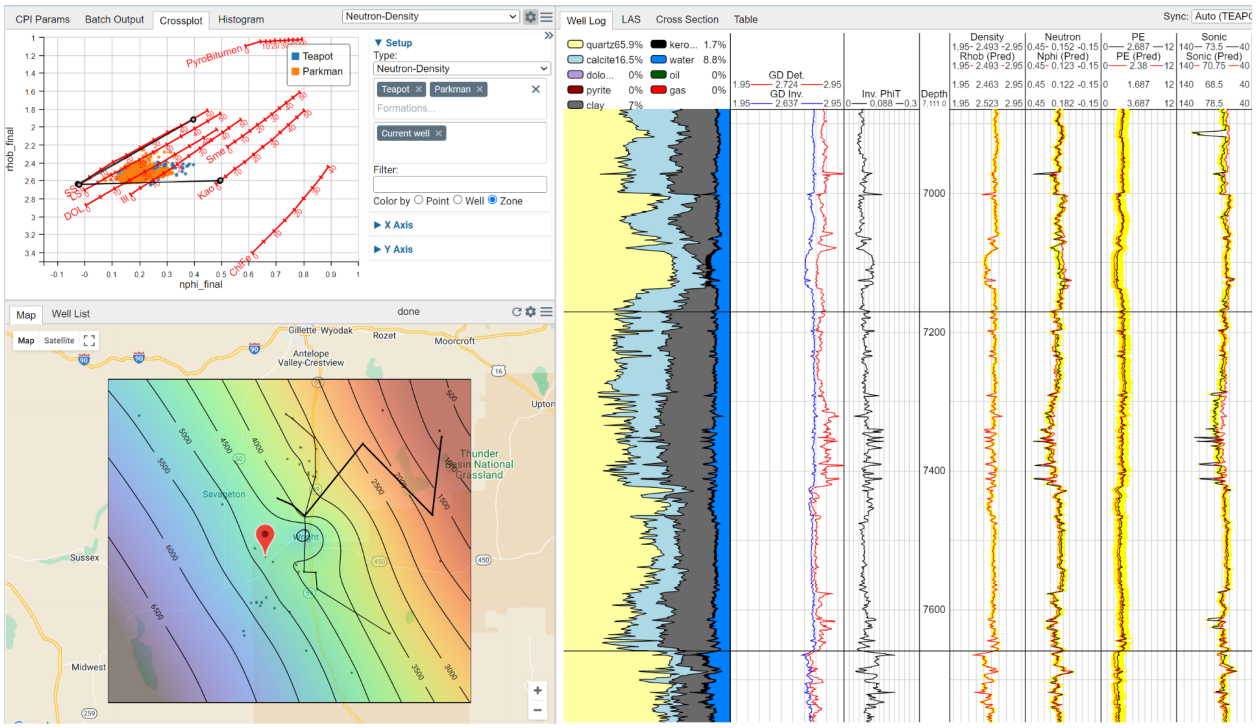
DANOMICS PETROPHYSICS INSIGHTS

Oil & Gas in the cloud

Product Info Sheet

Petrophysics Insights Product Specifications

Purpose: This document provides a high-level overview of the methods available within each module and some of the base functionality in a Danomics CPI file. This document is not intended as a tutorial or guide nor is it intended to be a comprehensive list of all the equations or methods.



Screenshot showing Danomics Petrophysics Insights platform.

PETROPHYSICS FUNCTIONALITY

Danomics Petrophysics Insights was designed to help users scale interpretations to 1000s of wells. To do this effectively Danomics has developed a number of specialized tools focused on multi-well petrophysics. These include:

- Key wells that serve as an interpretation blueprint
- Grid interpolation which allows users to populate parameters from grid files
- Parameter remapping which allows users to set parameters based on statistics
- Automated data conditioning and repair that gets your data *Interpretation Ready* from day one.

All the displays in Danomics are interactive, allowing users to navigate through their data using well lists, maps, and cross-sections. Search functionality allows you to rapidly locate wells and files and filtering allows you to drill down to the relevant data sets.

