

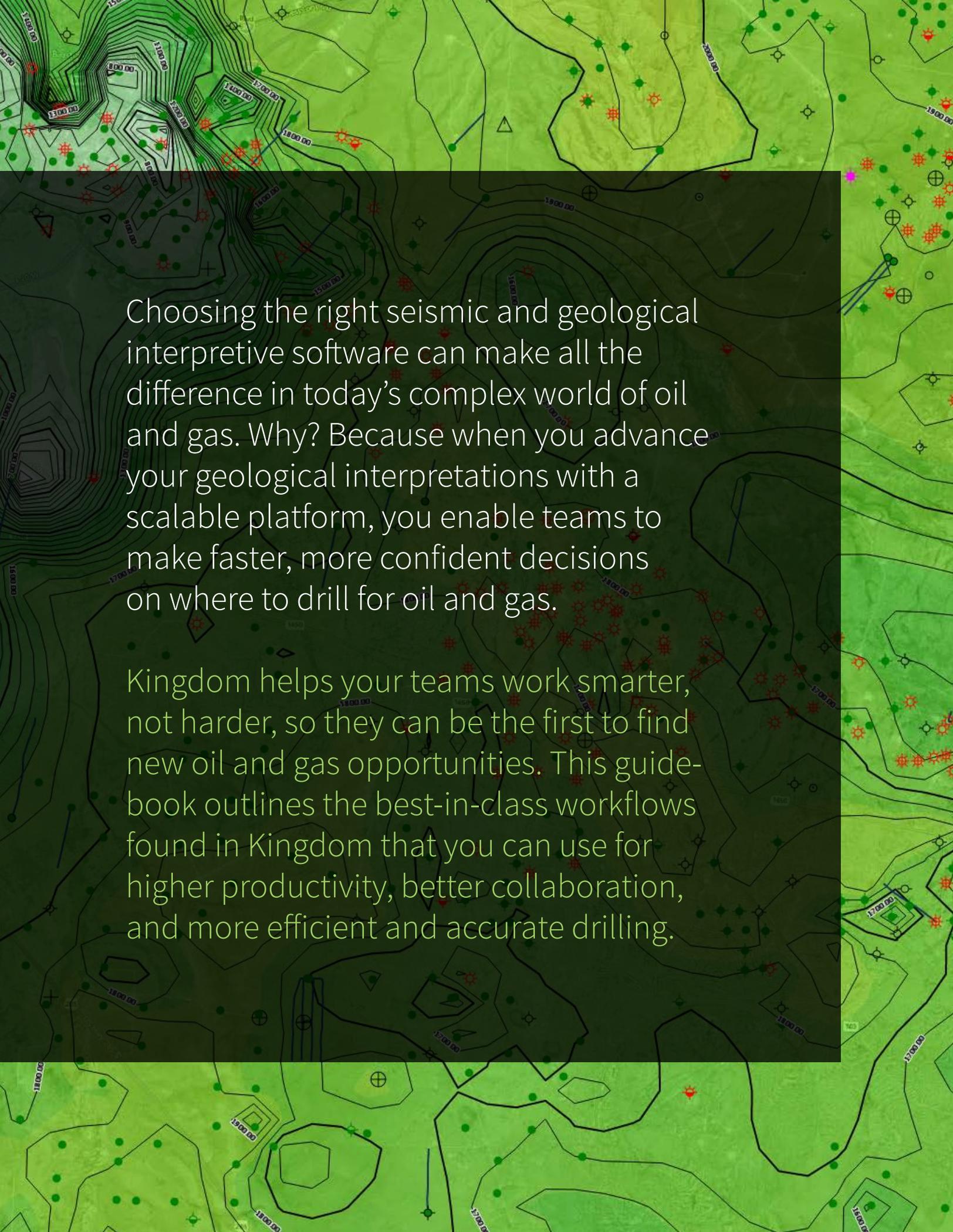


9 Ways to Optimize Drilling for Today's Energy Economy

Best in Class Workflows from Kingdom[®]



IHS Markit[®]

A topographic map with green contour lines and various data points. The map shows elevation contours ranging from 1100.00 to 2000.00. There are numerous red star-shaped markers and green circular markers scattered across the terrain. A dark grey rectangular overlay covers the central portion of the map, containing two paragraphs of text.

Choosing the right seismic and geological interpretive software can make all the difference in today's complex world of oil and gas. Why? Because when you advance your geological interpretations with a scalable platform, you enable teams to make faster, more confident decisions on where to drill for oil and gas.

Kingdom helps your teams work smarter, not harder, so they can be the first to find new oil and gas opportunities. This guidebook outlines the best-in-class workflows found in Kingdom that you can use for higher productivity, better collaboration, and more efficient and accurate drilling.

Workflow #1: Prospecting

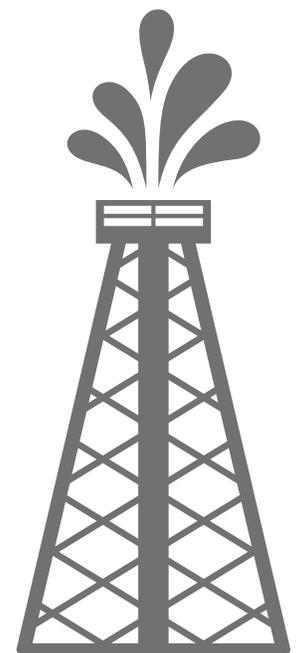
Efficiently tie well and seismic information for a truly integrated and accurate interpretation

When it comes to prospecting and drilling a well, the end-game is straightforward: You want to find a well that will produce the most hydrocarbons for the least cost with the most certainty. Yet getting to this point is a complex marriage of geological and geophysical interpretations that all depend on what data is available. In addition to having the right data at your fingertips, you must also be able to manipulate and interpret data, so you can minimize risk and increase the accuracy of predictions.

