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Brochure

Improve reservoir modeling accuracy

Aspen SKUA™ Fault Seal Analysis

Gain a Better Understanding of the Impact of Subsurface Faults on Reservoir Flow Characteristics

Faults can simultaneously serve as pathways for subsurface fluids to move into reservoirs and sealing structures to trap them in place. Their exact role depends on various parameters, such as the fault geometry, nature of the surrounding rocks, and geomechanical state of the field. The **Aspen SKUA Fault Seal Analysis Workflow** provides you with powerful tools to rigorously evaluate the sealing capacity of your faults and fractures.

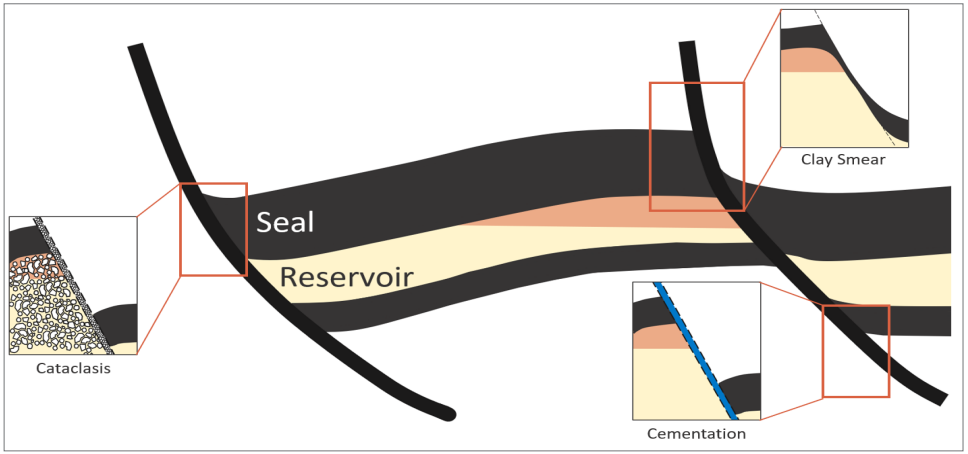
Use Aspen SKUA Fault Seal Analysis to:

- Identify potential hydrocarbon traps
- Identify potential pathways for fluid flow
- Improve reservoir modeling accuracy

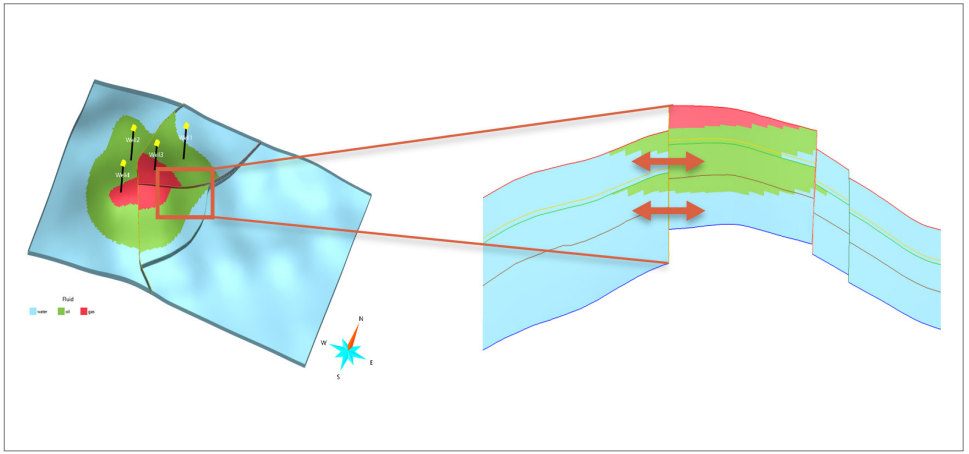
How is Fault Seal Analysis Performed?