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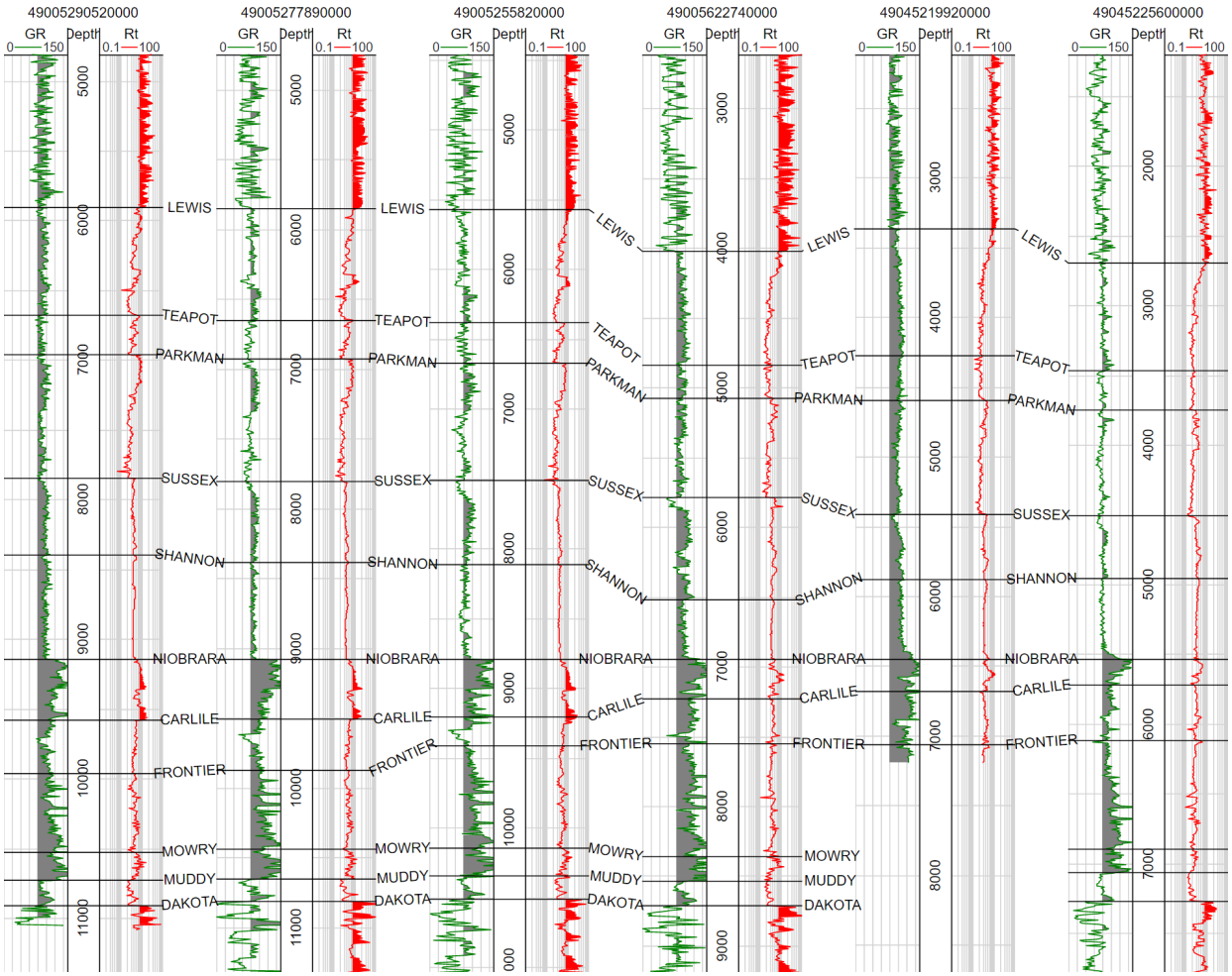
Well Log Panels

Every interpretation module comes with pre-built, user customizable well log displays that show the relevant input data and results. Users can drag and drop many parameters on the well tracks to update their interpretations.

Cross Sections

Users can generate cross-sections that include 1000s of wells. Cross-sections can either be automatically generated or can be constructed by the user. There are approximately 20 pre-built cross-section templates designed to help with data QC or top picking, all of which are user customizable. Cross-sections can be viewed in either structural or stratigraphic views.



