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Brochure

Integrated Earth Modeling

Aspen SKUA™

Towards High Definition Earth Modeling

Higher-definition reservoir modeling improves the accuracy of production forecasts and lowers risk in reservoir management decisions.

How?

- 1. Geologically consistent seismic interpretation:** Use Aspen SKUA™ Volumetric Interpretation for a full 3D interpretation of all faults and stratigraphic horizons in the entire seismic volume.
- 2. Enhanced geologic accuracy:** Extract stratigraphic features from seismic data that were undetectable until now, using 3D paleo-flattening, and honor all data for a more geologically realistic earth model.
- 3. Improved forecasting through comprehensive uncertainty assessment:** Use Aspen SKUA to quantify the impact of fault position and structural uncertainty on in-place hydrocarbon estimates and production forecasts.

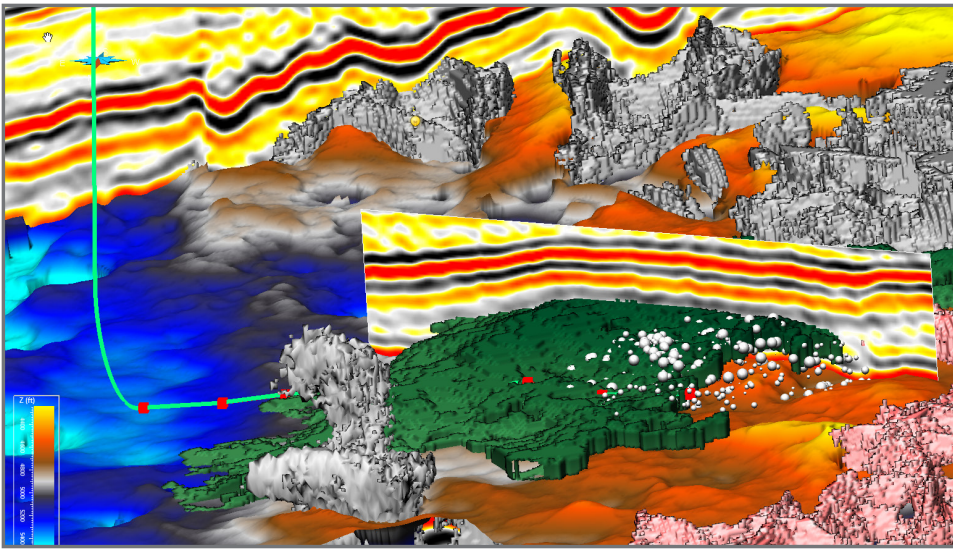
For more than 20 years, Aspen SKUA has led the industry in providing advanced capabilities for geological and reservoir modeling. Its comprehensive, step-by-step workflows enable users from multiple disciplines and industries to build realistic subsurface models that honor geological complexities while avoiding unwarranted simplification.

Aspen SKUA is a huge leap forward in geologic modeling and characterization. Geoscientists use it to integrate, visualize and manage all subsurface data, extract insights and build accurate models of the subsurface. Complex structures such as intrusions, salt domes and overthrust faults can all be incorporated seamlessly into the model. With a simple-to-use, workflow-based interface, users can obtain results quickly. And when the modeling gets tough, Aspen SKUA handles complexities that other solutions cannot.

A Shared Earth Model to Meet Your Team's Common Goals

From seismic to flow simulation, the Aspen SKUA common earth model provides consistent, discipline-specific views of the subsurface. Well, geophysical, geological and engineering data and concepts are all integrated with the earth model.





Integrated display of data in the Barnett shale (seismic, horizons, geobodies, karsts, wells and microseismic).

Software that Adapts to Fit the Geology

Aspen SKUA uses a proprietary implicit volume-based 3D modeling approach that removes all limitations and deformations caused by conventional methods. This unique technology uses all available data and honors geologic rules to build more accurate, simple-to-complex subsurface models in days or weeks instead of months or years. Any fault structure. Any stratigraphic system. Nothing is too complicated!

A Better Geological Foundation Means a Better Production Result

From well correlation to structural framework construction, 2D and 3D restoration and fault seal analysis, the Aspen SKUA product suite offers geologic interpretation and validation combined with unparalleled structural and stratigraphic modeling. Given the correct structural and depositional context, Aspen SKUA can help create property models that match geological concepts and honor all available data. Uncertainties are accounted for every step of the way.

Accurate Interpretation as a Crucial First Step

The unique Aspen SKUA modeling platform is based on the proprietary UVT Transform™ algorithm, which automatically creates sealed structural and stratigraphic models during the interpretation process and enables the consistent use of all interpretation data throughout the geoscience and engineering workflows. UVT Transform is a mathematically derived 3D methodology that generates a volume description of the subsurface, including the structure, stratigraphy, geological grid, flow simulation grid and geomechanical grid. It uses ALL of the data, without simplification.

UVT Transform removes the constraints of traditional (pillar-based) technology. Without pillars, Aspen SKUA users are able to create more accurate models of the subsurface. The algorithm delivers a consistent representation without “dumbing down” the data, which means your team will no longer need to simplify their interpretations. In addition, UVT Transform brings a wealth of new opportunities to all of your E&P workflows.