Fault seal analysis involves a multidomain combination of geological and engineering techniques:

1. **Data acquisition:** Integrate all available types of geological data, such as well logs, seismic data and core samples.
2. **Structural modeling:** Use the Aspen SKUA Structure and Stratigraphy Workflow to model fault surface geometries and their respective throw for each geological horizon.
3. **Rock property modeling:** Use the Aspen SKUA Reservoir Properties Workflow to model the distribution of rock properties around the faults that will determine their sealing capacity. This typically includes facies, porosity, permeability and capillary pressure.
4. **Fault characterization:** Compute fault properties and assess the likelihood of fluid flow across the fault. Parameters such as Allen diagrams, Shale Gouge Ratio, Fault Permeability and Fault Transmissibility can be inferred from the 3D model projected onto the faults.
5. **QC of results against measurements:** Verify result plausibility against fluid flow simulation, well tests and geomechanical models.



Geological processes involved in fault gouge seals

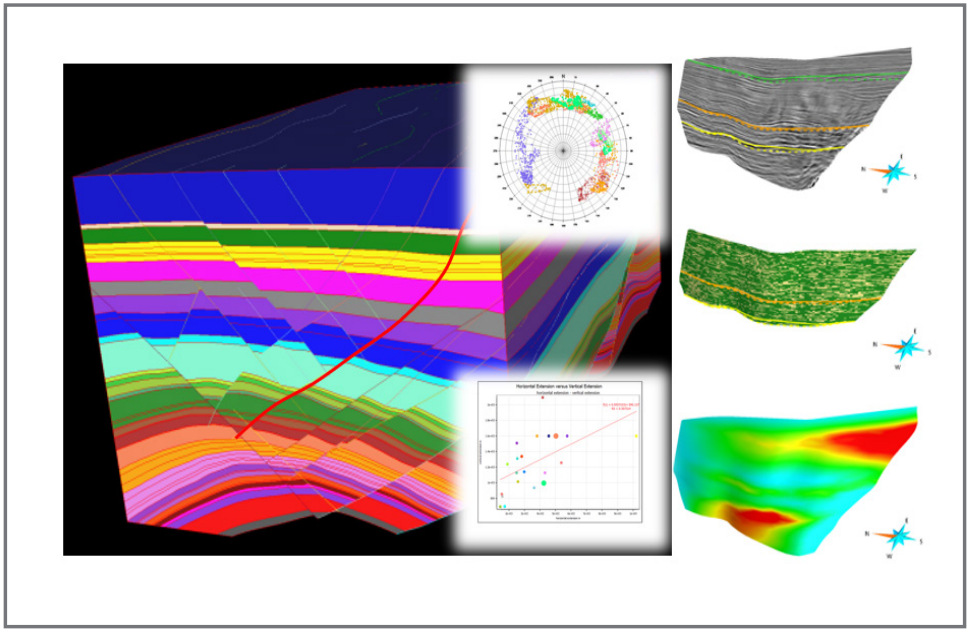


Fluid movement across a geological fault in a reservoir model

Superior Structural Modeling Capabilities for Even the Most Complex Geologies

The powerful and unique volume-based approach in Aspen SKUA enables accurate and efficient structural modeling of complex geological structures. In particular, realistic models of faults can be created with ease, no matter how complex their geometry is or how intricately they are linked to each other. Their integration into a 3D geocellular model is handled seamlessly due to SKUA's proprietary UVT Transform™ algorithm. This makes every fault available for fault seal analysis – even the most difficult types such as Listric faults and Y-shaped or λ-shaped cross faults.

Useful fault analysis tools such as throw cross-plots, 3D seismic attribute draping and Stereonets enable geologists to access information relevant to fault seal analysis. Different methods are available for geomechanical engineers to compute fault stress/strain and assess whether faults are critically stressed or not. Workflows can range from a relatively simple assessment through rock strength vs. 3D deformation, to more sophisticated workflows such as 3D kinematic restoration or external geomechanical simulation.

