



MOVE 2020, IPM 12.5 – Overview

- **MOVE 2020** is now a part of the IPM 12.5 release:
 - Single installer with **MOVE, RESOLVE, REVEAL, GAP, PROSPER, MBAL, PVTP, OPENSERVER**.
 - Important for API and workflows that utilise both **RESOLVE** and **MOVE**.
- **MOVE 2020** introduces a brand new 3D Regular Grid data type:
 - Supports Geostatistical data, Attribute data, Geophysical data, including seismic, potential field, electrical or electromagnetic data, Velocity data, and Porosity data;
 - Supports ASCII, GOCAD Voxet (.vo), or Move link for GST;
 - Support in 3D, Section and Map Views, as well as Attribute Browser and Query tool support;
 - Velocity cube support in the 3D Depth Conversion tool;
 - Porosity cubes support in the 3D Decompaction tool.
- **MOVE 2020** extends further the new API for either **RESOLVE** (licensed separately) or **OPENSERVER** (licensed separately) that was introduced in MOVE 2019. More **MOVE** tools exposed to the API.
- Included in the 2D Kinematic Modelling improvements:
 - Improved Displacement Analysis display in Section Analysis
 - Support polygons for improved calculations in Area-Depth
- New Calculate Effective Shale Gouge Ratio (ESGR) option in the Fault Analysis tool
- New direct solver option in the Fault Response Modelling tool for when applying the slip zone modelling technique.
- **MOVE 2020** also includes new developments to allow compatibility with Petex's Model Catalogue product (licenced separately)
- **MOVE** links to Petrel and GST updated to support latest versions
- Numerous additions and improvement are listed later in more detail in the What's New in **MOVE 2020 – IPM 12.5** section that can be found in the MOVE Knowledge Base
- To find out more about the developments, enhancements and bug fixes in **MOVE 2020** please visit the Petex Client Web User Area.



MOVE 2020, IPM 12.5 – What's New

MOVE 2020 is now here and is part of the **Integrated Production Modelling software (IPM) 12.5 release**. The first version was released on 7th December 2020 and is available for download to all our maintained clients and academic users.

There is a unified single installer which now includes all Petex engineering and geological software, including **MOVE, RESOLVE, REVEAL, GAP, PROSPER, MBAL, PVTP and OpenServer**. This is important for the creation and execution of visual workflows that utilise both RESOLVE and **MOVE** via the **Application Programming Interface (API)**.

The **MOVE 2020** release follows on from the previous 2019.1 release of **MOVE** and includes new features, as well as improvements to the existing functionality and usability. This section provides an overview of the new features, enhancements, and performance improvements that include any changes to Move Core, the Move Modules, the Move Knowledge Base, plus the 2020 additions to the new **MOVE** Application Programming Interface (API) which was introduced as part of MOVE 2019.

Integrated modelling is achieved using the API, which provides a two-way gateway for communication between **MOVE** and external applications. Modelling tasks in **MOVE** can now be automated.