Kingdom's workflow automation provides an easy path for building a subsurface interpretation and analyzing data to determine the best trends within a field for production capabilities. Kingdom efficiently ties well information to seismic data, so you have a truly integrated geologic and geophysical interpretation. And, whether it's production, property maps, or petrophysical calculations, Kingdom helps you easily analyze information to point you to the best opportunities within a basin, field or reservoir.

With Kingdom, you can:

- Make quick decisions on bid rounds, blocks, and land sales
- Quickly develop structure maps in time and depth
- Look for fluid indicators using AVO and seismic attributes
- Quick fault interpretation and identification of fault attributes
- Significantly enhance the identification and understanding of geologic structures and potential hydrocarbon trends compared to the traditional geological interpretation



Explore data sources for permitting activity, active rigs, numbers and types of wells, production from wells, producing zone(s), thickness, porosity, BVHC, perm maps.

Workflow #2: Structural mapping

Make the best decisions with the most recent information

As you drill wells, you get new information that can drive changes in your subsurface understanding. Is the well at a different depth than expected? Is it deeper or shallower than predicted? Accommodating this new information in real time for structural maps is vital to minimizing cost and ensuring you make the best decision with the most recent information.

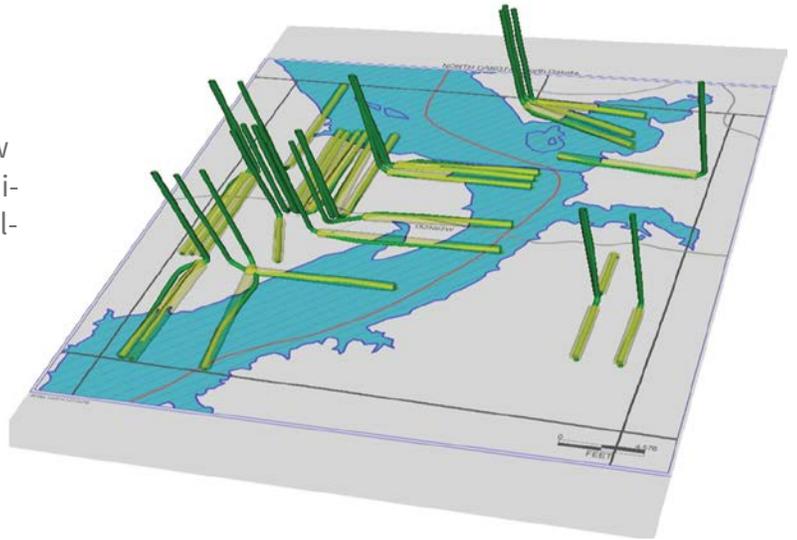
With Kingdom's Dynamic Map Update, it is easy to update subsurface information in a single mouse click, so all maps are automatically generated with the most current geologic principles. You can quickly and easily incorporate information from multiple wells from a similar location, ensuring that geologist and geophysicists access the most recent data, allowing them to collaborate and make accurate interpretations for the next well.

With Kingdom, you can:

- Quickly refresh maps to reflect new well data or new interpretations and the grid and contours update
- Define how each grid is to be displayed including automatically generated contours
- Gain more control over grid parameters and display preferences
- Build individual model layers at different grid increments for greater detail



Gather relevant lease ownership information, pad location, planned adjacent laterals to new well with distances, stratigraphic column, aquifers, coal seams, drilling hazards, planned well-bore, casing strings, completion plan.



Workflow #3:

Geological prognosis generation

Quickly generate integrated maps for better collaboration

A producing, profitable well gets all the glory, yet much of the heavy lifting in GG&E comes months, possibly years before the drilling even begins. While the level of planning and logistics prior to drilling vary for each project, for any well, the devil is in the details. From lease data and land access to environmental issues and regulatory requirements, a thorough geologic prognosis is the first phase of bringing a well into production.

Kingdom improves geological prognosis with the ability to quickly generate maps that help find the optimal geologic position for each structure that you are drilling through. Kingdom defines the depths and formations of the well and ensures that you are working within your lease or understand what leases you need to acquire in order to drill. Kingdom also enhances collaboration because the maps are integrated, so your geologist, engineer, landman and geophysicist can all work from the same database and in the same platform.

With the prognosis report for wells generated with Kingdom, you can:

- Ensure collection and distribution of your hydrocarbon are within proximity and capable of handling your production
- Be aware of environmentally sensitive surface constraints and assist by providing information to regulatory teams to ensure compliance
- Find the optimal geologic position for each well you develop and produce, including lithology thickness, stratigraphic columns, and lease understanding, to ensure you get your drill permit

Workflow #4: Geosteering

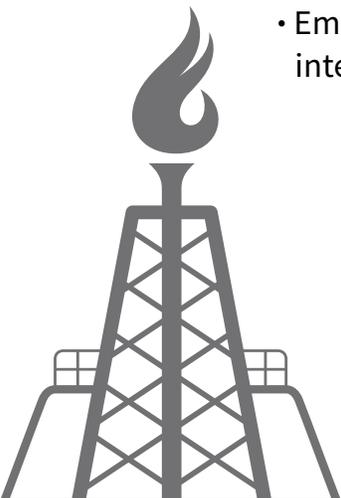
Make decisions in real time for a higher probability of success, saving time and money

For today's unconventional wells, the challenge is ensuring that you drill along the optimal portion of the subsurface for the greatest production. Geosteering is the answer to finding this optimal place, but if you don't get it right, you can end up in a sidetrack, wasting time and hundreds of thousands or possibly millions of dollars.

