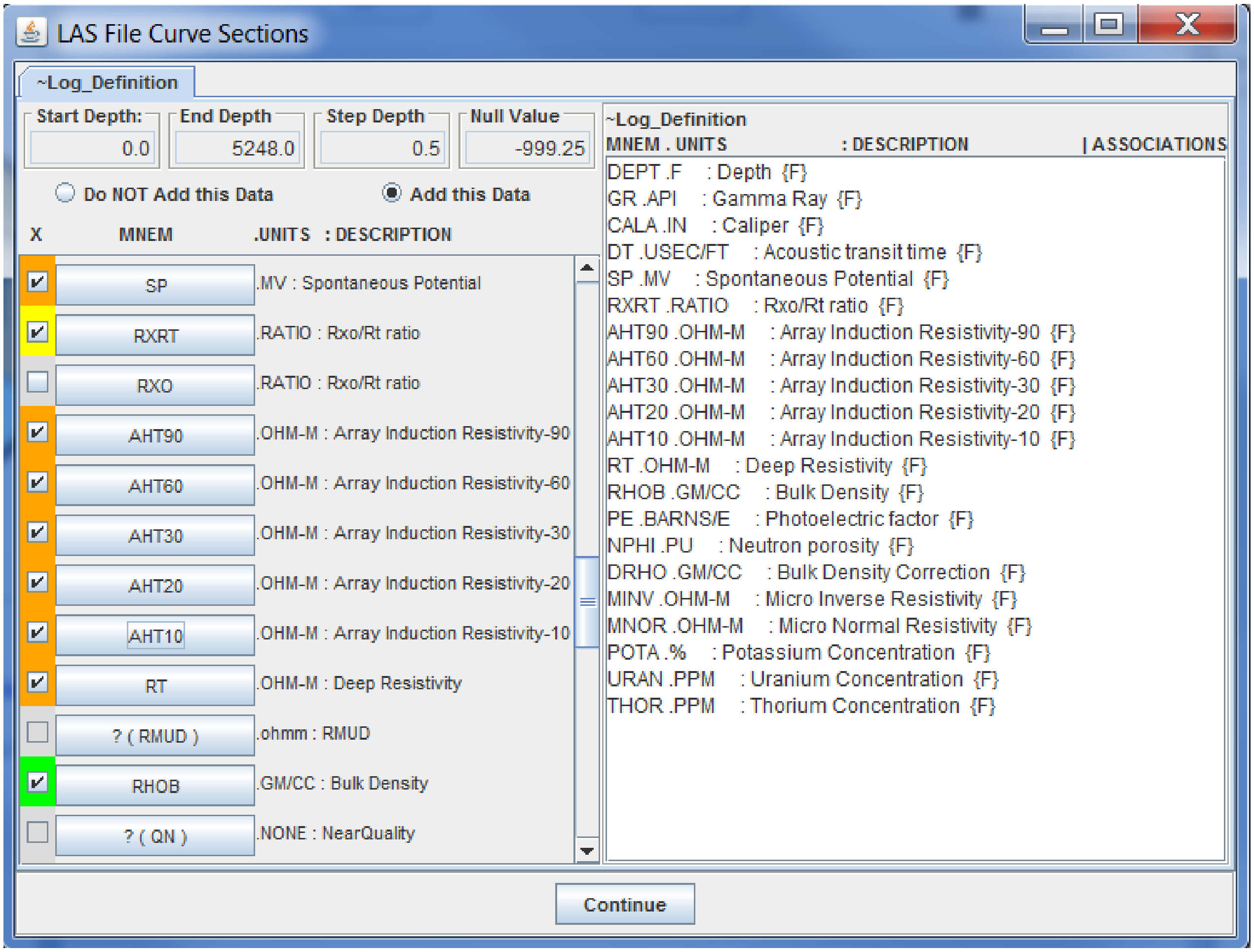
Mnemonic	Description	Units	Minimum	Maximum
GR	Gamma Ray	API	0	150
CGR	Gamma Ray Minus Uranium	API	0	150
SP	Spontaneous Potential	MV	0	1
CAL	Caliper	IN	6	12
PE	Photoelectric factor	BARNS/E	0	20
RHOB	Bulk Density	GM/CC	2	3
DRHO	Bulk Density Correction	GM/CC	-1.5	0.5
DPHI	Density porosity	PU	-0.1	0.3
NPHI	Neutron porosity	PU	-0.1	0.3
SPHI	Sonic porosity	PU	-0.1	0.3
DT	Acoustic transit time	USEC/FT	40	140
COND	Conductivity	MMHO/M	0	2,000
CILD	Deep Induction Conductivity	MMHO/M	0	2,000
CILM	Medium Induction Conductivity	MMHO/M	0	2,000
RES	Resistivity	OHM-M	0.1	1,000
RDEP	Deep Resistivity	OHM-M	0.1	1,000
RMED	Medium Resistivity	OHM-M	0.1	1,000
RSHAL	Shallow Resistivity	OHM-M	0.1	1,000
ILD	Deep Induction Resistivity	OHM-M	0.1	1,000
ILM	Medium Induction Resistivity	OHM-M	0.1	1,000
SFLU	Spherically Focused Resistivity	OHM-M	0.1	1,000
LL	Deep Laterolog Resistivity	OHM-M	0.1	1,000
MLL	Micro Laterolog Resistivity	OHM-M	0.1	1,000
LL8	Shallow Laterolog Resistivity	OHM-M	0.1	1,000
LN	Long Normal Resistivity	OHM-M	0.1	1,000
SN	Shallow Normal Resistivity	OHM-M	0.1	1,000
MNOR	Micro Normal Resistivity	OHM-M	0.1	1,000
MSFL	Micro Spherically Focused Resistivity	OHM-M	0.1	1,000
MINV	Micro Inverse Resistivity	OHM-M	0.1	1,000
AHT10	Array Induction Resistivity-10	OHM-M	0.1	1,000
AHT20	Array Induction Resistivity-20	OHM-M	0.1	1,000
AHT30	Array Induction Resistivity-30	OHM-M	0.1	1,000
AHT60	Array Induction Resistivity-60	OHM-M	0.1	1,000
AHT90	Array Induction Resistivity-90	OHM-M	0.1	1,000
THOR	Thorium Concentration	PPM	-10	30

Highlight the AHT90 and click on the "Select" Button.

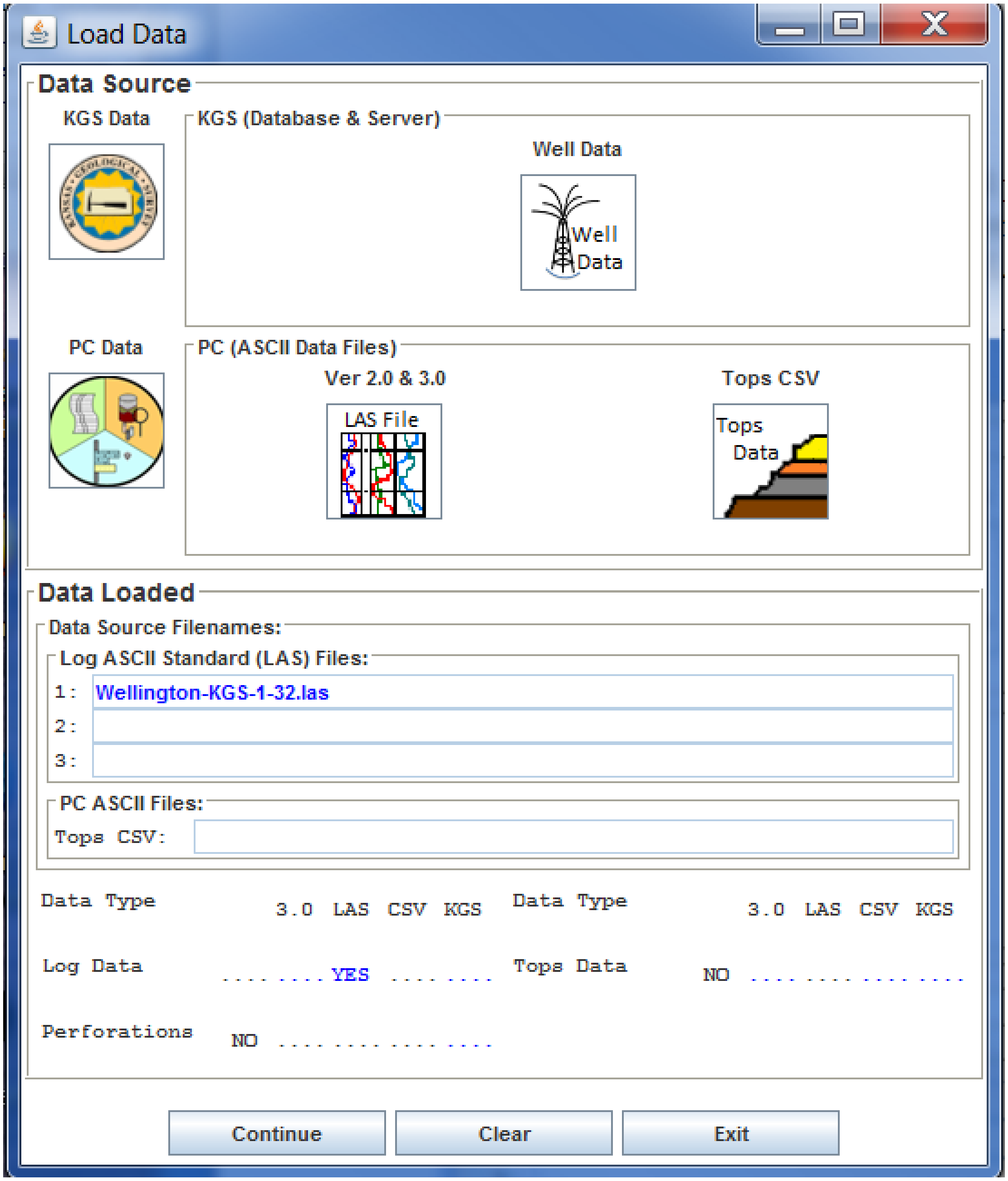


The “(?AHT90).ohmm : 90in Resistivity 2ft Res” has changed to “AHT90.OHM-M : Array Induction Resistivity-90” and the orange check box is selected. The rest of the Array Induction Log Curves each are mapped to the respective KGS Mnemonic Curve as follows,

(?RT90).ohmm : 90in Resistivity 2ft Res to AHT90.OHM-M : Array Induction Resistivity-90
(?RT60).ohmm : 60in Resistivity 2ft Res to AHT60.OHM-M : Array Induction Resistivity-60
(?RT30).ohmm : 30in Resistivity 2ft Res to AHT30.OHM-M : Array Induction Resistivity-30
(?RT20).ohmm : 20in Resistivity 2ft Res to AHT20.OHM-M : Array Induction Resistivity-20
(?RT10).ohmm : 10in Resistivity 2ft Res to AHT10.OHM-M : Array Induction Resistivity-10

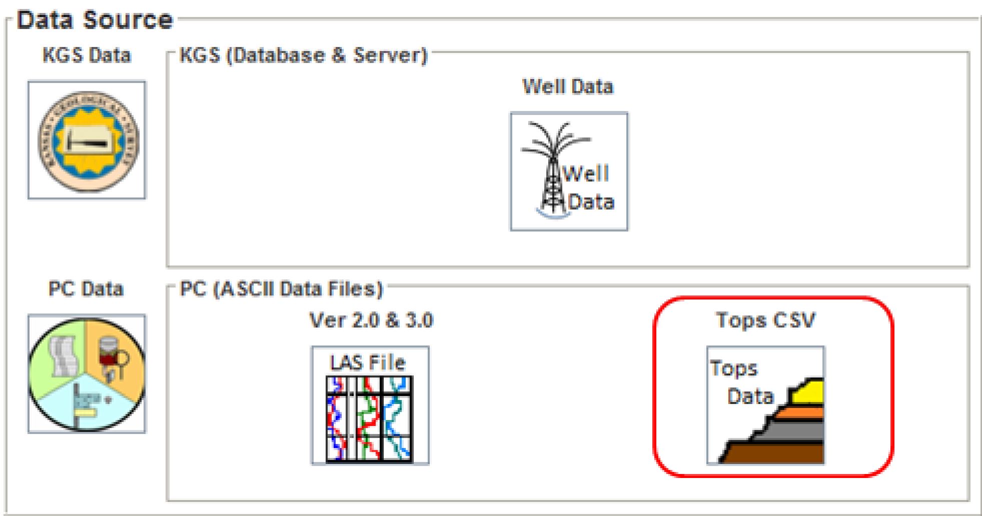

LAS File Curve Sections
~Log_Definition
Start Depth: 0.0
End Depth 5248.0
Step Depth 0.5
Null Value -999.25
Do NOT Add this Data
Add this Data
X MNEM .UNITS : DESCRIPTION
SP .MV : Spontaneous Potential
RXRT .RATIO : Rxo/Rt ratio
RXO .RATIO : Rxo/Rt ratio
AHT90 .OHM-M : Array Induction Resistivity-90
AHT60 .OHM-M : Array Induction Resistivity-60
AHT30 .OHM-M : Array Induction Resistivity-30
AHT20 .OHM-M : Array Induction Resistivity-20
AHT10 .OHM-M : Array Induction Resistivity-10
RT .OHM-M : Deep Resistivity
? (RMUD) .ohmm : RMUD
RHOB .GM/CC : Bulk Density
? (QN) .NONE : NearQuality
~Log_Definition
MNEM . UNITS : DESCRIPTION | ASSOCIATIONS
DEPT .F : Depth {F}
GR .API : Gamma Ray {F}
CALA .IN : Caliper {F}
DT .USEC/FT : Acoustic transit time {F}
SP .MV : Spontaneous Potential {F}
RXRT .RATIO : Rxo/Rt ratio {F}
AHT90 .OHM-M : Array Induction Resistivity-90 {F}
AHT60 .OHM-M : Array Induction Resistivity-60 {F}
AHT30 .OHM-M : Array Induction Resistivity-30 {F}
AHT20 .OHM-M : Array Induction Resistivity-20 {F}
AHT10 .OHM-M : Array Induction Resistivity-10 {F}
RT .OHM-M : Deep Resistivity {F}
RHOB .GM/CC : Bulk Density {F}
PE .BARNS/E : Photoelectric factor {F}
NPHI .PU : Neutron porosity {F}
DRHO .GM/CC : Bulk Density Correction {F}
MINV .OHM-M : Micro Inverse Resistivity {F}
MNOR .OHM-M : Micro Normal Resistivity {F}
POTA .% : Potassium Concentration {F}
URAN .PPM : Uranium Concentration {F}
THOR .PPM : Thorium Concentration {F}
Continue

Select the Continue Button to read and parse the LAS log curves selected into the Wavelet Web App. Notice that the "Data Source Filenames:" Panel lists the LAS version 2.0 File that was just read in as well as the type of data, i.e. Log Data from LAS Data Type.

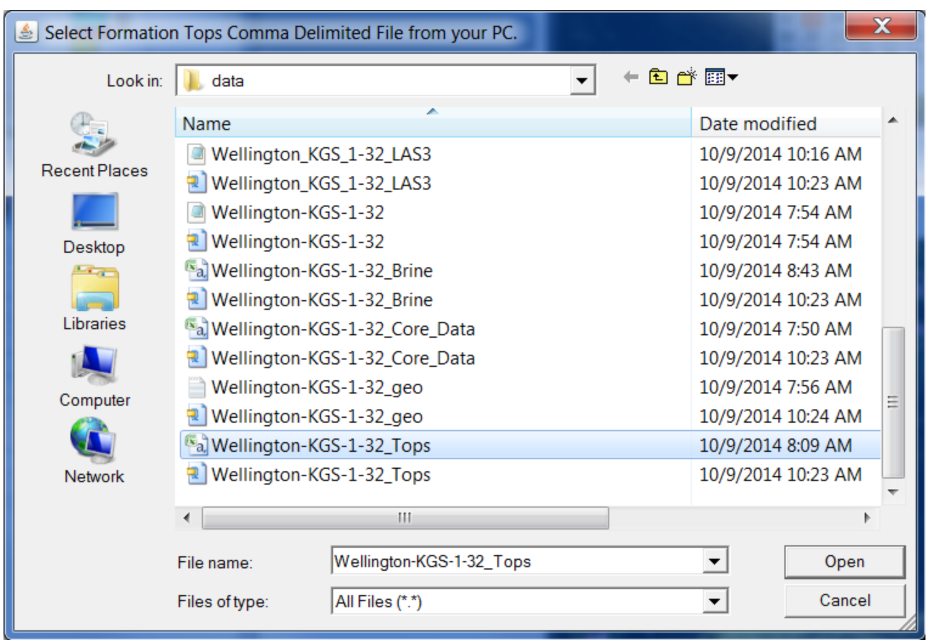


Importing PC Data – Tops CSV (Comma Separated Values) File.

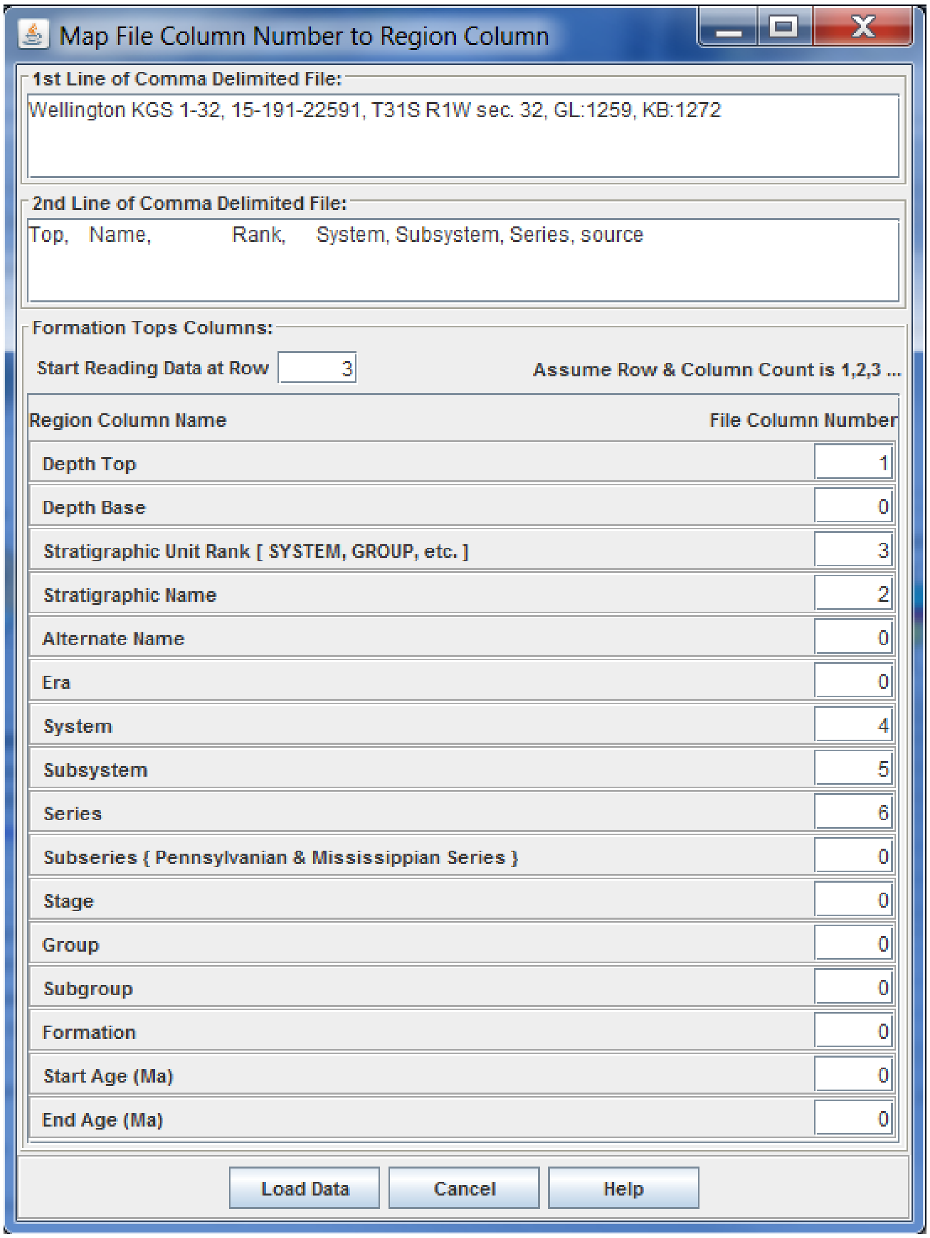
Most of the web apps will use the same input dialogs to import tops CSV (Comma Separated Values) file. The Load Data Dialog is basically the same for most of the Web Apps except they only load a subset of the total data types. In this example a Tops CSV file is being imported into the web app.



Left Click on the "Tops Data" Icon Button in the Data Source Panel of the Load Data Dialog. This will display the "Select Formation Tops Comma Delimited File from your PC" Dialog. This dialog allows the user to search their PC for the file of interest. In this example it is the Tops CSV file Wellington-KGS-1-32_Tops.csv, highlighted below. Select the Open button to display the "Map File Column Number to Region Column" Dialog.



The “Map File Column Number to Region Column” Dialog allows the user to map the file columns number to the web app tops data structure. In this example the file has the well information in line one of the Tops CSV File and line two of the Tops CSV File has the file data columns. In this case the chosen file columns match the Tops Mnemonics for the tops data structure. The File Column Number is automatically assigned to the Region Column Names. The user only needs to select the “Load Data” Button to parse the Tops Data into the web app.



Tops CSV (Comma Separated Values) File Structure.

The Wellington KGS 1-32 Tops CSV example has two introduction lines, the first line is the well header information and the second line is the actual column labels for the tops data, illustrated below,

```
Line 1  Well Header Info    Wellington KGS 1-32, 15-191-22591, T31S R1W sec. 32, GL:1259, KB:1272
Line 2  Data Column Labels  Top,    Name,                 Rank,      System, Subsystem, Series, source
Line 3  Data Start          620,    Chase,                GROUP,     Permian, ,  Wolfcampian, PG
                            748,    Towanda Limestone,    MEMBER,    Permian, ,  Wolfcampian, PG
                            1595,   Wabaunsee,            GROUP,     Carboniferous, Pennsylvanian, Upper, PG
                            1622,   Root Shale,           FORMATION, Carboniferous, Pennsylvanian, Upper, PG
                            1662,   Stotler Limestone,    FORMATION, Carboniferous, Pennsylvanian, Upper, PG
                            1920,   Severy Shale,         FORMATION, Carboniferous, Pennsylvanian, Upper, PG
                            1980,   Topeka Limestone,     FORMATION, Carboniferous, Pennsylvanian, Upper, PG
                            2312,   Lecompton Limestone, FORMATION, Carboniferous, Pennsylvanian, Upper, PG
                            2402,   Heebner Shale,        MEMBER, Carboniferous, Pennsylvanian, Upper, PG
                            2703,   Stalnaker Sandstone, BED, Carboniferous, Pennsylvanian, Upper, PG
                            3039,   Kansas City, GROUP, Carboniferous, Pennsylvanian, Upper, PG
                            3169,   Stark Shale, MEMBER, Carboniferous, Pennsylvanian, Upper, PG
```

Figure: Partial Contents of the Wellington-KGS-1-32_Tops.csv File.