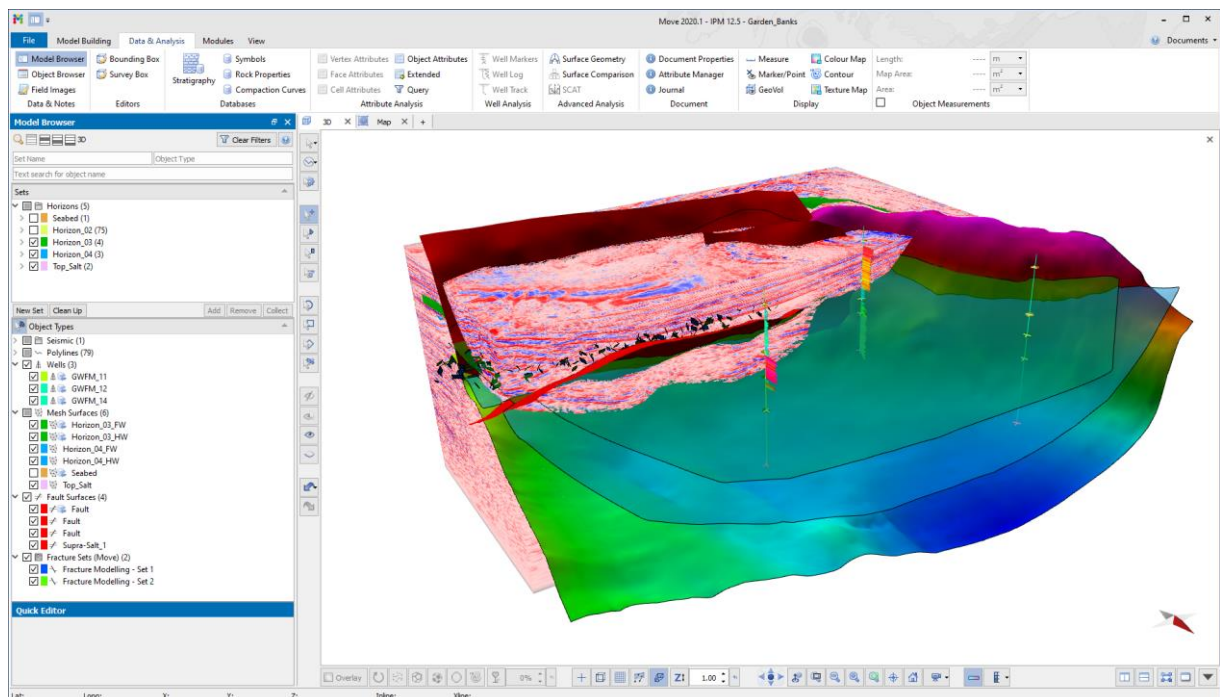


Figure 1: MOVE 2020 Interface with 3D View.



New data format - 3D Regular Grid

One of the major additions to 2020 is the new 3D Regular Grid format which allows users to load and display a range of data types including geostatistical data, attribute data including rock property data, geophysical data including seismic attributes and potential field data including gravity and magnetics.

For users, this provides the ability to integrate and analyse many additional data types in addition to those already supported in **MOVE**. The incorporation and visualization of data loaded using this new format can improve modelling of the subsurface in many ways. One advantage is that the data can be intersected onto 2D sections and used to better constrain 2D interpretations of the subsurface. It can also be used to improve workflows in the 3D Kinematic Modelling module. For example, velocity cubes based on this format can be used in the 3D Depth Conversion tool and similarly porosity cubes can be created in the 3D Decompaction tool.

Import/Export from/to ASCII files, GOCAD Voxet (.vo) files, or transfer via Move link for GST

Data loaded as 3D Regular Grid in MOVE can be converted to seismic attribute cubes or GeoCellular Volumes, and seismic velocity/amplitude or attribute cubes can be converted to 3D Regular Grid.

There is support for display in 3D, Section and Map Views, as well as Cell Attribute Browser support. Use of attribute and spatial query with the Query Tool is also supported.

