Release Notes

InterWell 2021

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BeicipFranlab

InterWell

Seismic inversion, seismic characterization and time-depth conversion solution

The major **InterWell 2021 release** brings a lot of new functionalities in the software, including but not limited to the following features :

- The **data conditioning** and **the database** have been improved, adding the **depth domain** for **seismic** and **horizon data**, as well as **key features** to scan and pre-process the **seismic gathers before stack**.

- The **seismic characterization offer** has been significantly enriched with **machine learning capabilities**, adding **new options** to the **discriminant analysis**, a **connected geobody extraction** module and **trace classification applications.**

- A **brand-new time-depth conversion** workflow allows to **build a velocity model** from **wells, horizons** and **seismic velocity,** while ensuring a perfect tie between the model and the **well markers.** It is now possible to **convert** any **seismic** or **horizon** from **time to depth,** and **reversely**, directly in the software.

Finally, the **licensing** has been reviewed to provide the **standard inversions**, the **seismic fracture** and **matrix characterizations**, **azimuthal workflow** and **the time-depth conversion** capabilities in the same "base" license bundle, to thank you all for your fidelity!

Feel free to contact us at support@beicip.com if you need any assistance while installing the new version.

INTERWELL : KEY FEATURES

An evolutive software used every day by specialists in multidisciplinary projects

QC & seismic data conditioning

Innovant tools and algorithm for :

- Signal analysis (frequency bandwidth, noise ratio…).
- Angle-stack generation and NMO correction on seismic gathers.
- New Seismic gather pre-conditioning.
- Post-stack and pre-stack seismic data conditioning, including RNMO correction.
- Fast-track AVO analysis to validate the AVO effects before inversion.
- 3D volume controls on maps (frequency maps, noise maps…).
- Variogram analysis and fitting.
- A global workflow for both 2D and 3D seismic data.

Seismic inversion

Acoustic inversion
Model-based or full-seismic inversion
Inter-Bed Multiples Modeling (IBMM) option

Elastic inversion
Model-based or full-seismic inversion

4D inversion

Azimuthal inversion

Geostatistical inversion

Multi-Component inversion

Reservoir characterization (Updated)

A large range of applications including applied machine learning

- Discriminant analysis to predict lithologies and its associated probabilities.
- Continuous property assessment through multi-variate analysis (VSH, porosity, TOC).
- Geostatistical 3D characterization (multi-realization, multi-seed).
- Complete extraction module to get key statistics on both property and facies volumes.
- Kriging to derive key property maps honoring both prediction and well data.
- Horizon-slice supervised and un-supervised clustering to identify typical zones as maps.
- 3D connectivity processing to extract geobodies and its associated analysis.
- Fracture network characterization through a dedicated workflow.

Time-depth conversion (New)

An exhaustive time-depth conversion module

- Velocity analysis including trends at wells and average velocity maps.
- A large range of functionalities to build the velocity model.
- Available post-processing for velocity models (merge and smoothing).
- Automatic residual analysis at wells and dedicated velocity calibration workflow.
- Generation of the calibrated velocity model, exportable as a SEG-Y.
- Time-to-depth and depth-to-Time conversion.

InterWell

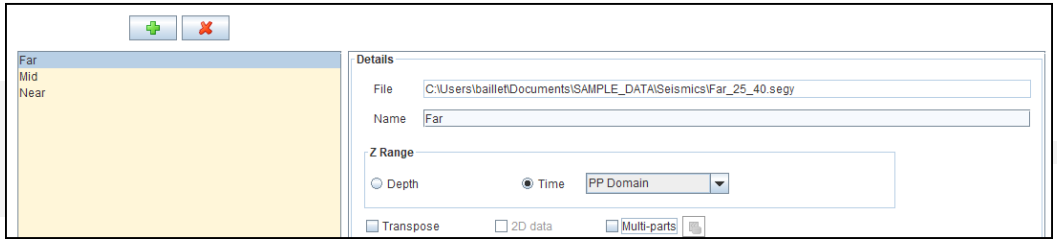
Release 2021.1

What's new in database and data conditioning ?

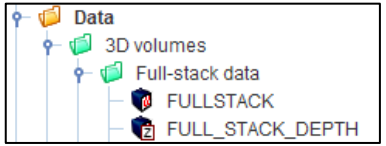
DEPTH SEISMIC DATA IMPORT

It is possible to **import seismic volumes (SEP or SEGY)** in **Depth domain**. For this domain, the step is independent from the survey definition in Time. The depth data have the same icon than the TWT data, with **a "Z"** indicating the Depth domain.