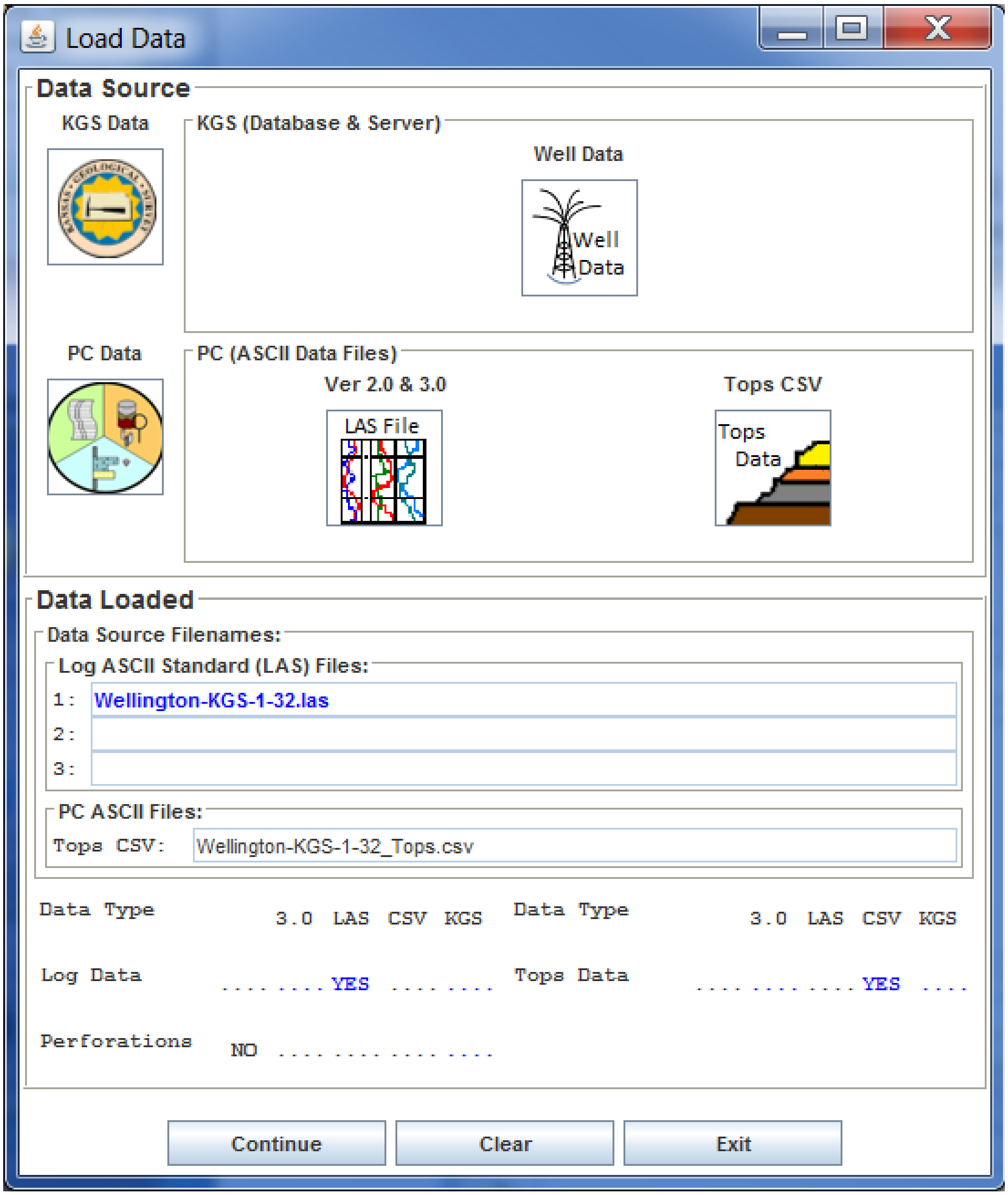
The "Map File Column Number to Region Column" Dialog allows the user to map the data in the Tops CSV File to the web app data structure variables. The program first reads the first and second line of the CSV File looking for the data column headers. The lines are each parsed to single out the data column headers and to match those headers to the tops data structure. The program then assigns the column number to the Region Column Name starting at column 1,2,3, … if the file column name used matches the expected region column name. The Column Names matrix used to parse the file column variables are listed below,

Depth Top	Top	Start
Depth Base	Base	End
Stratigraphic Unit Rank [SYSTEM, GROUP, etc.]	Rank	
Stratigraphic Name	Name	
Alternate Name	Alt Name	
Era		
System	Sys	
Subsystem	subsys	
Series	Ser	
Subseries { Pennsylvanian & Mississippian Series }	Subseries	Subser
Stage	Stg	
Group	Grp	
Subgroup	subgrp	
Formation	Form	
Start Age (Ma)	Start Age	
End Age (Ma)	End Age	

The Wellington KGS 1-32 Tops CSV File example above line 2 has only the Top, Tops Name, Rank, System, Subsystem, Series and Source as the column name variables. The program was able to map each of the column headers to the tops data structure, except Source, i.e.

Column	**File Column Label**	**Tops Data Name**
1	Top	Depth Top
2	Name	Stratigraphic Name
3	Rank	Stratigraphic Unit Rank
4	System	System
5	Subsystem	Subsystem
6	Series	Series
7	Source	

When the user selects the “Load Data” Button on the “Map File Column Number to Region Column” Dialog the data is parsed into the Wavelet Web App Program, where the Tops CSV file name is entered into the “PC ASCII Files:” Panel as well as the data type source.



Select the “Continue” Button to create a Wavelet Plot as illustrated below,

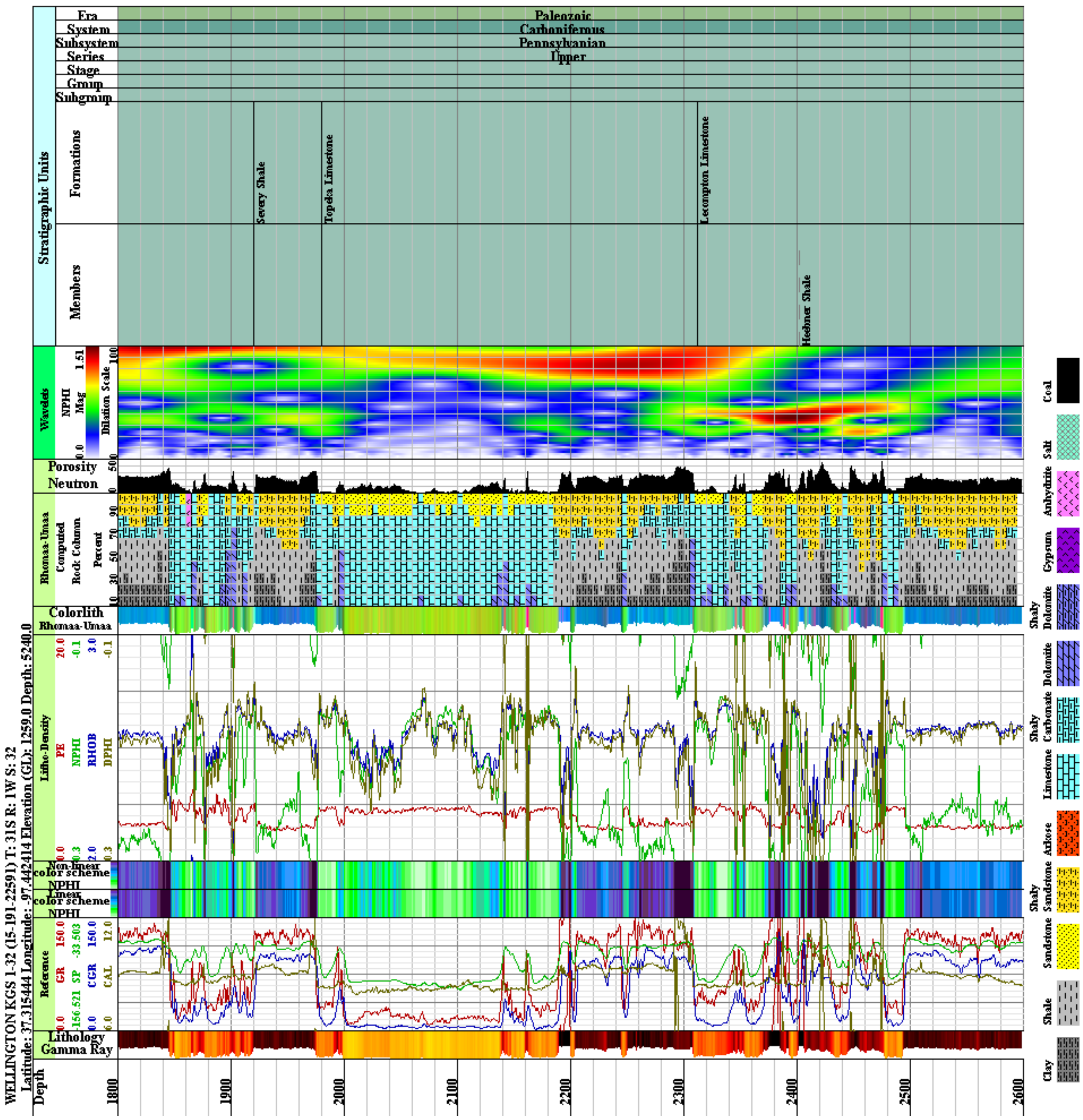
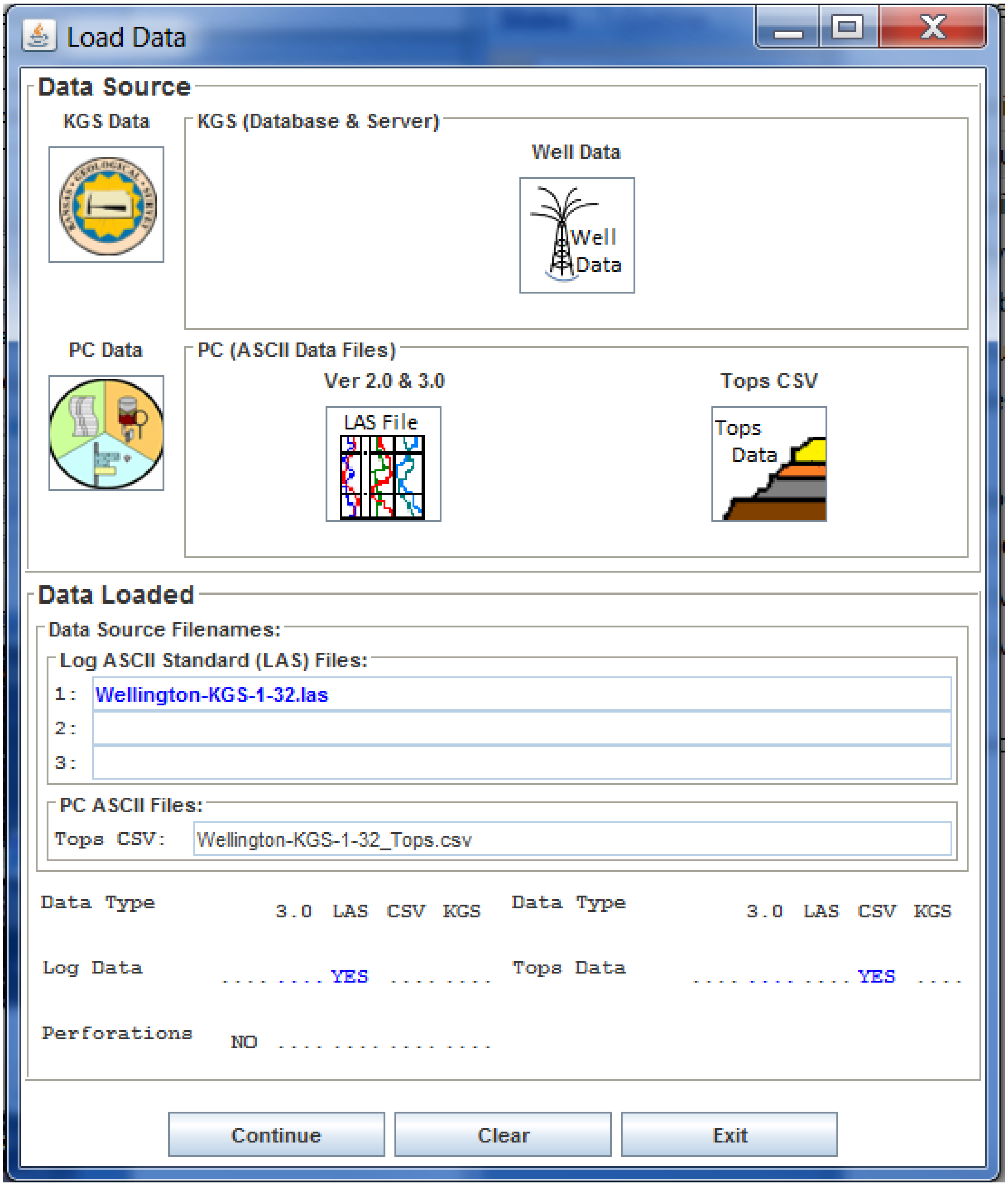


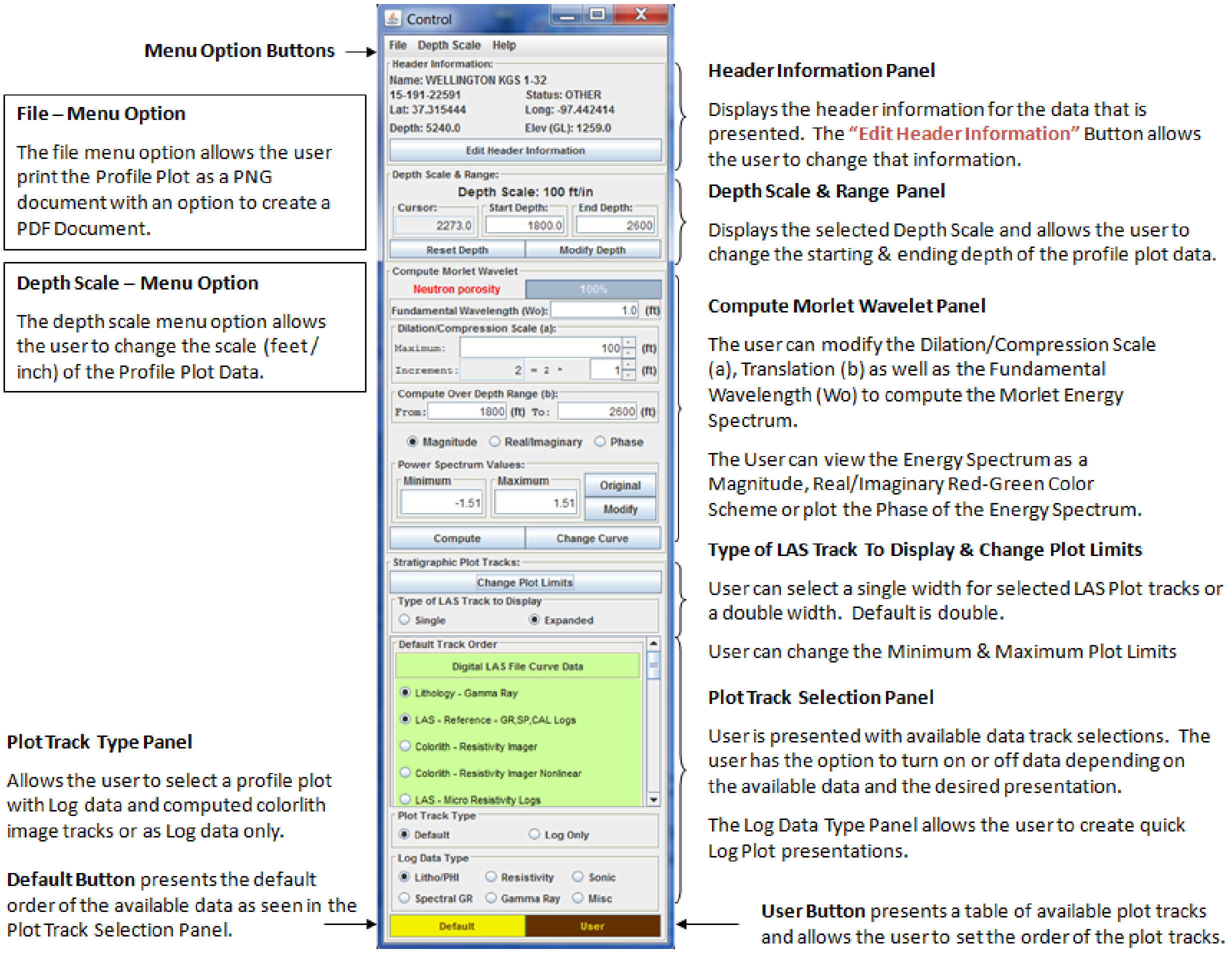
Figure: Wavelet Plot of the Wellington KGS 1-32 with all the Data, Log and Tops.

Wavelet Plot Control Dialog & Plot

The "Load Data" Dialog is the entry to the Wavelet Plot. The user searches the KGS Database for well data and/or from the User's PC. The Image below suggests that the well data came from both the user's PC and the KGS Database. Once the well data is loaded the "Continue" Button at the bottom of this dialog becomes enabled. Click on the "Continue" Button to plot the wells data.



The "Wavelet Plot Control" dialog allows the user to change the presentation of the Wavelet Plot, by depth range, by depth scale, by data type, by log type, modify the track curve limits, or add, modify or delete data through data entry dialogs.



The Load Data is the primary source for the Wavelet plot, but the Wavelet Plot Dialogs allow the user to add, modify or delete certain well data types, i.e.

- Wavelet Plot Control Dialog
    - Edit Header Information Button – This button will display the "Edit Well Header" Dialog, which allows the user to modify the default well header information from the Log ASCII Standard (LAS) File or the user can search the KGS Well Header Information Database for the well header information of the well.
- Wavelet Plot Dialog – Horizons Plot Tracks
    - Porosity & Resistivity (Conductivity) Colorlith Color Schema Plot Track – The user can left click the mouse on the Porosity & Resistivity (Conductivity) Colorlith Track to change the log curve that will display the colorlith track and the limits to compute the linear color schema plot track.
    - Stratigraphic Units Plot Track – The user can left click the mouse on the stratigraphics units plot track to display the "Enter Horizon Data" Dialog with the "Stratigraphic Units" Data Entry Panel displayed. This panel assists the user in adding, modifying or deleting tops from the Wavelet plot. This dialog has two buttons to set the Stratigraphic Units for a top, i.e.

- ICS (International Commission on Stratigraphy) Chart Button displays the accepted stratigraphic units.
- 1968 Kansas Chart Button displays the Accepted Kansas stratigraphic units.

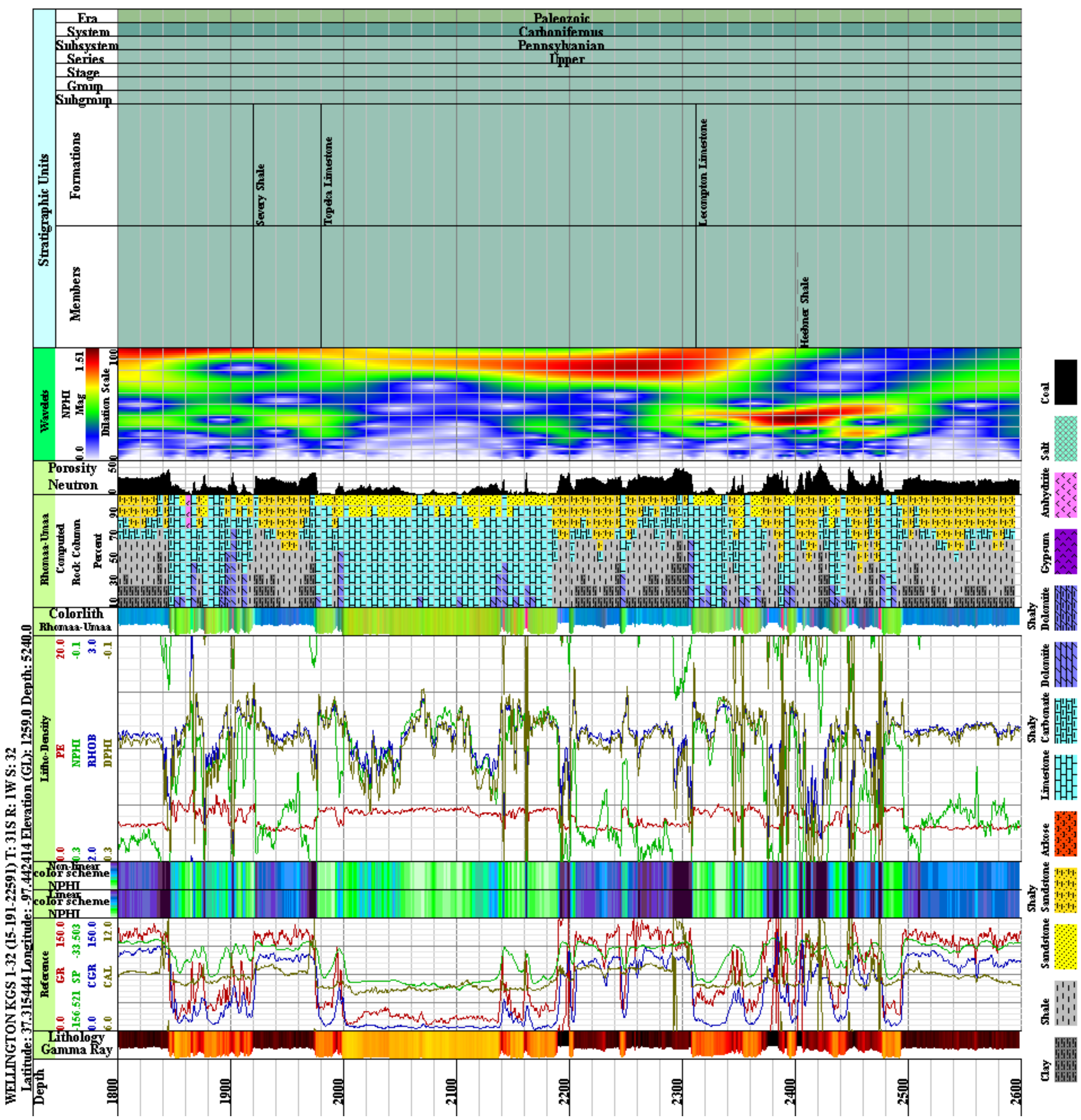
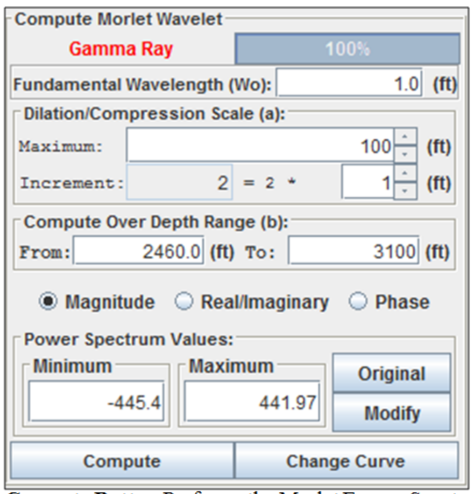


Figure: Wellington KGS 1-32 Wavelet Plot with Log and Tops.

Wavelet Control Panel

"The detection of cyclicity in sedimentary strata can be important to the understanding of the factors controlling sediment depositions. The presence of cyclic patterns and changes in their character have important consequences for geological interpretation, changes in wavelength may indicate changes in depositional facies." Detection of Cyclic Patterns Using Wavelets: An example Study in the Ormskirk Sandstone, Irish Sea By Nestor A. Rivera, S. Ray, Jerry L. Jensen, Andrew K. Chan, and Walter B. Ayers Mathematical Geology, Vol. 36, No. 5, July 2004



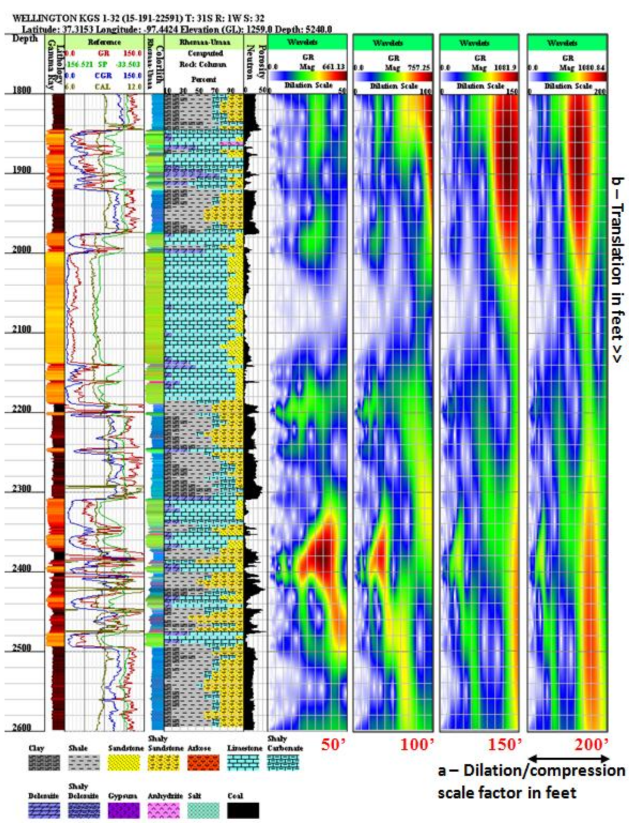
Progress Bar & Selected Log Curve

Morlet Energy Spectrum Variables
Note: Depth Range is automatically computed from the log data to exclude Null Log Values.