The answer to avoiding sidetracks is having the ability to analyze data in real time and make corrections to the drilling rig or well. Kingdom Enhanced Geosteering provides the tools needed to very accurately predict the geology ahead of the bit much more effectively than traditional tools. Powered by Dynamic Depth Conversion, the seismic and subsurface models are updated as new interpretations are made, providing insights to the entire team to enable them to optimally steer the well to potential targets, and avoid hazards in front of the bit.

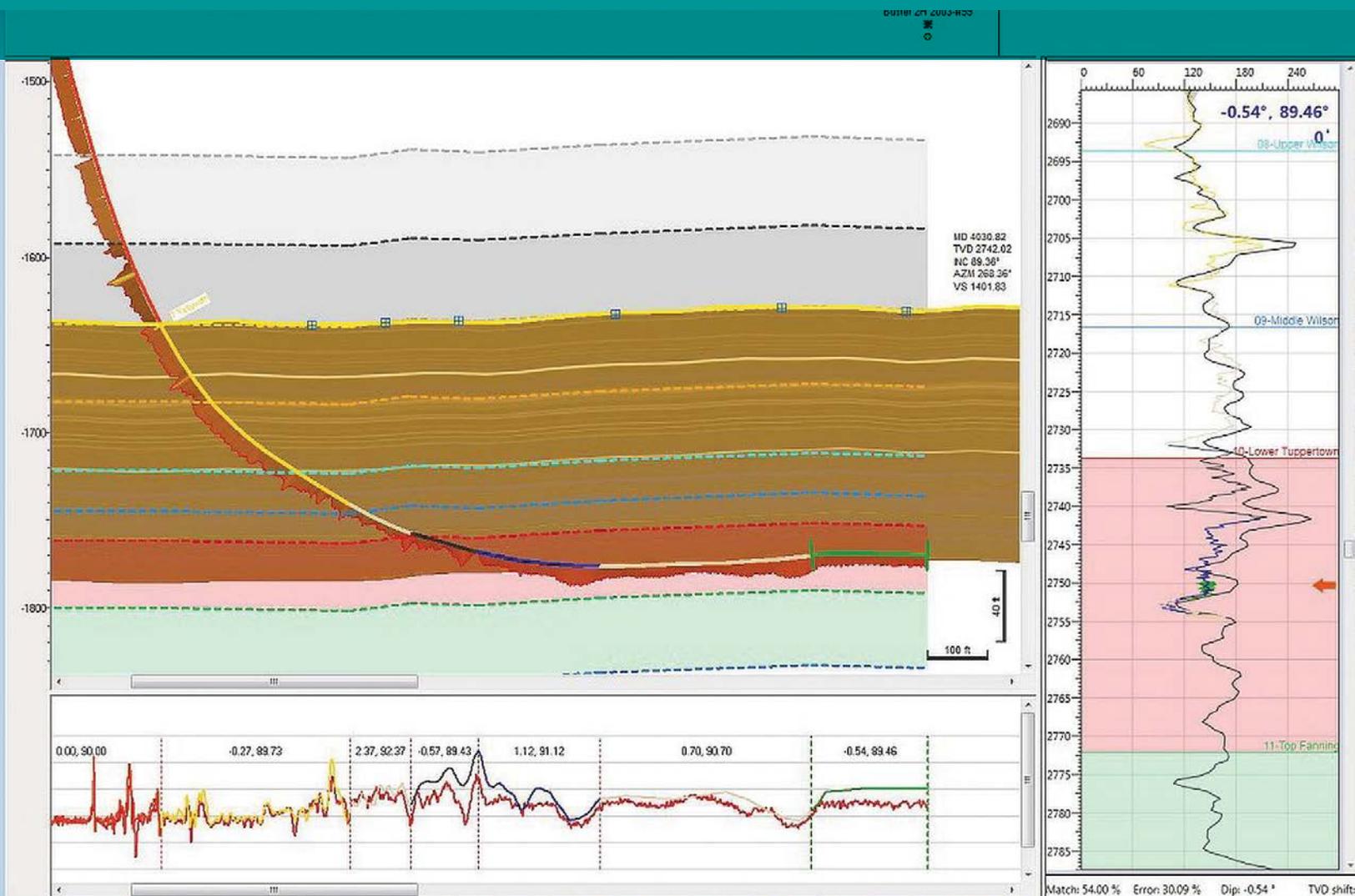
With Kingdom, you can:

- Build a consistent subsurface model that leverages the existing interpretations in all of the wells in close proximity to the drilling well to drive real-time decisions
- Transform map-making to an entirely new level of sophistication, providing unprecedented speed, efficiency, and accuracy over traditional workflows
- Empower the geosteerer by making the most accurate and up-to-date interpretation of the subsurface available at all times



Produce and manage well plans, create depth models from wells, update depth model dynamically, calculate and display in zone performance, display and quantify uncertainties in actual well placement.