A Broad Solution Suite

The Aspen SKUA product suite consists of numerous modules that can be used either as standalone applications or connected to the Aspen Epos™ database. Start with the core module, then add discipline- and process-specific modules to create a customized solution that meets your specific needs.



Aspen SKUA for Geophysics

Velocity Modeling

The range of powerful yet easy-to-use velocity modeling methods offered by Aspen SKUA enables accurate, efficient and productive time-to-depth conversion. Unlike other solutions where structural complexity is quickly a limiting factor and where the approach incorporates simple layering, Aspen SKUA structural and stratigraphic modeling enables accurate time-to-depth conversion in salt and structurally complex environments, using 3D operations that honor the stratigraphy and faults.

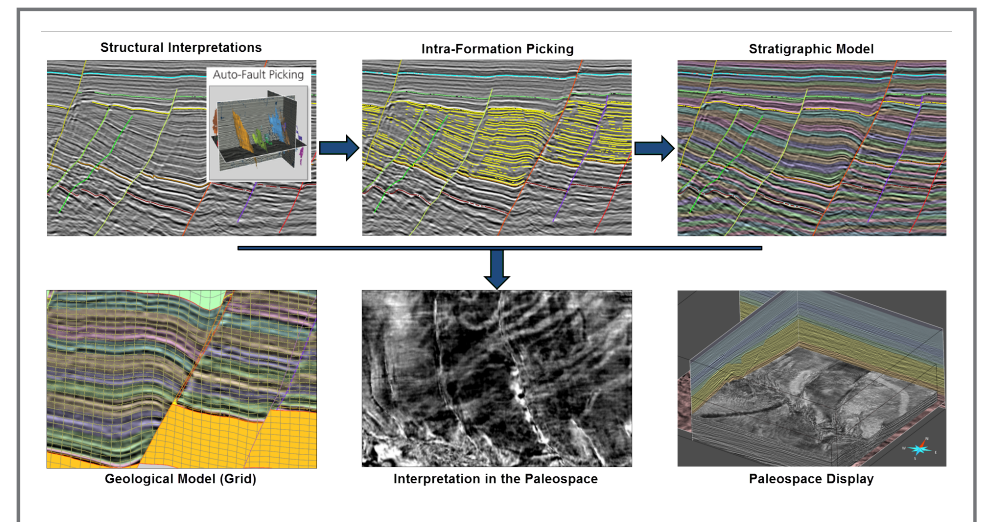
The Aspen SKUA velocity modeling technology allows users to:

- Construct salt bags or salt sheets from picks, and insert salt inside a sediment velocity background
- Construct layer-based velocity models interpolating interval velocities in Aspen SKUA paleo-space
- Apply structural smoothing of velocity volumes honoring fault displacement and subsurface stratigraphy
- Integrate complex structures such as salt, reverse faults and overthrust
- Manipulate and rework any velocity model to make time-to-depth conversion fit the horizons of the matching well markers
- Through tight integration with Aspen GeoDepth™, use velocity volumes, geological formation volumes, and dip/azimuth volumes created in Aspen SKUA for illumination, grid tomography and migrations, and RTM modeling workflows



Volumetric Interpretation

An enhanced interpretation modeling workflow includes tools for performing volumetric (global) interpretation. Faults can be semi-automatically interpreted by using a fault autopicker on fault attributes (e.g. fault likelihood attribute). The resulting Aspen SKUA model can be used to accurately flatten the seismic volume and enable advanced stratigraphic interpretation in paleo-space. 3D grids with seismically constrained layering are then produced, for accurate velocity and property modeling.



Volumetric interpretation workflow.



Aspen SKUA for Geology

Structure and Stratigraphy

The ability to rapidly create a fully sealed structural model, whatever the geologic complexity, is the most important piece of any seismic-to-simulation workflow. The unique technology in Aspen SKUA provides structure and stratigraphy capabilities in a user-friendly, highly advanced computing environment. Aspen SKUA structure and stratigraphy provide automatic construction of the structural framework, and a fully sealed structural model, yielding the most accurate models. There is no limitation to the complexity of the models, ensuring that none of the data is left out.

Structural Analysis

Given a structural framework constructed in Aspen SKUA, geologists can look at fracture probability, as well as stress and strain information. The stress/strain information can be computed from the Aspen SKUA UVT Transform or from 3D kinematic restoration. In addition, a geomechanical mesh can be constructed from an Aspen SKUA model, initialized with properties directly in Aspen SKUA, exported to the Abaqus™ geomechanical simulator from Dassault Systèmes, for deformation analysis, and re-imported in Aspen SKUA to transpose properties to other objects like reservoir simulation grids.

Fault Seal

Given a structural framework constructed in Aspen SKUA, fault displacement maps, fault juxtaposition maps and fault SGR properties can be computed. A weighted SGR attribute takes into account the smearing potential of a facies.

