PS Wave Java Applet

by John R. Victorine

Introduction

The PS Wave web app was designed to allow the user to build a spread sheet of average compression & shear times and velocities from a shallow seismic event in the subsurface within an array of seismic sensors. The program uses and extends the Zone Kluster ("ZeKe") - A Depth Constrained Cluster Analysis web applet to compute "Beds" from log data using digital Log ASCII Standard (LAS) version 2.0 & 3.0 files, which are ordered along the dimensions of depth. Depth Constrained Cluster Analysis appeared in PfEFFER Pro an Excel Spread Sheet Program developed by the Kansas Geological Survey, released 1998. It also appeared in GEMINI (**G**eo-**E**ngineering **M**odeling through **IN**ternet **I**nformatics) web application developed by Kansas Geological Survey 2000 - 2003. The program allows the user to save the log data averages used to compute the "beds" to a Comma Separated Values (CSV) ASCII file that can be imported into the PS Wave Java Applet. The program can be found at the GEMINI Tools Web site (http://www.kgs.ku.edu/Gemini/Tools/Tools.html) or directly to the Zonation Web Site (http://www.kgs.ku.edu/stratigraphic/ZONATION/). The PS Wave program allows the user to import a LAS version 2.0 or 3.0 file only and will force the user to the Zone Kluster ("ZeKe") - A Depth Constrained Cluster Analysis dialog to create "Beds" before computing the average times or velocities for the compression and shear waves.

A description for the Zone Kluster ("ZeKe") - A Depth Constrained Cluster Analysis web app can be found at http://www.kgs.ku.edu/stratigraphic/ZONATION/description.html.

NOTE: The PS Wave program requires both the Acoustic Transit Time (DTc) and Shear (DTs) log curves to work or the Acoustic Transit Time (DTc) and Litho-Density Logs, i.e. Gamma Ray (GR), Neutron Porosity (NPHI) and Density Porosity (NPHI) computed in a Limestone Matrix or Bulk Density (RHOB) as a minimum from which the Shear (DTs) log curve can be computed from defined Velocity Ratio (Vp/Vs) for specific lithologies, i.e.

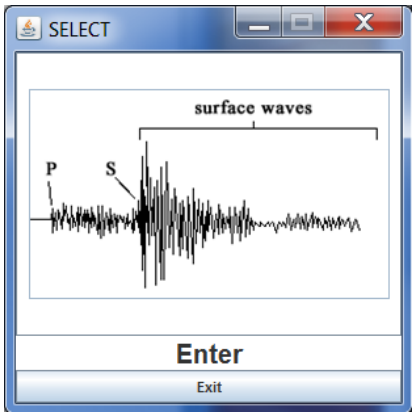
Vp/Vs	Lithology
1.55	Very Clean Sandstone
1.6	Clean Sandstone
1.68	Shaly Sandstone
1.7	Compact Shale
1.9	Limestone
1.8	Dolomite
1.75	Salt
1.85	Anhydrite
1.59	Coal

Pickett (1963)

The PS Wave 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, Zonation Output CSV File, Tops, and Geologist Cuttings Report/Core Description. The program basically creates a "spread sheet" of sonic times and velocities by "Bed" Thickness, the

PS Wave will merge the Tops data into the spread sheet, which the user can modify. The PS Wave program provides a plot button that allows the user to plot the zonation data as log data in a Profile Plot with the tops and geologist report to visualize the subsurface data. This program then allows the user to save the data in a Comma Separated Values (CSV) file, which can be read by the PS Wave Program or used in another Java program in predicting the depth of the seismic events (TBD).

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. 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 PS Wave Session and writes a CSV file to your PC to save data. To run the web app select the Seismic Image Icon Button in the "Enter" Panel illustrated below,



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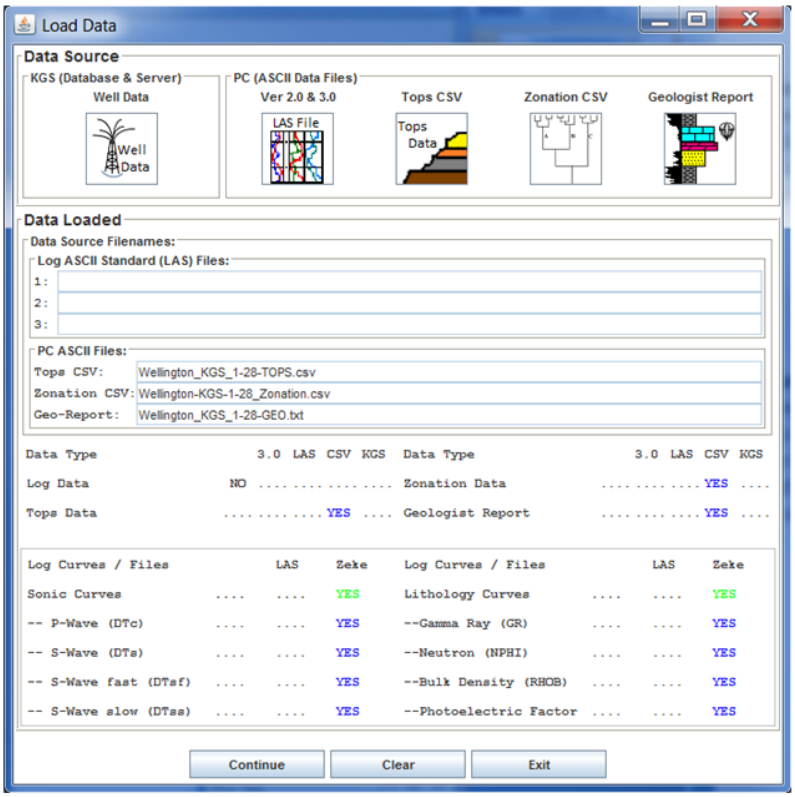
Loading Well Data

Click the "PS Wave 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 PS Wave Program.

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.



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

Load ASCII Delimited Data Files from PC.

Displays the Log ASCII Standard (LAS) file names.
Displays the Comma Separated Values (CSV) file name of files loaded.

Show the source of the data and type.

Show the well log data imported into the program.

Note: The log data used by this program are sonic and litho-density log curves.

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

Data Source Panel

The Data Source Panel provides two methods of importing data into the PS Wave 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, Database Data: Formation Tops (Stratigraphic Units).

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 Web Application.

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

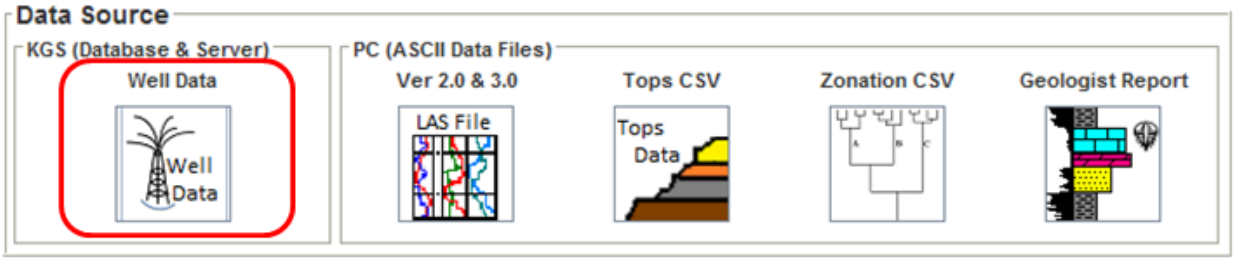
Geologist Report delimited ASCII File Read
This version will allow the user to read & parse a delimited geologist report ASCII file data.

Data Loaded Panel

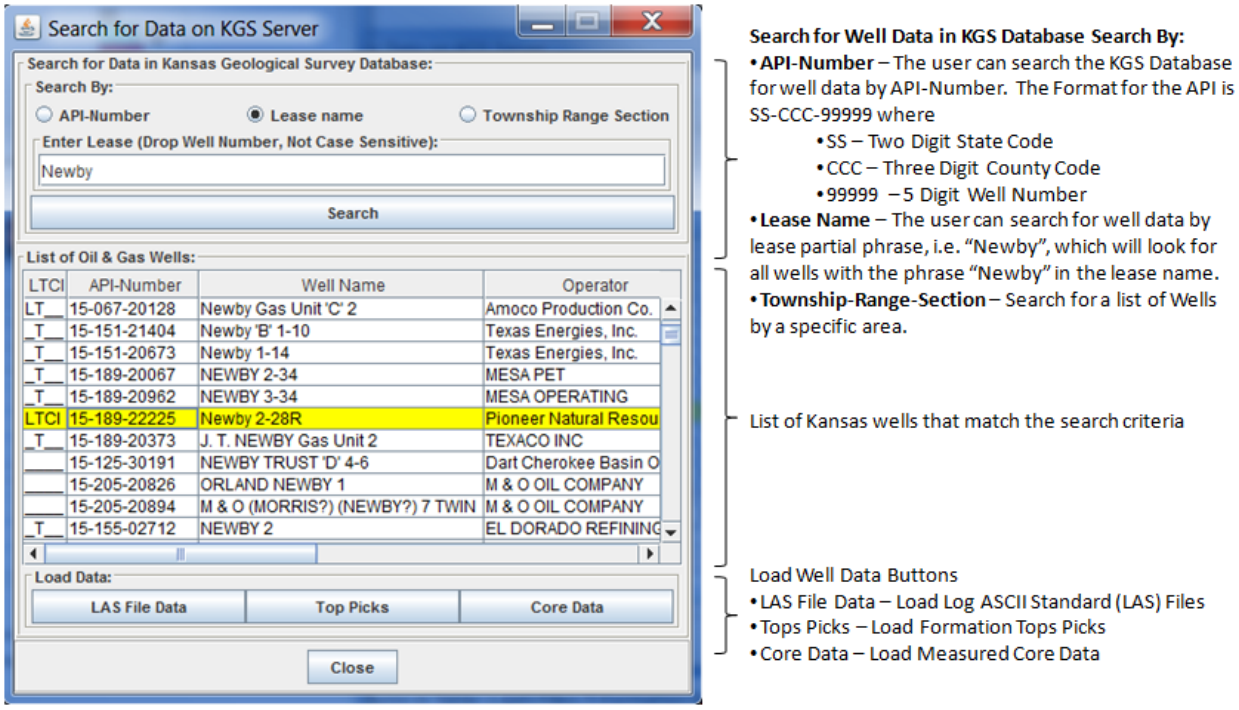
The Data Loaded Panel provides a visual feedback that the data type was loaded, by the file names of the files that were accessed to load the data and by the data type that is loaded. The data type is important in that it shows where the data came from. The KGS data has the ORACLE Database from which 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.

Importing KGS (Database & Server) 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.

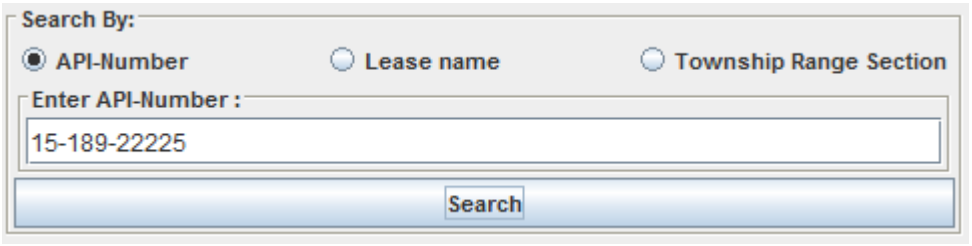


NOTE: LTCI Column in Table: L-LAS Files; T-Formation Tops; C-Measured Core Data; I-Core Images

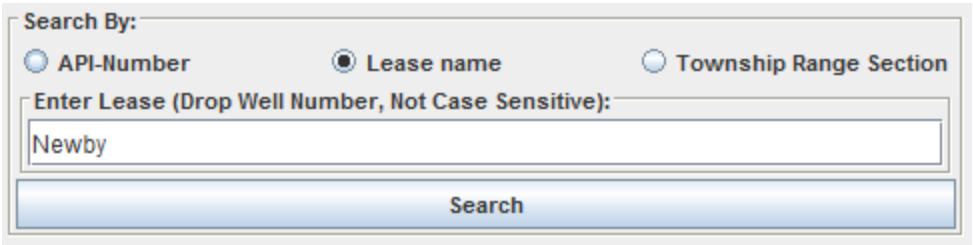
This will display the "Search for Data on KGS Server" Dialog, see above image. This dialog allows the user to search the KGS database for well data. In this example, the well of interest will be the Newby 2-28R, this well contains all the well data that can be retrieved from the KGS Database, i.e. Log 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.

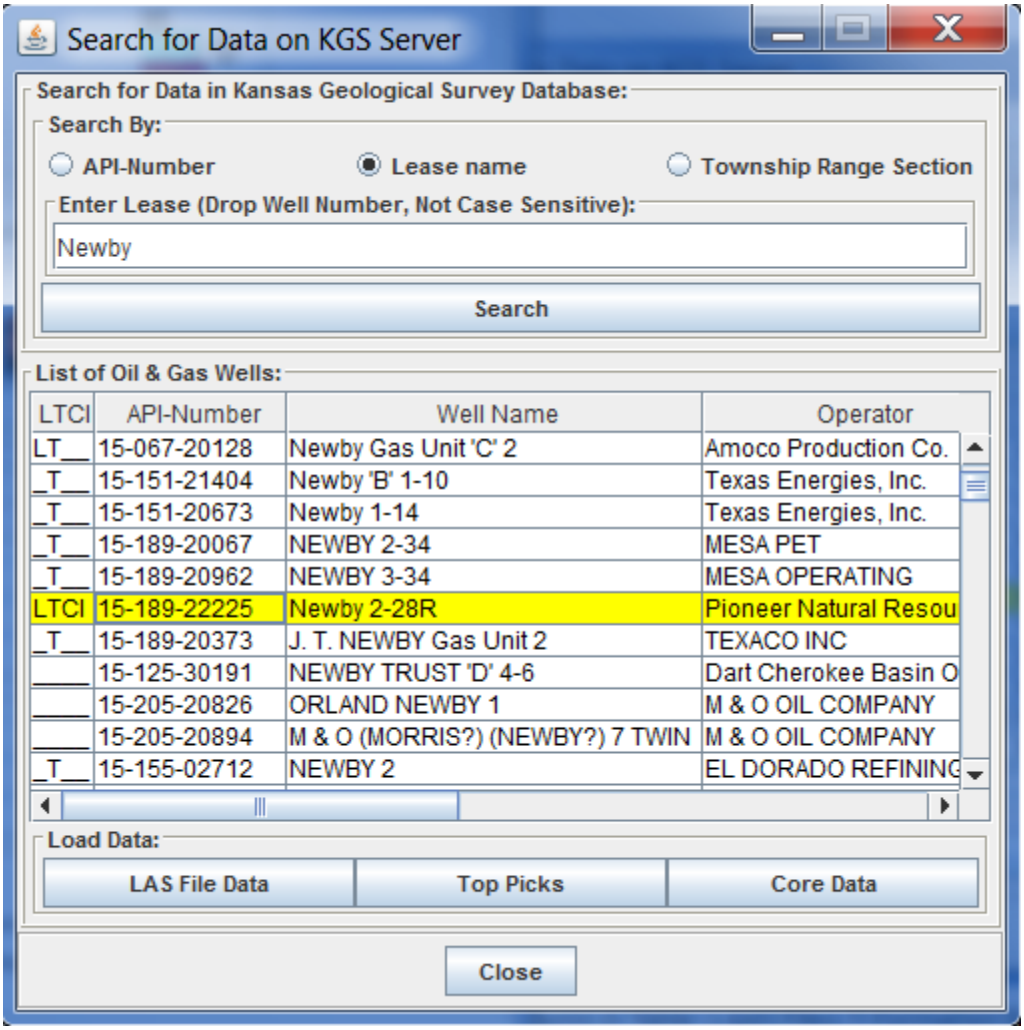


- By Partial Lease Name – The stored procedure used to retrieve the well header information allows the user to enter a partial phrase, in this example Newby. The program places a '%' in front and back of the phrase and sends the request to the Database, i.e. "%Newby%".



- 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.



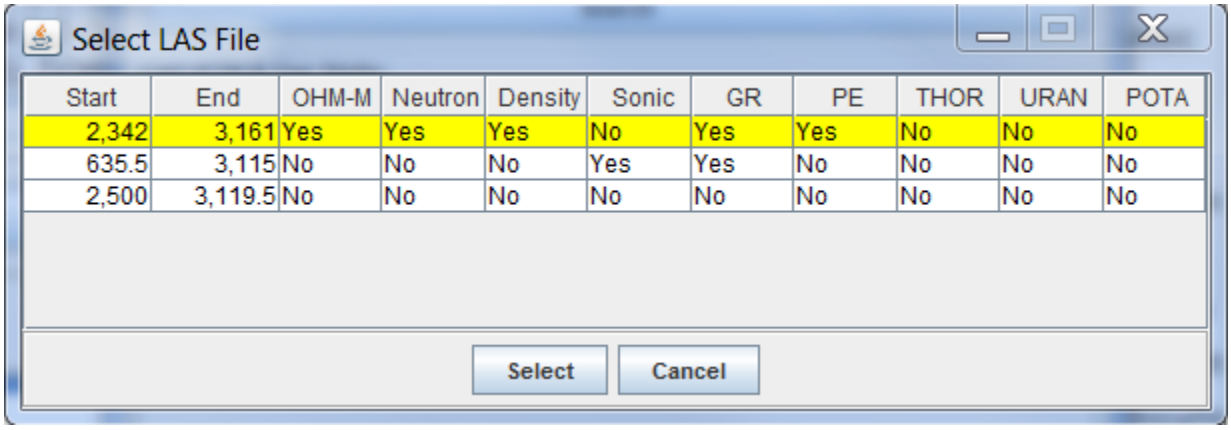
Notice that the LTCI represents the type of data that the well contains. It is a visual aid that lets the user see what is available before trying to download the data. If you require a LAS file you would want to see an L in that column. The LTCI labels stand for the following,

- 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.

Import Log ASCII Standard (LAS) version 2.0 Files from KGS Server

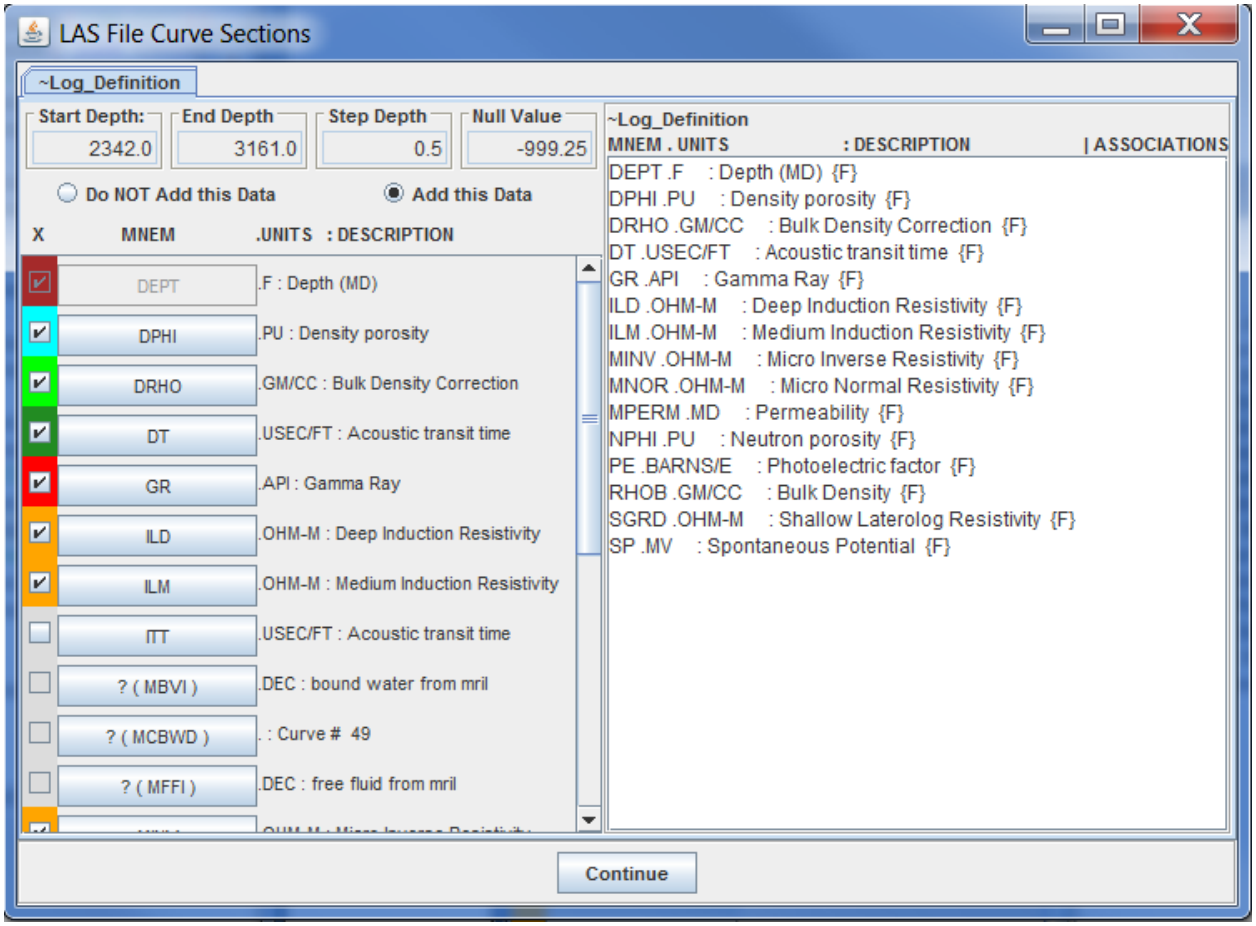
The "Search for Data on KGS Server" Dialog allows the user to download data from the KGS Database & Server to the web app. The "LAS File Data" Button will display the "Select LAS File" Dialog with a list of LAS version 2.0 Files that are available.



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 Profile 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,

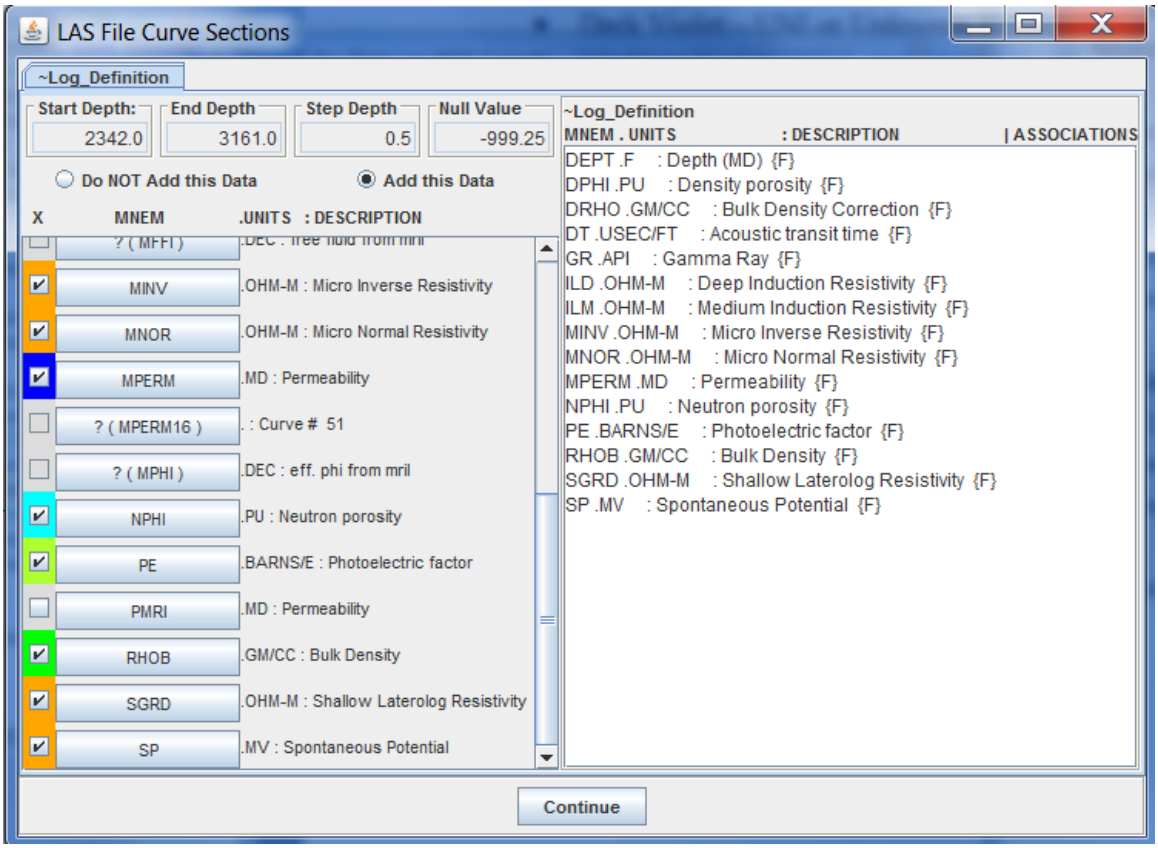
- Orange - OHM-M or Resistivity Logs
- Cyan – PU or porosity Logs, Neutron Porosity, Density Porosity, etc.
- Greenish yellow – BARNS/E or Photoelectric Factor Logs
- Green – GM/CC or Bulk Density Log
- Forest Green – USEC/FT or the Acoustic Transit Time Log
- Red – API, PPM or "%" as Radioactive logs,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

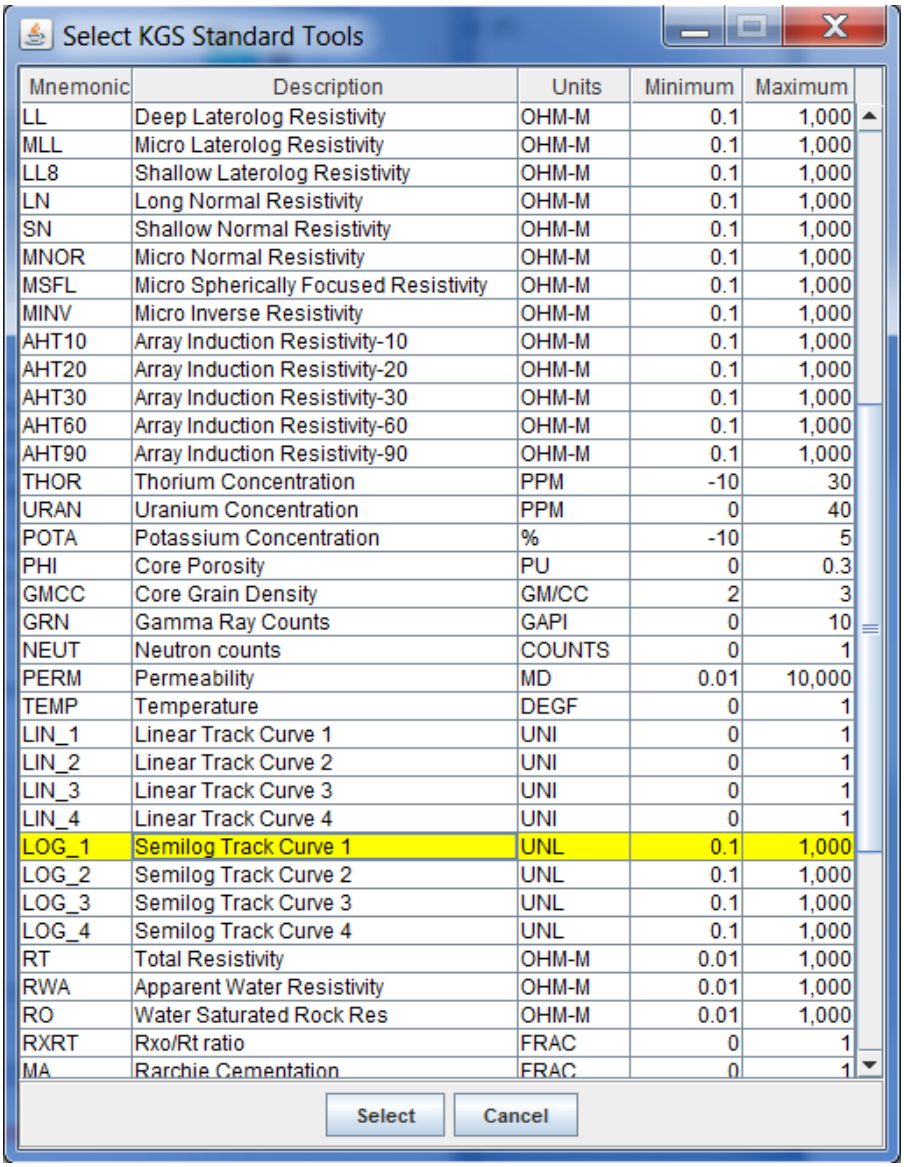
Some logs will have curve mnemonics that are not recognized as one of the KGS "Standard" Curve Mnemonics. The user will need to map the log curve to one of the KGS standard curves if they want to display the curve. Slide the scroll bar down to the Permeability Curves MPERM and ?(MPERM16).



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 PS Wave program is a later version of code from the GEMINI Project Profile 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"

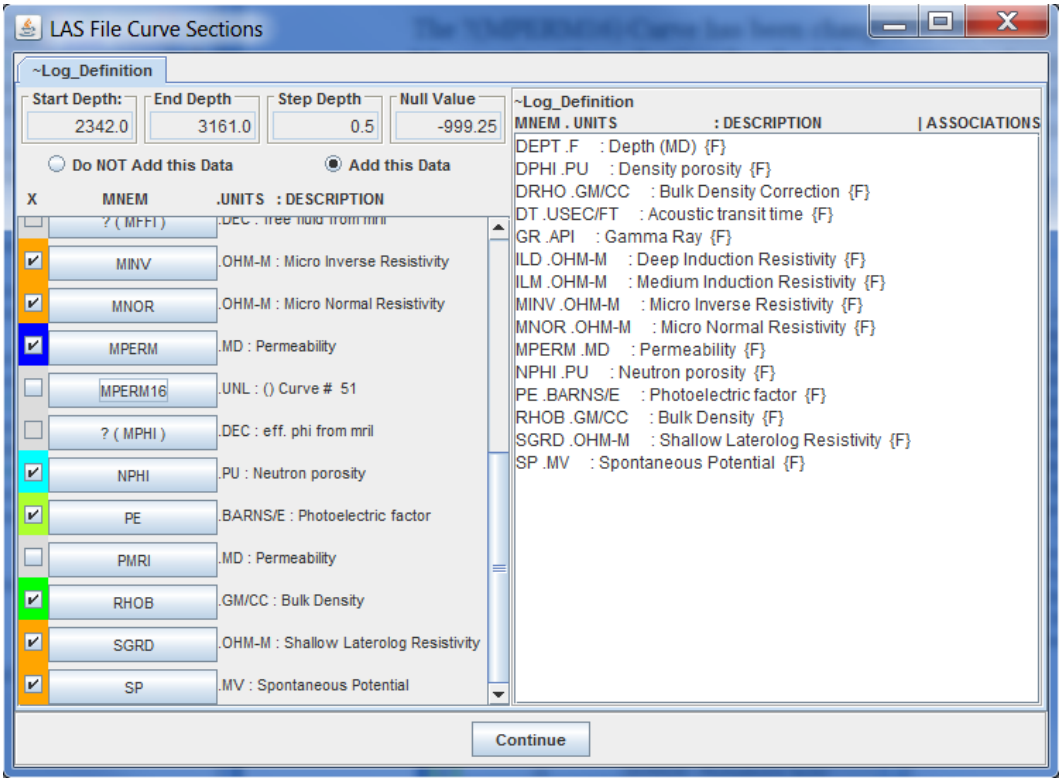
XML File was created to map the log curves from logs that were part of the KGS LAS File Collection which is not a complete list of possible curve mnemonics.

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

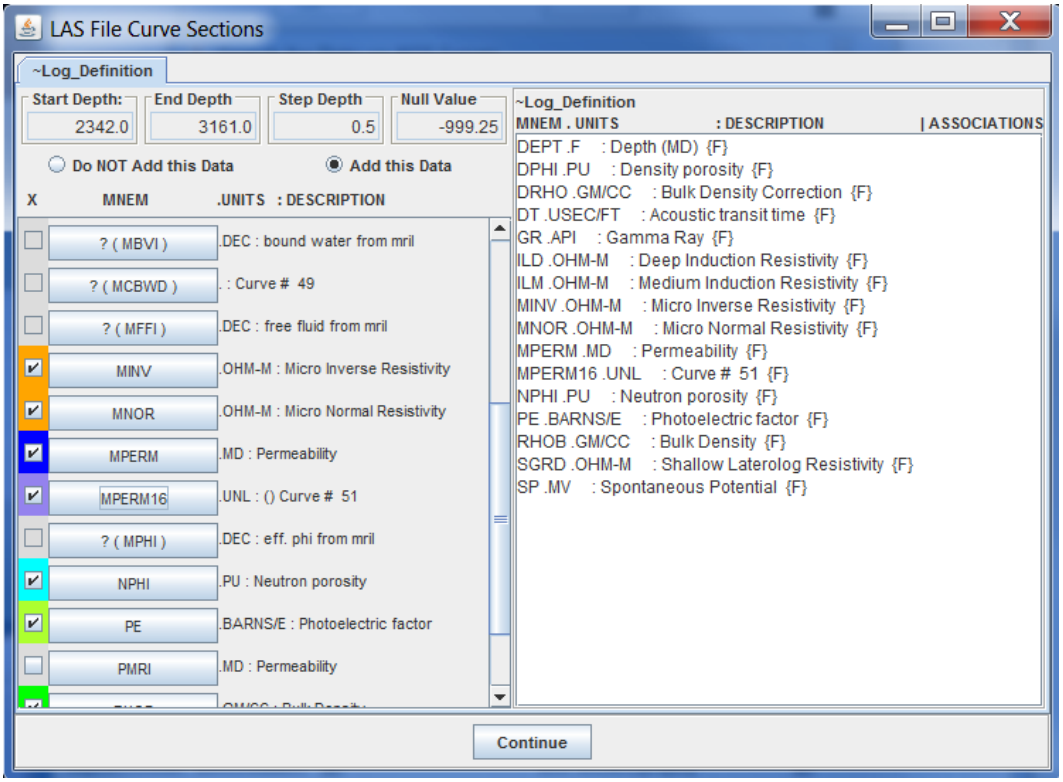


Mnemonic	Description	Units	Minimum	Maximum
LL	Deep Laterolog Resistivity	OHM-M	0.1	1,000
MLL	Micro Laterolog Resistivity	OHM-M	0.1	1,000
LL8	Shallow Laterolog Resistivity	OHM-M	0.1	1,000
LN	Long Normal Resistivity	OHM-M	0.1	1,000
SN	Shallow Normal Resistivity	OHM-M	0.1	1,000
MNOR	Micro Normal Resistivity	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

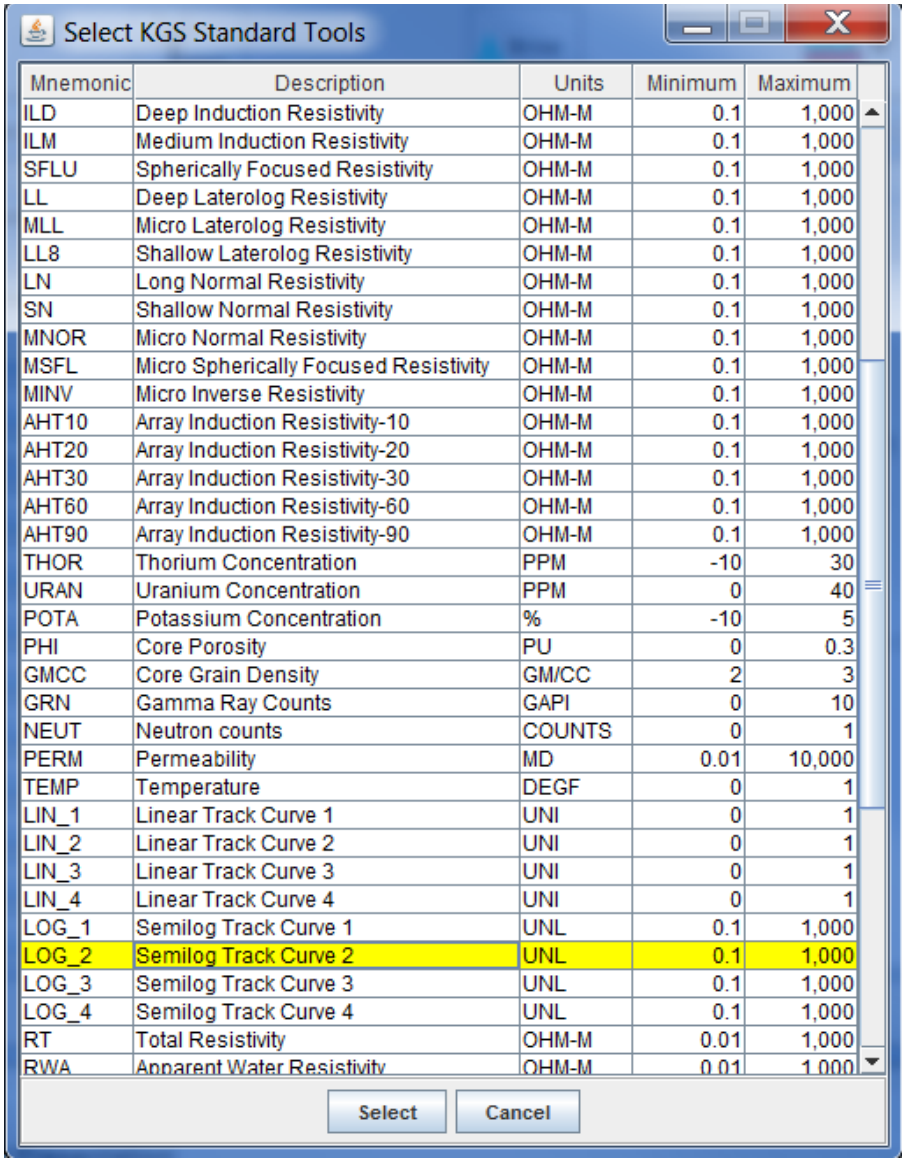
"Select KGS Standard Tools" Dialog. Slide the scroll bar down to the "LOG_1" Mnemonic – Semilog Track Curve 1 and highlight that curve. Click on the "Select" Button to map the "?(MPERM16) to the Semilog Track Curve 1.