Plot Control Radio buttons
- **Magnitude** is the absolute magnitude of the spectrum coefficient W(a,b).
- **Real/Imaginary** displays the real & imaginary terms as red & green in the RGB color value respectively.
- **Phase** is the arctan of the spectrum coefficient W(a,b).

Power Spectrum Control Values

Compute Button Performs the Morlet Energy Spectrum Computation.
Change Curve Button Allows the user to change the log curve.



Morlet Energy Spectrum Coefficient W(a,b)

$$W(a,b) = \sum_{t=b_l}^{b_u} \{ f(t)\, \Psi[(t-b)/a] \} / a^{1/2}$$

Dilation/Compression Scale (a) [feet]
a = i * **Increment**; i = 0,1,2 ... **Maximum** / **Increment**
Total of 50 or 25 points per log depth

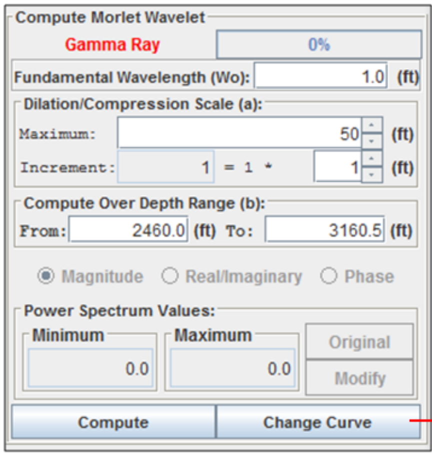
Translation (b) [feet]
b = **From** + k * Log Data STEP Size; k = 0,1,2...Total
where Total = (**To** – **From**)/ Log Data STEP Size

Morlet Wavelet: plane wave modified by a Gaussian envelope

f(t) = Selected Log Curve Data, i.e. Gamma Ray
$\Psi(t) = \exp(-t^2/2)\exp(2\pi j W_o t)$
where W_o is the Fundamental Wavelength

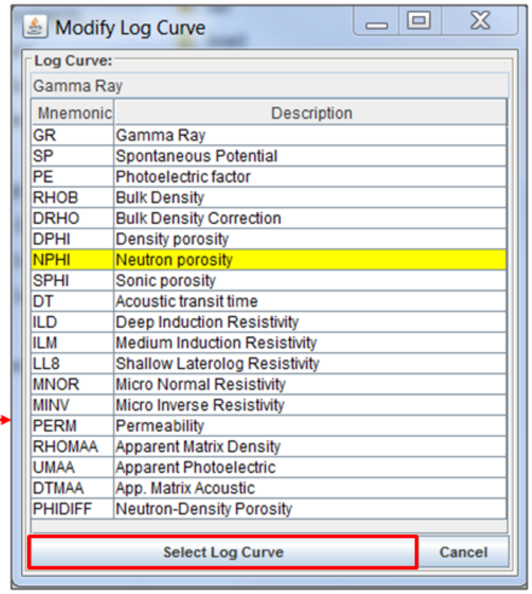
W(a,b) provides space-scale analysis rather than space-frequency analysis, proper scale-to-frequency transformation allows analysis that is very close to space-frequency analysis. Reducing the scaling parameter "a" reduces the support of the wavelet in space, which covers higher frequencies, and vice versa. Therefore 1/a is a measure of frequency. The parameter "b" indicates the location of the wavelet window along the space axis. This changing (b,a) enables computation of the wavelet coefficients W(a,b) on the entire space-frequency plane.

Change Log Curve

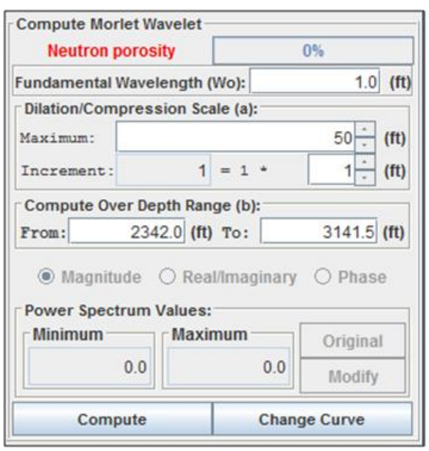


Step 1: Select the "Change Curve" Button in the "Compute Morlet Wavelet" Panel to change the Gamma Ray Log Curve (default curve if it is present) to the Neutron Porosity Log Curve.

Notice that the Depth Range is set to 2460.0' to 3160.5' for the Gamma Ray Log Curve. The Wavelet Panel automatically checks the Gamma Ray Log Curve data and sets the From and To Values by not including the depths that have the Log "Null" Value.

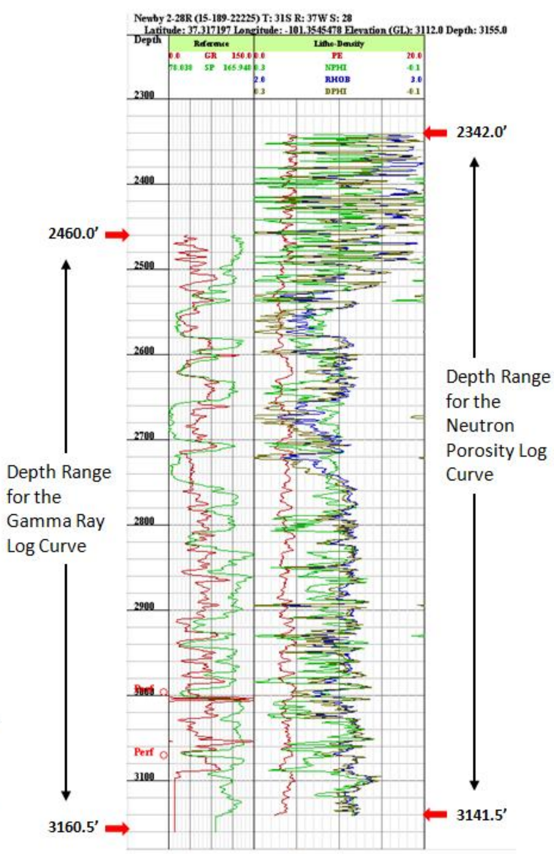


Step 2: Highlight the Neutron Porosity Curve and select the "Select Log Curve" Button.



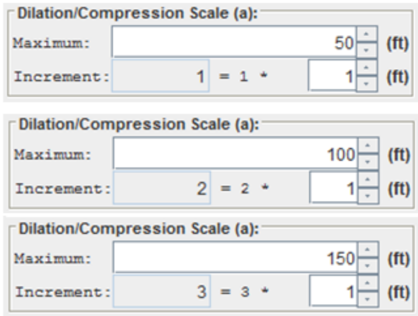
Step 3: Notice that the Neutron porosity Label in red as a positive feedback that the Neutron Porosity Curve was selected.

Notice also that the Depth Range is set to 2342.0' to 3141.5' for the Neutron Porosity Log Curve. The Wavelet Panel automatically checks the Neutron Porosity Log Curve data and sets the From and To Values by not including the depths that have the Log "Null" Value.



Note: The Gamma Ray Log Curve really quits at about 3100.0'

Dilation Scale (a) Maximum Compression Scale Value



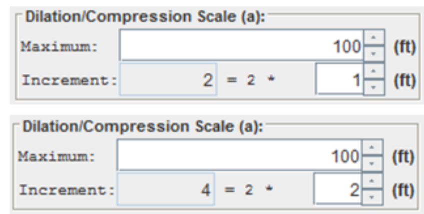
Step 4: Setting the Dilation Scale (a) Maximum Compression Scale Value

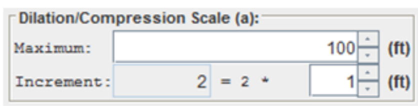
Notice the Maximum Compression Scale value is 50, by clicking on the spinner text field up arrow the values will change by 50 ft increments ONLY. This will initially set the absolute maximum value equal to the depth range of the LAS File divided by 4.

The dilation scale displays the sedimentary depositional frequency detected from the selected log curve.

Step 5: Setting the Dilation Scale (a) Increment Scale Value

The Increment Compression Scale value is 1, which is a multiplication factor. Only 1 and 2 are available, which will compute 50 or 25 points per depth row respectively. 25 points per row gives a more blocky plot, but it is faster by a factor of 2 to compute.

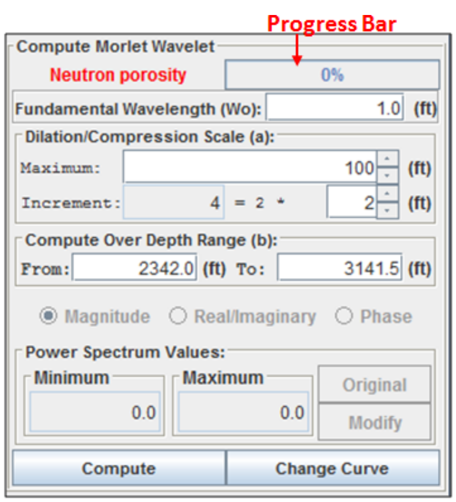




Step 6: Setting the Dilation Scale (a)

Step 3 selected the depth range of 2342.0' to 3141.5' or 799.5' or a maximum value of 250' feet for dilation scale, we will use 100' and select 1 for 50 points / row.

Compute Wavelet



Step 7: Compute

Neutron Porosity Log Curve will be used to compute the wavelet.

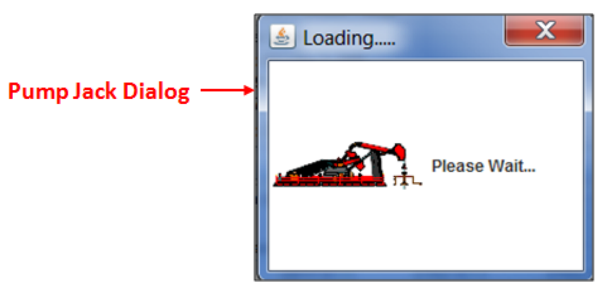
The fundamental frequency will be kept at 1.

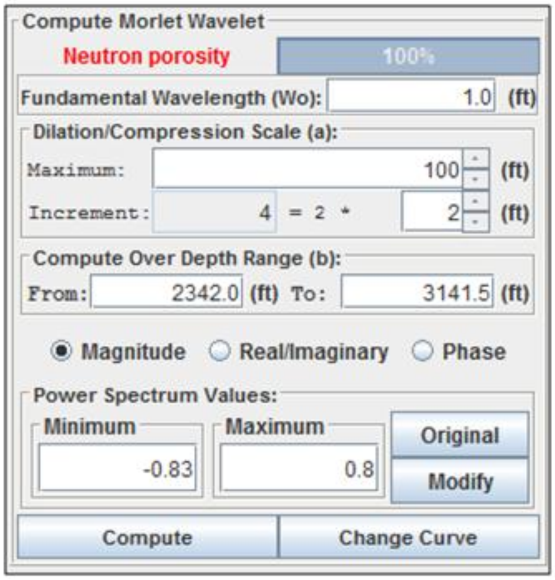
The Dilation Scale (a) Maximum is set to 100 feet sampling 50 points / row.

The Translation (b) will be computed over the depth range 2342.0' to 3141.5'.

Now Select the Compute Button.

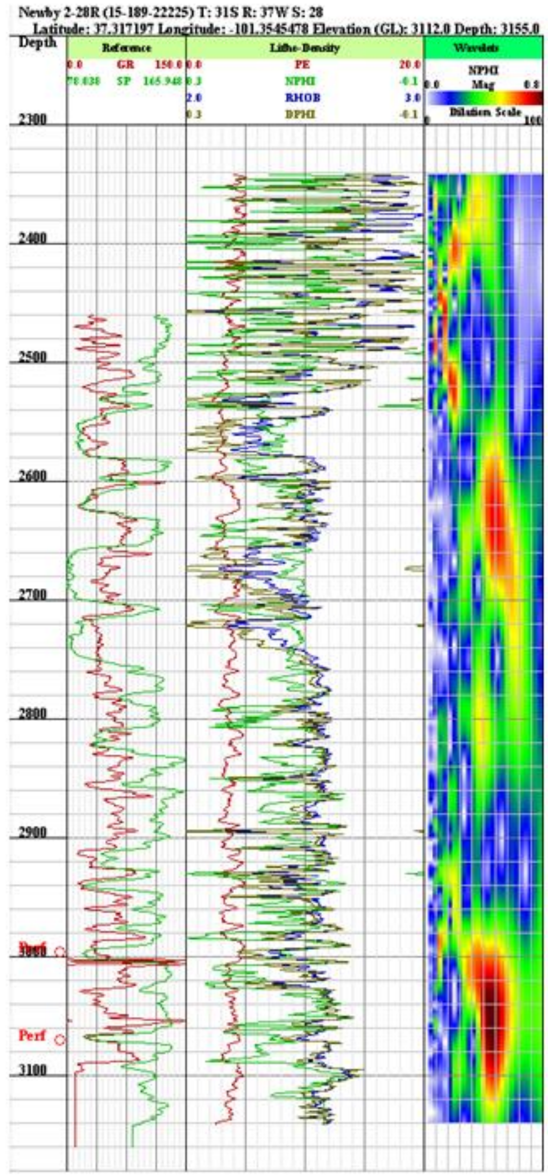
Notice that the Pump Jack Dialog will be displayed as well as the Progress Bar will show the % computed.



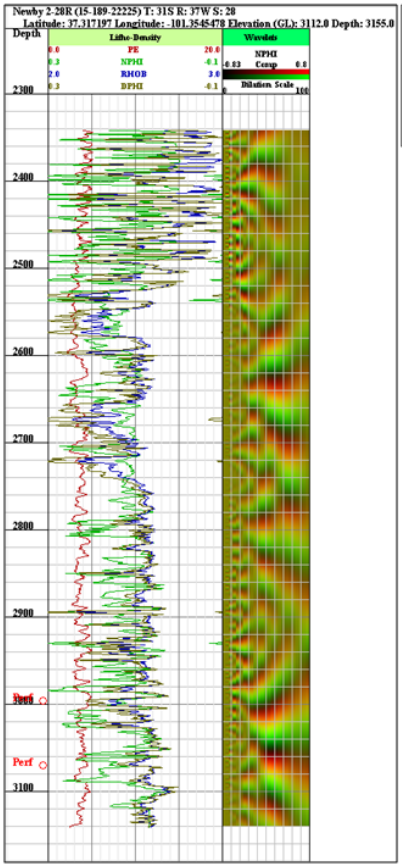


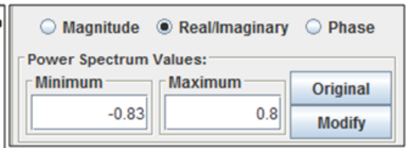
Step 8: Computed Morlet Energy Spectrum

Once the Wavelet Panel is completed the computation the Morlet Wavelet Energy Spectrum Magnitude will be display in the Wavelets Plot Track in the Profile Plot. The Power Spectrum Minimum and Maximum Values will also be displayed in the "Power Spectrum Values" Panel text fields.



Change Power Spectrum Value Limits

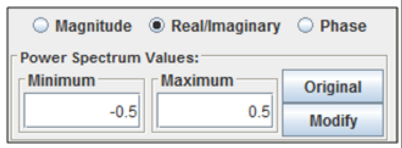




Step 1: Power Spectrum Value Limits

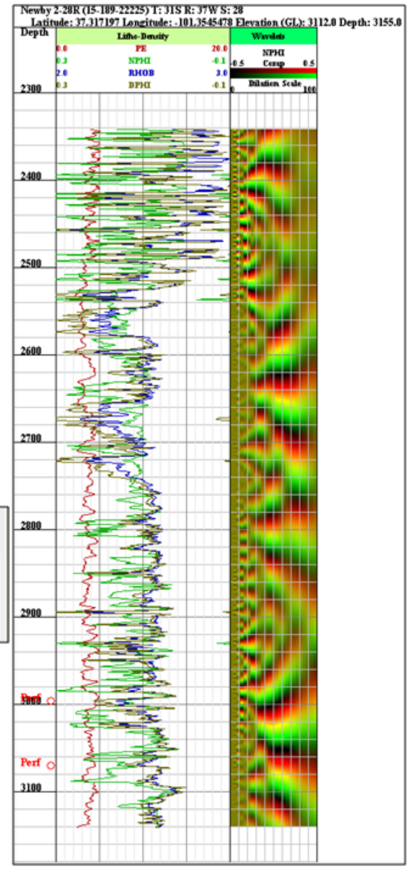
The Minimum and Maximum Values displayed are the computed Wavelet Spectrum Coefficient Minimum and Maximum Values.

Some depths will be fainter than other depths and it may be useful to enhance those values by changing the Minimum and Maximum Values.

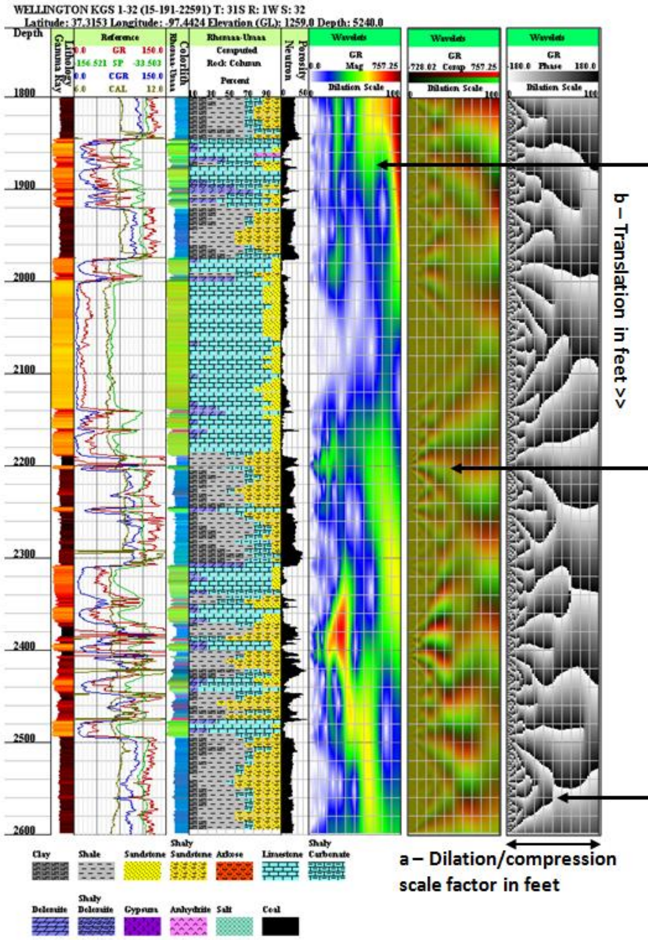


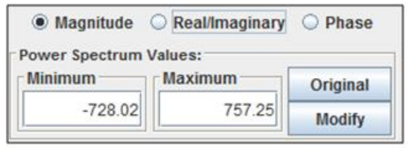
Step 2: Change the Power Spectrum Value Limits

Change the Minimum value to -0.5 and the Maximum value to 0.5 then select the "Modify" Button. Notice the change in the wavelet spectrum plot.



Change Wavelet Plot Presentation

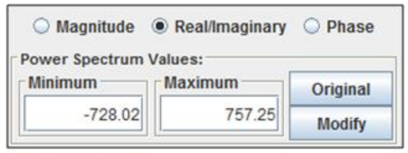




Magnitude

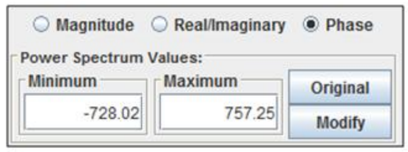
The "Magnitude" Radio button will display the magnitude of the complex energy spectrum coefficient W(a,b), which is computed as,

Sqrt([real(W(a,b)]² + [imaginary(W(a,b)]²)



Real/Imaginary

The "Real/Imaginary" Radio button will display the complex energy spectrum coefficient W(a,b) by assigning the real and imaginary values as graded scales of red and green respectively and inserting the respective color magnitude value into the RGB color with blue set to 0.

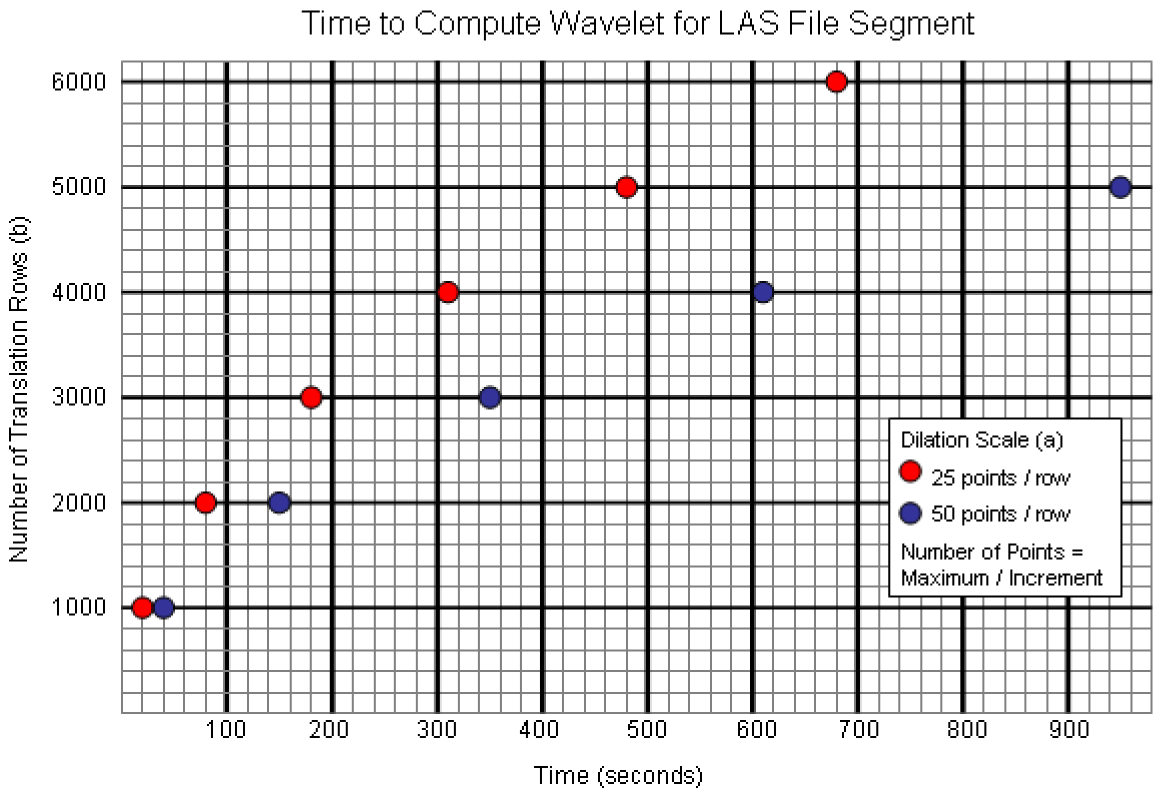


Phase

The "Phase" Radio button will display the magnitude of the complex energy spectrum coefficient W(a,b) by computing the angle between the imaginary part and the real part as,

Phase = arctan(imaginary(W(a,b)) / real(W(a,b)))

Wavelet Process Time



Translation (b) Rows	Dilation Scale (a) = 25 Time (sec)	Dilation Scale (a) = 50 Time (sec)
1000	22	42
2000	79	157
3000	176	347
4000	308	612
5000	476	950
6000	682	1359

Note: Translation Rows = Depth Range / LAS Sampling Rate,

e.g. 1000 Rows = 500 Feet @ ½ foot LAS sampling rate.