Import wizard : Z range domain, supporting depth or time selection

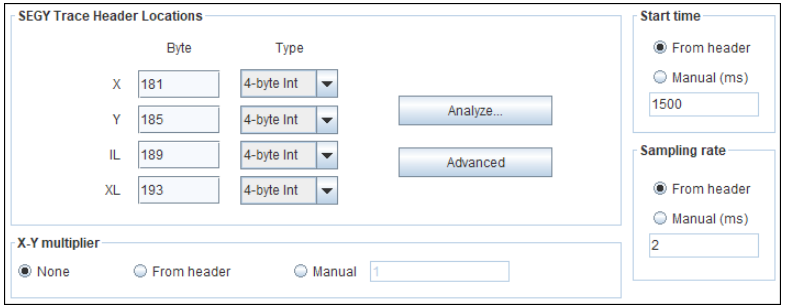


Depth/time seismic example



Depth data in InterWell

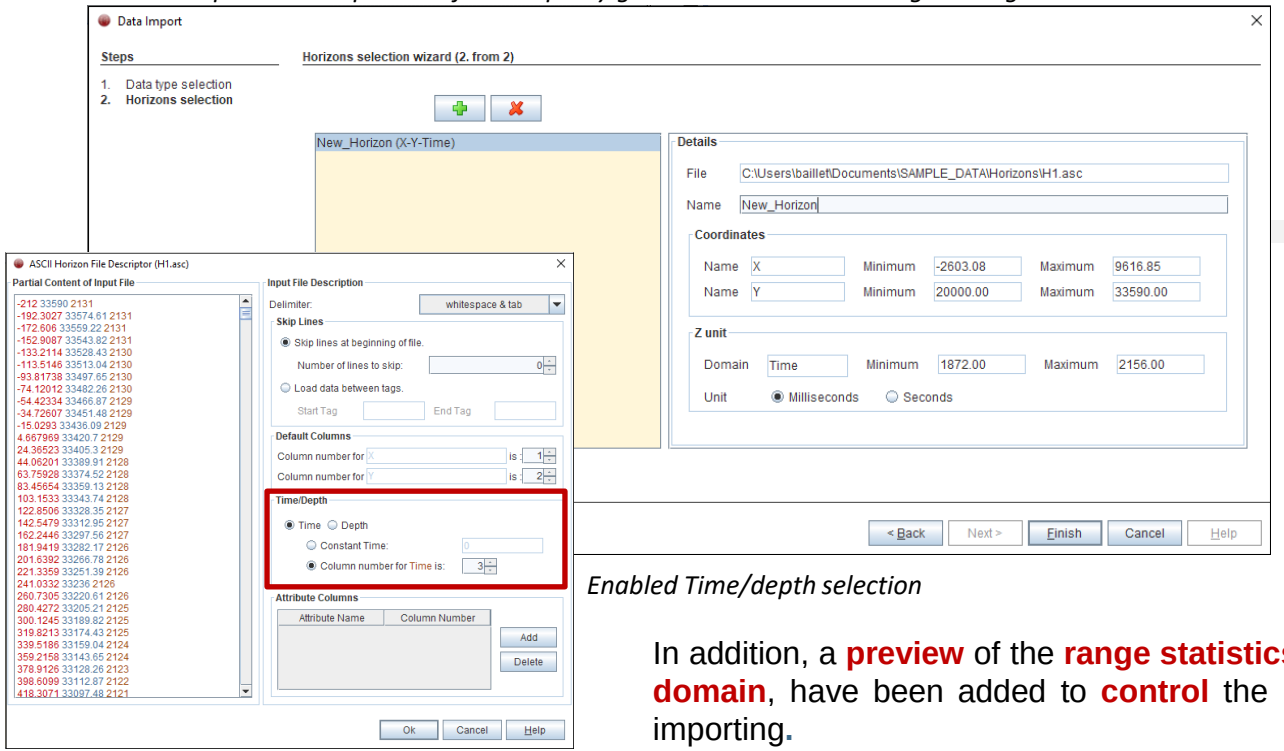
In addition, a **preview of the sampling rate** and **the start time** from the header is available in the wizard to evaluate the need of override them before importing the data.



DEPTH HORIZON IMPORT

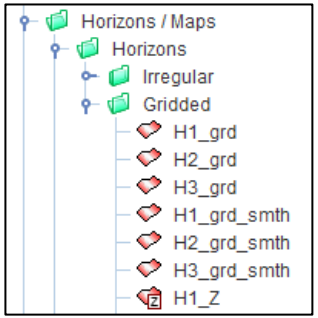
It is possible to load **horizon data** in **Depth domain**. The depth data have the same icon than the TWT data, with a **"Z"** indicating the Depth domain.

Horizon import : revamped interface to quicky get access to the data ranges at a glance



Enabled Time/depth selection

Depth horizon example



Depth data in InterWell

In addition, a **preview** of the **range statistics** (X/Y/Z or IL/XL/Z), and the **domain**, have been added to **control** the **horizons** and **maps** before importing.

ASCII VELOCITY FILE IMPORT

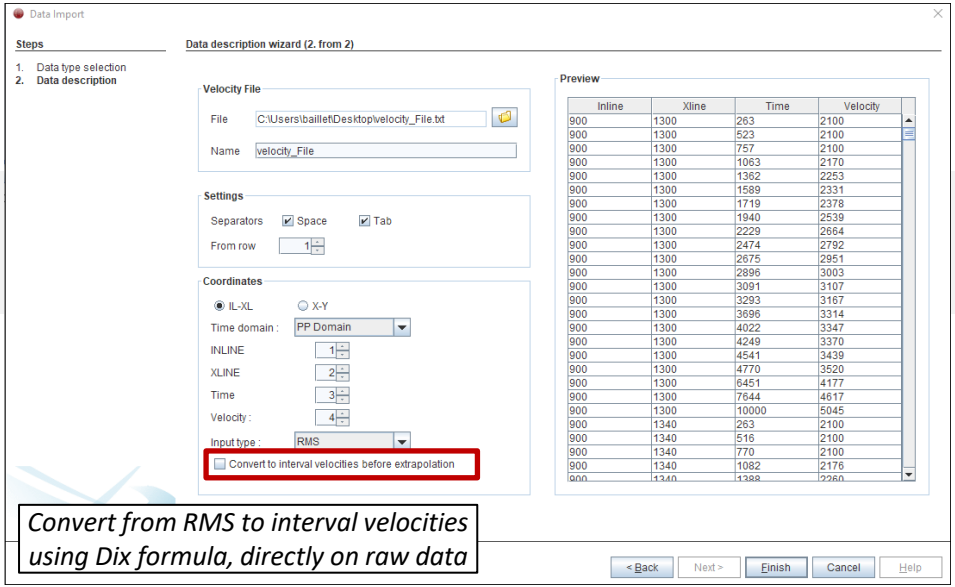
It is possible to import **ASCII columned velocity files** directly in InterWell. The file should be described and is **dynamically previewed.** The volume is afterward automatically filled to provide a **velocity volume**. If required, the algorithm converts the raw data into **interval velocities** before interpolating.

ASCII velocity file example

velocity_File.txt

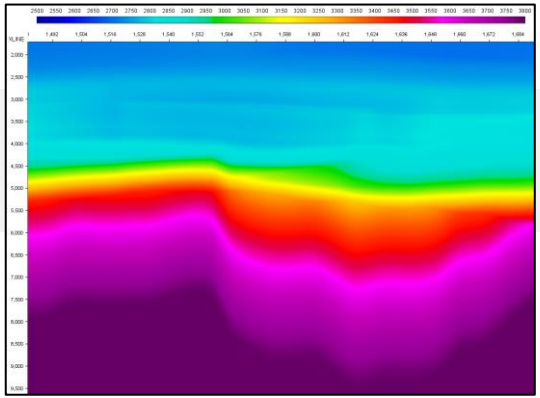
```
900 1300 263 2100
900 1300 523 2100
900 1300 757 2100
900 1300 1063 2170
900 1300 1362 2253
900 1300 1589 2331
900 1300 1719 2378
900 1300 1940 2539
900 1300 2229 2664
900 1300 2474 2792
900 1300 2675 2951
900 1300 2896 3003
900 1300 3091 3107
900 1300 3293 3167
900 1300 3696 3314
900 1300 4022 3347
900 1300 4249 3370
900 1300 4541 3439
900 1300 4770 3520
900 1300 6451 4177
900 1300 7644 4617
900 1300 10000 5045
900 1340 263 2100
900 1340 516 2100
900 1340 770 2100
900 1340 1082 2176
900 1340 1388 2260
900 1340 1752 2401
900 1340 1908 2537
900 1340 2207 2681
900 1340 2369 2771
900 1340 2610 2951
900 1340 2909 3077
900 1340 3117 3125
900 1340 3520 3281
900 1340 3933 3330
900 1340 4242 3361
900 1340 4422 3400
```