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.

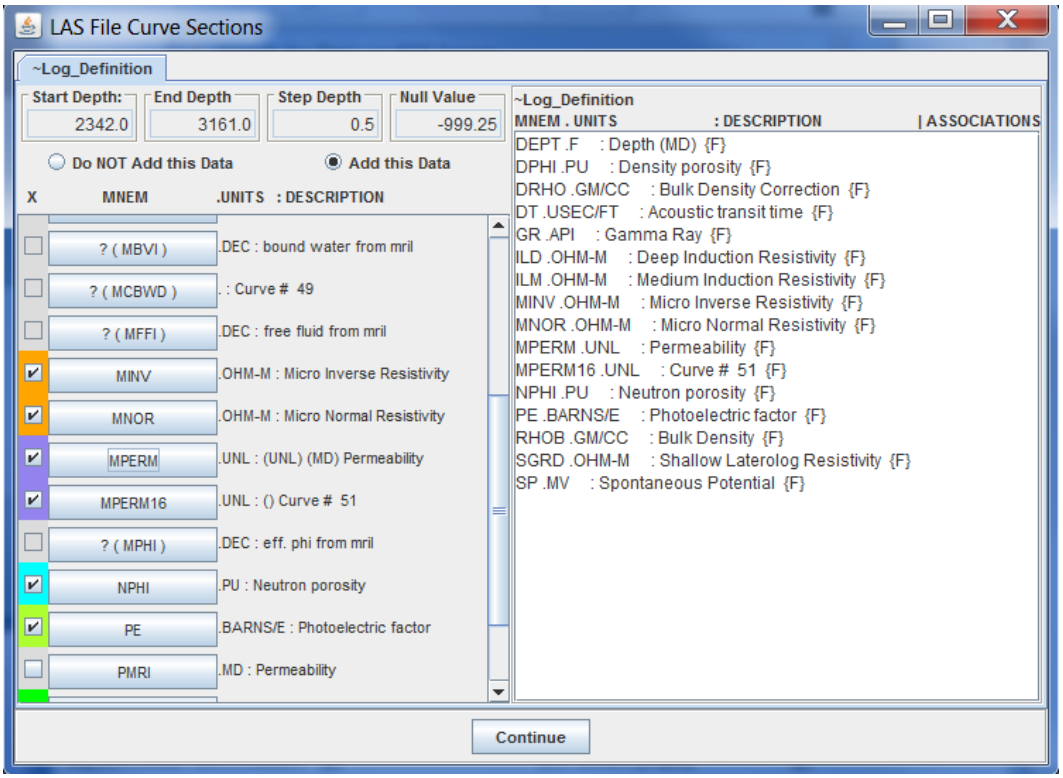


In order to plot both Permeability Curves on the same track, the MPERM must be assigned to the unknown Log Curves with MPERM16. Click on the MPERM Mnemonic Button to display the



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

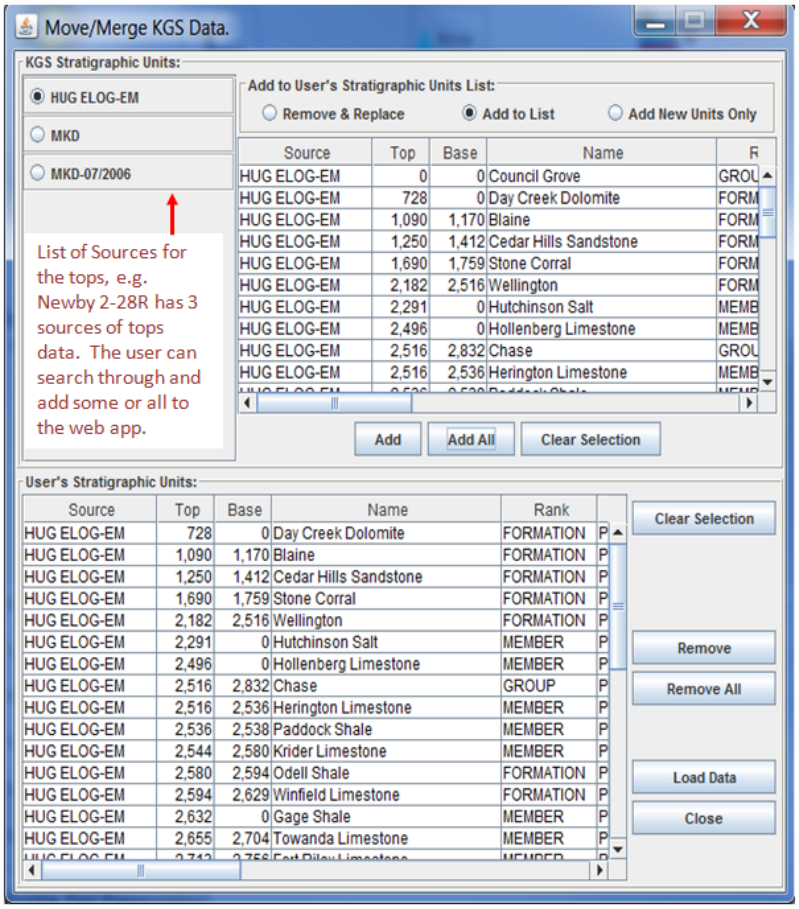
"Select KGS Standard Tools" Dialog. Slide the scroll bar down to the "LOG_2" Mnemonic – Semilog Track Curve 2 and highlight that curve. Click on the "Select" Button to map the "MPERM to the Semilog Track Curve 2.



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.

Import Top Data from KGS Database

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

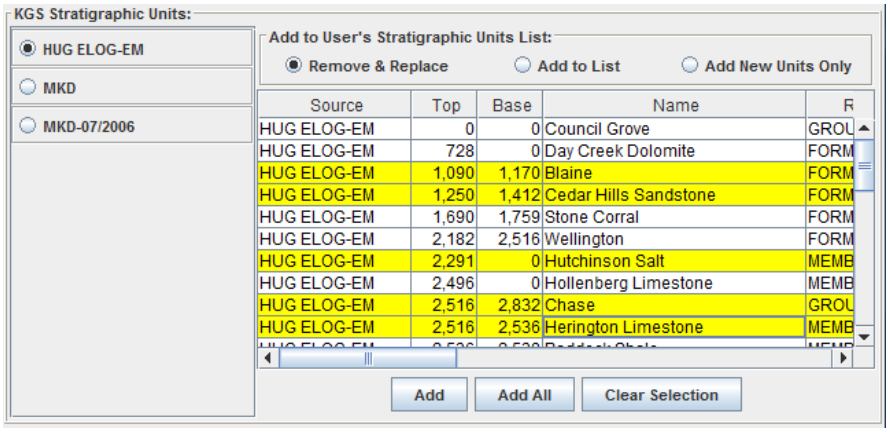
Add – add the highlighted top(s) to the "User's Stratigraphic Units" Table. Note: this table will allow the user to select multiple wells by using the "Ctrl" Key and the left click of mouse.
Add All – copy the list of tops to the "User's Stratigraphic Units" Table.
Clear Selection – remove the highlight 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

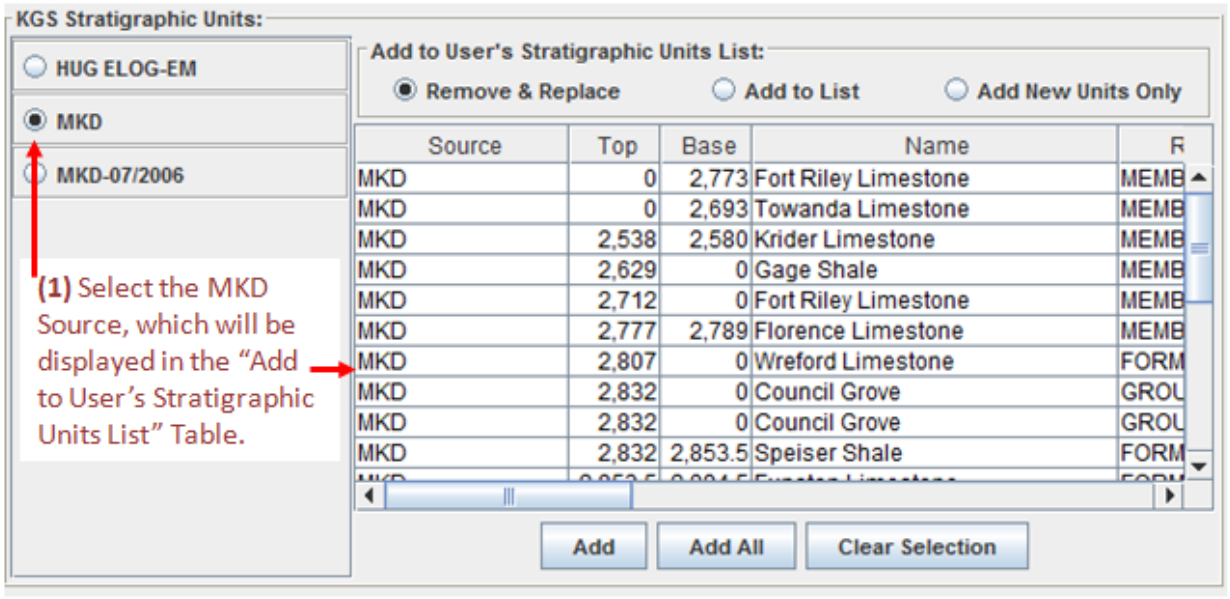
Clear Selection – remove the highlight on tops selected.
Remove – remove the highlighted top(s) from the table. Note: this table will allow the user to select multiple wells by using the "Ctrl" Key and the left click of mouse.
Remove All – remove all tops from the table.
Load Data – transfer the tops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

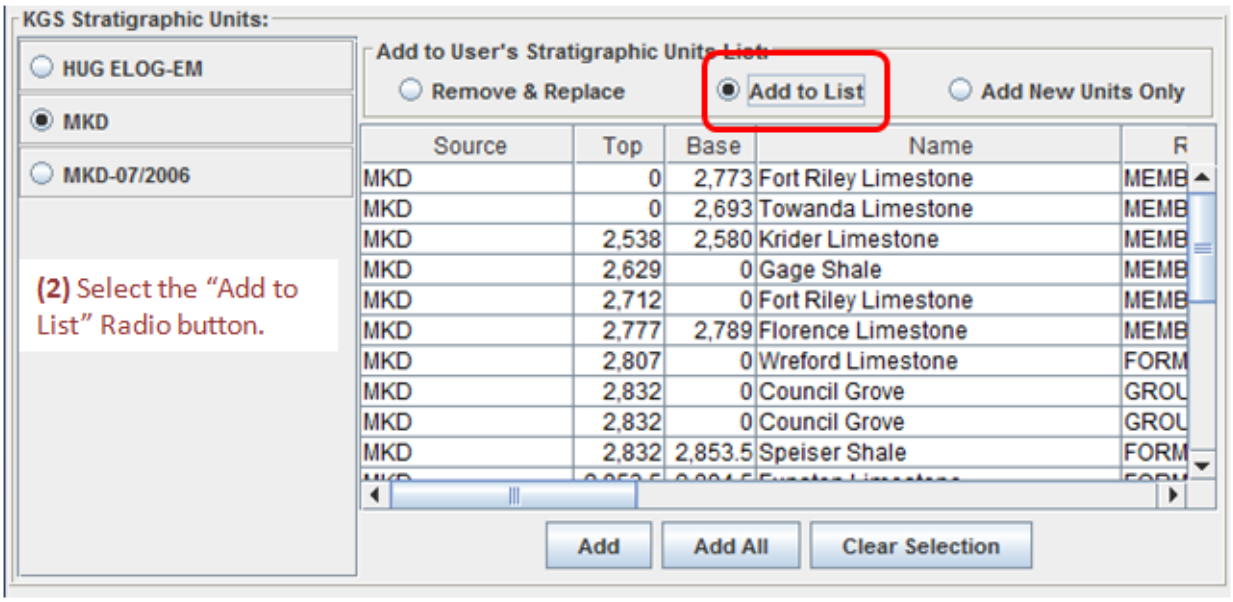
This dialog allows the user to add all or some the tops from each of the sources. Both tables are set up so the user can use the "Ctrl" Key with the left click of mouse to select multiple tops, i.e.

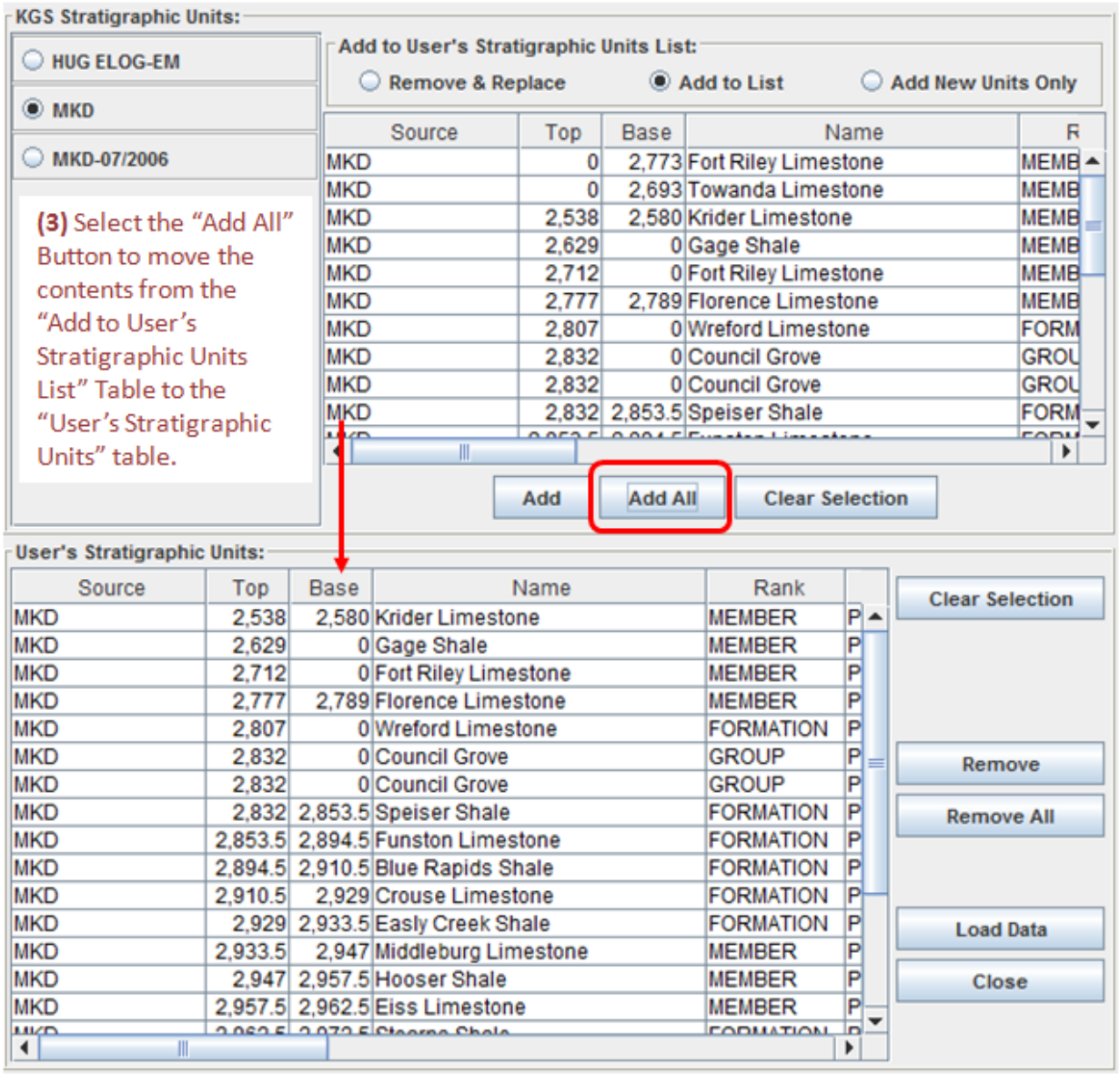


Notice that the only some of the tops are selected. You can then select the Add Button to move only the selected tops to the "User's Stratigraphic Units" Table.

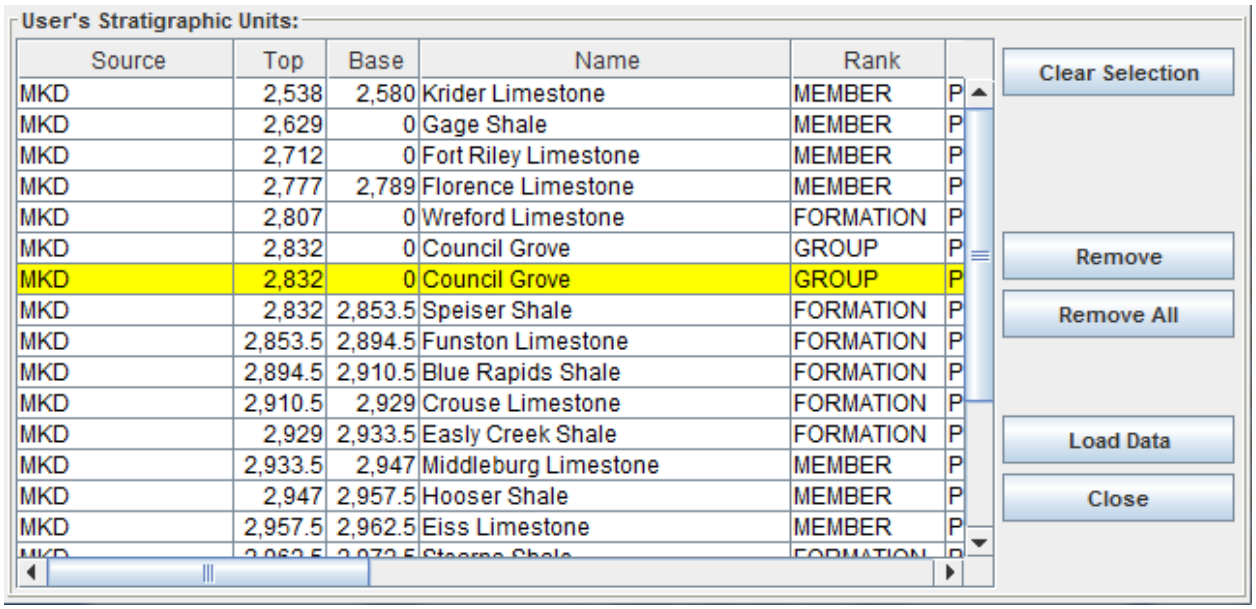
MKD Source Example:



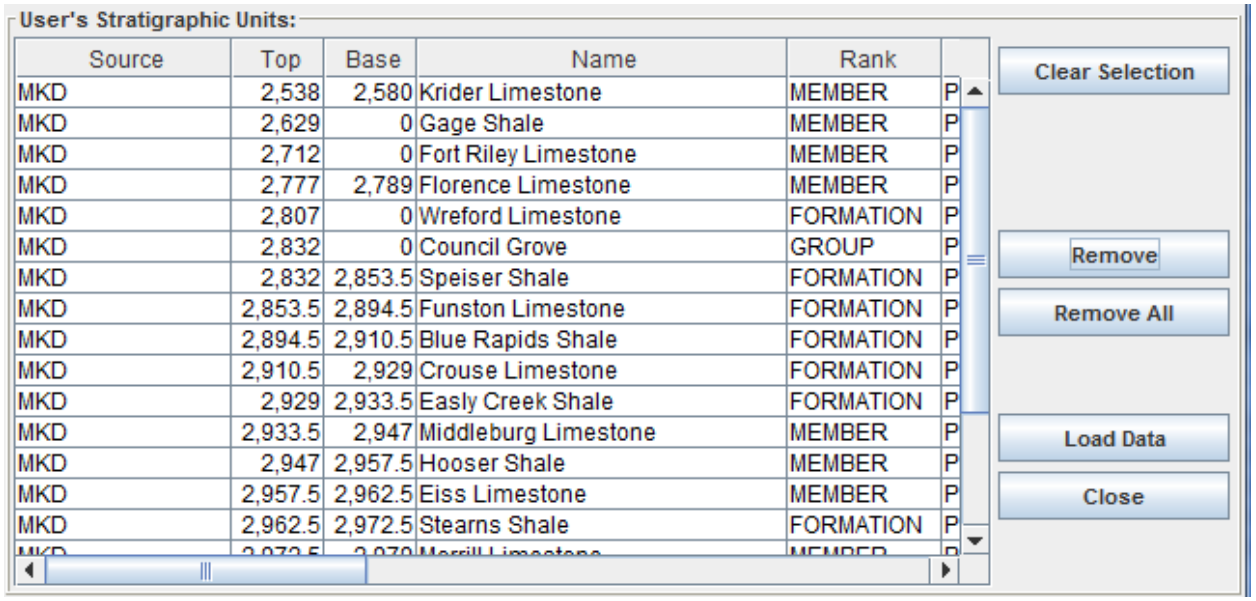




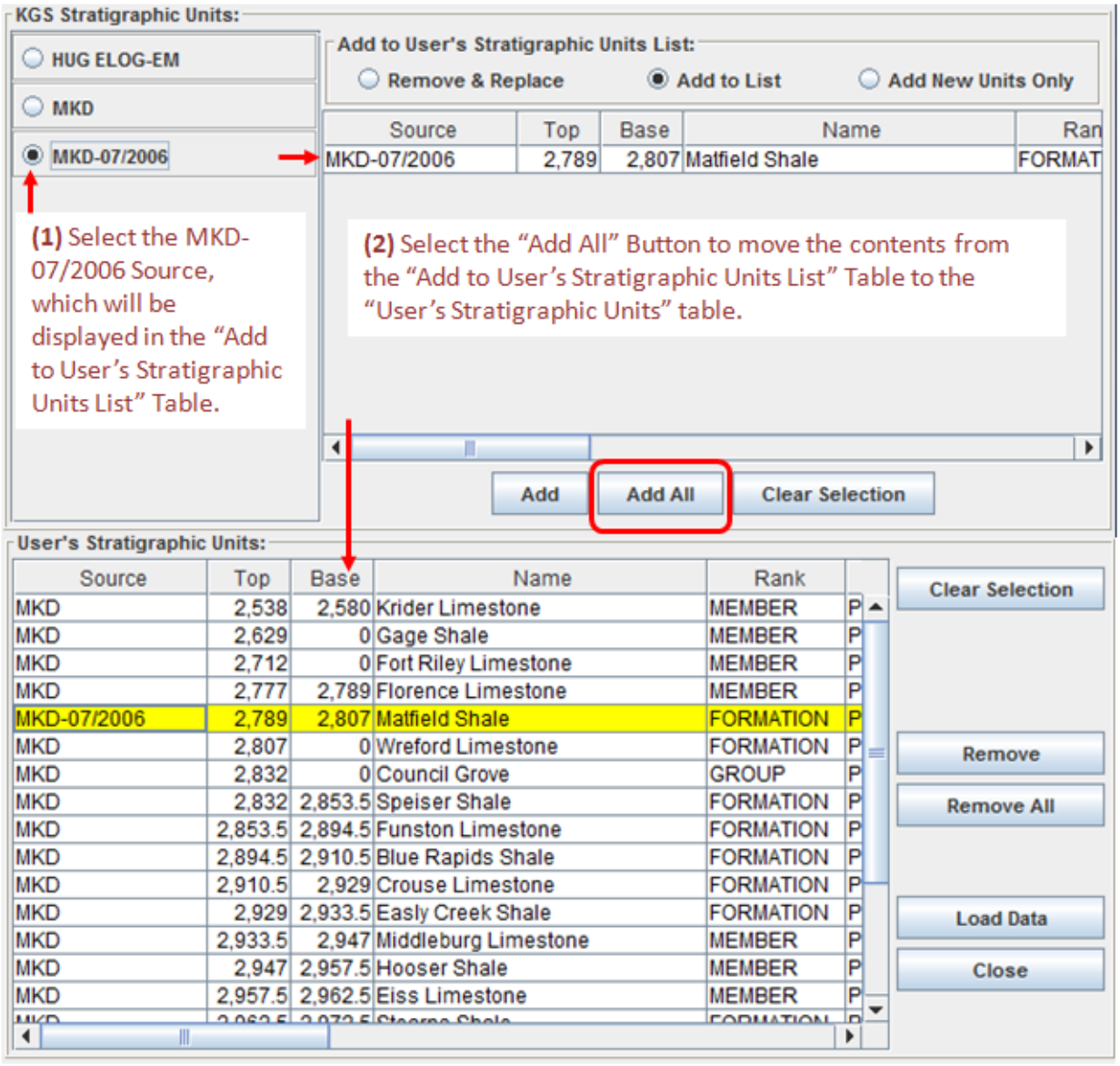
Once the list of tops are in the "User's Stratigraphic Units" Table the user can edit the list by removing any duplicate or invalid tops. Notice that the "Council Grove" Top occurs 2 times in the list. Highlight the one of the "Council Grove" tops.



Now select the “Remove” Button.

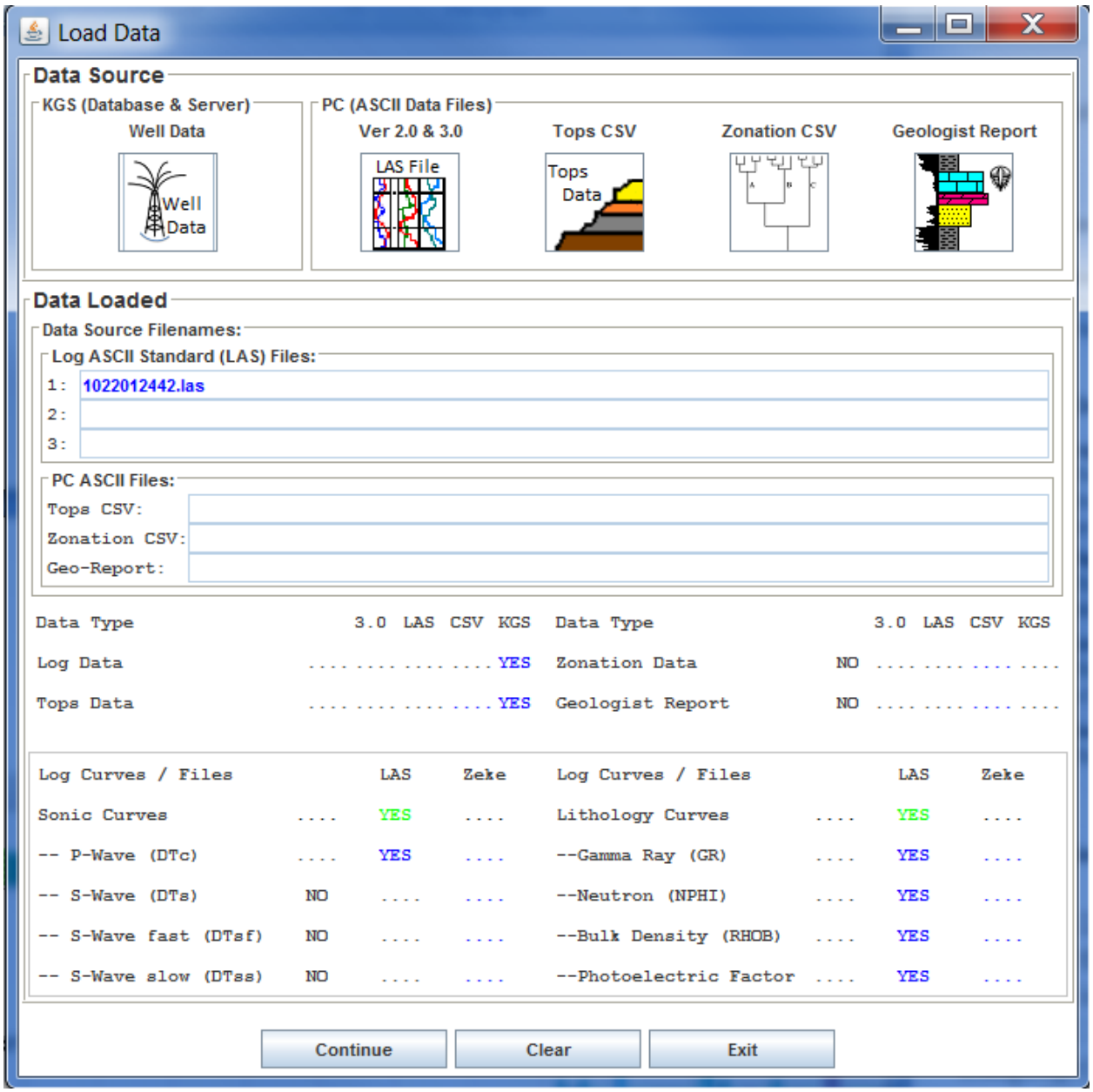


The MKD-07/2006 has only one top, so this dialog allows the user to add that top to the “User’s Stratigraphic Units” Table. The MKD does not have this top and this is an extra top missing from the MKD data set.



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

As the user accepted each data type the "Data Source Filenames:" Panel in the Load Data Dialog changes. The LAS File that was downloaded from the KGS Server to the PS Wave Web App is added to the "Log ASCII Standard (LAS) Files" panel will show the filename downloaded. The Log Data and Tops Data have been downloaded from KGS.



Note that the "Sonic Curves" Row in the lower table is green, which informs the user that the necessary data is present to compute the sonic times and velocities from the imported LAS file. Although the "p-Wave (DTc) log curve is present and not the "s-Wave (DTs) log curve, the "s-Wave (DTs) log curve will be computed from with the help of the litho-density logs (Gamma Ray, Neutron Porosity and Bulk Density. The curves that are listed in the bottom table are the necessary curves for this program any other curves will be ignored, i.e. resistivity, permeability, etc.

Importing PC ASCII File Well Data

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.

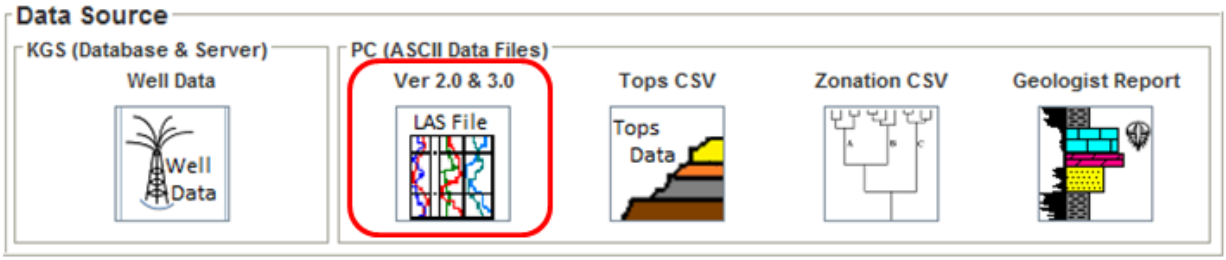
Well Data: Wellington KGS 1-32, Sumner County, Kansas

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
Report	http://www.kgs.ku.edu/Gemini/Tools/documentation/Wellington-KGS-1-32_geo.txt

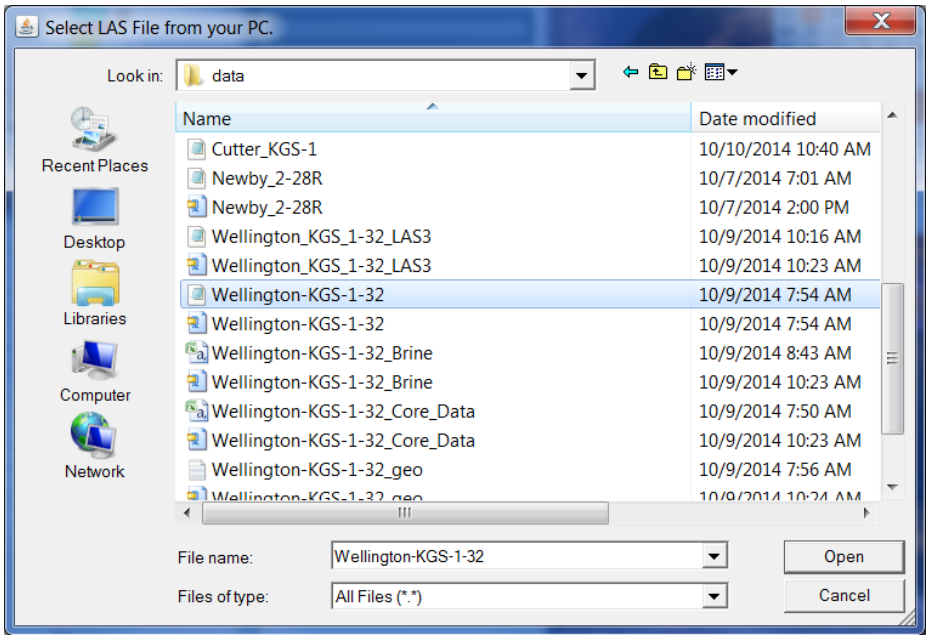
Type	Zip Files
LAS 2.0	http://www.kgs.ku.edu/Gemini/Tools/documentation/Wellington-KGS-1-32.zip
Tops	http://www.kgs.ku.edu/Gemini/Tools/documentation/Wellington-KGS-1-32_Tops.zip
Report	http://www.kgs.ku.edu/Gemini/Tools/documentation/Wellington-KGS-1-32_geo.zip

Import Log ASCII Standard (LAS) version 2.0 & 3.0 Files

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.