Screenshot showing Danomics Petrophysics Insights' cross-section capabilities.

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Crossplots

There are both custom and built-in crossplots available. Data can be shown zone-by-zone and for single and multiple wells. The built-in crossplots are associated with different interpretation modules and allow users to interactively set petrophysical parameters.

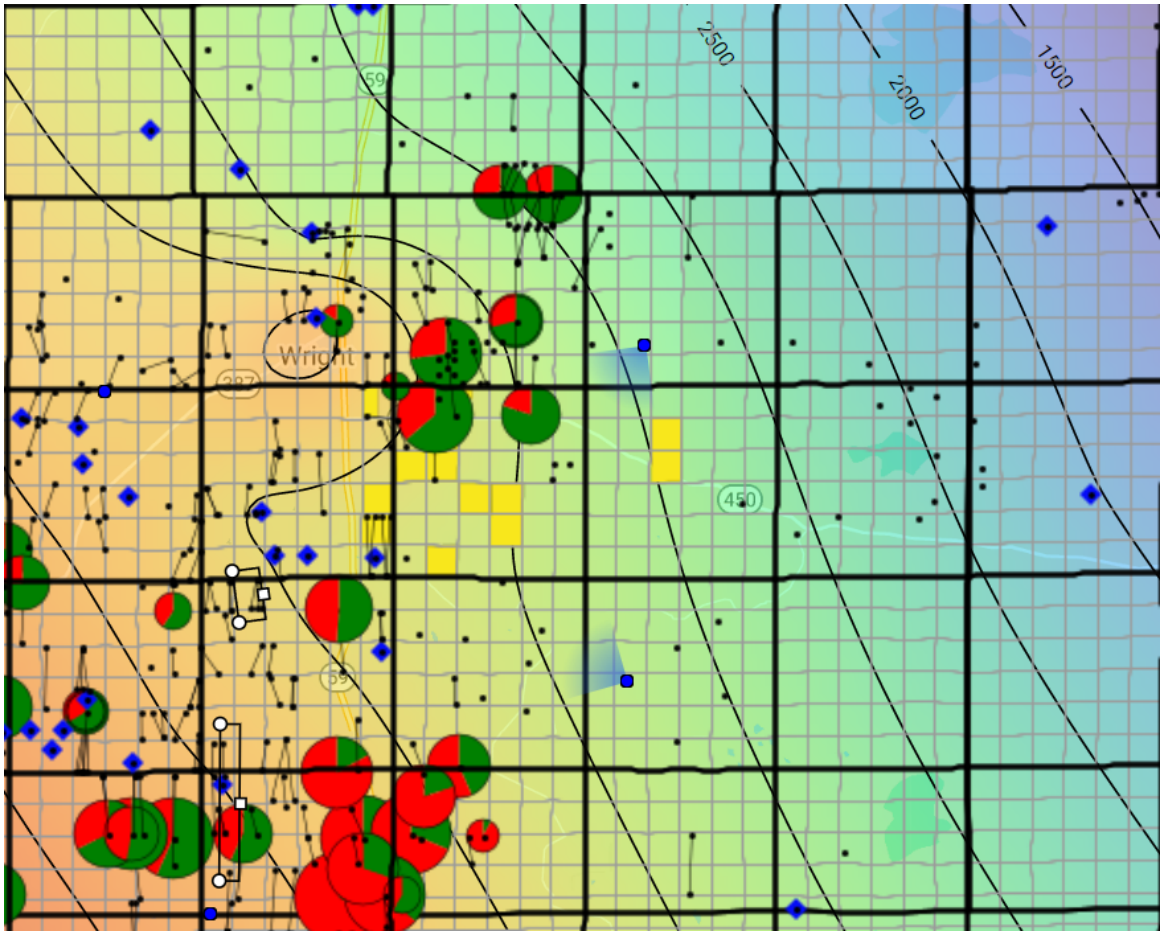
Histograms

Users can generate histograms of multiple properties on a zone-by-zone basis. When relevant, interpretation parameters can be set in histograms as well.

Maps

Users can generate structure, isopach, and reservoir property maps both through the petrophysics interpretation and via Flows. There are over 40 pre-built maps that are available by default on a zone-by-zone basis with controls for color bars, scales, and contours. Users can also bring in point data sets in XYZ formats for gridding in Danomics.

