Core Analyses Logs & Phase Analytics Dashboard Module

Quick start guide and tutorial

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About Core Analyses Logs & Phase Analytics Dashboard Module

The Core Analyses Logs & Phase Analytics Dashboard module converts a multi-well routine core analysis CSV table into high-resolution core logs, cross-sections, core parameters maps, and a geologist-friendly Phase Analytics dashboard. The Core Logs Module fills an important industrial gap related to modern geologist-friendly multi-well routine core analysis data presentation.

Usually, major upstream data providers, based on a user-defined well list, can generate the multi-well routine core analysis CSV file required to run the application.

The embedded land grid is approximate and intended for orientation only. It is not to be used to outline actual land parcels or delineate administrative or international boundaries.

The module is a 64-bit .NET desktop application written in C#. It also can be deployed in the cloud in DaaS (Desktop as a Service) mode.

Tutorial Data

Raw CSV Data used for this tutorials from: "Alberta Energy and Utilities Board, Alberta Geological Survey, Michael, K. Wabamun Lake Modelling Case Study - Core Analysis Data (point features, comma separated text file) (NTS 83G)". Publisher: Alberta Geological Survey; Publication Place: Edmonton, Alberta, Canada, 2006.03. Contains information licensed under the Open Government Licence – Alberta.

- Open Government Licence – Alberta https://open.alberta.ca/licence

Data required to create a project

A simple Comma-Separated Values (CSV) file is required to create a project. Each core analysis row should also include the UWI (API), Latitude, Longitude, and Elevation. Column names and column order can differ from those shown below.

UWI,LATITUDE_BOTTOM_HOLE,LONGITUDE_BOTTOM_HOLE,ELEVATION_KB,INTERVAL_TOP,INTERVAL_BASE,K_MAX,POROSITY,LITHOLOGY
73431,53.19462,-114.37371,793.7,1183.49,1183.57,0.01,0.08,ss vf slt argl
73431,53.19462,-114.37371,793.7,1184.4,1184.45,0.01,0.11,ss vf slt arglsid
73431,53.19462,-114.37371,793.7,1185,1185.07,0.01,0.09,ss vf slt argl

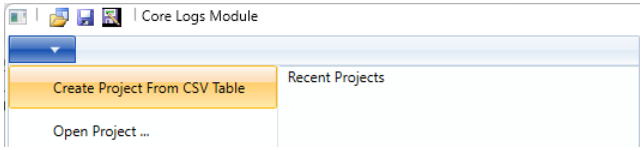
Double quotes are needed when the lithology description itself contains commas.

UWI,LATITUDE_BOTTOM_HOLE,LONGITUDE_BOTTOM_HOLE,ELEVATION_KB,INTERVAL_TOP,INTERVAL_BASE,K_MAX,POROSITY,LITHOLOGY
73431,53.19462,-114.37371,793.7,1183.49,1183.57,0.01,0.08,”ss, vf, slt argl”
73431,53.19462,-114.37371,793.7,1184.4,1184.45,0.01,0.11,”ss, vf, slt arglsid”
73431,53.19462,-114.37371,793.7,1185,1185.07,0.01,0.09,”ss, vf, slt argl”

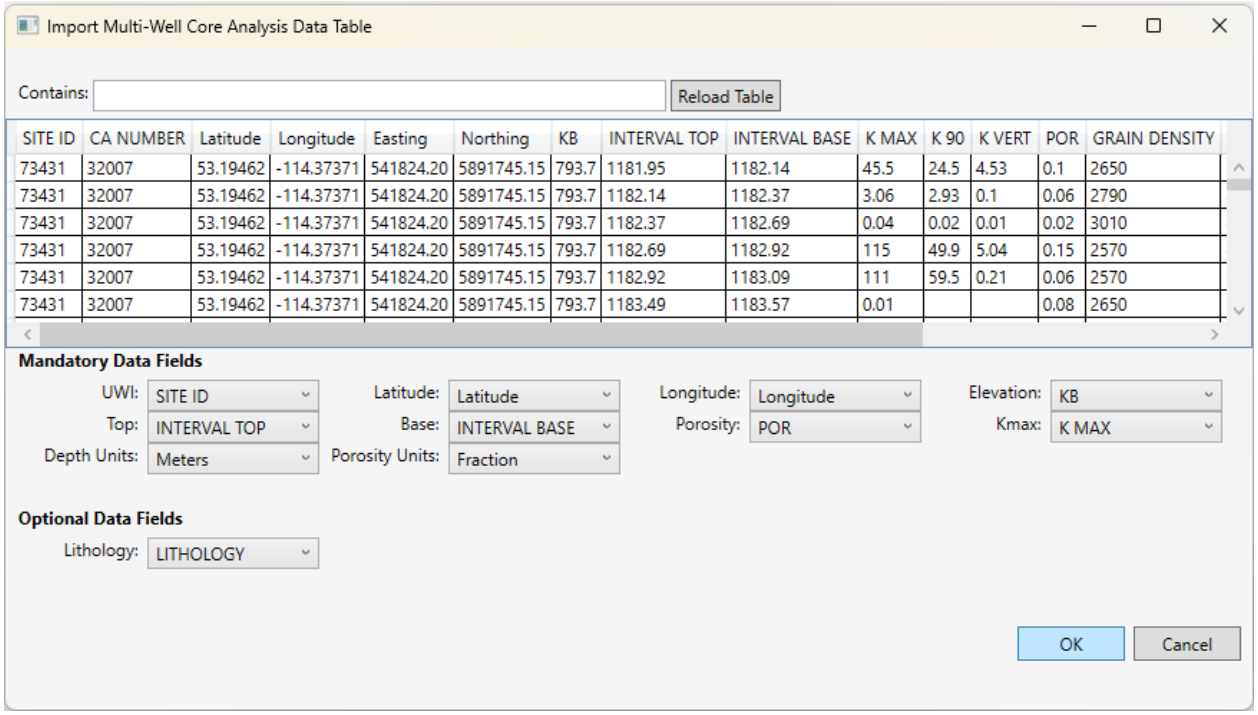
Usually, major upstream data providers, based on a user-defined well list, can generate the multi-well routine core analysis CSV file required to run the application. For example, on the S&P Global AccuMap™ main map or on another O&G data provider's main map, you can navigate to the Pembina field area and create a well list based on the following query criteria: Area – Screen or Polygon, Has Core Analysis, Producing Formation – Cardium. Using this well list, you can create the required multi-well core analysis CSV file in the export manager.

Bringing Core Analysis Data into a Project (Tutorial)

To create a new project, start the Core Logs module and, from the ribbon application menu, select "**Create Project From CSV Table**".
Navigate to the supplied tutorial CSV file **...\Tutorial Projects and Data\OpenGovernmentLicenceCoreData\CardiumOpenGovernmentLicenceData.csv** and click **Open**.