Before using Kingdom's Dynamic Depth Conversion, a large oil producer was confronting a sidetrack every 6 to 8 wells, costing millions of dollars each time. With Kingdom, the company did not have a sidetrack for two years, resulting in \$5 billion in additional production and cost savings.

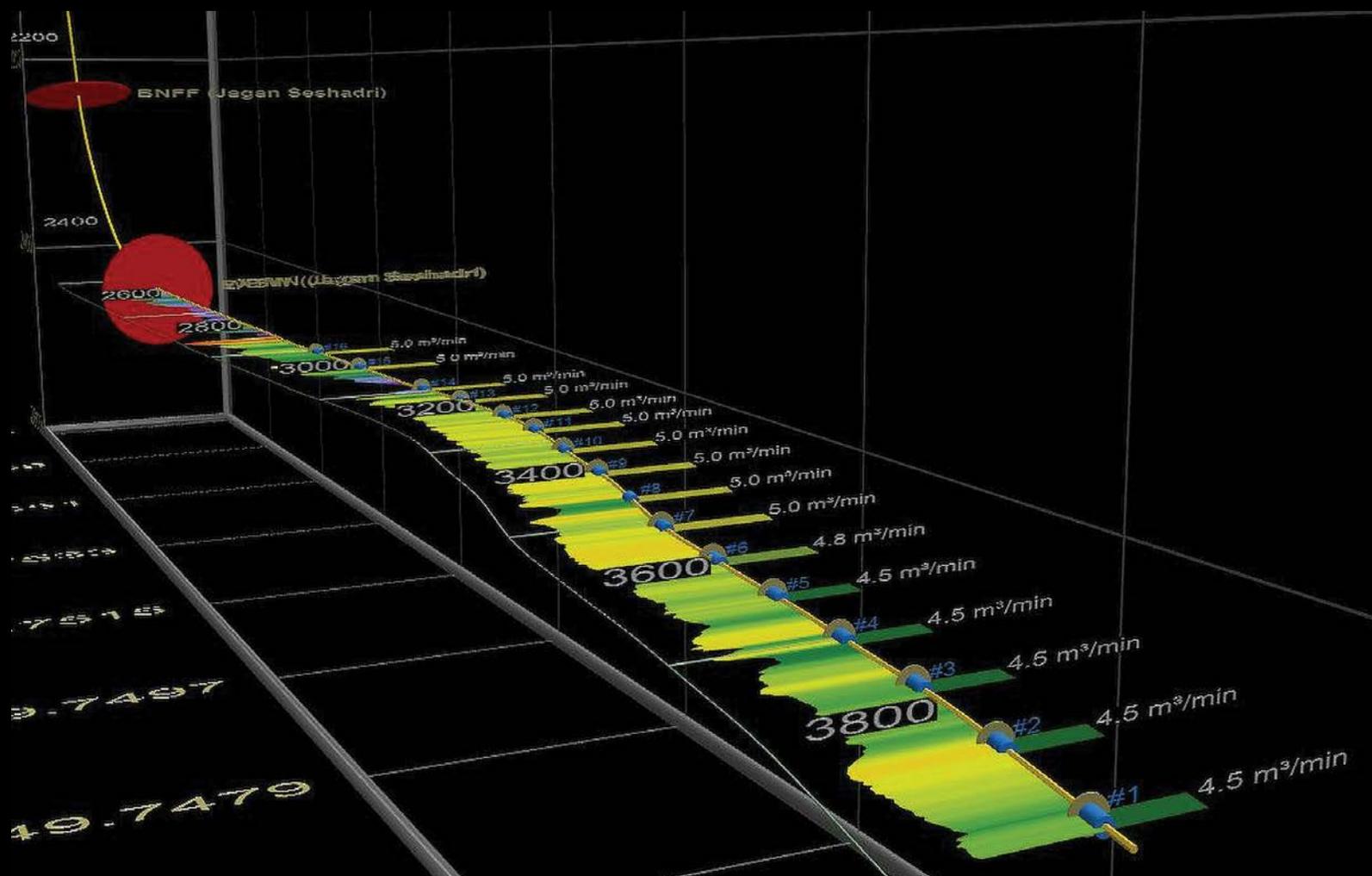


Workflow #5: Completion Optimization Support

Design and develop wells more accurately and efficiently

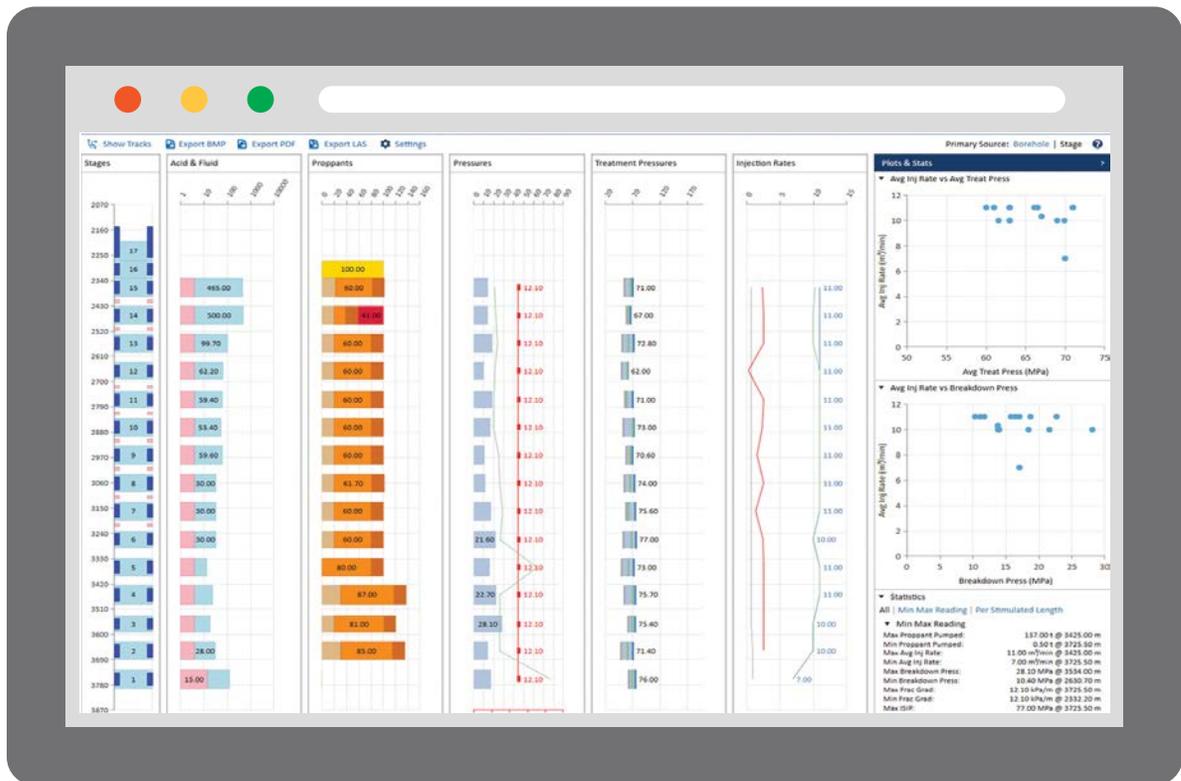
After you have successfully drilled the well, you must figure out how to best complete it and do it most cost effectively. The questions arise: How long should the well be? What's my frac stage and length? What's my perforation methodology? How much material should I pump in there? What is the type of material? How much acid do I use?

Kingdom gives you access data on completed wells in the area and lets you take advantage of the methodology used to develop those wells. By understanding the subsurface and attributes of other wells, you can interpret or predict how a new well will perform. Having this completion data available all in one place enhances the integration and collaboration between the geoscientists, engineers, geologist and other on the team.



