Petroleum Experts

SOFTWARE • TECHNICAL SOLUTIONS • TRAINING

Integrated structural geology

move

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WHO WE ARE

Petroleum Experts (Petex) are the global standard in petroleum engineering and structural geology tools, developing a wide range of software. We are a team of highly skilled engineering and geoscience professionals with extensive experience in petroleum engineering and structural geology software. Following the acquisition of Midland Valley, we are now established as the world leader in the field of structural geology, providing expert consultancy, training and the MOVE suite of geological software, and have a single-minded commitment to the needs of our clients.

OUR HISTORY

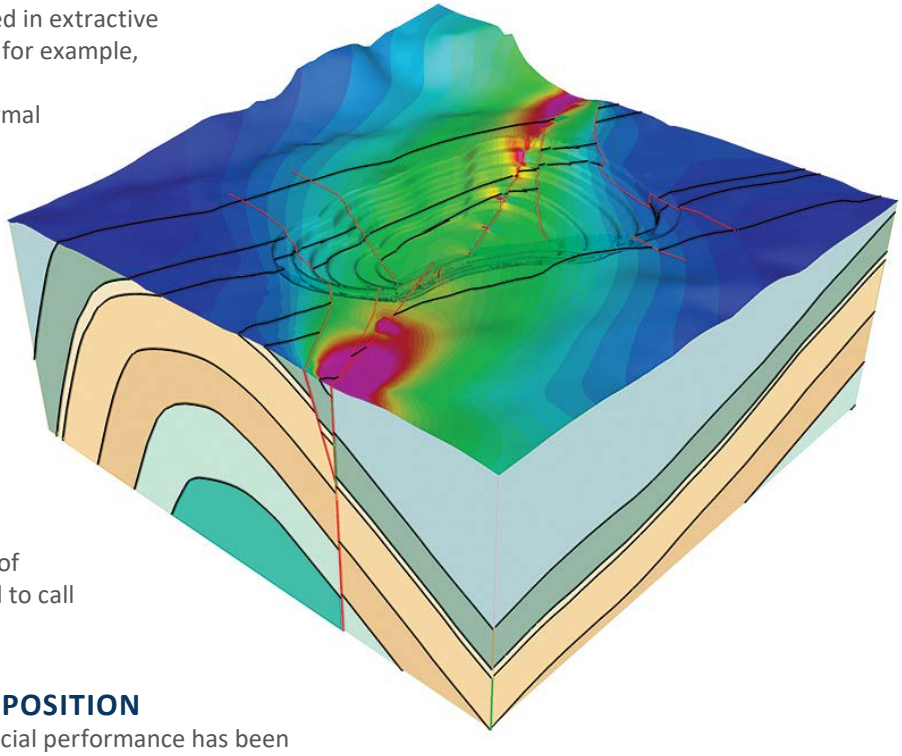
Petroleum Experts started in business in 1990. All members of the team have been involved in the development of software engineering products, as well as having extensive experience in petroleum engineering and structural geology. The corporate strategy developed from this experience, and a long-term business outlook, were fundamental to the prompt success of Petroleum Experts. The company's petroleum engineering software tools enable the oil and gas industry to dynamically model their oil reservoirs, production and injection wells and surface pipeline networks as an integrated production system.

For more than thirty five years, geoscientists at Midland Valley (named after an area of Scotland that lies between the Southern Uplands Fault and the Highland Boundary Fault) used restoration and balancing techniques to understand geological evolution and extract unseen information from available data. The ground-breaking approach minimises technical uncertainty – enabling your organisation to reduce risk in a methodical and cost-effective way. The main focus of the company was to commercialise applied structural modelling and balancing in the extractive industries, e.g. oil and gas exploration and production or mining, through the MOVE software suite.

In October 2017, Petroleum Experts and Midland Valley joined forces. Petroleum Experts pioneered integrated field modelling with the objectives of improving field management, production and recovery, with their petroleum engineering IPM suite – fully integrated reservoir, well, surface network modelling system, and the Digital Oil Field platform (DOF). The next evolutionary step of integration is to incorporate geology and geophysics through MOVE, to deliver a seamless set of workflows from field geology to production and oil and gas field management – field discovery to late production life.

BUSINESS

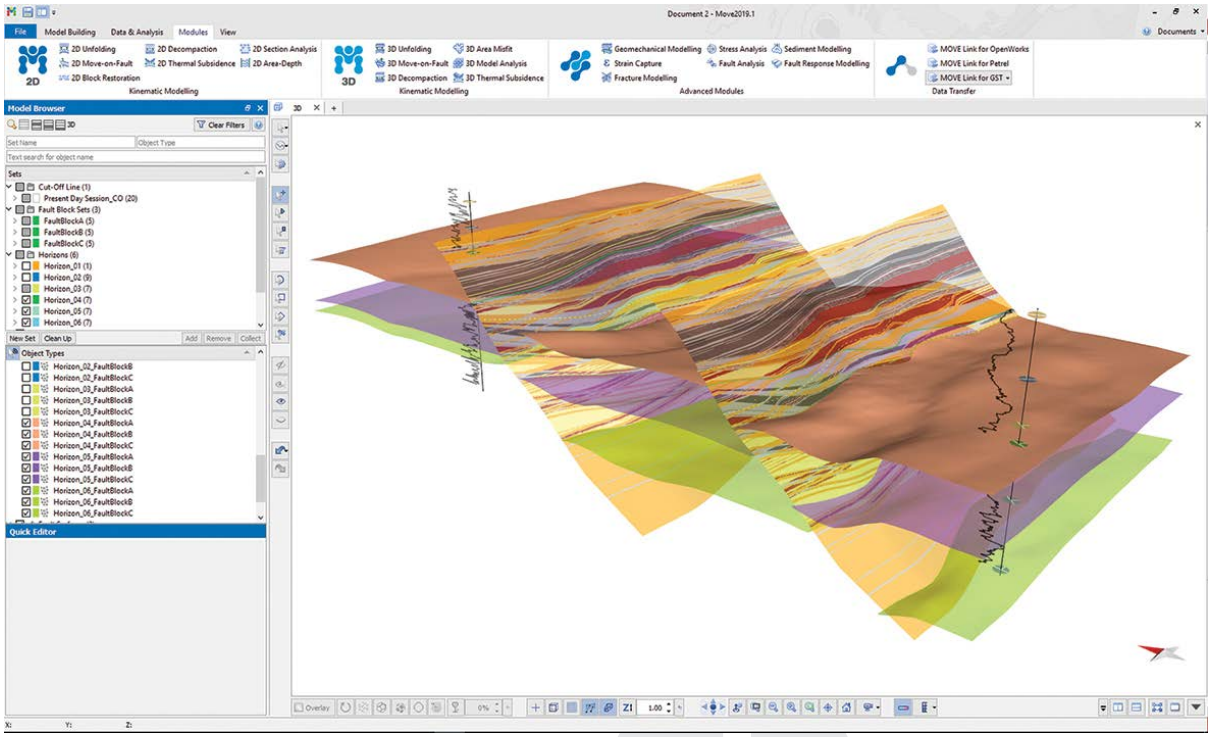
The success of our business is down to a highly-focused and – more importantly – sustained drive towards incremental and measurable steps in innovation of new engineering and structural geology modelling techniques. Our drive has brought direct, bottom-line production gains to our clients directly or indirectly involved in extractive and subsurface storage industries, for example, oil & gas, mining & quarrying, CCS, radioactive waste storage, geothermal energy, geological survey and geotechnical engineering. Key to the company's long-term business success has been our ability to guide our clients. We offer our clients constructive, holistic advice on how to best adopt our technology, enabling them to enhance their organisation; maximising not only exploration and production success but also technical efficiency. This can be evidenced by our extensive list of industry leaders who we are proud to call our clients.



FINANCIALS AND MARKET POSITION

Since the very beginning, our financial performance has been outstanding. Petroleum Experts has enjoyed a consistent increase in both turnover and profit. All of our product development is self-financed, which enables us to focus on technical innovation and quality technology; without reliance on external funding. Petroleum Experts was awarded Company of the Year 2010 at the SME awards for Scotland and, in 2009, we were awarded Business of the Year for Scotland. In previous years we have won several awards for business growth, including European Business Awards "Ruban d'Honneur" in 2009 as well as the fastest growing technology companies for six of the seven years that Deloitte Fast 50 Awards were run in Scotland.

Petroleum Experts has over 450 clients worldwide. In fact, more than 80% of the revenue comes from outside Europe. Our company is recognised across the international oil and gas industry as the technical market leader within its area of expertise and has been ranked number one in all technical evaluations across the industry for more than eight years.



OUR PEOPLE

One of the reasons that we are the world leader in structural geology is because our specialists and software developers are leaders in their respective fields and strive for excellence. We're lucky enough to work with a great team of creative, innovative and passionate people – from all over the world – who are key to delivering cutting-edge software, services and training. We have a team of expert geoscientists and engineers, who have a wealth of experience and knowledge between them, ready to offer insight and expertise on any project. Our dedicated software engineers are also exceptionally skilled and ensure that MOVE continues to be the market leader in structural geology software. And we are all dedicated to your support. Professional and efficient, we make sure all your questions are answered, assist you when you need help and make sure you can get MOVE up and running with no fuss.

OUR ETHICS

We operate a policy of inclusion and equality. Each member of our team is recruited on merit and technical ability. We expect all individuals to contribute to the decision making process and to help drive the company forward, no matter their role. We encourage communication and cooperation between all teams enabling us to perform at the highest level – both for ourselves and for our clients.

TECHNICAL SOLUTIONS

It's all about reducing the uncertainty in the structural model to make better decisions. We apply restoration and balancing techniques to the geological model to reveal its geological evolution and extract unseen information from available data. Our ground-breaking approach minimises technical uncertainty – enabling your organisation to reduce risk in a methodical and cost-effective way.

Our experienced team of structural geologists and petroleum engineers has worked on a wide range of projects both onshore and offshore, on all continents, and in all structural settings. Our technical solutions draw on the resources and experience of the whole company, including the geologists and engineers of the consulting teams, and the software development teams. Each project involves input from multiple parts of the company and is designed around the specific requirements of the client. We use MOVE every day as an essential tool in our software development, support and project work.

Our aim is to work in close collaboration with our client throughout a project. Often the knowledge of local geology comes directly from the client and we provide wider insights, techniques and expertise in structural modelling to help answer specific questions about the geological evolution, and reduce the uncertainty in the geological model.

THE SCOPE OF OUR PROJECTS INCLUDES:

- Creating geometrically consistent and balanced geological models in 2D and 3D space.
- Testing, validating and improving existing client interpretation using the modelling tools in MOVE (geometric and kinematic restoration and forward modelling).
- Determining the timing, geometry and kinematics of trap formation, fault movement and salt tectonics.
- Stress and strain analysis and fault response modelling.
- Fracture analysis and fracture network prediction.
- Reservoir structure, volumetrics and compartmentalisation.
- Orebody structure and evolution for exploration and mining.
- Present-day and palaeo fault seal analysis.
- Reconstructing palaeobathymetry and depositional modelling.
- Structural characterisation for mining, including block caving.
- Digital field mapping.

Projects providing technical solutions for clients range in duration from a few days to several months, depending on client requirements. We routinely build-in a component of training and technology transfer so that you are able to replicate the workflows used in the project, and if required, undertake a complete project independently in the future.

If you have a project that you would like to discuss then please don't hesitate to call us or email us at edinburgh@petex.com – get the experts on your side.