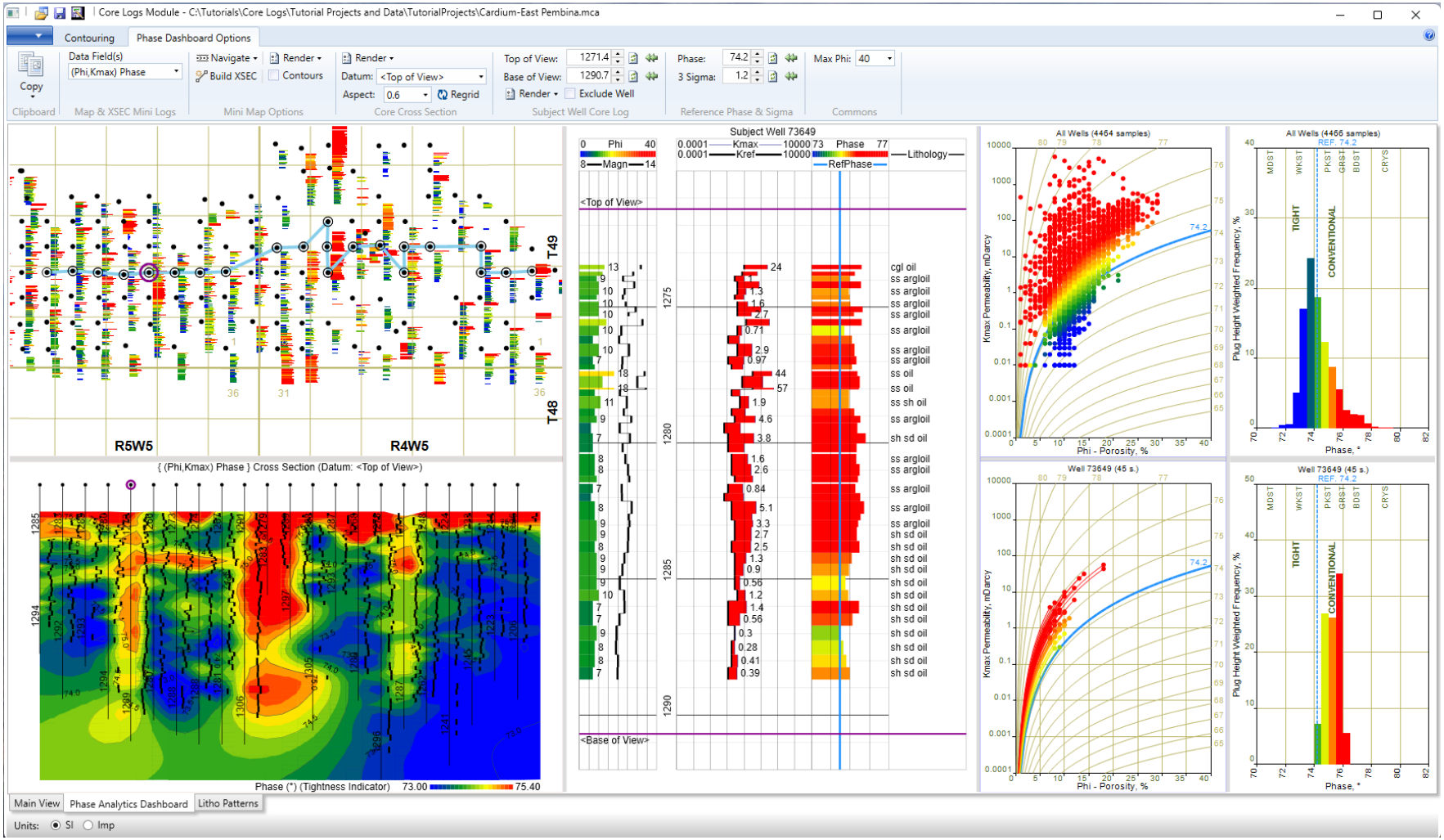


You should see the "**Import Multi-Well Core Analysis Table**" dialog. Leave the selections as they are and click the **OK** button.