Well Correlation

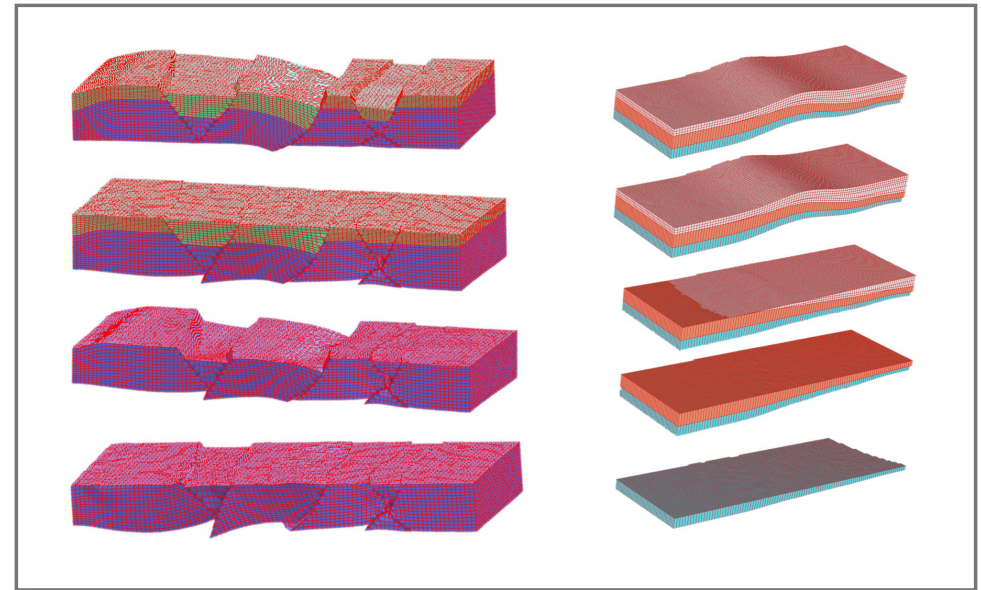
Well correlation tools allow the geologist to create well sections showing many different types of tracks, digitize markers in different domains (TVT, TST, flatten) and correlate markers with ghosting. Elevation and thickness maps are updated automatically, and everything communicates with the 3D viewer. Correlations can also be done inside geological cross-sections, with additional tools to digitize and paint conceptual geological models.

Facies Interpretation

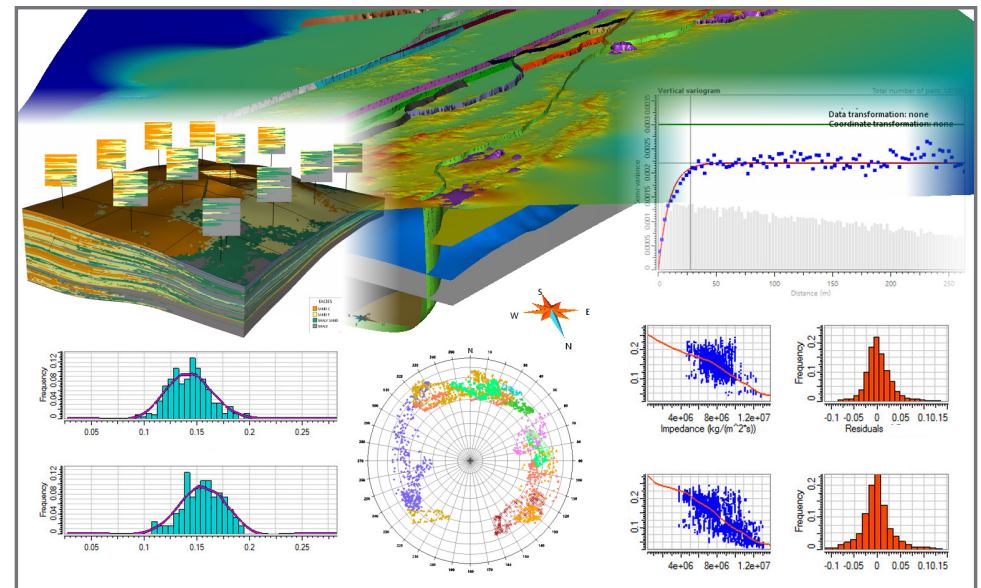
Given a stratigraphic framework constructed in Aspen SKUA, geologists can perform paleo-facies interpretation on any chrono-stratigraphic time slice from well facies. Vertical facies trends and stratigraphic trend maps can be interpreted and manipulated to create a full 3D facies volume for later use by the reservoir engineer.

2D/3D Restoration

The Aspen Kine3D™ structural analysis tool restores 3D basin and reservoir models in complex areas where seismic data is scarce or of poor quality. As part of the Aspen SKUA toolset, Kine3D dramatically simplifies and accelerates the 3D restoration process by applying geologic, lithologic and geomechanical parameters to restore models to their undeformed state in both 2D and 3D. The process validates structural interpretations and geometries with embedded geologic constraints.



Sequential restorations of a grid defined inside a SKUA model.