New ASCII velocity import functionality



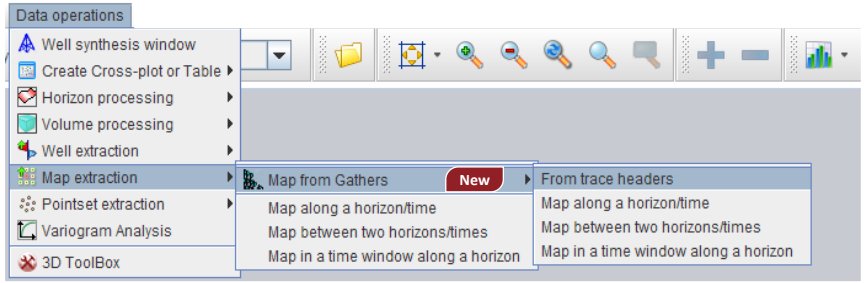
Convert from RMS to interval velocities using Dix formula, directly on raw data

Resulting interval velocity volume



MAP EXTRACTION ON SEISMIC GATHERS

Extract key information from gathers as a map to support angle range decision



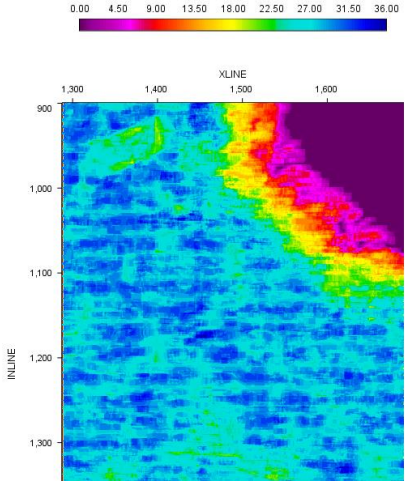
Seismic gathers can be scanned **before stacking** according to :

- **SEG-Y trace headers** (offset values, number of traces…).
- A horizon or a time, including a **conversion from offset to incident angle**, to output the **minimum or maximum angle**, the **number of traces within a range**…
- A time window (1 or 2 horizon based), to output the **key frequency, correlation or energy statistics**.

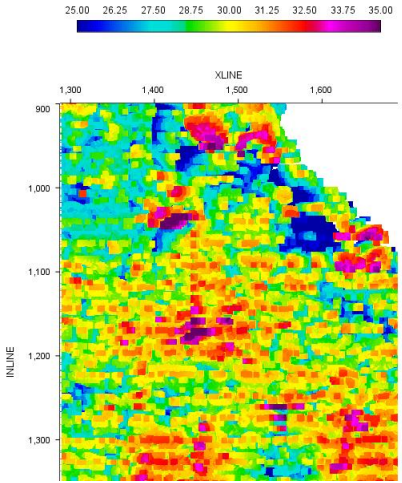
These processes allow to save **disk space**, stocking maps rather than temporary angle-stacks, scanning not only key locations but **all the locations** of the survey.

Example for an onshore seismic

Fold map (number of offset traces by position)



Maximum angle along a key horizon (°)

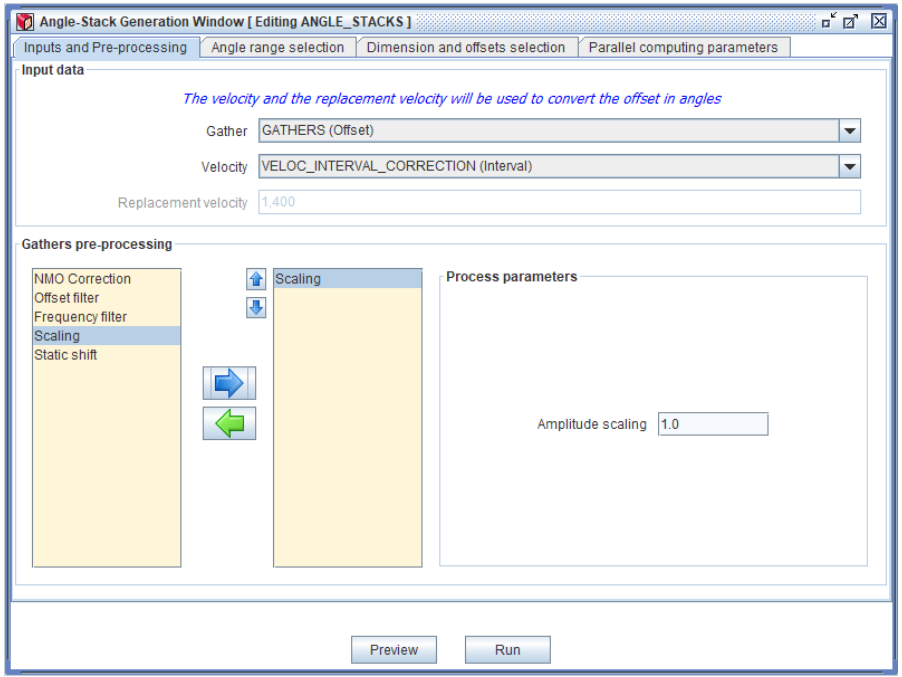


Dynamic trace processing of seismic gathers before stacking

The angle-stack generation module has been revamped to include **gathers pre-processing** :

- **NMO Correction :** dynamically shift the traces according to the NMO equation, based on RMS velocities (zero-offset position).
- New **Offset filter :** apply a median filter or moving average at a given location, considering several offset traces.
- New **Frequency filter :** apply a low-pass, high-pass or bandpass Hanning filter to the traces.
- New **Scaling :** multiply the samples by a scalar.
- New **Static shift :** shift the traces by a scalar.

The **sequential order** of the processes can be changed.

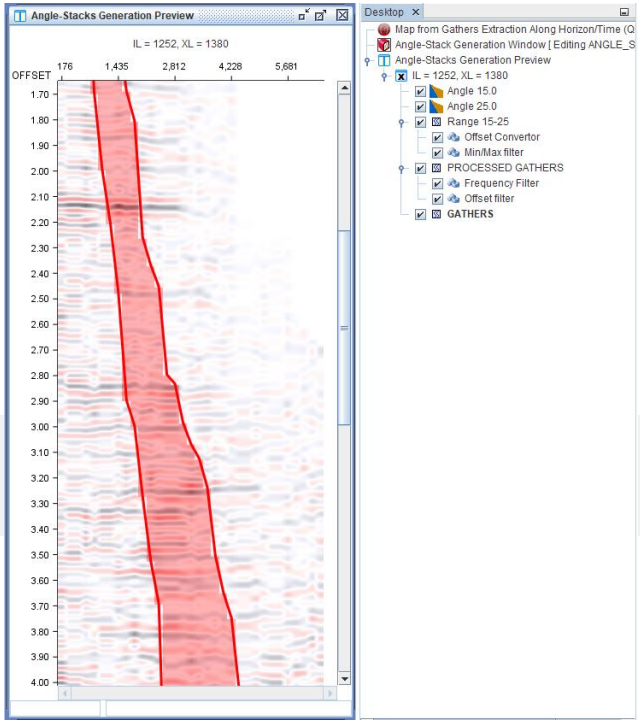


Dynamic trace processing of seismic gathers before stacking

If the processes are informed, the preview displays the **processed gathers as a new layer**. Each process can be **enabled** or **disabled** to see the impact on the gathers.