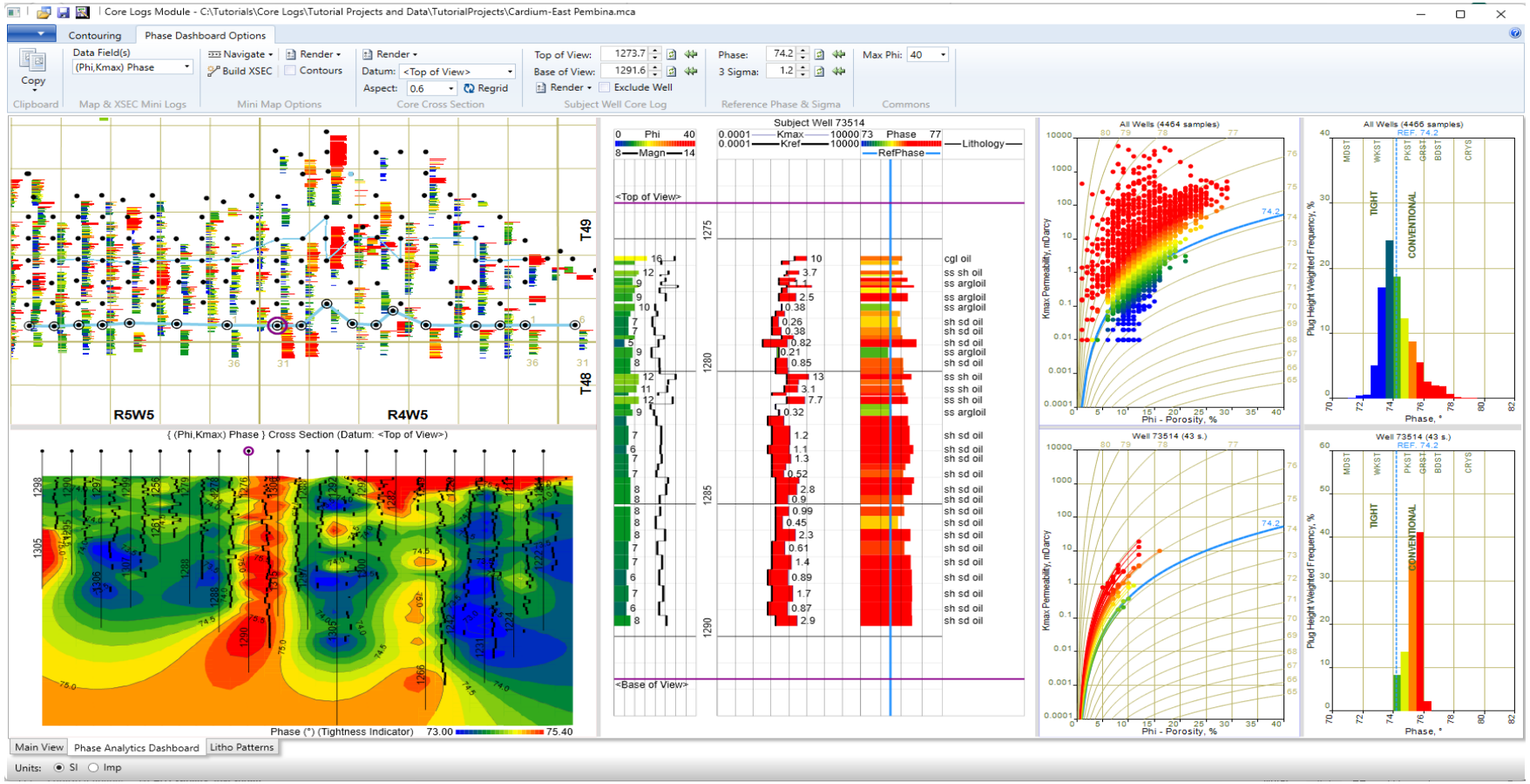


Anomalous Vertical Labyrinth detection

At the bottom of the window, click the "**Phase Analytics Dashboard**" tab, go to the mini-map inset, and, using the mouse wheel, zoom and pan the map to be similar to the one shown below. Press the ribbon button "**Build XSEC**" and, by clicking map wells from left to right, build a cross section as shown below. Double-click to finish the cross section. You should see a **Flattened Continuous Phase Cross Section (Tightness Cross Section)** created using the **kriging method** of spatial interpolation. You can modify the XSEC using the map well's right-click context menu (remove well, insert after, or before). Using the **Derivative Phase** parameter, acting as a **Tightness Indicator**, you can now detect **Anomalous Sub-Vertical Labyrinths** with abnormally increased flow capacity. Anomalous Sub-Vertical Labyrinths can potentially affect reservoir drainage, inter-well communication, water injection, and hydraulic fracturing programs. The **Phase parameter** demonstrates higher granularity and spatial coverage compared to the core coarseness grade, because the coarseness grade is missed in many lithology descriptions or remains unchanged. The Flattened Continuous Phase Cross Section (Tightness Cross Section) shows the Cardium formation (East Pembina, Alberta) topped with a conglomerate crust (**red**), and highlights 3 Anomalous Sub-Vertical Labyrinths (**reddish-yellow**) surrounded by tighter rocks (**blue**). An increased coarseness grade (m/c - medium-coarse) for two wells within the Middle Labyrinth was reported for all analyzed core plugs from top to base. **Magenta** circles on the map and mini cross section correspond to the **Subject Well** rendered in the middle of the dashboard. You can change the Subject Well by double-clicking a well ball within the mini cross section or by choosing "**Set As Subject Well**" from the mini-map well's right-click context menu.

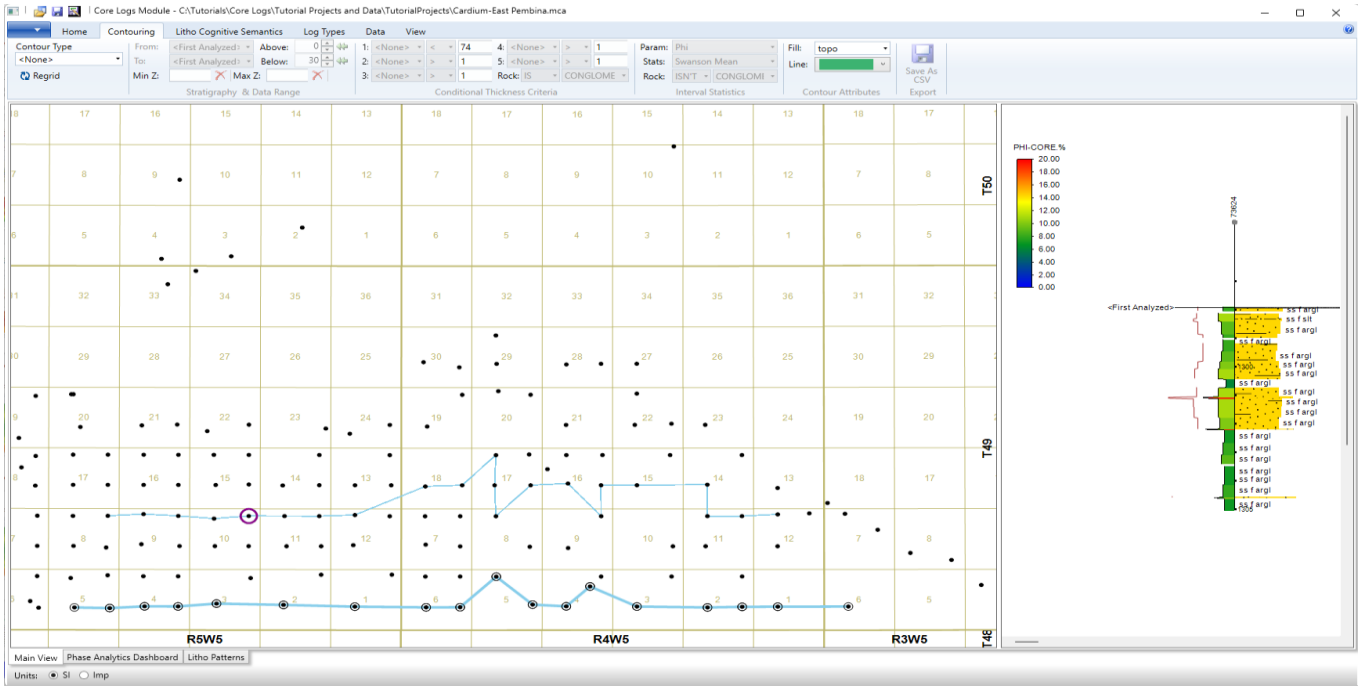


Press the ribbon button "**Build XSEC**" and, by clicking map wells from left to right, build another cross section as shown below. You should see another **Flattened Continuous Phase Cross Section** showing the Cardium formation partially topped with a conglomerate crust (red), and Anomalous Sub-Vertical Labyrinths (reddish-yellow) surrounded by tighter rocks (blue). Magenta circles on the map and mini cross section correspond to the Subject Well rendered in the middle of the dashboard. The ribbon up-down numerical control "**Phase**" corresponds to the **Reference Phase (RefPhase).** The color palette is centered at the **RefPhase**, and the palette bounds are defined by the **3 Sigma** up-down numerical control. A **common Phase Color Scheme** is applied to all dashboard visual Phase presentations. So, for example, if you change 3 Sigma, the color contrast will change for the Phase Mini Logs (rendered on the mini-map), Phase Cross Section, Phase in the Subject Well Plot, Scatter Plots, and Phase Histograms. **Note: There are no Phase values corresponding to an exact boundary between conventional and tighter reservoir rocks. This type of boundary is statistically diluted and approximate**.