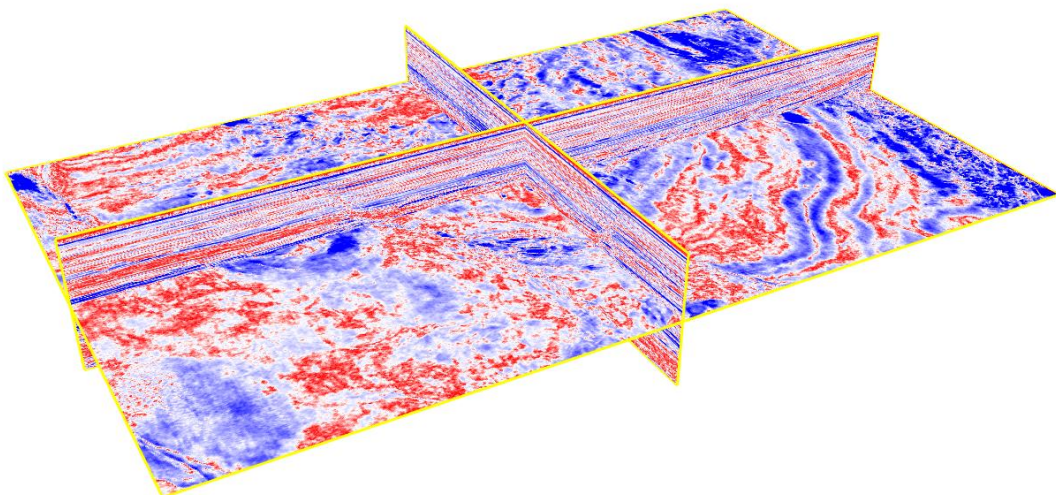


Figure 2: Seismic envelope attribute data loaded into MOVE using 3D Regular Grid format and displayed as a volume with inline, xline and depth slices shown.



Integrated modelling & API

For MOVE 2019, a brand new **Application Programming Interface (API)** was developed and introduced, and MOVE 2020 builds further on this.

Petroleum production systems incorporate many modelling domains and specialities. The multi-disciplinary nature of such systems risks isolation of modelling and imposition of artificial boundary conditions. This risks the model deviating from the reality in the field and therefore not being representative and predictive. Integrated modelling is the practice of using technology to remove artificially-imposed boundaries using automated and efficient communication between modelling software tools. This enables automatic review of a model in one domain against models and data from other disciplines, ensuring assumptions are consistent in all components of an integrated model. For geological modelling, integrated modelling will streamline the validation process with any available dynamic production data, as well as enable efficient update of the reservoir model as understanding evolves.

Integrated modelling is achieved using the API, which provides a two-way gateway for communication between **MOVE** and external applications. Modelling tasks in **MOVE** can now be automated. Doing so:

- Increases **efficiency**.
- Removes **subjectivity**.
- Makes analyses **documented** and **repeatable**.
- **Encapsulates** knowledge.

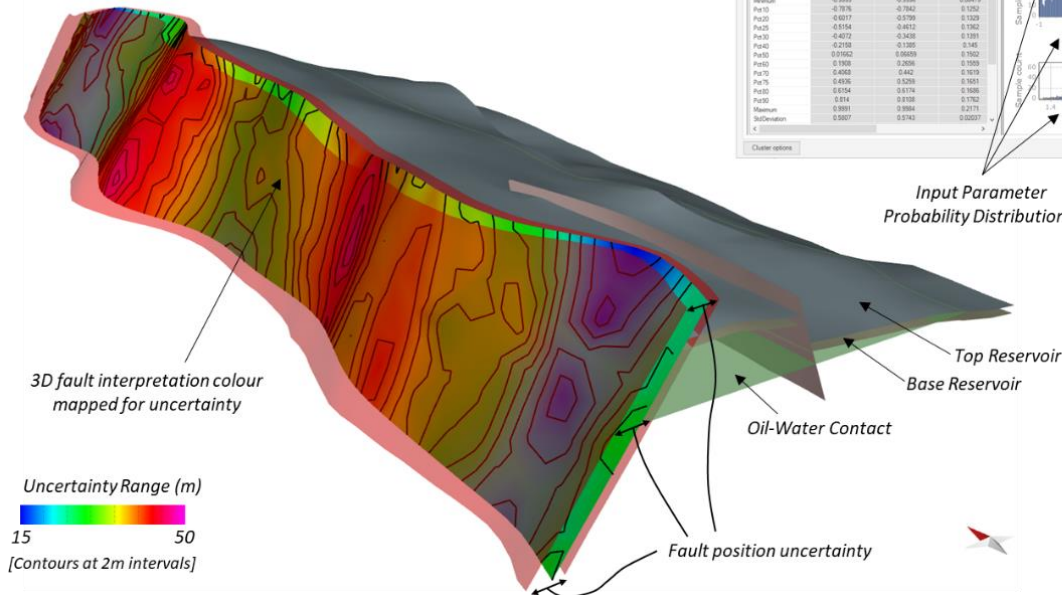
In addition to automation, connection of **MOVE** with the **RESOLVE** software (licensed separately) provides access to additional modelling tools and connections to a large network of software (Petex and non-Petex). As an example, tools such as the optimised search and sensitivity modelling tools in **RESOLVE** can be combined with structural analysis in **MOVE** to perform modelling tasks that were previously not possible. Additionally, the connection of **RESOLVE** to many other programs, such as reservoir simulators, provides a mechanism to automatically connect the outputs from structural modelling with dynamic modelling.