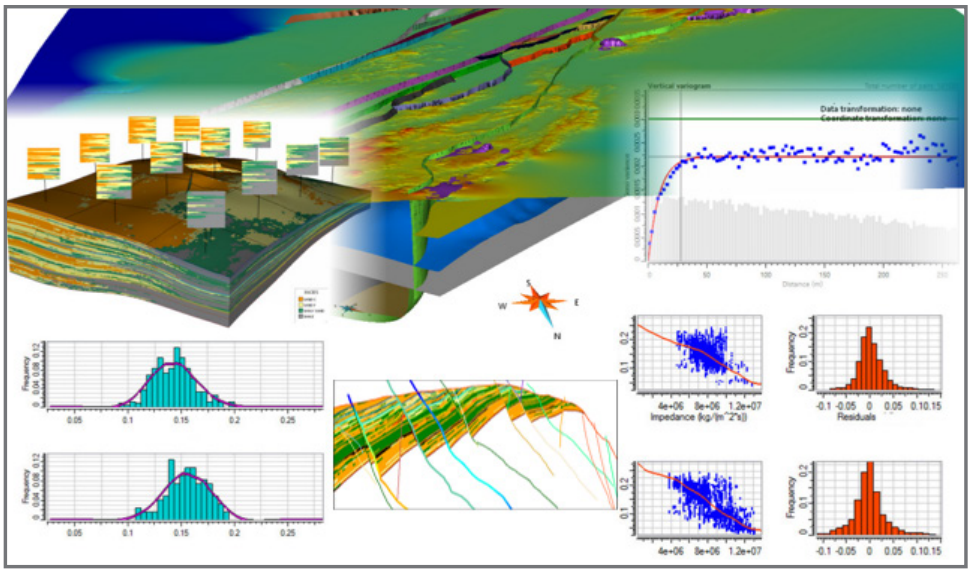


Advanced structural modeling workflow for superior fault characterization

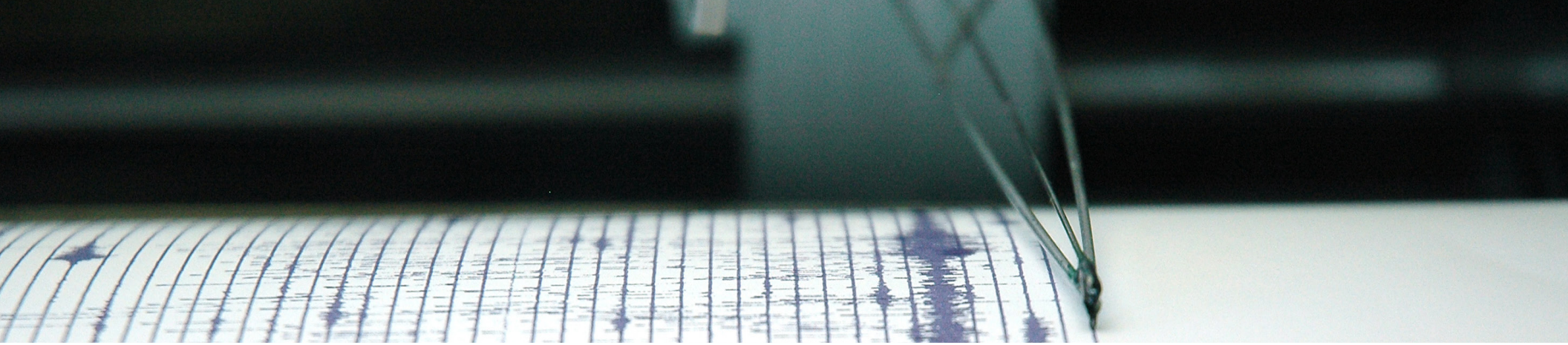
A Robust Property Modeling Suite Enhances Confidence in Modeled Fault Properties

Building a detailed property model of the rock formations surrounding a fault allows a better analysis of which materials have been put in contact with each other, and how this can affect potential fluid flow.