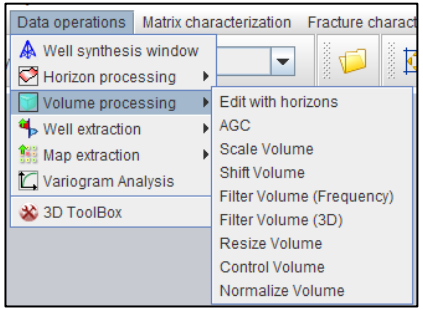
The preview in section (angle-stack) considers all the processes.

Preview (gathers part) – with the process "Offset filter"



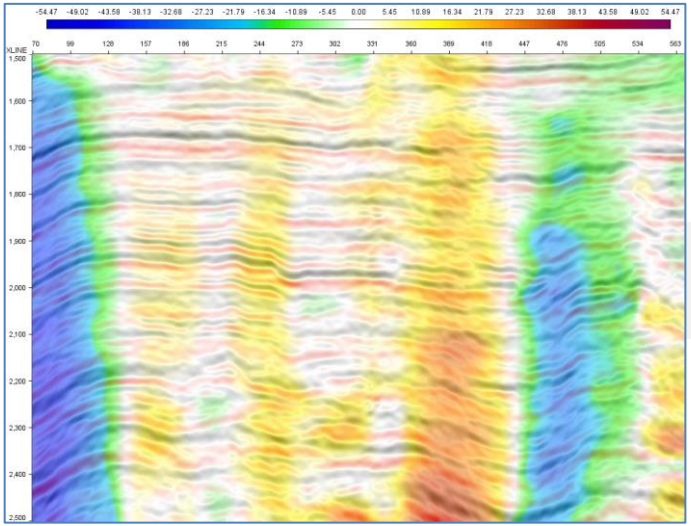
VOLUME PROCESSING

Functionalities to pre-process or post-process 2D/3D volumes



- ***Edit with horizons :*** *set a free value between/outside horizons.*
- **New** ***AGC :*** *apply a gain according to the local maximum in a constant time window.*
- ***Scale Volume :*** *multiply a volume with a scalar or a map.*
- ***Shift Volume :*** *shift vertically a volume with a scalar or a map.*
- **New** ***Filter Volume (Frequency) :*** *apply a low-pass, high-pass or band-pass Hanning filter.*
- **New** ***Filter Volume (3D) :*** *apply a 3D moving average or 3D median filter, with optional dip correction.*
- ***Resize Volume :*** *resize a volume using IL, XL and Time sub-ranges.*
- ***Control Volume :*** *search for/correct anomalous values in a volume.*
- ***Normalize Volume :*** *apply a threshold and normalize a volume.*

Seismic derived Dip, used during the filter (° along XLs)



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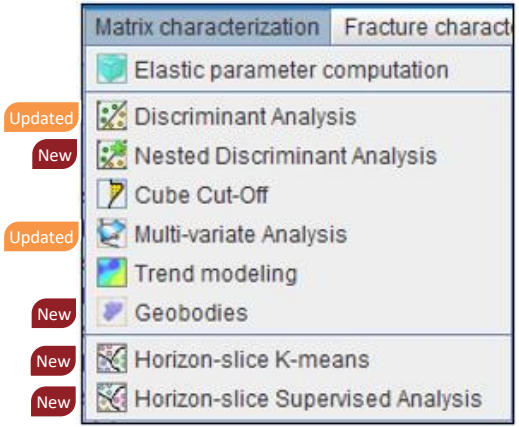
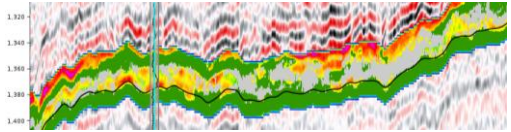
Release 2021.1

What's new in seismic characterization ?

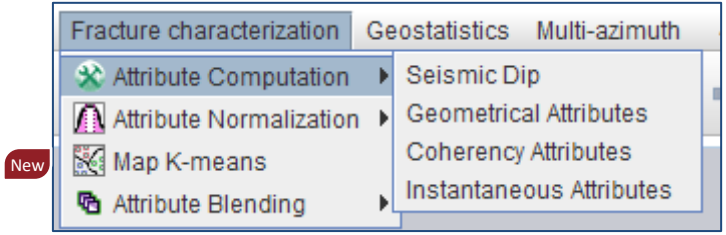
A large range of applications including applied machine learning

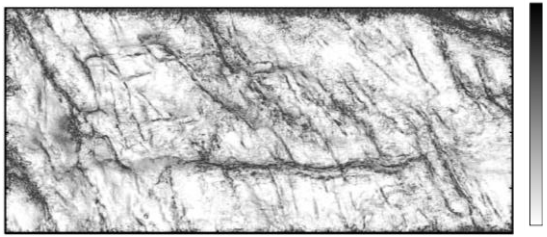
Matrix characterization





Fracture characterization





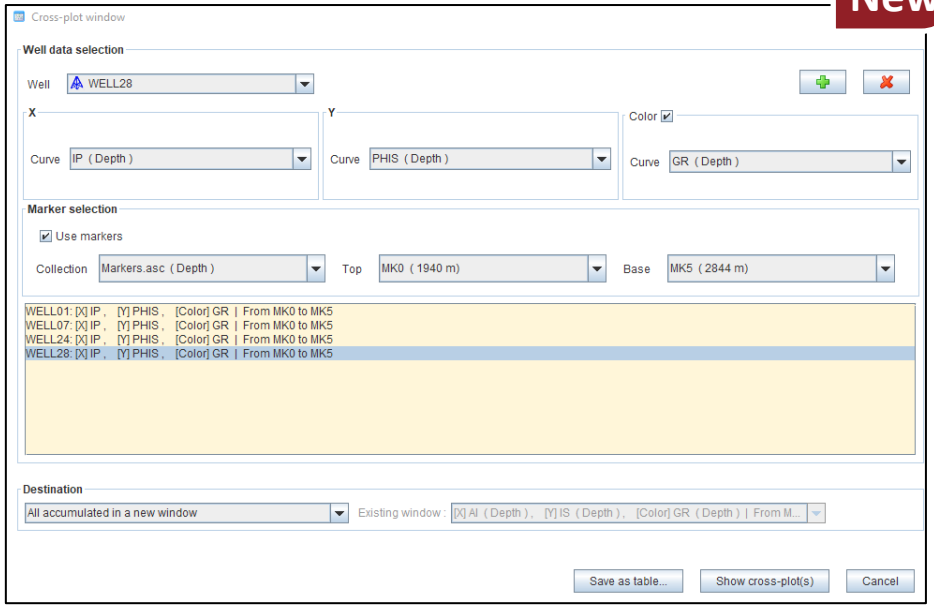
Constant updating and innovation to tackle your challenges and **improve your characterization workflows**