Several practical examples have been developed to demonstrate how automation of **MOVE** adds value to current modelling practices, including:

- Automated creation of deformation profiles from several 2D interpretations.
- Integrated analysis of propagation folding, including automated fault prediction and identification of optimal trishear parameters.
- Assessment of how structural uncertainties impact volumetric estimates (*see image below*).
- Automatic modification of faulted geometry and fault-rock properties in a simulation grid and comparison with production data.



a) Geological Model in MOVE



b) Sibyl Sensitivity Modelling in RESOLVE

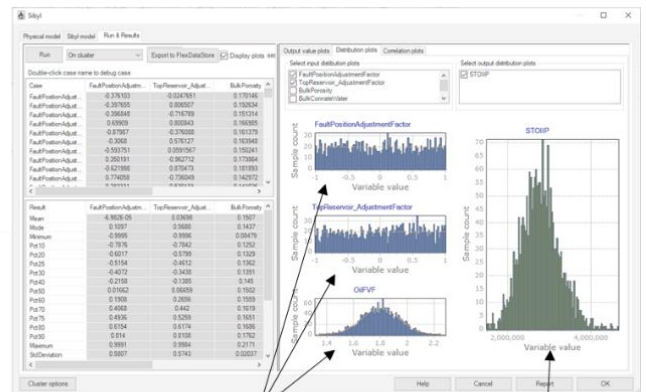


Figure 3: Assessment of how uncertainty in the interpretation of structural features impacts volumetric calculations. Uncertainty ranges are quantified (a) and the impact of the uncertainty on volumetric estimates is explored using the Sibyl sensitivity analysis tool in RESOLVE (b).

The continuing development work during 2020 facilitated the connection of many more **MOVE** tools and operations with **RESOLVE** and **OpenServer** for IPM 12.5 - MOVE 2020.

In Data & Analysis, the Surface Geometry and Compaction Curves tools have been connected to the API. Within Model Building tools, Create Point, Create Dip, Create Line (From Points), Create Fault (From Points), Split Surfaces, and Advanced Transform have been exposed to the API, among others. This increases the flexibility of users' workflows, which now can add basic automatic model creation to validation and restoration automated analyses. Lastly, Unfolding, Decompaction and Thermal Subsidence (in 2D and 3D) have been added to the list of available tools to be handled from **RESOLVE** and **OpenServer**, allowing complete structural restoration and forward modelling visual workflows to be built and run.



Model Catalogue Updates

MOVE 2020 includes developments to continue to allow compatibility with Petex's Model Catalogue product (licenced separately).

Model Catalogue is a version control and model management system. This new development provides significant improvements for multiple users that are working on a single **MOVE** file. A **MOVE** model can be loaded into **Model Catalogue** and the contents of the model are registered. The most up-to-date version of a model is maintained and **Model Catalogue** notifies a user if the model is being worked on by someone else. Once a user has finished working on the model, any changes are tracked and recorded. Users can leave comments for other users outlining the work that has been completed or the changes that have been made.