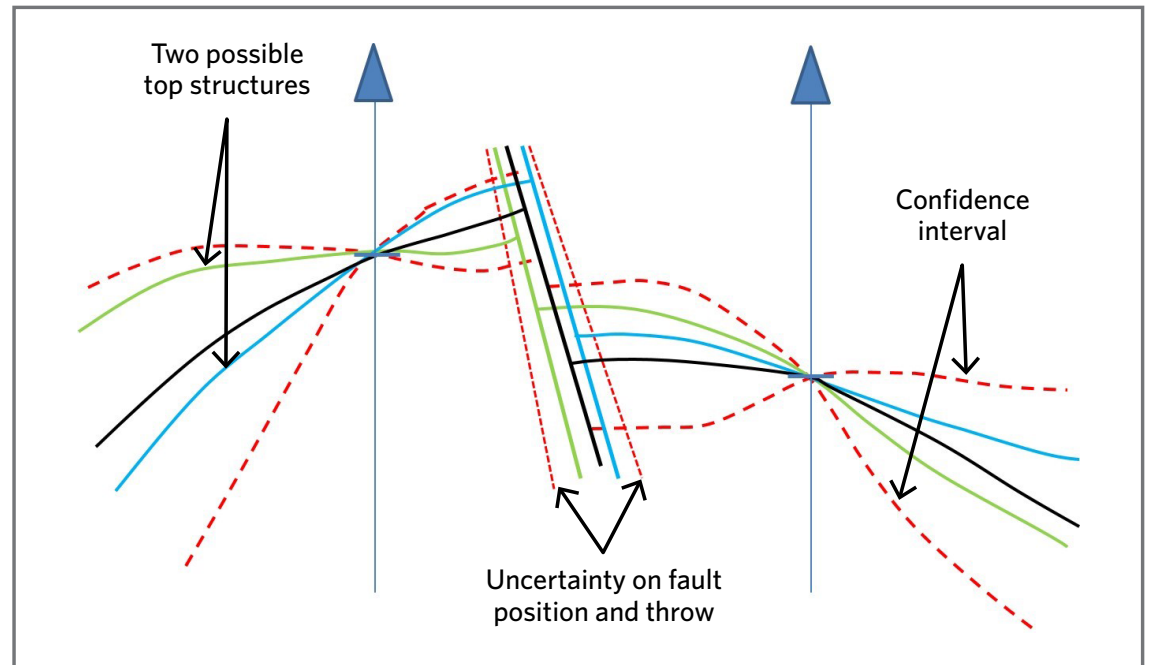
A rich toolbox for accurate and systematic structural and reservoir data analysis.



Basin Modeling

Basin Modeling allows users to construct structural models, from the overburden to the basement. Aspen SKUA enables the construction of 4D basin models for transfer to basin model simulation software by:

- Simplifying the creation of a consistent structural model
- Empowering the construction of special grids for basin modeling
- Sequential 3D restoration of the 3D volume
- Sequential restoration of the basin grids from the present date to the depositional time



Principles of structural uncertainties.



Aspen SKUA for Reservoir Modeling

Data and Trend Analysis

This module offers tools to organize, validate, analyze, interpret and model reservoir data. It is designed to guide users through all steps required to establish reliable input statistics for constructing robust reservoir property models. It focuses on de-clustering, histogram identification, and trend modeling for both facies and continuous petrophysical properties, with or without seismic data.

Reservoir Properties

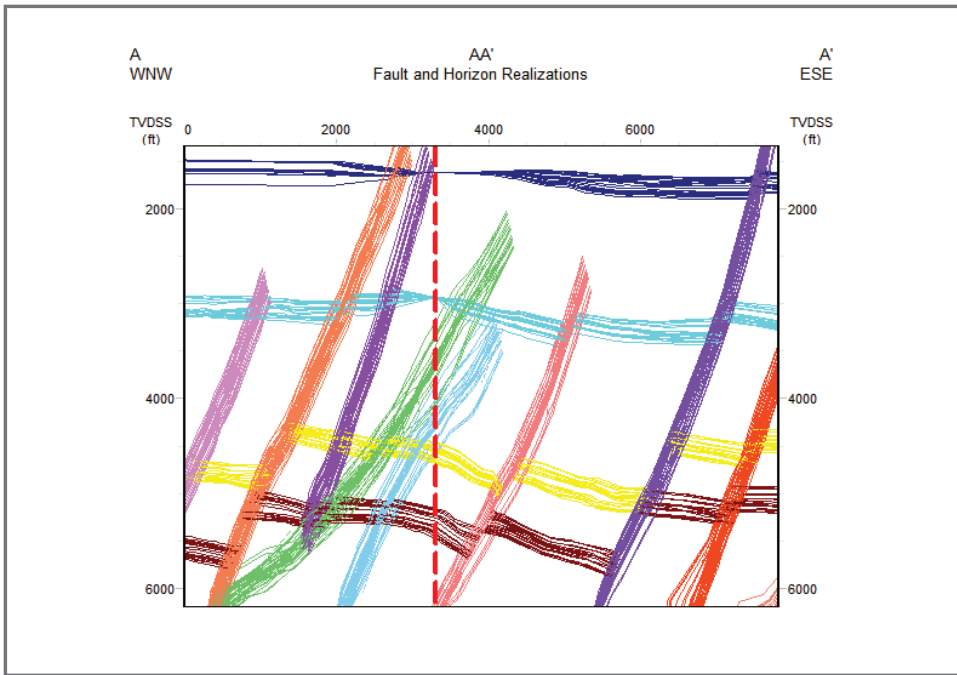
The Reservoir Properties application contains a flexible and dynamic workflow for populating reservoir grids. It offers an extensive suite of geostatistical algorithms for spatially interpolating (mapping), and stochastically simulating geological facies (or any discrete variables) and petrophysical properties, such as porosity and permeability (or any continuous variables). A post-processing workflow provides tools for summarizing and analyzing simulation results, together with decision-making support tools such as volumetric map computation and connectivity analysis.

