

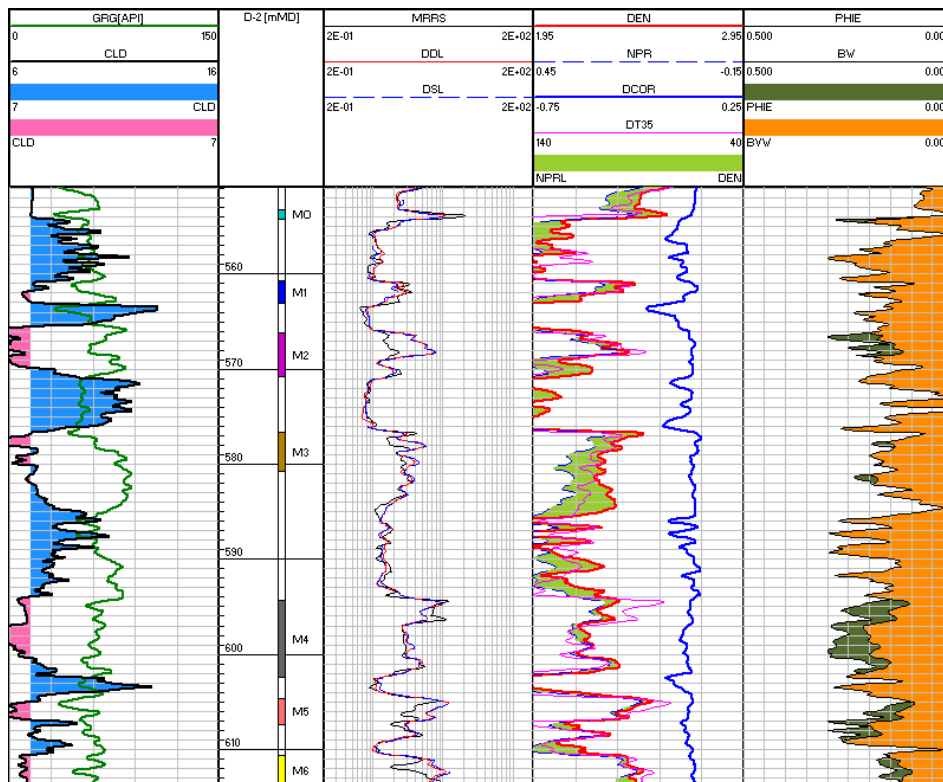
PETROPHYSICAL TOOLS

Collection of data is one of the essential elements for a petrophysical analysis. One of the characteristics of Sahara is to maintain in order all the information necessary to carry out a basic petrophysical analysis.

The electrical logs of the wells can be visualized in templates with multiple tracks customized by the user. These same templates fit the Cross Sections window, enabling layer correlations by means of specific tools. Additionally, in the Wellworks window it is possible to visualize the logs together with the well diagram and the activities carried out in it.

Petrophysical tools allow the creation of synthetic logs using the most studied correlations for each variable or a user-designed equation. It is also possible to calculate petrophysical values by consulting any of the logs and using cut off values.

With the Mapping tool, grids can be created based on point data associated with the wells in the each layer. Another tool makes possible to perform operations among the different grids. Finally, the Volumetrics window is used to obtain average values for a grid or volumes associated with it.



Sahara offers a set of tools to perform a basic petrophysical analysis, using calculation, visualization and analysis tools as a complement.

Sahara

In order to study the information within a project, it is important to keep it organized. Using the Log Settings window, the user can review the logs available for each well, set up their units and display histograms for each log. It offers the possibility of using aliases, as an efficient way to handle the great diversity of curve names existing for the same variable in the different wells. An alias is a fantasy name that has an ordered list of curves associated so as to give them a hierarchy. When selecting an alias to perform a calculation or for visualization, Sahara will use the first available log in the list for the selected well. In addition to importing standard electrical logs, other types of logs can be imported and viewed, such as those that measure in-depth data or fluid transit. The last of them can be used as a basis for calculating production and/or injection allocation factors in the different production levels.