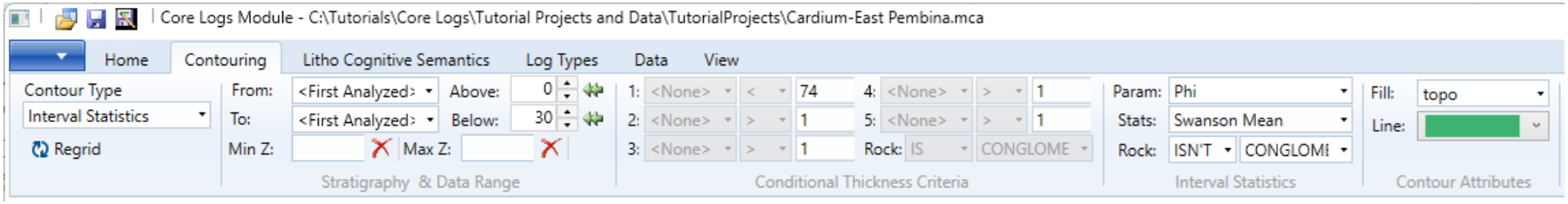


Mapping Reservoir Parameters

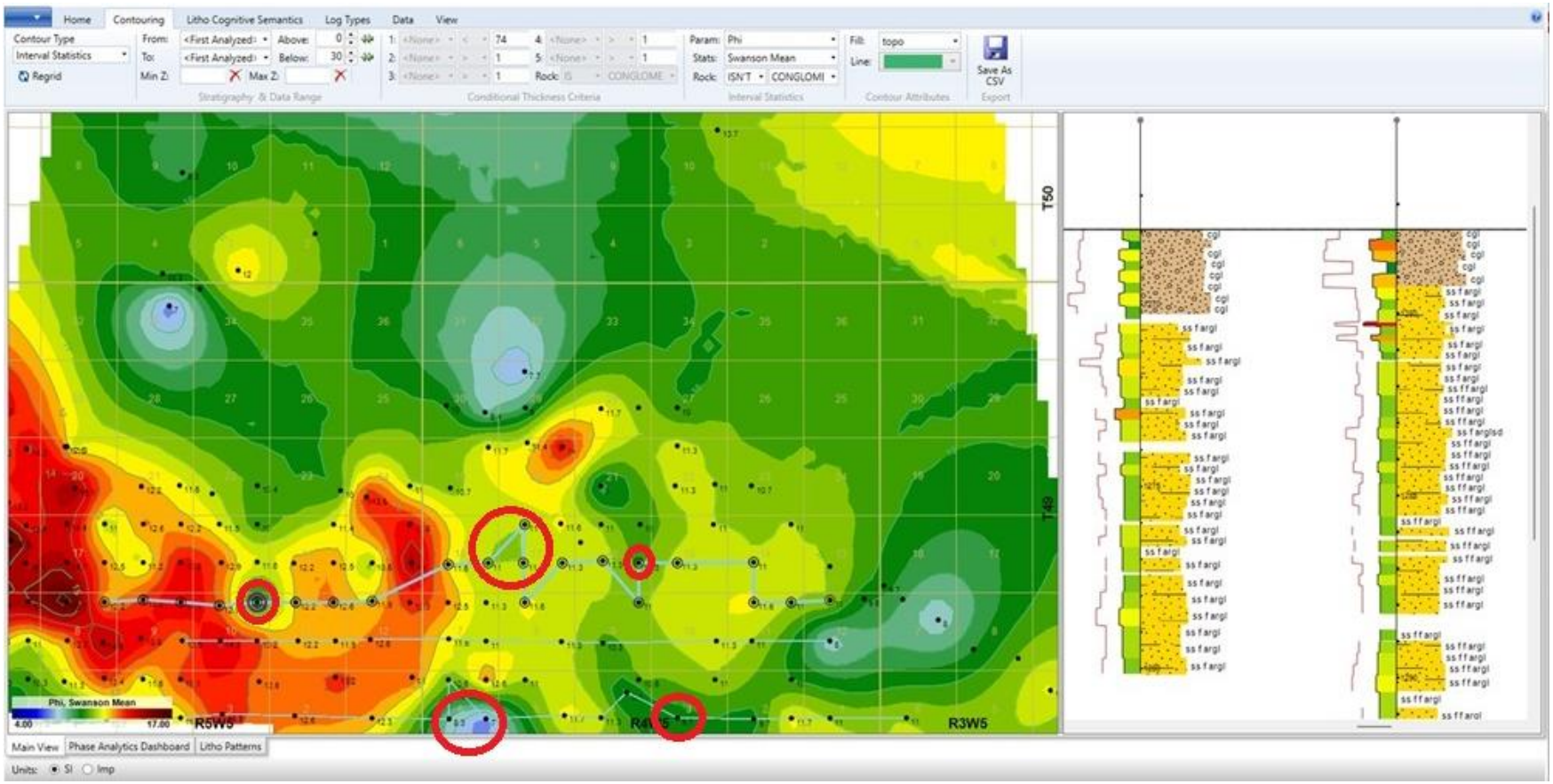
At the bottom of the window, click the "**Main View**" tab, go to the main map, and, using the mouse wheel, zoom and pan the map to be similar to the one shown below.



Go to the "**Contouring**" ribbon tab and set the "**Contour Type**" to "Interval Statistics" and other parameters as shown below. You can also define the primary rock type for Interval Statistics mapping. For example, you can generate a **Swanson Mean Core Porosity** map with an additional non-numeric condition "**ROCK ISN'T CONGLOMERATE**" as shown below. **Even though the app allows you to import formation tops, in most cases formation tops are not mandatory to calculate interval statistics.** While reading the source CSV file, the application automatically creates a top for each well, corresponding to the top of the first core plug with valid porosity or permeability. If, for example, you create a well list with the additional query criteria "**Producing Formation equal Cardium**", the top will be equal to the top of the Cardium Sand or below this top (in the case of a lost core for the upper part of the formation). The absolute depth value for the top is not critical, because core depth shifting does not affect interval stats if the analyzed plugs are located within the correct stratigraphy range. So, in this tutorial, we will go with the default Stratigraphy Range defined as "**From = First Analyzed**" and "**To = (First Analyzed + Below 30m)**". Additionally, if necessary, you can adjust the top for some wells in the right-pane cross section or, using the right-click context menu, **totally delete wells with core data that do not belong to the formation of interest**.