Fault Analysis – new Fault Seal Analysis technique

The Fault Analysis module in **MOVE** now provides the capability to calculate **Effective Shale Gouge Ratio (ESGR)** values across faults enabling a more comprehensive set of options for calculating fault seal potential. The ESGR algorithm (Knipe et al., 2004) alters the SGR algorithm (Yielding et al., 1997) to give a greater weighting for fault rock composition to units that are more proximal to the part of the fault being examined (Figure 4). The newly implement algorithm also considers both hanging wall and footwall lithological packages rather than just the hanging wall. ESGR values can be computed in **MOVE** by combining hanging wall and footwall values using a variety of methods and various proximity weightings can be applied to lithologies that make use of Gaussian and linear functions. Published work indicated that ESGR can provide a more realistic prediction of fault rock clay distribution than SGR (Freeman et al., 2008).

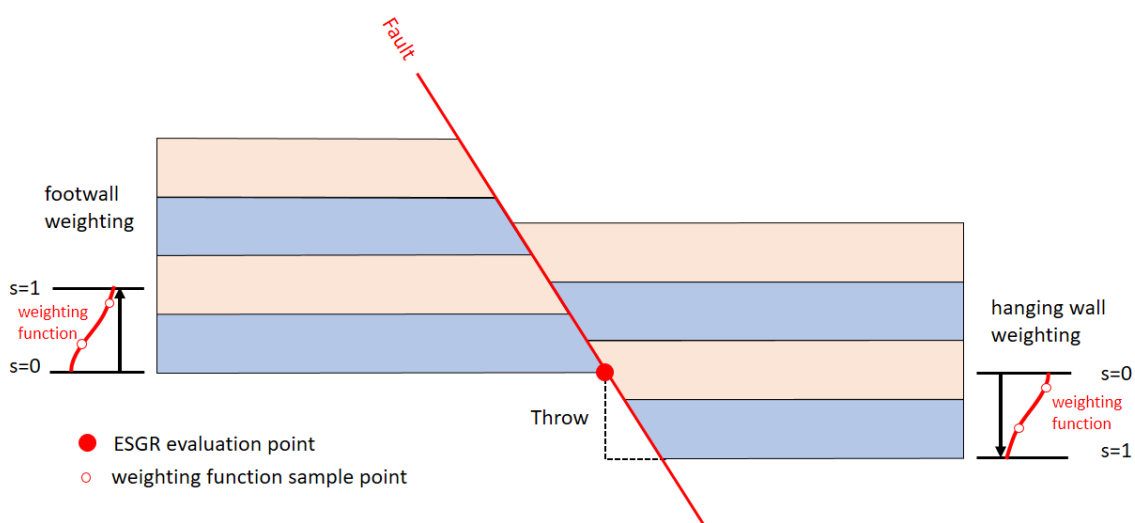


Figure 4: Schematic diagram showing weighting of hanging wall and footwall rock properties for ESGR calculation.



Fault Response Modelling - new slip zone modelling method

A new **direct solver option** is now available in Fault Response Modelling (FRM) when applying the slip zone modelling technique. This new technique favours accuracy over speed, thus providing more accurate results when forward modelling slip on faults. Additionally, this method can solve where the previously implemented conjugate solver does not, ensuring more consistent and reliable results.

The new solver expands the capabilities of the slip zone modelling technique to calculate slip distributions on faults, which can then be used in FRM to calculate the associated displacement, strain and stress in the surrounding rock mass. This approach is used for many extractive industries, and in earthquake studies, to understand the likely behaviour of secondary features, such as fractures, following slip on faults (Figure 5).