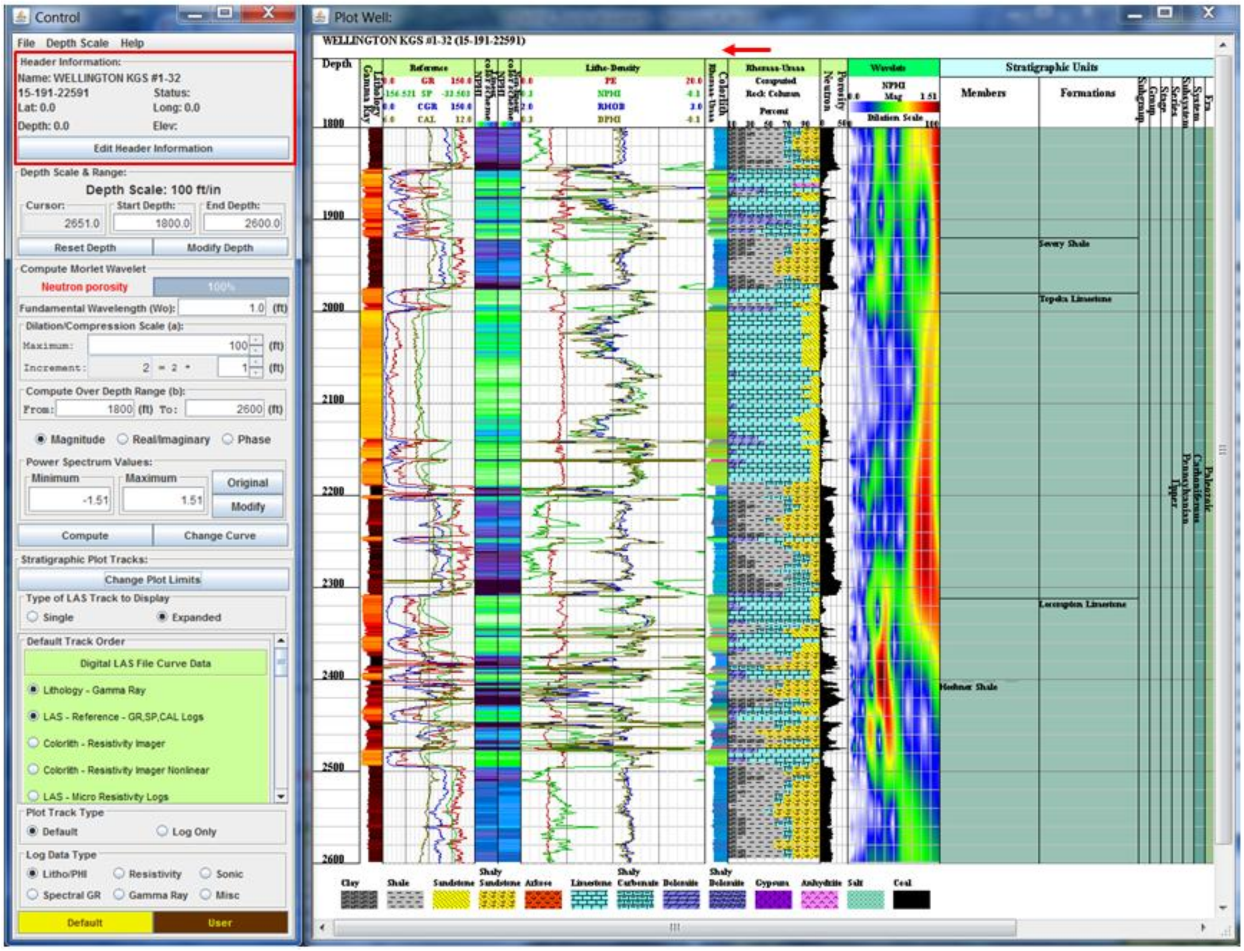
Number of Dilation Scale Columns = Scale Maximum / Scale Increment,

e.g. 100 Maximum feet / 2 Increment feet = 50 Columns.

Data Entry Dialogs

Edit Header Information Dialog

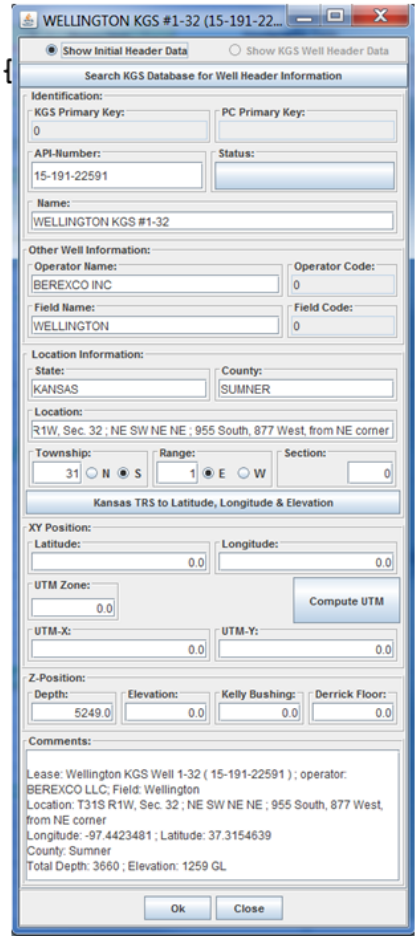
The Well Header Information Summary is displayed in the "Header Information" Panel on the Wavelet Control Dialog as well as at the top of the Wavelet Plot.



It is obvious that there are fields missing in the "Header Information" Panel, i.e. Status, Latitude & Longitude, etc. The "Edit Header Information" Button allows the user to edit the header information that is in the program. This missing information applies to the Wavelet Plot.

The user can select the "Edit Headers Information" Button to display the Edit Header Information Dialog. The data displayed holds the initial information stored in the Log ASCII Standard (LAS) file and the Geologist Report ASCII Delimited file if the user loads the files from their PC. If the user loads the Log ASCII Standard (LAS) File from the KGS Server then the Well Header Information is automatically downloaded from the KGS Well Header Database Table.

Search KGS Database for Well Header Information Button
Displays a "Search for Data on KGS Server" Dialog that allows the user to .
Identification Panel
KGS & PC Primary KEY – Identification Numbers for the well
API-Number – API Number of Well
Well Status - Status, i.e. OIL, GAS, etc.
Name – Lease Name & Number
Other Well Information Panel
Operator Name & KGS Database KEY
Field Name & KGS Database KEY
Location Information Panel
State Name
County Name
Location
Township Range Section
XY Position
Latitude
Longitude
UTM Zone
UTM X Position
UTM Y Position
Z-Position
Depth – Total Depth of Well
Elevation – by Ground Level
Elevation – by Kelly Bushing
Elevation – by Derrick Floor
Comments – User Comments, not saved to the LAS version 3.0.



Header Information Source Buttons:
- **Show Initial Header Data** – Shows the Header Information initially loaded into Program.
- **Show KGS Well Header Data** – Shows the Header Information loaded from KGS Database.

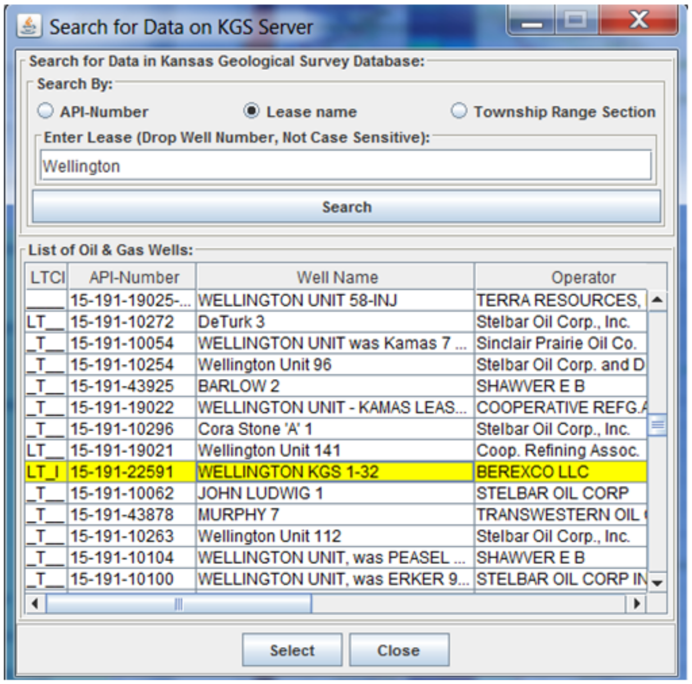
Buttons:
Status – Displays "Select Status of Data" Dialog, user searches for the well status list for status of well.
Kansas TRS to Latitude, Longitude & Elevation – The buttons calls a KGS database routine to compute the Latitude, Longitude and Elevation from the Township, Range and Section.
Compute UTM – This button calls a UTM Java Math Package to convert Latitude & Longitude into UTM X, Y Coordinates.
OK – Transfer Data Values to Program
Close – Close this Dialog

NOTE: Initially the Basic Header information is loaded from the LAS version 2.0 file and other fields like Comments, Location are loaded from the Geologist Report Header Section.

The Header Information Dialog displays the contents of the header information data structure. The user can edit the fields and select the "Ok" Button to transfer the information back to the Wavelet Program and any summary information will be updated in the Wavelet Control and Plot.

As this example illustrates there are missing fields in the header information data. The user can select the "Search KGS Database for Well Header Information" Button, which will display a "Search for Data on KGS Server" Dialog that will allow the user to build a query that will download all wells that match the query.

This will display the "Search for Data on KGS Server" Dialog, see image below. This dialog allows the user to search the KGS database for well header data. In this example, the well of interest will be the Wellington KGS 1-32.



Search for Well Header Data in KGS Database Search By:

- **API-Number** – The user can search the KGS Database for well data by API-Number. The Format for the API is SS-CCC-99999 where
  - SS – Two Digit State Code
  - CCC – Three Digit County Code
  - 99999 – 5 Digit Well Number
- **Lease Name** – The user can search for well data by lease partial phrase, i.e. "Wellington", which will look for all wells with the phrase "Wellington" in the lease name.
- **Township-Range-Section** – Search for a list of Wells by a specific area.

List of Kansas wells that match the search criteria

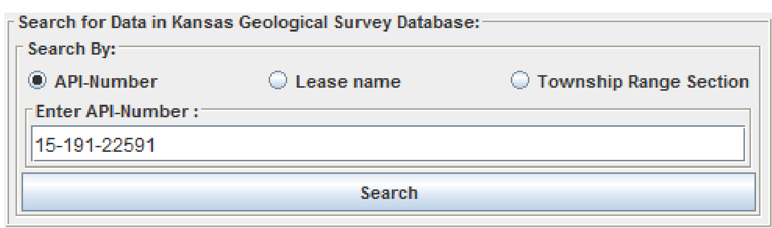
Load Well Header Buttons

- Select – Download the header information for the well selected.
- Close – Close this dialog

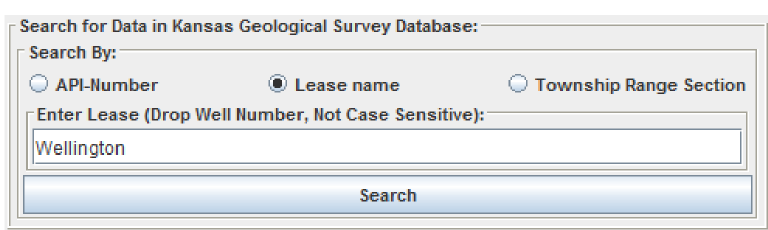
NOTE: LTCI Column in Table: L-LAS Files; T-Formation Tops; C-Measured Core Data; I-Core Images

As the Summary image suggests there are 3 methods for searching for the well header information within this dialog,

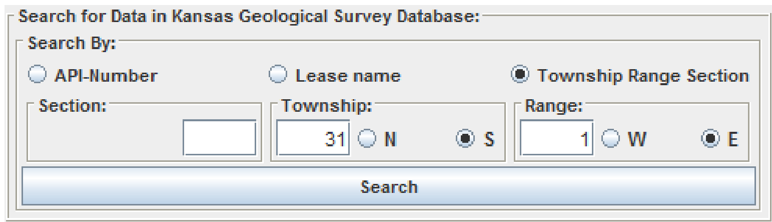
- By API-Number – KGS has a specific format for the API-Number, i.e.SS-CCC-99999 where SS is the state code for Kansas 15, CCC is the county code for Wellington KGS 1-32 it is 191 for Sumner County and the 5-Digit Well Number for the Wellington KGS 1-32 is 22591.



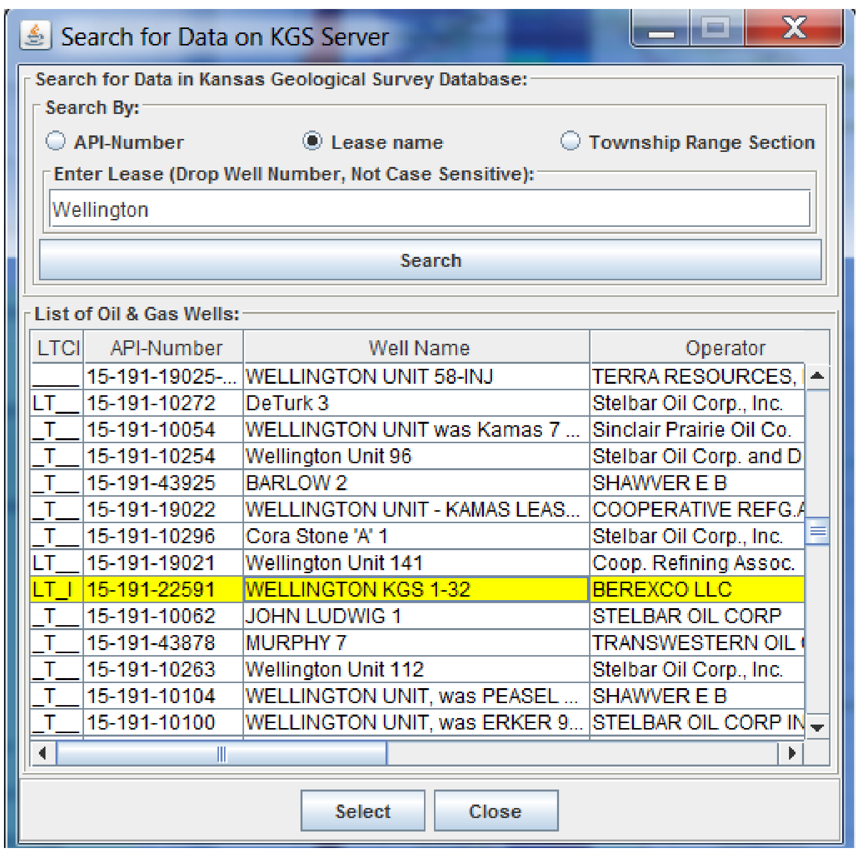
- By Partial Lease Name – The stored procedure used to retrieve the well header information allows the user to enter a partial phrase, in this example Wellington. The program places a '%' in front and back of the phrase and sends the request to the Database, i.e. "%Wellington%".



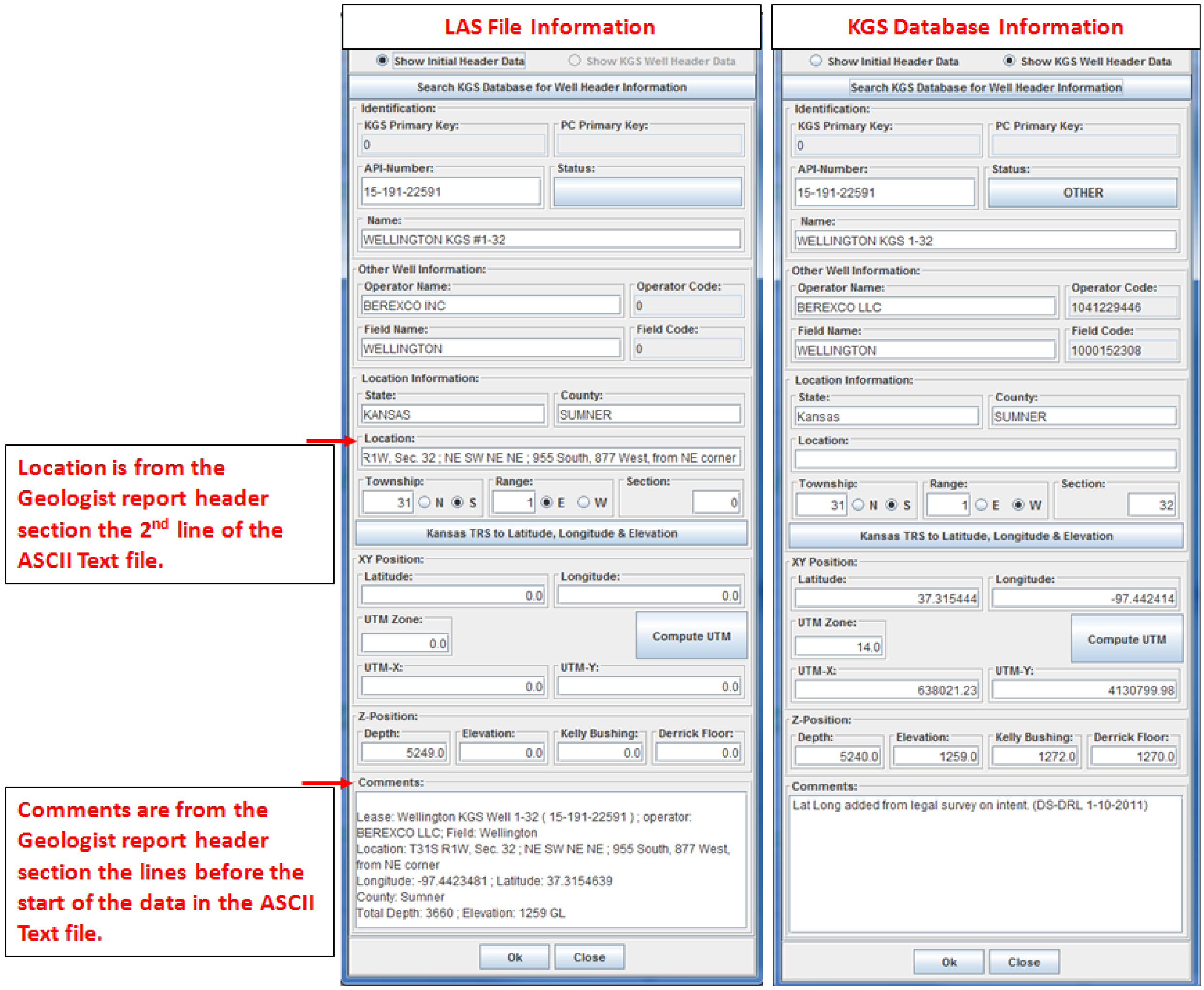
- By Township Range Section – This search is by location in Kansas, this search also allows the user to enter just the Township and Range to search for wells, e.g. to look for the Wellington KGS 1-32, enter Township as 31 set the S (South) Radio button and Range as 1 set the E (East) Radio button.



The user only needs to enter the above data and select the "Search" Button to display the list of Wells in the Kansas Database that match the search criteria. In the image below the Lease Name "Wellington" is entered to search for all wells in Kansas with the Phrase Wellington in it. The user searches through the list until they find the well of interest. In this example it is the Wellington KGS 1-32, which is highlighted.



The user clicks on the "Select" button to transfer the header information to the Edit Header Information Dialog.



The "Show KGS Well Header Data" radio button will become enabled if the KGS well header information has been downloaded. The user can move between the initial header information by selecting the "Show Initial Header Data" radio button the KGS well header information by selecting the "Show KGS Well Header Data" radio button.

There a number of buttons on the panel that will allow the user to change or compute data in the header information. The "Kansas TRS to Latitude, Longitude & Elevation" Button computes the latitude, longitude and elevation from the township, range and section by making an Oracle PL/SQL Stored Procedure, e.g.

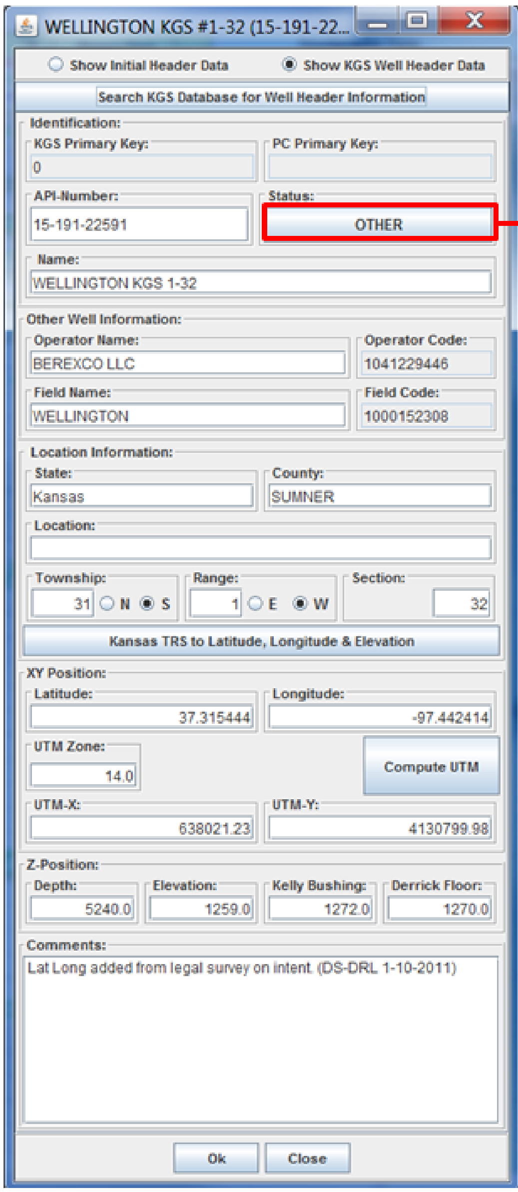
http://chasm.kgs.ku.edu/ords/iqstrat.TRS2LL_pkg.getXML?iTownship=31&sTownship=S&iRange=1&sRange=E&iSection=32

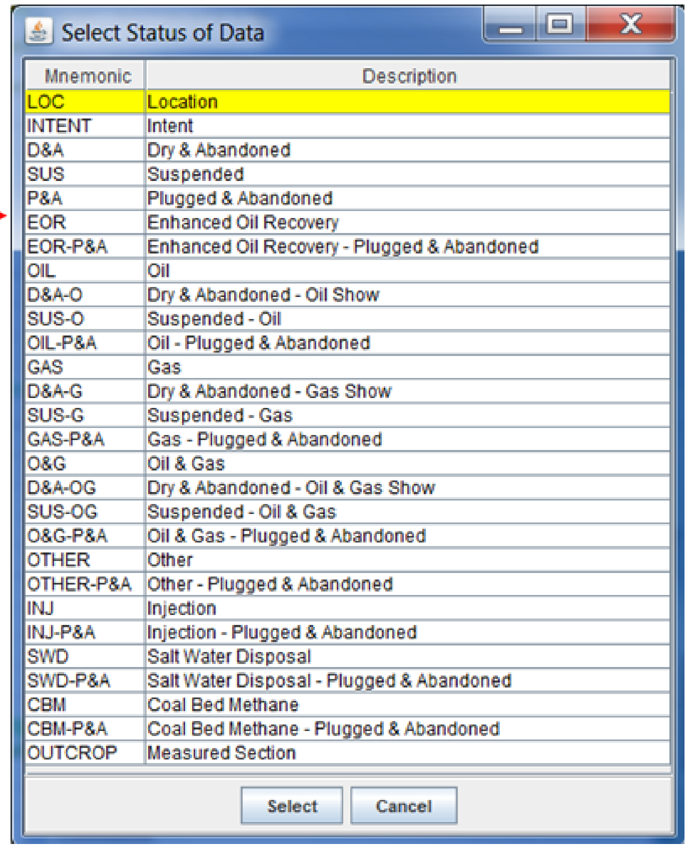
The call will return a XML with the latitude, longitude and ground level elevation.

```
<?xml version="1.0"?>
<!DOCTYPE headers [
<!ELEMENT headers (data*)>
<!ATTLIST headers records CDATA #IMPLIED>
<!ELEMENT data (info*,
                other?,
                loc?,
                xy?,
                z?,
                comments?,
                misc?,
                cnt?)>
<!ELEMENT info  EMPTY>
<!ATTLIST info  kid    CDATA #IMPLIED
                well_kid    CDATA #IMPLIED
                key    CDATA #IMPLIED
                type   CDATA #IMPLIED
                api    CDATA #IMPLIED
                name    CDATA #IMPLIED
                status CDATA #IMPLIED
                error  CDATA #IMPLIED>
<!ELEMENT other EMPTY>
<!ATTLIST other operator  CDATA #IMPLIED
                oper_kid  CDATA #IMPLIED
                field     CDATA #IMPLIED
                field_kid CDATA #IMPLIED>
<!ELEMENT loc EMPTY>
<!ATTLIST loc state      CDATA #IMPLIED
              state_cd   CDATA #IMPLIED
              county     CDATA #IMPLIED
              county_cd CDATA #IMPLIED
              loc        CDATA #IMPLIED
              town       CDATA #IMPLIED
              town_dir   CDATA #IMPLIED
              range      CDATA #IMPLIED
              range_dir CDATA #IMPLIED
              section    CDATA #IMPLIED>
<!ELEMENT xy  EMPTY>
<!ATTLIST xy  latitude  CDATA #IMPLIED
              longitude CDATA #IMPLIED
              zone      CDATA #IMPLIED
              utm_x     CDATA #IMPLIED
              utm_y     CDATA #IMPLIED>
<!ELEMENT z   EMPTY>
<!ATTLIST z   depth     CDATA #IMPLIED
              gl        CDATA #IMPLIED
              kb        CDATA #IMPLIED
              df        CDATA #IMPLIED>
<!ELEMENT comments (#PCDATA)>
<!ELEMENT misc EMPTY>
<!ATTLIST misc user      CDATA #IMPLIED
               access    CDATA #IMPLIED
               source    CDATA #IMPLIED
               date      CDATA #IMPLIED>
<!ELEMENT cnt EMPTY>
<!ATTLIST cnt  las       CDATA #IMPLIED
               tops      CDATA #IMPLIED
               core      CDATA #IMPLIED
               images    CDATA #IMPLIED>]>
<headers records="1">
  <data>
    <loc town="31" town_dir="S" range="1" range_dir="E" section="32" />
    <xy latitude="37.311703" longitude="-97.339619" />
    <z gl="1277" />
  </data>
</headers>
```

The "UTM" Button will compute the UTM XY coordinates from the latitude & longitude. The analysis uses A Working Manual by John P. Snyder, U.S. Geological Survey Professional Paper 1395, USG Printing Office, Washington, DC, 1987 (http://pubs.er.usgs.gov/djvu/PP/PP_1395.pdf).