Facies Modeling

Facies Modeling offers tools and algorithms to develop geologically realistic 3D models of depositional facies and post-depositional features. Integrated with Reservoir Properties and used in combination with Data and Trend Analysis, Facies Modeling includes a flexible object-based stochastic simulation algorithm (Boox), an efficient plurigaussian simulation (PGS) and robust multiplepoint simulation (MPS) algorithms that allow facies and petrophysical properties to be modeled jointly.

Saturation Modeling

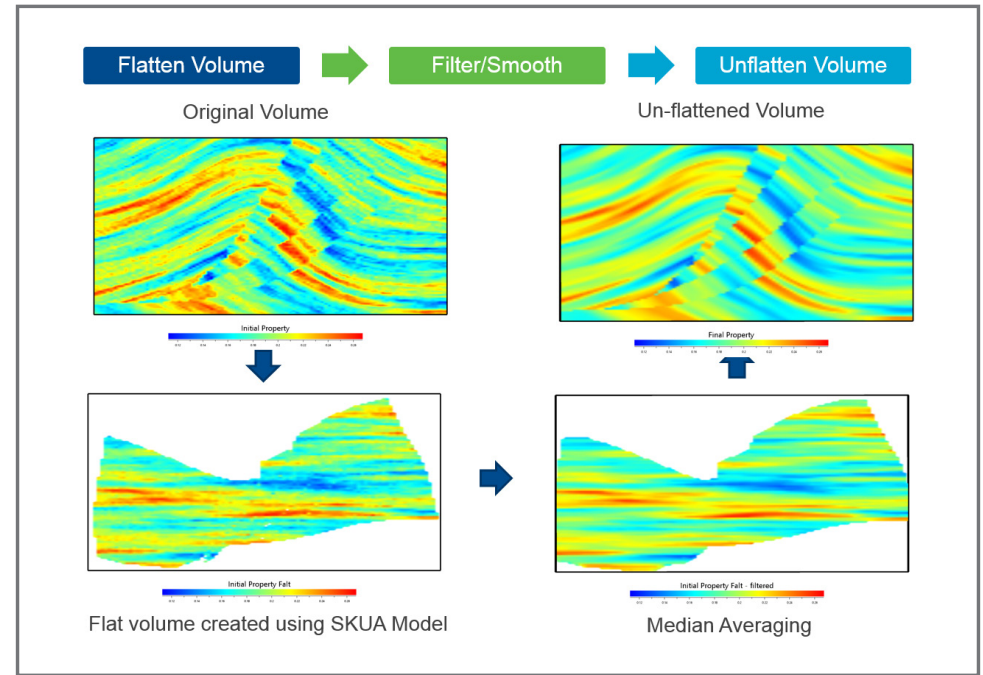
The Aspen SKUA fluid saturation workflow provides a guided process for building 3D models of initial water saturation, taking into account reservoir heterogeneities and compartmentalization. Many advanced methods are provided to define transition zones. Multiple methods can be combined for a single model by defining a different method for each compartment and/or lithology. The same functions applied to the reservoir model can be applied to wells, to create saturation curves at well resolution that can be compared to the available saturation logs or core data.



Apply fault and horizon uncertainties while maintaining a consistent model.

Reservoir Uncertainty

The Reservoir Uncertainty system (Jacta®, developed in collaboration with Total) is the industry's leading tool for quantifying uncertainty in the position and volume of hydrocarbon plays. Designed to integrate all sources of uncertainty, the system guides users through the construction of 3D reservoir models. The results are multiple valid alternatives that can be ranked and exported to commercial flow simulators, summarized for optimal appraisal or infill target identifications, or used to reliably inform traditional Monte Carlo-based economic assessment applications.



Structural smoothing using Aspen SKUA paleospace.

Structural Uncertainty

The structural uncertainty workflow in this module enables users to assess the impact of fault, horizon, velocity and fluid contact uncertainties on reservoir volumes and production. Uncertainty can be defined for fault and horizon positions, interval velocities and fluid contacts to assess the hydrocarbon rock volume uncertainty range. This module also connects to the Reservoir Uncertainty (Jacta) module to enable full reservoir volume uncertainty assessment on geologic grids.

Fracture Modeling

Fracture Modeling (FracMV, developed by Midland Valley) uses fracture density and orientation information to generate geologically constrained discrete fracture networks (DFN) and compute effective fracture flow properties.