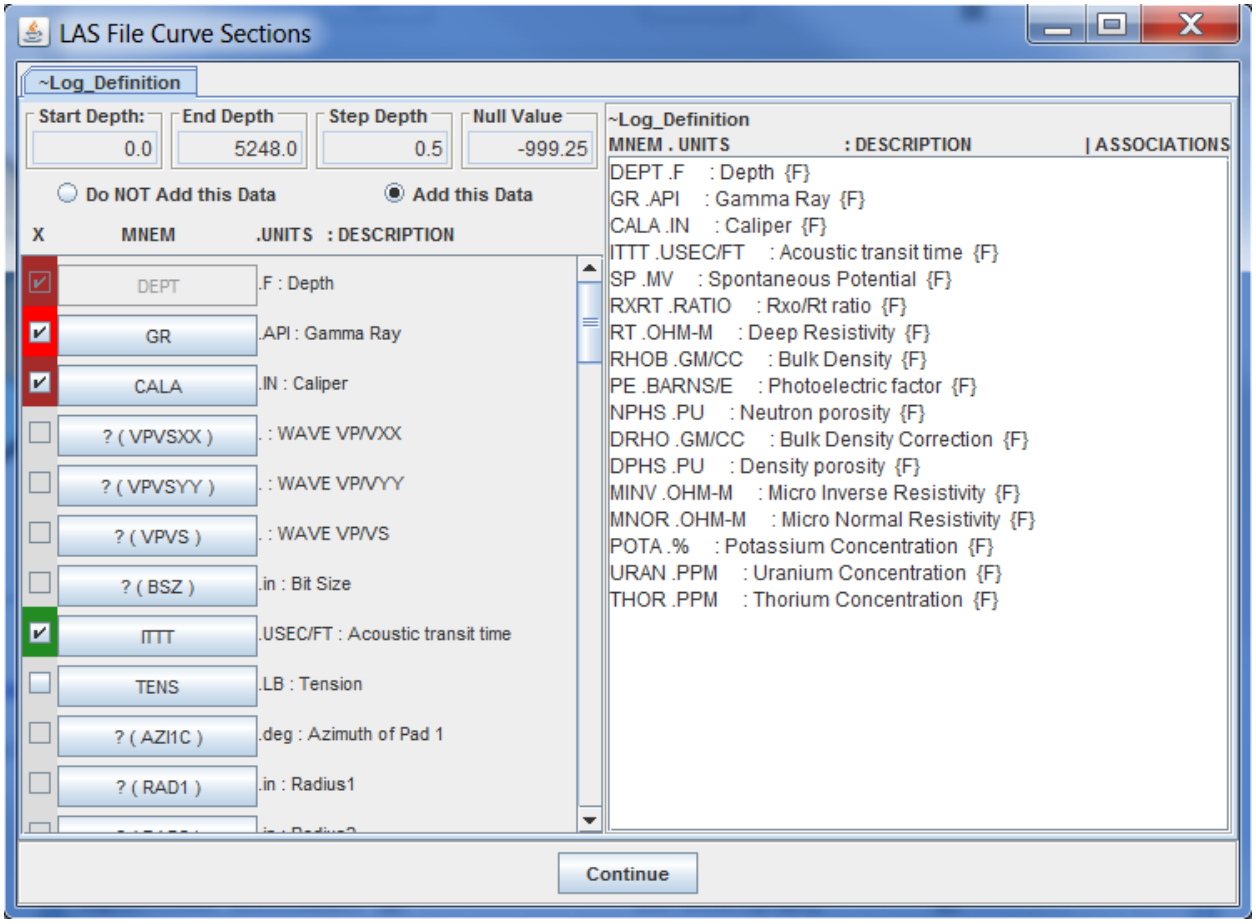


Left Click on the "LAS File" Icon Button in the Data Source Panel of the Load Data Dialog. This will display the "Select LAS File from your PC" Dialog. This dialog allows the user to search their PC for the file of interest. In this example it is the LAS version 2.0 file Wellington-KGS-1-32.las, highlighted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



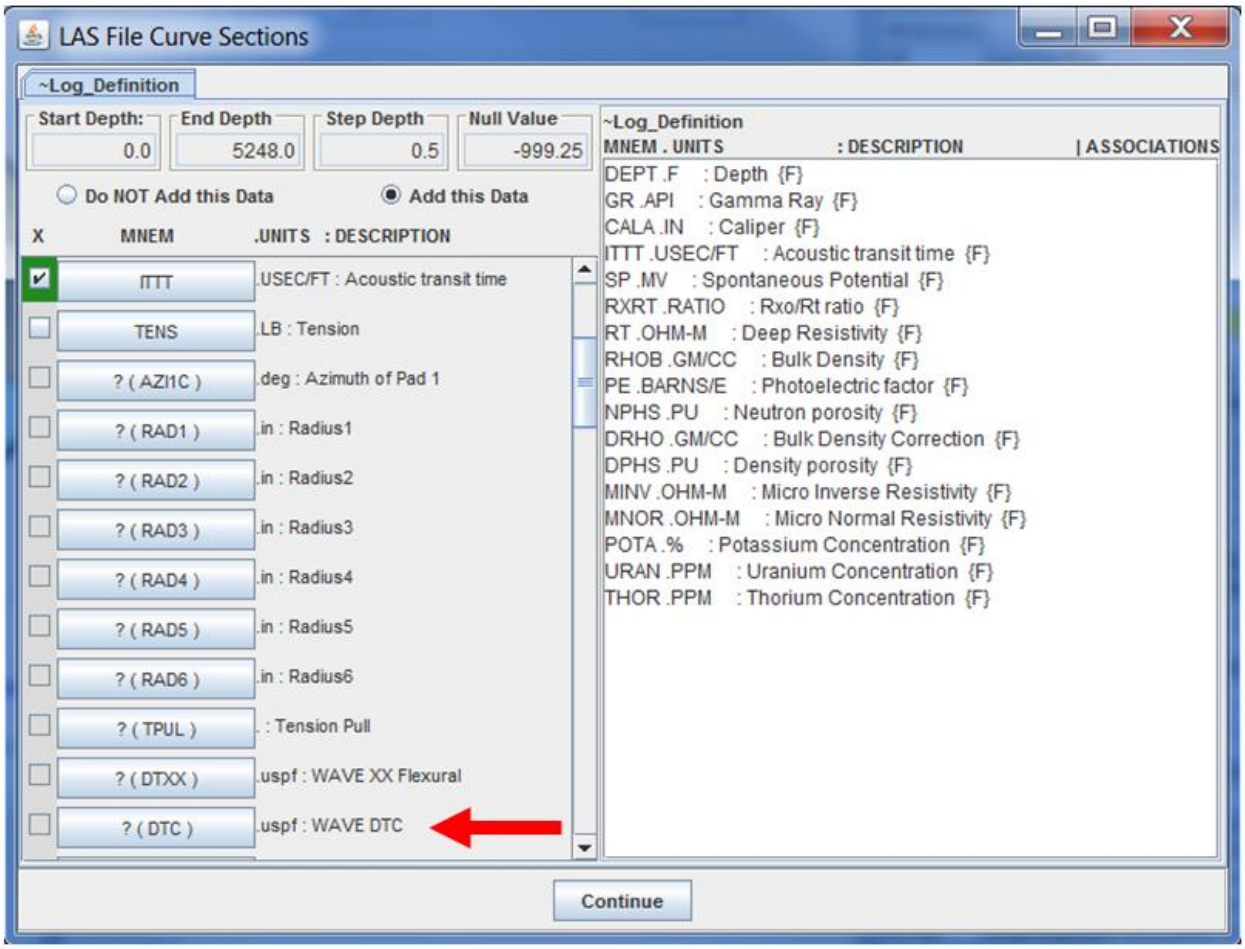
Notice that some of the check boxes are colored with different colors, which shows that the curves were automatically selected, but also to represent the curve type by color.The Curves are colored by type (data units) as follows,

- 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

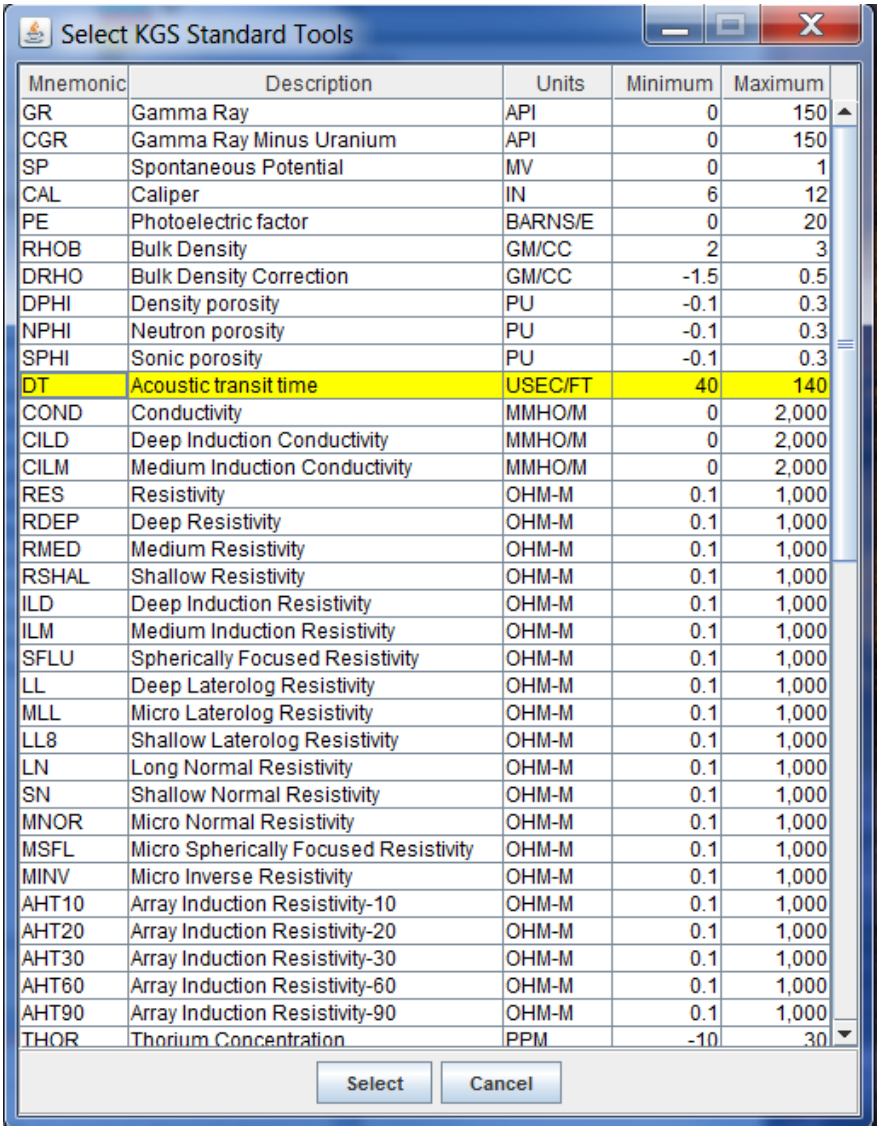
Some logs will have curve mnemonics that are not recognized as one of the KGS "Standard" Curve Mnemonics. The user will need to map the log curve to one of the KGS standard curves if they want to display the curve. The first example is to map the Acoustic Transit Time (DT),which is labeled as ".uspf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

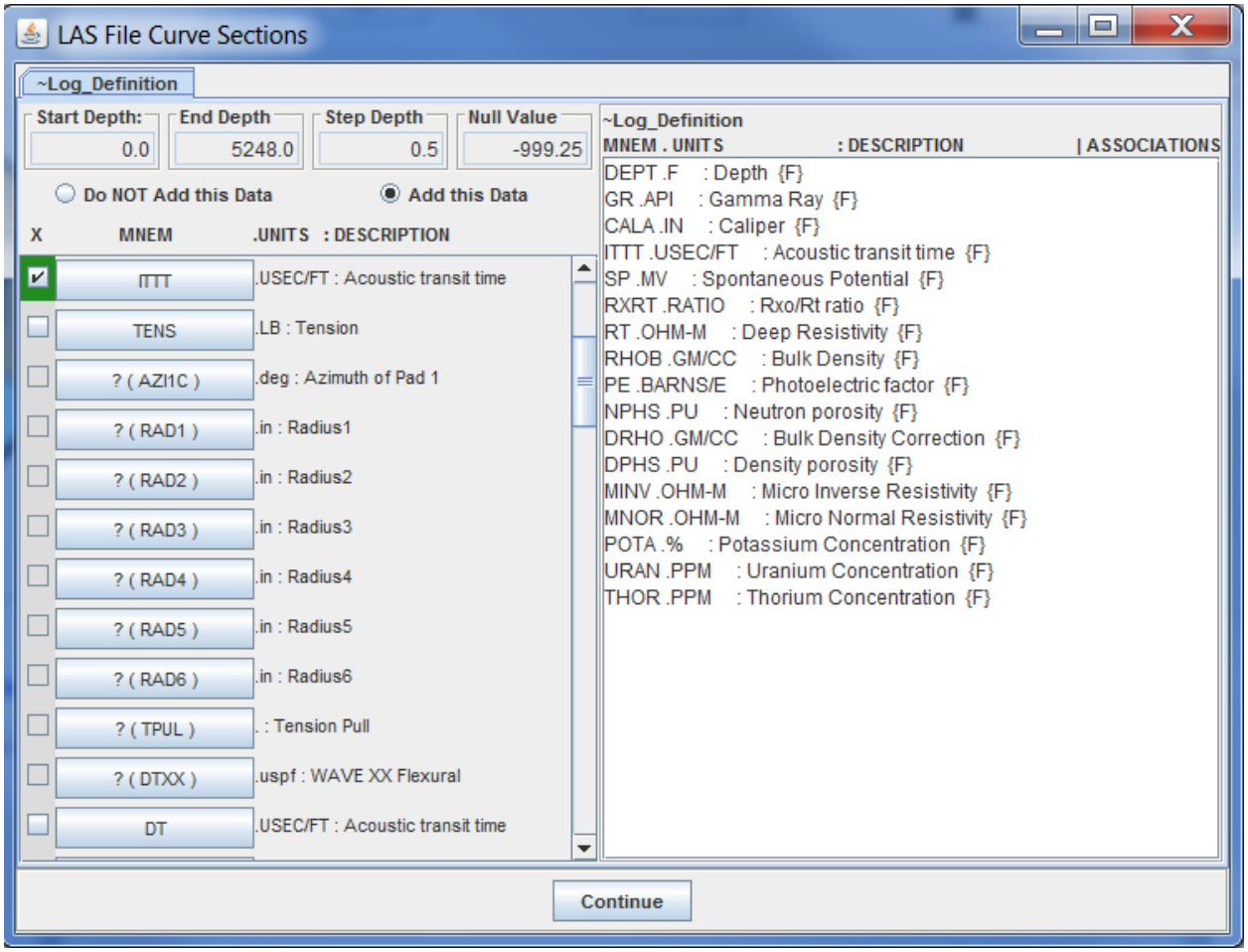
XML File was created to map the log curves from logs that were part of the KGS LAS File Collection which is not a complete list of possible curve mnemonics.

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.

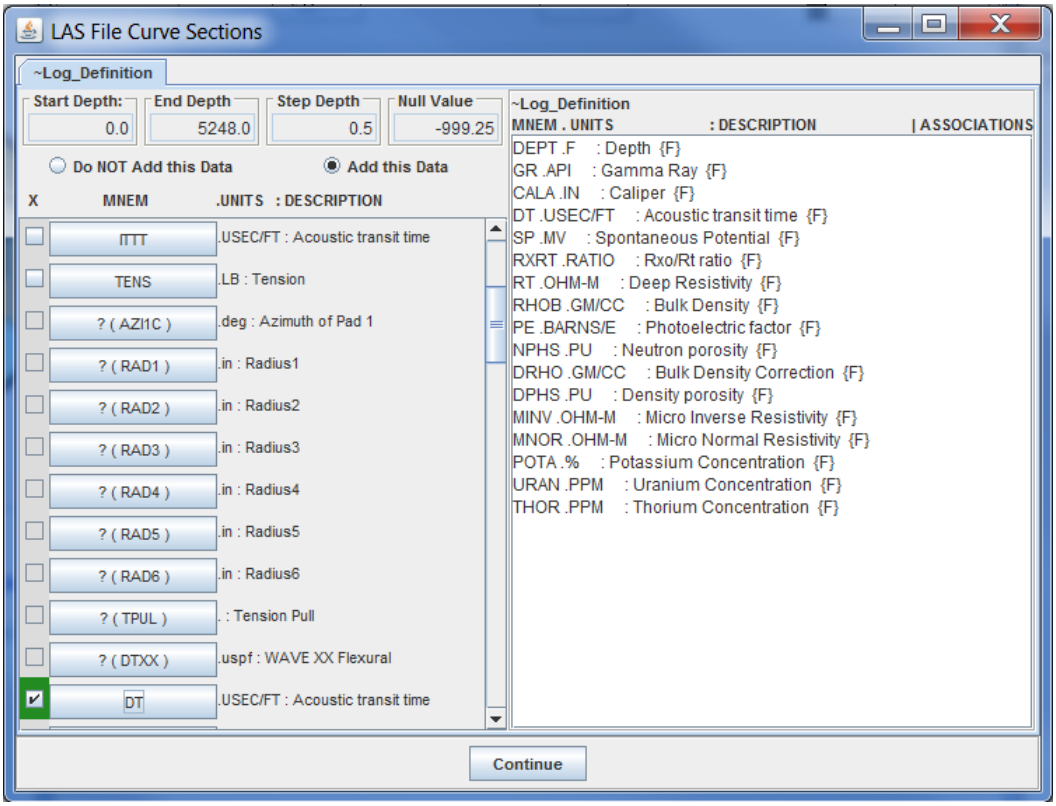


Mnemonic	Description	Units	Minimum	Maximum
GR	Gamma Ray	API	0	150
CGR	Gamma Ray Minus Uranium	API	0	150
SP	Spontaneous Potential	MV	0	1
CAL	Caliper	IN	6	12
PE	Photoelectric factor	BARNS/E	0	20
RHOB	Bulk Density	GM/CC	2	3
DRHO	Bulk Density Correction	GM/CC	-1.5	0.5
DPHI	Density porosity	PU	-0.1	0.3
NPHI	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

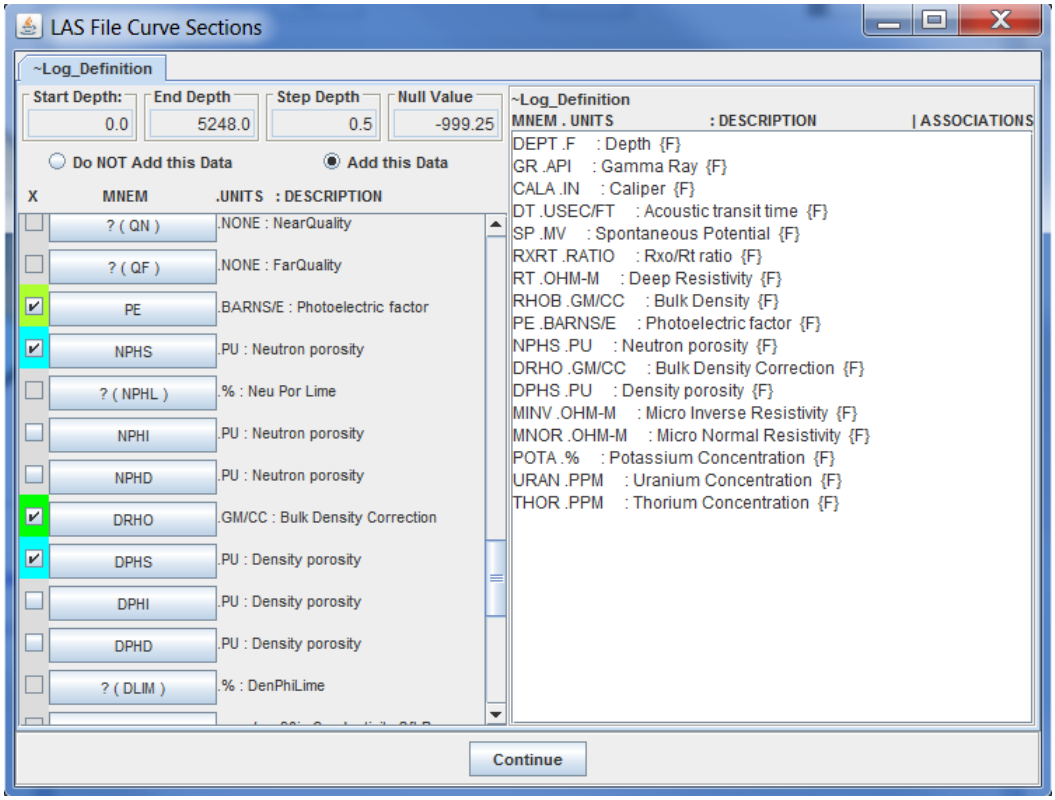
Highlight the "DT" Mnemonic Row and click on the "Select" Button to map the "?(DTC)" Curve Mnemonic to "DT" KGS Standard Curve Mnemonic.



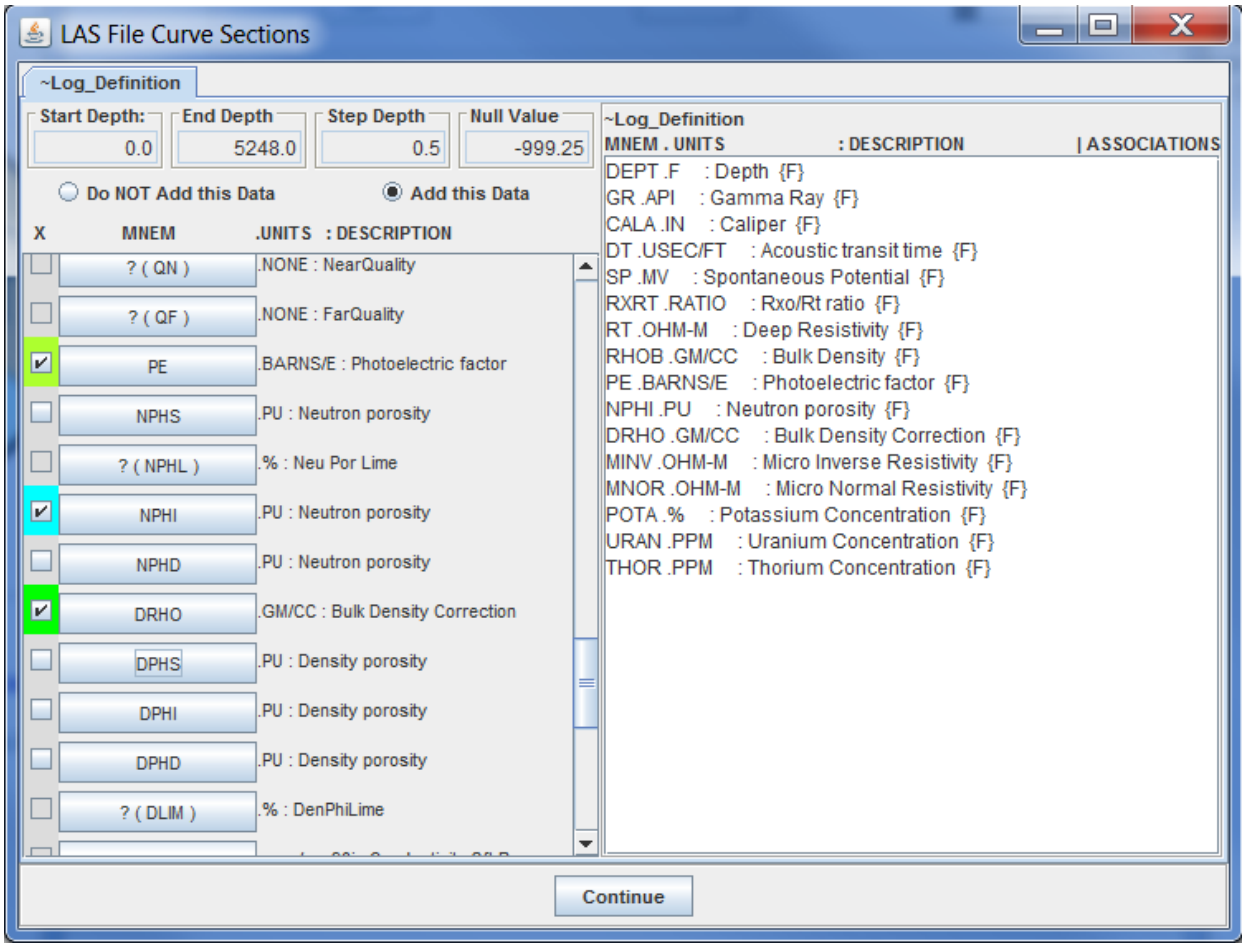
The "?(DTC). .uspf : WAVE DTC" has changed to "DT.usec/ft : Acoustic transit time". We want to change the selected "ITTT" Log Curve to "DT" Log Curve. The reason is that "ITTT" is the wrong curve type for the Acoustic Transit Time. The program found the curve mnemonic as similar to the "DT" Standard Curve Mnemonic, but this curve will not plot correctly in the PS Wave 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.



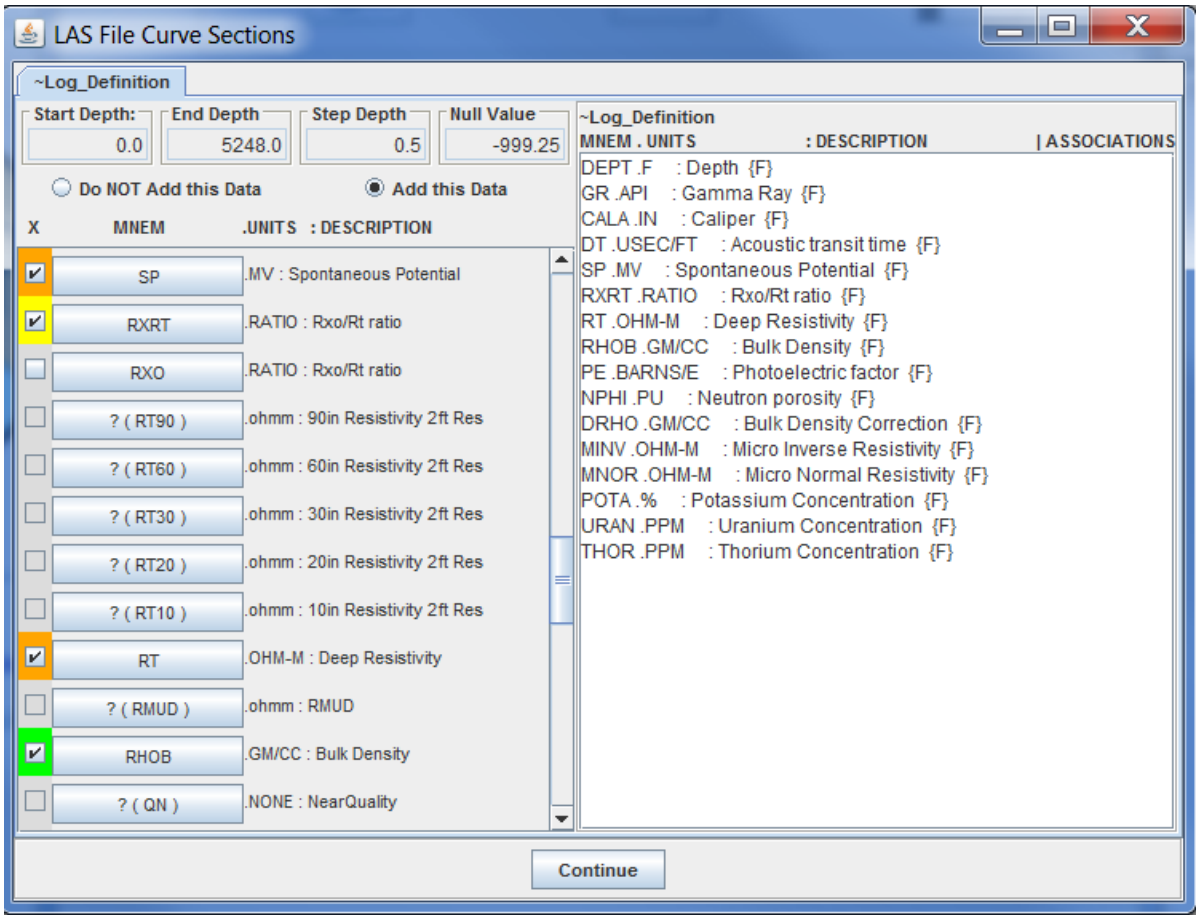
Moving the scroll bar down to the porosity curves, Neutron Porosity, and Density Porosity.



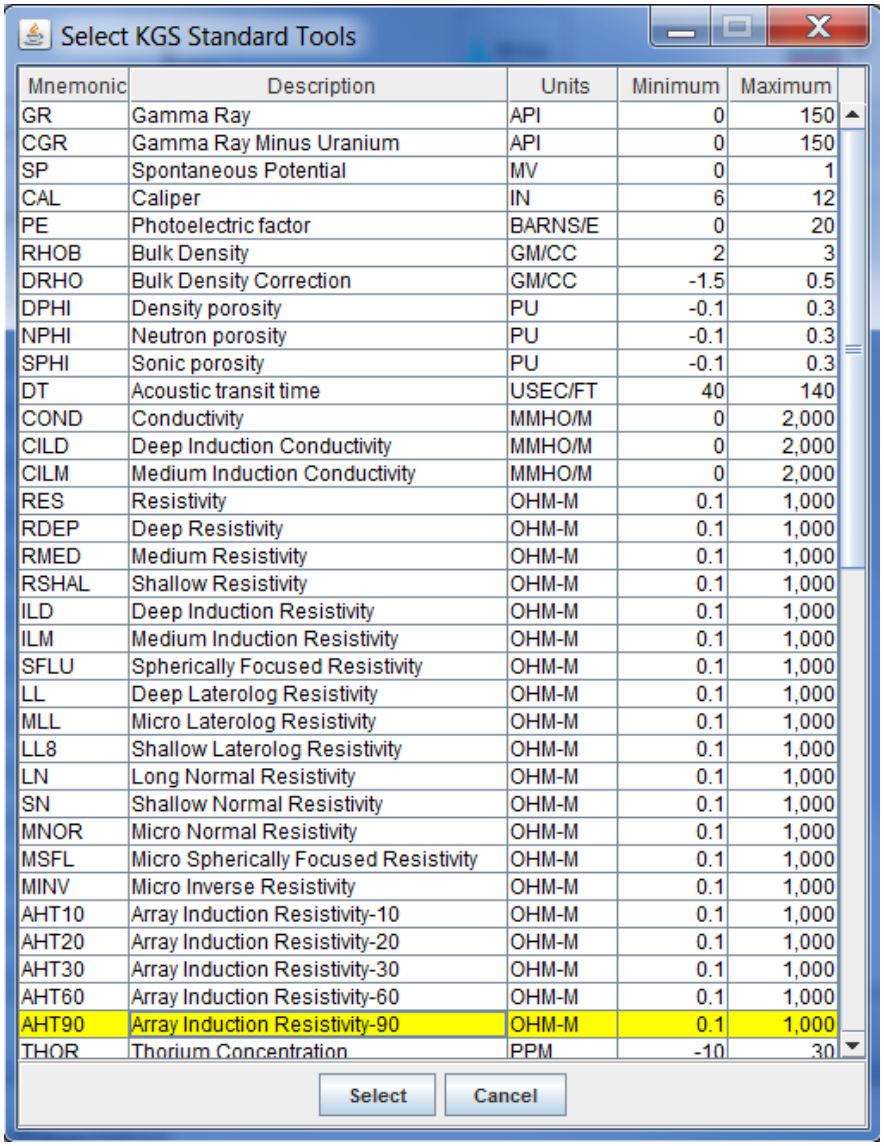
The LAS File Read will select the first curve that it recognizes and selects and color codes the curve. In this case the Neutron porosity mnemonic selected is “NPHS”, which is a valid curve, but the “NPHI” curve is desired so like the Acoustic Transit Time, you can deselect the “NPHS” and then select 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 PS WAVE 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.



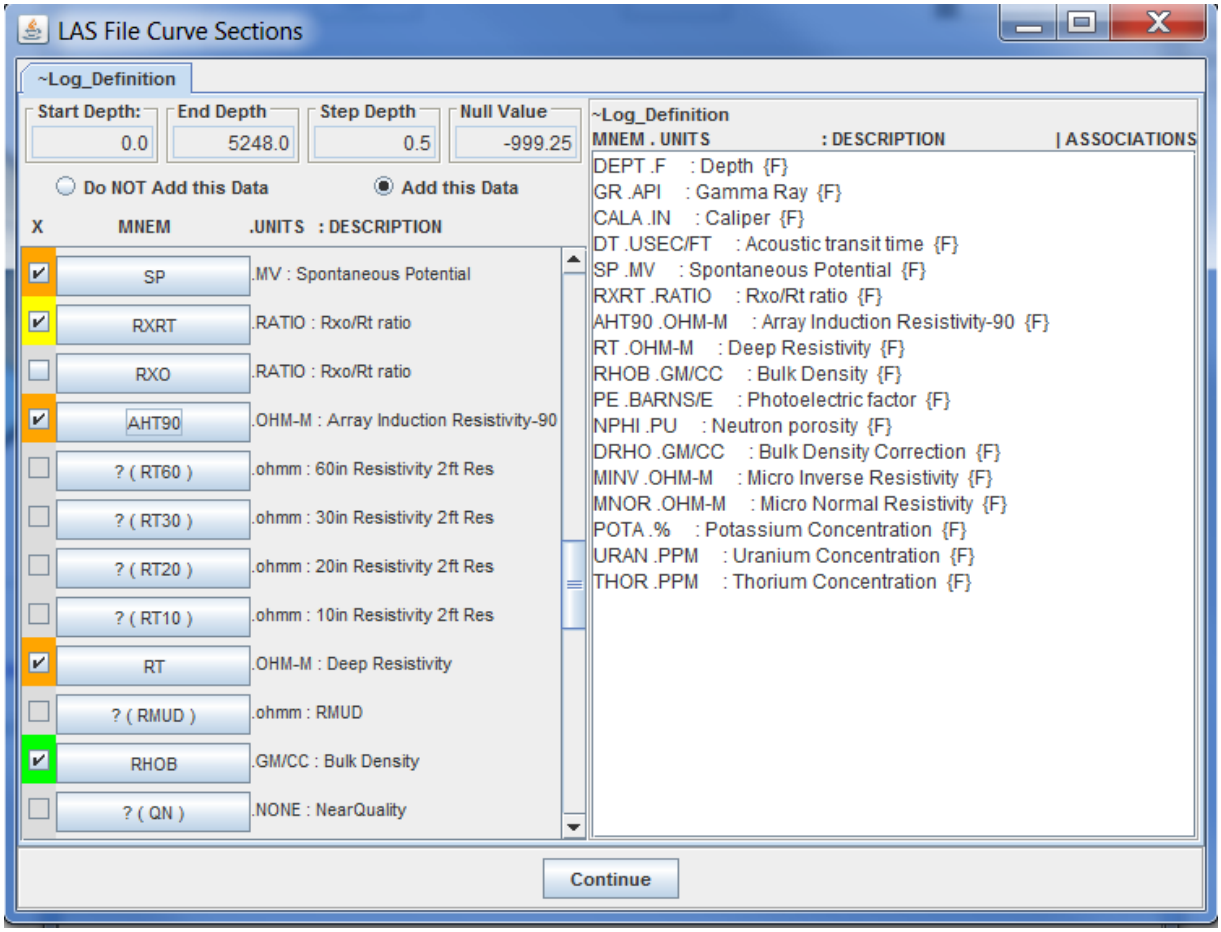
The above dialog represents the changes made for the neutron/density porosity logs. The last curves to be modified are the Array Induction Logs. Haliburton uses a different curve mnemonic for these logs. Move the scroll bar up to find the Array Induction Logs, RT90, RT60, etc.