The Status button allows the user to change the well status.

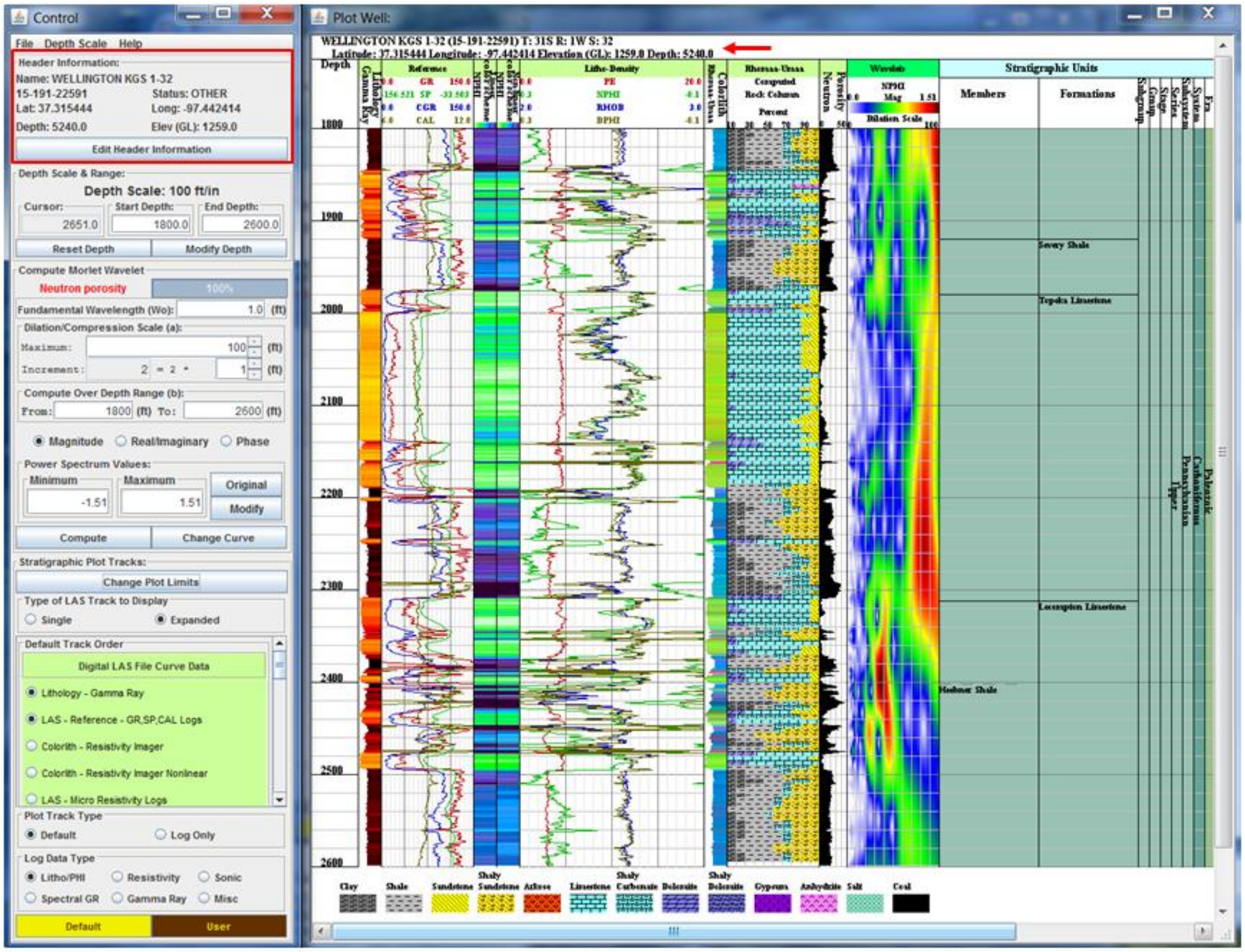




Select "Status" Button to display the "Select Status of Data" Dialog, which displays the list of possible common well status.

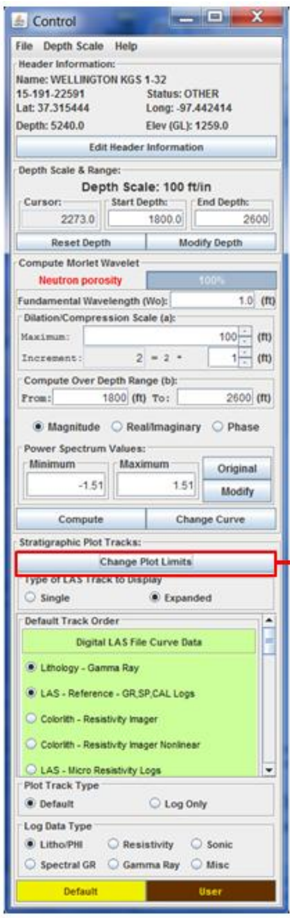
Highlight the desired status and click on the "Select" Button to transfer the Mnemonic to the "Status" Button text.

Select the “Ok” Button to update the Header Information in Wavelet program. The “Header Information” Summary Panel in the Control Dialog will change if any of the fields were modified, e.g. the latitude, longitude, status, depth and elevation and the Wavelet Plot.

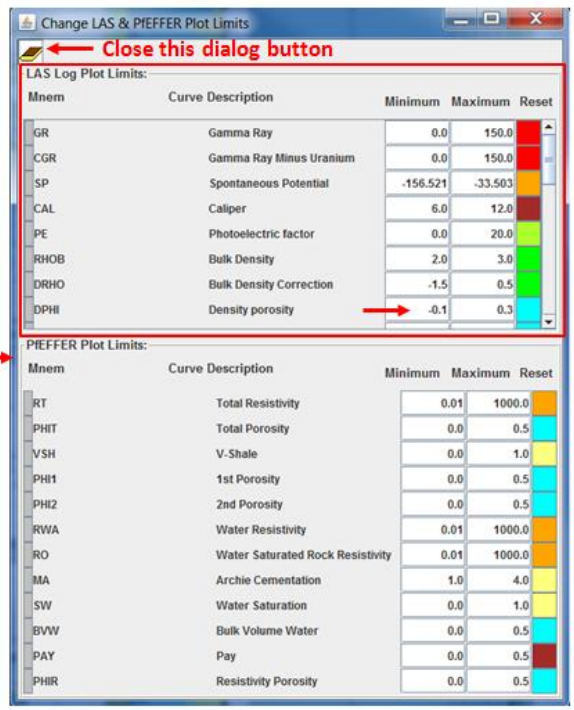


Change the Plot Track Limits

The “Change Plot Limits” Button on the Wavelet Control Dialog allows the user to change the limits of the log curves.



Select “Change Plot Limits” Button to display the “Change LAS & PfEFFER Plot Limits” Dialog. This dialog allows the user to change the plot limits in the Profile Plot. For Profile only the “LAS Log Plot Limits” Panel is important.



The user can change the limits of the curve limits in the plot track by changing the contents in the Minimum and Maximum text fields. The limits will change by group so if you change one porosity limit, e.g. DPHI from “-0.1 - 0.3” to “0.0 – 0.5” then all the porosity curves will change to the same limit.

Each color curve is color coded by unit to visually assist the user in the type of curves present.

Notice that the color boxes next to the curve limits of the curves are colored with different colors, which shows the curve type by unit.The Curves are colored by type (data units) as follows,

- Orange - OHM-M or Resistivity Logs
- Cyan – PU or porosity Logs, Neutron Porosity, Density Porosity, etc.
- Greenish yellow – BARNS/E or Photoelectric Factor Logs
- Green – GM/CC or Bulk Density Log
- Forest Green – USEC/FT or the Acoustic Transit Time Log
- Red – API, PPM or “%” as Radioactive logs, Gamma Ray, Spectral Gamma Ray, etc.
- Blue – MD or Permeability Logs
- Brown – F, FT or IN or Depth
- Middle yellow – FRAC, or other log curve types.
- Dark Violet – UNI or Unknown Linear Curves
- Medium Violet – UNL or Unknown Logrithum Curves

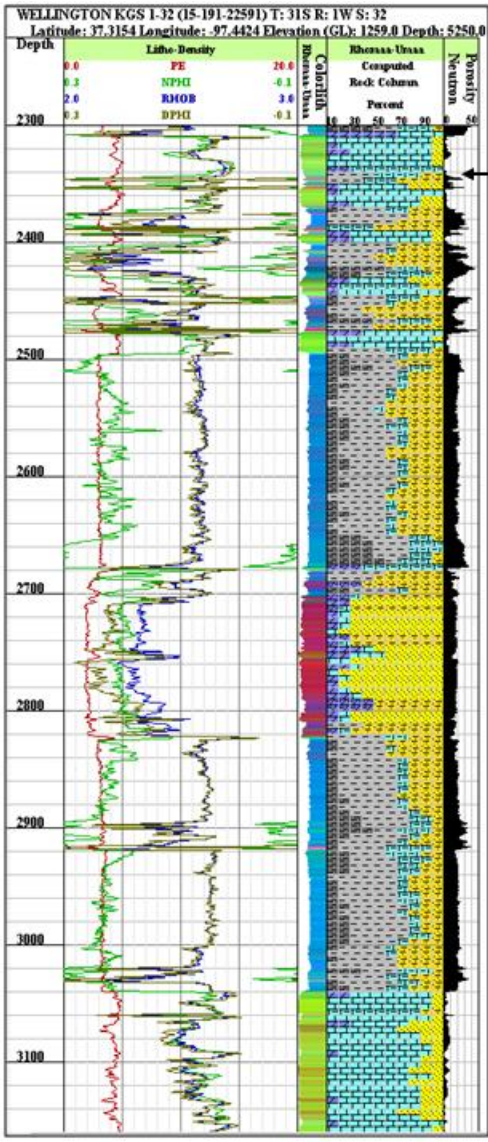
The color coding is the same as the “LAS File Curve Sections” Dialog that helps the user distinguish the type of curves available at a glance.

The user can change as many curves as they wish, understanding that each plot curves are grouped together, i.e. Porosity. The Resistivity curves are grouped by Plot Track so that if you change the Micro Normal Resistivity (MNOR) and Micro Inverse Resistivity (MINV) the Array Induction Resistivity (AHT) Curves will not automatically change unless the user wishes.

The above changes above are entered, i.e.

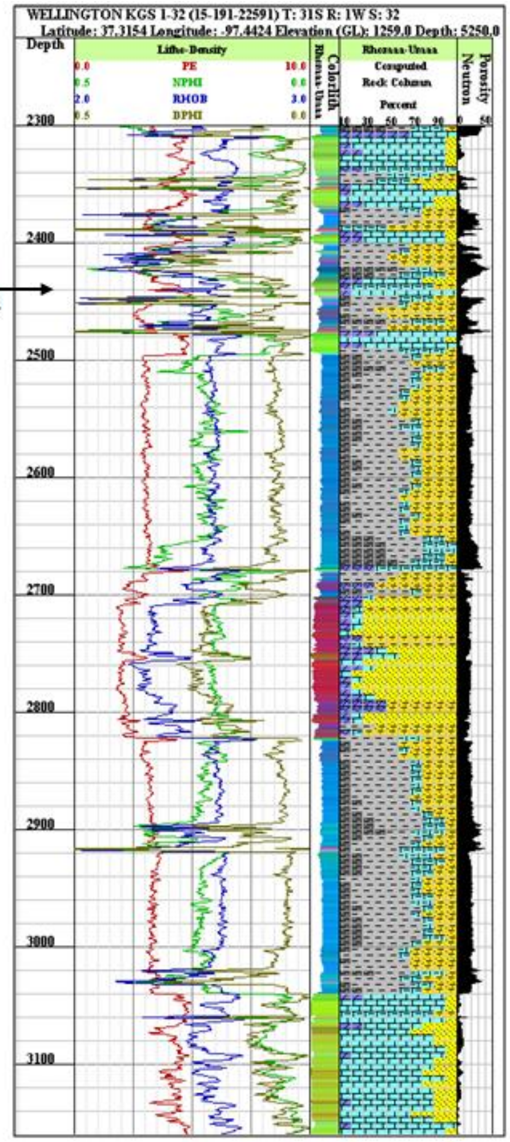
- The Photoelectric factor (PE) curve is changed from “0.0 to 20.0” to 0.0 to 10.0”
- The Neutron Porosity (NPHI) curve is changed from “-0.1 to 0.3” to “0.0 to 0.5” which also modifies the Density Porosity (DPHI) and the Sonic Porosity (SPHI) to the same limits.

As noted in the image the Wavelet plot is automatically modified as the user makes changes to each text field. View the “Litho-Density” Plot track (see image below) reflects the changes made to the plot curves.



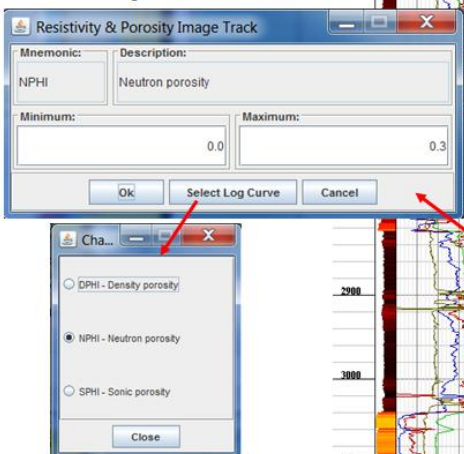
Before Limits are changed.

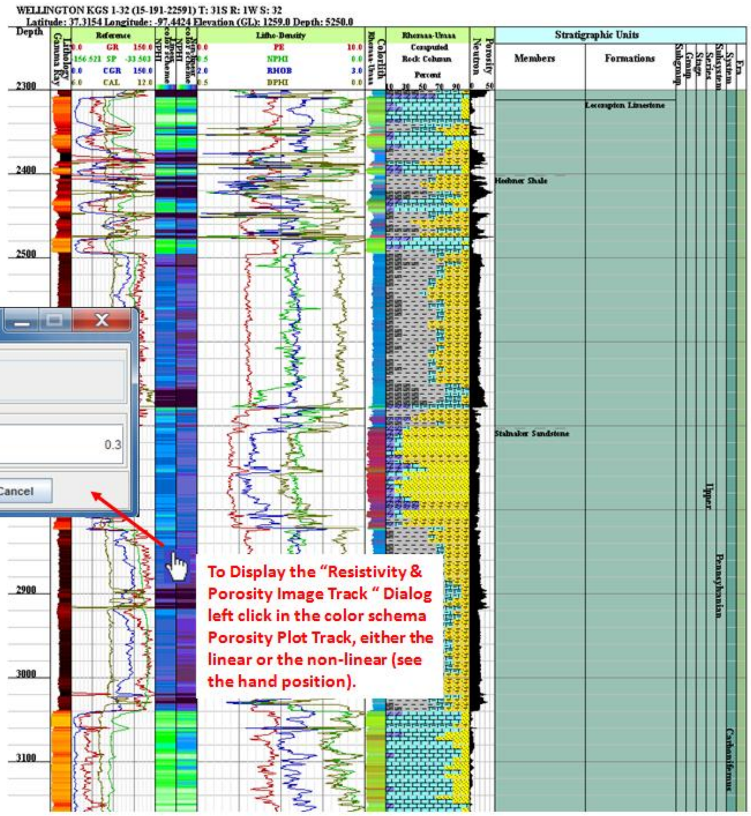
After Limits are changed.

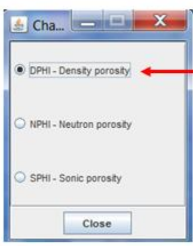


Changing the Colorlith – Porosity Imager Linear & Nonlinear Color Schema Tracks

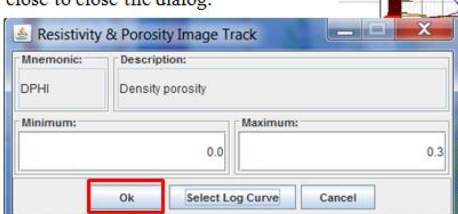
Click on the "Select Log Curve" Button to display the possible porosity curves that can be represented with the Porosity color schema plot track.





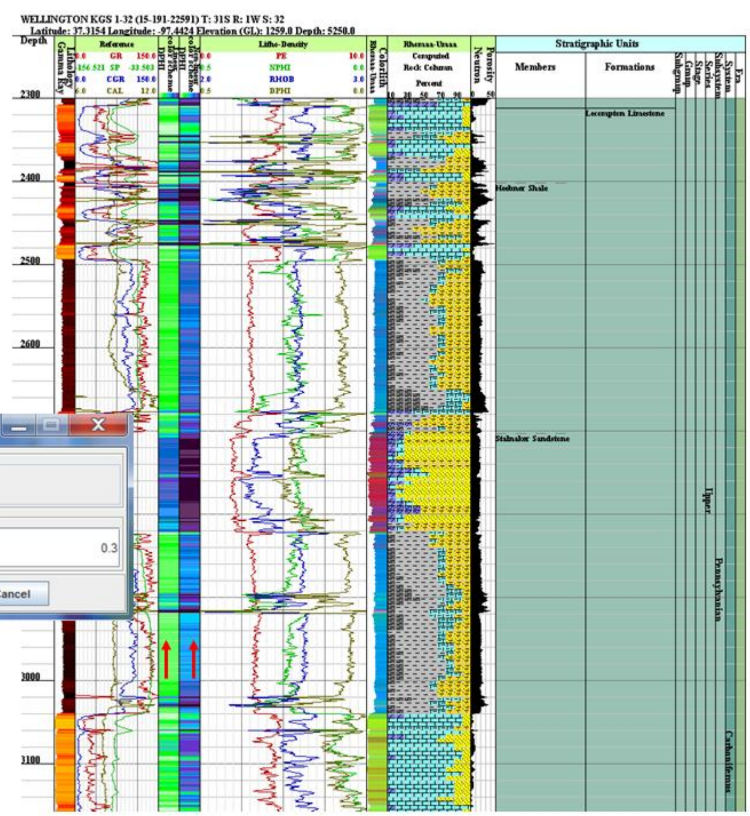


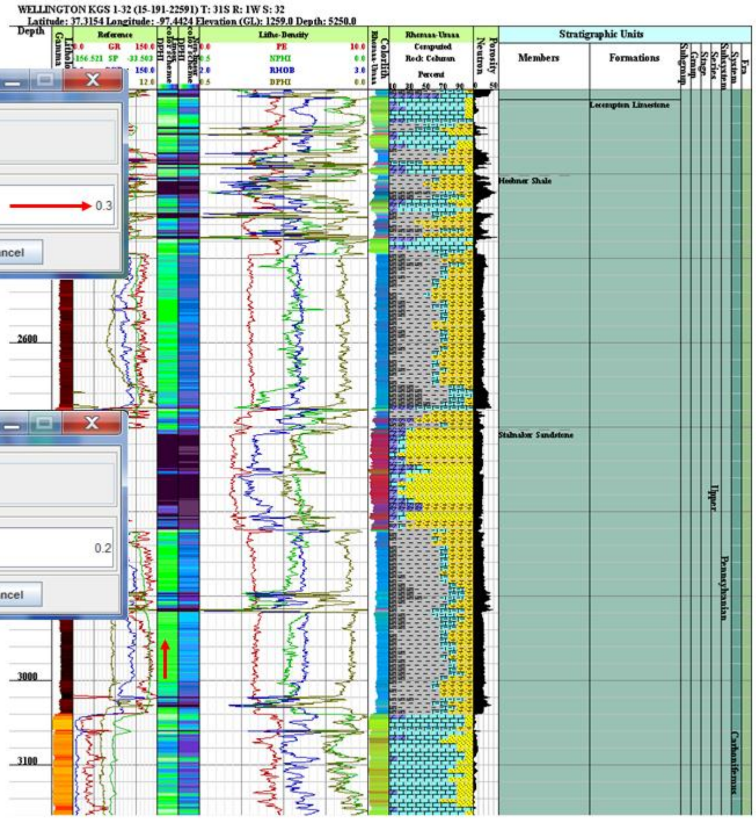
Click on "DPHI-Density porosity" radio button to change the porosity curve used to compute the color schema colorlith tracks. Then select close to close the dialog.

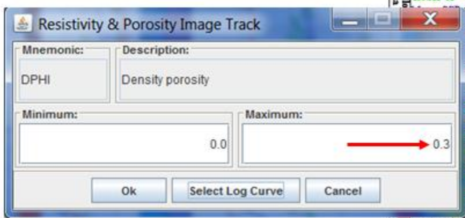


Select the Ok button to change the curve used in building the colorlith tracks.

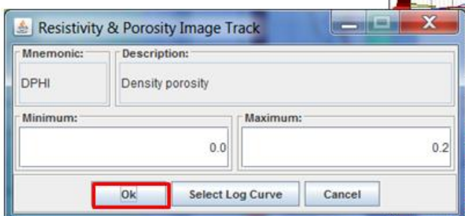
The linear & non-linear colorlith tracks are changed to represent the Density Porosity curve.







Change the Maximum value from 0.3 to 0.2 to change the color details in the linear track (left porosity colorlith color schema track).