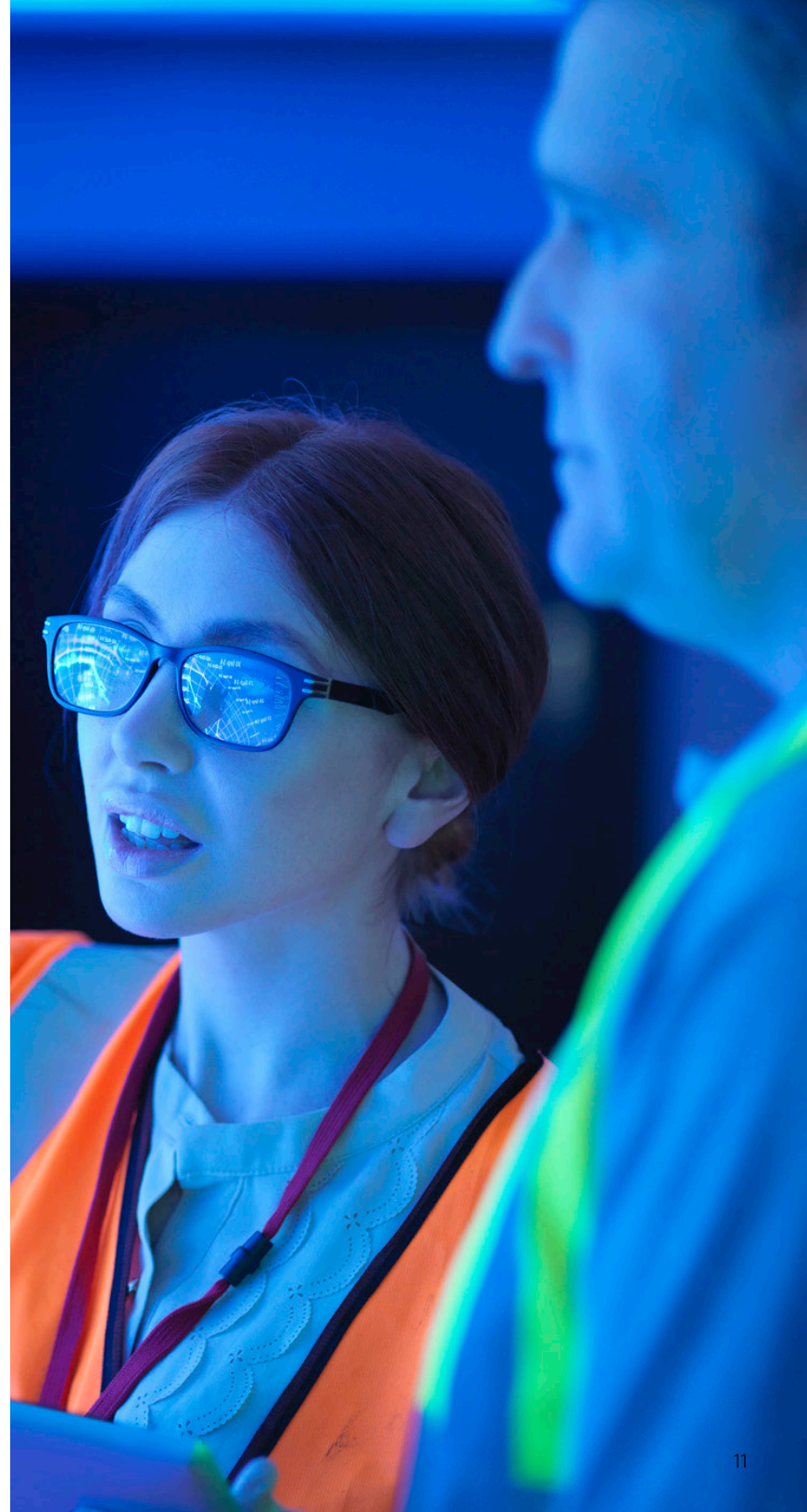
FracMV is part of a complete set of tools for characterizing, modeling and dynamically simulating fractured reservoirs. It facilitates the rapid investigation of the impact of natural fractures on production and field development decisions. Fracture density constraints result from structural analysis using Aspen SKUA Structural Analysis and Aspen Kine3D, from seismic analysis using Aspen EarthStudy 360™, and well analysis from Aspen Geolog™. All of these can be calibrated and combined using SKUA Data and Trend Analysis and SKUA Reservoir Properties.