TRAINING

Learn from our experts and build your knowledge in the application of structural geology using MOVE.

We offer training courses to suit all levels, learning styles and budgets. These include structural geology theory training using MOVE; Advanced MOVE software training; and knowledge transfer workshops, all of which can be delivered in-house if required. The courses are relevant for geoscientists and engineers working in a variety of sectors and can be tailored to both individual and company requirements.

INTEGRATED STRUCTURAL GEOLOGY STANDARD COURSE (MOVE)

Normally held in either Edinburgh or Houston, our Integrated Structural Geology Standard Course using MOVE follows a fixed course structure over five days. The course provides an introduction to basic structural geology theory and practice aimed at geologists and engineers. This course is intended for those that: (i) work with geological models in the exploration or production domain and need to become familiar with structural geology tools/analysis; (ii) attended the course already some time ago, and require a refresher, or; (iii) are in other disciplines trying to understand how structural geology is integrated into the exploration or production context. A background in structural geology is not required. The course uses practical exercises and the MOVE Software Suite as required. It is largely hands-on, introducing the theory and principles underlying the application of structural geology analysis in extractive industries such and oil & gas and mining.

For more information on our training courses, visit petex.com/services/training-courses

INTEGRATED STRUCTURAL GEOLOGY ADVANCED COURSE (MOVE)

Normally held in either Edinburgh or Houston, our Integrated Structural Geology Advanced Course follows a fixed course structure over five days using MOVE structural modelling and analysis software. This course is intended for users who want to enhance their knowledge of integrated structural geology to assess interpretations and evaluate structural evolution of assets. Those who attend should have completed the Integrated Structural Geology – St ndard Course, but this course is also aimed at those who are, through use and application, proficient in MOVE, or who are experienced structural geologists. The objective is to learn how to use MOVE to model complex structural geological processes in 2D and 3D, including fault seal analysis. Attendees will learn how to formulate and apply advanced structural geology workflows and analyses, where key economic decisions are dependent on integration of modelling results and outcomes. The course provides in-depth training in all products in the MOVE Software Suite and is largely hands-on, using exercises and data from our software tutorials with supporting presentations and on-screen demonstrations.

For more information on our training courses, visit petex.com/services/training-courses

KNOWLEDGE TRANSFER WORKSHOP

We can design a Knowledge Transfer Workshop specific to your needs, showing the most effective application of MOVE to address your specific workflow requirements. We can provide parts of our standard and advanced courses and data to achieve this and incorporate your own data into the training. Courses can vary in length from one or two days up to five days or longer and can be designed standalone or as part of a consulting project. Generally, a Knowledge Transfer Workshop is split into two parts: the first part focuses on structural geology theory and software training in MOVE, and the second part focuses on client-specific structural geology techniques and workflows, using MOVE tutorial or prepared client data. If client data is used, and not part of a consulting project, this must be provided in advance of the workshop.

If you would like to discuss a knowledge transfer workshop, please email us at edinburgh@petex.com

IN-HOUSE TRAINING

We can provide any of our training options to you at your company premises. A company in-house training course can include elements of any of our MOVE software training options outlined above, customised to suit specific requirements.

If you would like to discuss in-house training, please email us at edinburgh@petex.com

TRAINING COURSE COSTS

Courses with a fixed structure delivered in Edinburgh or Houston have prices published on our website. Where courses are tailored to your needs; costs will depend on the length, preparation required and location of training. Please contact us directly to discuss the best option for you and your organisation and to get a quote.

Email us at edinburgh@petex.com

We also maintain close links with university research groups and we are continually looking at ways to invest in the future of new generations of geoscientists.

SUPPORT

Client support is a fundamental part of what we do. All members of our team are involved in client support, whether it's on the frontline providing a rapid and technically detailed response to queries, or in making sure that our software documentation is of the very highest standard. In addition to one-on-one resolution of client support requests, we provide the MOVE Knowledgebase as a one-stop-shop for software help, explanation of underlying MOVE theory and self-instruction tutorials. Once a year, we host a User Group meeting in Edinburgh and invite all of our clients to attend. The meeting provides an opportunity for us to find out how our clients are using MOVE. It allows our clients to learn about the latest developments in the software and to submit development requests. For attending clients, these will be discussed in open forum, increasing the likelihood of support from other clients, and considered for inclusion in our software development plans. We also have an annual Technical Meeting in Houston, and smaller meetings globally across the year.

To learn more about our user meetings, please email us at edinburgh@petex.com

MOVE KNOWLEDGE BASE

This resource contains all MOVE Help Pages, Tutorials, a back catalogue of MOVE Features and the release documentation presented in a single, offline, searchable entity, independent of MOVE. The material is cross-referenced and brings together tutorial workflows with more detailed help topics including algorithm theory and recommendations for tool application and parameter values. The Knowledge Base is updated regularly and made available to our users, therefore it is more up-to-date than the application help pages. This allows us to continually improve our support materials, independently of the MOVE software release cycle.

TUTORIALS

MOVE tutorials are based on real datasets and provide users with detailed step-by-step instruction on the best practice workflows recommended by our structural geologists. They cover all functionality in the software. All 38 tutorials can be accessed from the Knowledge Base and from the software download link.

HELP PAGES

The Help Pages allow our users to find everything they need to know about MOVE. Help topics are linked with relevant tutorials to assist our users to understand best-practice workflows and how each tool is used. Help provides information on the core elements and tools of the MOVE software, how to navigate the user interface, explains advanced modules for more complex analysis and modelling, and provides guidelines on how to manage a project in MOVE and how to get the best from the software.

MOVE FEATURES

MOVE Features form part of the newsletter issued by Petex. Each feature focuses on a topic or key workflow to provide our users with a deeper theoretical understanding of the software, its real-world applications and give tips and tricks to streamline workflows. Past features can be accessed from the MOVE Knowledge Base.

To learn more about MOVE support resources, please email us at edinburgh@petex.com

MOVE SOFTWARE SUITE OVERVIEW

Structural modelling and analysis software to reduce risk and uncertainty in geological models.

move™

KINEMATIC MODULES

2D Kinematic modelling

3D Kinematic modelling

ADVANCED MODULES

Geomechanical modelling

Fracture modelling

Stress Analysis

Fault Analysis

Fault Response modelling

Sediment modelling

DATA TRANSFER

move Link Petrel

move Link OpenWorks

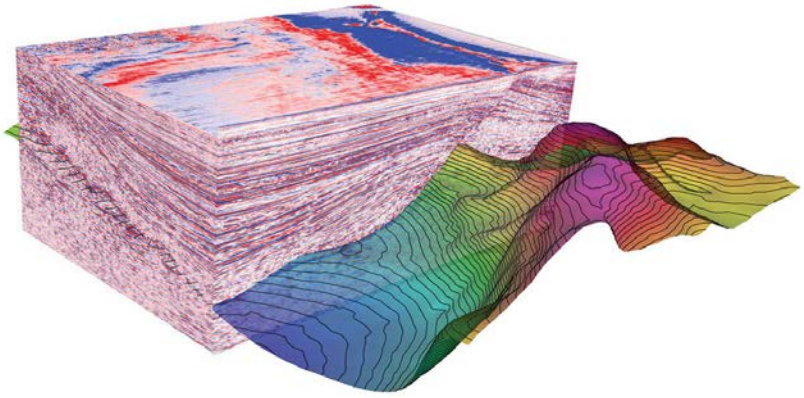
move Link GST

DIGITAL FIELD MAPPING

Fieldmove

Fieldmove Clino

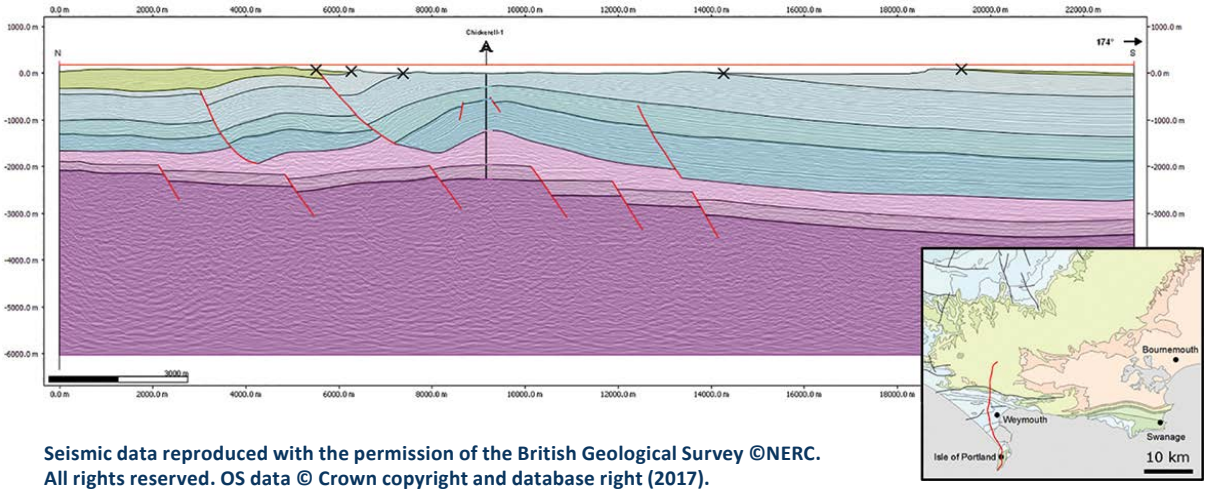
The MOVE suite is the most complete structural modelling and analysis toolkit available. It provides a full digital environment for best practice structural modelling to reduce risk and uncertainty in geological models.



Seismic data reproduced courtesy of Triezenberg, P. J., Hart, P. E., and Childs, J. R., 2016, National Archive of Marine Seismic Surveys (NAMSS): A USGS data website of marine seismic reflection data within the U.S. Exclusive Economic Zone (EEZ): U.S. Geological Survey Data Release, doi: 10.5066/F7930R7P.

The MOVE suite provides a platform for integrating and interpreting data, cross-section construction, 3D model building, kinematic restoration and validation, geomechanical modelling, fracture modelling, fault response modelling, sediment modelling and fault and stress analysis. The software is designed by geoscientists working in close collaboration with software developers and enables you to create valid geological models. MOVE reduces uncertainty by going beyond static models, which may be no more than an artist's impression. By addressing timing, development of structure, and checking geometric and evolutionary feasibility, you are three times more likely to produce the correct result.*

MOVE can be applied to any geological province or tectonic setting, including extensional, compressional, and strike-slip basins, as well as areas that have undergone inversion, erosion, thermal subsidence and salt tectonics. With the Knowledge Base, we offer our users access to fully integrated help and tutorials. MOVE is easy to use, bringing your ideas and concepts alive. The software provides you with the tools to check the geometric and evolutionary feasibility of your geological models.

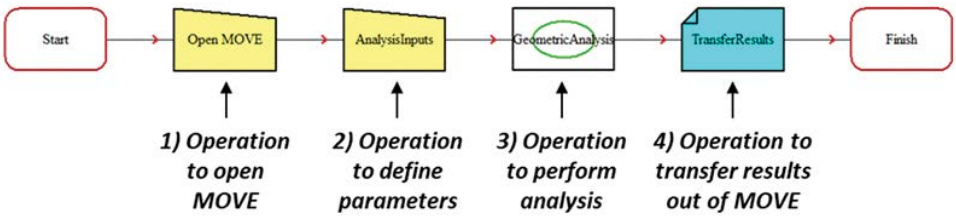


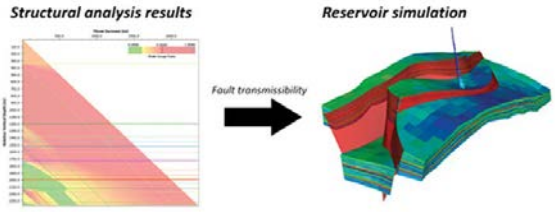
*Bond et al 2012, "What makes an expert effective at interpreting seismic images?", Geology, January 2012, v40, no1, p75-78.