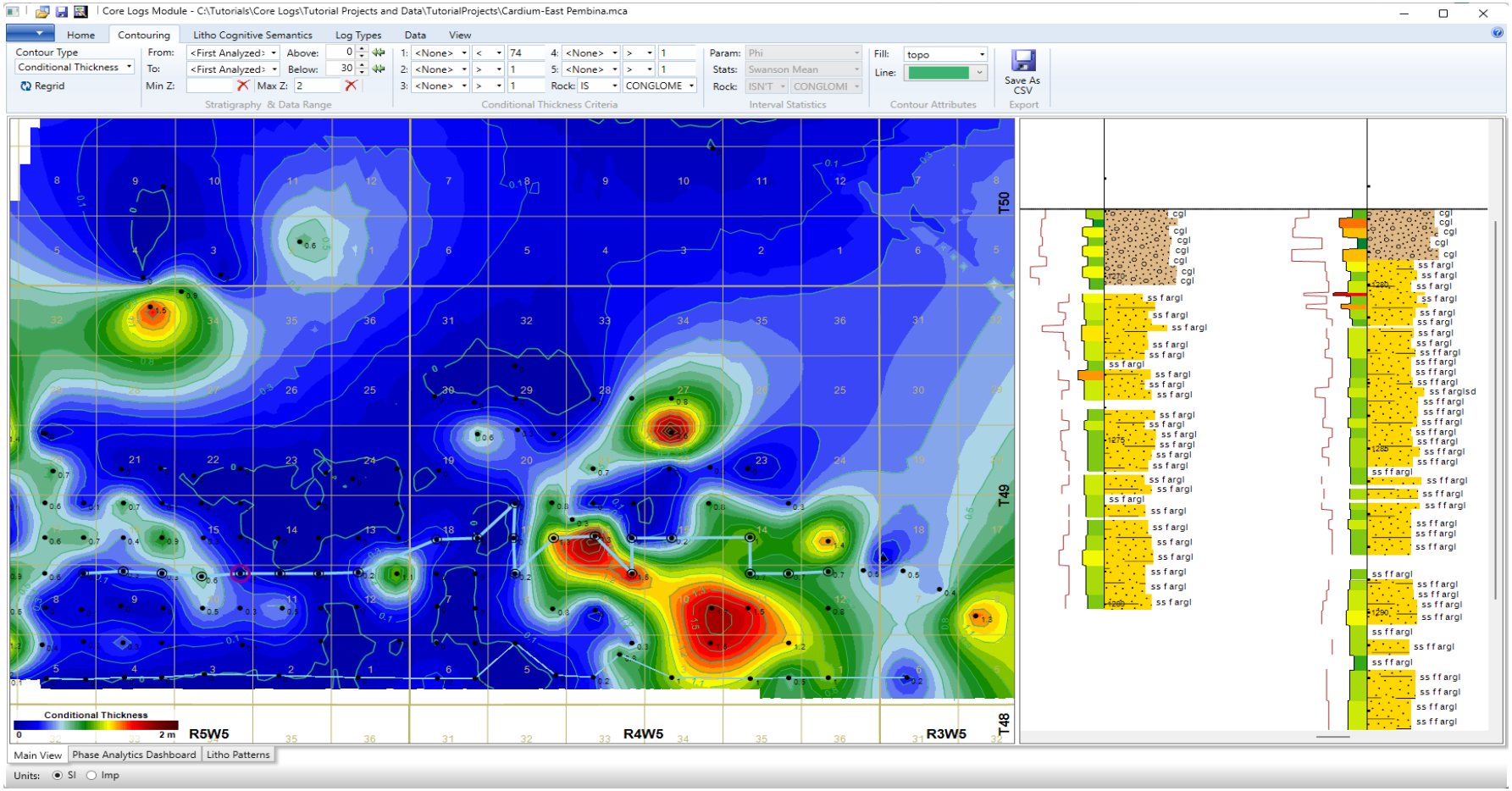


Click the "**Regrid**" button. You should see a **Swanson Mean Core Porosity** map generated for the Cardium formation (East Pembina, Alberta) with the additional non-numeric condition "**ROCK ISN'T CONGLOMERATE**" as shown below (created using the kriging method of spatial interpolation). Swanson's rule defines the mean of a moderately skewed probability distribution as a weighted average of the P10, P50, and P90 percentiles. **Because it is based on percentiles, the rule is robust to outliers**. It is worth noting that the Anomalous Sub-Vertical Labyrinths (**red circles**) are associated with local minimums of the Swanson Mean Core Porosity map.



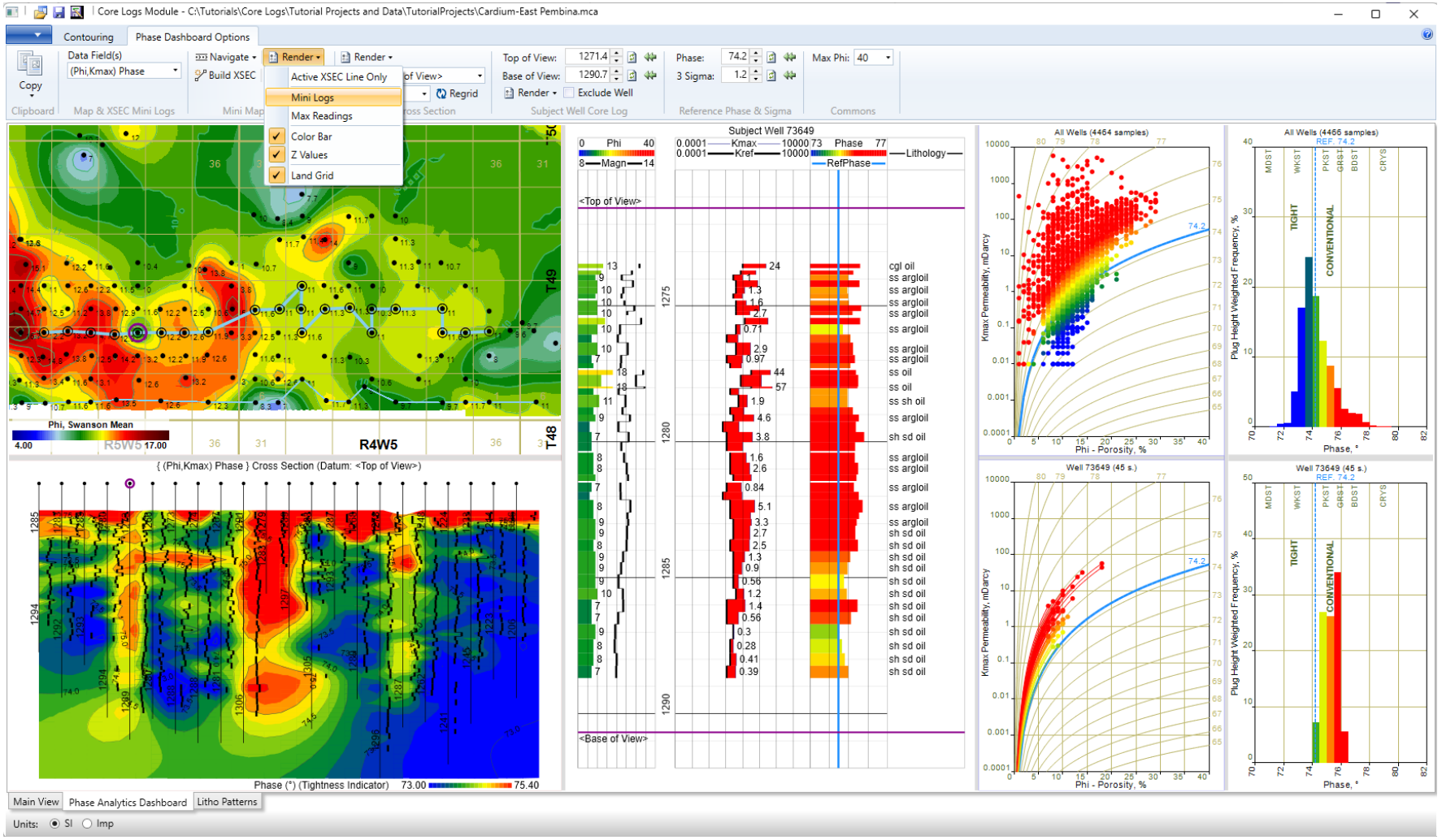
Mapping Conglomerates to Determine the Risk of Inter-Wellbore Communication During a Fracturing Program