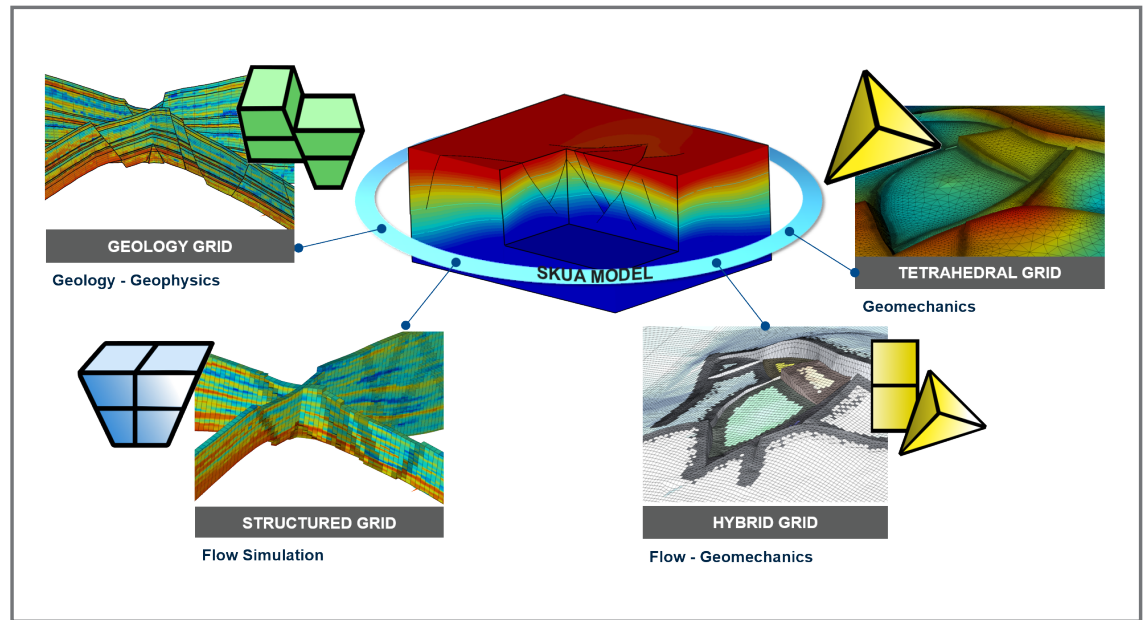
Aspen SKUA for Reservoir Engineering

Simulation Grids

The Simulation Grid workflow enables geoscientists and engineers to construct robust, fit-for-purpose, 3D reservoir grids that are optimal for numerical simulations. These grids are true to the interpreted geology in terms of both structure and stratigraphy. No simplification is required. The fault blocks observed on seismic volumes are accurately captured.

For flow simulation, the Aspen SKUA stair-step grid has orthogonal cells with minimal deformation to improve numerical accuracy. For geomechanical simulation, the Aspen SKUA hybrid grid has a mix of structured hexahedral cells for computational efficiency and unstructured tetrahedral cells along faults to capture geometrical and geomechanical detail needed for finite element calculations.





Fit-for-purpose 3D reservoir grids created from SKUA structural model.

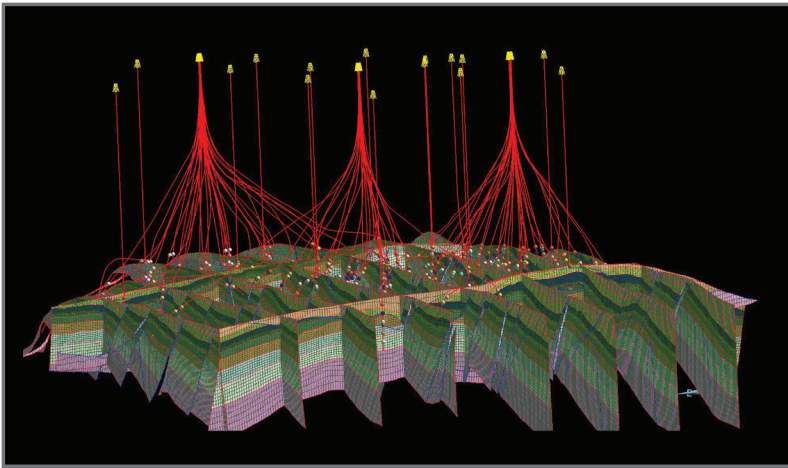
LGR and Upscaling

The LGR and Upscaling workflow provides a systematic yet flexible approach to grid coarsening, grid refining (including local grid refinement/LGR) and property upscaling. Blocks of cells to be refined or coarsened are automatically identified using key features of the model, such as faults, wells and fluid contacts.

A wide range of upscaling methods is offered to upscale discrete (e.g. facies), static (e.g. porosity) and dynamic (permeability) properties from the geological model to the simulation model.

Aspen SKUA and Flow Simulation

The Production Data Analysis and Reservoir Simulation Link modules provide direct connections to reservoir simulators from Aspen SKUA. The application enables the creation of input parameter files for commercially available reservoir flow simulators, the launch of simulation runs, and the loading, visualization, analysis and manipulation of flow simulation results as well as historical production data.