ADVANTAGES OF USING MOVE

Petroleum Experts (Petex) software MOVE is the industry leading software for structural geological modelling and is under continuous development for more than 30 years. It is used by geoscientists and engineers in more than 200 companies worldwide to get maximum value from their data and reduce risk and uncertainty across a variety of resource industry sectors (oil & gas, mining, CO2 storage, geothermal energy, geological surveys, geotechnical engineering).

- The MOVE suite comprises methodologies that range from model creation, structural quality-control and validation, to more advanced analysis, such as investigating reservoir compartmentalisation and fracture prediction, aiding decision making and prospect planning.
- Ensuring that the geological model is valid, reduces uncertainty in the shape and position of faults and economically significant horizons in the subsurface, for example, hydrocarbon reservoirs. The results of model validation in E & P can be used to have greater confidence in well planning, field development strategies and gross rock volume calculations, ultimately reducing costs.
- Structural evolution can be determined, to help understand how economic traps have developed through time. For example, in E & P this can be used to improve understanding of formation of hydrocarbon plays, which will inform exploration strategies.
- With a valid model and an understanding of the structural evolution, further analysis can be done on the reservoir, for example assessing fault transmissibility and secondary porosity and permeability associated with natural fractures. This information can be used to improve reservoir models and ultimately make predictions about production.
- Integration of MOVE with the Petex IPM suite gives geoscientists and engineers the ability to access more data in the production system to improve geological and production models.





APPLICATION PROGRAMMING INTERFACE (API)

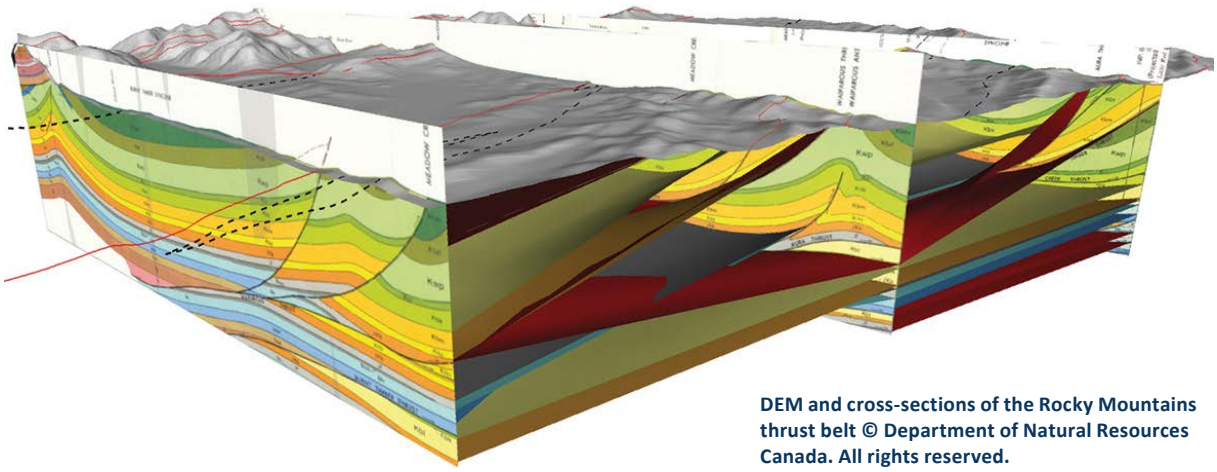
Use MOVE as part of automated workflows and integrate MOVE with modelling from other disciplines (e.g. reservoir simulation).

A mechanism for automating functionality in MOVE and communicating with PETEX or third-party applications, such as Excel. Communication with PETEX applications is achieved via the RESOLVE software (licenced separately) and third-party applications via the OpenServer (licenced separately). The API provides a two-way gateway for information between MOVE and external applications.

- Tools in MOVE can be controlled and workflows orchestrated by third party applications.
- A series of logical steps can be defined computationally.
- RESOLVE or third-party applications control the flow of information in MOVE as well as into and out of MOVE.
- Operations and workflows can be automated and standardised to increase efficiency, reduce subjectivity, and minimise operator bias.
- Workflows can be shared within an organisation to allow others to benefit from the knowledge and expertise of structural specialists.
- Connection between MOVE and other modelling packages facilitates integration of static geological models/data (e.g. fault and horizon interpretations) in MOVE with dynamic production models/data (e.g. reservoir pressure data and fluid compositions).
- Geoscientists now have access to any dynamic data that are available and can use the additional data to validate geological models and concepts.

MOVE CORE APPLICATION

Fully integrated 2D and 3D model building and analysis.



DEM and cross-sections of the Rocky Mountains thrust belt © Department of Natural Resources Canada. All rights reserved.

MOVE is the core application of the MOVE suite and all other modules require it to run. It provides a powerful stand-alone environment for data loading and integration, cross-section construction and 3D model building, and forms the base for our specialist structural modules including 2D and 3D Kinematic Modelling, Geomechanical Modelling, Fracture Modelling and Fault Response Modelling, as well as Sediment Modelling, Fault Analysis and Stress Analysis.

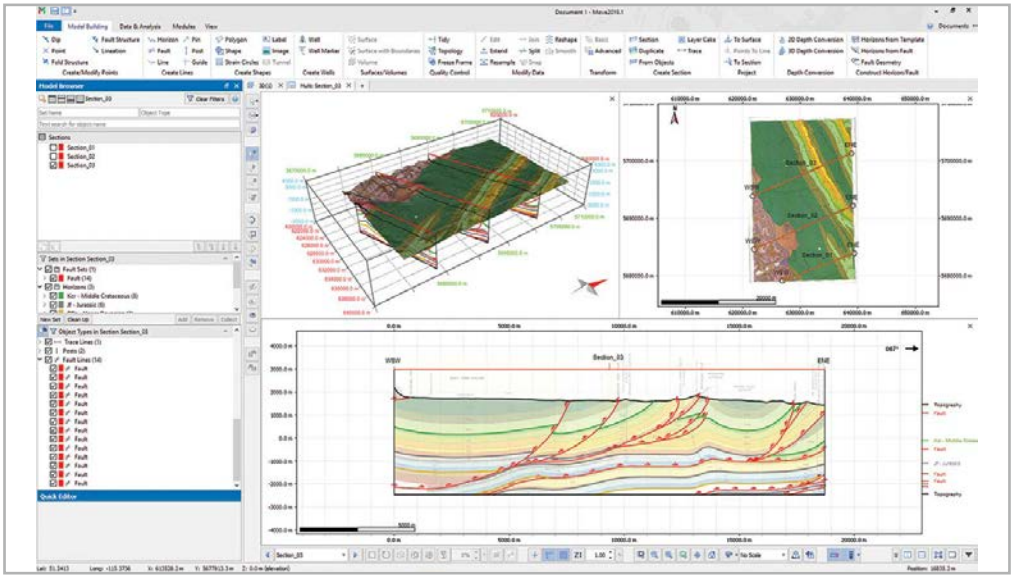
The MOVE application provides a platform which integrates geo-referenced 2D and 3D views, allowing over 100 different data formats to be combined. The integrated views can be used to construct geologically valid cross-sections and 3D models using manual and automated tools.

The 2D/3D space provides a best practice environment to develop models, which can then be directly tested and validated using the kinematic modules. Orientation plots, cross plots, stereonets, rose diagrams and object property tables can then be used to thoroughly investigate and analyse the model and construction process. MOVE is used by geoscientists and engineers with the intention of getting maximum value from their data, in any tectonic regime and across a variety of resource industry sectors.

- Multiple data imports including Seismic, GIS, OBJ and ASCII
- Seamlessly integrated 2D and 3D model building
- Cross-section construction
- Attribute and Object Attribute analysis including SCAT
- Section, Map, 3D, and Google Map views of data
- Logical attribute and spatial query tool
- GIS Vector data live-stage connection
- 3D PDF export of 3D models and 2D animations

- Import and integrate a wide variety of data types including: digital field data, digital elevation models, seismic data, well and borehole data, geological maps, point clouds and point data, volume data, annotated field images, scanned cross-sections, grav/mag and remotely sensed data, ASCII, GIS shape and DXF files.
- Navigate the Model Browser quickly and efficiently using the Model Browser search bar.
- Quickly create shaded 2D maps and sections and 3D models in fully geo-referenced space, using automated and manual digitization tools.
- Create 3D surfaces, shapes and volumes from a wide variety of data types and honour input data points for surface creation using ordinary kriging.
- Maintain surface boundaries when resampling.
- Pick or part-select geocellular volumes/3D grids, create regions based on selection and extract faults.
- Photogrammetry support including the projection and draping of photographic outcrop images on an existing mesh.
- Create and slice 2D sections at any angle and orientation through your model with controllable display of 3D object intersections in the Section View.
- Copy and paste images from the Windows clipboard straight into the Views.
- Project data onto sections and surfaces or manually transform objects.
- Condition and check your model and systematically improve its integrity.
- Full attribute analysis with multiple graphical plots including SCAT.
- Update your model in real-time using the Reshape tool to rapidly modify surfaces, whilst maintaining structural geometry.
- Display and analyse well and borehole data efficiently with the Well Track and Well Marker analysers.
- Visualize your data and model with advanced tools, including animation, lighting, section navigation and the ability to save camera views.
- Create and export MBTiles from MOVE for use in our digital mapping software, FieldMove and FieldMove Clino.
- Export your data in a variety of formats for further analysis and modelling, including 3D PDF and 2D and 3D SEG-Y.

Use the MOVE Core application as your platform for the advanced structural modules: 2D Kinematic Modelling, 3D Kinematic Modelling, Geomechanical Modelling, Fracture Modelling, Fault Response Modelling, Fault Analysis and Stress Analysis, and for links to third-party products: MOVE Link for Petrel*, MOVE Link for OpenWorks and MOVE Link for GST.