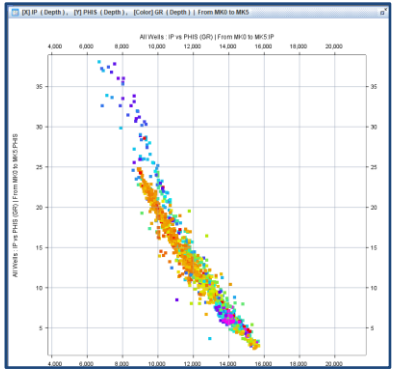
EVOLUTION OF THE CROSS-PLOT MODULE : TABLE GENERATOR

Evolution of the existing cross-plot module to **explore the well data**, using **the markers** to target **specific intervals**. The result can also be **stored as a table** for characterization applications.

Cross-plot module

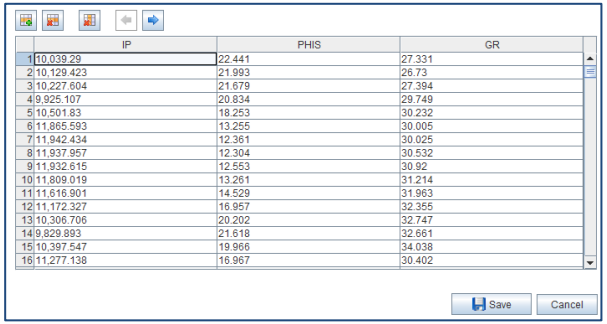
New





Example : Porosity as a function of AI, colored by GR

Save the triplets as a table to be further used in multi-variate analysis



	IP	PHIS	GR
1	10,039.29	22.441	27.331
2	10,129.423	21.993	26.73
3	10,227.604	21.679	27.394
4	9,925.107	20.834	29.749
5	10,501.83	18.253	30.232
6	11,865.593	13.255	30.005
7	11,942.434	12.361	30.025
8	11,937.957	12.304	30.532
9	11,932.615	12.553	30.92
10	11,809.019	13.261	31.214
11	11,616.901	14.529	31.963
12	11,172.327	16.957	32.355
13	10,306.706	20.202	32.747
14	9,829.893	21.618	32.661
15	10,397.547	19.966	34.038
16	11,277.138	16.967	30.402

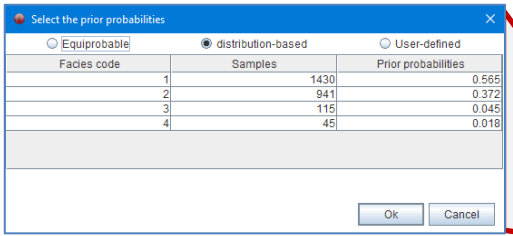
Save
Cancel

DISCRIMINANT ANALYSIS : PRIOR PROBABILITIES

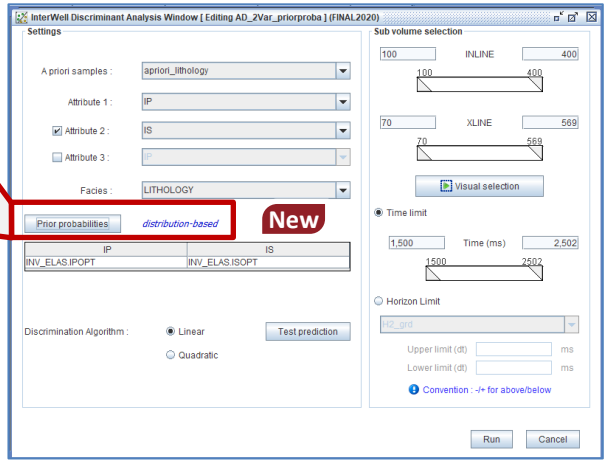
To handle distribution bias in lithology prediction

The prior probabilities can be modified with three possibilities : **equiprobable** (default), **distribution-based**, and **user-defined.** It prevents from **overestimating** or **underestimating**, respectively **underrepresented** or **overrepresented** lithology samples in the training dataset.

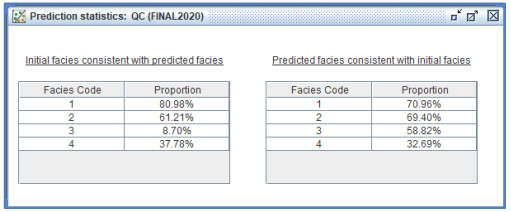
Prior probabilities



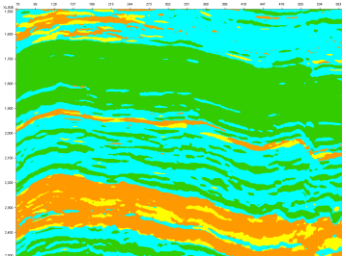
Discriminant Analysis Module



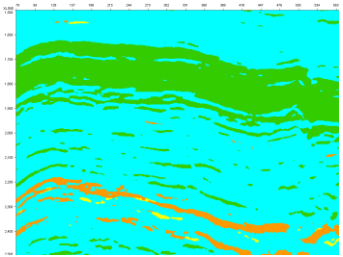
*Assess the prior probabilities impact on the discrimination using "**Test prediction**"*