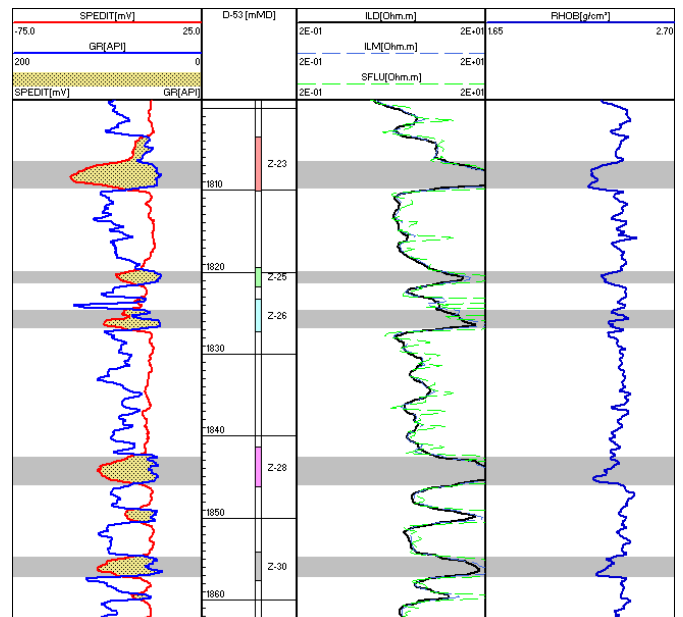
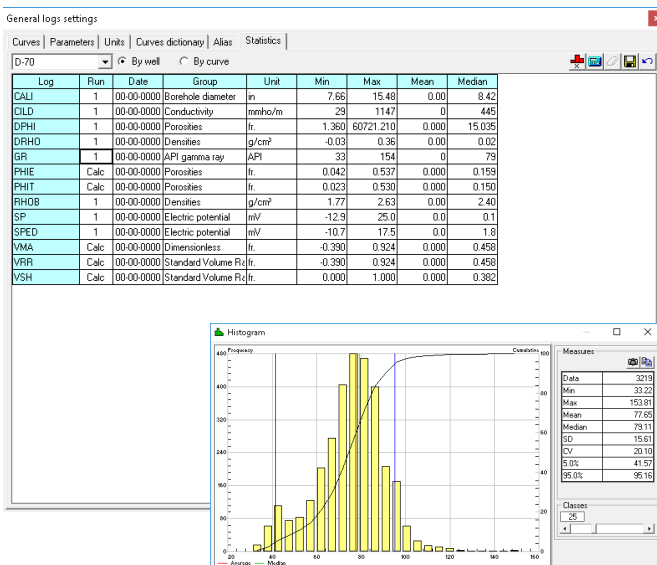
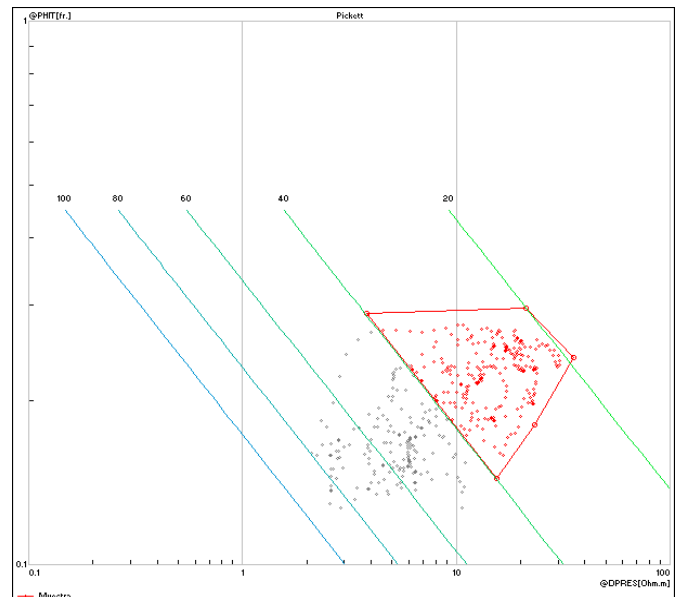
Templates with several tracks can be created for logs visualization in the Logs window. These templates can also be used in the Cross Sections window with the purpose of facilitating the correlation of the productive reservoirs. In this way, it is possible to define layer tops and bottoms, reviewing the tests performed for each layer and using a group of specific tools to carry out depth measurements, compare logs for different wells and copy picks from one well to another.

Once layer correlations have been made, using the different tools available in Sahara, relevant information can be obtained, such as petrophysical values, maps and productions, among others.