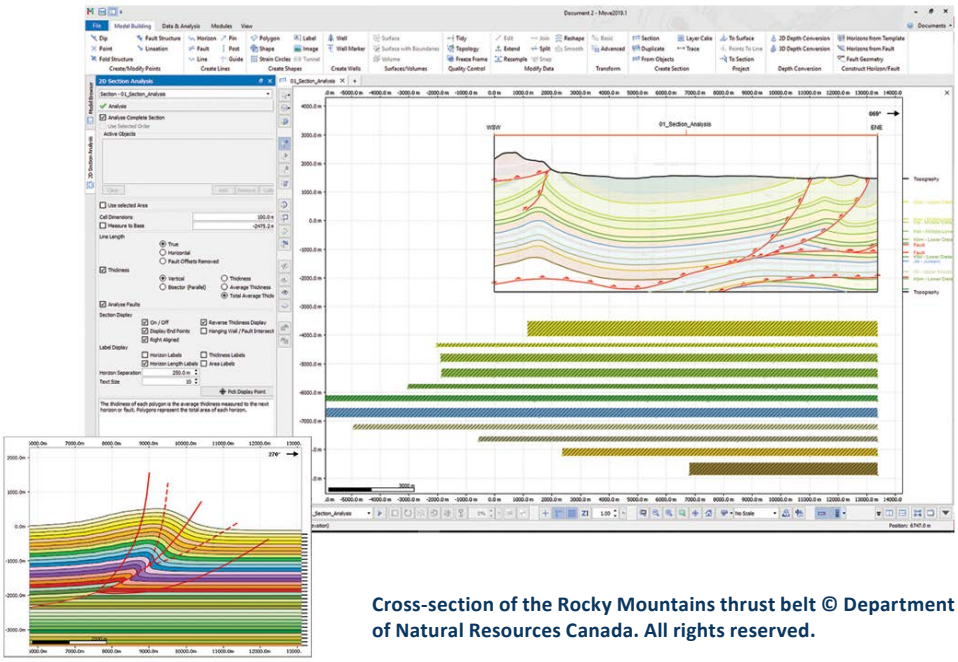


DEM, scanned map and cross-sections of the Rocky Mountains thrust belt © Department of Natural Resources Canada. All rights reserved.

* Mark of Schlumberger

2D KINEMATIC MODELLING

World-leading forward and reverse modelling tools for validating your interpretation and reducing uncertainty in your geological model.



Cross-section of the Rocky Mountains thrust belt © Department of Natural Resources Canada. All rights reserved.

Our 2D Kinematic Modelling module provides a comprehensive range of tools to build, balance, restore and analyse cross-sections at a local and regional scale. The impact of geological time on the structures present in a model can be accounted for in any decisions.

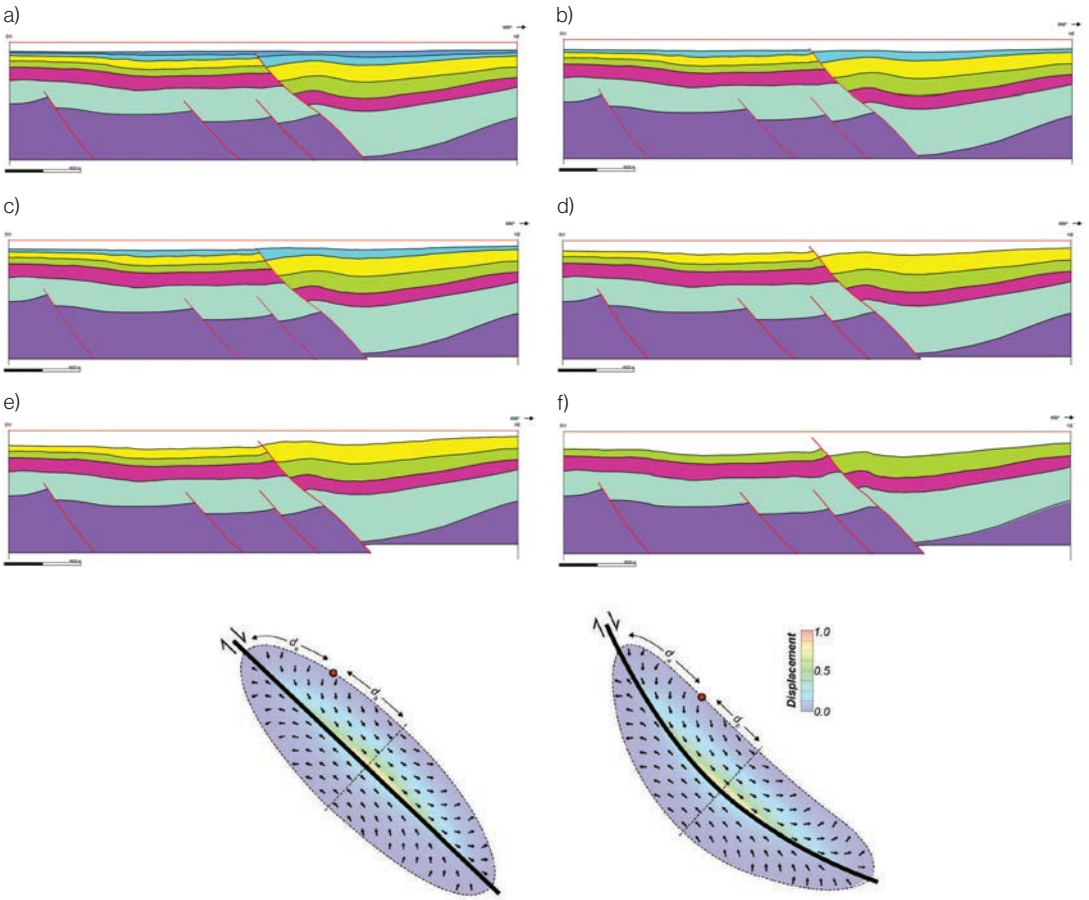
Kinematic algorithms are used to restore and remove deformation on geological cross-sections. The tools allow the un-deformed state to be defined while staying true to line length and area balancing principles.

Tools in the 2D Kinematic Modelling module can be used to interactively determine deformation rates, check the geometric and evolutionary feasibility of your model, highlight areas of geological uncertainty and constrain the evolution.

Analyse present-day structure and validate your section through geological time. Evolve models backwards and forwards through time and assess the timing of critical geological events such as trap formation, juxtaposition and basin evolution.

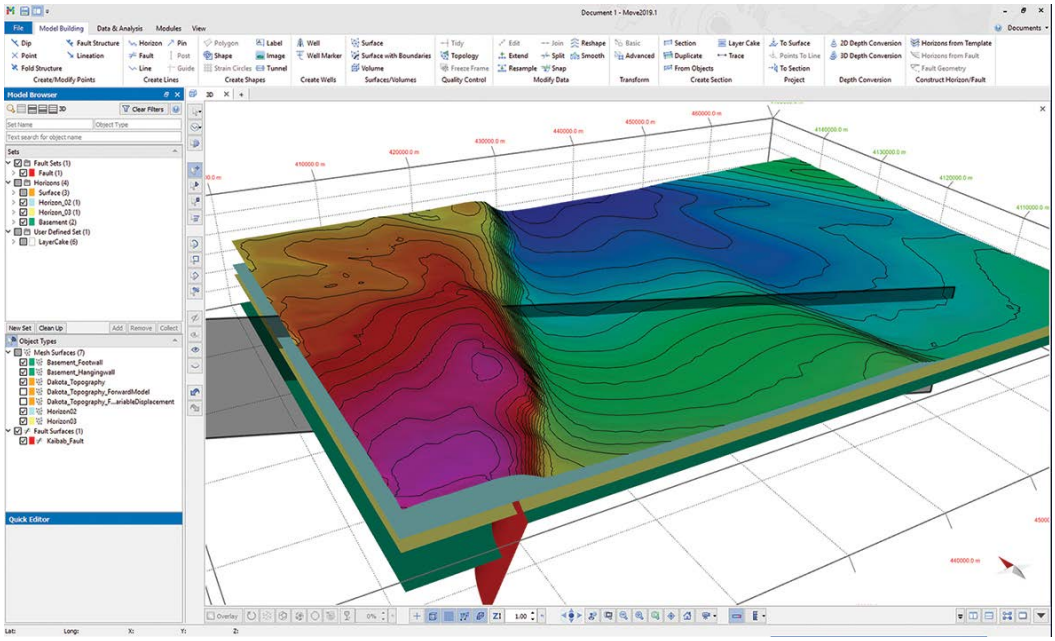
- Comprehensive suite of 2D kinematic algorithms
- Interactive tools to help quickly generate balanced sections
- Restore, forward model and analyse sections
- Apply to any tectonic setting including salt
- Improved Area-Depth and layer-parallel strain calculations
- Fault and horizon construction
- Decompaction
- Depth conversion
- Thermal Subsidence

- Use kinematic algorithms for both restoration and forward modelling including:
  - Block Restoration
  - Flexural Slip Unfolding
  - Simple Shear Unfolding
  - Simple Shear Move-on-Fault
  - Trishear (planar and non-planar faults) Move-on-Fault
  - Fault Parallel Flow Move-on-Fault
  - Fault Bend Folding Move-on-Fault
  - Elliptical Fault Flow Move-on-Fault
- Include sedimentation, erosion and salt movement.
- Backstripping techniques including compaction, thermal subsidence and isostasy. *New* Auto-population and synchronisation of compaction and subsidence tools for quicker and easier restoration workflows.
- *New* Improved depth conversion tool to account for large velocity changes between horizons in faulted sections and the ability to quickly set a constant water velocity for submarine environments
- Seismic data and images can be carried through the restoration.
- Interactively define fault displacement, shear angle, regional level, position, propagation angle, trishear angle, pin position, unfolding template, sediment erosion and deposition when forward modelling.
- Preview kinematic calculations for quick sensitivity testing of input parameters when carrying out forward modelling and restorations.
- Develop realistic fault trajectories and depths to detachment.



3D KINEMATIC MODELLING

World-leading 3D forward and reverse modelling tools to help validate your model, and reduce uncertainty.



Our 3D Kinematic Modelling module uses leading edge kinematic algorithms to validate and restore 3D geological models. Complex geological structures can be restored to identify alternative scenarios in areas of high structural uncertainty. Discover the geological history of your modelled scenario to reveal unseen structures and changing geometries.

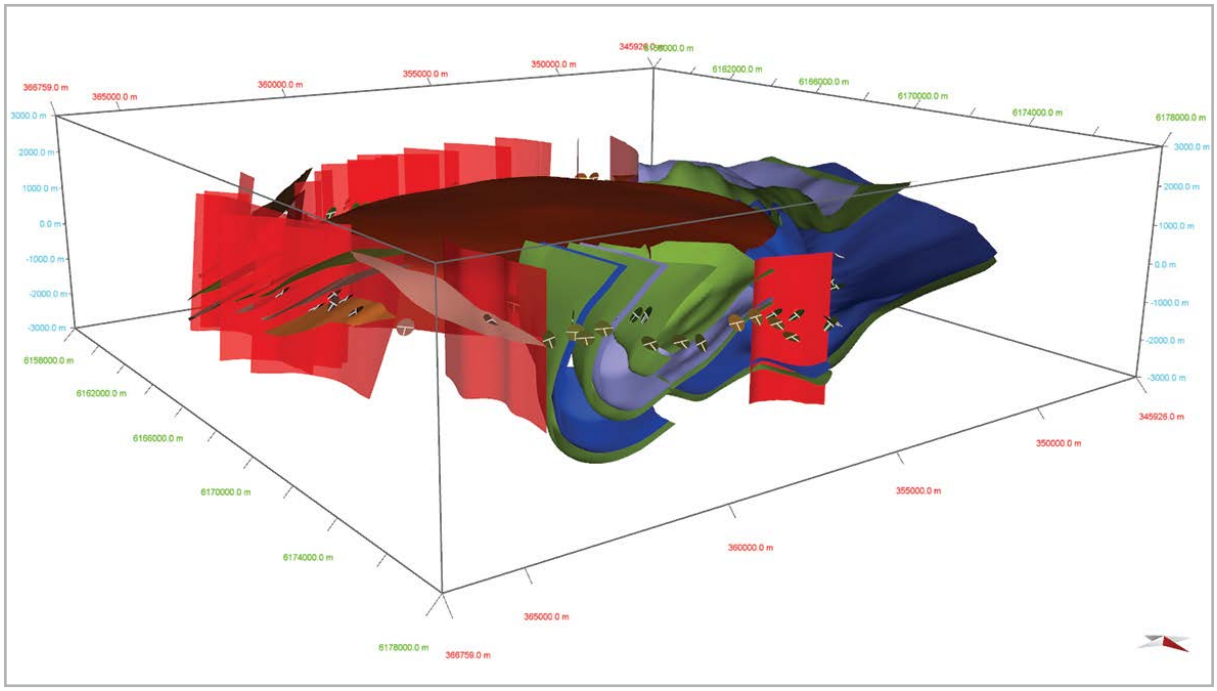
This module can be applied to any geological setting including: extensional, compressional and strike-slip basins as well as areas that have undergone inversion, thermal subsidence and salt tectonics.