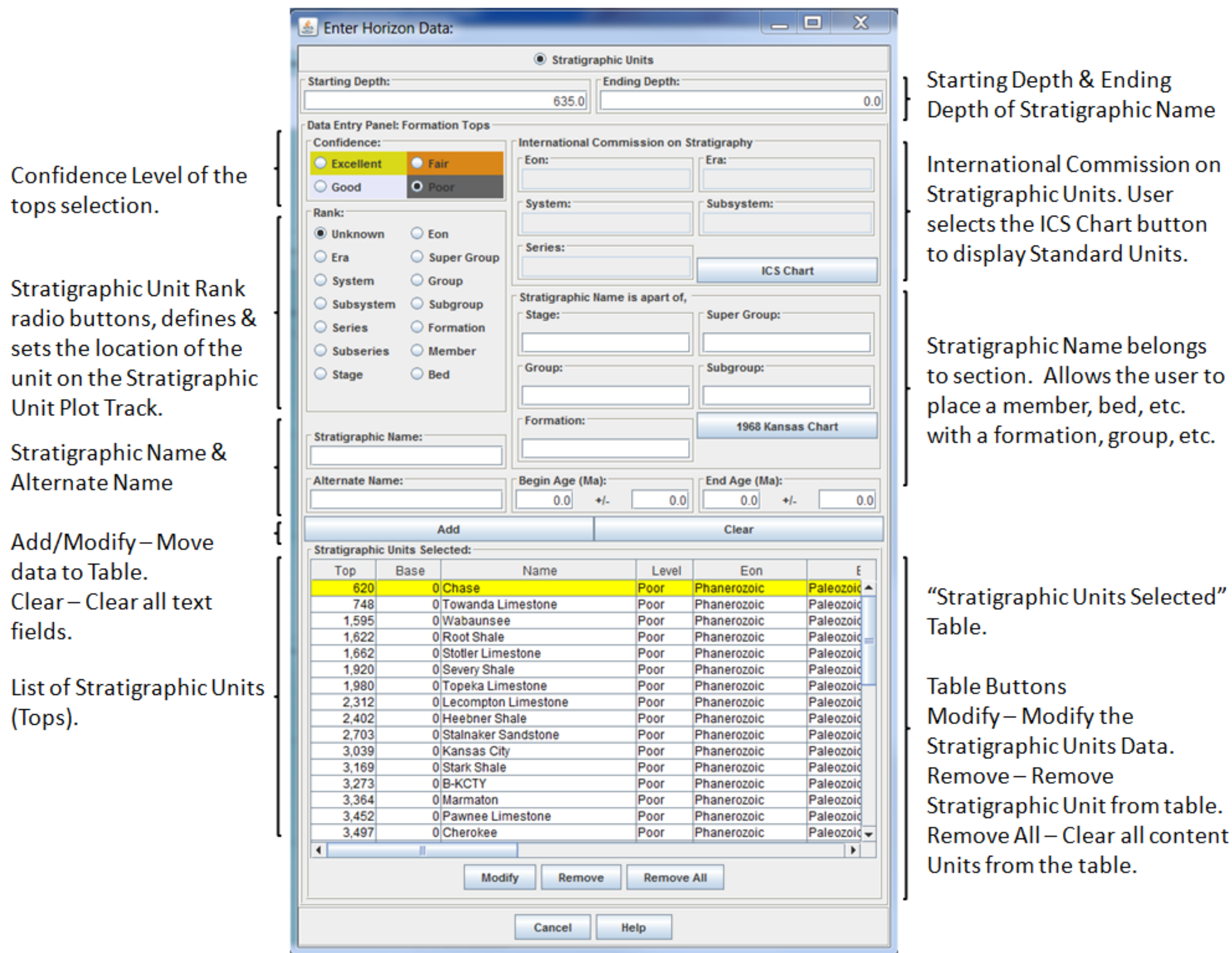
Select the Ok button to change the color details in the linear track.

Adding & Modifying Tops

Enter Horizon Data - Stratigraphic Units Panel

The Stratigraphic Units Panel allows the user to Add, Modify or Remove Stratigraphic Units. There are two files that are used to assist in mapping Stratigraphic Units to a specific top name.

- The 2010 International Commission on Stratigraphy Stratigraphic Units and RGB color for the Stratigraphic Units XML File (http://www.kgs.ku.edu/software/gemini/data/ISC.xml) are used to display the tops in the Stratigraphics Plot Track by Age (RGB Color).
- The Kansas Geological Survey (KGS) Stratigraphic Succession in Kansas, edited by D.E. Zeller, December 1968, updated 2012 (http://www.kgs.ku.edu/software/gemini/data/kansas.xml) will help map the Kansas Top Names to Stratigraphic Units, System, Sub-System, Series, etc. and to map the top depth of one top pick to the base depth of another top pick.



The KGS Stratigraphic Succession of Kansas edited by D. E. Zeller, Dec. 1968, updated 2012 (http://www.kgs.ku.edu/PRS/Ozark/TYPE_LOG/Stratigraphic/index.html).

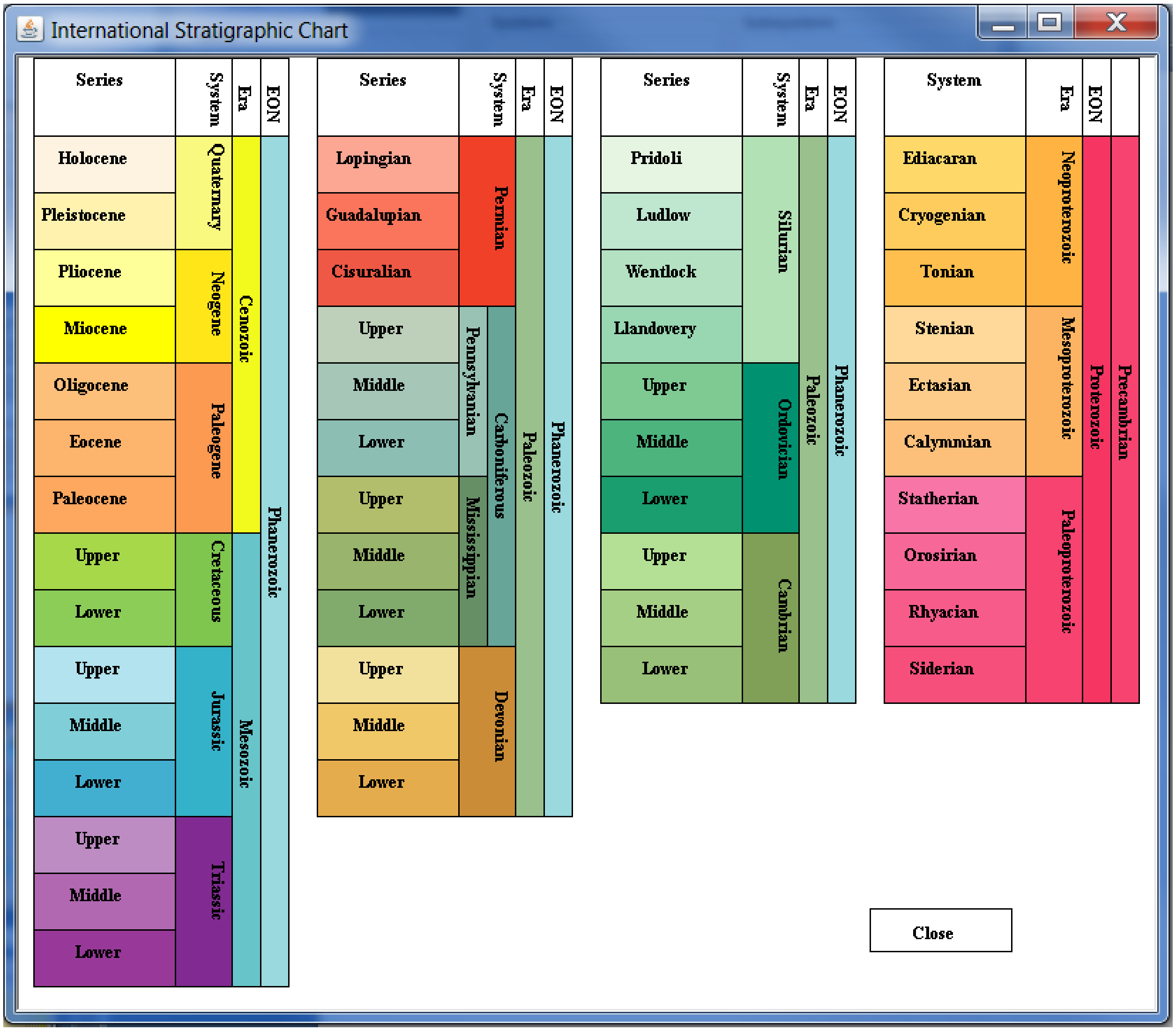
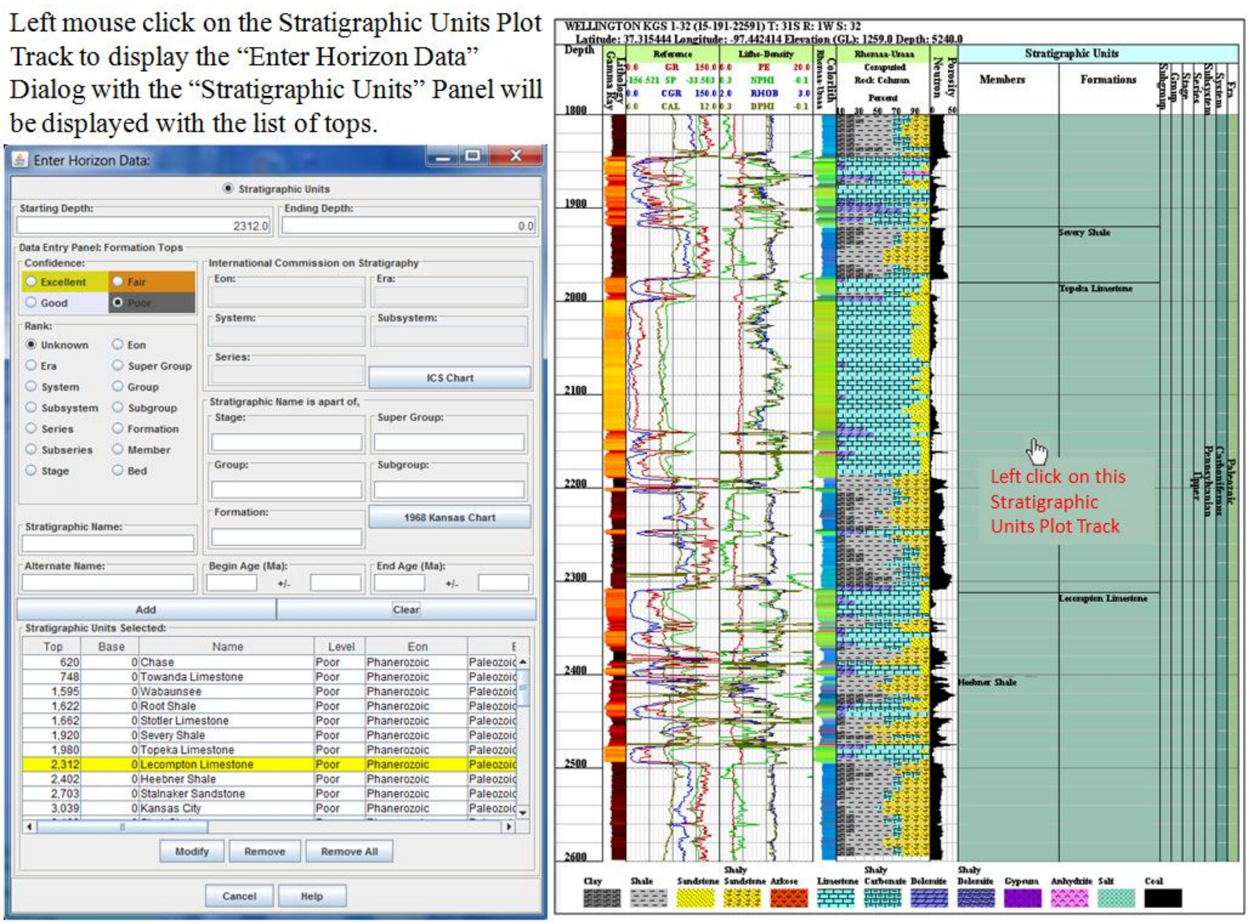


Figure: The 2010 International Commission on Stratigraphy Stratigraphic Units and RGB colors for the Stratigraphic Units.

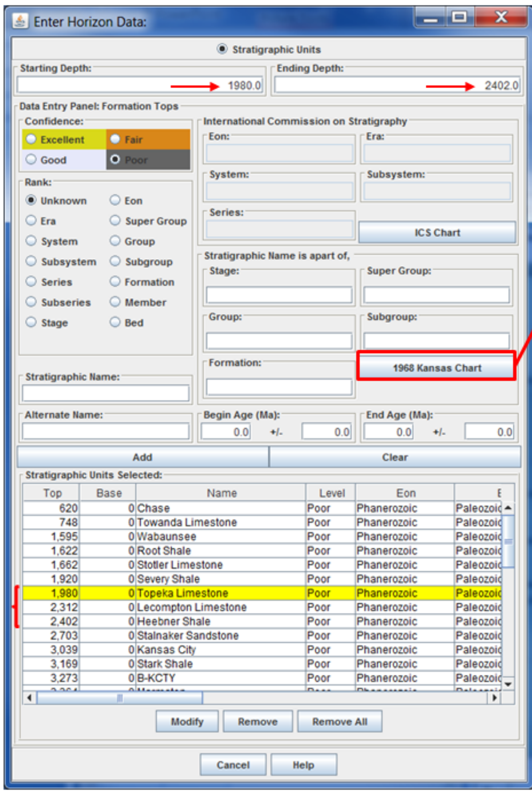
Add Shawnee Group to the Stratigraphic Units List

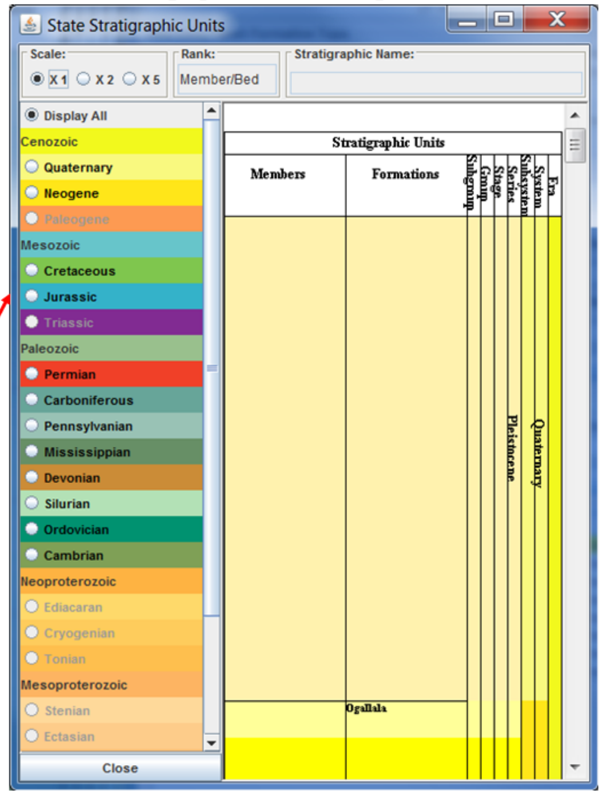
This first example is to add a Shawnee Group, which is part of the KGS Stratigraphic Succession in Kansas. First place the mouse in the Stratigraphic Units Plot Track and left click with the mouse to display the "Enter Horizon Data" Dialog with the "Stratigraphic Units" Panel.



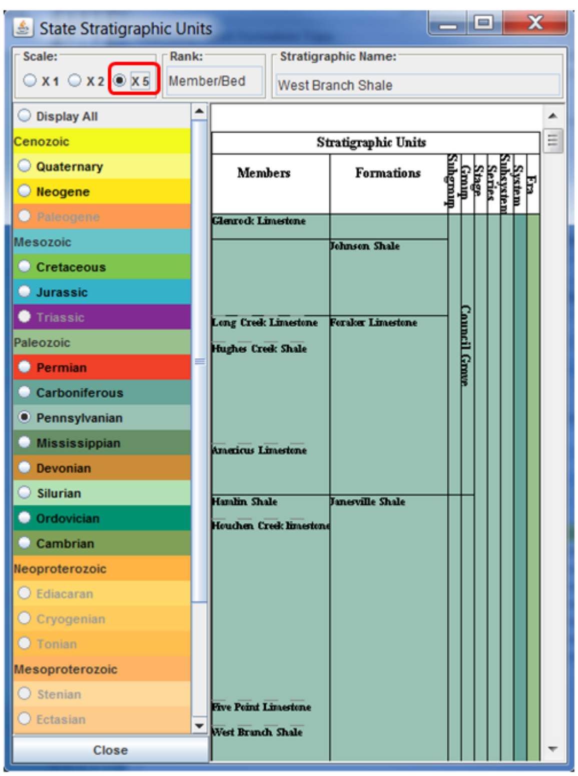
The user can manually enter the tops with as much information as they wish to display. If the stratigraphic unit is part of the Kansas Stratigraphic Units List all necessary fields can be loaded by using the "1968 Kansas Chart" button to display the list of Kansas Stratigraphic Units.

The Topeka Limestone, Lecompton Limestone and the Heebner Shale belong to the Shawnee Group, set the Starting Depth text field to 1980 and the Ending Depth text field to 2402.
Click on the "1968 Kansas Chart" Button to display the State Stratigraphic Units Dialog.

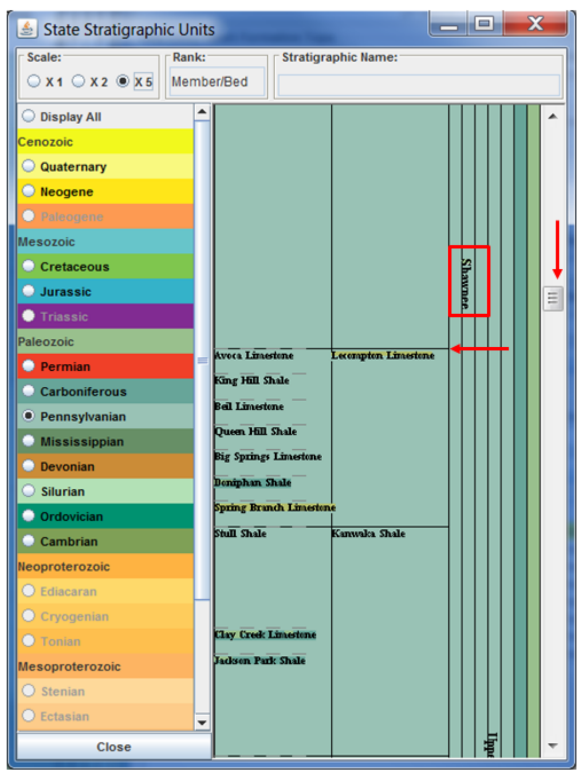




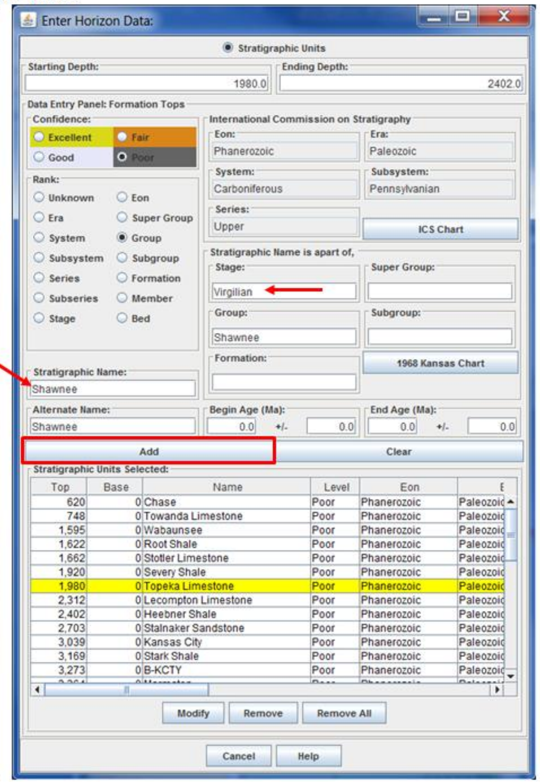
Change the Scale to X5, select the "Pennsylvanian" radio button.



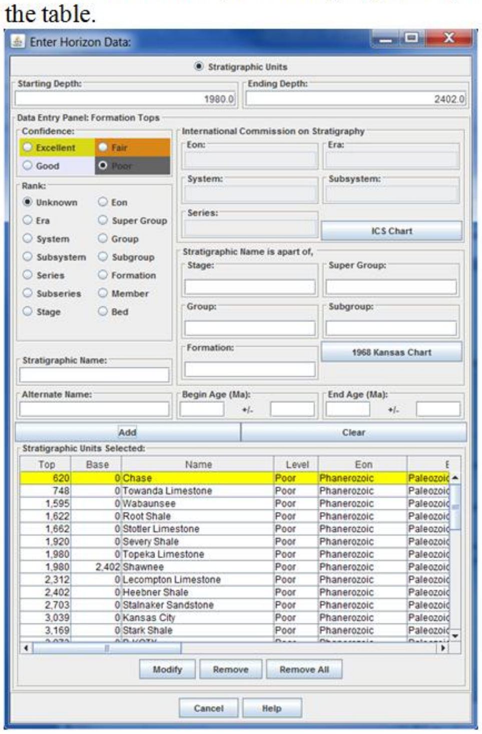
Scroll down to the Lecompton Limestone Formation. Notice it is part of the Shawnee Group.

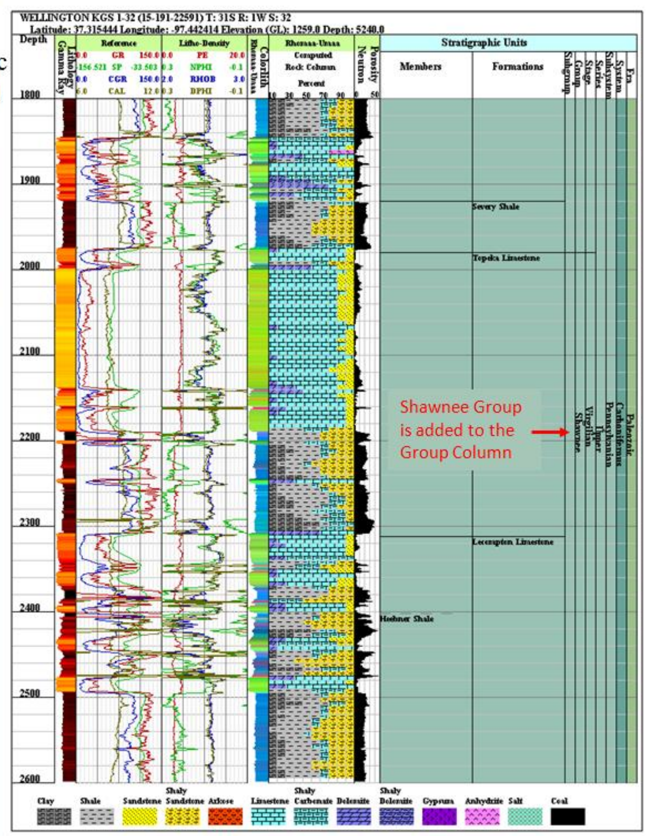


Left mouse click on the Shawnee Group text to transfer all the Stratigraphic Units to the "Stratigraphic Units" Panel on the "Enter Horizon Data" Dialog. Notice also that the Shawnee Group belongs to the Virgilian Stage. Select the "Add" Button to move Shawnee into the table.



Notice that the Shawnee Group is added to the Group Column of the Stratigraphic Units Plot Track. Shawnee was added to the "Stratigraphic Units Selected" table, see the highlighted top in the table.