With Kingdom, you can:

- Generate completion variables used by completion engineers to stimulation optimization
- Make maps and tables of up-dip vs down dip, lateral length, total pounds of sand, total number of stages, total fluid injected, total gel used, max pressures, max rates
- Provide variables by stage and distribute the values spatially according to spatial location of variable for mapping purposes
- Compute percent in zone, average vertical distance per stage from plan

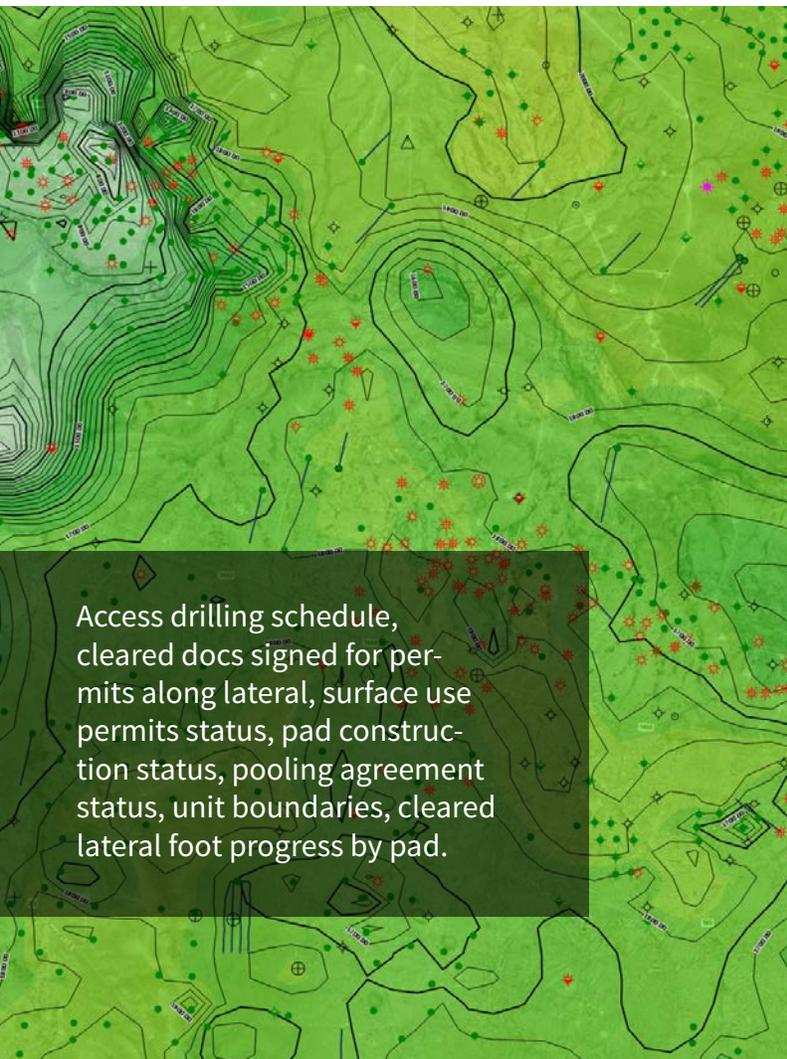


Workflow #6: Land Clearing Process

Plan wells efficiently for a better return on investment

When you have an inventory of 1,000 or 10,000 potential drillable locations, how do you prioritize which areas to drill first? Much of it depends on quickly understanding the potential costs and the value of the return on the investment. To do that, you need access to important data that will help in decision making such as lease data, permit status, unit boundaries, and drilling schedules.