Statistical analyses can be performed with the log values of each well, and using the Cross Plot window, data can be analyzed for a group of wells and/or reservoirs.

Sahara's petrophysical tools include the Cross Plot window that is used to create charts based on logs data. In the different charts, values of maximum and minimum cut off can be used for each of the axes. This tool also allows selecting points on the chart and highlighting those zones in the Logs window. The charts available include the following:

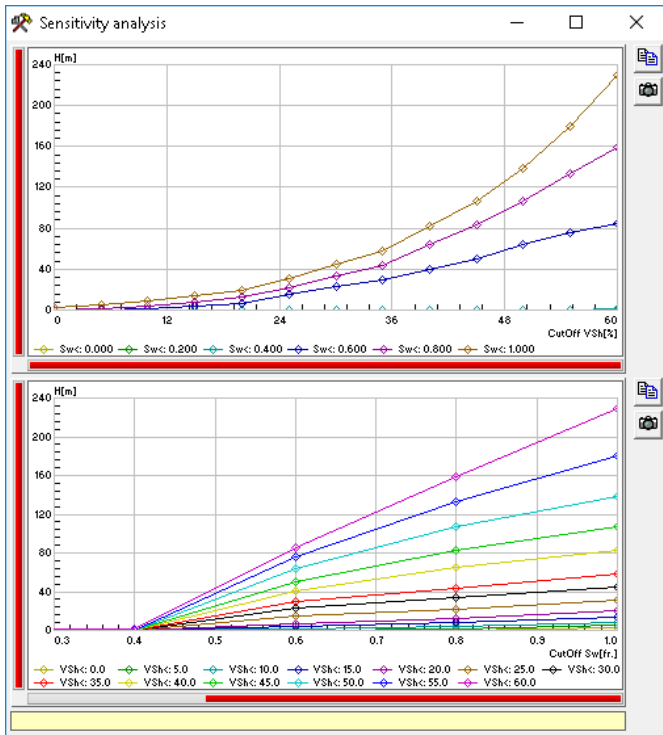
- X-Y-Z
- 3D
- Neutron-Density
- Sonic-Density
- Neutron-Sonic
- Pickett
- Hingle



Log Configuration. The image shows the statistics tab displaying all the logs associated with a particular well. For each well a histogram can be visualized.

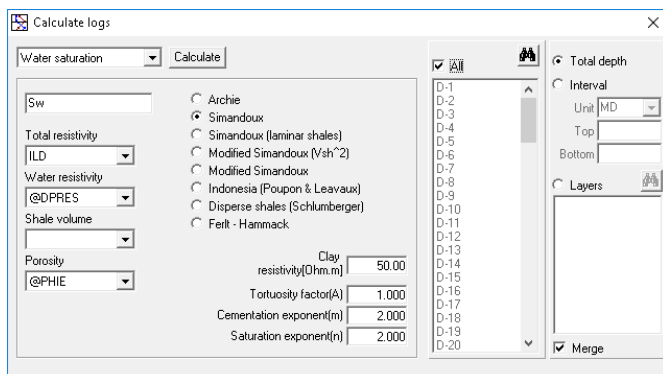
Cross Plot. The image shows a Pickett chart where 20%-40% water saturation data were selected.

Sahara also has a Sensitivity analysis tool, which allows porosity, clay volume and water saturation cut off analysis. Given the curves, cut off ranges and their increments, average porosity, net thickness, average saturation, and hydrocarbon pore volume values are calculated for each of the cut off combinations set for the selected wells and layers.



Sensitivity Analysis. There are two charts where the thickness value has been set. The upper chart shows a family of curves for the water saturation and in the lower chart, for the volume of clay.

The Log Calculation tool creates synthetic logs based on measured electrical logs, using defined correlations for the different variables. The correlations offered for each variable are the most used within the industry. In order to perform the calculation, the values of the necessary parameters for each correlation must be defined. Some of them can be determined using the Cross Plot window, such as those needed to calculate the water saturation log obtained from the Pickett chart. However, if the desired equation is not available, it is possible to generate a user equation to calculate the expected log.