Go to the "**Contouring**" ribbon tab and set the "Contour Type" to "**Conditional Thickness**". In the Conditional Criteria, use only a single non-numeric rule "**ROCK IS CONGLOMERATE**" as shown below (Cardium formation, East Pembina, Alberta) and then click "Regrid". You should see the contoured rock thickness created using the kriging method of spatial interpolation. Save the Mapping Points as a CSV file to contour in S&P Global AccuMap™ or in other data provider mapping packages. Conglomerates acting as "**thief zones**" can potentially affect water injection and hydraulic fracturing programs. **It is worth mapping conglomerates before actual hydraulic fracturing to determine the risk of inter-wellbore communication and to arrange monitoring of wells that are considered at risk**, because conglomerates can dramatically affect the potential **Inter-Wellbore Communication Distance** (pressure and/or fluid communication during hydraulic fracturing). "The AER does not specify how to determine this distance. However, be aware that the distance at which inter-wellbore communication can occur is often underestimated. Preliminary reporting indicates that about 10 per cent of these events occur at distances greater than 1100 metres. This distance can also vary significantly, particularly if you are using an energizing agent (N2 or CO2) in the hydraulic fracture fluid. You should also consider previous hydraulic fracturing done in the area. Fracture half-length model distances have many variables and have a low correlation to actual communication events. This type of modelling attempts to predict how much of the rock will break." (AER - Frequently Asked Questions Directive 083: Hydraulic Fracturing – Subsurface Integrity)



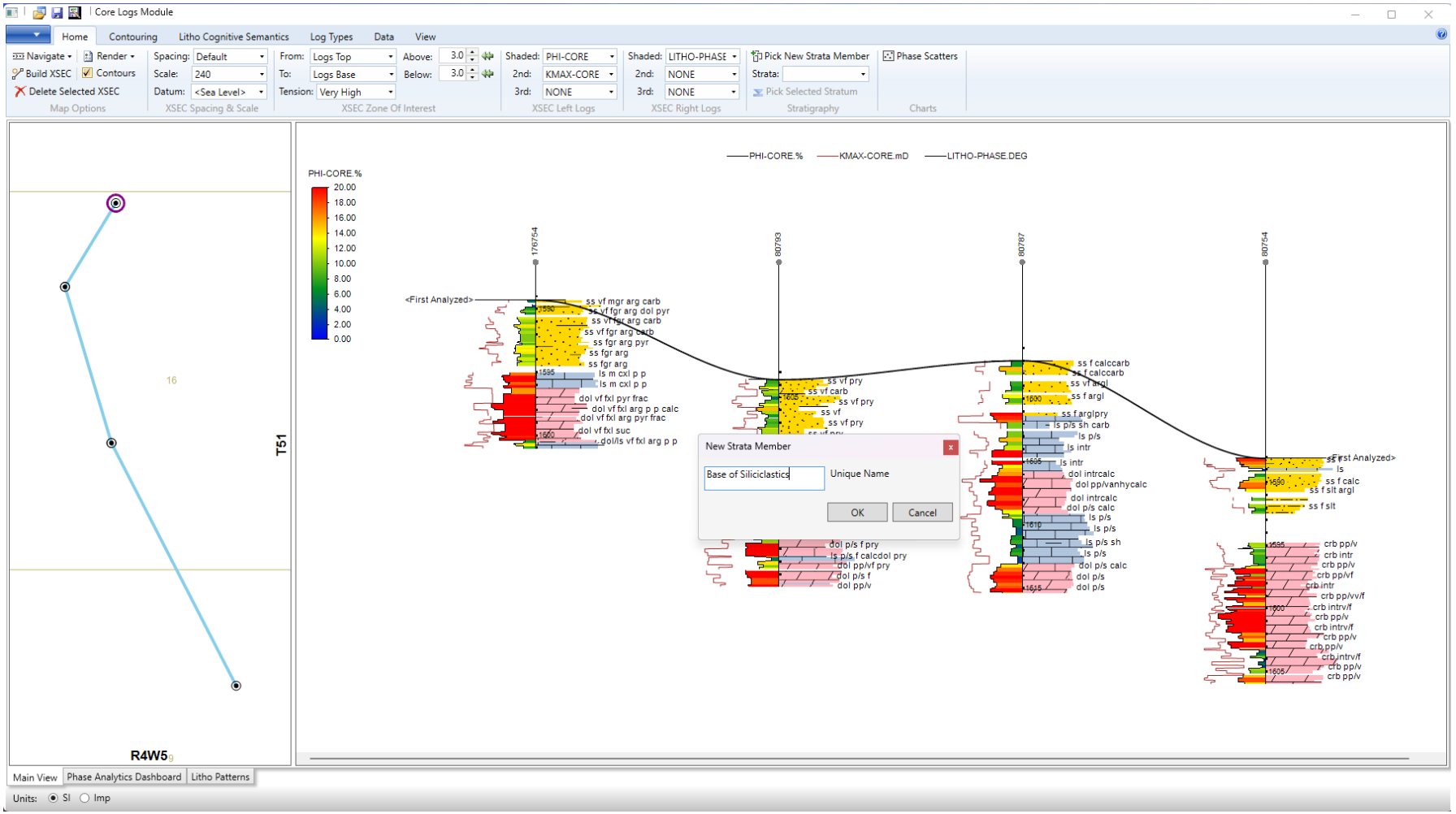
Displaying a Contour Map in the Dashboard

The “**Contouring**” ribbon tab is also accessible from the Phase Analytics dashboard, and you can display contoured parameters within the dashboard's mini-map. To turn on contours, you have to check the box “**Contours**” located in the “**Mini Map Options**” ribbon group. Contouring settings are shared between the Main Map and the Mini Map, so both windows display the same type of contour map, but use their own map scale, spatial center, and some attributes. You can also hide the **Mini Logs** posted on the mini-map by unchecking the “**Mini Logs**” ribbon menu item as shown below.