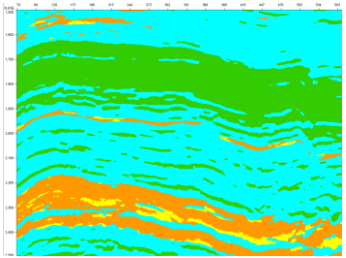
Lithology prediction : equiprobable



Lithology prediction : distribution-based



Lithology prediction : user-defined

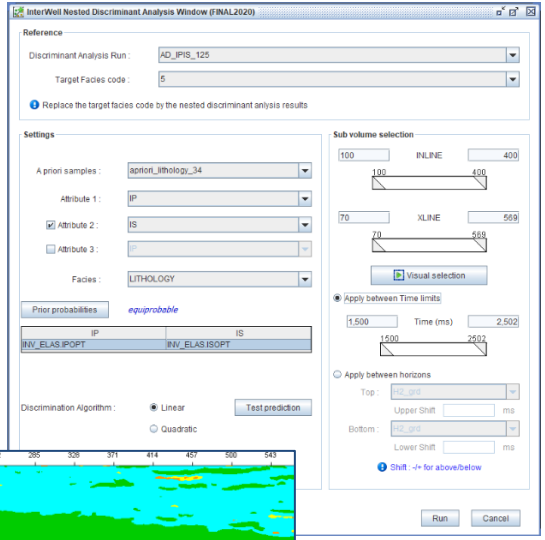


Discrimination in a two-pass approach for complex cases

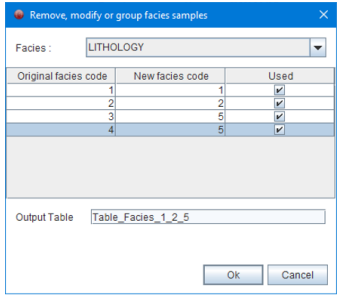
New

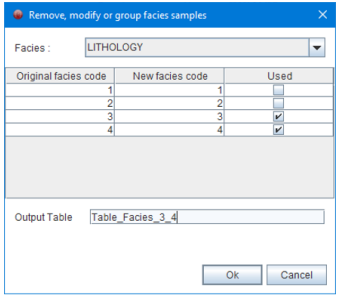
- The methodology aims at solving **complex classification problems** in two steps:
  - Focusing first on the main lithology poles obtained after grouping some facies.
  - Perform a second discrimination applied only in one specific facies
- Allows a **better management of uncertainties**, trying out more **subtle subdivisions** in the target facies without lowering the **robustness of the main boundaries**
- Unlocks the possibility to **use a different set of elastic** parameters for the second step.
- Dedicated editor to **conveniently edit facies tables** to be used as training samples

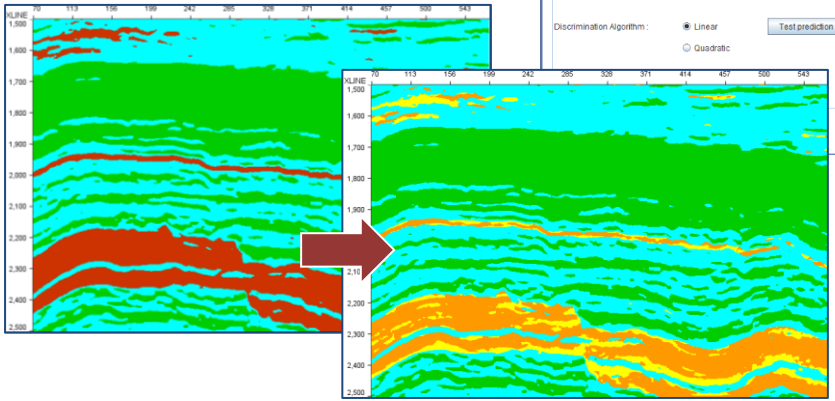
Nested Discriminant Analysis Module



Remove, modify or group facies samples



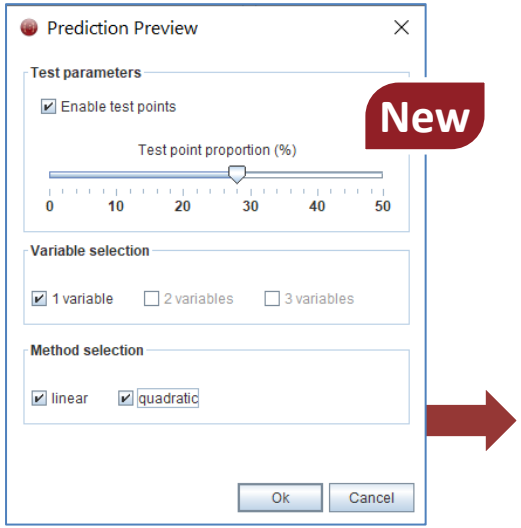




MULTI-VARIATE ANALYSIS : TEST DATA

Randomly isolate data (test) from the rest of the table (training) to assess the prediction

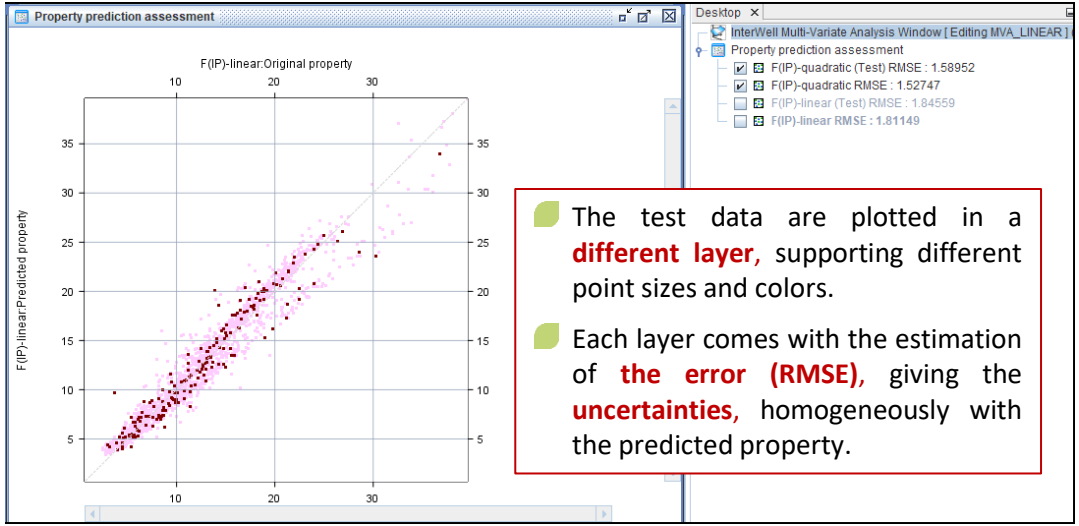
Multi-Variate Analysis Preview



Supports the **test option** and the customization of its **proportion** compared to the training samples.

The multi-variate analysis consists in optimizing a least-square problem allowing the estimation of a continuous variable, using one or more known variables.

Resulting cross-plot view



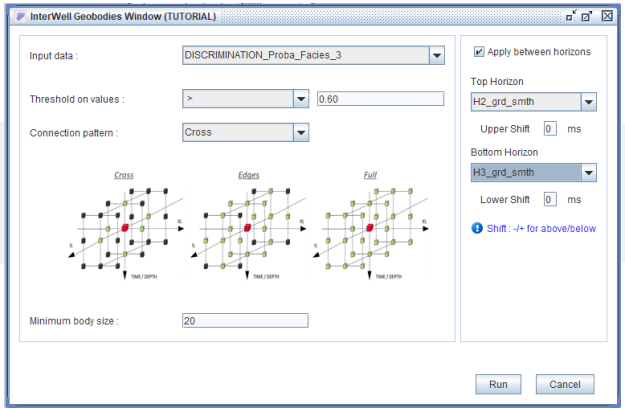
- The test data are plotted in a **different layer**, supporting different point sizes and colors.
- Each layer comes with the estimation of **the error (RMSE)**, giving the **uncertainties**, homogeneously with the predicted property.