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.

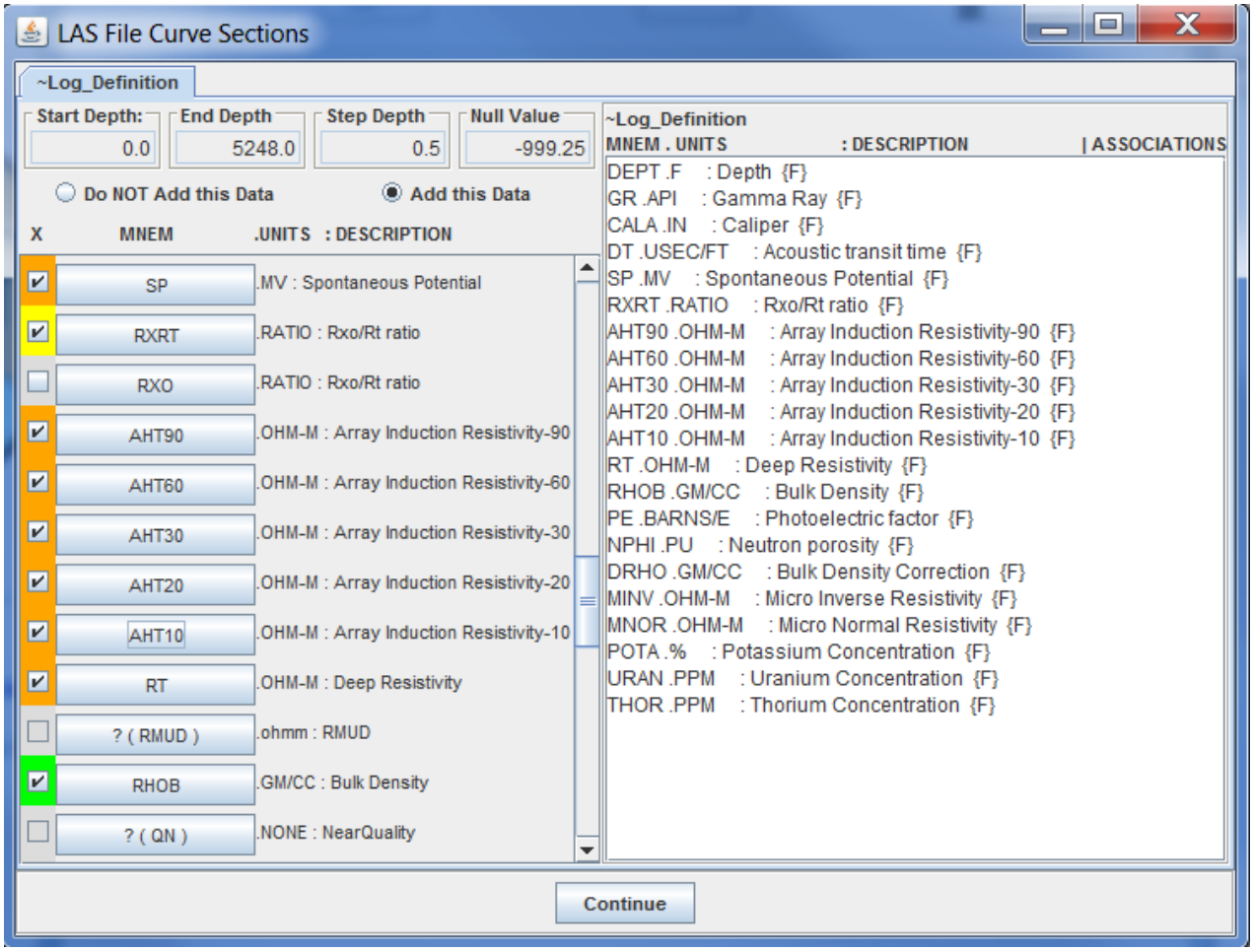


Highlight the AHT90 and click on the “Select” Button.



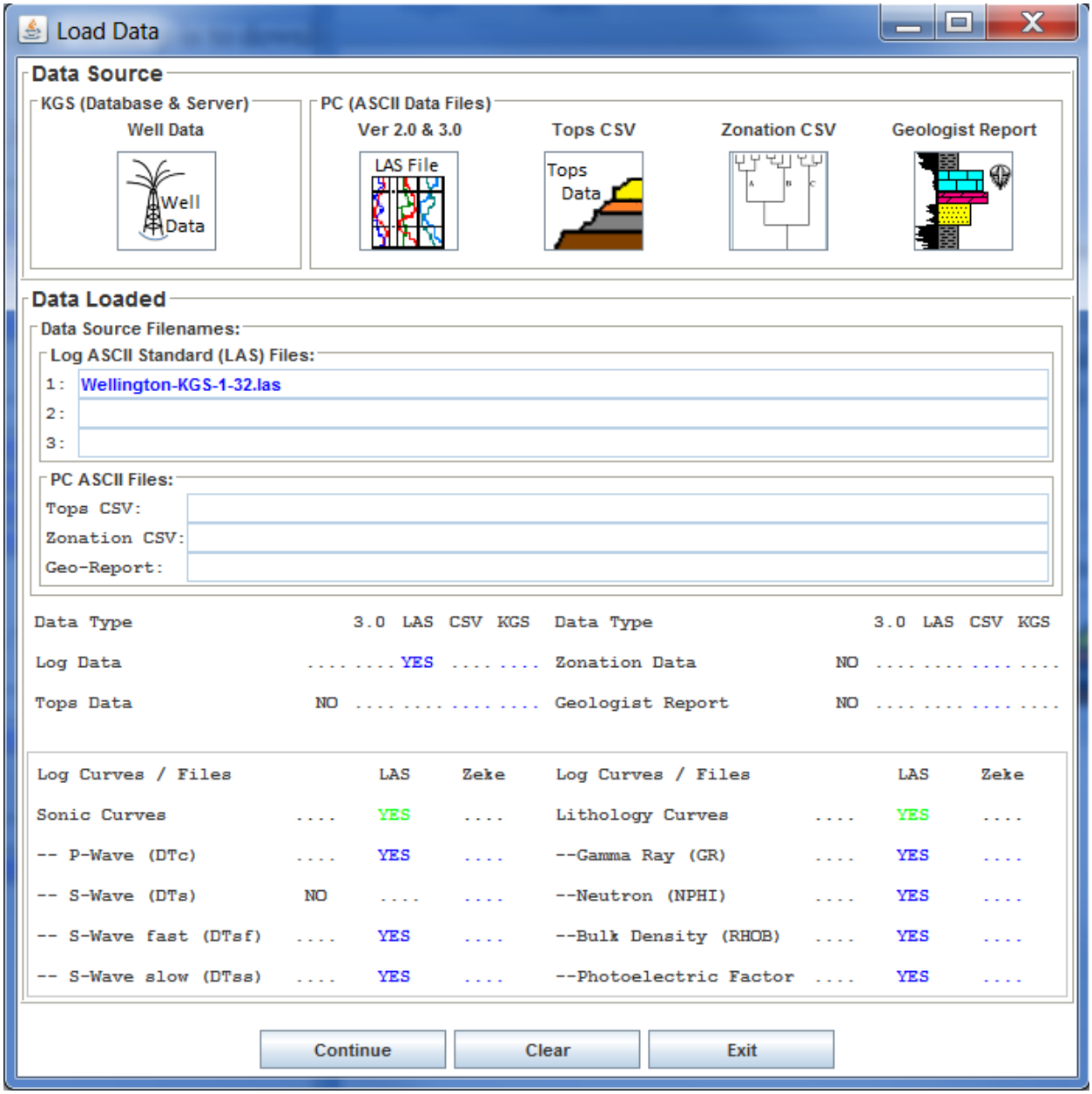
The "(?AHT90).ohmm : 90in Resistivity 2ft Res" has changed to "AHT90.OHM-M : Array Induction Resistivity-90" and the orange check box is selected. The rest of the Array Induction Log Curves each are mapped to the respective KGS Mnemonic Curve as follows,

(?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



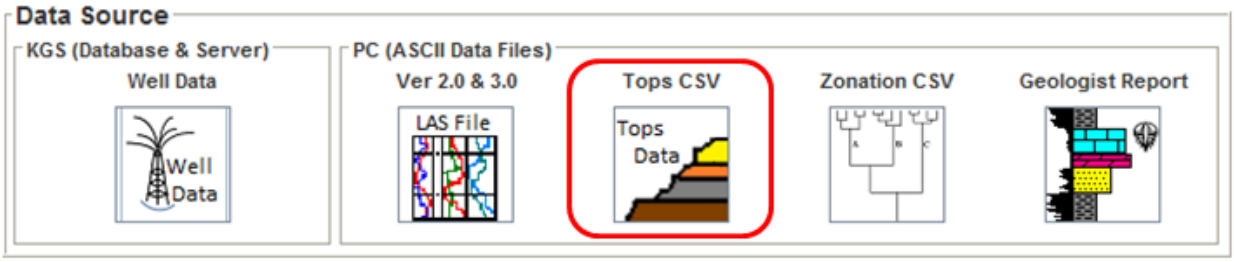
Select the Continue Button to read and parse the LAS log curves selected into the PS WAVE Web App. Notice that the "Data Source Filenames:" Panel lists the LAS version 2.0 File that was just read in as well as the type of data, i.e. Log Data from LAS Data Type.

Note in the Load Data Dialog displayed below, that the "Sonic Curves" Row in the lower table is green, which informs the user that the necessary data is present to compute the sonic times and velocities from the imported LAS file. Although the "p-Wave (DTc) log curve is present and not the "s-Wave (DTs) log curve, the "s-Wave (DTs) log curve by computing the average of the "S-Wave fast (DTsf)" and the "S-Wave slow log (DTss)" log curves. The curves that are listed in the bottom table are the necessary curves for this program any other curves will be ignored, i.e. resistivity, permeability, etc.

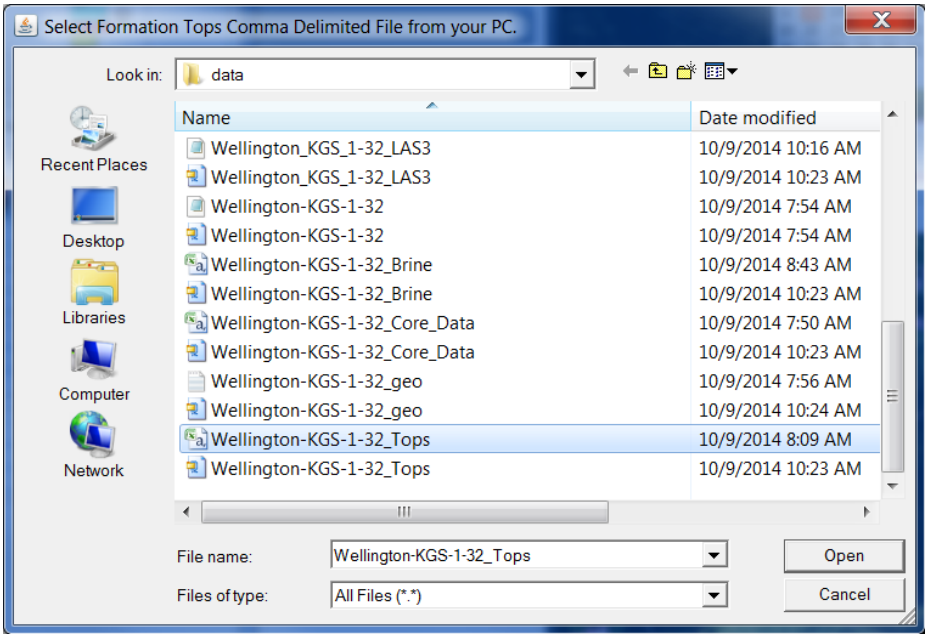

Load Data
Data Source
KGS (Database & Server)
Well Data
Well Data
PC (ASCII Data Files)
Ver 2.0 & 3.0
LAS File
Tops CSV
Tops Data
Zonation CSV
Geologist Report
Data Loaded
Data Source Filenames:
Log ASCII Standard (LAS) Files:
1: Wellington-KGS-1-32.las
2:
3:
PC ASCII Files:
Tops CSV:
Zonation CSV:
Geo-Report:
Data Type 3.0 LAS CSV KGS
Log Data YES
Tops Data NO
Data Type 3.0 LAS CSV KGS
Zonation Data NO
Geologist Report NO
Log Curves / Files LAS Zeke
Sonic Curves YES
-- P-Wave (DTc) YES
-- S-Wave (DTs) NO
-- S-Wave fast (DTsf) YES
-- S-Wave slow (DTss) YES
Log Curves / Files LAS Zeke
Lithology Curves YES
--Gamma Ray (GR) YES
--Neutron (NPHI) YES
--Bulk Density (RHOB) YES
--Photoelectric Factor YES
Continue
Clear
Exit

Import Tops Comma Separated Values (CSV) File.

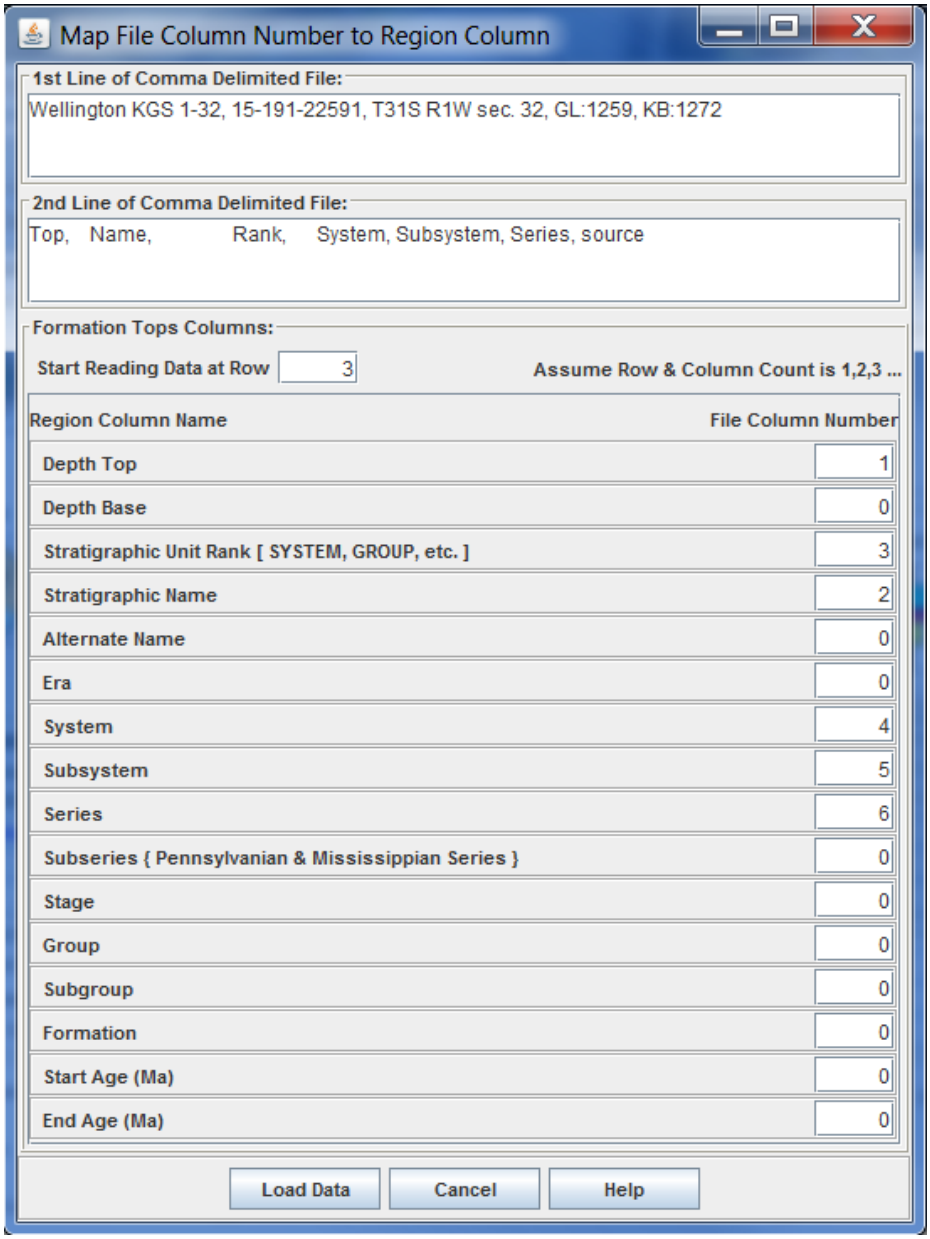
Most of the web apps will use the same input dialogs to import tops CSV (Comma Separated Values) file. The Load Data Dialog is basically the same for most of the Web Apps except they only load a subset of the total data types. In this example a Tops CSV file is being imported into the web app.



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
Line 2 Data Column Labels
Line 3 Data Start

```
Wellington KGS 1-32, 15-191-22591, T31S R1W sec. 32, GL:1259, KB:1272
Top,    Name,               Rank,      System, Subsystem, Series, source
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.

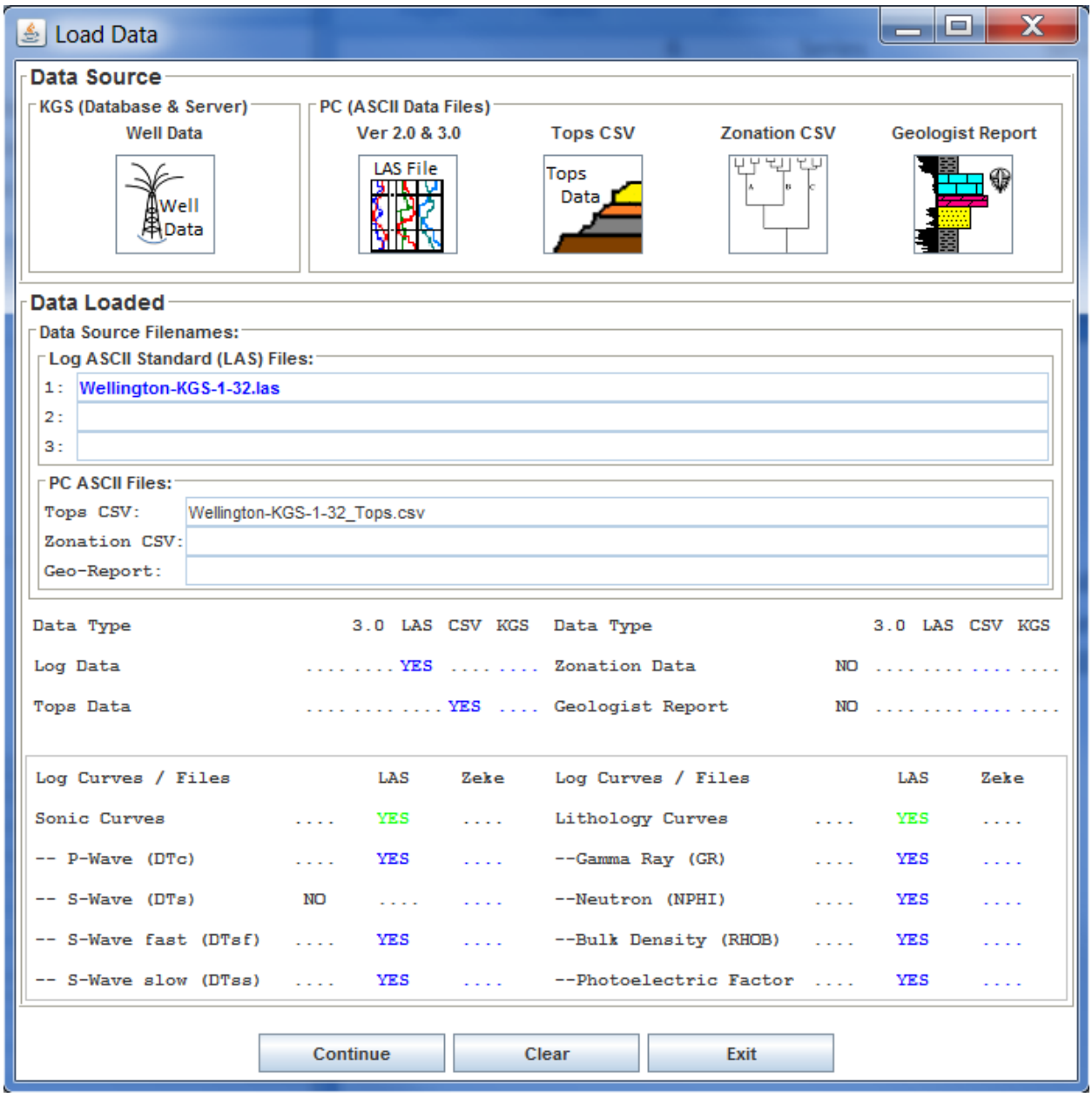
The "Map File Column Number to Region Column" Dialog allows the user to map the data in the Tops CSV File to the web app data structure variables. The program first reads the first and second line of the CSV File looking for the data column headers. The lines are each parsed to single out the data column 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.

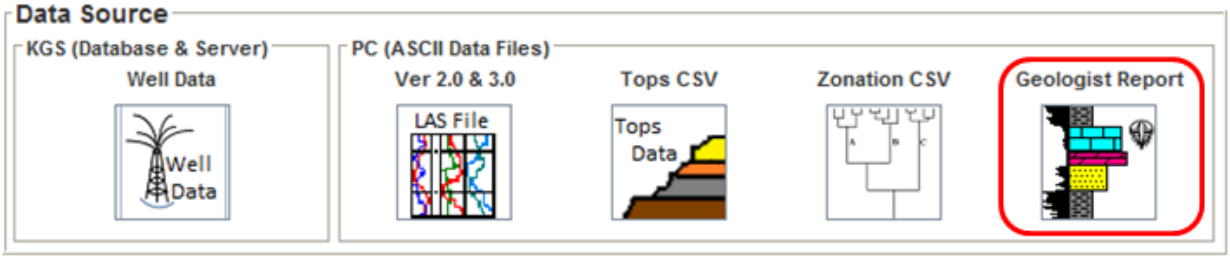
Column	File Column Label	Tops Data Name
1	Top	Depth Top
2	Name	Stratigraphic Name
3	Rank	Stratigraphic Unit Rank
4	System	System
5	Subsystem	Subsystem
6	Series	Series
7	Source	

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



Import Geologist Report (Cuttings/Core Descriptions) ASCII Delimited File

Some of the web apps will use the same input dialogs to import Geologist Report ASCII Delimited 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 Geologist Report ASCII Delimited file is being imported into the web app.

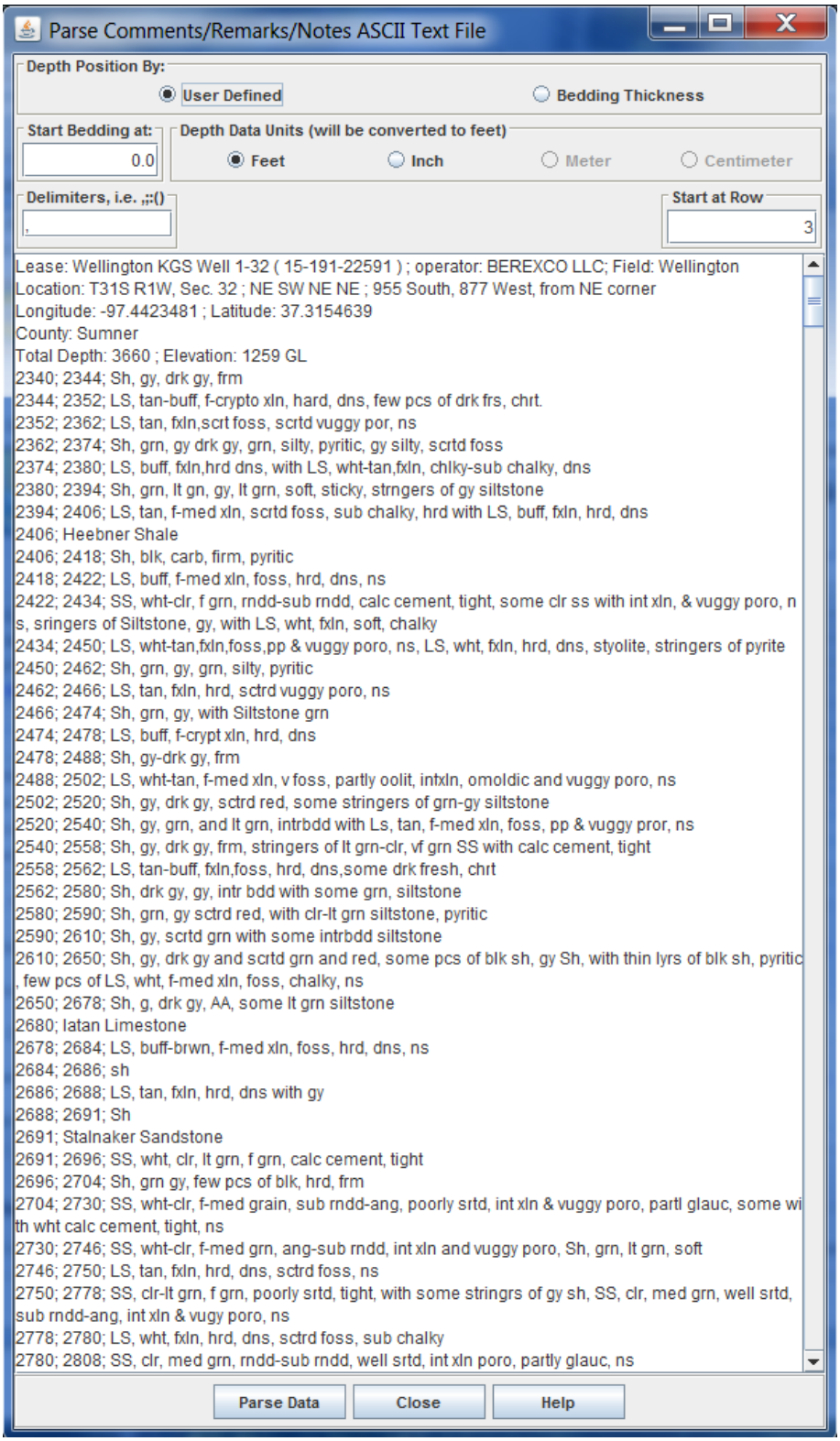


Left Click on the "Geologist Report" Icon Button in the Data Source Panel of the Load Data Dialog. This will display the "Select Comments/Remarks/Notes Delimited File from your PC" Dialog. This dialog allows the user to search their PC for the file of interest. In this example it is the Geologist Delimited file Wellington-KGS-1-32_geo.txt, highlighted below. Select the Open button to display the "Parse Comments/Remarks/Notes ASCII Text File" Dialog.

The Select Comments/Remarks/Notes Delimited File from your PC Dialog allows the user to import the geologist report into the web app. The data is parsed into the one of number of rock description data structures, i.e. Rock Color, Rock Lithology, Porosity, Sedimentary Structure, and General Fossils.

There are two sections to this dialog the Top controls how the depth data is found and interpreted. The "User defined" Depth assumes that the first two columns will be the start and stop depth followed by the text as this example below shows. The "Bedding Thickness" Depth assumes that there is one depth with the description. The user should take care to use a delimiter that does not appear in the description if the bedding thickness follows the bed descriptions.

The "Delimiters, i.e. ,;:()" text field has default ',' by default, which for the example below, showed be changed to ';' to match the depth data separation delimiter shown. And the "Start at Row" text field should be changed to 6 since the data starts at line 6. The default depth is in feet, but it is possible that a measured section would be measured in inches, note this setting is for all depths in the file. This panel allows the user to see all the data and to edit the Depth Delimiter, Starting point of the Data and Bedding Depth Start text fields to match the data and then select the "Parse Data" to parse the text into the rock data structures.


Parse Comments/Remarks/Notes ASCII Text File
Depth Position By:
User Defined
Bedding Thickness
Start Bedding at:
0.0
Depth Data Units (will be converted to feet)
Feet
Inch
Meter
Centimeter
Delimiters, i.e. ,;:()
,
Start at Row
3
Lease: Wellington KGS Well 1-32 (15-191-22591) ; operator: BEREXCO LLC; Field: Wellington
Location: T31S R1W, Sec. 32 ; NE SW NE NE ; 955 South, 877 West, from NE corner
Longitude: -97.4423481 ; Latitude: 37.3154639
County: Sumner
Total Depth: 3660 ; Elevation: 1259 GL
2340; 2344; Sh, gy, drk gy, frm
2344; 2352; LS, tan-buff, f-crypto xln, hard, dns, few pcs of drk frs, chrt.
2352; 2362; LS, tan, fxln,scrt foss, scrtd vuggy por, ns
2362; 2374; Sh, grn, gy drk gy, grn, silty, pyritic, gy silty, scrtd foss
2374; 2380; LS, buff, fxln,hrd dns, with LS, wht-tan,fxln, chlky-sub chalky, dns
2380; 2394; Sh, grn, lt gn, gy, lt grn, soft, sticky, strngers of gy siltstone
2394; 2406; LS, tan, f-med xln, scrtd foss, sub chalky, hrd with LS, buff, fxln, hrd, dns
2406; Heebner Shale
2406; 2418; Sh, blk, carb, firm, pyritic
2418; 2422; LS, buff, f-med xln, foss, hrd, dns, ns
2422; 2434; SS, wht-clr, f grn, rndd-sub rndd, calc cement, tight, some clr ss with int xln, & vuggy poro, n
s, sringers of Siltstone, gy, with LS, wht, fxln, soft, chalky
2434; 2450; LS, wht-tan,fxln,foss,pp & vuggy poro, ns, LS, wht, fxln, hrd, dns, styolite, stringers of pyrite
2450; 2462; Sh, grn, gy, grn, silty, pyritic
2462; 2466; LS, tan, fxln, hrd, sctrd vuggy poro, ns
2466; 2474; Sh, grn, gy, with Siltstone grn
2474; 2478; LS, buff, f-crypt xln, hrd, dns
2478; 2488; Sh, gy-drk gy, frm
2488; 2502; LS, wht-tan, f-med xln, v foss, partly oolit, intxln, omoldic and vuggy poro, ns
2502; 2520; Sh, gy, drk gy, sctrd red, some stringers of grn-gy siltstone
2520; 2540; Sh, gy, grn, and lt grn, intrbdd with Ls, tan, f-med xln, foss, pp & vuggy pror, ns
2540; 2558; Sh, gy, drk gy, frm, stringers of lt grn-clr, vf grn SS with calc cement, tight
2558; 2562; LS, tan-buff, fxln,foss, hrd, dns,some drk fresh, chrt
2562; 2580; Sh, drk gy, gy, intr bdd with some grn, siltstone
2580; 2590; Sh, grn, gy sctrd red, with clr-lt grn siltstone, pyritic
2590; 2610; Sh, gy, scrtd grn with some intrbdd siltstone
2610; 2650; Sh, gy, drk gy and scrtd grn and red, some pcs of blk sh, gy Sh, with thin lyrs of blk sh, pyritic
, few pcs of LS, wht, f-med xln, foss, chalky, ns
2650; 2678; Sh, g, drk gy, AA, some lt grn siltstone
2680; Iatan Limestone
2678; 2684; LS, buff-brwn, f-med xln, foss, hrd, dns, ns
2684; 2686; sh
2686; 2688; LS, tan, fxln, hrd, dns with gy
2688; 2691; Sh
2691; Stalnaker Sandstone
2691; 2696; SS, wht, clr, lt grn, f grn, calc cement, tight
2696; 2704; Sh, grn gy, few pcs of blk, hrd, frm
2704; 2730; SS, wht-clr, f-med grain, sub rndd-ang, poorly srtd, int xln & vuggy poro, partl glauc, some wi
th wht calc cement, tight, ns
2730; 2746; SS, wht-clr, f-med grn, ang-sub rndd, int xln and vuggy poro, Sh, grn, lt grn, soft
2746; 2750; LS, tan, fxln, hrd, dns, sctrd foss, ns
2750; 2778; SS, clr-lt grn, f grn, poorly srtd, tight, with some stringrs of gy sh, SS, clr, med grn, well srtd,
sub rndd-ang, int xln & vugy poro, ns
2778; 2780; LS, wht, fxln, hrd, dns, sctrd foss, sub chalky
2780; 2808; SS, clr, med grn, rndd-sub rndd, well srtd, int xln poro, partly glauc, ns
Parse Data
Close
Help

Geologist Report ASCII Delimited File Structure - By Depth Range:

The Wellington KGS 1-32 Geologist Report Delimited file example has a more relaxed format. The well header information is at the top of the file with as many lines needed. The data starts immediately after the header section. The Geologist Report Example for the Wellington KGS 1-32 well is as follows,

Line 1 to Line 5: Well Header Information

Line 6 Data Start

Line 13 Tops Pick Depth example, if there are no other tops sources then the geologist report will be parsed for tops.