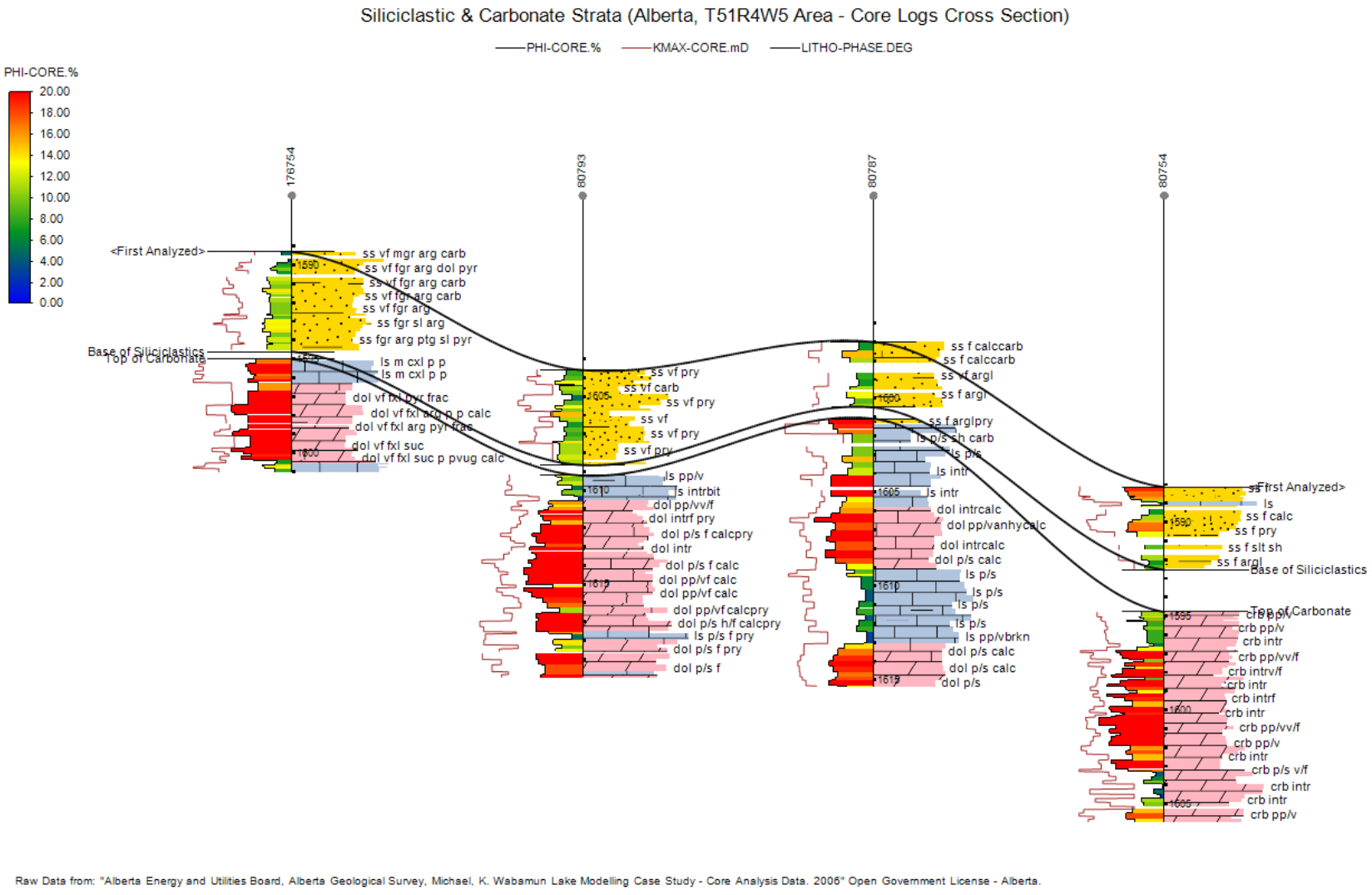
Building a Core Logs Cross Section

We are going to use another dataset for this tutorial, because there are 2 basic sedimentary rock families: **siliciclastic and carbonate**. To create a new project, start the Core Logs module and, from the ribbon application menu, select "**Create Project from CSV Table**". Navigate to the supplied tutorial CSV file …\Tutorial Projects and **Data\OpenGovernmentLicenceCoreData\CarbonateAndSandstoneRocksOpenCoreData.csv** and click Open. You should see the "**Import Multi-Well Core Analysis Table**" dialog. Leave the selections as they are and click the **OK** button. Go to the "**Home**" ribbon tab, press "**Build XSEC**", and, by clicking map wells from north to south, build a cross section. Double-click to finish. You should see a Core Logs Cross Section with an automatically generated top, corresponding to the top of the first core plug with valid porosity or permeability, as shown below. Click the "**Pick New Strata Member**" ribbon button, type a name, and place tops in each well.



Adding a Title, Subtitle, and Footer

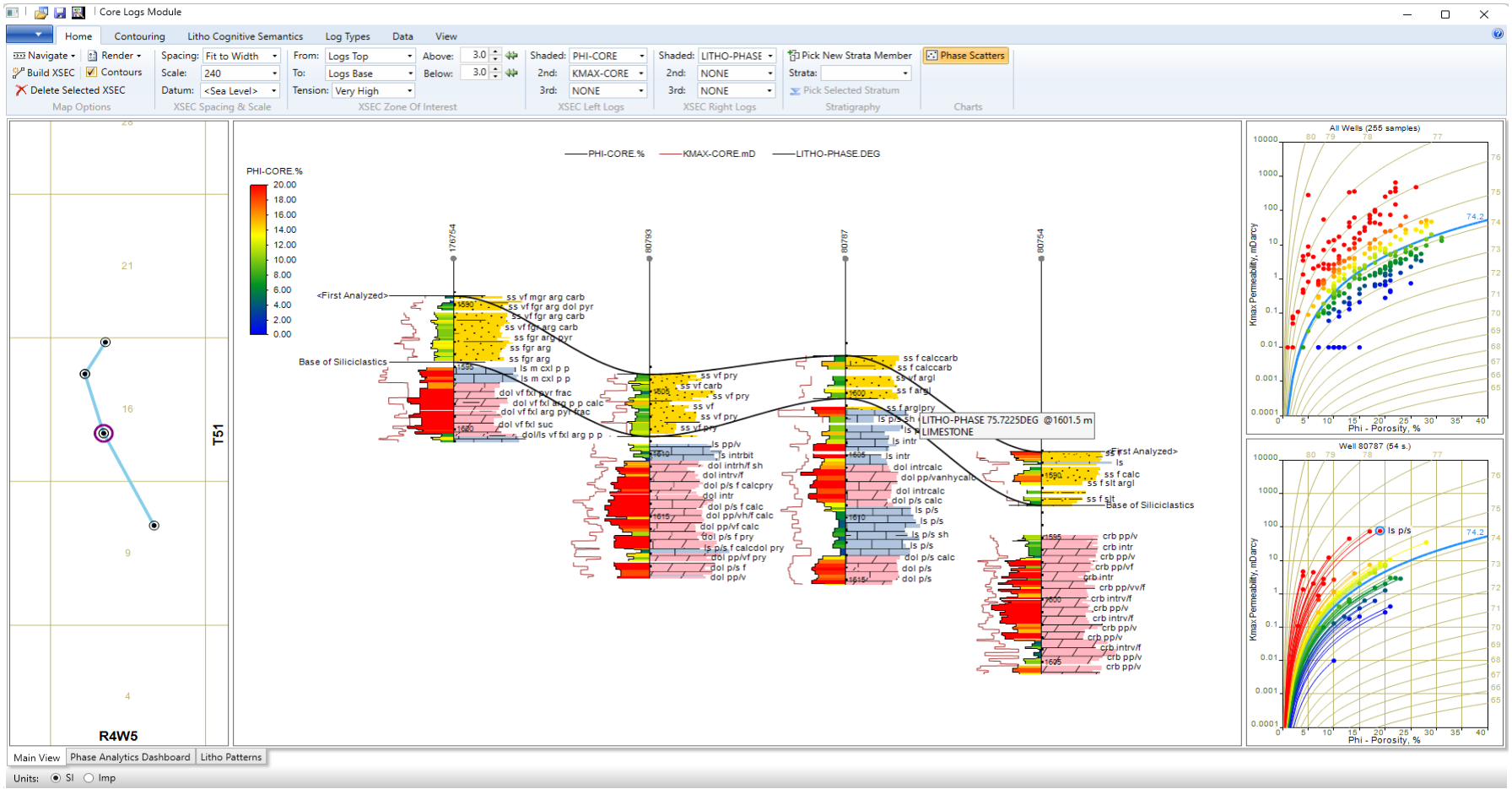
To add a **Title, Subtitle, and Footer**, go to the ribbon "**View**" tab and click the "**XSEC Header-Footer**" button. Right-click on the cross section and, from the context menu, select "**Copy Client Area**" to copy and paste the visible part into a geological report or PowerPoint presentation as shown below.