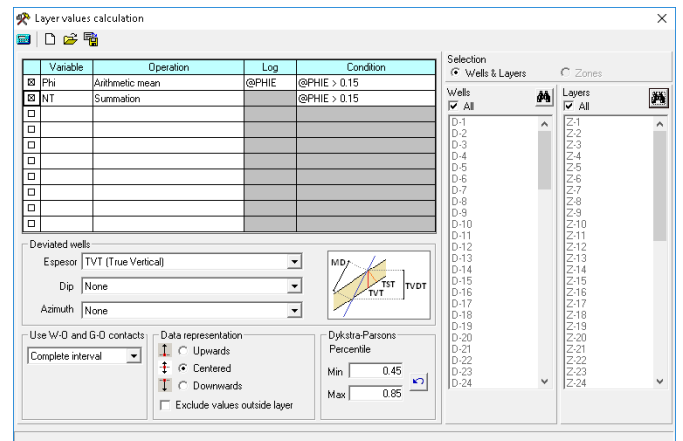


Calculate logs. The image shows the statistics tab displaying all the logs associated with a particular well. For each well a histogram can be visualized.

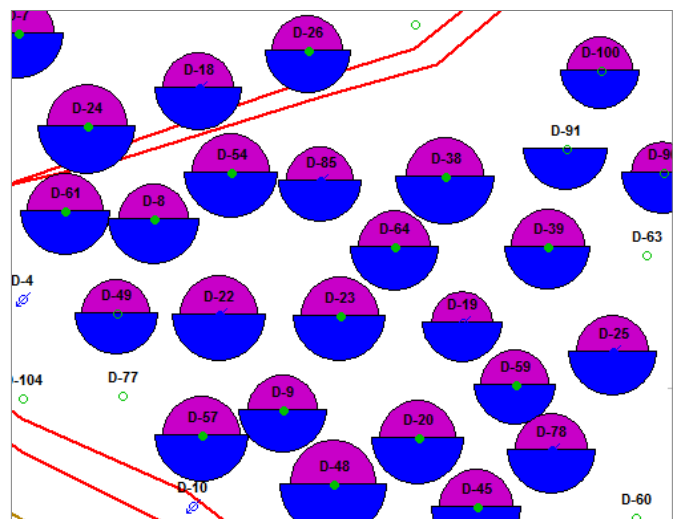
The calculation can be done by well, for the entire length of the well, for a defined interval or for a selection of the correlated layers. An additional option combines an existing log with a log to be calculated, keeping the existing log in the depth range in which there is no data to calculate. It is also possible to perform a mass calculation for a group of wells, provided the logs have been registered under similar conditions.

Finally, the petrophysical tools include the calculation of layer average values. In this window, the user can calculate petrophysical data for each well-layer based on the electrical logs, using different cutoff values. It is possible to simultaneously select different variables to calculate, choosing the operation to be performed and the cutoff condition for each of them. Summations of thicknesses and log mean values can be obtained, which are stored in the corresponding variables at well-layer level.

There are special options that take into account the well path deviation and the layer top inclination and azimuth to calculate thicknesses, and therefore the desired thickness.



Mean Layer Values. The image shows the statistics tab displaying all the logs associated with a particular well. For each well a histogram can be visualized.



Bubbles in the Map window. The static model porosity values compared to the values calculated using the Mean Layer Values tool are shown in a multiple bubble layout.

A workflow can be created in order to obtain a grid of the desired variable from the electrical logs.

While Sahara supports grids in multiple formats from other software, they can also be created with the Mapping tool, using different algorithms by interpolating the point values of any variable at well-layer level. Each of the calculation algorithms has its own configuration, being possible to define calculation regions considering the layer borders and the existence of faults, and to use control points with defined values.

Just as static variable values can be mapped, production data, test results or data associated with the flow elements, obtained as a result of a simulation, can also be mapped.