```
Lease: Wellington KGS Well 1-32 ( 15-191-22591 ) ; operator: BEREXCO LLC; Field: Wellington
Location: T31S R1W, Sec. 32 ; NE SW NE NE ; 955 South, 877 West, from NE corner
Longitude: -97.4423481 ; Latitude: 37.3154639
County: Sumner
Total Depth: 3660 ; Elevation: 1259 GL
2340; 2344; Sh, gy, drk gy, frm
2344; 2352; LS, tan-buff, f-crypto xln, hard, dns, few pcs of drk frs, chrt.
2352; 2362; LS, tan, fxln,scrt foss, scrtd vuggy por, ns
2362; 2374; Sh, grn, gy drk gy, grn, silty, pyritic, gy silty, scrtd foss
2374; 2380; LS, buff, fxln,hrd dns, with LS, wht-tan,fxln, chlky-sub chalky, dns
2380; 2394; Sh, grn, lt gn, gy, lt grn, soft, sticky, strngers of gy siltstone
2394; 2406; LS, tan, f-med xln, scrtd foss, sub chalky, hrd with LS, buff, fxln, hrd, dns
2406; Heebner Shale
2406; 2418; Sh, blk, carb, firm, pyritic
2418; 2422; LS, buff, f-med xln, foss, hrd, dns, ns
2422; 2434; SS, wht-clr, f grn, rndd-sub rndd, calc cement, tight, some clr ss with int xln, & vuggy poro, ns,
2434; 2450; LS, wht-tan,fxln,foss,pp & vuggy poro, ns, LS, wht, fxln, hrd, dns, styolite, stringers of pyrite
2450; 2462; Sh, grn, gy, grn, silty, pyritic
2462; 2466; LS, tan, fxln, hrd, sctrd vuggy poro, ns
2466; 2474; Sh, grn, gy, with Siltstone grn
2474; 2478; LS, buff, f-crypt xln, hrd, dns
2478; 2488; Sh, gy-drk gy, frm
```

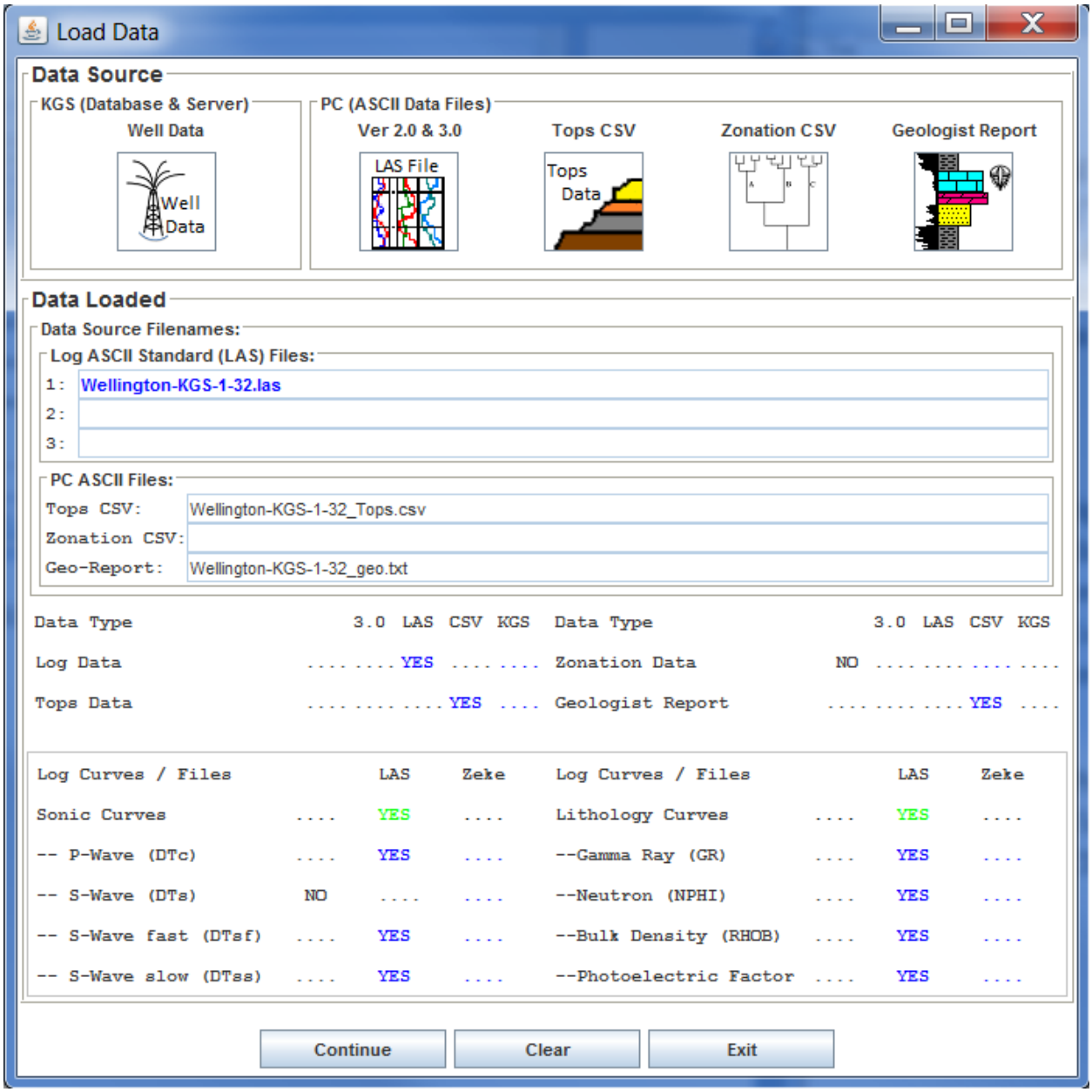
Figure: Partial contents of the Wellington-KGS-1-32_geo.txt File.

In this example the depth range information is separated by semicolons (;) and is in the front of each description, e.g. “2340; 2344; Sh, gy, dark gy, frm”. The depth range parse engine assumes that there will be two numbers at the beginning of each description. The semicolon is not necessarily unique in the line, but the program expects to find two number fields at the front of the line. The program will separate the description from the depth range using the delimiter ‘;’. Using an example line from above,

“2340; 2344; Sh, gy, dark gy, frm”

The parse engine will determine which part is the description and which is the depth information. The depths are then cleaned of any other non-numeric characters leaving the numbers, e.g. 2340 and 2344. The parse engine sets the starting depth and ending depths for the description and computes the thickness and adds to the cumulative total depth. The description is parsed later (Lithology, Rock Color, Porosity, Sedimentary Structure, Fossils and Fossil Genera/Species Names) when the user selects the “Parse Data” Button.

When the user selects the “Parse Data” Button on the “Parse Comments/Remarks/Notes ASCII Text File” Dialog the data is parsed into the PS Wave Program, where the Geologist Report Delimited file name is entered into the “PC ASCII Files:” Panel as well as the data type source.



All data is loaded in the Load Data Dialog needed for computing the sonic times and velocities. The program computes the sonic times and velocities for beds, so the log data needs to be converted to "Beds", which is accomplished using the Depth Constrained Cluster Analysis (Zonation) Dialog. If the data is not already in beds, i.e. importing the Zonation data CSV File, then when the user clicks on the "Continue" button the program will automatically send the user to the Depth Constrained Cluster Analysis (Zonation) Dialog first. This program wants to compute the times from the surface so a log that at least has a gamma ray (GR) log curve from the surface is necessary to create "Beds" for this program.

Example: Wellington KGS 1-32

To illustrate the data loaded in the "Importing PC Data" Section will be used to illustrate the depth constrained cluster analysis (zonation).

Zonation By Depth-Constrained Cluster Analysis

The Zonation by depth-constrained multivariate cluster analysis segments the entire depth interval based on user-specified set of logs. A hierarchical cluster is used to produce subintervals that are as homogeneous as possible and distinct as possible from each other, in terms of their log characteristics. The software employs Ward's method which, at each step of the clustering process, joins the two groups (subintervals) whose merger produces the least possible increase in the total within-groups sum-of-squares. The sum-of-squares for a single group, k, is given by

$$W_k = \sum_{i=1}^{n_k} ||x_i - \underline{x}_k||^2$$

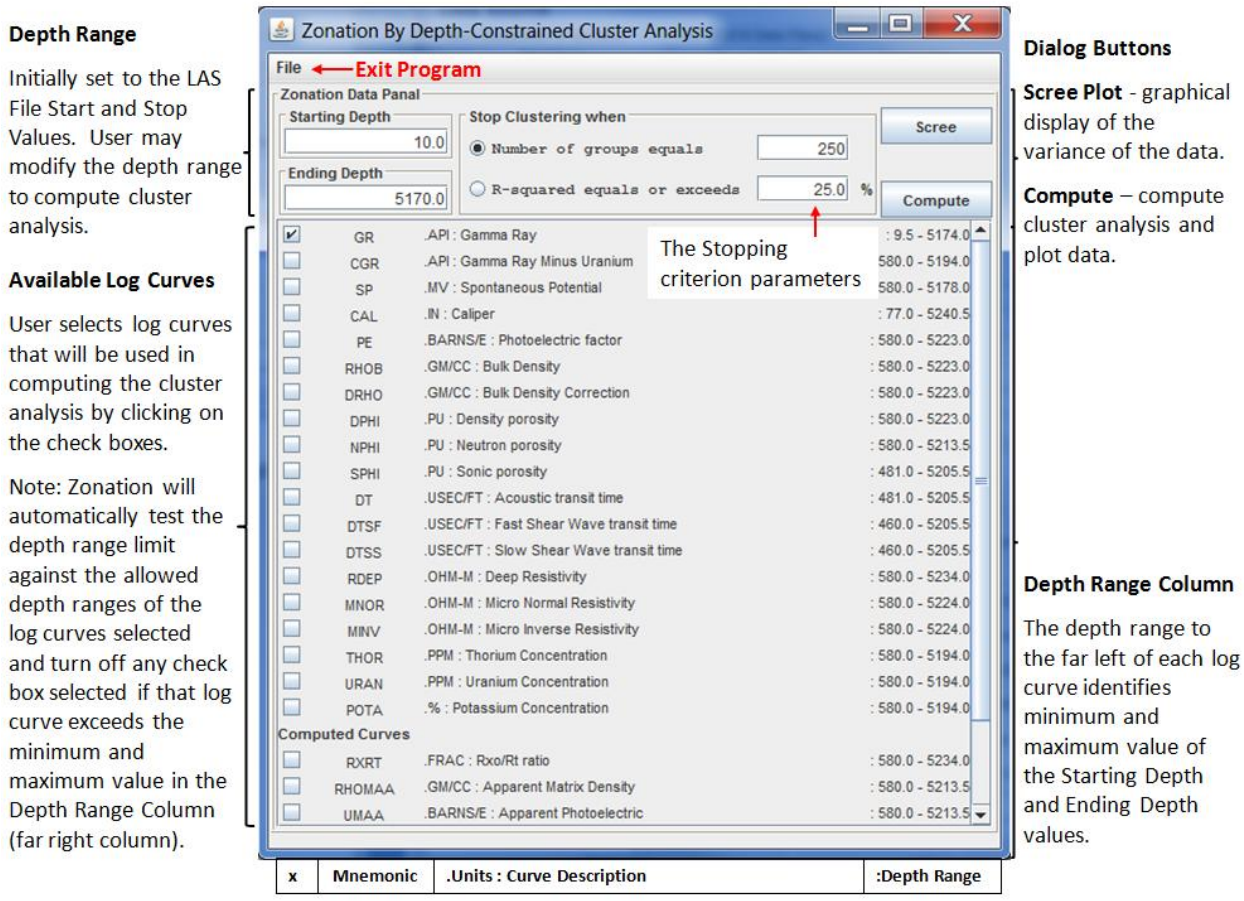
where $||x_i - \underline{x}_k||^2$ is the squared distance between the vector of the log values for data point i, x_i, and the vector mean for group k, x_k. The within-groups sum-of-squares, W, is simply the sum of the W_k values over all groups. At each step of the clustering process, the number of groups is reduced by one and the within-groups sum-of-squares increases. When all the data are joined into a single group, the total within-groups sum of squares equal the total sum-of-squares, T, given by the sum of the squared distances from all the data points to the global mean. At any step in the process, the relative amount of variation "explained" by the grouping can be measured by the value $R^2 = W/T$. R^2 increases with every merger and equals 100% when all the data points are joined in a single group.

The depth-constrained cluster analysis implemented in Zonation only allows vertically adjacent groups (subintervals) to be joined, greatly reducing the amount of computation relative to a more general cluster analysis, which would allow the possibility of joining any possible pair of groups at each step. The depth- constrained cluster analysis always produces a sequence of group memberships, represented as integers, beginning with 1 at the top of the interval and proceeding sequentially downward.

The "Zonation By Depth-Constrained Cluster Analysis" Dialog will display. The depth range panel initially displays the depth range of the log data. The user must set the Starting Depth and Ending Depth within the selected Log Curves or the log curves will be dropped when you select the "Compute" Button.

The stopping criterion can be specified either in terms of the number of groups (clustering will stop when the number of groups has be reduced to the number specified) or in terms of R^2 (clustering will stop when the R^2 equals or exceeds the specified value).

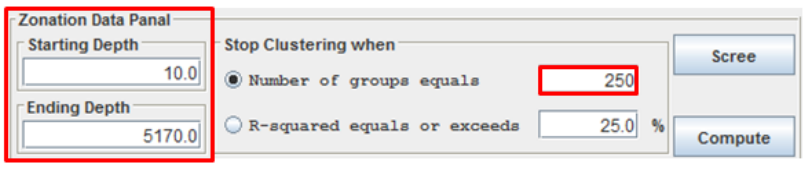
If you noticed on the dialog the log curves are listed together and only the Gamma Ray (GR) log curve has measurements from 9.5 to 5174.0 feet, but the other curves go from about 481.0 and580.0 feet to TD.



Note: This analysis will not process zones with LAS File Null values in the data. The Available log curves are presented in the Zonation dialog with the non Null value depth ranges of the individual curves. The program will turn off your curve selection if the depth range you select has a Null value. Try varying the depth by subtracting 5-10 feet on the end depth if you see the curves being deselected.

With this example first decide what depth range you wish to perform the depth constrained cluster analysis. Note: you can do the whole log, but if you select "R-squared equals or exceeds" radio button you will only get a maximum of 50 groups.

In the "Zonation Data Panel" change the Starting Depth to 10.0 and the Ending Depth to 5170.0. Also select 200 to 250 groups next to the "Number of groups equals" radio button.



This depth range looks at the whole well from surface to the Pre-Cambrian. You only need to select 1 curve to run the analysis, but combining multiple curves would give you better results. Since none of the curves besides the Gamma Ray goes from surface to TD, only the Gamma Ray will be selected.

Notice that only the Gamma Ray (GR) curve goes from the surface to TD (Total Depth). Select the Gamma Ray (GR) curve by selecting the check box next to the GR Curve.

Note: Next to each curve there is a depth range that identifies the minimum and maximum depth values that can be inserted in the Starting and Ending Depth text fields.

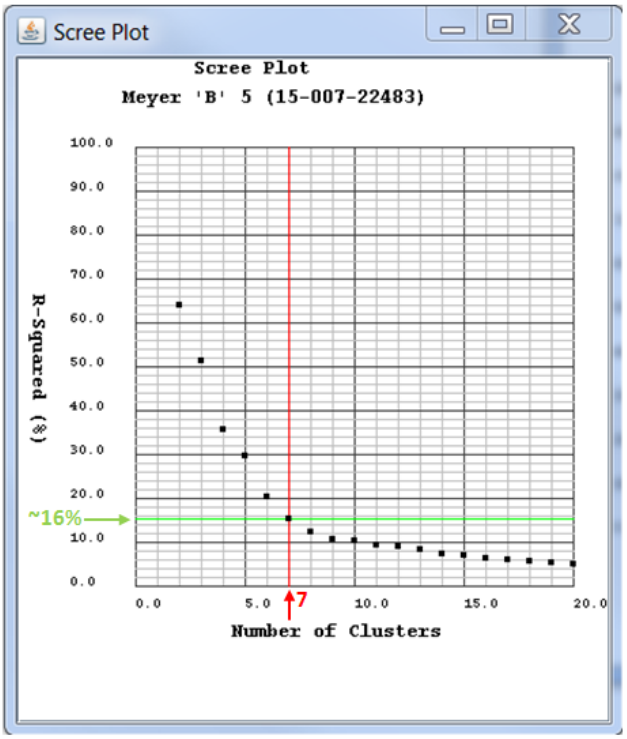
Since the PS Wave Program is computing the sonic times and velocities from the surface to TD (total depth), only the Gamma Ray (GR) curve is selected.

☑	GR	.API : Gamma Ray	: 9.5 - 5174.0
☐	CGR	.API : Gamma Ray Minus Uranium	: 580.0 - 5194.0
☐	SP	.MV : Spontaneous Potential	: 580.0 - 5178.0
☐	CAL	.IN : Caliper	: 77.0 - 5240.5
☐	PE	.BARNS/E : Photoelectric factor	: 580.0 - 5223.0
☐	RHOB	.GM/CC : Bulk Density	: 580.0 - 5223.0
☐	DRHO	.GM/CC : Bulk Density Correction	: 580.0 - 5223.0
☐	DPHI	.PU : Density porosity	: 580.0 - 5223.0
☐	NPHI	.PU : Neutron porosity	: 580.0 - 5213.5
☐	SPHI	.PU : Sonic porosity	: 481.0 - 5205.5
☐	DT	.USEC/FT : Acoustic transit time	: 481.0 - 5205.5
☐	DTSF	.USEC/FT : Fast Shear Wave transit time	: 460.0 - 5205.5
☐	DTSS	.USEC/FT : Slow Shear Wave transit time	: 460.0 - 5205.5
☐	RDEP	.OHM-M : Deep Resistivity	: 580.0 - 5234.0
☐	MNOR	.OHM-M : Micro Normal Resistivity	: 580.0 - 5224.0
☐	MINV	.OHM-M : Micro Inverse Resistivity	: 580.0 - 5224.0
☐	THOR	.PPM : Thorium Concentration	: 580.0 - 5194.0
☐	URAN	.PPM : Uranium Concentration	: 580.0 - 5194.0
☐	POTA	.% : Potassium Concentration	: 580.0 - 5194.0
Computed Curves			
☐	RXRT	.FRAC : Rxo/Rt ratio	: 580.0 - 5234.0
☐	RHOMAA	.GM/CC : Apparent Matrix Density	: 580.0 - 5213.5
☐	UMAA	.BARNS/E : Apparent Photoelectric	: 580.0 - 5213.5
☐	DTMAA	.USEC/FT : App. Matrix Acoustic	: 580.0 - 5205.5
☐	PHIDIFF	.PU : Neutron-Density Porosity	: 580.0 - 5213.5
☐	Th/U	.LOG_RATIO : Thorium/Uranium Ratio	: 580.0 - 5194.0
☐	Th/K	.LOG_RATIO : Thorium/Potassium Ratio	: 580.0 - 5194.0

The Depth Constrained Cluster Analysis (Zonation) is being used to create “Beds” for the whole well for the PS Wave program.

The stopping criterion can be specified either in terms of the number of groups (clustering will stop when the number of groups has been reduced to the number specified) or in terms of R^2 (clustering will stop when the R^2 equals or exceeds the specified value). In another example where the user only wants to do zonation over a specific depth range it would be important to select the “Scree” button to display the Scree Plot, which will assist in deciding the stopping criteria for the data set.

Meyer ‘B’ 5 Scree Plot Example

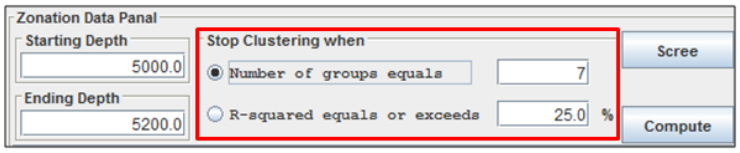


*A **scree plot** is a graphical display of the variance of each component in the dataset which is used to determine how many components should be retained in order to explain a high percentage of the variation in the data.*
Reference:
http://www.stats.gla.ac.uk/glossary/?q=node/451

Click on the “Scree” button to create a scree plot, which can assist the user in selecting the Stop Criteria Parameters in the “Stop Clustering when” text fields.

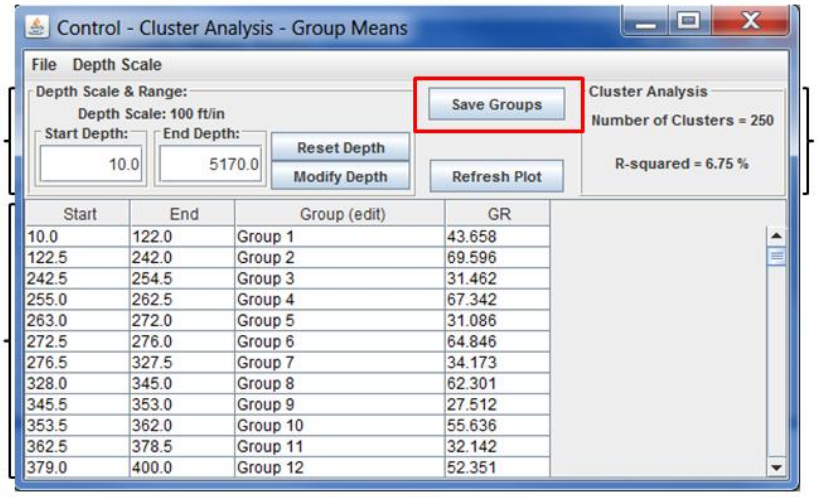
Since the “Number of groups equals” radio button is selected you will see a vertical red line on 7 “Number of Clusters” equal to the value entered in the text field. You will also see a horizontal green line, which will illustrate the R^2 (%) value of ~16%.

The Scree Plot illustrates that “Number of groups equal” radio button selected with 7 groups would be an adequate number of groups (zones) to split the depth range entered.



When the Compute button is selected in the Zonation Data Panel, this program will perform the cluster analysis. For the sake of the cluster analysis, each of the input variables is standardized to zero mean and unit variance. It is more than likely that the selected logs will be in incommensurate units and will thus differ greatly in magnitude. The standardization assures that each variable will be given approximately equal weight in the analysis. The analysis begins with each data point (zone) considered as a separate group (subinterval) and proceeds either until the stopping criterion is achieved. At that point the "Cluster Analysis - Group Means" Plot Dialog will be displayed with the results.