Kingdom helps you understand where you have proposed wells and which ones have the best opportunities based on different properties, such as subsurface rights or fee lease data. You can quickly interpret vast amounts of data to plan wells efficiently for a better return on investment.



Workflow #7: Dynamic Depth Conversion

Depth conversion that is accessible to generalist interpreters

Traditionally, creating velocity models take a geophysicist's expertise and a deep knowledge of how to convert seismic data into depth for drilling. This process can take time, and in the field, time is money.

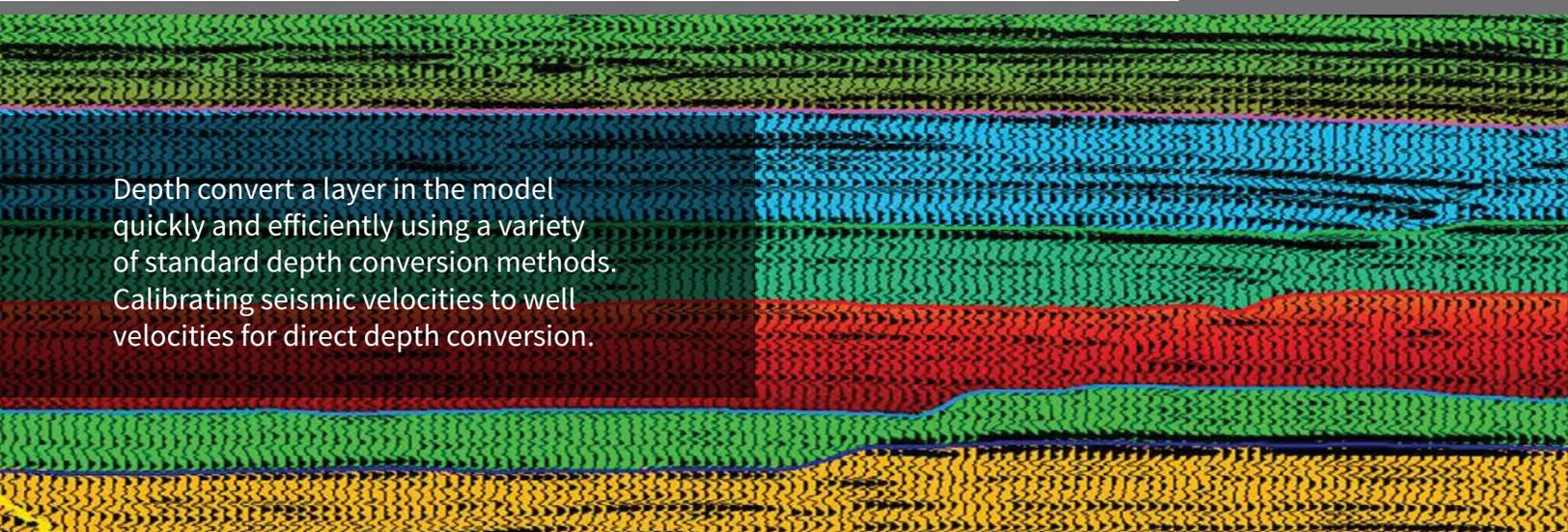
With Dynamic Depth Conversion, Kingdom makes creating velocity models accessible and easy for generalists who may not be familiar with seismic interpretation. Geologists and geosteers can feel confident and comfortable building velocity models, so they can quickly and efficiently interpret the different attributes that may be indicators of reservoir quality. Dynamic Depth Conversion supports more traditional velocity modeling to more accurately create images in areas of sparse well control, grid space interval velocities, and converts stacking velocities to interval velocities to quality control against existing wells.

With Kingdom, you can:

- Dynamically build velocity models by tying your well and seismic data
- Easily incorporate geophysical and geological interpretations into a single consistent subsurface model
- Define stratigraphic framework and geologic rules
- Leverage IHS Data and seismic data



Depth convert a layer in the model quickly and efficiently using a variety of standard depth conversion methods. Calibrating seismic velocities to well velocities for direct depth conversion.