Aspen SKUA offers tools to organize, validate, analyze, interpret and model reservoir data. With the SKUA Data and Trend Analysis module, users can establish reliable inputs for constructing robust reservoir property models. This module is designed to produce relevant statistical data analysis and create realistic trends to be used as soft data by subsequent geostatistical algorithms. With the Aspen SKUA Reservoir Properties workflow, users can spatially interpolate or stochastically simulate geological facies and petrophysical properties such as VShale and permeability (or any continuous variables relevant to fault seal analysis). Thanks to its wide palette of different geostatistical methods, the workflow offers the flexibility needed to build the most rigorous property model possible, resulting in a higher degree of confidence in the modeled fault properties.

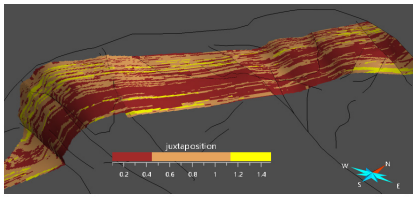


A rich toolbox for reservoir data analysis and property modeling

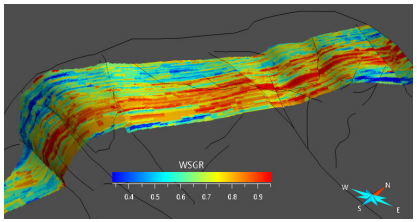


Dedicated Fault Seal Analysis Tools Help Evaluate Fluid Migration Across Faults

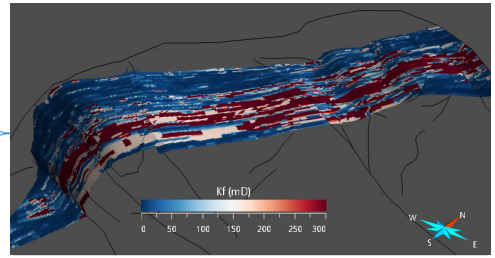
Once a structural framework and a 3D property model have been constructed in Aspen SKUA, faults can be parametrized to output attributes relevant to fault seal analysis workflows. Displacement maps can be important clues for evaluating the sealing potential of a fault, as faults with high throws tend to be sealing. Juxtaposition maps (also known as Allen diagrams) can be computed to show where conductive facies may connect fluid flow. In clastic environments, the displacement and the mineralogy properties can be used together to compute a Shale Gouge Ratio (SGR) attribute, taking into account the possibility that the clay facies has created a gouge seal in the fault interstice. A weighted SGR attribute can be created by weighting the SGR attribute by the clay smearing distance. Finally, Fault Permeability and Transmissibility Multipliers can be created using published predictors or by a user-defined formula. These attributes can be exported to flow simulators in order to rigorously evaluate the extent of fluid migration across faults.