NOTE: The "Save Groups" Button will transfer the Zonation Data back to the PS Wave Program.



Depth Range Plot Control Text fields and buttons

Summary Table of the Groups and average values for each curve selected.

Summary information of the cluster analysis

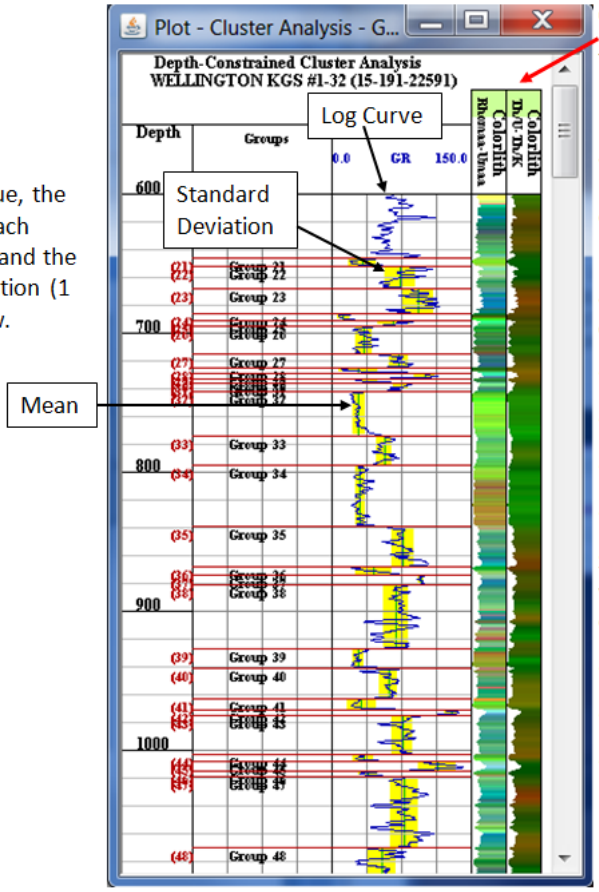
File Menu Option:

Create Portable Document Format (PDF) & Portable Network Graphics (PNG) of Cluster Analysis Plot, Group Data Table and Curve Descriptions.

Depth Scale Menu Option:

Allows the user to change the plot depth scale.

Log Curve is blue, the Mean within each group is green and the Standard Deviation (1 sigma) is yellow.



Colorlith Plot Tracks:

The Colorlith tracks provide a visual bed separation and a visual "goodness" indicator. Colorlith assigns a log curve to a single color, i.e. Rhomaa – Red, Umaa – Green, Gamma Ray-Blue.

Rhomaa-Umaa Colorlith will only appear if all the litho-density log curves are present,

- GR – Gamma Ray
- NPHI – Neutron Porosity
- RHOB – Bulk Density
- PE – Photoelectric Factor

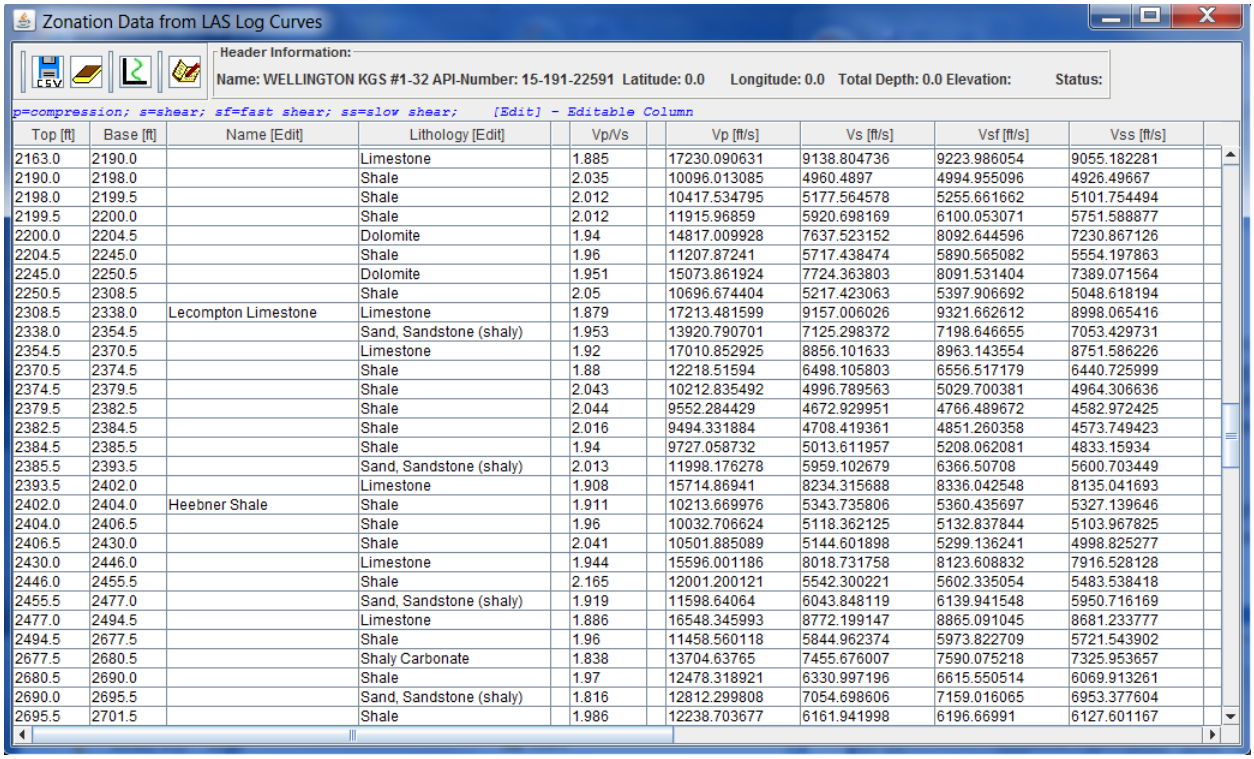
Spectral Gamma Ray Ratio Colorlith will only appear if all the Spectral Gamma Ray curves are present,

- Th – Thorium
- U – Uranium
- K - Potassium

Transfer "Beds" to PS Wave Program

To Transfer the groups to the PS Wave program select the "Save Groups" button on the "Control - Cluster Analysis - Group Means" Dialog and the created flow units will be transferred to the PS Wave Dialog and automatically loaded, i.e. the sonic, litho-density and spectral gamma ray log curves will automatically compute the averages over each "Bed". The program also back fills the log data back to the surface.

Click on the "Save Groups" button to display the Zonation Data from LAS log Curves "Spread Sheet" displaying the sonic times and velocities along with the tops and suggested lithology from the computed from the litho-density logs.


Zonation Data from LAS Log Curves

Header Information:

Name: WELLINGTON KGS #1-32 API-Number: 15-191-22591 Latitude: 0.0 Longitude: 0.0 Total Depth: 0.0 Elevation: Status:

p=compression; s=shear; sf=fast shear; ss=slow shear; [Edit] - Editable Column

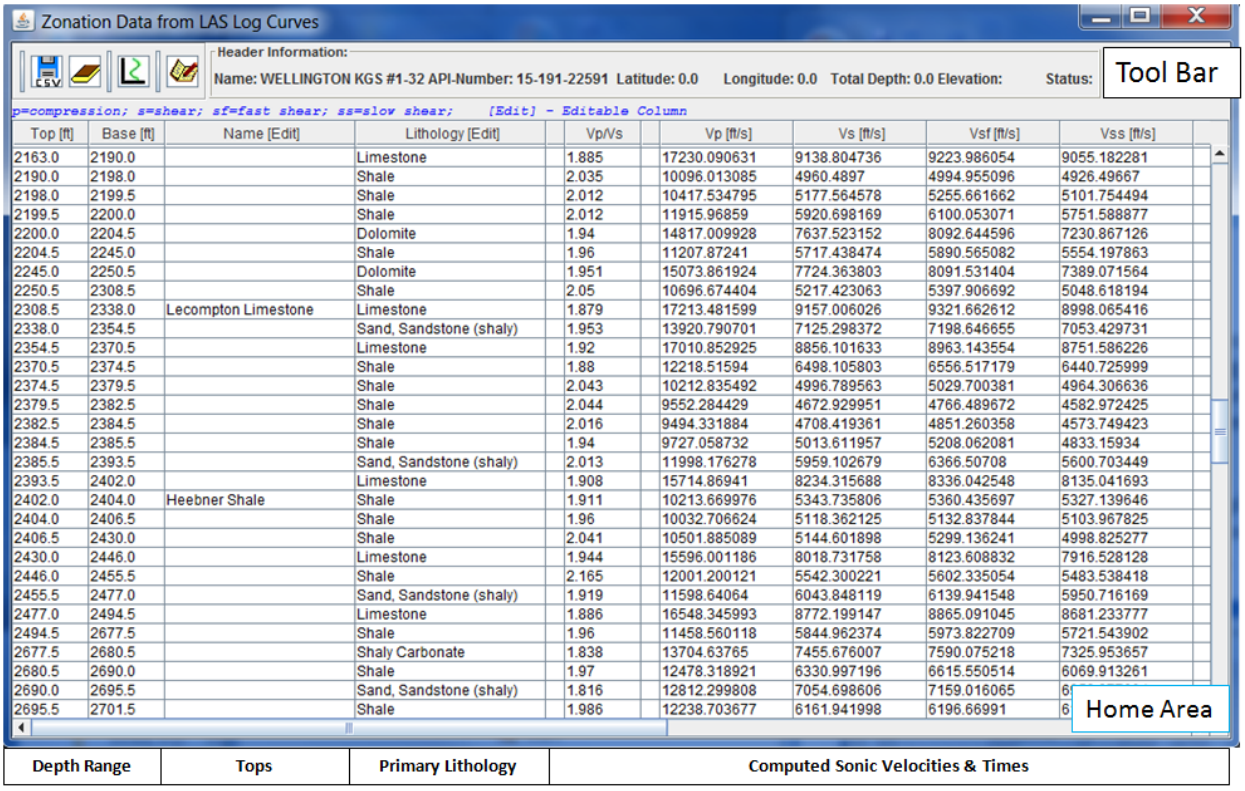
Top [ft]	Base [ft]	Name [Edit]	Lithology [Edit]	Vp/Vs	Vp [ft/s]	Vs [ft/s]	Vsf [ft/s]	Vss [ft/s]
2163.0	2190.0		Limestone	1.885	17230.090631	9138.804736	9223.986054	9055.182281
2190.0	2198.0		Shale	2.035	10096.013085	4960.4897	4994.955096	4926.49667
2198.0	2199.5		Shale	2.012	10417.534795	5177.564578	5255.661662	5101.754494
2199.5	2200.0		Shale	2.012	11915.96859	5920.698169	6100.053071	5751.588877
2200.0	2204.5		Dolomite	1.94	14817.009928	7637.523152	8092.644596	7230.867126
2204.5	2245.0		Shale	1.96	11207.87241	5717.438474	5890.565082	5554.197863
2245.0	2250.5		Dolomite	1.951	15073.861924	7724.363803	8091.531404	7389.071564
2250.5	2308.5		Shale	2.05	10696.674404	5217.423063	5397.906692	5048.618194
2308.5	2338.0	Lecompton Limestone	Limestone	1.879	17213.481599	9157.006026	9321.662612	8998.065416
2338.0	2354.5		Sand, Sandstone (shaly)	1.953	13920.790701	7125.298372	7198.646655	7053.429731
2354.5	2370.5		Limestone	1.92	17010.852925	8856.101633	8963.143554	8751.586226
2370.5	2374.5		Shale	1.88	12218.51594	6498.105803	6556.517179	6440.725999
2374.5	2379.5		Shale	2.043	10212.835492	4996.789563	5029.700381	4964.306636
2379.5	2382.5		Shale	2.044	9552.284429	4672.929951	4766.489672	4582.972425
2382.5	2384.5		Shale	2.016	9494.331884	4708.419361	4851.260358	4573.749423
2384.5	2385.5		Shale	1.94	9727.058732	5013.611957	5208.062081	4833.15934
2385.5	2393.5		Sand, Sandstone (shaly)	2.013	11998.176278	5959.102679	6366.50708	5600.703449
2393.5	2402.0		Limestone	1.908	15714.86941	8234.315688	8336.042548	8135.041693
2402.0	2404.0	Heebner Shale	Shale	1.911	10213.669976	5343.735806	5360.435697	5327.139646
2404.0	2406.5		Shale	1.96	10032.706624	5118.362125	5132.837844	5103.967825
2406.5	2430.0		Shale	2.041	10501.885089	5144.601898	5299.136241	4998.825277
2430.0	2446.0		Limestone	1.944	15596.001186	8018.731758	8123.608832	7916.528128
2446.0	2455.5		Shale	2.165	12001.200121	5542.300221	5602.335054	5483.538418
2455.5	2477.0		Sand, Sandstone (shaly)	1.919	11598.64064	6043.848119	6139.941548	5950.716169
2477.0	2494.5		Limestone	1.886	16548.345993	8772.199147	8865.091045	8681.233777
2494.5	2677.5		Shale	1.96	11458.560118	5844.962374	5973.822709	5721.543902
2677.5	2680.5		Shaly Carbonate	1.838	13704.63765	7455.676007	7590.075218	7325.953657
2680.5	2690.0		Shale	1.97	12478.318921	6330.997196	6615.550514	6069.913261
2690.0	2695.5		Sand, Sandstone (shaly)	1.816	12812.299808	7054.698606	7159.016065	6953.377604
2695.5	2701.5		Shale	1.986	12238.703677	6161.941998	6196.66991	6127.601167

References:

Pfeffer-Pro (Petrofacies Evaluation of Formation for Engineering Reservoirs), Kansas Geological Survey, Release Date February 1998. Zonation by Depth-Constrained Cluster Analysis pages 141 to 144.

PS Wave Sonic Data "Spread Sheet" Panel

Spread Sheet



Top [ft]	Base [ft]	Name [Edit]	Lithology [Edit]	Vp/Vs	Vp [ft/s]	Vs [ft/s]	Vsf [ft/s]	Vss [ft/s]
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2382.5	2384.5		Shale	2.016	9494.331884	4708.419361	4851.260358	4573.749423
2384.5	2385.5		Shale	1.94	9727.058732	5013.611957	5208.062081	4833.15934
2385.5	2393.5		Sand, Sandstone (shaly)	2.013	11998.176278	5959.102679	6366.50708	5600.703449
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2477.0	2494.5		Limestone	1.886	16548.345993	8772.199147	8865.091045	8681.233777
2494.5	2677.5		Shale	1.96	11458.560118	5844.962374	5973.822709	5721.543902
2677.5	2680.5		Shaly Carbonate	1.838	13704.63765	7455.676007	7590.075218	7325.953657
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2690.0	2695.5		Sand, Sandstone (shaly)	1.816	12812.299808	7054.698606	7159.016065	6
2695.5	2701.5		Shale	1.986	12238.703677	6161.941998	6196.66991	6

Depth Range	Tops	Primary Lithology	Computed Sonic Velocities & Times

Depth Range computed from Depth Constrained Cluster Analysis (Zonation), breaking the log into distinct beds.
Name merges the stratigraphic units data by matching the depths of the "Bed" with the top pick depth.
Primary Lithology computed from the litho-density logs, Gamma Ray (GR), Neutron Porosity (NPHI) and Bulk Density (RHOB).
Computed Sonic Velocities & Times columns displays the velocities and times by depth over bed thickness.

Tool Bar

Save Imported Log Data & computed Seismic Data as Comma Separated Values (CSV) File

Exit Workbook

Display Log Profile Plot

Modify Well Header Information

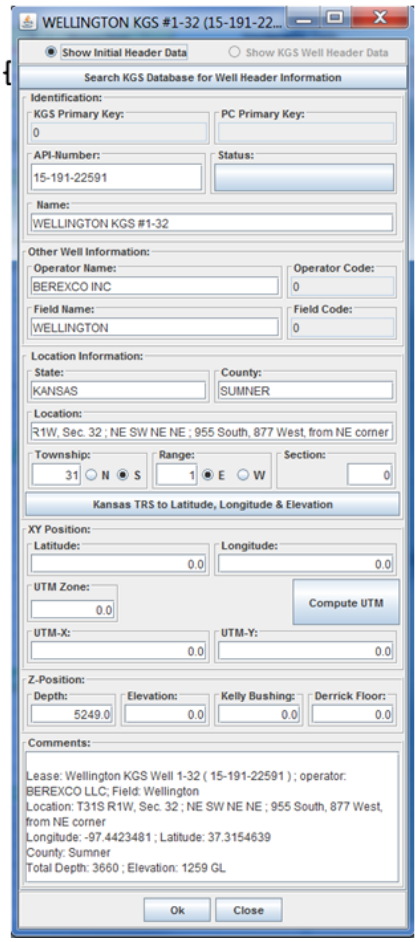
"Header Information" Panel display's the Well Header Summary Information that will appear at the top of the Comma Separated Values (CSV) File. To modify this information select the "Modify Well Header Information" icon button directly to the left of the "Header Information" Panel.

PS Wave Sonic Data Tool Bar Icon Buttons

Edit Header Information Icon Button

The Well Header Information Summary is displayed in the "Header Information" Panel on the "Zonation Data from LAS Log Curves" Dialog. To modify the header information at the top of the "Spread sheet" click on the Modify Header Information  icon image button; this will 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

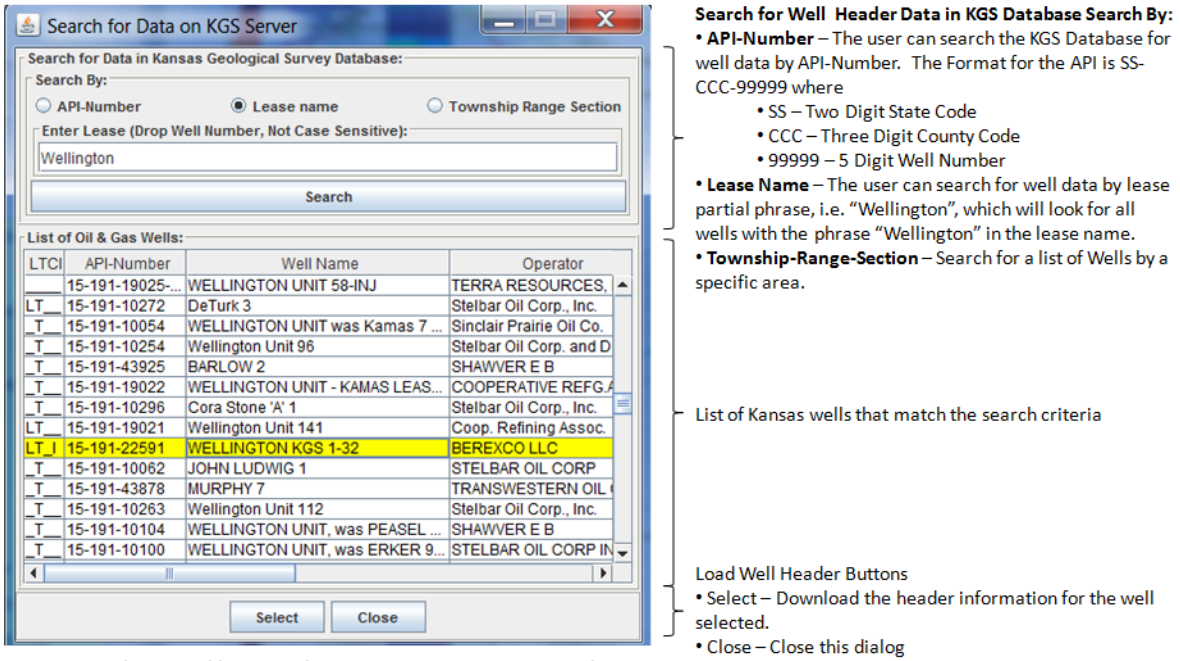
NOTE: Initially the Basic Header information is loaded from the LAS version 2.0 file and other fields like Comments, Location are loaded from the Geologist Report Header Section.

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 PS Wave Program and any summary information will be updated in the Profile 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.

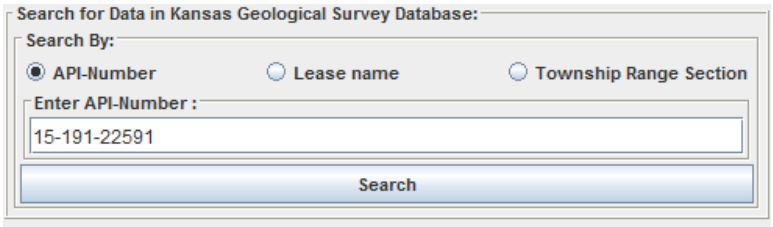
This will display the "Search for Data on KGS Server" Dialog, see image below. This dialog allows the user to search the KGS database for well header data. In this example, the well of interest will be the Wellington KGS 1-32.



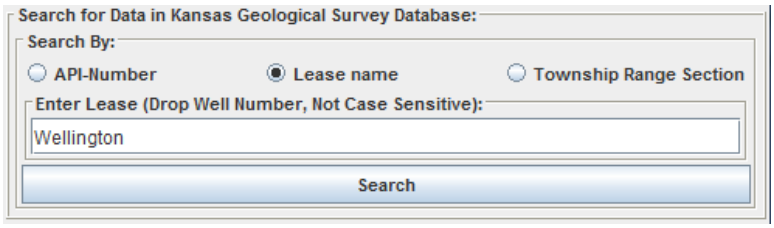
NOTE: LTCI Column in Table: L-LAS Files; T-Formation Tops; C-Measured Core Data; I-Core Images

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

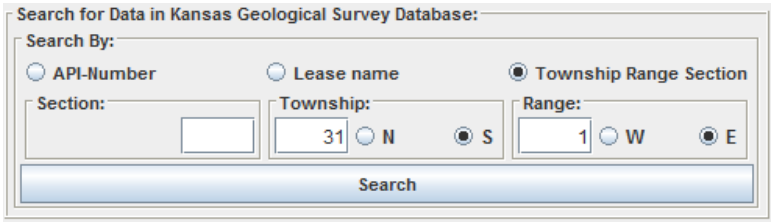
- By API-Number – KGS has a specific format for the API-Number, i.e.SS-CCC-99999 where SS is the state code for Kansas 15, CCC is the county code for Wellington KGS 1-32 it is 191 for Sumner County and the 5-Digit Well Number for the Wellington KGS 1-32 is 22591.



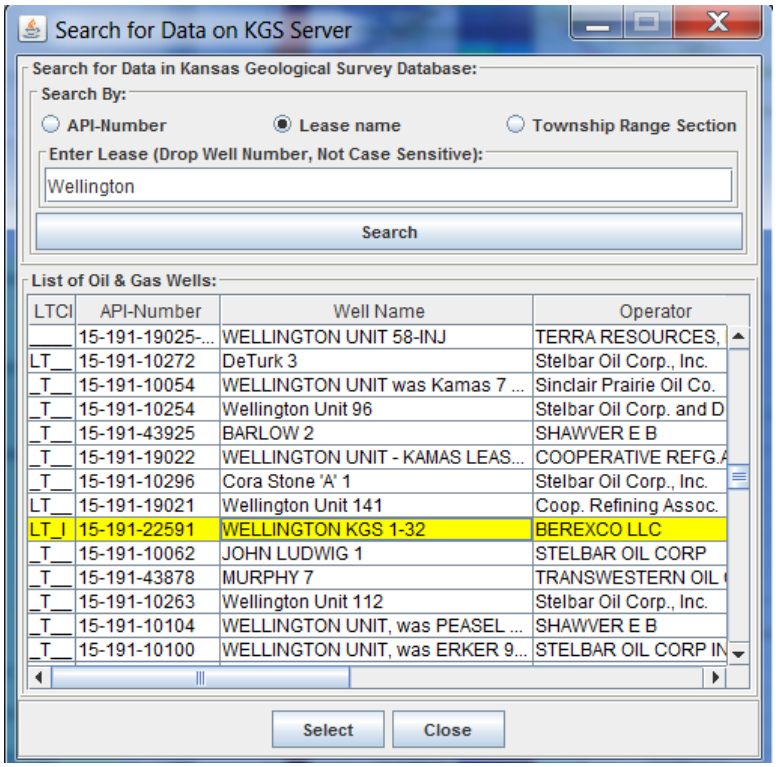
- By Partial Lease Name – The stored procedure used to retrieve the well header information allows the user to enter a partial phrase, in this example Wellington. The program places a '%' in front and back of the phrase and sends the request to the Database, i.e. "%Wellington%".



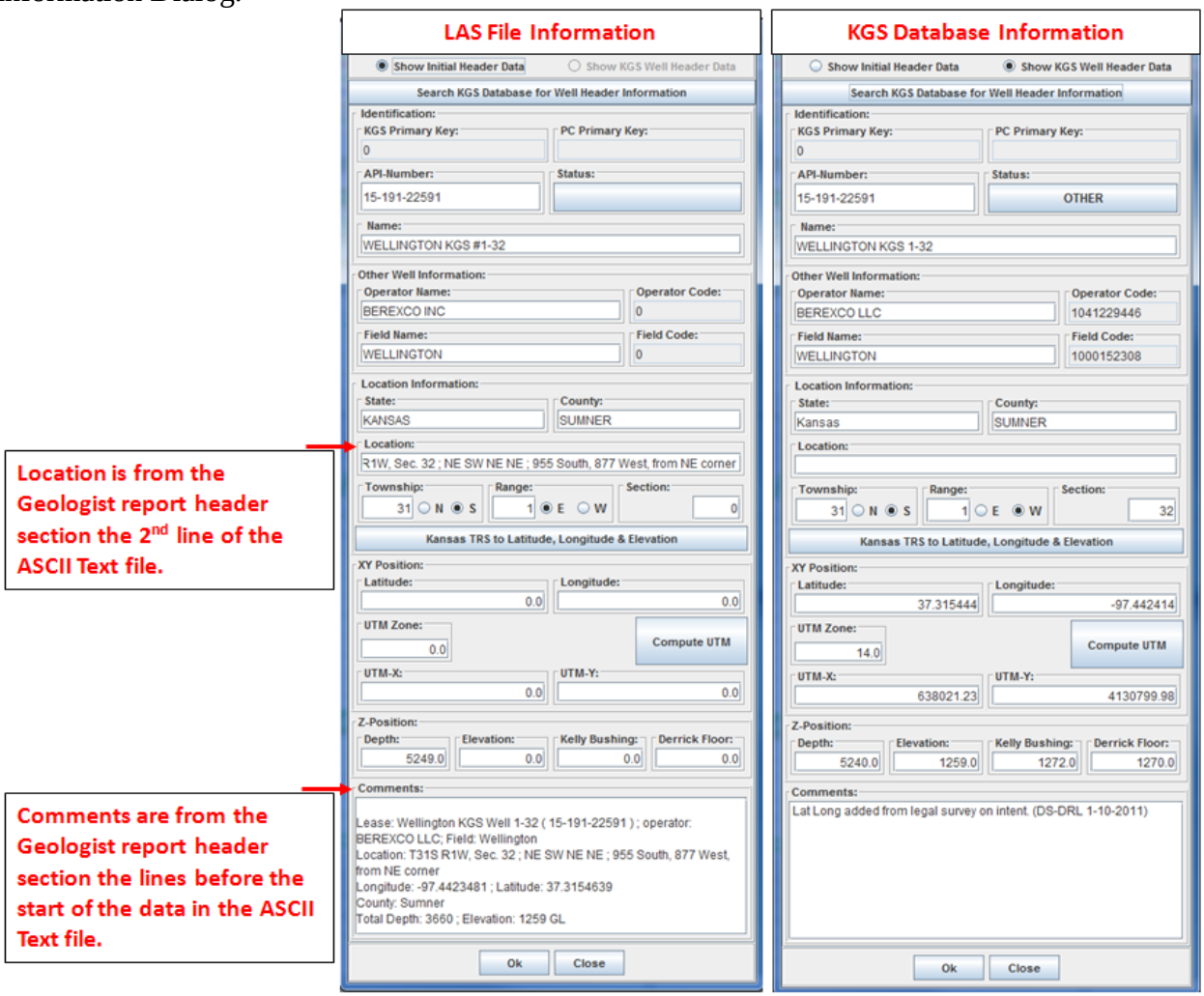
- By Township Range Section – This search is by location in Kansas, this search also allows the user to enter just the Township and Range to search for wells, e.g. to look for the Wellington KGS 1-32, enter Township as 31 set the S (South) Radio button and Range as 1 set the E (East) Radio button.



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.

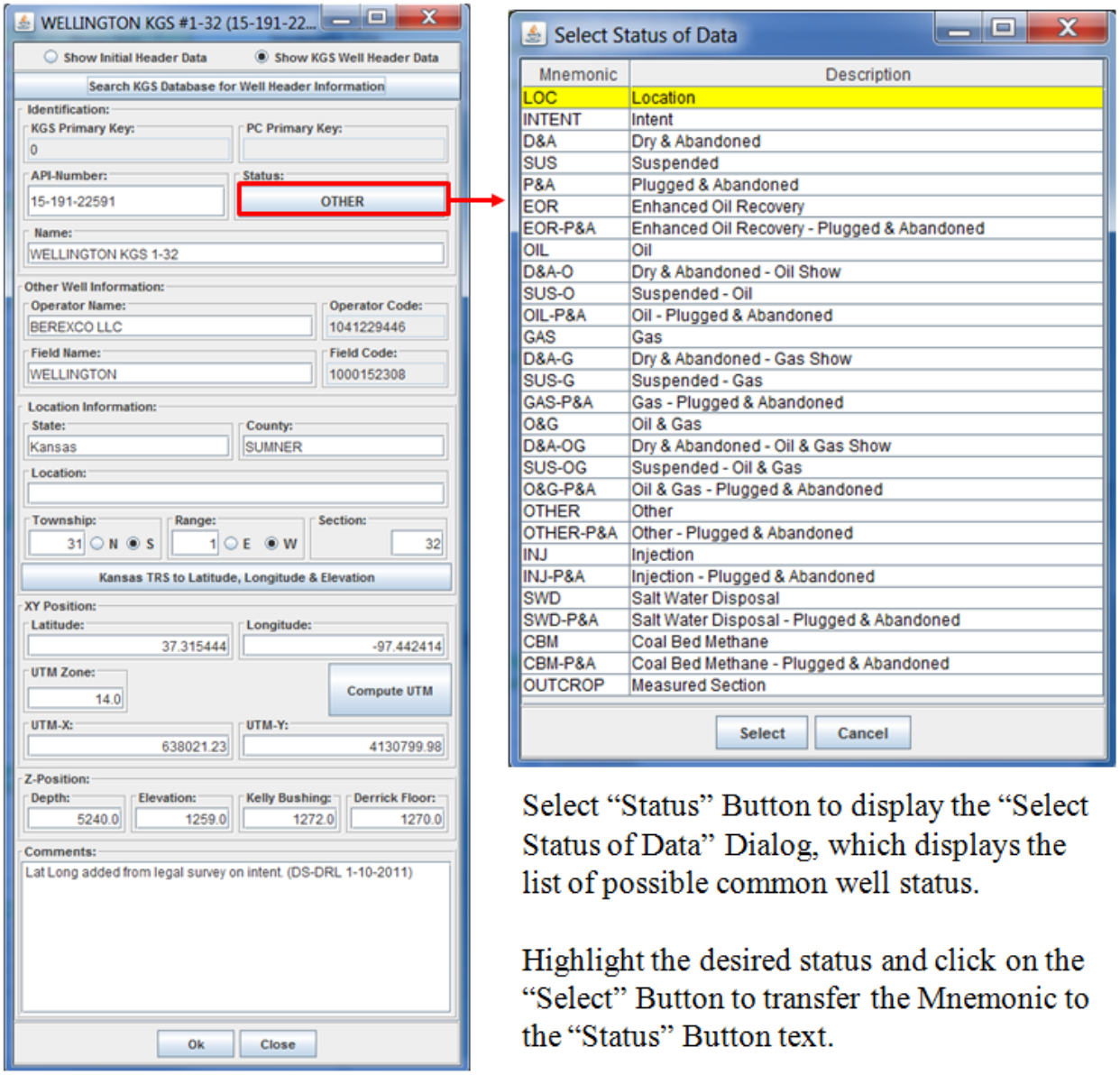
http://chasm.kgs.ku.edu/ords/iqstrat.TRS2LL_pkg.getXML?iTownship=31&sTownship=S&iRange=1&sRange=E&iSection=32

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.



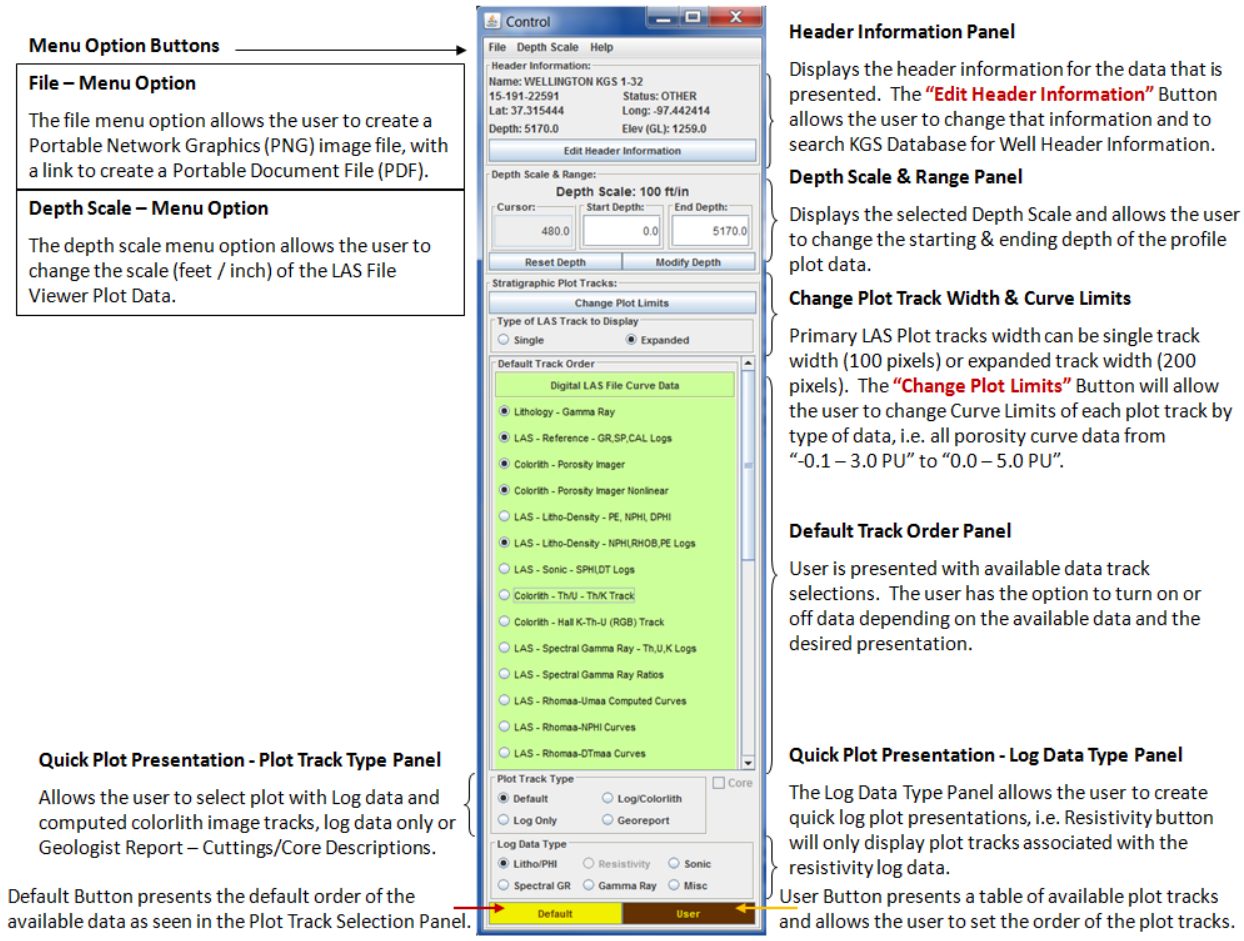
Select “Status” Button to display the “Select Status of Data” Dialog, which displays the list of possible common well status.

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 Zonation Data from LAS Log Curves dialog.

Profile Plot Icon Button

To display the profile plot of the log data click on the Profile Plot icon image button at the top of the "spreadsheet" panel. The "Profile Plot Control" dialog allows the user to change the presentation of the Profile Plot, by depth range, by depth scale, by data type, by log type, and modify the track curve limits.



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

- Profile 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.
- Profile 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 Profile 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.

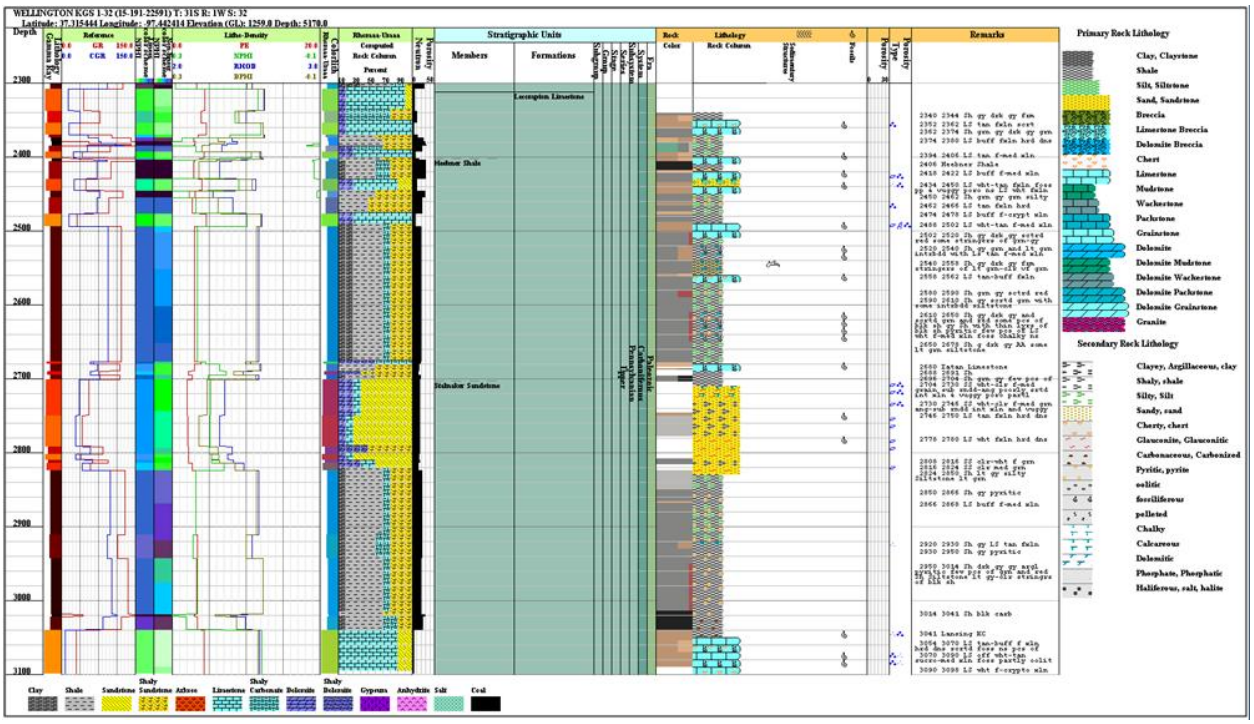
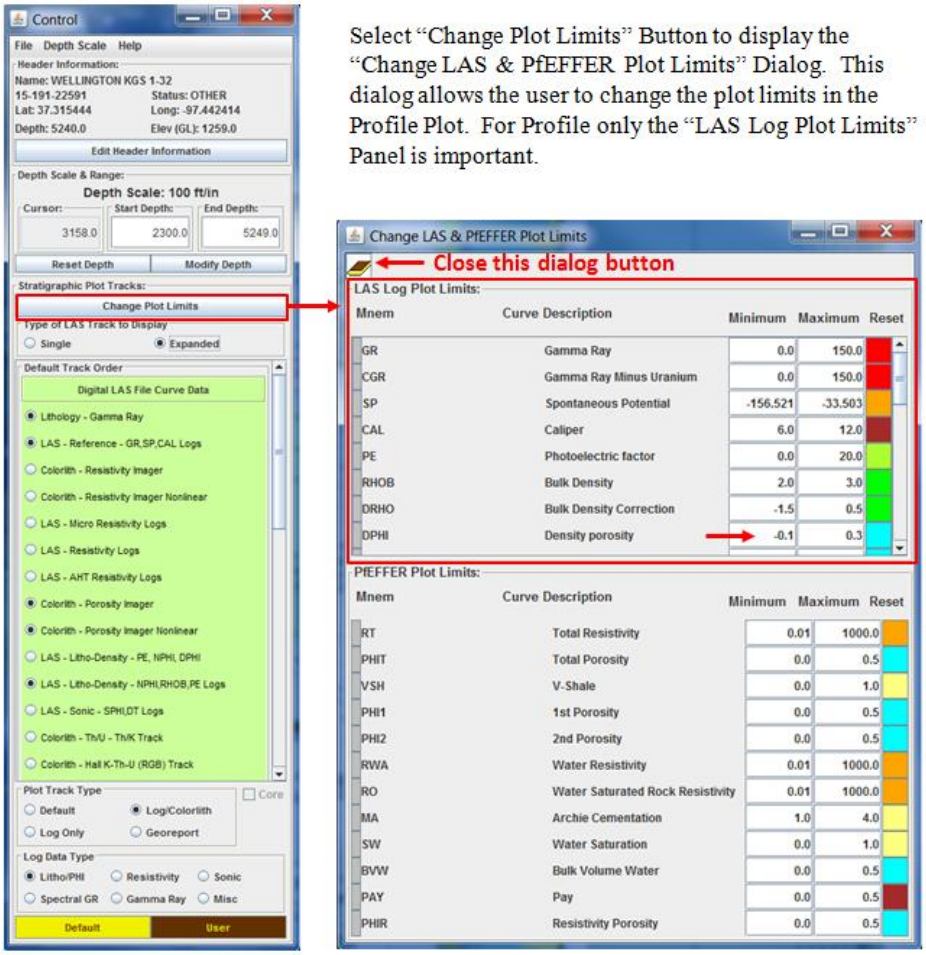


Figure: Wellington KGS 1-32 Profile Plot with Log, Tops, and Cuttings/Core Descriptions.

Change the Plot Track Limits

The "Change Plot Limits" Button on the Profile 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

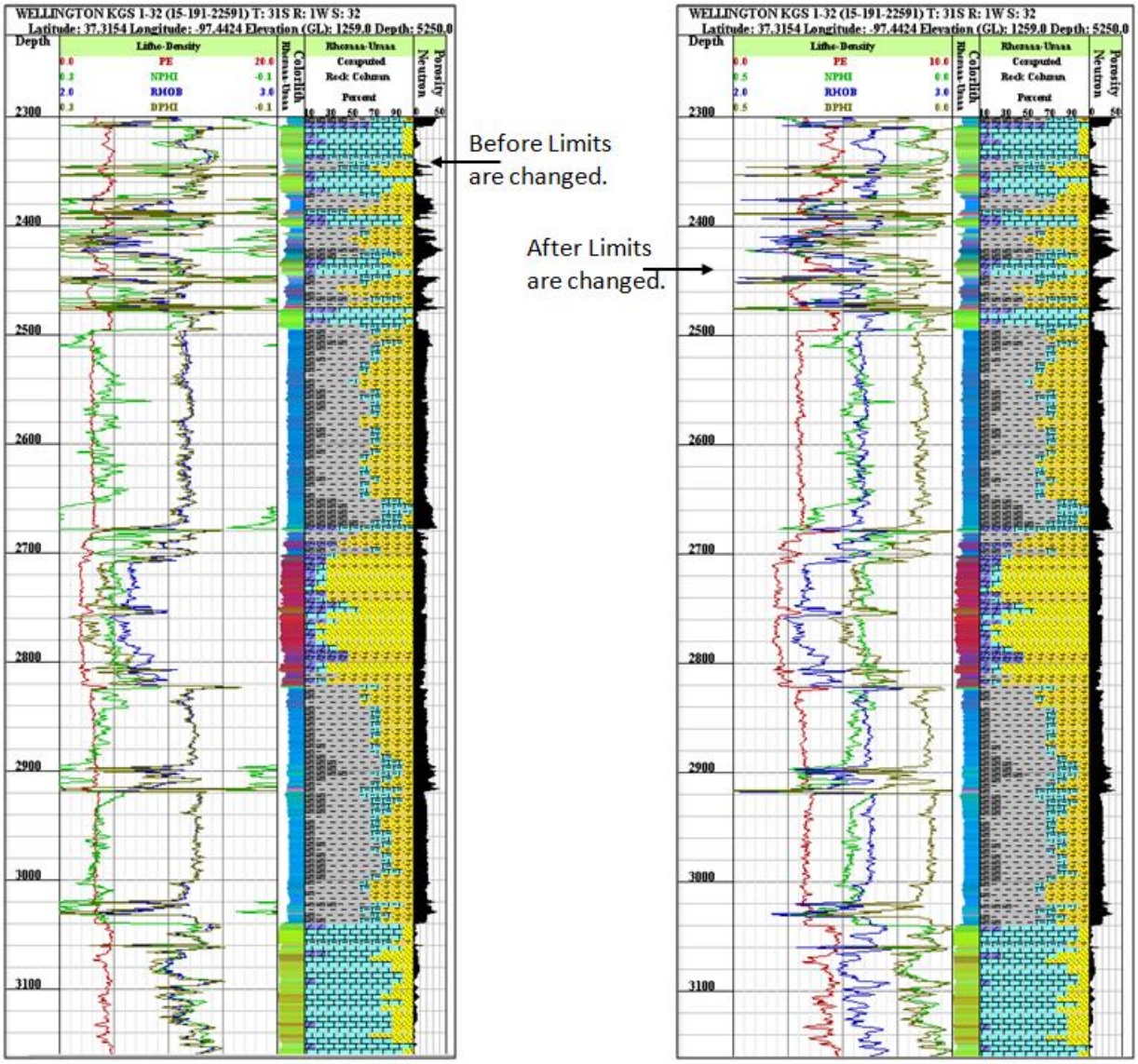
The color coding is the same as the "LAS File Curve Sections" Dialog that helps the user distinguish the type of curves available at a glance.

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.

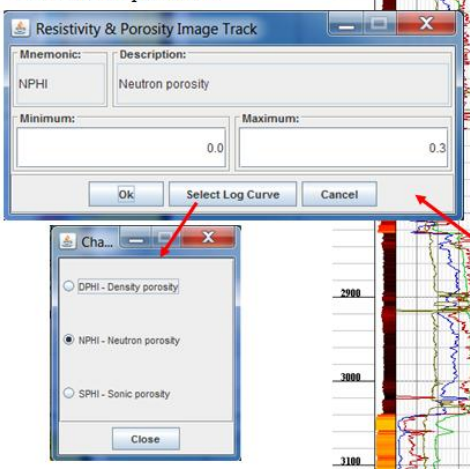
- The Photoelectric factor (PE) curve is changed from "0.0 to 20.0" to 0.0 to 10.0"
- The Neutron Porosity (NPHI) curve is changed from "-0.1 to 0.3" to "0.0 to 0.5" which also modifies the Density Porosity (DPHI) and the Sonic Porosity (SPHI) to the same limits.

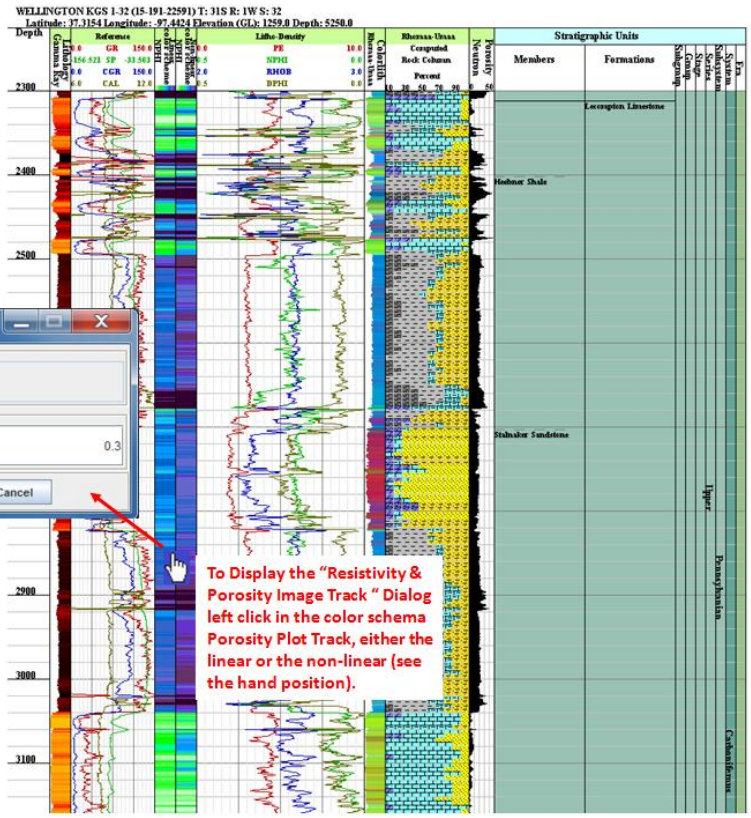
As noted in the image the Profile plot is automatically modified as the user makes changes to each text field. View the "Litho-Density" Plot track (see image below) reflects the changes made to the plot curves.


WELLINGTON KGS 1-32 (15-191-22591) T: 31S R: 1W S: 32
Latitude: 37.3154 Longitude: -97.4424 Elevation (GL): 1259.0 Depth: 5250.0
Depth
Lithe-Density
PE
NPHI
RHOB
DPHI
Rhomaa-Umaa
Computed
Rock Column
Percent
Porosity
Neutron
2300
2400
2500
2600
2700
2800
2900
3000
3100
Before Limits
are changed.
After Limits
are changed.

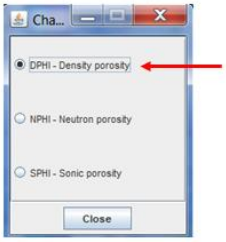
Changing the Colorlith – Porosity Imager Linear & Nonlinear Color Schema Tracks

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

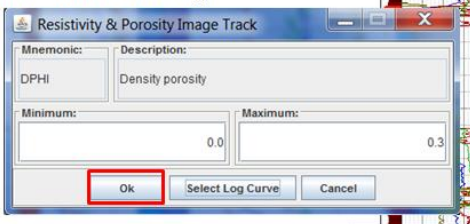