GEOBODIES APPLICATIONS

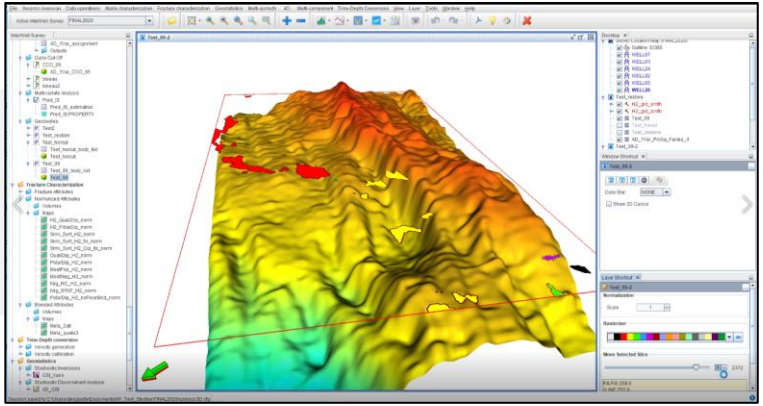
Extract connected bodies from a lithology volume or a continuous property

New

Geobodies module

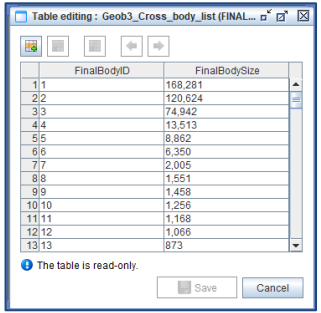


3D Geobodies identification : a volume containing the body labels



- Supports any input volume, in **depth** or in **time.**
- Supports **3 types of connectivity** to test the **stability** of the bodies.
- Supports the computation **between two horizons** to **ignore** the data **out of the area of interest.**

Body list with associated size



	FinalBodyID	FinalBodySize
1	1	168,281
2	2	120,624
3	3	74,942
4	4	13,513
5	5	8,862
6	6	6,350
7	7	2,005
8	8	1,551
9	9	1,458
10	10	1,256
11	11	1,168
12	12	1,066
13	13	873

The table is read-only.

Save Cancel

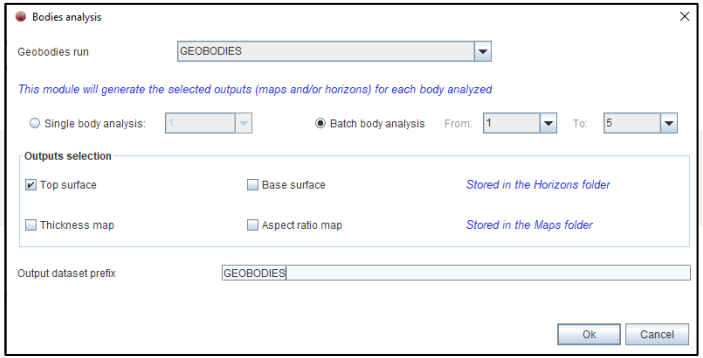
GEOBODIES ANALYSIS

Extract key information from your geobodies

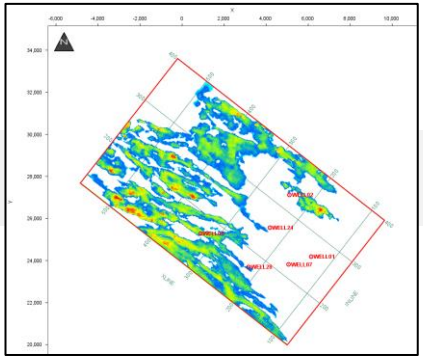
New

- **Auto-extraction** of the **top**, the **base**, the **true thickness** and the **aspect ratio**

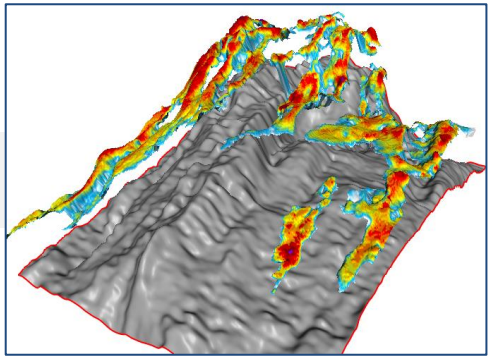
Geobodies analysis module



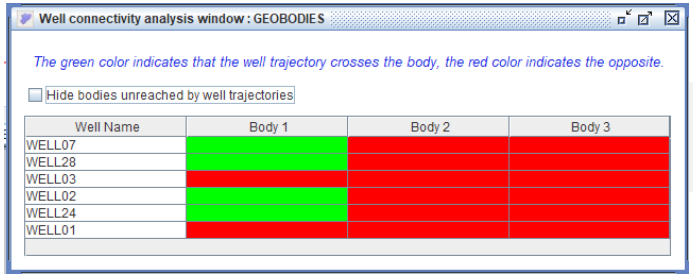
Thickness maps for different bodies



Tops of the geobodies in 3D with key property



- **Connectivity between wells** through a well-identified body.
- **In-depth connectivity analysis** for realistic volume estimation

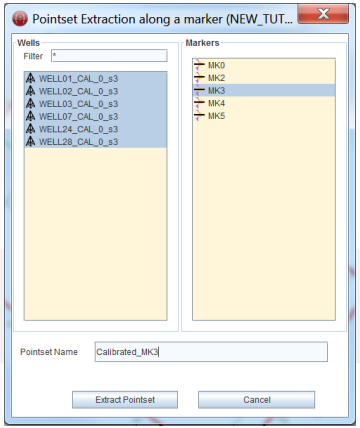


Well connectivity analysis

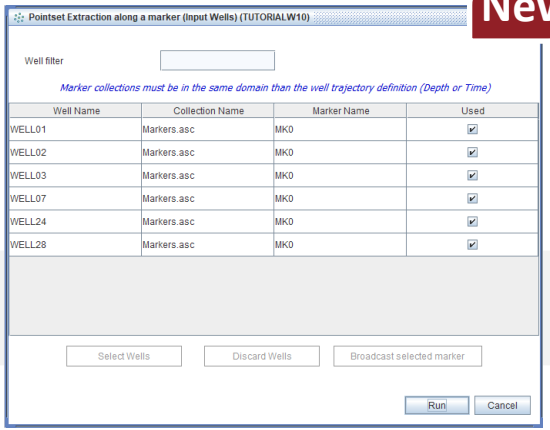
POINTSET EXTRACTION TOOLS AND STATISTICS

Create a pointset from any well at a given marker position for visualization and provide an input to constrain a property map using trend modelling.