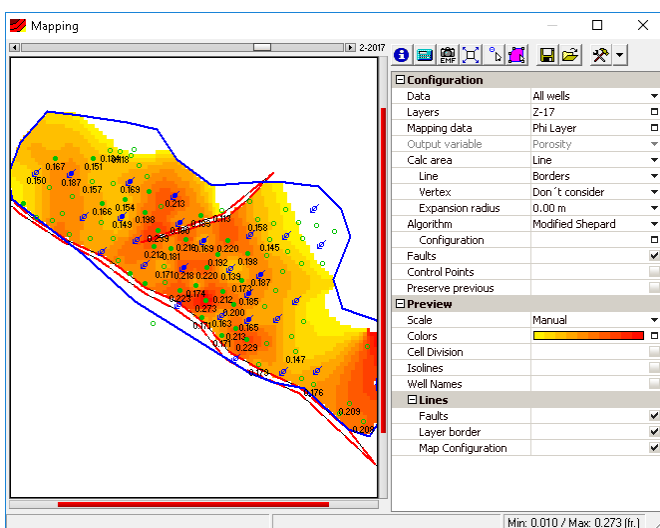
Available mapping algorithms:

- Shepard
- Modified Shepard
- Directional Shepard
- Nearest Neighbor
- Polynomial
- Triangulation
- Kriging
- Radial Basis Function
- Discrete Smoothed Interpolation (DSI)

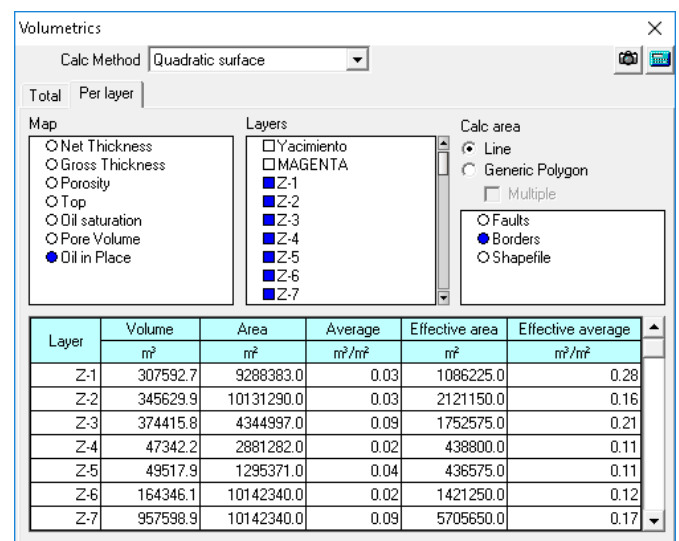
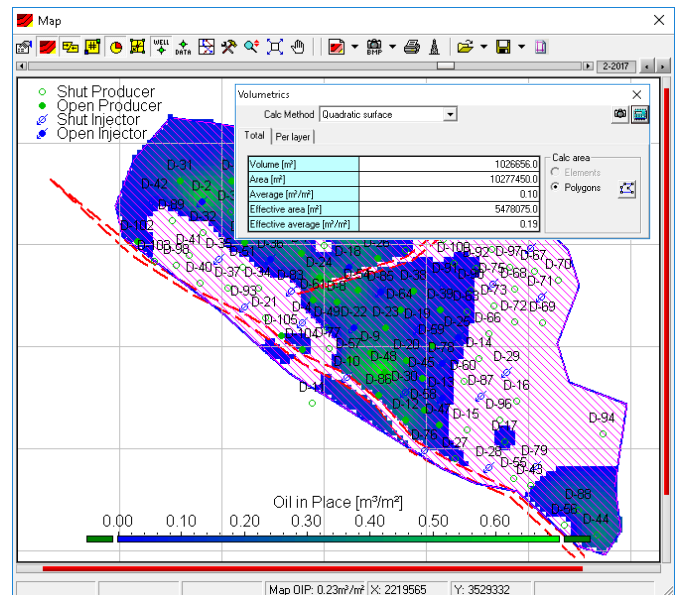
As a complementary tool to mapping, there is the possibility of performing operations across maps, through which grids can be created from adding or multiplying others. For example, the OOIP map can be obtained multiplying the Pore Volume map, the saturation map, and dividing the volume factor at layer level.

Sahara presents a group of variables with predefined equations, but also can create user variables by means of the desired operation across grids.

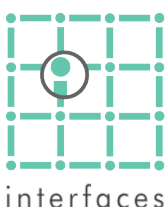
Finally, volumes associated with the grids can be obtained using the Volumetrics tool. The window has two options: perform a quick calculation for the map displayed in the Map window within a polygon, or a more detailed calculation for a particular map, for the selected layers and using some line or polygon as the calculation boundary.



Mapping. The image shows the calculation of a porosity map with the modified Shepard algorithm.



Volumetrics. The images show both calculation options inside the Volumetrics tool.



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