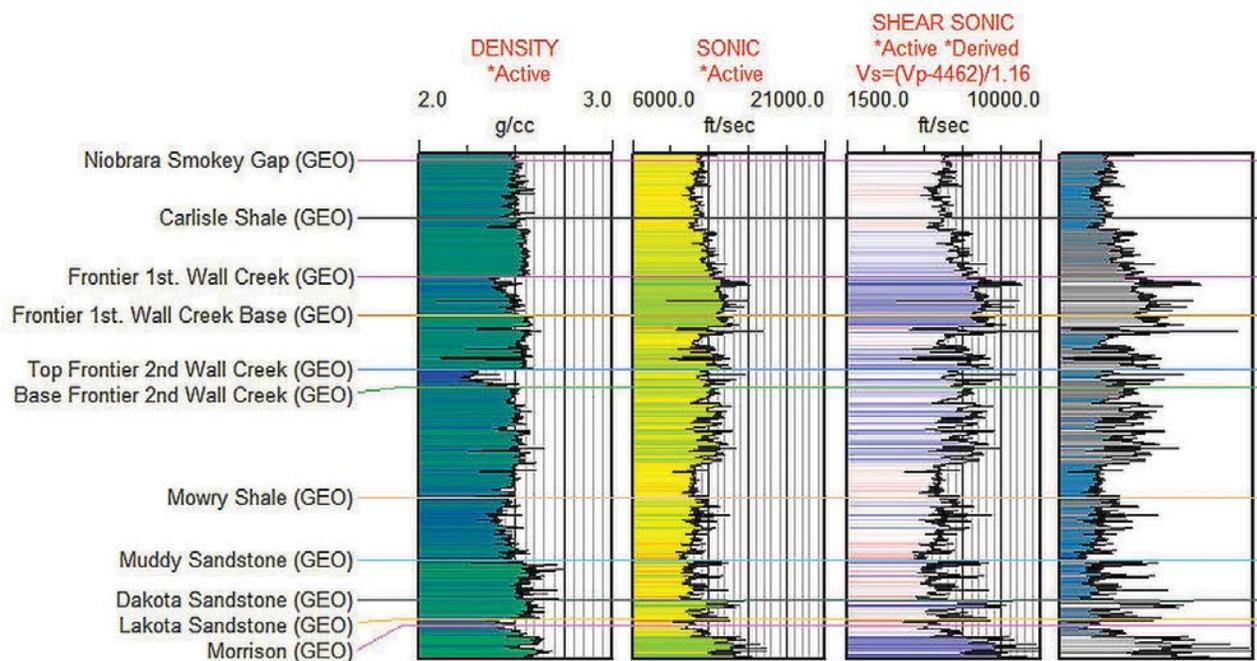


Workflow #8: Geophysical Prospecting Workflows

Reliable data and multiple attributes for accurate interpretations

To identify and locate viable reservoirs, you need to understand the properties and attributes that indicate hydrocarbons are present. Essential to accurate interpretation of reservoir is the quality of the data. Is it good enough to tell the reservoir from the non-reservoir? Another critical piece to geophysical prospecting is the number of attributes that are available for interpretation. Too few, and the results could be inaccurate and lead to costly mistakes.

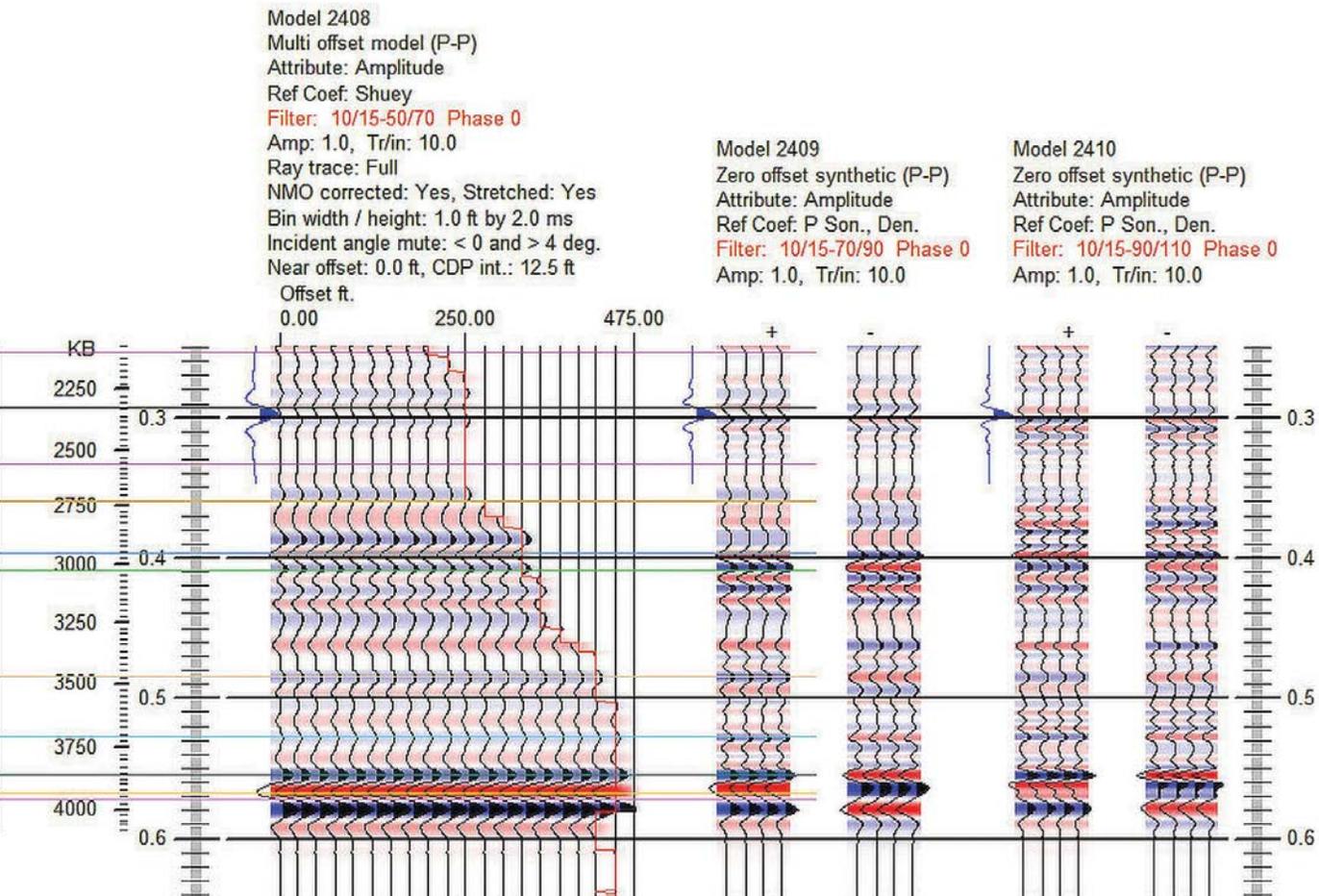
Understand the subsurface with advanced interpretations of seismic data