Forward and reverse model through time in 3D, whilst adhering to line length, area and volume balancing principles. The module will help you construct realistic geological models, which can then be used as the basis for further analysis.

- Support Lagrangian and Eulerian strain calculations, with Finite or Infinitesimal strain output.
- Comprehensive suite of 3D kinematic algorithms
- Enhanced structural understanding
- Model real-world scenarios
- Predict unseen structures and reduce uncertainty
- Depth conversion
- Decompaction
- Thermal Subsidence

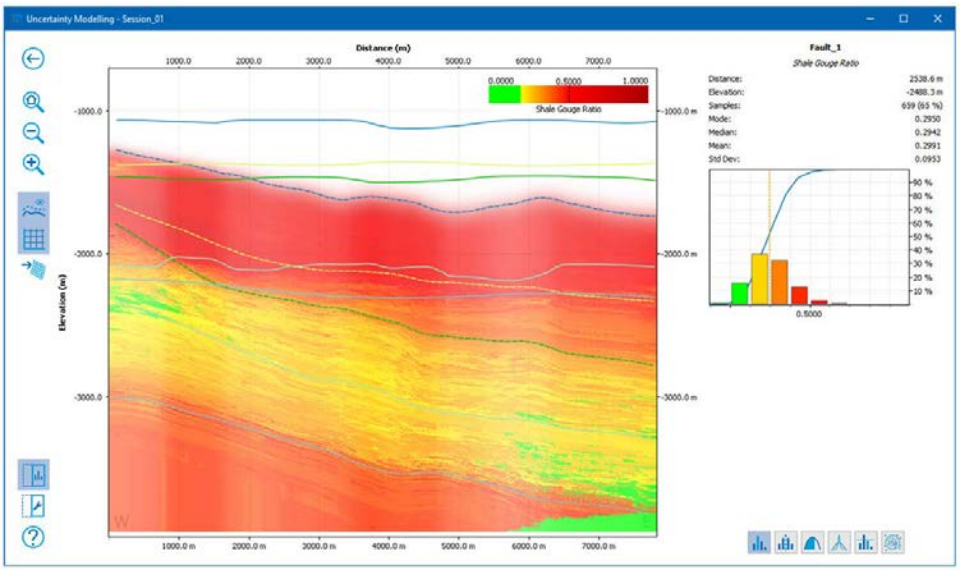
3D Kinematic Modelling analysis allows the timing of critical geological events such as trap formation to be determined; accurate reservoir geometries and volumes to be constrained; palaeo-surfaces to be reconstructed; and areas of instability and enhanced permeability to be identified ahead of drilling.

- Work in 3D plus geological time. Evolve models backwards and forwards through time and assess the timing of key geological events.
- Model fault movement using 3D kinematic Move-on-Fault algorithms, with freedom to vary parameters along strike:
  - Simple Shear: model penetrative deformation throughout the hanging wall of extensional faults.
  - Fault Parallel Flow: model hanging wall deformation by discrete movement between beds in fold-thrust belts.
  - Trishear: model deformation associated with a propagating fault tip.
- Restore and forward model folding with Simple Shear and Flexural Slip Unfolding.
- Take into account physical compaction, isostatic and thermal subsidence effects to investigate basin architecture through time.
- Perform Jigsaw-fit restorations to assess the geometric validity of geological interpretations. Measure horizon areas and volumes in 3D models using the 3D Model Analysis tool, which allows for quick validation of 3D models. Use this to estimate reservoir volumes, sweet spots and optimise oil and mineral extraction.
- Calculate strain for areas and volumes, and save strain attributes for further analysis. This essential output can then be used with our Fracture Modelling module to produce a discrete fracture model (DFN) and assess fracture porosity and permeability.



FAULT ANALYSIS

Quantitative analysis of fault throw, juxtaposition and seal through geological time.

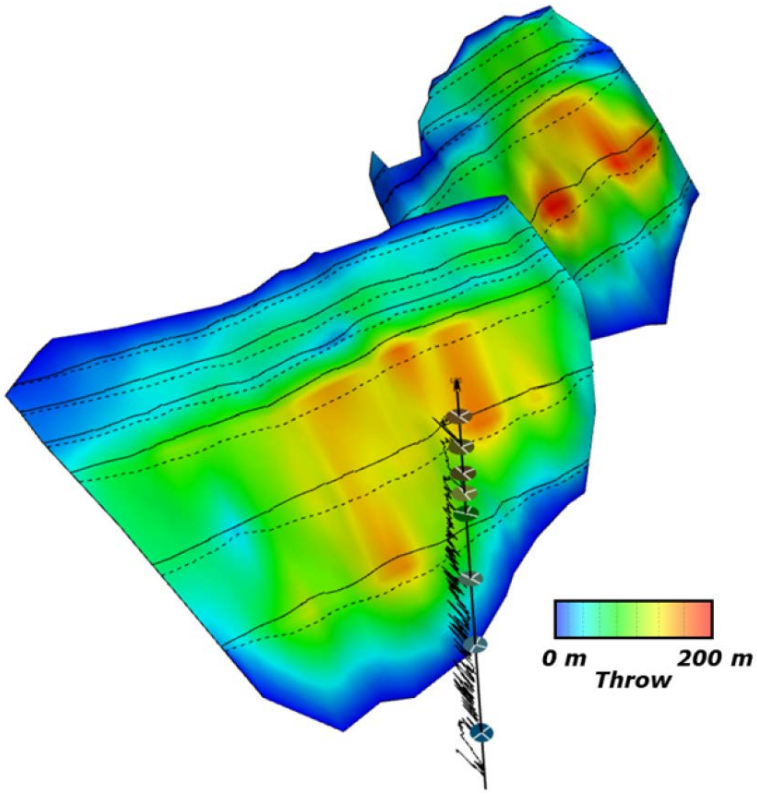


A tool for rapid evaluation of throw distribution, across-fault juxtaposition and fault sealing capacity in 3D. Combined with statistical analysis of fault displacement and scaling relationships, the tool provides powerful validation of geological interpretations.

Uniquely, the module can be integrated with restoration workflows using MOVE's 3D Kinematic Modelling and Stress Analysis modules to provide a complete temporal fault displacement and seal investigation. This workflow delivers key information on potential baffles or conduits to flow at the time of hydrocarbon generation and migration. The sealing potential of faults and joints encountered in a wide range of mineral and ore systems can also be investigated using this approach.

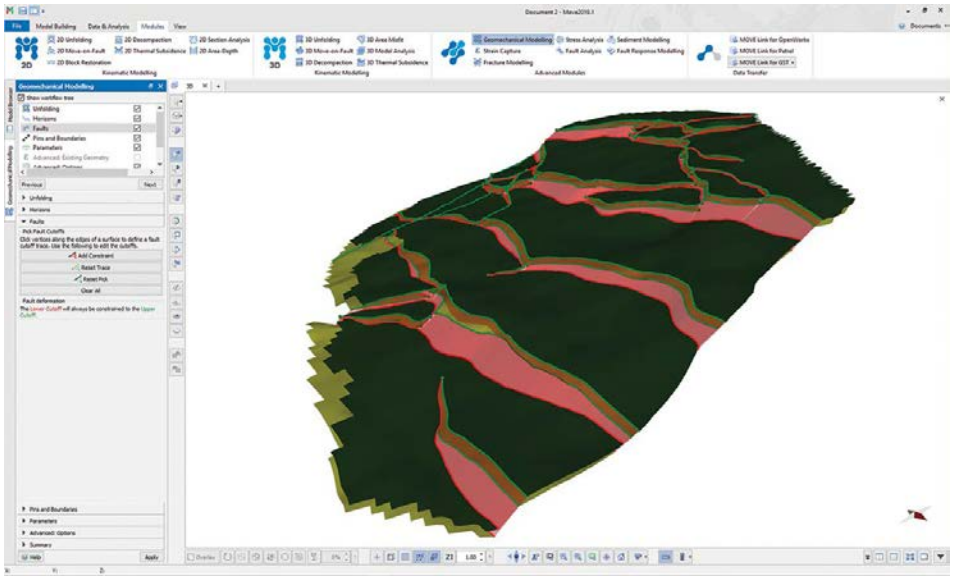
- Complete temporal fault displacement and seal analysis.
- Visualize throw, juxtaposition and shale gouge ratio on fault surfaces.
- Statistical analysis of fault scaling properties.
- Quantify the potential impact of uncertainties in your input data.

- Create hanging wall and footwall fault cut-offs highlighting interpretation inconsistencies and allowing subsequent analysis.
- Create hanging wall and footwall fault cut-offs highlighting interpretation inconsistencies and allowing subsequent analysis.
- Plot 3D throw colour maps and create 2D strike projections (throw profiles) for multiple faults.
- Define lithologies and Vshale in the Stratigraphy and Rock Properties database to create juxtaposition diagrams and plot shale gouge ratio in 3D.
- Visualize throw, juxtaposition and shale gouge ratio on fault surfaces.
- Calculate a broad range of seal proxies including: shale gouge ratio, shale smear factor, clay smear potential, permeability and hydrocarbon column height.
- Statistically analyse fault scaling properties, including throw/length and cumulative frequency.
- Calculate heave polygons for all faults and horizons in a model.
- Create instantaneous fault-growth curves to review movement history of faults.
- Restore model to analyses palaeo-juxtaposition and fault sealing.
- Create triangle diagrams that account for across-fault thickness variations, or using two wells.
- Quantify the potential impact of uncertainties in your input data by rapidly running multiple model iterations to quantify risk based on input uncertainty.
- Interrogate distributions of possible outcomes, and visualize aggregate statistics, distribution percentiles and probabilities of specific outcomes across a fault surface.
- Complete rapid temporal fault displacement and seal analysis.
- Carry out statistical analysis of fault scaling properties.



GEOMECHANICAL MODELLING

Physics-based restoration of surfaces and volumes using elastic rock properties.