Juxtaposition Map



Shale Gouge Ratio



Fault Permeability

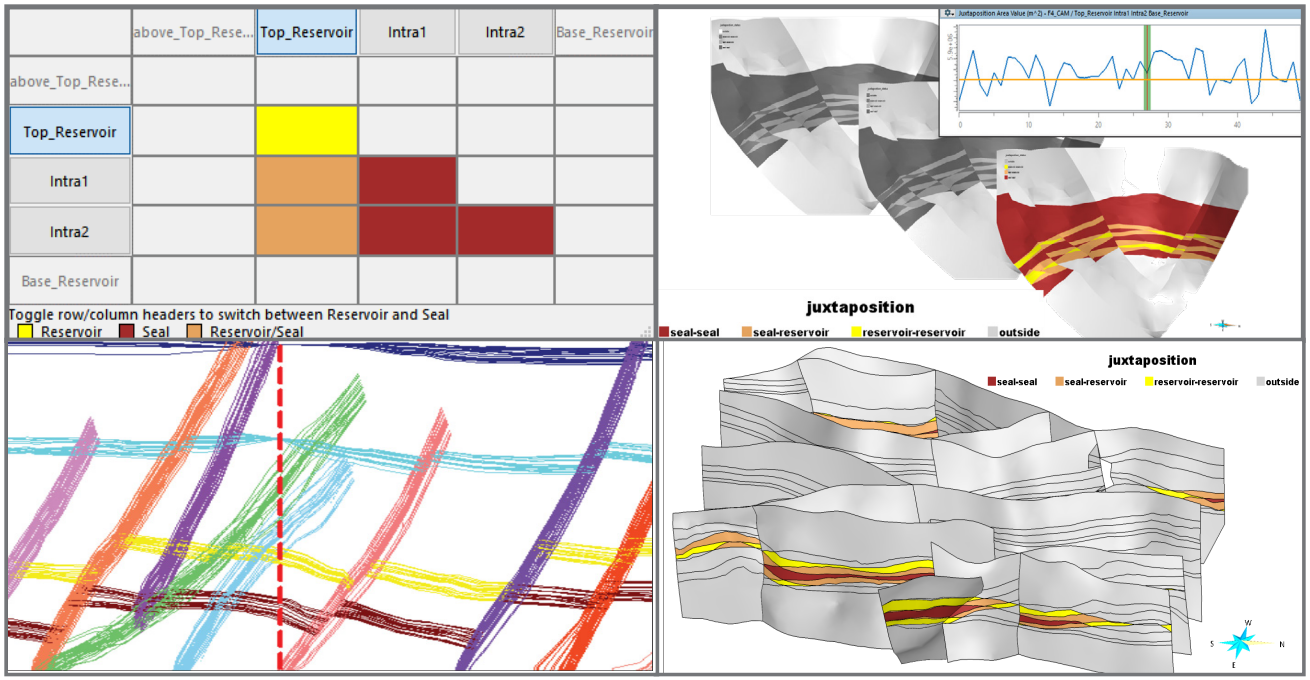
$$Kf = 10^{((-4)SGR-\frac{1}{4}log(ft\times(1-SGR))^5)}$$ From Manzoc

Accurate computation of fault attributes

Integrated Uncertainty Assessment Quantifies the Impact of the Model Uncertainty on Sealing Capacity

Uncertainty and sensitivity analysis tools in Aspen SKUA are a great, user-friendly resource to evaluate fault sealing capacity in a probabilistic manner. The Structural Uncertainty workflow enables users to assess the impact of fault, horizon, velocity and fluid contact uncertainties on reservoir volumes and production. Reservoir/non-reservoir matrix units can be interactively defined to compute fault seal analysis statistics and attributes under uncertainties. For each realization, displacement maps and juxtaposition maps can be computed and displayed.

The Structure Uncertainty module can be integrated within the Reservoir Uncertainty (Aspen Jacta™) module to enable a rigorous property model uncertainty assessment around faults. Geocellular grids can be exported to flow and/or to geomechanical simulators as a final step to capture the variability in the fault sealing capacity resulting from the model uncertainty.



Effect of structural and property uncertainty on faults

The Aspen SKUA Advantage for Conducting Fault Seal Analysis

- Create more realistic subsurface geology representations
- Model any type of simple-to-complex fault system
- Honor all available data and retain full subsurface complexity, without compromise
- Allow both experts and beginners to produce fast, simple, accurate reservoir models
- Reduce risk by seamlessly incorporating uncertainty into data and interpretations
- Use better models to identify potential hydrocarbon traps or potential pathways for fluid flow

Interoperability

All Epos-based applications enable interoperability with third-party data stores, including:

- RESQML 2.0.1
- OpenWorks® R5000.10
- Petrel* 2021, 2020, 2019
- Recall™ 5.4.2

(a mark of Schlumberger)*

System Specifications

- Microsoft® Windows® 10, 11
- 64-bit Red Hat® Enterprise Linux® 7.6+, 8.4+

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About AspenTech

Aspen Technology, Inc. (NASDAQ: AZPN) is a global software leader helping industries at the forefront of the world's dual challenge meet the increasing demand for resources from a rapidly growing population in a profitable and sustainable manner. AspenTech solutions address complex environments where it is critical to optimize the asset design, operation and maintenance lifecycle. Through our unique combination of deep domain expertise and innovation, customers in capital-intensive industries can run their assets safer, greener, longer and faster to improve their operational excellence.

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