To Display the "Resistivity & Porosity Image Track " Dialog left click in the color schema Porosity Plot Track, either the linear or the non-linear (see the hand position).

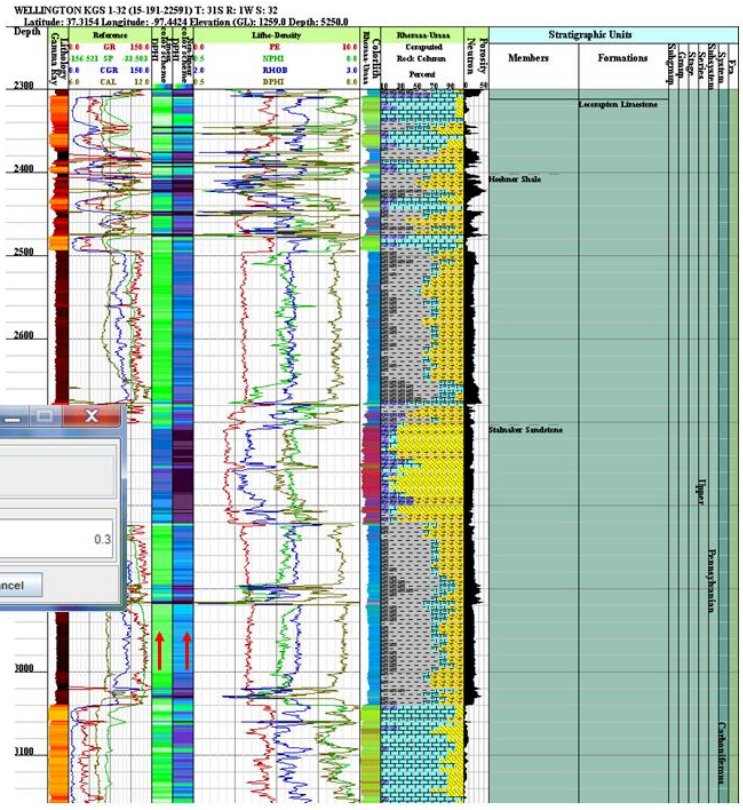


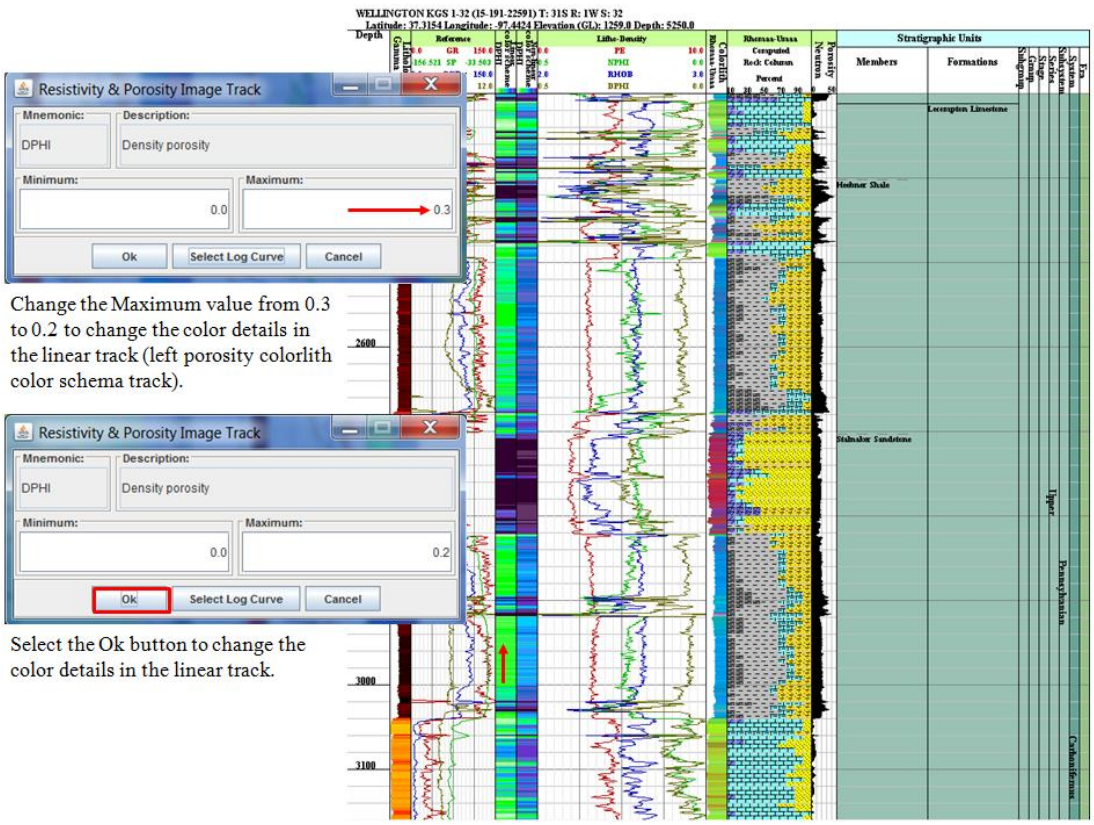
Click on "DPHI-Density porosity" radio button to change the porosity curve used to compute the color schema colorlith tracks. Then select close to close the dialog.



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.





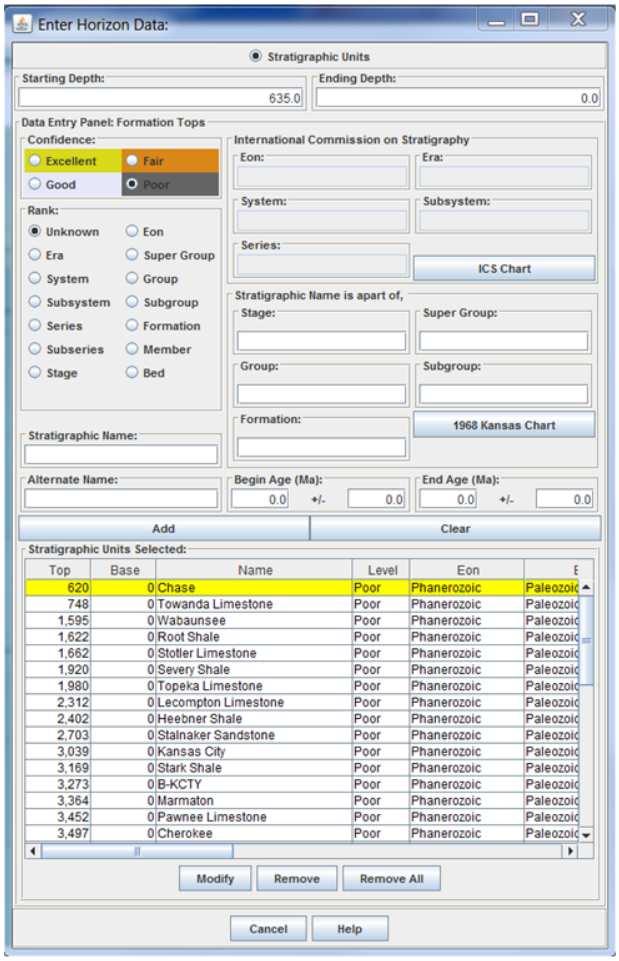
Change the Maximum value from 0.3 to 0.2 to change the color details in the linear track (left porosity colorlith color schema track).

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

Stratigraphic Uints Panel - Adding & Modifying Tops

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.



Confidence Level of the tops selection.

Stratigraphic Unit Rank radio buttons, defines & sets the location of the unit on the Stratigraphic Unit Plot Track.

Stratigraphic Name & Alternate Name

Add/Modify – Move data to Table.
Clear – Clear all text fields.

List of Stratigraphic Units (Tops).

Starting Depth & Ending Depth of Stratigraphic Name

International Commission on Stratigraphic Units. User selects the ICS Chart button to display Standard Units.

Stratigraphic Name belongs to section. Allows the user to place a member, bed, etc. with a formation, group, etc.

"Stratigraphic Units Selected" Table.

Table Buttons
Modify – Modify the Stratigraphic Units Data.
Remove – Remove Stratigraphic Unit from table.
Remove All – Clear all content Units from the table.

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).

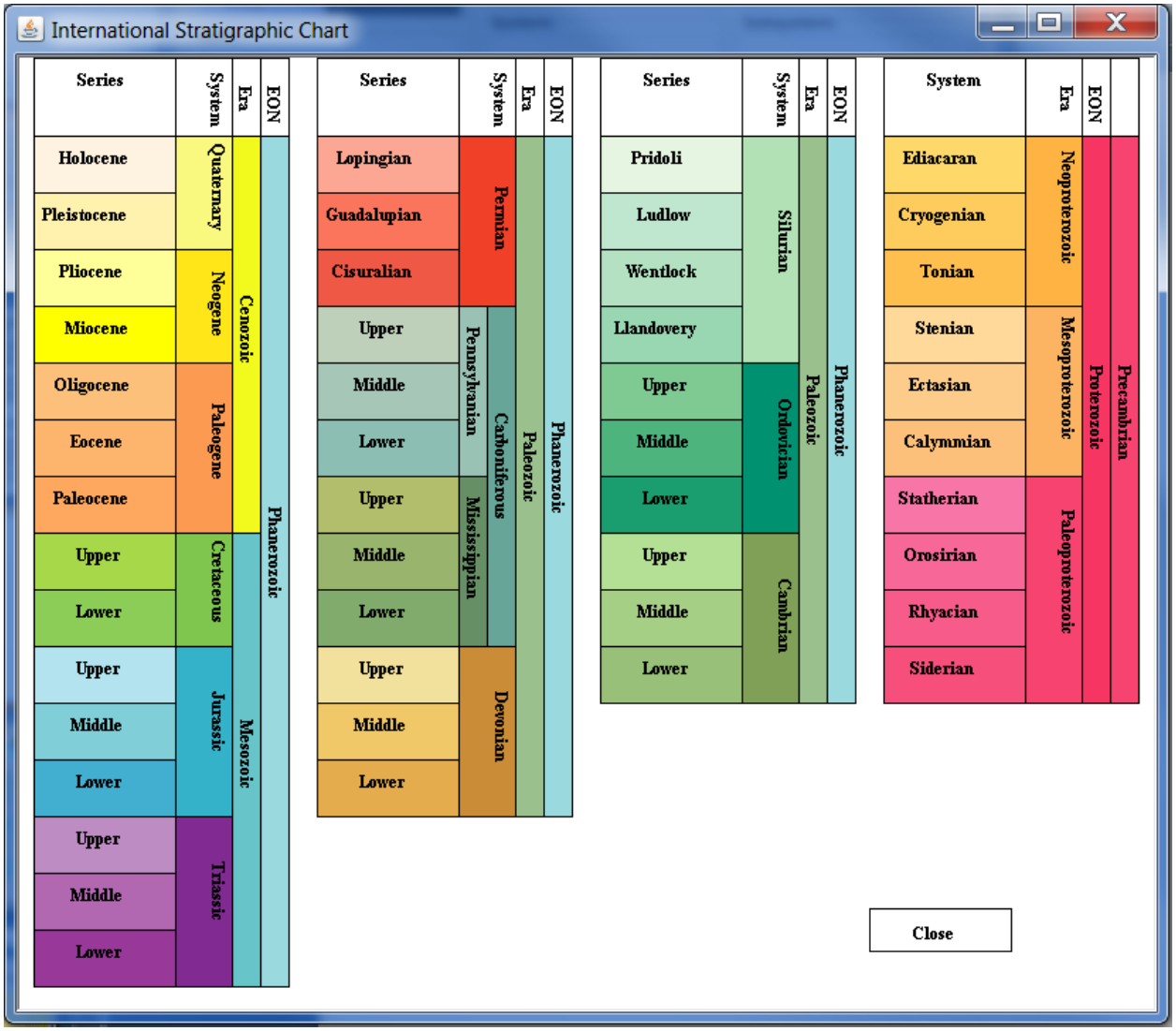


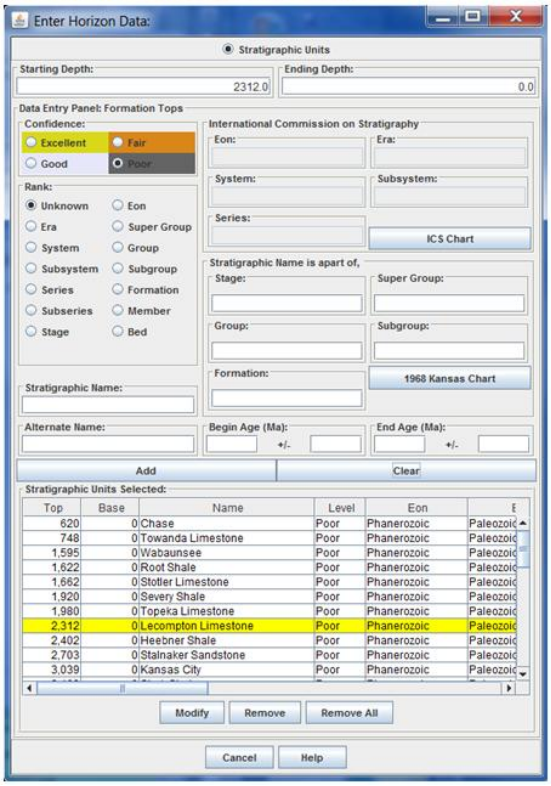
Figure: The 2010 International Commission on Stratigraphy Stratigraphic Units and RGB colors for the Stratigraphic Units.

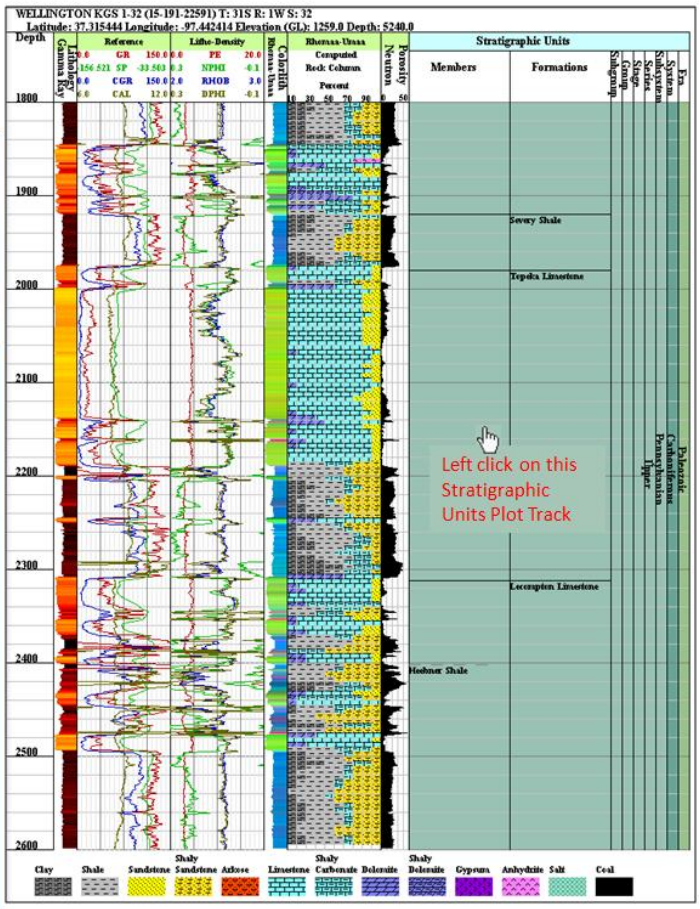
NOTE: Although you can modify the tops depth with the Synthetic Seismic Profile Plot Web App, this web app is plotted in milliseconds, there is no real exact way of setting the depth of the tops. The following uses the Help from Wavelets to illustrate how to add and modify tops, which is the same for this web app, although you will have to hit the "Modify Time" Button in the "Time Scale & Range" Panel on the Control Dialog to refresh the profile plot.

Add Shawnee Group Example

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.

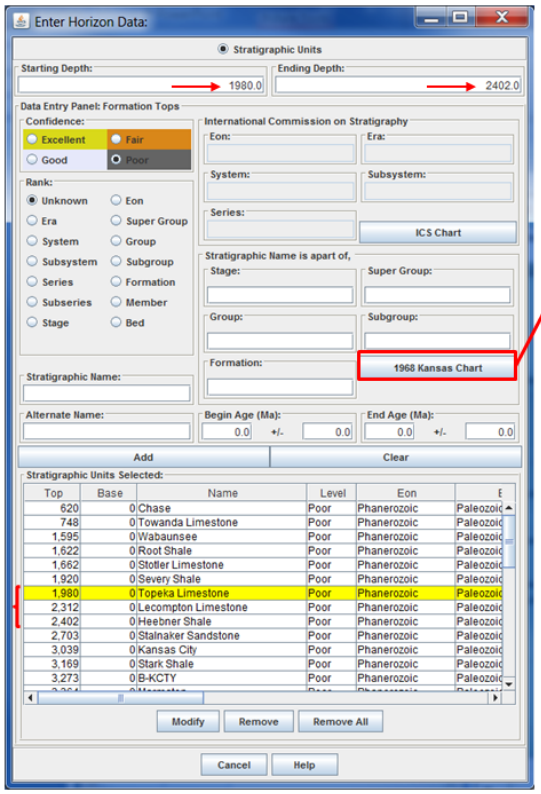
Left mouse click on the Stratigraphic Units Plot Track to display the "Enter Horizon Data" Dialog with the "Stratigraphic Units" Panel will be displayed with the list of tops.

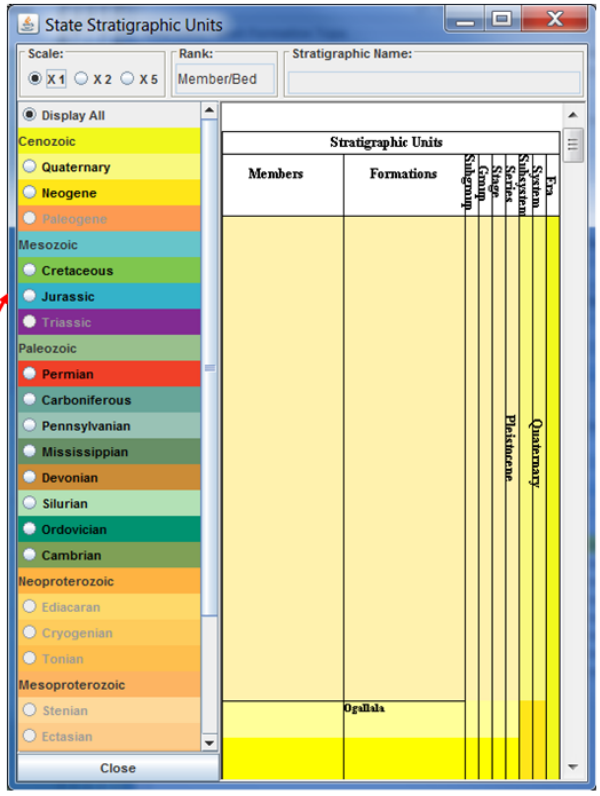




The user can manually enter the tops with as much information as they wish to display. If the stratigraphic unit is part of the Kansas Stratigraphic Units List all necessary fields can be loaded by using the "1968 Kansas Chart" button to display the list of Kansas Stratigraphic Units.

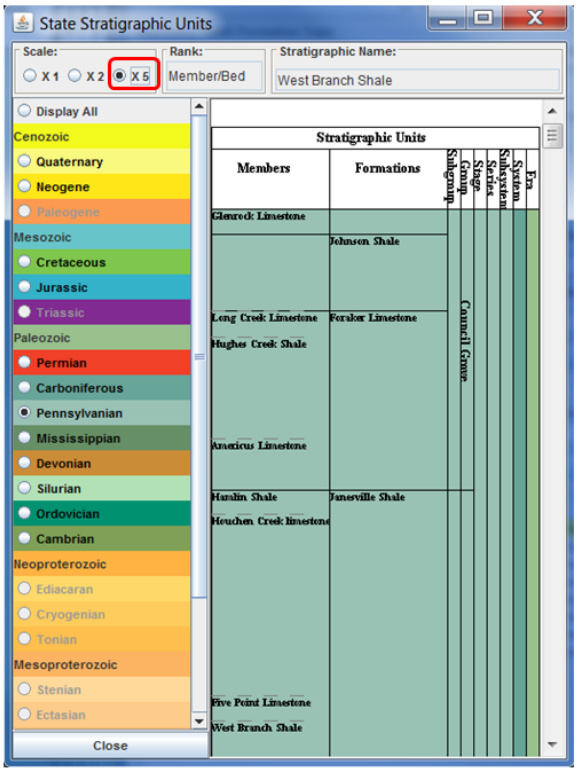
The Topeka Limestone, Lecompton Limestone and the Heebner Shale belong to the Shawnee Group, set the Starting Depth text field to 1980 and the Ending Depth text field to 2402.
Click on the "1968 Kansas Chart" Button to display the State Stratigraphic Units Dialog.

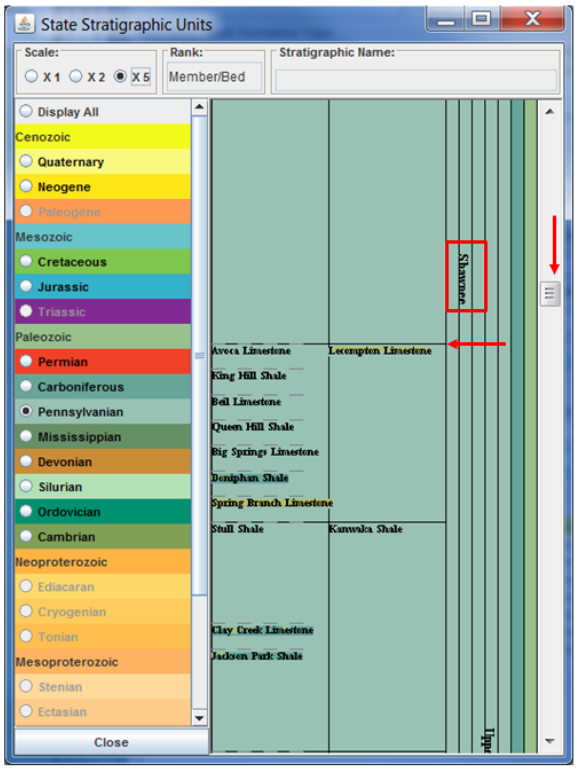




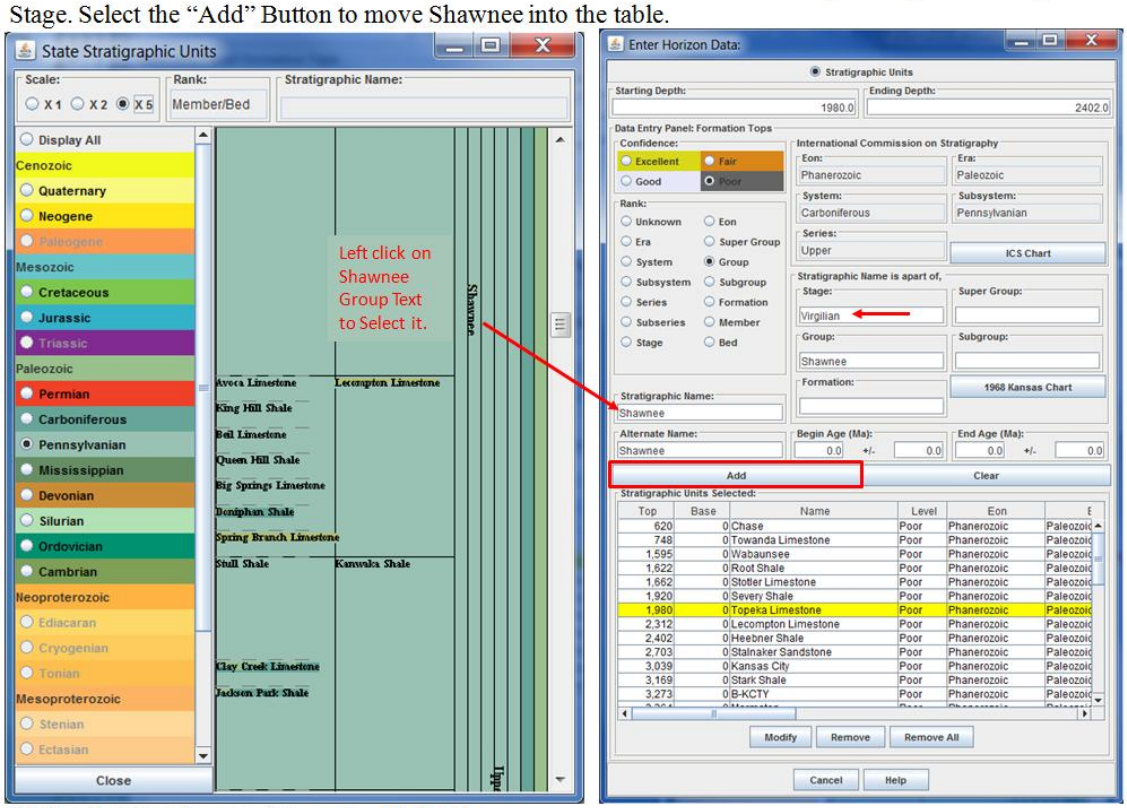
Change the Scale to X5, select the "Pennsylvanian" radio button.

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

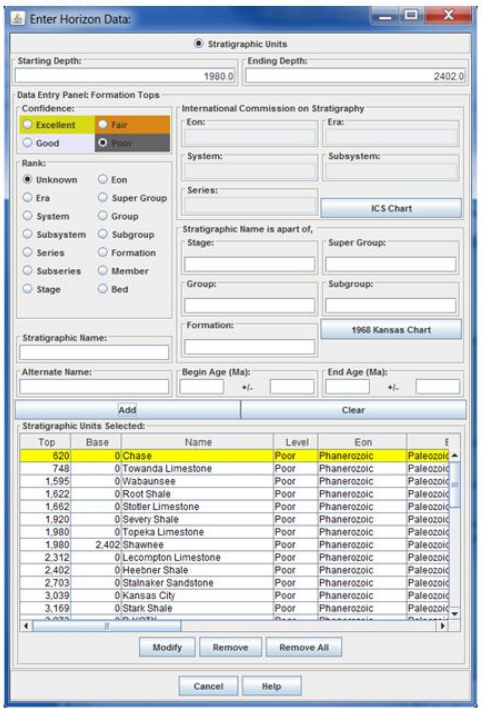


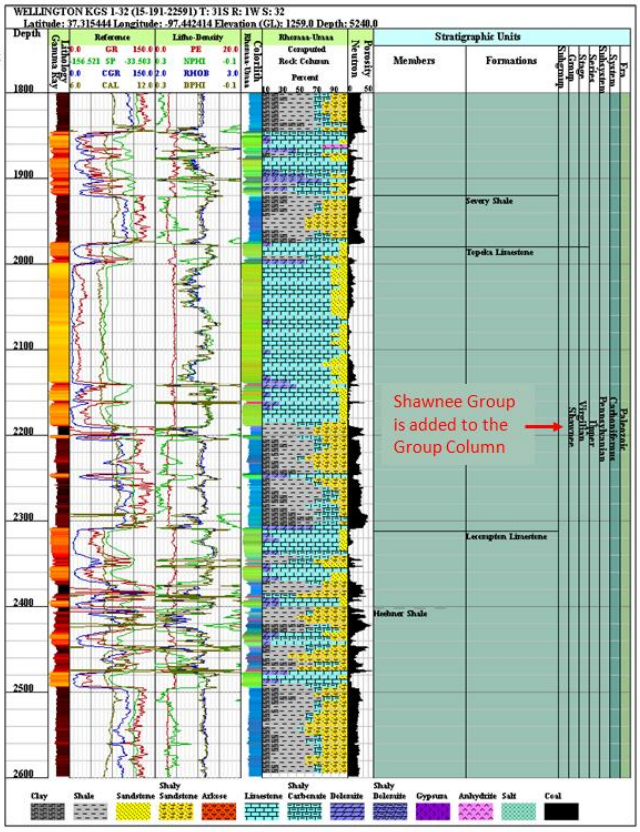


Left mouse click on the Shawnee Group text to transfer all the Stratigraphic Units to the "Stratigraphic Units" Panel on the "Enter Horizon Data" Dialog. Notice also that the Shawnee Group belongs to the Virgilian Stage. Select the "Add" Button to move Shawnee into the table.



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.

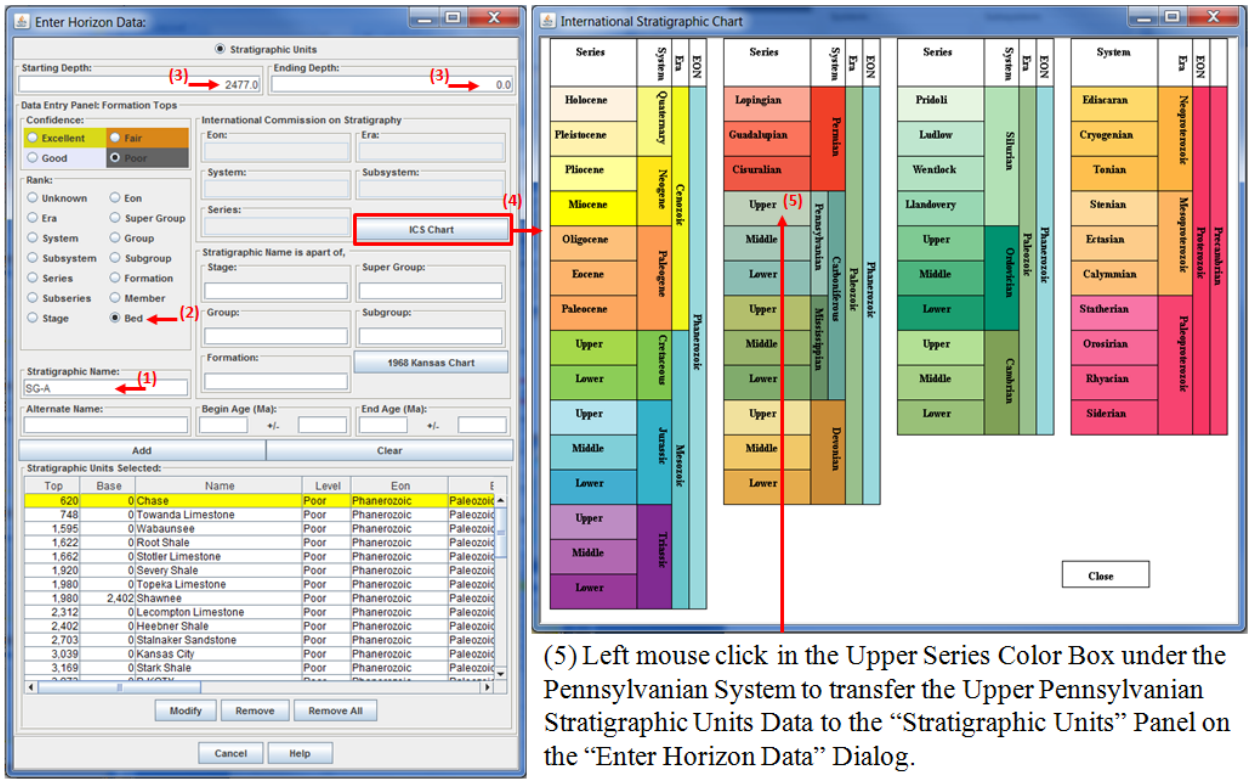




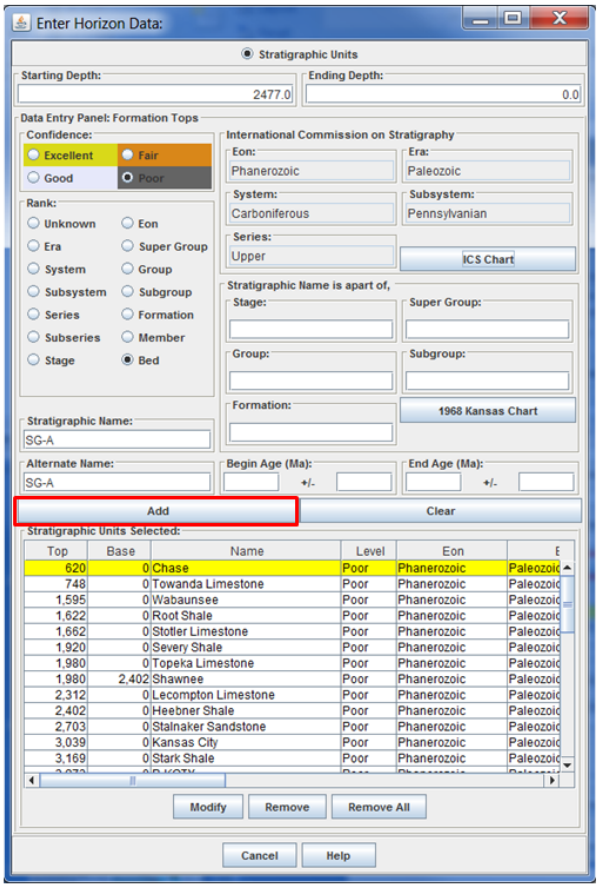
Add Unknown Bed (SG-A Bed) Example

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.



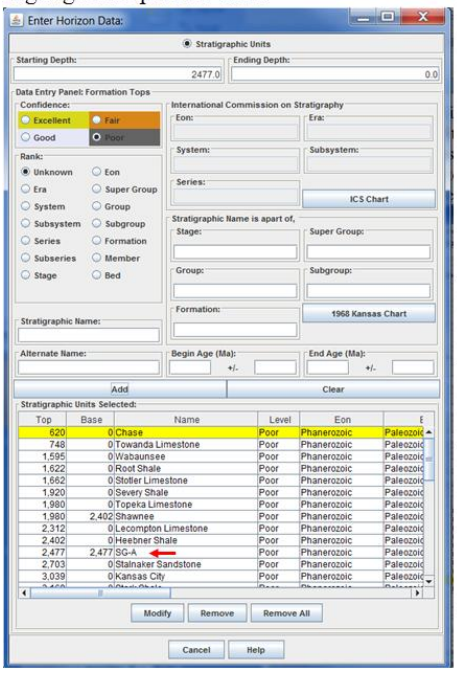
(5) Left mouse click in the Upper Series Color Box under the Pennsylvanian System to transfer the Upper Pennsylvanian Stratigraphic Units Data to the "Stratigraphic Units" Panel on the "Enter Horizon Data" Dialog.

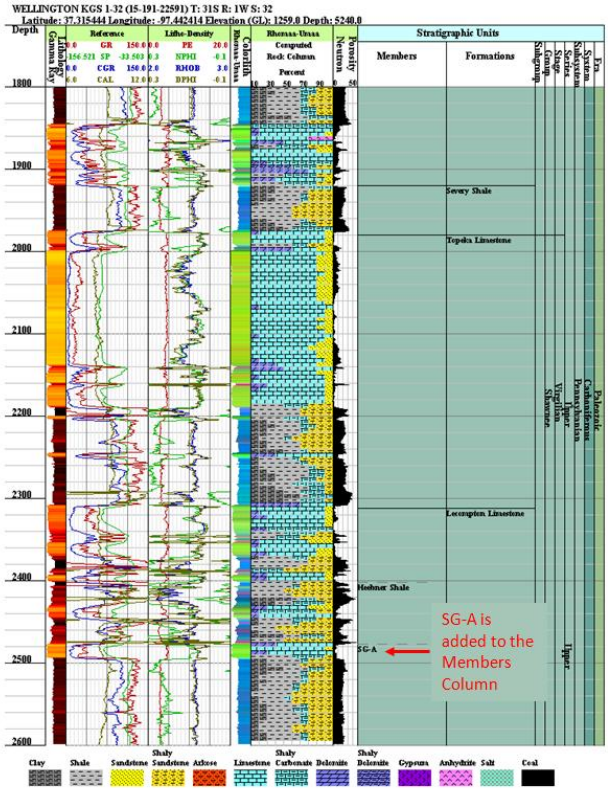


Notice that the Stratigraphic Units Data from the ICS Chart is transferred to the "International Commission on Stratigraphy" Panel.

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

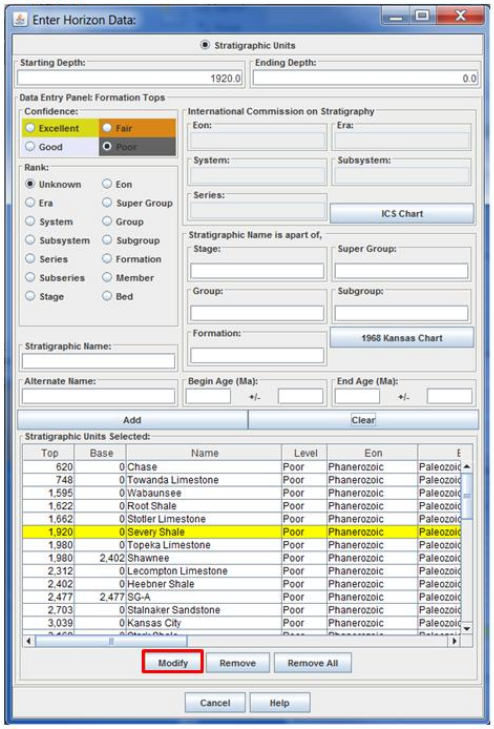
Notice that the SG-A Bed is added to the Members Column of the Stratigraphic Units Plot Track. SG-A Bed was added to the "Stratigraphic Units Selected" table, see the highlighted top in the table.



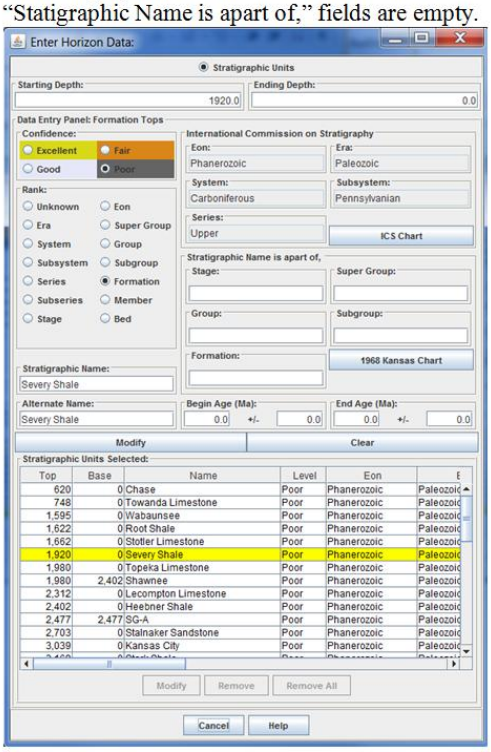


Modify Severy Shale Formation Example

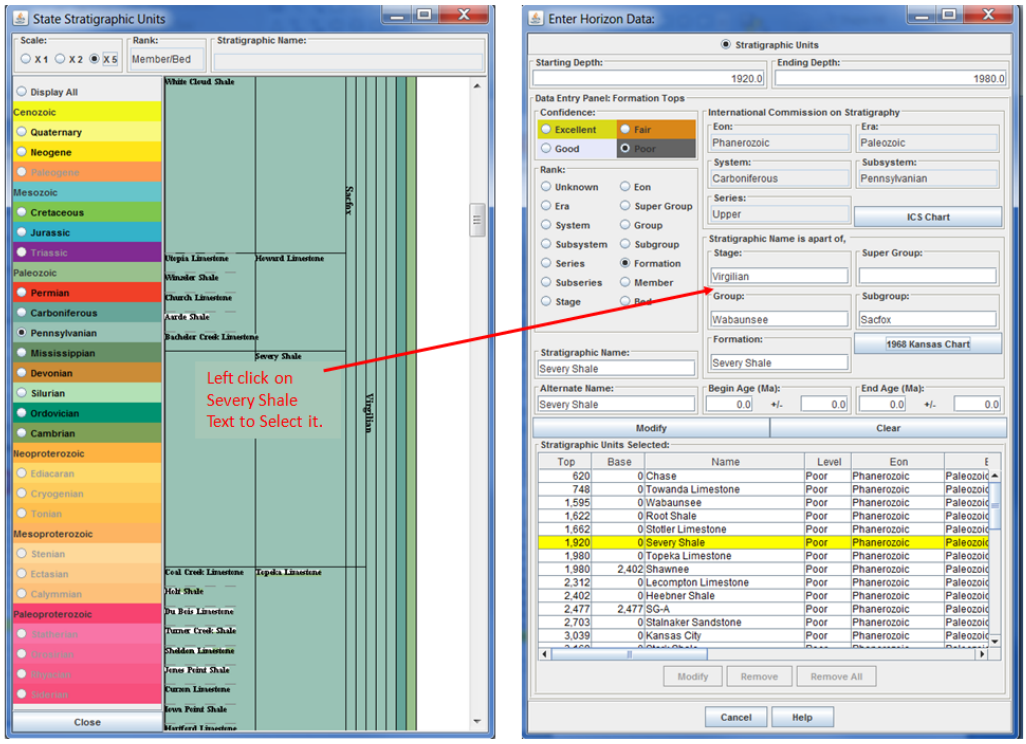
Highlight the Severy Shale, select the "Modify" Button.

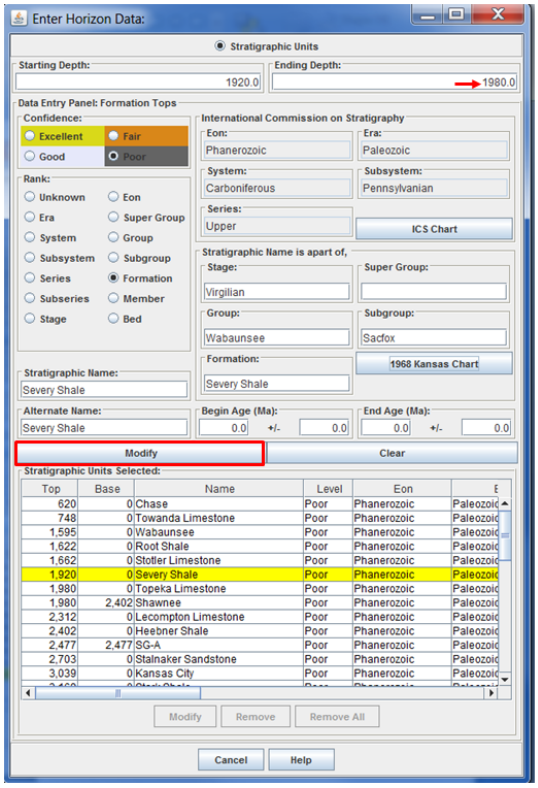


Notice the Stratigraphic Units Data are loaded into the Stratigraphic Units Panel Fields and the "Statigraphic Name is apart of," fields are empty.



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.

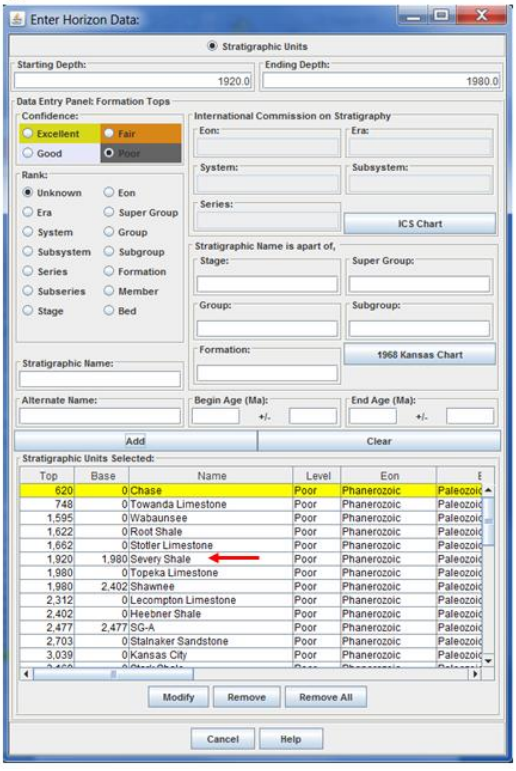


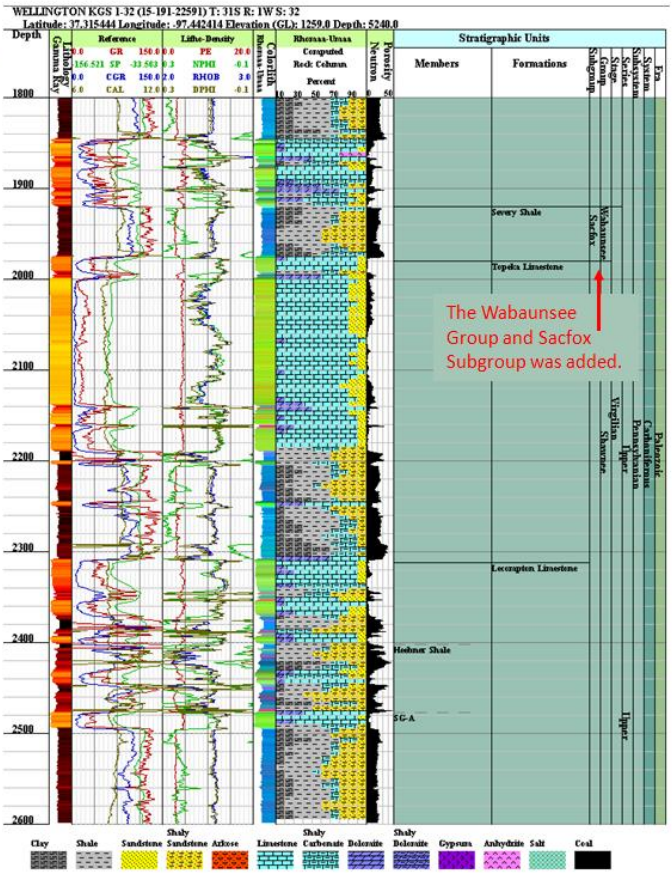


Change the Ending Depth to 1980.0, which is the start Depth of the Topeka Limestone and the next Formation.

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.

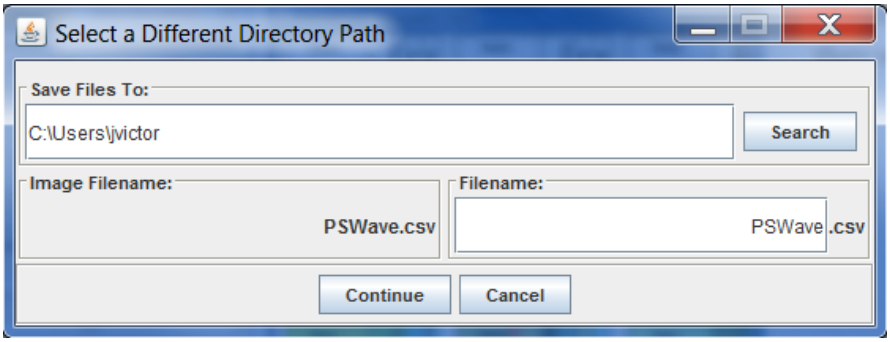
Notice that the Kanwaka Shale Formation has been modified to extend the ending depth to 1980'. This also add the "Stratigraphic Name is apart of" text fields.



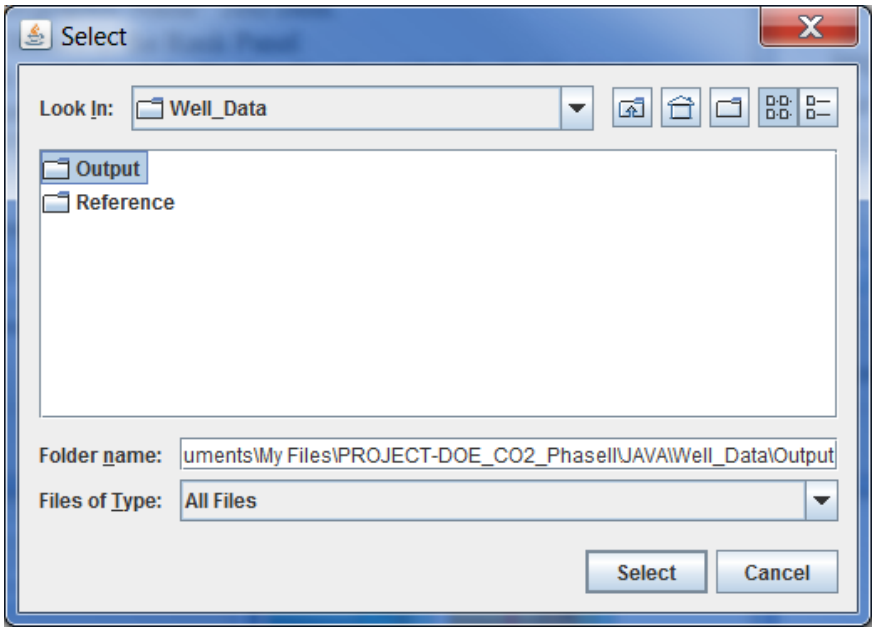


Save PS Wave Data as a Comma Separated Values (CSV) File

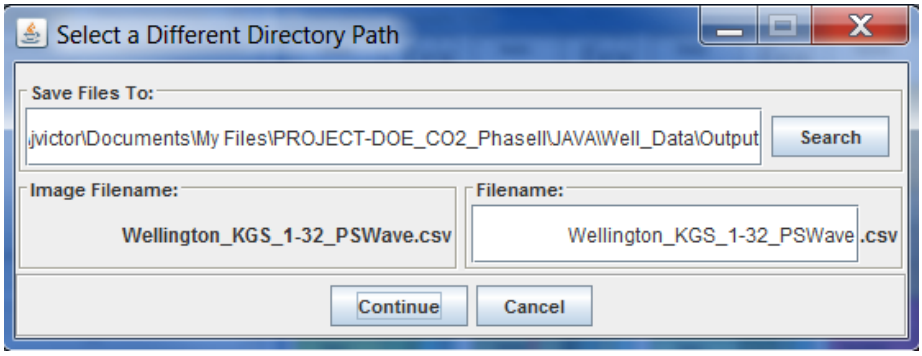
To save the contents of the "Zonation Data from LAS Log Curve" "spreadsheet" data as a Comma Separated Values (CSV) File to be imported into Excel or another program, click on the  icon image button, which will display the "Enter Directory Path & Filename" dialog, which the user can search their PC for the directory they wish to save the CSV file in.



The default directory is your home directory, but you can save the file anywhere on your PC, click on the "Search" Button to search your PC for the correct path. The default filename is PSWave, which will prepended to ".csv" when it is saved.

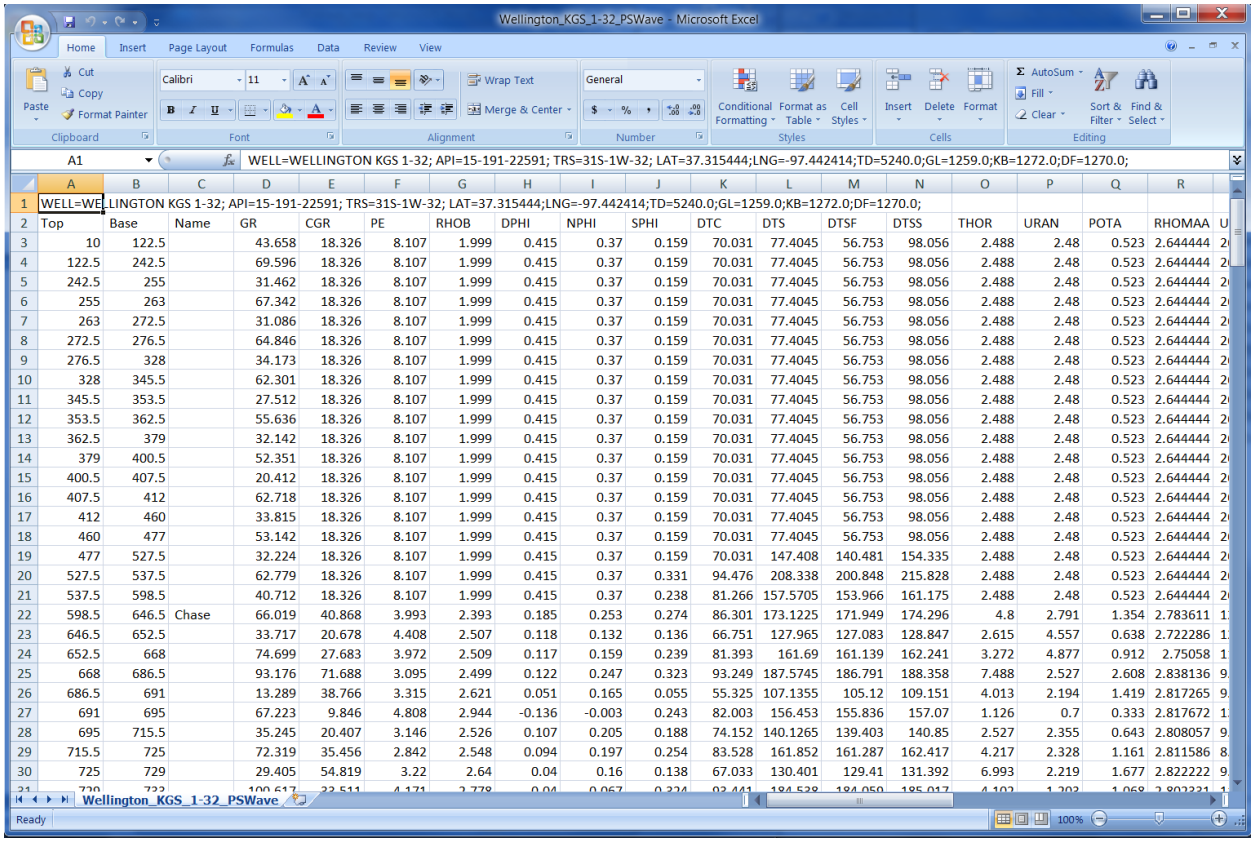


Once you find the directory path you wish to save the file into, click on the "Select" button to transfer the directory path to the "Select a Different Directory Path" dialog.



You can now change the Filename text field to any name you wish, e.g. Wellington_KGS_1-32_PSWave. Now click on the "Continue" button to create the file.

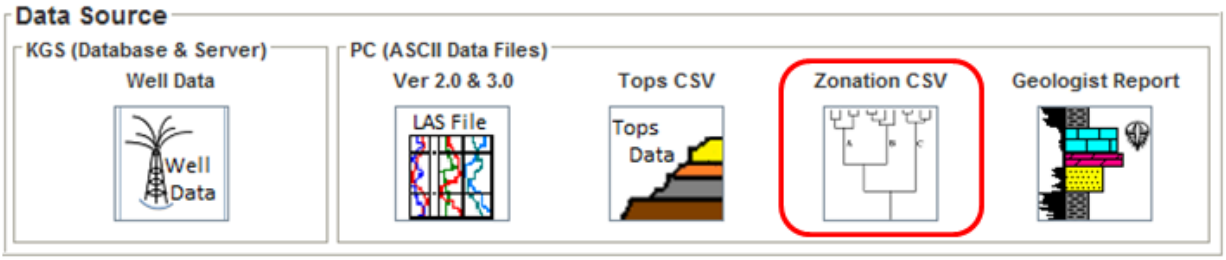
The contents of the above csv file can be imported directly into Excel as illustrated below,



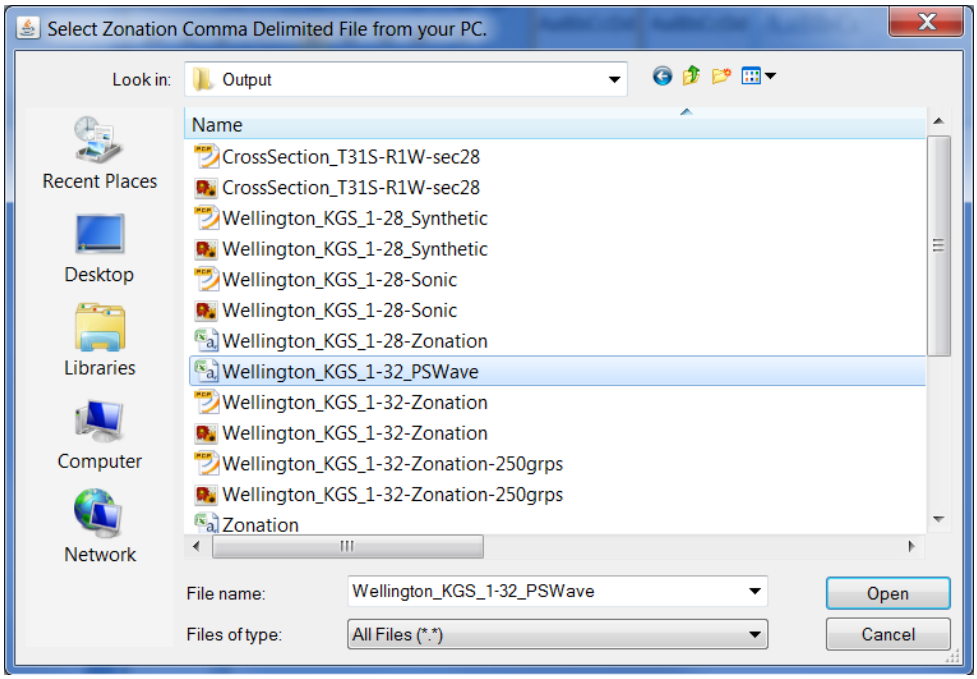
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	WELL=WELLINGTON KGS 1-32; API=15-191-22591; TRS=31S-1W-32; LAT=37.315444;LNG=-97.442414;TD=5240.0;GL=1259.0;KB=1272.0;DF=1270.0;																	
2	Top	Base	Name	GR	CGR	PE	RHOB	DPHI	NPHI	SPHI	DTC	DTS	DTSF	DTSS	THOR	URAN	POTA	RHOMAA
3	10	122.5		43.658	18.326	8.107	1.999	0.415	0.37	0.159	70.031	77.4045	56.753	98.056	2.488	2.48	0.523	2.644444
4	122.5	242.5		69.596	18.326	8.107	1.999	0.415	0.37	0.159	70.031	77.4045	56.753	98.056	2.488	2.48	0.523	2.644444
5	242.5	255		31.462	18.326	8.107	1.999	0.415	0.37	0.159	70.031	77.4045	56.753	98.056	2.488	2.48	0.523	2.644444
6	255	263		67.342	18.326	8.107	1.999	0.415	0.37	0.159	70.031	77.4045	56.753	98.056	2.488	2.48	0.523	2.644444
7	263	272.5		31.086	18.326	8.107	1.999	0.415	0.37	0.159	70.031	77.4045	56.753	98.056	2.488	2.48	0.523	2.644444
8	272.5	276.5		64.846	18.326	8.107	1.999	0.415	0.37	0.159	70.031	77.4045	56.753	98.056	2.488	2.48	0.523	2.644444
9	276.5	328		34.173	18.326	8.107	1.999	0.415	0.37	0.159	70.031	77.4045	56.753	98.056	2.488	2.48	0.523	2.644444
10	328	345.5		62.301	18.326	8.107	1.999	0.415	0.37	0.159	70.031	77.4045	56.753	98.056	2.488	2.48	0.523	2.644444
11	345.5	353.5		27.512	18.326	8.107	1.999	0.415	0.37	0.159	70.031	77.4045	56.753	98.056	2.488	2.48	0.523	2.644444
12	353.5	362.5		55.636	18.326	8.107	1.999	0.415	0.37	0.159	70.031	77.4045	56.753	98.056	2.488	2.48	0.523	2.644444
13	362.5	379		32.142	18.326	8.107	1.999	0.415	0.37	0.159	70.031	77.4045	56.753	98.056	2.488	2.48	0.523	2.644444
14	379	400.5		52.351	18.326	8.107	1.999	0.415	0.37	0.159	70.031	77.4045	56.753	98.056	2.488	2.48	0.523	2.644444
15	400.5	407.5		20.412	18.326	8.107	1.999	0.415	0.37	0.159	70.031	77.4045	56.753	98.056	2.488	2.48	0.523	2.644444
16	407.5	412		62.718	18.326	8.107	1.999	0.415	0.37	0.159	70.031	77.4045	56.753	98.056	2.488	2.48	0.523	2.644444
17	412	460		33.815	18.326	8.107	1.999	0.415	0.37	0.159	70.031	77.4045	56.753	98.056	2.488	2.48	0.523	2.644444
18	460	477		53.142	18.326	8.107	1.999	0.415	0.37	0.159	70.031	77.4045	56.753	98.056	2.488	2.48	0.523	2.644444
19	477	527.5		32.224	18.326	8.107	1.999	0.415	0.37	0.159	70.031	147.408	140.481	154.335	2.488	2.48	0.523	2.644444
20	527.5	537.5		62.779	18.326	8.107	1.999	0.415	0.37	0.331	94.476	208.338	200.848	215.828	2.488	2.48	0.523	2.644444
21	537.5	598.5		40.712	18.326	8.107	1.999	0.415	0.37	0.238	81.266	157.5705	153.966	161.175	2.488	2.48	0.523	2.644444
22	598.5	646.5	Chase	66.019	40.868	3.993	2.393	0.185	0.253	0.274	86.301	173.1225	171.949	174.296	4.8	2.791	1.354	2.783611
23	646.5	652.5		33.717	20.678	4.408	2.507	0.118	0.132	0.136	66.751	127.965	127.083	128.847	2.615	4.557	0.638	2.722286
24	652.5	668		74.699	27.683	3.972	2.509	0.117	0.159	0.239	81.393	161.69	161.139	162.241	3.272	4.877	0.912	2.75058
25	668	686.5		93.176	71.688	3.095	2.499	0.122	0.247	0.323	93.249	187.5745	186.791	188.358	7.488	2.527	2.608	2.838136
26	686.5	691		13.289	38.766	3.315	2.621	0.051	0.165	0.055	55.325	107.1355	105.12	109.151	4.013	2.194	1.419	2.817265
27	691	695		67.223	9.846	4.808	2.944	-0.136	-0.003	0.243	82.003	156.453	155.836	157.07	1.126	0.7	0.333	2.817672
28	695	715.5		35.245	20.407	3.146	2.526	0.107	0.205	0.188	74.152	140.1265	139.403	140.85	2.527	2.355	0.643	2.808057
29	715.5	725		72.319	35.456	2.842	2.548	0.094	0.197	0.254	83.528	161.852	161.287	162.417	4.217	2.328	1.161	2.811586
30	725	729		29.405	54.819	3.22	2.64	0.04	0.16	0.138	67.033	130.401	129.41	131.392	6.993	2.219	1.677	2.822222

Importing PC Data – PS Wave Data Comma Separated Values CSV 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 "Zonation Data" Icon Button in the Data Source Panel of the Load Data Dialog. This will display the "Select Zonation 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 Zonation CSV file Wellington-KGS-1-32_PSWave.csv, highlighted below. Select the Open button to display the "Map File Column Number to Region Column" Dialog.

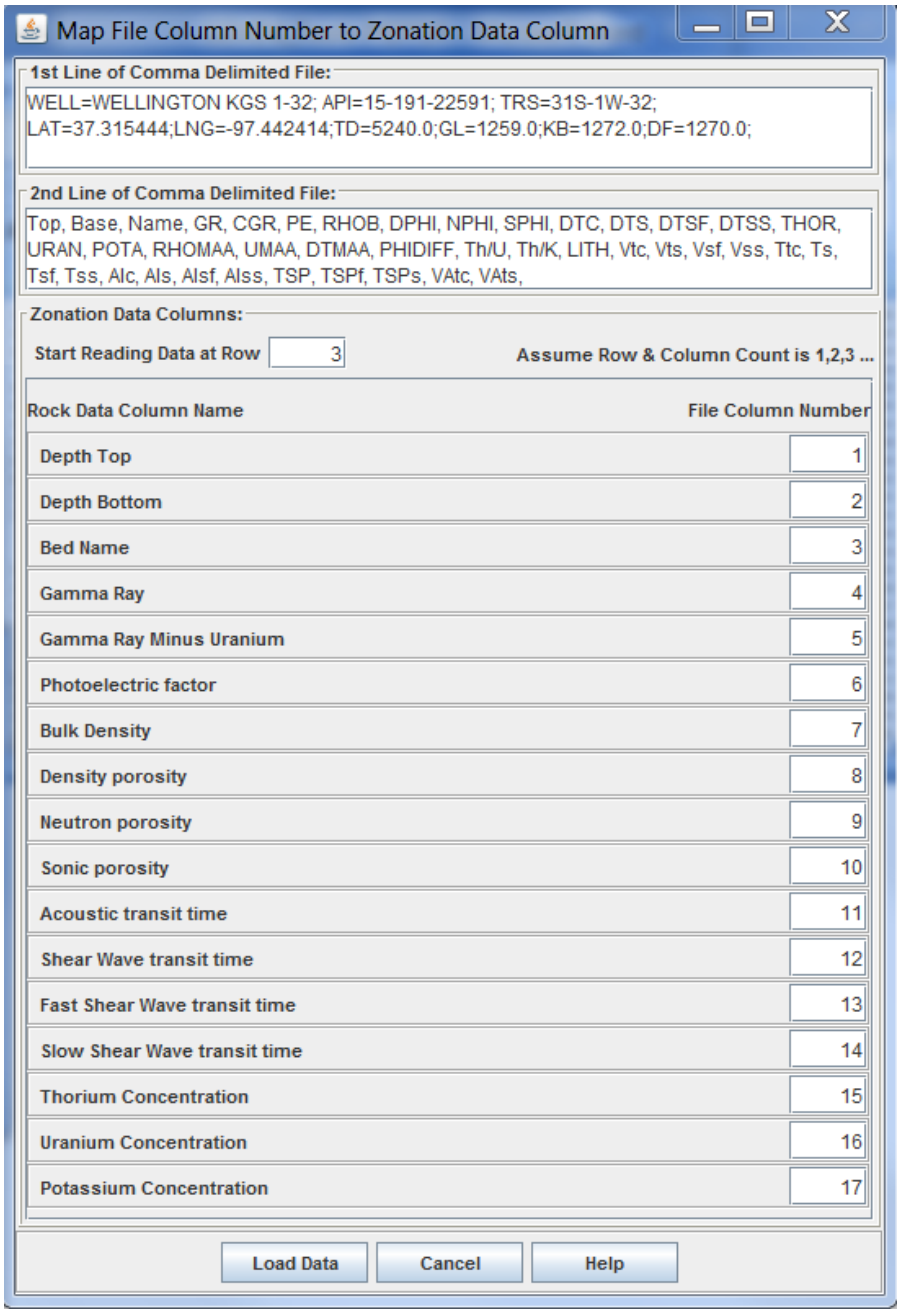


The "Map File Column Number to Region Column" Dialog allows the user to map the file columns number to the web app tops data structure. In this example the file has the well information in line one of the Zonation CSV File and line two of the Zonation CSV File has the file data columns. In this case the chosen file columns match the Zonation Mnemonics for the tops data structure. The File Column Number is automatically assigned to the Zonation Log

Column Names. The user only needs to select the “Load Data” Button to parse the Zonation Data into the web app.

PS Wave CSV (Comma Separated Values) File Structure.

The Wellington KGS 1-32 PS Wave 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,



This program only imports the log data since all the sonic velocities and times can be computed from the raw data.

Line 1: Well header information
Line 2: Data Column Mnemonics
Line 3: Data Start