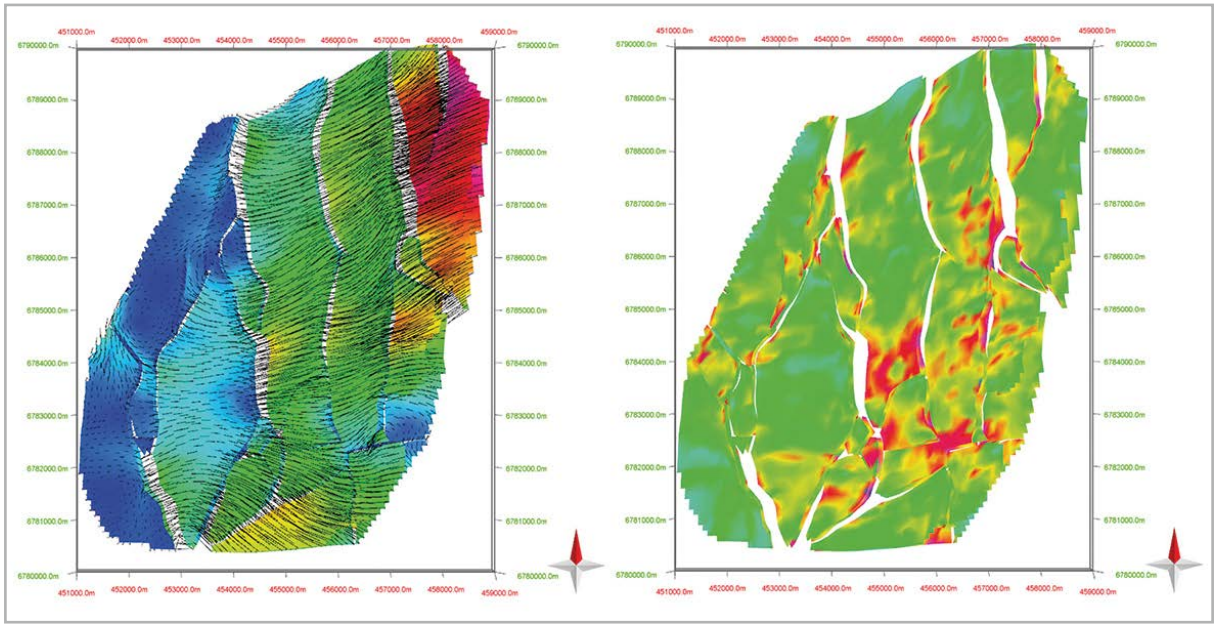


Our Geomechanical Modelling module uses elastic mechanical properties and physical laws of motion (Mass-Spring methodology, e.g. Wang et al. 2006) to mimic 3D rock deformation. Rapid modelling based on different geological assumptions can be done by running and saving multiple restoration scenarios with different mechanical properties, pin and fault displacement parameters.

The Mass-Spring algorithm calculates forces on the point masses, which are assigned to the surface or volume vertices (and are connected by simulated springs). These forces govern the point mass trajectories and simulate physical behaviour of the surfaces during restoration, associated with heterogeneous strain. This differs from the approach used in kinematic modelling, where geometric rules govern point trajectories.

- Physics-based 3D rock deformation modelling
- Save scenarios
- Rapid run times
- Strain capture
- Multiple outputs for Fracture Modelling

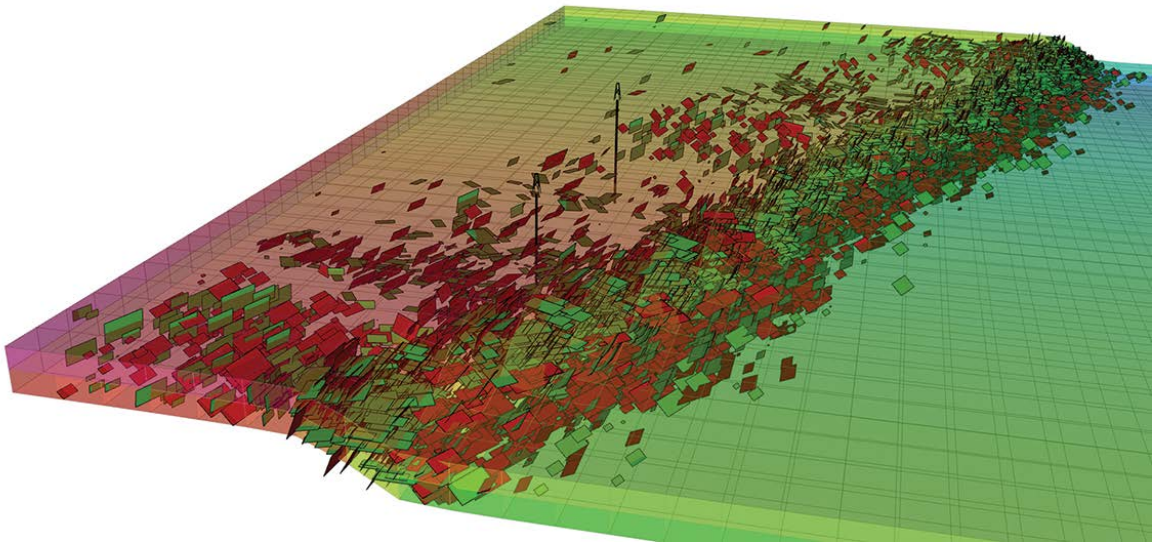
- Use a flexible workflow to conduct the restoration.
- Model rock deformation using Young's Modulus and Poisson's Ratio.
- Define fault displacement cut-offs to close fault gaps on the selected surface.
- Apply boundary conditions: projection to target, restore fault displacements, change area/volume.
- Control how quickly the restoration converges on a solution, and is deemed to be complete.
- Use the strain magnitude captured during modelling as an input for Fracture Modelling.



Wang, Y., Xiong, Y., And Xu, K., 2006, A mass-spring model for surface mesh deformation based on shape matching: proceedings of ACM Graphite 2006, pp. 376-380, Kuala Lumpur.

FRACTURE MODELLING

A tool for creating Discrete Fracture Network (DFN) models from an input geocellular volume and for calculating properties for reservoir simulation.



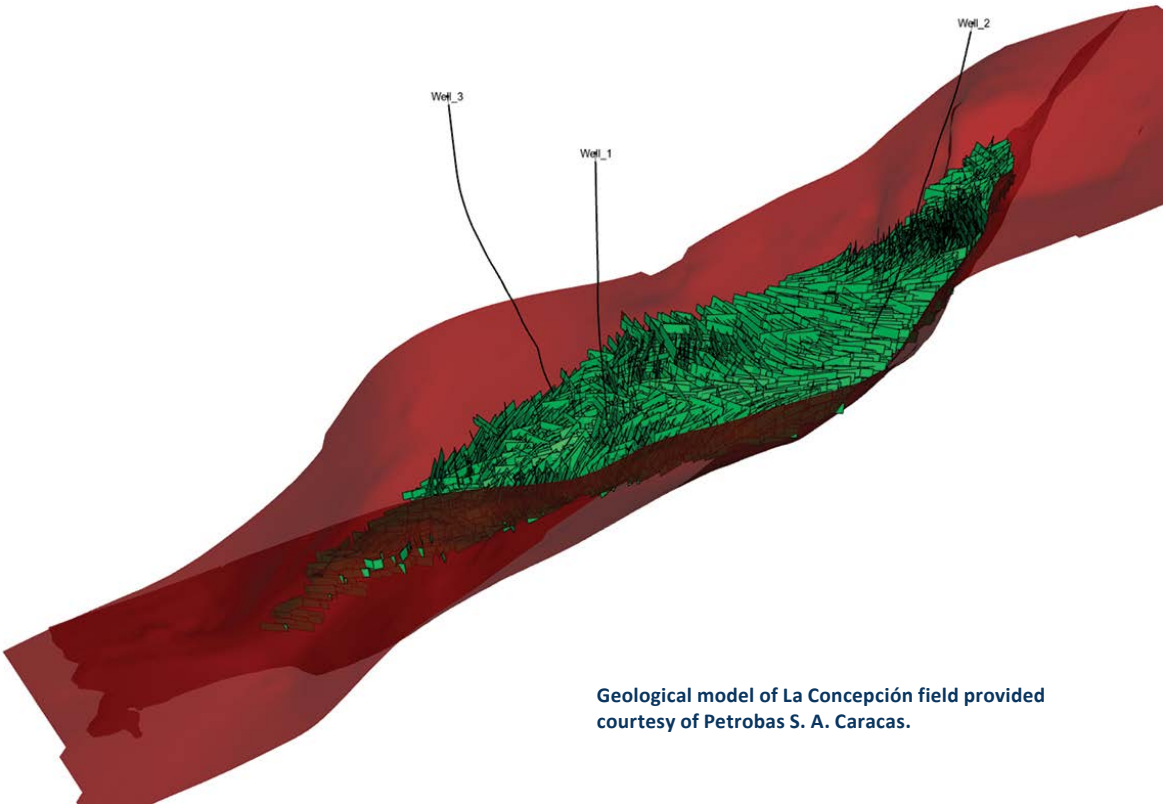
The Fracture Modelling module generates Discrete Fracture Network (DFN) models from an input geocellular volume. The workflow-driven approach guides users through the fracture modelling process, is easy to use, and facilitates rapid development of multiple fracture models. Combination with other MOVE modules (e.g. 3D Kinematic Modelling) provides a unique capability to build and test geologically valid fracture systems.

- Creation of 3D Discrete Fracture Network (DFN) models comprising multiple fracture sets.
- Versatile modelling from a range of input properties.
- Connectivity analysis of DFN models.
- Calculation of volume-based, flow related properties of the fracture network such as secondary porosity and secondary permeability tensors.

The tool uses a volume-based approach to create fractures on a cell-by-cell basis with input parameters defined for each cell of the volume. Input parameters are the size (length and aspect ratio), size distribution, orientation (dip and dip azimuth), density, and aperture of fractures. Fractures are discrete rectangular elements and multiple fracture sets can be created simultaneously. After creation of a DFN, the connectivity of fractures in the network can be calculated as well as fracture-related flow properties for each cell, including secondary porosity, secondary permeability, sigma, and fracture intensity.

Combining the Fracture Modelling module with other advanced modules, such as the 3D kinematic modelling, Strain Capture, and Stress Analysis modules allows integrated fracture modelling workflows to be performed. As an example, strain calculated using the 3D Kinematic Modelling module can be used to define input properties for fracture modelling. The mechanical stability of the DFN model can then be calculated using the Stress Analysis module.

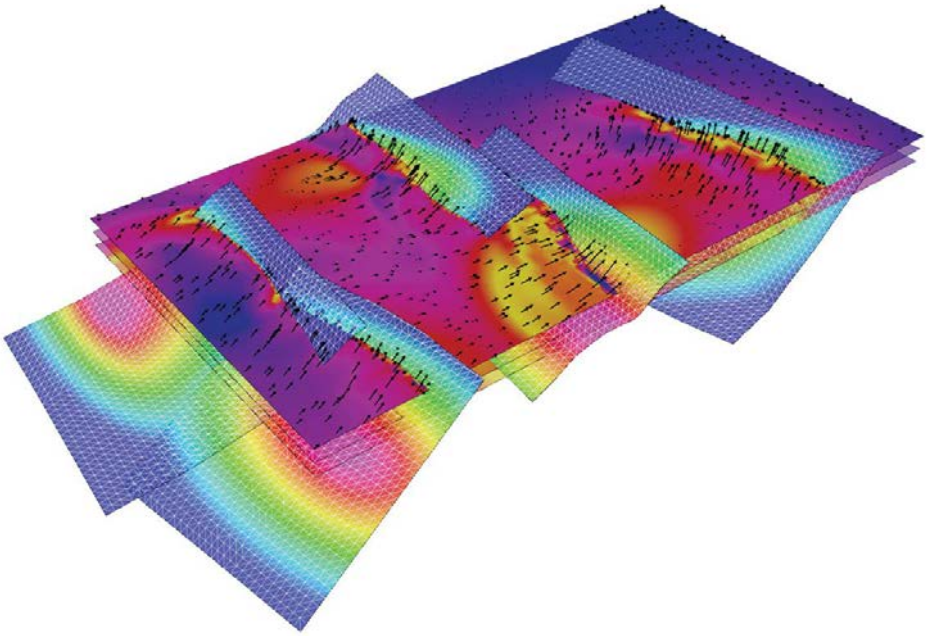
- Generate DFN models from a range of input parameters, including:
  - Purely statistical DFN models created from no input properties.
  - DFN models created from properties in each cell of the input volume (e.g. strain).
  - Hybrid DFN models combining statistical and property-based methods.
- Save Fracture Modelling sessions so that previous sessions can be quickly revisited.
- Preview results before running a full simulation allowing for computationally expensive simulations to be identified.
- Filtering of fracture sets for easy visual interrogation of results.
- Save results as discrete fracture objects, either as sets or as individual fractures.