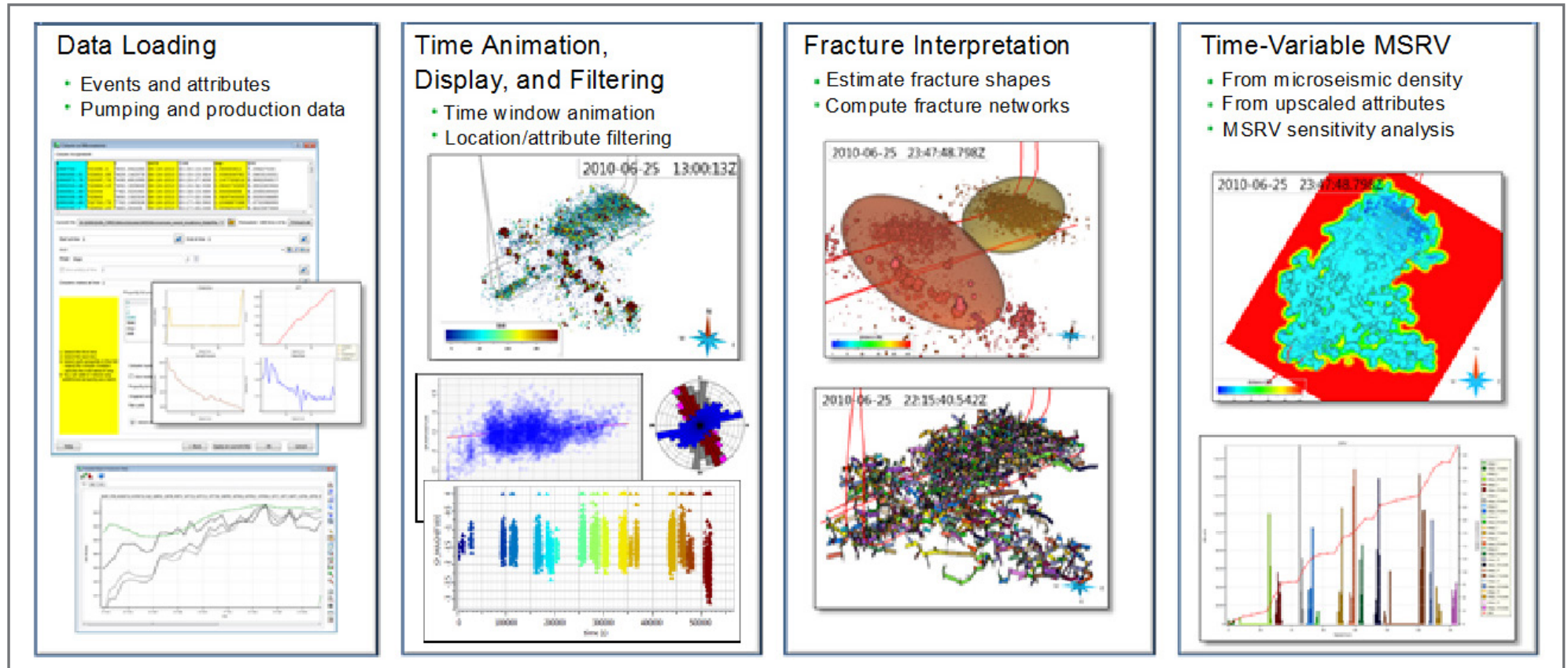


The Aspen SKUA Reservoir Simulation Link is an innovative workflow that guides users through all the steps in the construction of a flow simulation model. It is available for ECLIPSE® 100 and 3DSL, but can be used to launch any simulator that functions with an ASCII parameter file.

Aspen SKUA for Geomechanics

Aspen SKUA offers robust tools for creating grids for geomechanical simulations. These grids include structured and unstructured meshes, both of which conform to faults and stratigraphic horizons. The grids can then be exported to the Abaqus geomechanical simulator.

Aspen SKUA delivers a comprehensive seismic-to-simulation workflow.



Example of a microseismic analysis workflow.

Well Planning

The Well Planning tool is used to plan both onshore multi-lateral wells and offshore wells or platforms. Integrated with reservoir engineering tools, it provides complete well planning and reservoir optimization capabilities in one package.

Microseismic Data Analysis

Aspen SKUA includes integrated tools for loading, visualizing and analyzing microseismic data, to better understand the propagation of fractures, estimate stimulated volumes, and optimize well spacing in hydraulically stimulated reservoirs. It may also be used to monitor reservoir activity during injection and production operations for Oil & Gas, Geothermal and CO₂ reservoirs.

Increased Openness and Connectivity

AspenTech is fully committed to supporting the Open Group's industry-wide OSDU® initiative. Aspen SKUA can connect to Reservoir DDMS DataSpaces (or OpenETPServer) using Reservoir Domain APIs (the Energistics Transfer Protocol - ETP) and exchange data in RESQML™ format with other third-party applications. The Reservoir DDMS is part of the OSDU software ecosystem and one of the backend services aiming at storing, accessing and retrieving geomodeling and reservoir simulation data.

Aspen SKUA for IT and Developers

Whether your company is large or small, Aspen SKUA customization capabilities enable your users and developers to create the exact plug-in, program or solution you need.

For developers, Aspen SKUA offers a rich Software Development Kit to create fit-for-purpose plugins or to embed the Aspen SKUA algorithms inside other applications.

For users, Aspen SKUA offers a wide range of scripting capabilities with both Python and JavaScript APIs and with on-the-fly user interface creation through Macros.

Aspen SKUA runs as a standalone application or within the Aspen Epos framework, allowing you to select the exact configuration to meet your company's unique goals.



Work Smarter

- Leverage a single, comprehensive, seismic-to-simulation workflow solution.
- 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.
- QC your interpretation in unique Aspen SKUA paleo-stratigraphic space.

Work Faster

- Complete reservoir models in days or weeks, not months or years.
- Use a single model for velocity modeling, structural analysis and restoration, fault seal, reservoir modeling and reservoir simulation; save time in prospect generation and seismic-to-simulation workflows.
- Deploy a cost-efficient, open and customizable modular solution that integrates all data types and works seamlessly with other software.
- Create a unique, detailed stratigraphic model using all seismic signals with Aspen SKUA global interpretation.

Improve Quality

- Enhance the speed and accuracy of prospect mapping and interpretation, giving you more confidence in prospective wells.
- Reduce risk by seamlessly incorporating uncertainty into data and interpretations.
- Create more realistic subsurface geology representations using our unique QC tools.
- Make better decisions, reduce uncertainty and increase recovery.

Interoperability

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

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

(* a mark of SLB)

System Specifications

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



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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