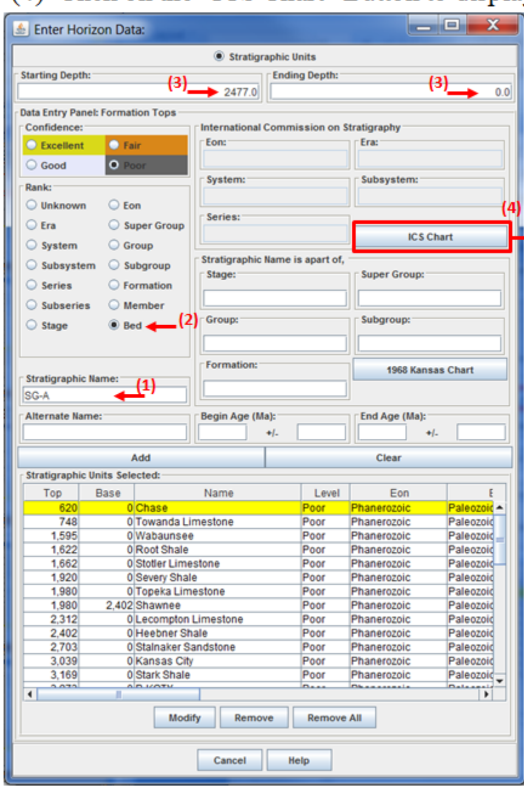


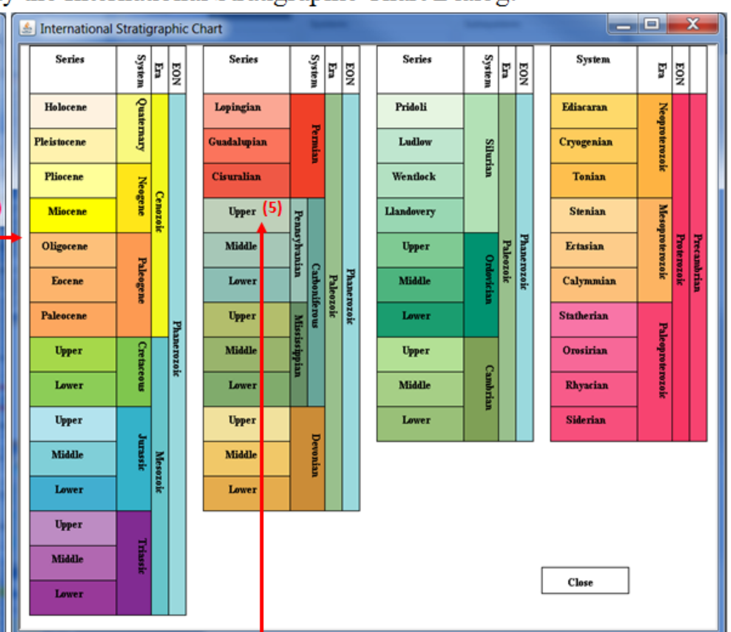


Add Unknown Bed (SG-A Bed) to the Stratigraphic Units List

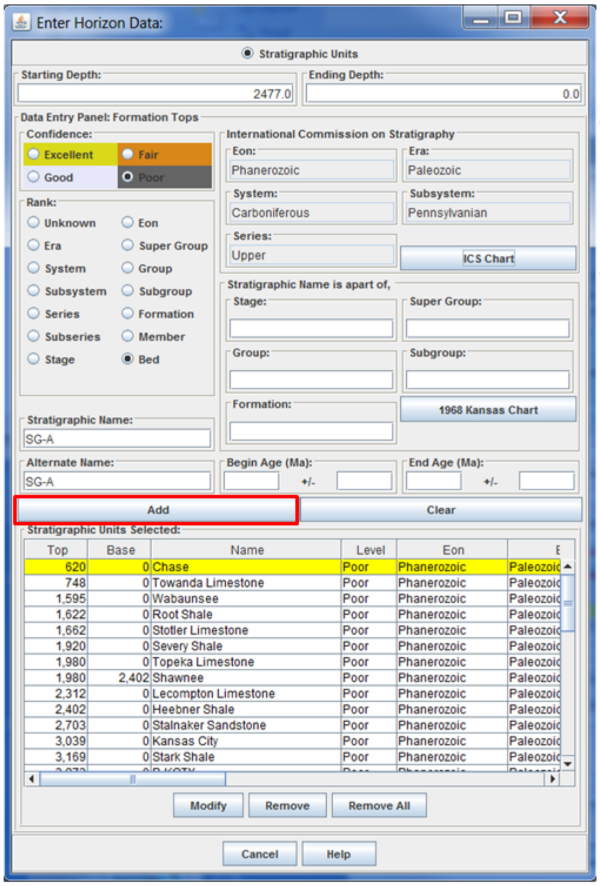
This second example is to add an unknown bed (SG-A Bed) to the Stratigraphic Units List, which is not part of the KGS Stratigraphic Succession in Kansas. This example will enter the basic information to the Depth Range text fields, the Stratigraphic Name text filed and setting the Rank as a BED. The Stratigraphic Units will be provided by the International Commission on Stratigraphy Dialog by selecting the "ICS Chart" Button. The "International Stratigraphic Chart" Dialog displays the stratigraphic units as a series of colored boxes, each stratigraphic unit is has the recommended RGB (Red-Green-Blue) Color defined by the International Commission on Stratigraphy. The user only needs to click the colored box to select all the stratigraphic data associated with the selected stratigraphic unit and transfer the data back to the "Stratigraphic Units" Panel in the "Enter Horizon Data" Dialog.

(1) Add SG-A to the "Stratigraphic Name" Text field.
(2) Select the Bed Radio Button in the Rank Panel
(3) Set the Starting Depth to 2477.0 and the Ending Depth to 0.0 Limestone Depth Range.
(4) Click on the "ICS Chart" Button to display the International Stratigraphic Chart Dialog.





(5) Left mouse click in the Upper Series Color Box under the Pennsylvanian System to transfer the Upper Pennsylvanian Stratigraphic Units Data to the "Stratigraphic Units" Panel on the "Enter Horizon Data" Dialog.

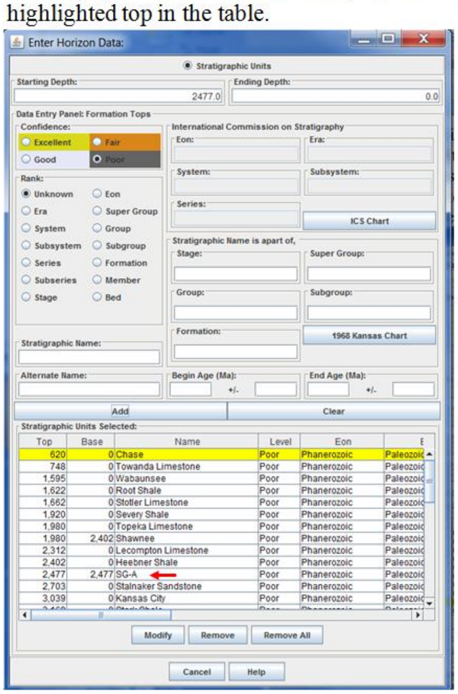


Top	Base	Name	Level	Eon	E
620	0	Chase	Poor	Phanerozoic	Paleozoic
748	0	Towanda Limestone	Poor	Phanerozoic	Paleozoic
1,595	0	Wabaunsee	Poor	Phanerozoic	Paleozoic
1,622	0	Root Shale	Poor	Phanerozoic	Paleozoic
1,662	0	Stotler Limestone	Poor	Phanerozoic	Paleozoic
1,920	0	Severy Shale	Poor	Phanerozoic	Paleozoic
1,980	0	Topeka Limestone	Poor	Phanerozoic	Paleozoic
1,980	2,402	Shawnee	Poor	Phanerozoic	Paleozoic
2,312	0	Lecompton Limestone	Poor	Phanerozoic	Paleozoic
2,402	0	Heebner Shale	Poor	Phanerozoic	Paleozoic
2,703	0	Stalnaker Sandstone	Poor	Phanerozoic	Paleozoic
3,039	0	Kansas City	Poor	Phanerozoic	Paleozoic
3,169	0	Stark Shale	Poor	Phanerozoic	Paleozoic

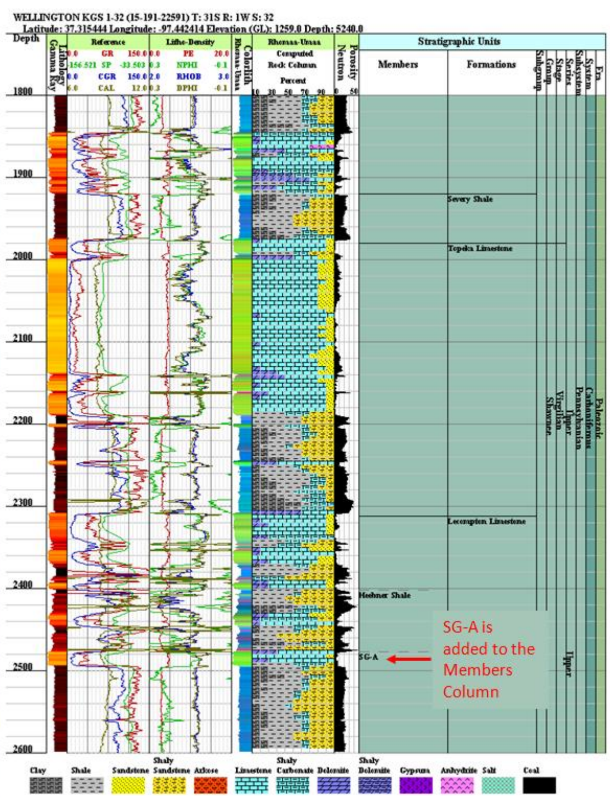
Notice that the Stratigraphic Units Data from the ICS Chart is transferred to the "International Commission on Stratigraphy" Panel.

Now Select the "Add" Button to transfer the Stratigraphic Units Data for the SG-A Bed to the "Stratigraphic Units Selected" Table.

Notice that the SG-A Bed is added to the Members Column of the Stratigraphic Units Plot Track. SG-A Bed was added to the "Stratigraphic Units Selected" table, see the highlighted top in the table.

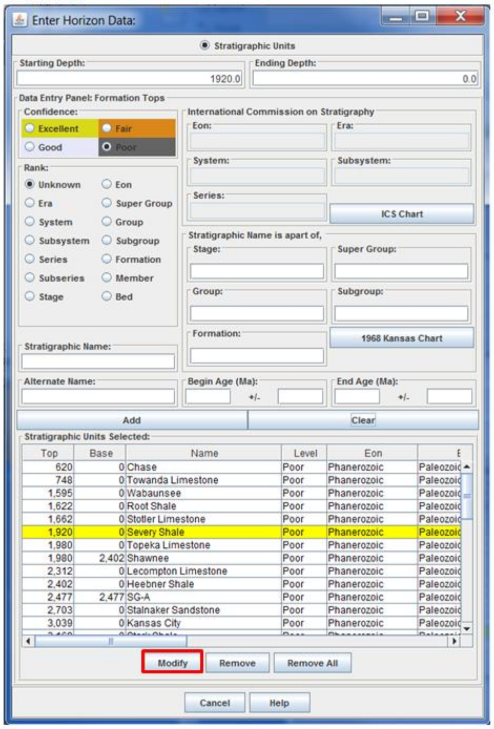


Top	Base	Name	Level	Eon	E
620	0	Chase	Poor	Phanerozoic	Paleozoic
748	0	Towanda Limestone	Poor	Phanerozoic	Paleozoic
1,595	0	Wabaunsee	Poor	Phanerozoic	Paleozoic
1,622	0	Root Shale	Poor	Phanerozoic	Paleozoic
1,662	0	Stotler Limestone	Poor	Phanerozoic	Paleozoic
1,920	0	Severy Shale	Poor	Phanerozoic	Paleozoic
1,980	0	Topeka Limestone	Poor	Phanerozoic	Paleozoic
1,980	2,402	Shawnee	Poor	Phanerozoic	Paleozoic
2,312	0	Lecompton Limestone	Poor	Phanerozoic	Paleozoic
2,402	0	Heebner Shale	Poor	Phanerozoic	Paleozoic
2,477	2,477	SG-A	Poor	Phanerozoic	Paleozoic
2,703	0	Stalnaker Sandstone	Poor	Phanerozoic	Paleozoic
3,039	0	Kansas City	Poor	Phanerozoic	Paleozoic

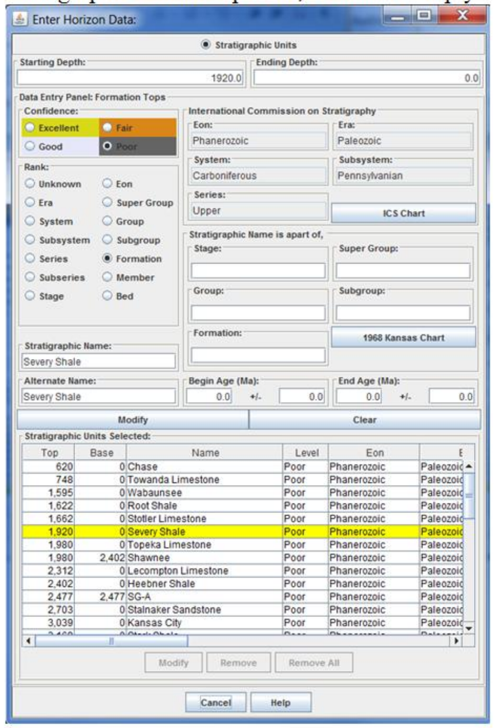


Modify data for the Severy Shale Formation in the Stratigraphic Units List

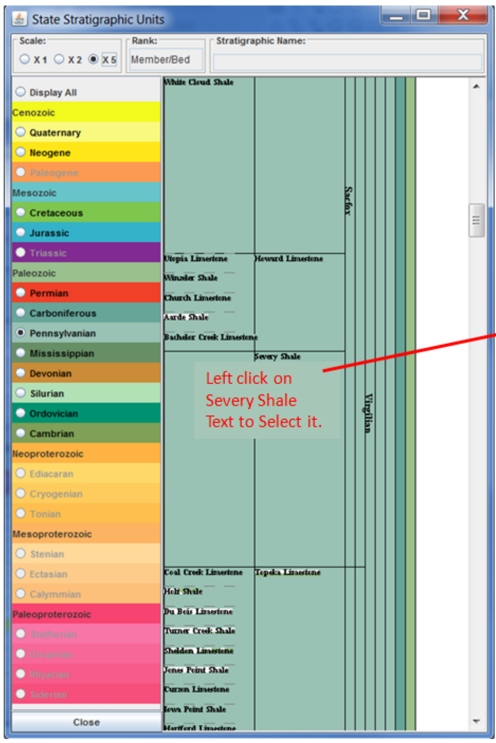
Highlight the Severy Shale, select the "Modify" Button.

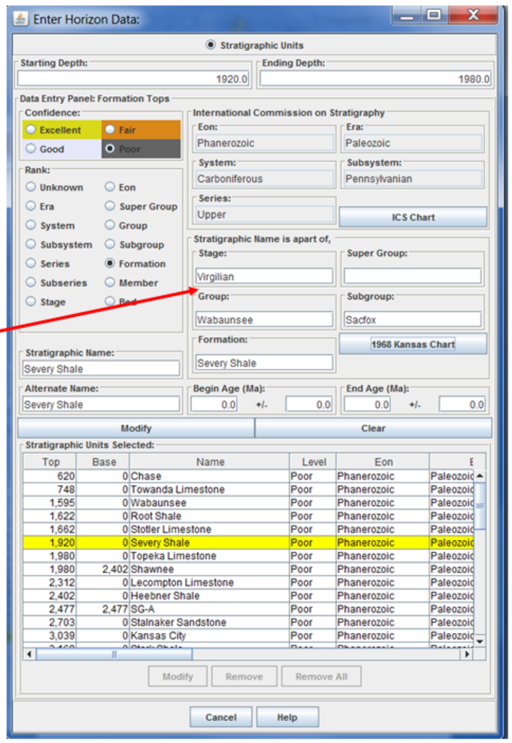


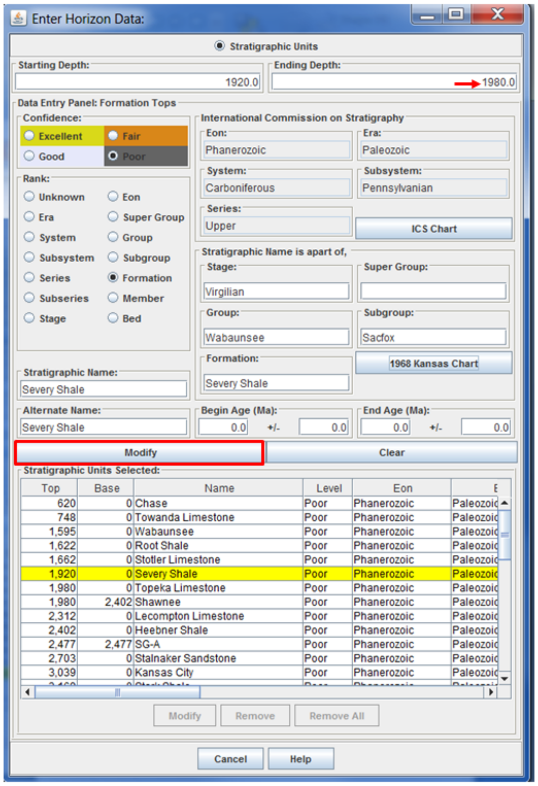
Notice the Stratigraphic Units Data are loaded into the Stratigraphic Units Panel Fields and the "Statigraphic Name is apart of," fields are empty.



Left mouse click on the Severy Shale text to transfer all the Stratigraphic Units to the "Stratigraphic Units" Panel on the "Enter Horizon Data" Dialog. Notice also that the Severy Shale belongs to the Wabaunsee.



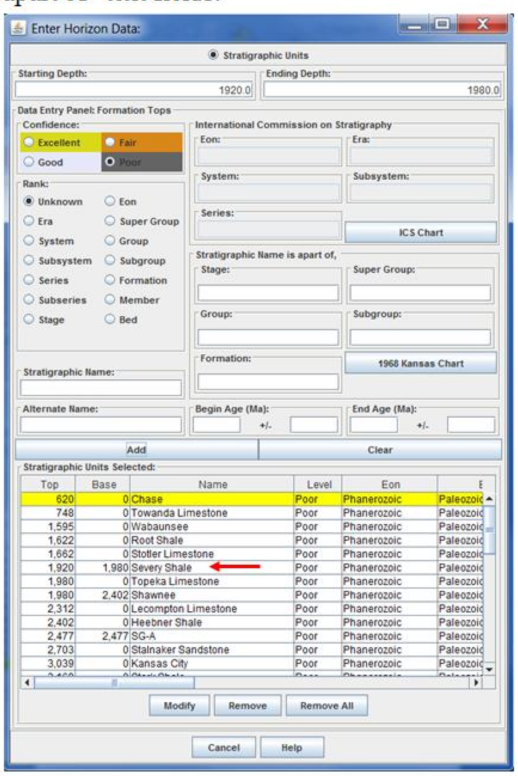


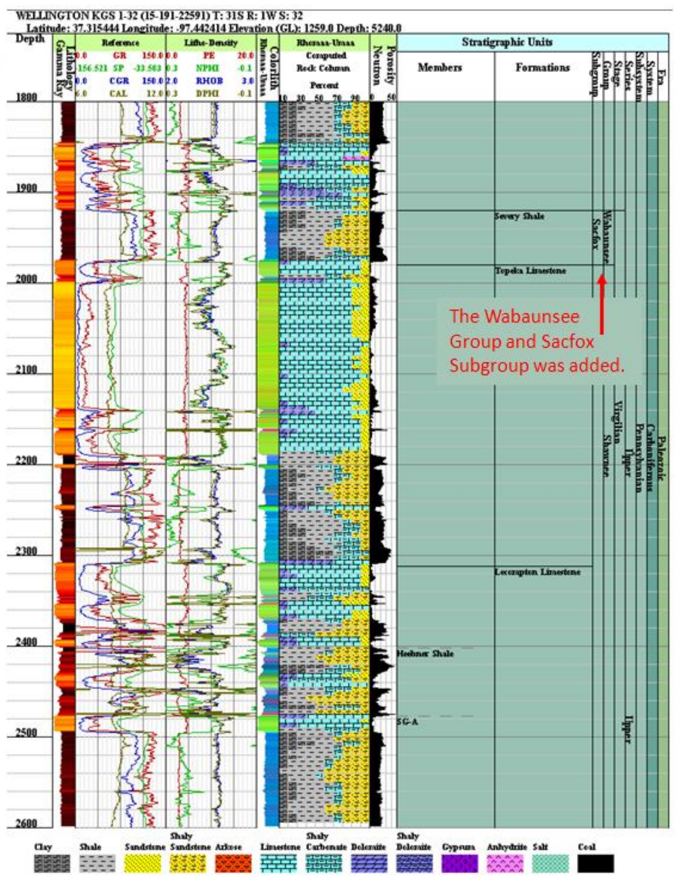


Change the Ending Depth to 1980.0, which is the start Depth of the Topeka Limestone and the next Formation.

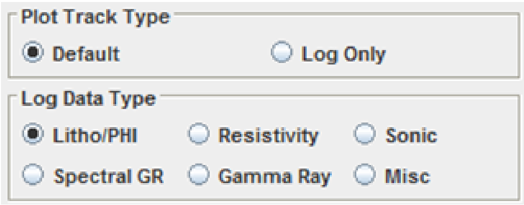
Now Select the "Modify" Button to save the changes and modify the contents of the "Severy Shale" Stratigraphic Units in the "Stratigraphic Units Selected" table.

Notice that the Kanwaka Shale Formation has been modified to extend the ending depth to 1980'. This also add the "Stratigraphic Name is apart of" text fields.