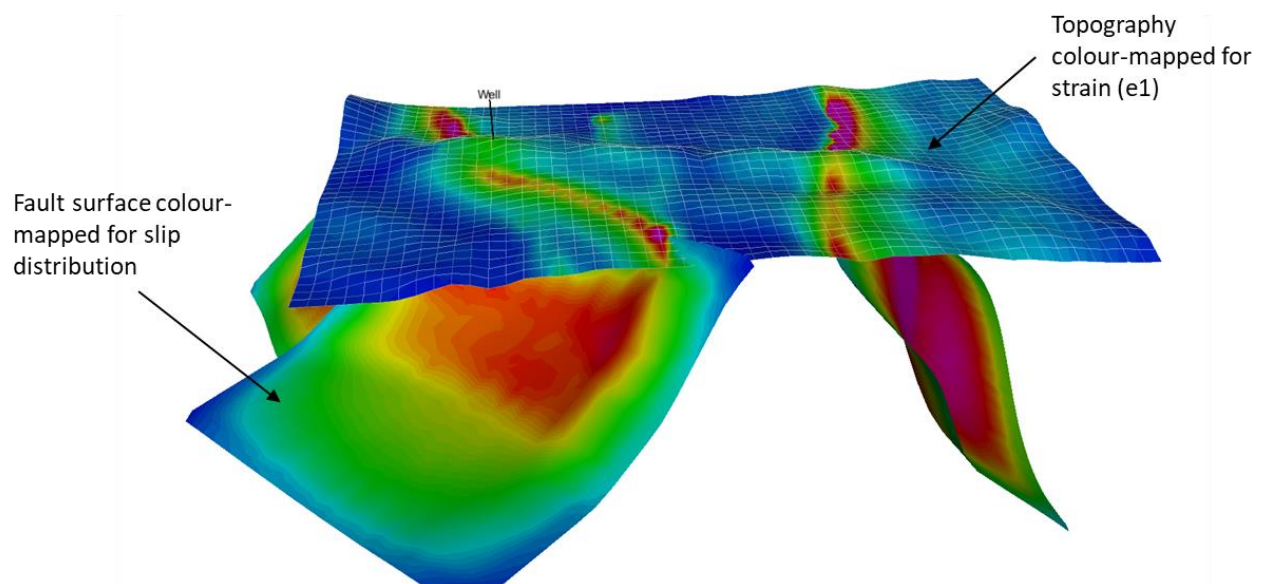


Figure 5: Fault Response Modelling simulation run with slip calculated using the direct solver option.

Slip zone modelling (SZM) takes into account the interaction of each triangular dislocation element (TDE) with all other fault TDEs in the simulation. As a consequence, a linear system of equations must be solved to determine fault slip for each TDE. A variety of linear solvers exist and often a trade-off must be made between accuracy and speed. By default, **MOVE** uses a conjugate gradient iterative solver with a relatively high tolerance applied which favours speed over numerical accuracy. Iterative solvers can fail to converge and the new direct solver provides a robust alternative to handle such scenarios.



MOVE 2020, IPM 12.5 – Updates & Fixes

As well as the major changes and additions outlined above please find below is a list of updates and improvement to **MOVE 2020** organised by **MOVE** interface tab:

Model Building

- In Surface Geometry, Attribute Creation is now set to Vertex Attributes by default where possible.
- In Project to Section, when projecting only wells within a fixed distance, there is a new option available to always project the complete well if part of the well track is within the distance.
- In the Split tool, when creating Intersection Lines, new options are available to transfer Object Attributes and/or Object Colours from the objects being split.
- Keyboard shortcut Ctrl+Alt+N can now be used to create a default new section.

Data and Analysis

- New 3D Regular Grid object (**see MOVE 2020 – IPM 12.5 - What's New section above**)
- In Colour Map tool, when using a logarithmic colour map, values are now rebinned. This equalises the division spacing on the colour bar.
- Logarithmic colour maps are now available for 3D Regular Grids.
- For GeoCellular Volumes, the Cell Attributes browser now supports displaying only the selected cells. When displaying only the selected cells, the Cell Attributes browser is read-only.
- Surface Geometry tool now allows creating Dip, Azimuth and Strike simultaneously.
- The Query Tool now supports querying 3D Regular Grids.
- Object Attributes now displays Average Plunge and Average Plunge Azimuth for each line.
- Object Attributes now displays Average Dip, Average Dip Azimuth and Average Strike for each surface. It can be used for selected objects or for all objects in the **MOVE** project.
- In the GeoVol display tool, the 'Remove Cells' option has now been replaced by a 'Select Cells' option. If desired, the selected cells can still be deleted using the Del key.
- **MOVE** now allows acres and acres-feet to be selected for displaying large areas / volumes.
- The Tree View controls for displaying attributes in tables has been improved with new options to collapse/ expand and select/ deselect the whole tree.
- A new ShapeFile export option has been added to split geometries into 2D and 3D files.
- When objects are exported in a 3D PDF, the current center of rotation for the 3D View is matched in the exported PDF.