```
WELL=WELLINGTON KGS 1-32; API=15-191-22591; TRS=31S-1W-32; LAT=37.315444;LNG=-97.442414;TD=5240.0;GL=1259.0;
Top, Base, Name, GR, CGR, PE, RHOB, DPHI, NPHI, SPHI, DTC, DTS, DTSF, DTSS, THOR, URAN, POTA, RHOMAA, UMAA,
10.0, 122.5, , 43.658, 18.326, 8.107, 1.999, 0.415, 0.37, 0.159, 70.031, 77.4045,   56.753, 98.056, 2.488, 2
122.5, 242.5, , 69.596, 18.326, 8.107, 1.999, 0.415, 0.37, 0.159, 70.031, 77.4045,  56.753, 98.056, 2.488, 2
242.5, 255.0, , 31.462, 18.326, 8.107, 1.999, 0.415, 0.37, 0.159, 70.031, 77.4045,  56.753, 98.056, 2.488, 2
255.0, 263.0, , 67.342, 18.326, 8.107, 1.999, 0.415, 0.37, 0.159, 70.031, 77.4045,  56.753, 98.056, 2.488, 2
263.0, 272.5, , 31.086, 18.326, 8.107, 1.999, 0.415, 0.37, 0.159, 70.031, 77.4045,  56.753, 98.056, 2.488, 2
272.5, 276.5, , 64.846, 18.326, 8.107, 1.999, 0.415, 0.37, 0.159, 70.031, 77.4045,  56.753, 98.056, 2.488, 2
276.5, 328.0, , 34.173, 18.326, 8.107, 1.999, 0.415, 0.37, 0.159, 70.031, 77.4045,  56.753, 98.056, 2.488, 2
328.0, 345.5, , 62.301, 18.326, 8.107, 1.999, 0.415, 0.37, 0.159, 70.031, 77.4045,  56.753, 98.056, 2.488, 2
345.5, 353.5, , 27.512, 18.326, 8.107, 1.999, 0.415, 0.37, 0.159, 70.031, 77.4045,  56.753, 98.056, 2.488, 2
353.5, 362.5, , 55.636, 18.326, 8.107, 1.999, 0.415, 0.37, 0.159, 70.031, 77.4045,  56.753, 98.056, 2.488, 2
362.5, 379.0, , 32.142, 18.326, 8.107, 1.999, 0.415, 0.37, 0.159, 70.031, 77.4045,  56.753, 98.056, 2.488, 2
379.0, 400.5, , 52.351, 18.326, 8.107, 1.999, 0.415, 0.37, 0.159, 70.031, 77.4045,  56.753, 98.056, 2.488, 2
400.5, 407.5, , 20.412, 18.326, 8.107, 1.999, 0.415, 0.37, 0.159, 70.031, 77.4045,  56.753, 98.056, 2.488, 2
407.5, 412.0, , 62.718, 18.326, 8.107, 1.999, 0.415, 0.37, 0.159, 70.031, 77.4045,  56.753, 98.056, 2.488, 2
412.0, 460.0, , 33.815, 18.326, 8.107, 1.999, 0.415, 0.37, 0.159, 70.031, 77.4045,  56.753, 98.056, 2.488, 2
460.0, 477.0, , 53.142, 18.326, 8.107, 1.999, 0.415, 0.37, 0.159, 70.031, 77.4045,  56.753, 98.056, 2.488, 2
477.0, 527.5, , 32.224, 18.326, 8.107, 1.999, 0.415, 0.37, 0.159, 70.031, 147.4,    140.481, 154.335, 2.488,
527.5, 537.5, , 62.779, 18.326, 8.107, 1.999, 0.415, 0.37, 0.331, 94.476, 208.338,  200.848, 215.828, 2.488,
537.5, 598.5, , 40.712, 18.326, 8.107, 1.999, 0.415, 0.37, 0.238, 81.266, 157.5705, 153.966, 161.175, 2.488,
598.5, 646.5, Chase, 66.019, 40.868, 3.993, 2.393, 0.185, 0.253, 0.274, 86.301, 173.1225, 171.949, 174.296,
```

Figure: Partial Contents of the Wellington_KGS_1-32_PSWave.csv File.

The "Map File Column Number to Zonation Column" Dialog allows the user to map the data in the PS Wave 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 zonation file data structure. The program then assigns the column number to the Zonation File Column Name starting at column 1,2,3, … if the file column name used matches the expected Zonation column name.

Column #	PS Wave Variable Label	File Column Mnemonic
1	Depth Top	Top
2	Depth Bottom	Base
3	Bed Name	Name
4	Gamma Ray	GR
5	Gamma Ray Minus Uranium	CGR
6	Photoelectric factor	PE
7	Bulk Density	RHOB
8	Density Porosity	DPHI
9	Neutron Porosity	NPHI
10	Sonic Porosity	SPHI
11	Acoustic transit time	DTC
12	Shear Wave transit time	DTS
13	Fast Shear Wave transit time	DTSF
14	Slow Shear Wave transit time	DTSS
15	Thorium Concentration	THOR
16	Uranium Concentration	URAN
17	Potassium Concentration	POTA

Note the PS Wave only imports only the basic log data, the times and velocities will be recomputed from the raw data.

The program expects the first line to be header information and will parse it as header data. In the figure above the first line, you will notice that each of the variables are paired with a unique name, i.e. WELL=WELLINGTON KGS 1-32; API=15-191-22591, etc. The program firsts

splits the ‘;’ semicolon into individual strings and then splits the ‘=’ equal signs into two words, an identifier string and a data string. The identifier is unique to the header information and the data is assign to a specific variable based on the identifier.

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