Geological model of La Concepción field provided courtesy of Petrobas S. A. Caracas.

FAULT RESPONSE MODELLING

Boundary element modelling to simulate displacement on faults, and geomechanical analysis of surrounding fracture systems.



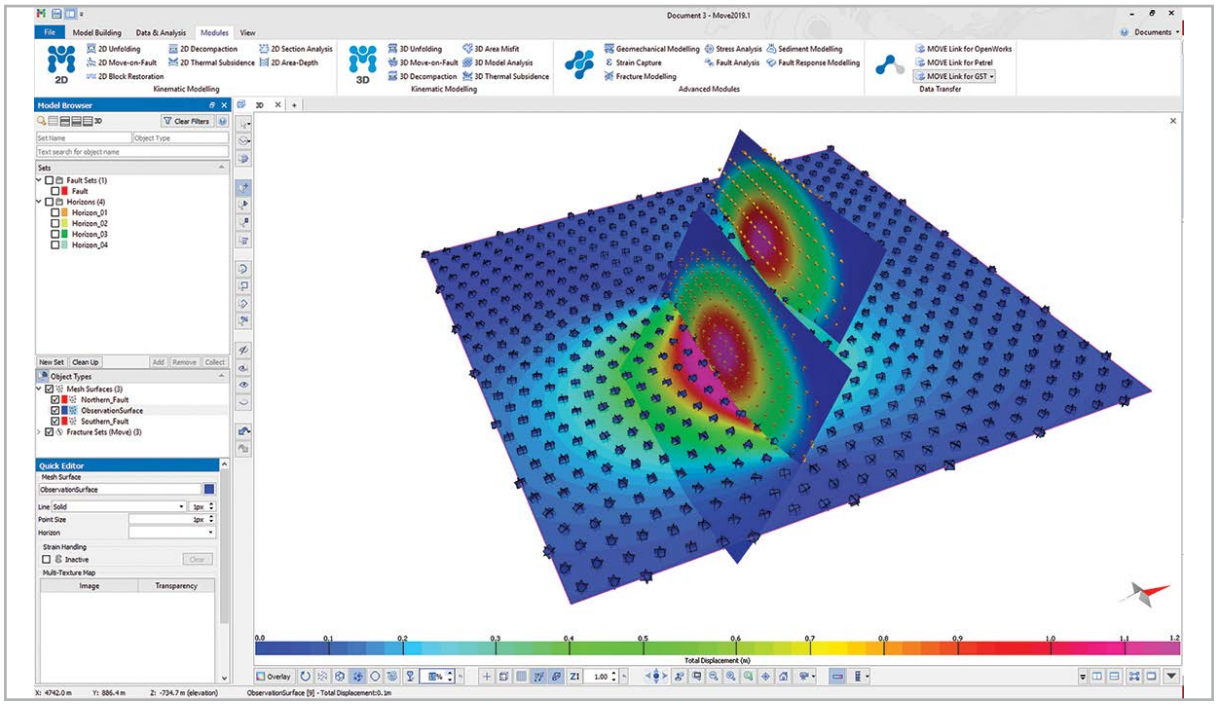
The Fault Response Modelling module is a highly versatile tool that can be used to validate your interpretation, identify highly fractured zones and realistically model stress perturbations around faults and other discontinuities.

The module considers mechanical properties to reproduce fault-related deformation and provides a quantitative assessment of the surrounding fracture system. Faulting is simulated using a boundary element method with triangular elastic dislocations. This approach allows complex faulting scenarios to be quickly tested and evaluated.

Results of Fault Response Modelling simulations can be used to predict near fault fractures which has an application for many sectors including hydrocarbons and mining. Fractured reservoir potential can be evaluated and the risks associated with drilling near faults can be better understood. Areas near faults which may have acted as conduits for upwelling mineralizing fluids can be assessed and the results used for exploration and development of mineral deposits, such as Carlin-type.

- Calculate the displacement on faults from a regional stress field
- Compute and visualize displacement, strain and stress induced by faulting
- Predict spatial distributions of sub-seismic fault and fracture systems
- Assess the reactivation potential of faults and fractures

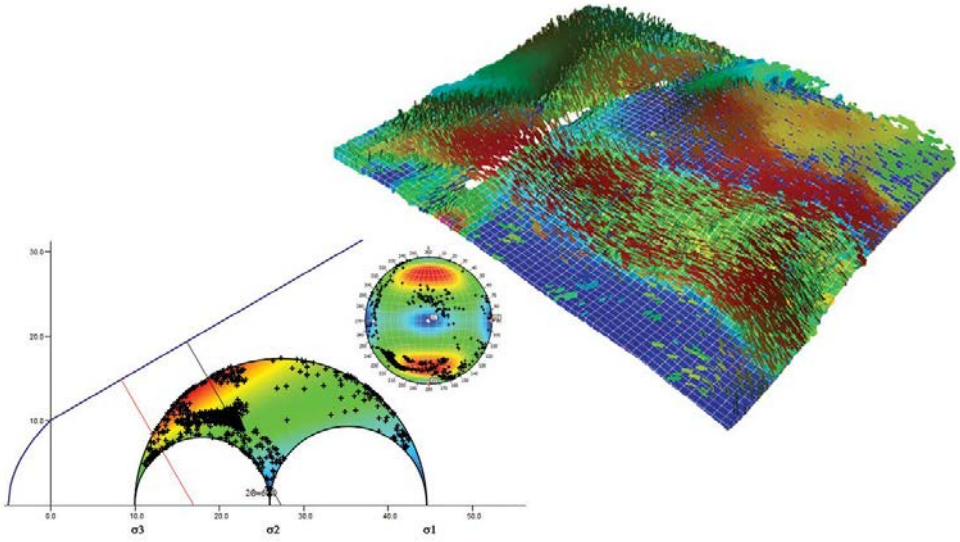
- Ability to model a wide range of scenarios; displacement on faults can be individually defined or calculated from a user-defined regional stress field, with the ability to model strike-slip, dip-slip or opening/closing components of displacement.
- Complex geometries of faults and other discontinuities can be modelled, including enclosed bodies like salt diapirs and igneous intrusions.
- The inclusion of Slip Zone Modelling (Jeyakumaran 1992) allows the user to model realistic slip profiles and strain transfer between faults.
- Displacement, strain and stress are calculated at observation points in surrounding rock volume with defined elastic and mechanical properties.
- Shear and normal stress components can be calculated for fault and fracture systems.
- Relationships between shear and normal stress can provide information about fracture intensity, mode of failure and reactivation potential.
- Optimal fracture orientations can be derived by using the shear and normal stress components to identify the fractures with highest Coulomb Stress.
- Fracture sets can be filtered based on fracture stability and Coulomb Stress failure, allowing the fractures exceeding the failure criteria to be easily visualized.
- Different fracture sets can be generated and compared to the orientations of real fractures using Angular Misfit.
- Pressure perturbations around reservoirs can be simulated by calculating the displacement induced by pressure acting on a triangulated surface. The Boundary Element Modelling approach provides rapid results, and the ability to model multiple scenarios quickly.
- *New* Monte Carlo Stress Inversion: an iterative-statistical approach to reduce uncertainty when calculating principal stress orientations and ratios from earthquake or microseismic data.



Jeyakumaran, M, Rudnicki, J.W, Keer, L.M., 1992, Modeling slip zones with triangular dislocation elements; Bulletin of the Seismological Society of America, Vol 82, no. 5, p.2153-2169.

STRESS ANALYSIS

A tool for quickly evaluating the geomechanical response of geological features to stress field scenarios, such as present day or paleo-stress. Additionally, a tool for inverting stress fields from lineation data and loading micro-seismicity data for integration with other data in MOVE.

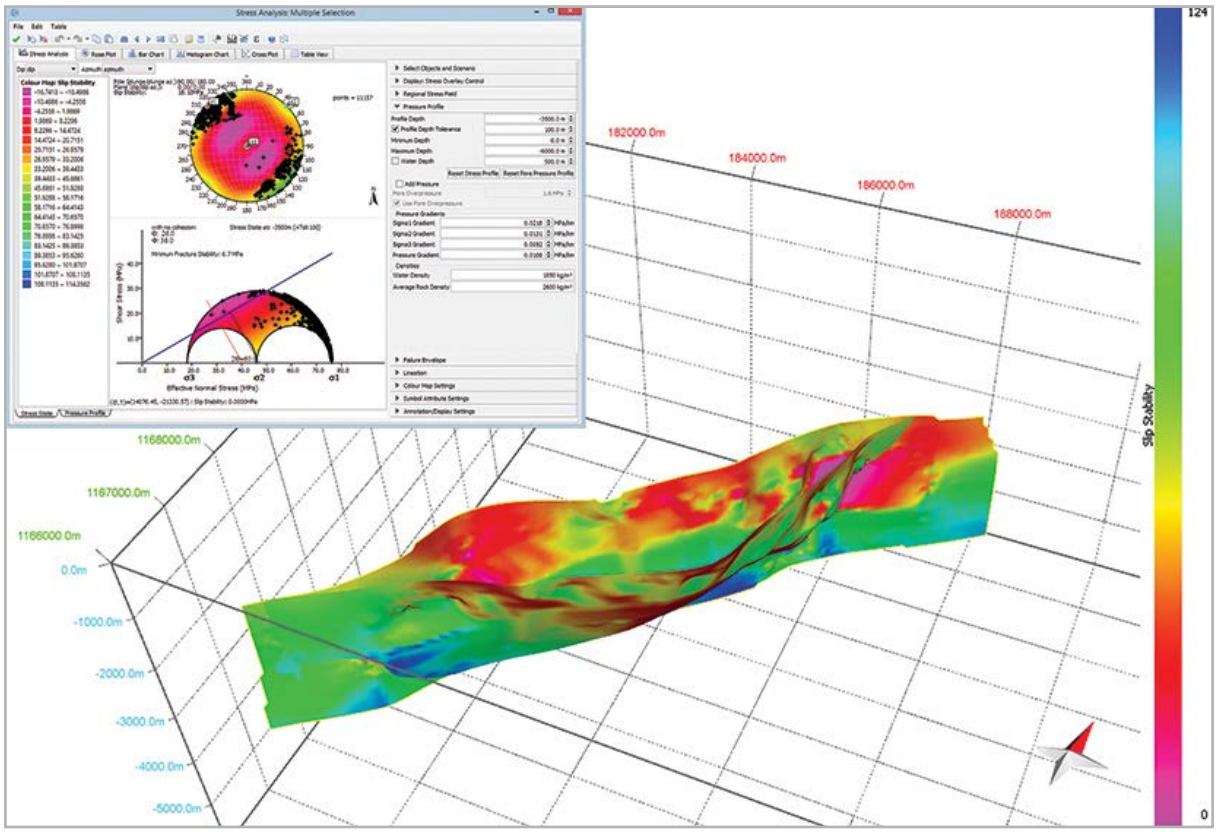


The Stress Analysis module is a tool for assessing the geomechanical response of geological features (e.g. faults and fractures) to an applied stress field. The orientation and magnitudes of the principle stress axes are easily defined in the tool, either manually in the toolbox or interactively in the stereonet. Stress magnitudes can be set as linearly increasing with depth or variable, using a pressure profile. Stress field scenarios can be saved to objects, allowing for quick scenario testing.