Raw Data from: "Alberta Energy and Utilities Board, Alberta Geological Survey, Michael, K. Wabamun Lake Modelling Case Study - Core Analysis Data. 2006" Open Government License - Alberta.

Displaying Scatter Plots

Push the "**Phase Scatters**" ribbon button to display scatter plots on the right side. The scatter plot for the Subject Well (located in the bottom-right corner) corresponds to the magenta circle on the main map. You can change the **Subject Well** chart by double-clicking a cross-section view well or by choosing "**Set as Subject Well**" from the map well's context menu. When you place the cursor over the subject well curve or shaded curve outline, you should see a **blue** circle around the corresponding core plug and lithology description in the subject well scatter plot.

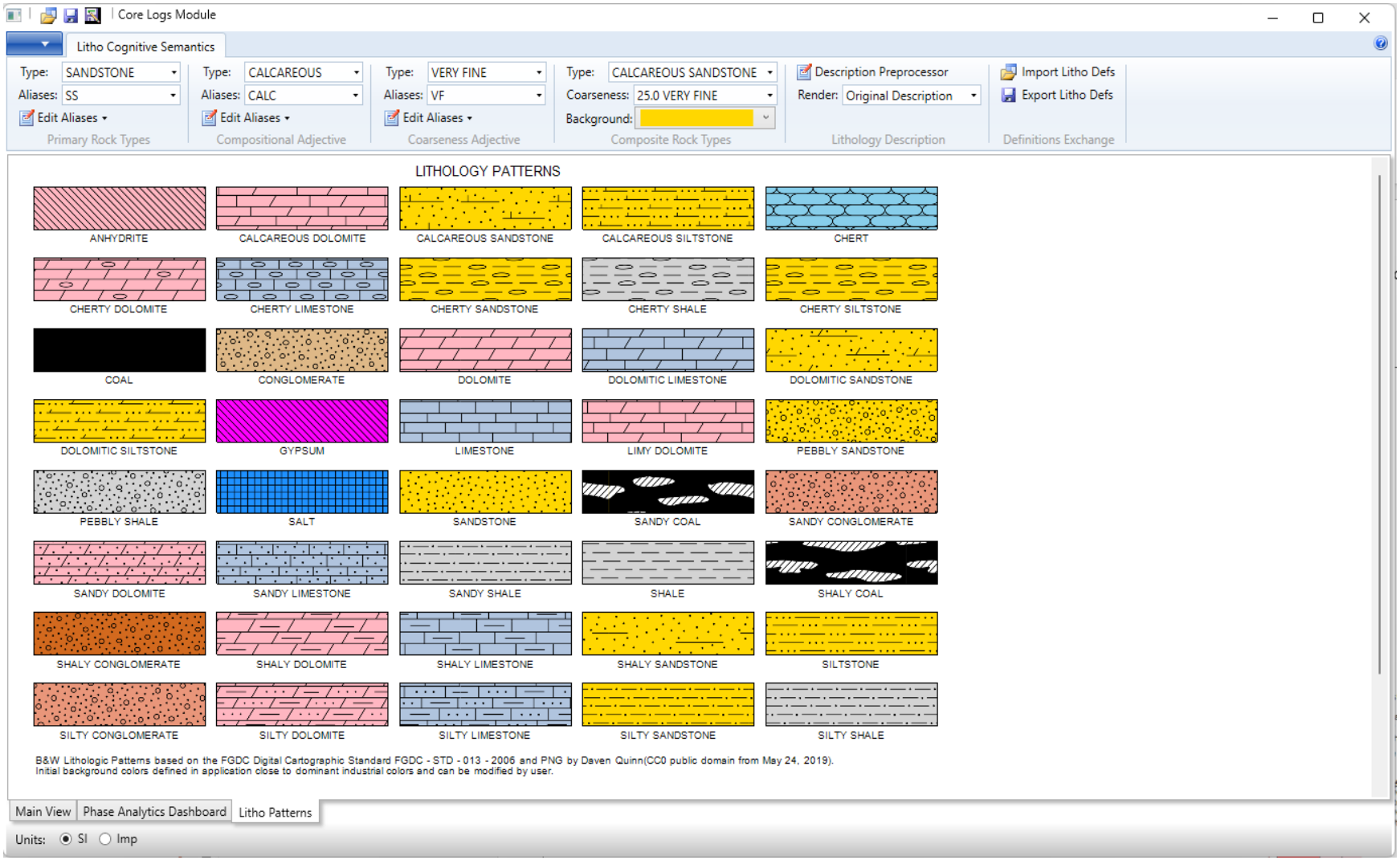


Changing the Vertical Resolution

To increase the vertical resolution and see more lithology description rows, go to the “XSEC Spacing & Scale” ribbon group and select a higher depth resolution scale as shown below.

Lithology Definitions

The app determines the Composite Rock Type from lithology abbreviations, and the litho pattern collection supports up to 40 sedimentary Composite Rock Types. Definitions are mainly based on CANSTRAT/AMSTRAT and SHELL 1995 abbreviations. However, the UI allows you to add non-standard or new abbreviations as aliases to Primary Rock Types and Compositional Adjectives. You can also modify the background colors in the lithology patterns.



Importing Formation Tops

As mentioned above, even though the app allows you to import formation tops, in most cases formation tops are not mandatory to calculate interval statistics or conditional thickness. However, if you decide to bring formation tops into the project, make sure they are stored as a **simple CSV file** with a header row and include at least 3 mandatory data fields: UWI, Top Name, and Measured Depth, as shown below.

```
#UWI,Top Name,Depth
176754,Top Of Siliciclastic,1589.26
176754,Base Of Siliciclastic,1594.6
176754,Top Of Carbonate,1595
80793,Top Of Siliciclastic,1603.57
80793,Base Of Siliciclastic,1608.69
80793,Top Of Carbonate,1609.14
```

Double quotes are needed when the stratigraphic unit name itself contains commas.

```
#UWI,Top Name,Depth,Subsea
49-009-28822,"Unit N, 28",874.51,698.56
49-009-28869,"Unit N, 28",986.55,570.36
49-009-28911,"Unit N, 28",851.74,753.03
```

To import tops, go to the "**Data**" ribbon tab and click the "**Import Tops**" button.