- The status bar now shows the number of objects selected by the user (provided the user selects more than one object).
- Better visualisation of inner polygons in 3D views.

2D and 3D Kinematic Modelling

- Performance improvements when using Polygons to forward model or restore seismic images.
- In the Depth Conversion tools, the option Use Fixed Velocity to First Horizon is now available for Fixed, Equation and Database methods. This allows for water above the top of the model to be accounted for in the Depth Conversion calculation.
- It is now possible to view and attach to the model the calculated porosity as a 3D Regular Grid.
- 3D Regular Grids can now be used to depth convert using a velocity cube.
- It is now possible to view and attach to the model the calculated velocity as a 3D Regular Grid.
- In Decompaction tools, there is now an additional option to not remove the Top Bed when the option Calculate Isostasy Only is enabled.
- In 3D Move-on-Fault, performance improvements for the Fault Parallel Flow and Trishear methods.

Fault Analysis

- Effective Shale Gouge ratio (Knipe, 2004; Freeman, 2010) has been added to the fault seal proxy calculations. **(see MOVE 2020 – IPM 12.5 - What's New section above)**

Fault Response Modelling

- In Fault Response Modelling, when the option Slip Zone Modeling is enabled, there is a new Direct Solver option. **(see MOVE 2020 – IPM 12.5 - What's New section above)**

MOVE connections to RESOLVE and OpenServer (API)

- **See MOVE 2020 – IPM 12.5 - What's New section above.**
- 2D and 3D Decompaction tools are now exposed to API (RESOLVE and OpenServer).
- 2D and 3D Unfolding tools are now exposed to API (RESOLVE and OpenServer).
- Surface Geometry tool is now exposed to API (RESOLVE and OpenServer).
- Split surfaces functionality is now exposed to API (RESOLVE and OpenServer).
- Create Dip, Point, Fold Structure, Fault Structure and Lineation are now exposed to API (RESOLVE and OpenServer).
- Create Line (From Points) is now exposed to API (RESOLVE and OpenServer).
- Create Fault (From Points) is now exposed to API (RESOLVE and OpenServer).
- Creation and edition of Compaction Curves exposed to API (RESOLVE and OpenServer).



- Create Base Line and Create Top Line from selected objects exposed to API (RESOLVE and OpenServer).

MOVE Link for Petrel

- The MOVE Link for Petrel now supports use with Petrel 2020, Petrel 2019 and Petrel 2018.
- Arbitrary seismic lines can now be transferred as Section Traces and the 2D Seismic Image reinserted from the 3D Seismic Cube.

MOVE Link for GST

- 3D Regular Grids now transfer to GST
- Feature Sets and Features are now displayed in alphabetical order.
- The "Check for Name and Colour Updates" option is now set to on by default.
- There is now a means of rounding the extents to the nearest 10, 100 or 1000 m with the press of a button.
- New option to detect name and colour changes made by GSTDesktop (these changes do not produce a commit key), and update these when the refresh button has been pressed.
- Match Attribute Sheet has an improved layout.
- It is now possible to remove saved project extents from GST Storage.
- The version of MOVE Link to GST is displayed in the Modules Panel.
- When Loading objects from GST there are fewer delays when objects to load are selected.
- Method added to select the Extents as those of the selected **MOVE** objects.
- New option to do the same Attribute matching for all objects being uploaded
- It is now possible to download sets containing Features which are at Unit Level.
- Items connected to GST are identified by a Giga icon.
- It is now possible to define Polygon shaped Spatial Extents.

To find out more about the developments, enhancements and bug fixes in MOVE 2020 please visit the Petex Client Web User Area.