Once a stress field is defined, the effect of the stress field can be rapidly visualised and evaluated, both graphically and in 3D. Filtering of the results can be used to identify areas of greatest mechanical instability, which might indicate sweet-spots or reveal potential migration pathways or spill points. The tool has many applications in the hydrocarbon, mining, CO2 storage, and engineering sectors.

- Visualisation of geological features (planes and lineations) on a stereonet and Mohr diagram.
- Definition of a tri-axial stress system (σ1 > σ2 > σ3), with depth-dependent stress magnitude and pore pressure.
- Calculation of mechanical stability parameters (e.g. slip tendency and fracture stability) of features under any applied stress.
- Colour and visualise the mechanical stability of features in 3D.

- Freedom to define any stress regime scenario and a Mohr-Coulomb failure envelope suitable for the material being investigated.
- Visual display of shear and normal stress values when moving the cursor over the stereonet plot.
- Colour mapping of the stereonet plot and Mohr diagram for each stress attribute allowing easy assessment of likely unstable orientations.
- Compute and save stress-related attributes for slip tendency, dilation tendency, fracture stability, slip stability, retention capacity and leakage factor of planes and lines.
- Inversion of fault kinematic indicators (slickenlines) to derive a regional stress state.
- Moment tensor decomposition from earthquakes and focal mechanism display (beachballs).



Geological model of La Concepción field provided courtesy of Petrobas S. A. Caracas.

MOVE LINK FOR PETREL

MOVE Link for Petrel provides a means for Petrel users to share data with Petex's structural modelling and analysis software suite MOVE.

- Achieve fast, direct transfer of data from Petrel to MOVE and back again
- Once data is in MOVE, it is possible to perform the full range of restoration, validation, balancing and advanced structural modelling workflows.
- The Petrel Input and Models panes are replicated inside MOVE to allow easy and fast selection of objects to be transferred.
- Interactively add and remove data objects from the session, even if the connection between MOVE and Petrel is closed.
- Automatically detects changes to geometry and attributes and allows these to be saved back to Petrel.
- Provides support for 3D grids, horizon surfaces, fault surfaces, point set, triangle mesh, fault sticks, fault and horizon interpretation, structured surface objects, fracture sets and attributes, 2D/3D seismic data and wells including markers and logs.
- Ability to transfer complete 3D grids with functionality to extract horizon and fault surfaces.
- New for MOVE 2019, fault sticks can now be extracted from 3D grids and an option to exclude well logs when transferring wells so that trajectory and marker information may be transferred faster.

MOVE LINK FOR OPENWORKS

The MOVE Link for OpenWorks lets MOVE users import their data directly from a Landmark OpenWorks R5000 data store.

Once in MOVE, it is possible to perform the full range of restoration, validation, balancing and advanced structural modelling operations.

There is support for multiple OpenWorks data object types including seismic data and faults plus horizon extraction.

- Validate your models without the need to export ASCII using the MOVE Link for OpenWorks.
- Achieve fast, direct transfer of data from R5000 to MOVE.
- Interactively add and remove data objects from the session.
- Pull a subset of objects from R5000 via a MOVE standard tree view.
- Supports geometry and attributes.
- Provides support for data types including faults, grid surfaces, horizon 2D data, horizon 3D data, 2D/3D seismic data and well tracks.
- Provides a detailed OpenWorks model description and attributes output.

MOVE LINK FOR GST

Share project data across your organisation using the MOVE Link for GST (Geosciences in Space and Time).

The MOVE Link for GST provides a direct, two-way link to Giga Info Systems (giga-infosystems.com) and the GST Database solution. This allows you to share the results of MOVE's full range of restoration, validation, balancing and advanced structural modelling workflows across your organisation and via GST's web-portal. Multiple users can view, edit and query data held within GST directly from the MOVE desktop.

- Support for GST 2 and GST 3.
- Fast retrieval of features based on spatial locations, geometry type and schema.
- Supports point, line, polygon, mesh, and GST Block Models.
- New for MOVE 2019, compatibility with Regular 3D Grids.
- Features retrieved from GST are fully integrated with standard MOVE tools.
- Automatic filtering of connections streamlines the loading of features.
- Edits can be saved back to GST storage or kept within MOVE.
- Auto Match speeds up matching attributes for upload.
- Using full or partial locking, multiple users can make and save changes at the same time.
- Changes to GST features made by other users can be applied to update existing MOVE documents with a single click.
- Data is held securely within corporate database systems and can be shared with other MOVE users or via GST Desktop and Web Interface.

DIGITAL FIELD MAPPING

Collect data in the field ten times faster than using traditional methods with our two applications for field geologists.

FIELDMOVE CLINO

FieldMOVE Clino is a free digital compass-clinometer app for gathering geological data on your smartphone. The app allows you to use your phone as a traditional hand-held bearing compass, as well as a digital compass-clinometer for measuring and collecting georeferenced orientations of planar and linear features in the field. You can also capture and store geo-referenced text notes and photographs within the app.

FieldMOVE Clino been designed and optimised for compact iPhone and Android smartphone devices (screen sizes <7”). Summary of features:

- Digital compass clinometer using device internal sensors to quickly measure the orientation of planar and linear features in the field, which are then recorded and georeferenced.
- User defined list of rock units or stratigraphy.
- Digital notebook and camera within the app allowing geo-referenced text notes, photographs and screenshots to be captured and stored.
- Geo-referenced basemaps in MBTile or GeoTIFF format can be imported and stored on the device for use where mobile data is not available, or use online map services.
- Automatic positioning using the GPS in your device or manual over-ride.
- Use Bluetooth GPS (iOS tested).
- Easy editing of data and projects.
- Export your data as MOVE or CSV files to other applications such as MOVETM.
- Expanded library of symbols for planar and linear data.
- Data can be plotted on stereonets in the App, allowing users to analyse and plan based on field observations and measurements.
- Draw contacts, faults and outcrop polygons on your chosen basemap (iOS only).
- Export your data as KMZ for integration with Google Earth.

FIELDMOVE

FieldMOVE is a free map-based app for digital field mapping and geological data capture. The app is presented in a map-centric format for use on larger (> 7”) touchscreen tablets. You can use the drawing tools, which include a virtual cursor, for precision drawing to add georeferenced geological boundaries, fault traces and other linework to your basemap. It is also possible to create simple polygons to show the extent and distribution of rock types and other geological features.

FieldMOVE is designed for iPad and Android tablets and has the following features in addition to those of FieldMOVE Clino:

- Virtual mouse for creation of detailed linework.
- Interactive editing of linework and the ability to sketch on captured photographs.
- Support for devices with screens larger than 7”.
- Layering of map images with adjustable transparency.
- Map-centric workspace.
- Supports Mapbox™ online maps and can cache this extensive online map service to work offline in the field.

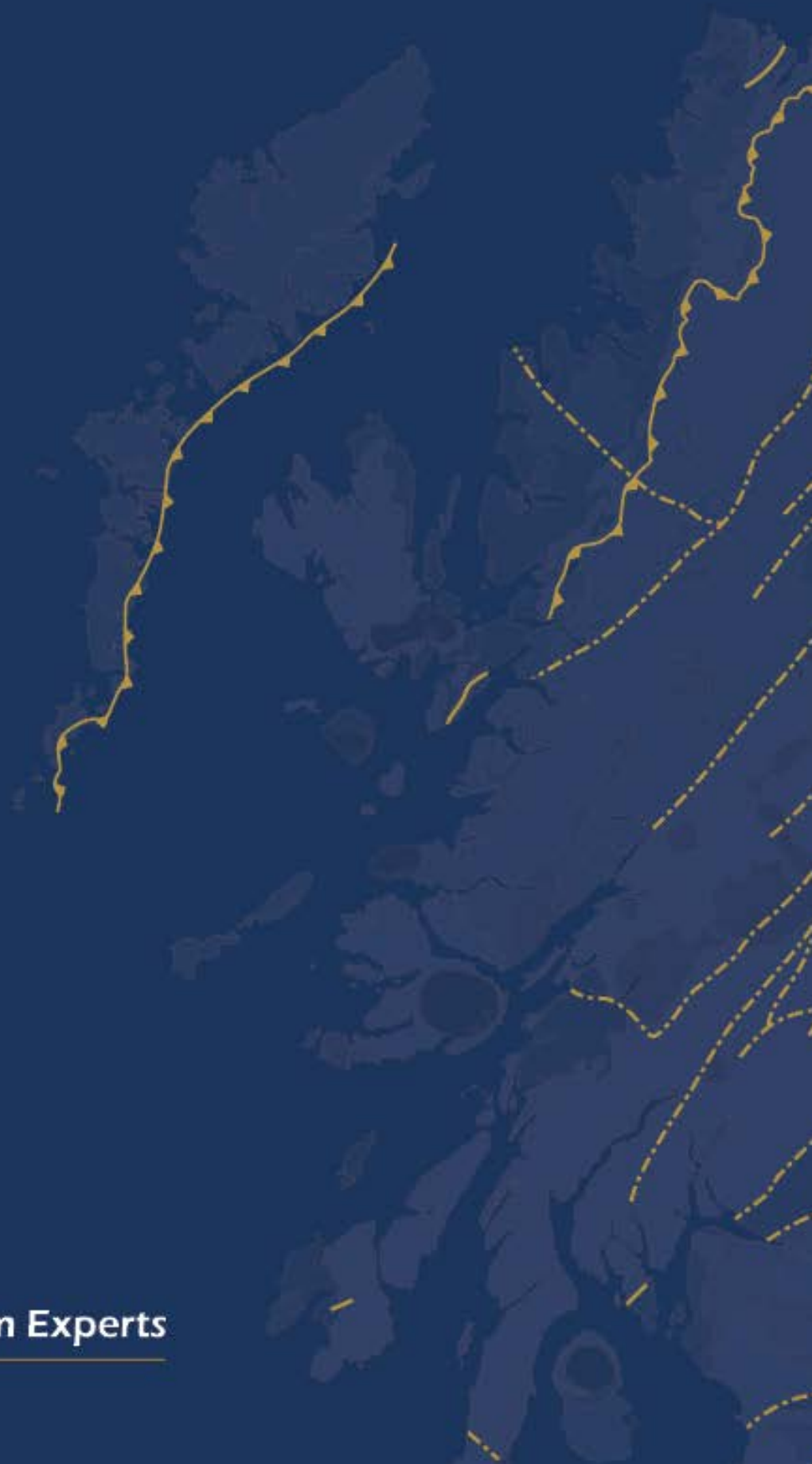
A more in-depth user guide and brochure is available on our website: www.petex.com/products/move-suite/digital-field-mapping

FieldMOVE and FieldMOVE clino are available to download from the following app stores:

Download on the App Store GET IT ON Google Play

Petex House
10 Logie Mill
Edinburgh
EH7 4HG
Scotland, UK

Tel: (44) 131 474 7030
Fax: (44) 131 474 7031
Email: edinburgh@petex.com
www.petex.com



Petroleum Experts