Advanced mapping is available in the designated .map file type which allows users to include shape files, production overlays, and other data overlays.



Screenshot showing Danomics Petrophysics Insights' mapping capabilities.

Zone Management and Formation Tops
Users can establish petrophysical zones that can ensure an apples-to-apples interpretation across your area even with variable stratigraphy. The zone manager allows you to correctly handle unconformities as well as set petrophysical zones that ignore tops.
Users can modify tops in both well log and cross section panels. In cross-sections users can use our convenient “capture” function to rapidly pick tops across a play.

INTERPRETATION MODULES

All equations, parameters, and methods are user-visible in the CPI Config. Users can modify or extend the methods using the CPI Config overrides to customize the workflows to their interpretation needs. Typically most methods and parameters can be set on a zone-by-zone, well-by-well basis as needed.
Interpretation parameters are typically set on the key well, which then serves as a blueprint for other wells. The non-key wells can then be modified on a zone-by-zone basis as required. Parameters can also be set via our grid interpolation methodology, which extracts values from the intersection of the wellbore and the grid.

Setup
The Setup module allows the user to set some basics related to displays and how statistics are generated for use in other modules. This module is also where a significant number of automated calculations are performed. On bringing data into a CPI file the software automatically:

- Evaluates units and performs conversions as required
- Applies an alias table of over 5500 curated curve mnemonics
- Converts logs to the correct measurement space (e.g., density porosity to bulk density)
- Performs lithological conversions to a common reference space

Editing
The Editing module allows the user to perform basic edits to each curve group prior to compositing data across curve families. User controls include:

- Depth shift data either on a File-by-file or curve-by-curve basis
- Set a custom priority order when multiple curves of the same type are present
- Filter data to meet specific criteria
- Null out data within designated depth ranges
- Scale data for individual curves

Curve Normalization
The Curve Normalization module allows the user to normalize data for several logs that are used in subsequent interpretation modules. Normalization methods include:

- Simple shifting to align all wells to a specified percentile
- Simple scaling to stretch/squeeze all wells to specified low and high percentiles

- Advanced scaling to stretch/squeeze all wells to specified low, mid, and high percentiles
- Scaling to a fixed range to stretch/squeeze all wells to specified values at specified percentiles.

The scale to fixed range can be combined with grid interpolation to perform spatial-based normalization.

Badhole ID & Repair

The Badhole ID & Repair module allows users to flag washout using a combination of criteria. Flagged data can then be (optionally) repaired using either automated multi-linear regression or random forest techniques that select and apply the best model based on the available data. Options present include:

- Identifying badhole for density, sonic, neutron, and photoelectric curves
- Padding badhole flags
- Blending repaired and original curves to minimize edge effects
- Curve despiking options

After performing the interpretations and QC checks for the above modules, your data is now Interpretation Ready.

Clay Volume

The Clay Volume module allows users to interpret the volume of clay on a zone-by-zone basis using a variety of single-clay and dual-clay methods. These include:

- Gamma Ray (Linear, Larionov Young, Larionov Old, Clavier, Steiber)
- Neutron-Density
- Neutron-Sonic
- Sonic-Density
- Neutron
- SP

The results from the selected methods can be combined to take either a minimum or average of the selected results.

TOC Analysis

The TOC Analysis module allows users to calculate the total organic carbon content and the volume of kerogen. Methods include:

- Modified Passey
- Passey overlay methods for sonic, density, and neutron
- Schmoker
- Avg. RhoB-based (an average of 12 Schmoker-like correlations)
- Vernik
- Faust
- Conversion from TOC (weight fraction) to Kerogen (volume fraction) using correlations from Danomics and Schlumberger.

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Mineral Inversion

The Inversion module allows users to calculate the grain density and mineral composition based on an inversion of the well log data and a user mineral model. Users can establish both a default mineral model and a zone-by-zone mineral model. Highlights include:

- User customizable mineral models
- Established defaults for ~20 of the most common minerals
- Fit and constraint modes for curve fitting
- Full user customization for mineral models and curve inputs.