Kingdom includes a variety of attributes including the ability to interpret in time or depth on 2D/3D survey in-lines, cross-lines, Z-slices, arbitrary lines and 3D space. Kingdom also allows you to uncover the hidden information from seismic data by generating seismic attributes and makes data easier to interpret by processing it with de-spiking, re-sampling, scaling, filtering, algorithms.

With Kingdom, you can:

- Support a variety of reservoir types such as conventional, unconventional, carbonates and deep water
- Work with 2D or 3D data or the integration of both
- Delineate the structural complexities of the subsurface



Workflow #9:

Reservoir Characterization Workflows

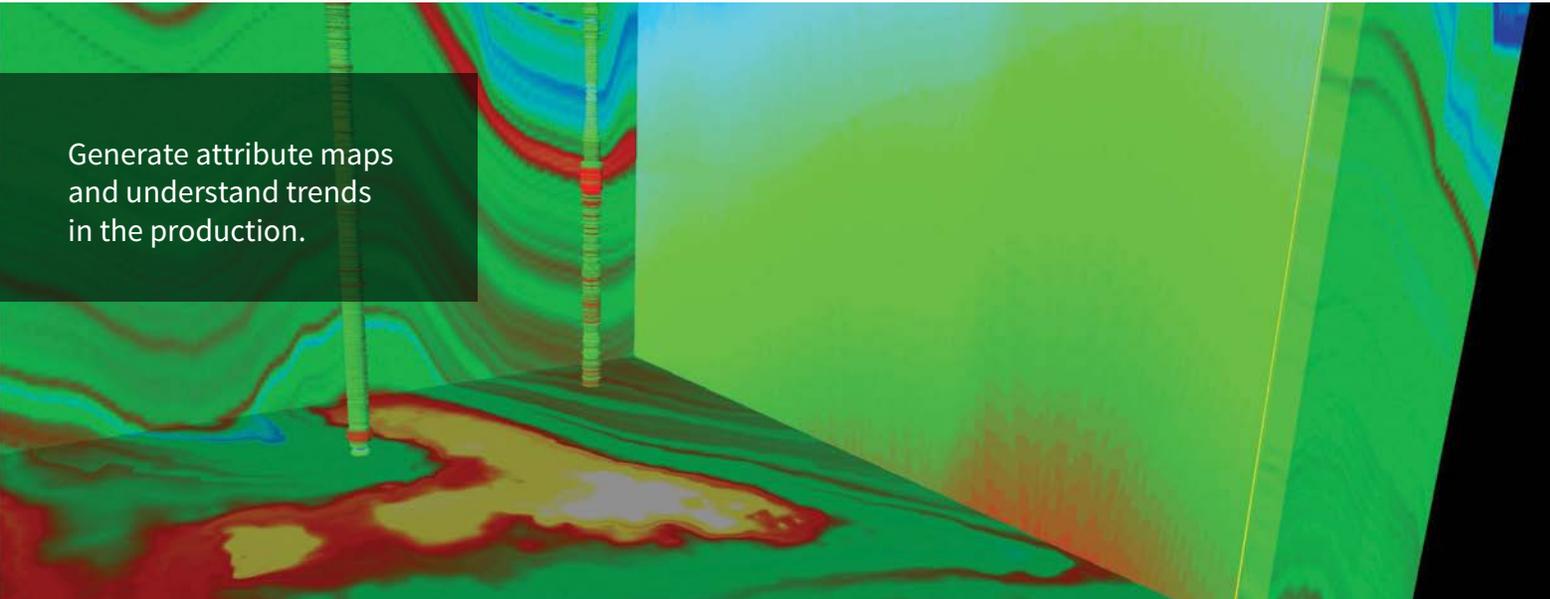
Generate maps you can trust

The better you understand your reservoir, the better positioned you are to optimize its performance. Is it sand? Is it shale? Is it carbonate? What is the capacity for holding volumes of hydrocarbon? It is essential to have accurate measurements and characterization of reservoir rocks and fluids.

The benefit of performing reservoir characterization in Kingdom is the integration of tools and data in one platform. Kingdom can handle whatever geologic challenge you face and helps you make decisions and interpretations quickly. Enhance collaboration with the entire asset team from geologists to engineers to petrophysicists. Kingdom also has a strong synthetics capability that allows you to generate synthetic seismograms that allow you to create scenarios of lithology, porosity, and fluid even when you haven't drilled in that type of geology.

With Kingdom, you can:

- Generate a porosity curve from the electric logs
- Generate a volume of shale curve, a V-shale curve and fluid area saturation curves
- Generation synthetic seismograms



Generate attribute maps and understand trends in the production.



Summary

When it comes to GG&E workflows, Kingdom is the industry leader for geoscience interpretation, incorporating best of breed science that spans geological, geophysical and engineering capabilities. Kingdom integration allows your entire asset team to work in one application, while enabling team members to use day-to-day business process tools.

To learn more or request a demo, contact us at www.ihs.com/kingdom



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