Quick Plot Buttons – Plot Track Type - Default

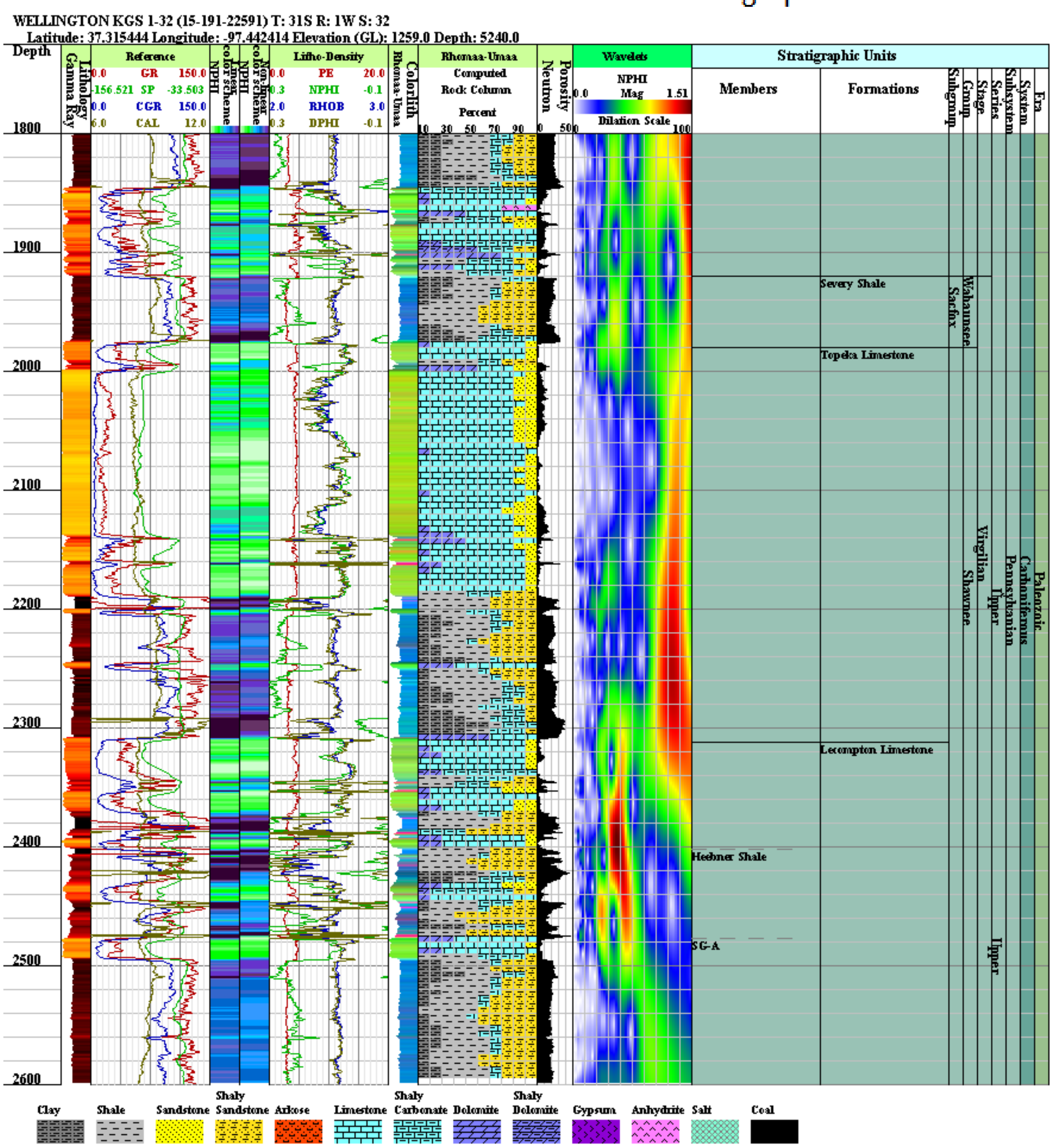


Digital LAS File Curve Data

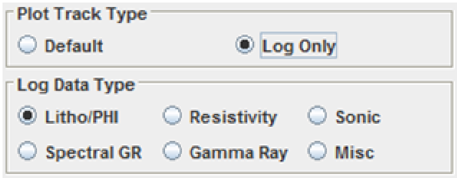
- Lithology – Gamma Ray
- LAS – Reference – GR, SP, CAL, Logs
- Colorlith – Porosity Imager
- Colorlith – Porosity Imager Nonlinear
- LAS – Litho-Density – NPHI, RHOB, PE Logs
- Colorlith – Rhoma-Umaa Track
- Lithology – Rhomaa-Umaa Track
- Thin Porosity Track
- Compute Wavelet Energy Spectrum

Horizons

- Horizons – Stratigraphic Units

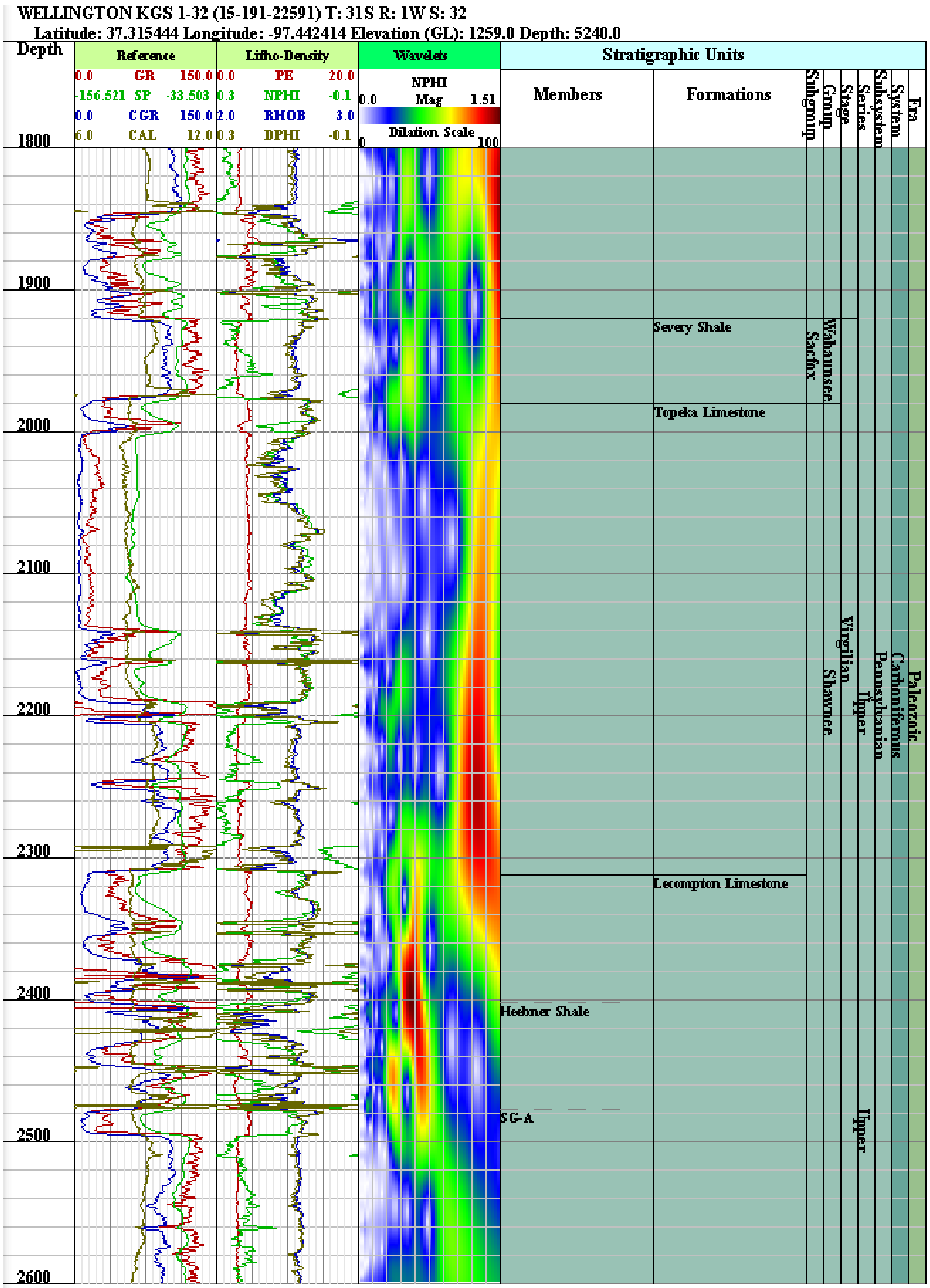


Quick Plot Buttons – Plot Track Type – Log Only

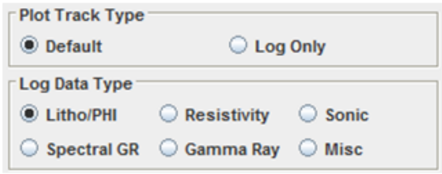


Digital LAS File Curve Data

- Lithology – Gamma Ray
- LAS – Reference – GR, SP, CAL, Logs
- LAS – Litho-Density – NPHI, RHOB, PE Logs
- Compute Wavelet Energy Spectrum Horizons
- Horizons – Stratigraphic Units



Quick Plot Buttons – Plot Track Type - Log/Colorlith

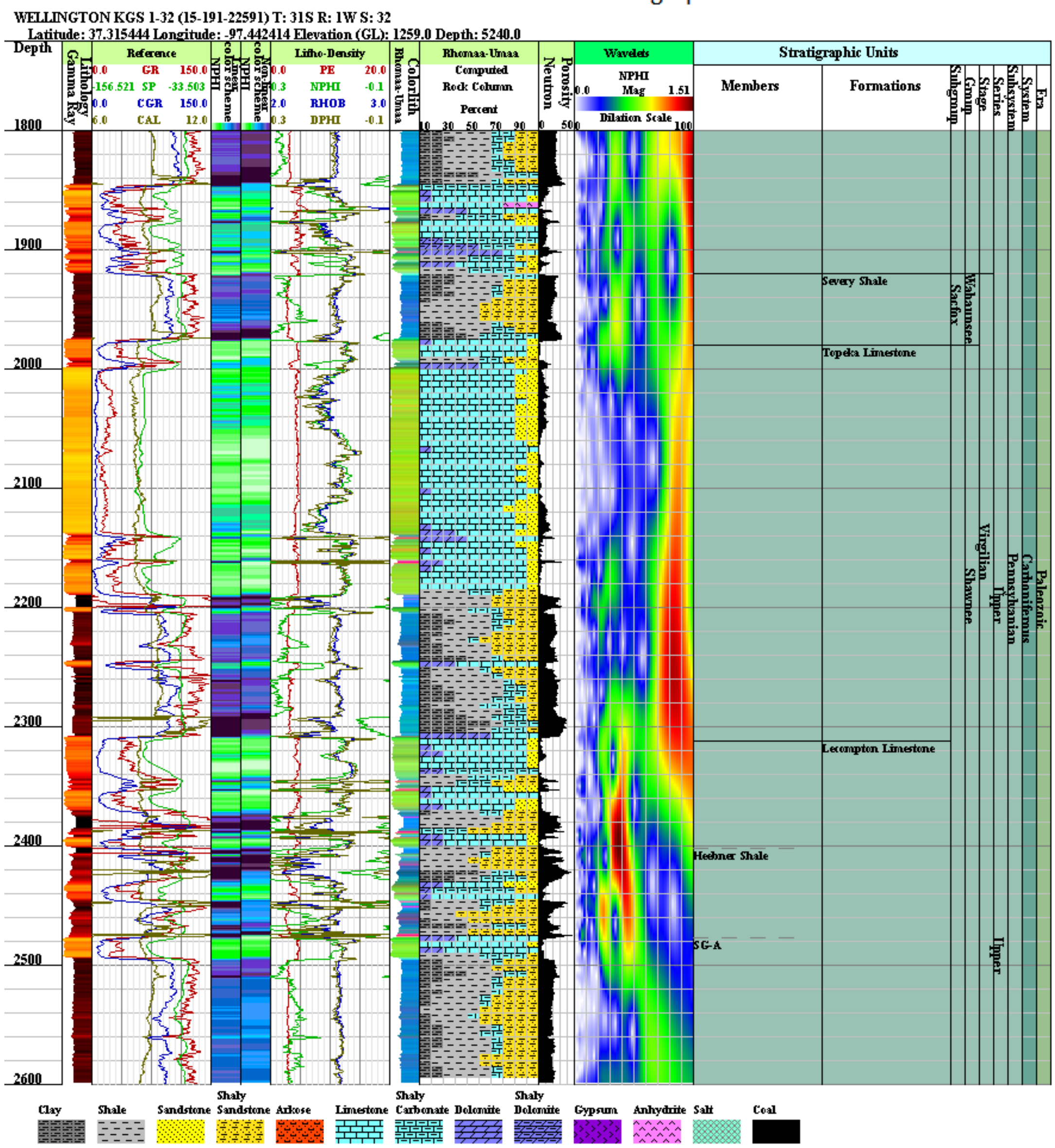


Digital LAS File Curve Data

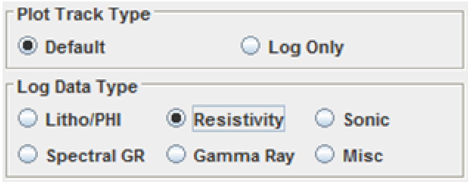
- Lithology – Gamma Ray
- LAS – Reference – GR, SP, CAL, Logs
- Colorlith – Porosity Imager
- Colorlith – Porosity Imager Nonlinear
- LAS – Litho-Density – NPHI, RHOB, PE Logs
- Colorlith – Rhoma-Umaa Track
- Lithology – Rhomaa-Umaa Track
- Thin Porosity Track
- Compute Wavelet Energy Spectrum

Horizons

- Horizons – Stratigraphic Units



Quick Plot Buttons – Log Data Type - Resistivity

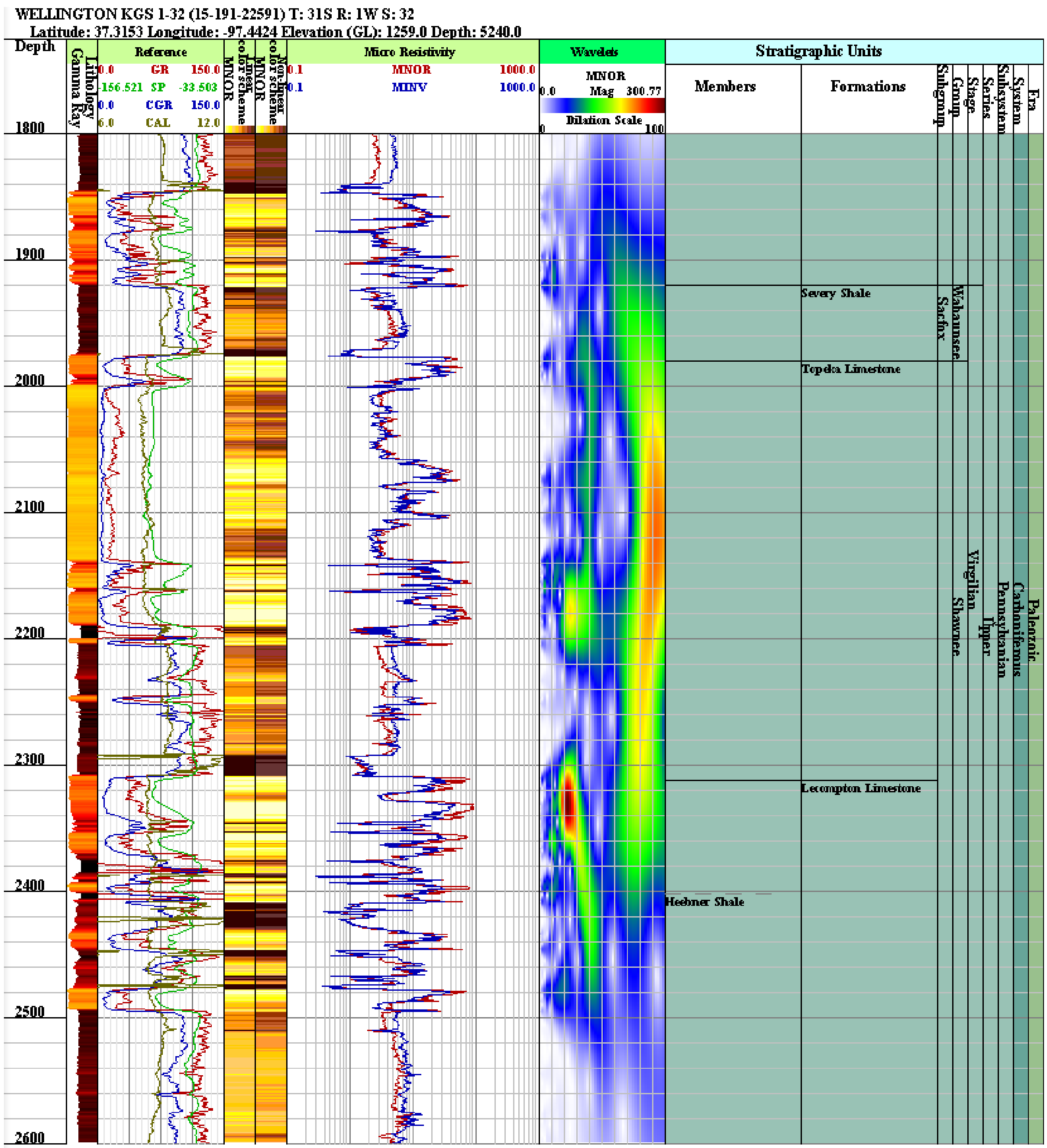


Digital LAS File Curve Data

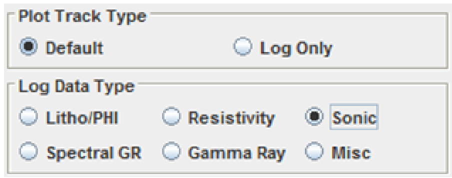
- Lithology – Gamma Ray
- LAS – Reference – GR, SP, CAL, Logs
- Colorlith – Resistivity Imager
- Colorlith – Resistivity Imager Nonlinear
- LAS – Micro Resistivity Logs
- Compute Wavelet Energy Spectrum

Horizons

- Horizons – Stratigraphic Units



Quick Plot Buttons – Log Data Type - Sonic

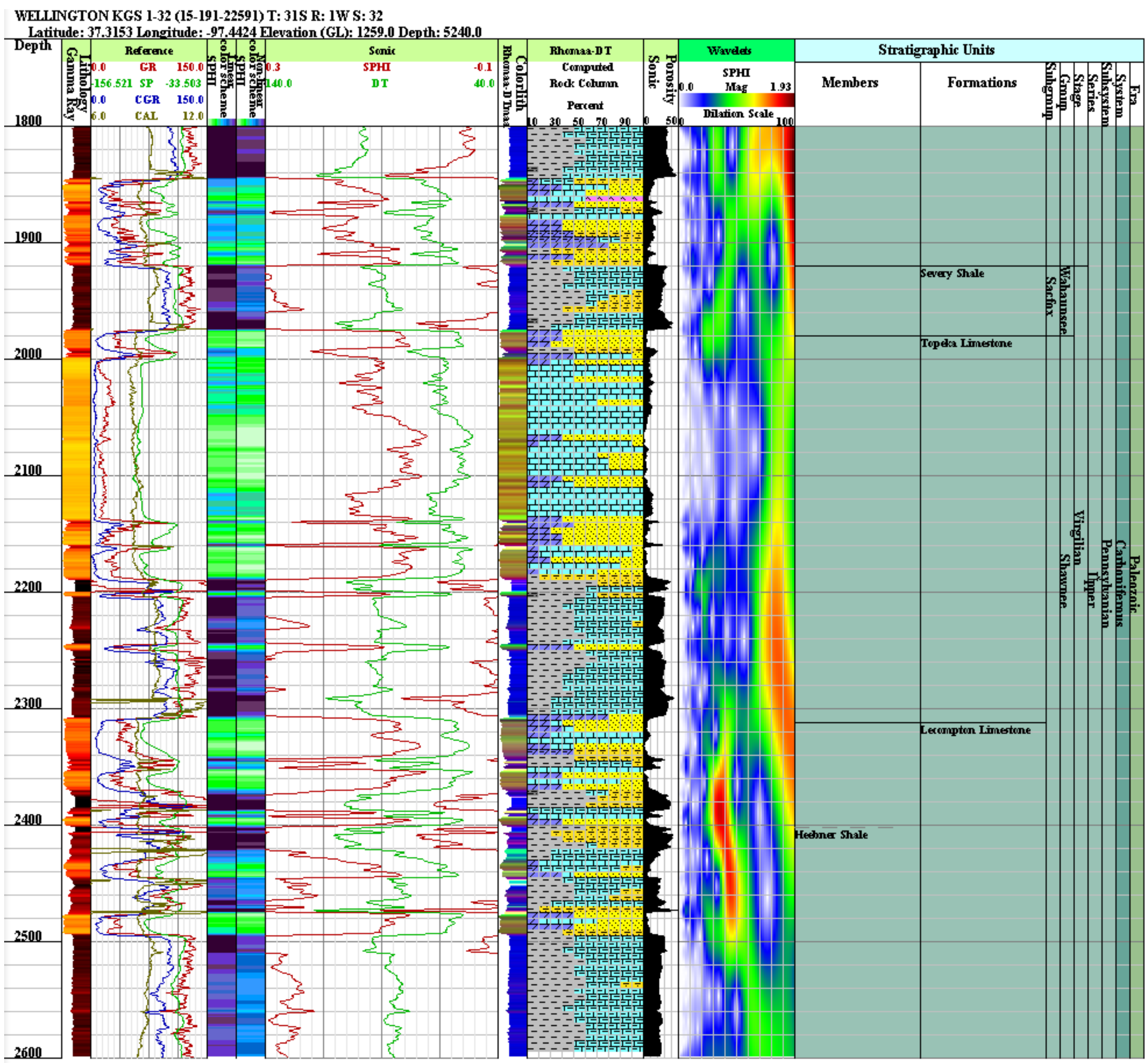


Digital LAS File Curve Data

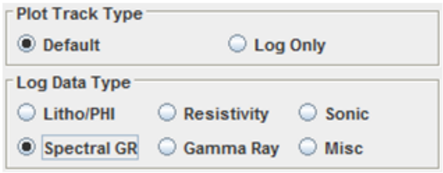
- Lithology – Gamma Ray
- LAS – Reference – GR, SP, CAL, Logs
- Colorlith – Porosity Imager
- Colorlith – Porosity Imager Nonlinear
- LAS – Sonic – SPHI, DT Logs
- Colorlith – Rhomaa-DT Track
- Lithology – Rhomaa-DTmaa Track
- Thin Porosity Track
- Compute Wavelet Energy Spectrum

Horizons

- Horizons – Stratigraphic Units



Quick Plot Buttons – Log Data Type - Spectral GR

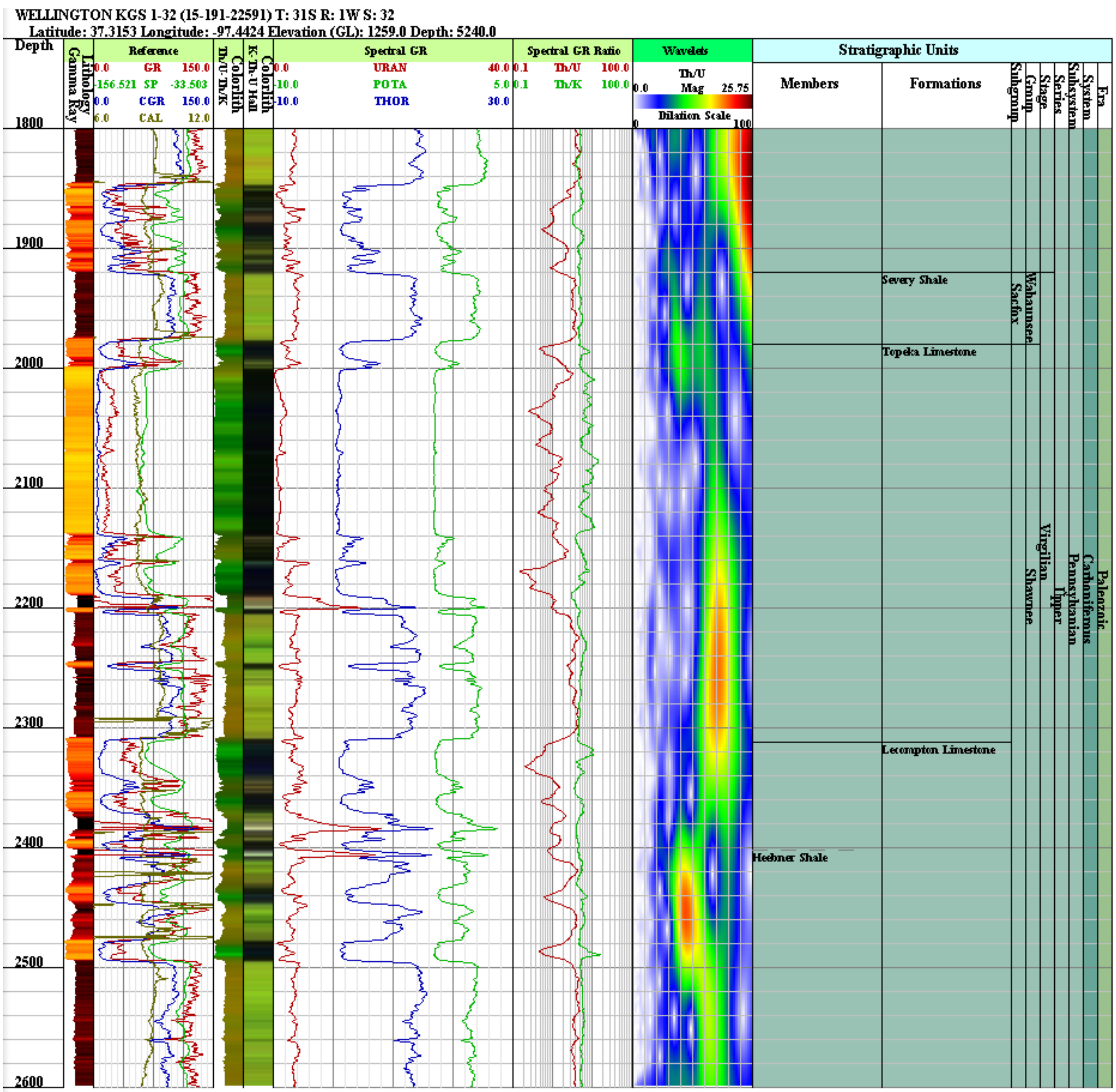


Digital LAS File Curve Data

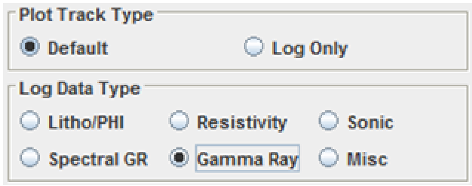
- Lithology – Gamma Ray
- LAS – Reference – GR, SP, CAL, Logs
- Colorlith – Th/U – Th/K Track
- Colorlith – Hall K-Th-U (RGB) Track
- LAS – Spectral Gamma Ray – Th, U, K Logs
- LAS – Spectral Gamma Ray Ratios
- Compute Wavelet Energy Spectrum

Horizons

- Horizons – Stratigraphic Units



Quick Plot Buttons – Log Data Type - Gamma Ray



Digital LAS File Curve Data
- Lithology – Gamma Ray
- LAS – Reference – GR, SP, CAL, Logs
- Compute Wavelet Energy Spectrum

Horizons
- Horizons – Stratigraphic Units