Porosity Interpretation

The Porosity Interpretation module allows users to calculate reservoir porosity with options for clay and kerogen corrections. Methods include:

- Neutron-Density
- Density
- Sonic
- Mineral Inversion porosity (from grain density)
- Mineral Inversion porosity (sum of fluids)
- Deterministic grain density porosity

Water Saturation

The Sw Interpretations module allows users to calculate water saturation using a number of methods. All calculations are done using the downhole temperature based on user inputs for surface temperature and geothermal gradient. Methods include:

- Archie
- Archie total porosity
- Simandoux
- Modified Simandoux
- Dual water
- Waxman Smits

Users can also choose to calculate permeability, with methods such as:

- Wyllie-Rose
- Coates
- Timur
- Tixier
- Heslop

To assist in performing interpretations at scale, Danomics parameter re-mapping can be applied to auto-interpret Rw across large numbers of wells.

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Cutoffs Interpretation
The Cutoffs Interpretation module allows users to calculate gross reservoir, net reservoir, and net pay flags based on user specified criteria. Users can combine criteria in several combinations to establish the flags most relevant to their interpretation.

Volumetrics Interpretation
The Volumetrics Interpretation module allows users to calculate the OOIP and OGIP for their wells based on either the total or effective porosity and the net reservoir or pay flags. Users can choose to either enter their formation volume factors or can use the Vasquez and Beggs correlations to determine the formation volume factors for gas and oil.

Many users may end their interpretation workflow after calculating the volumetrics. However, Danomics Petrophysics Insights includes many additional modules that can be used as desired. These are given below.

Deviations
This module allows users to perform operations in TVD space when working with deviated wells. This can provide better results for many properties such as hydrocarbon pore volume, OOIP, OGIP, and other properties that use thickness.

Shear Log Modeling
This module allows users to employ the Greenberg and Castagna models to calculate synthetic shear logs from their compressional sonic logs. This enables users to then generate geomechanical properties such as theYoung's modulus and Poisson’s ratio.

Geomechanics
This module allows users to calculate a number of geomechanical properties as well as brittleness parameters. Calculations include:

- Young’s modulus
- Bulk modulus
- Shear modulus
- Poisson’s ratio
- Brittleness via Jarvie et al., Wang and Gale, and Danomics’ methodologies

1D Geomechanical Earth Model
This module allows users to evaluate wellbore stability of both vertical and deviated wells using Mohr-Coulomb failure criteria. Highlights include:

- Nine methods for converting from dynamic to static Young’s modulus
- Seven correlations for determining unconfined compressive strength
- Three methods for determining internal friction angle
- Four methods for calculating minimum horizontal stress
- Three methods for calculating maximum horizontal stress

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Lithofacies Modeling
This module allows users to calculate either a key-well or multi-well model for lithofacies utilizing a K-means methodology.

Pore Pressure
This module allows users to calculate the pore pressure of their well. Methods include:

- Eaton sonic
- Eaton resistivity
- Modified Eaton sonic
- Modified Eaton resistivity

Saturation Height Modeling
This module allows users to incorporate capillary pressure data into their interpretations to calculate saturation height profiles, determine free water levels, and evaluate the irreducible water saturation.
Users can also evaluate permeability using the flow zone indicator / hydraulic flow units methodology.

Fluid Substitution Modeling
This module allows users to evaluate the change in Vp/Vs that would be expected with a change in fluid saturation and composition. This is useful for users that wish to perform further analysis on seismic data.

Cased Hole Interpretation
This module allows users to interpret cased hole sigma logs to evaluate the water saturation.

FLOW TOOLS

Flows are Danomics' system for performing batch operations at scale. There are a number of tools that are designed to help with your interpretations including:

- Log Health Checks, Curve Mnemonics Analysis, and Metadata Analysis tools
- Several tools for log data cleanup
- Speciality tools for building multi-well facies models and curve prediction for sonic and pe curves
- Tools for renaming and removing log curves
- Gridding petrophysical results

Flows are a productivity enhancement tool as they allow you to perform operations repetitively. For example, if you wanted a consistent process for updating results and renaming curves to feed into a corporate database, you would build a Flow once and execute it as your interpretation is updated.

For more information visit www.danomics.com or contact us at sales@danomics.com.