Module for calibrated wells



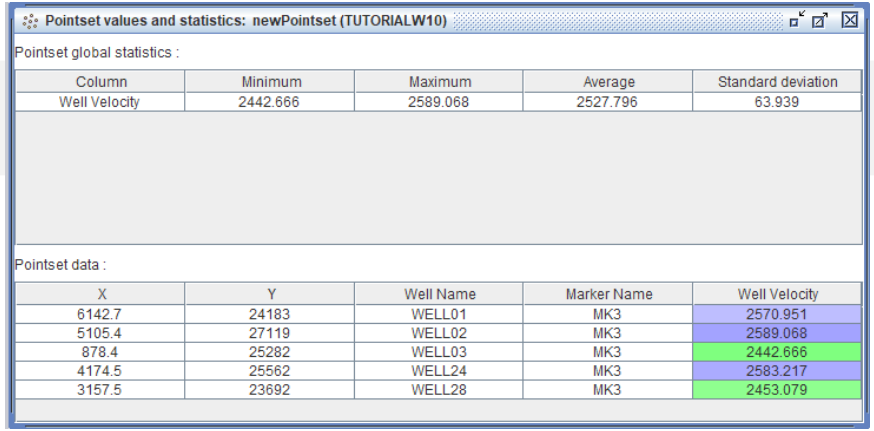
Module for input wells



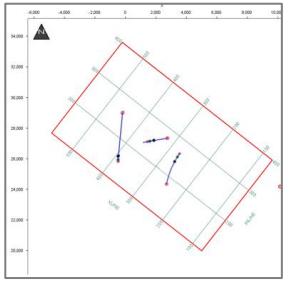
New

The **View Pointset** functionality detects the numerical attributes and provides **key statistics**. The values are **colored** as a function of **the distance to the mean**.

New "View" pointset window



Resulting Map view

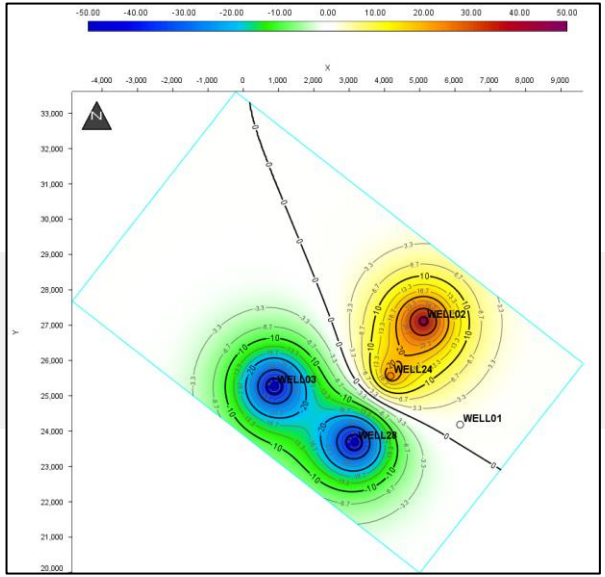


NEW TREND MODELING FEATURE : OVERRIDE THE MEAN DURING KRIGING

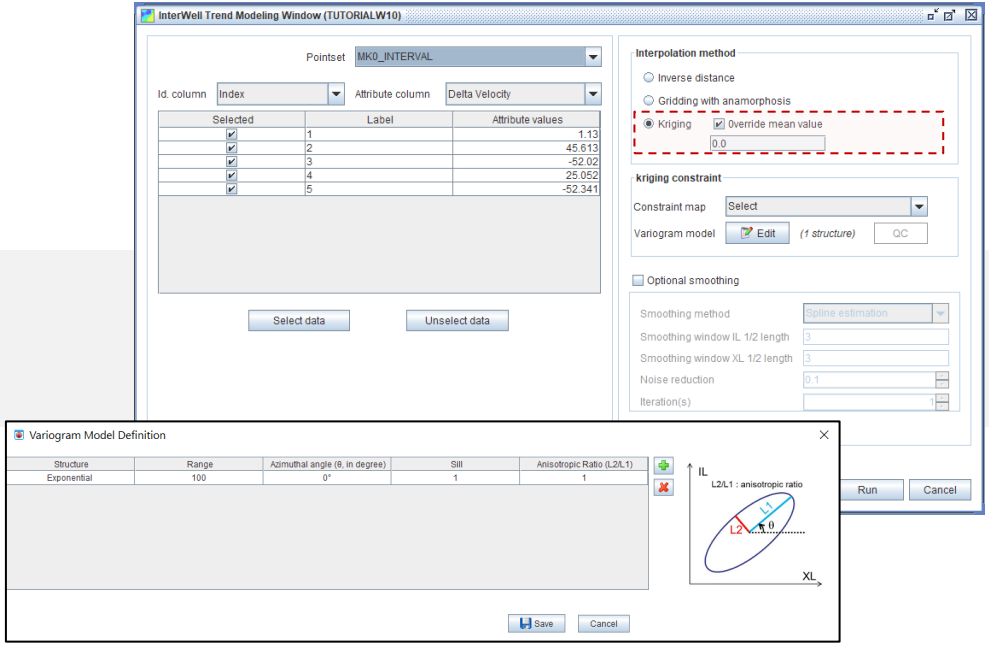
Possibility to perform kriging overriding the mean, especially useful for kriging residuals

New

Velocity error (m/s)



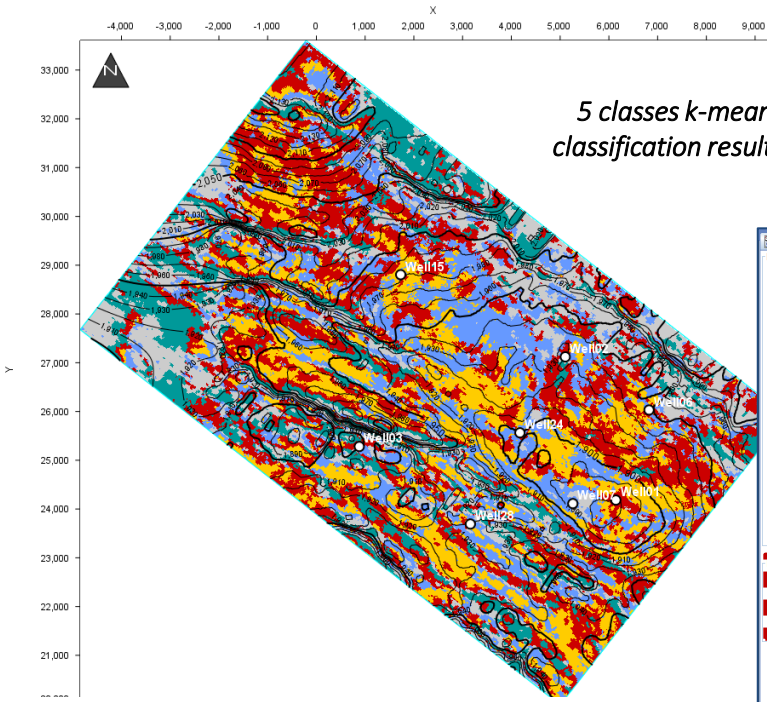
Trend modeling module



UNSUPERVISED SEISMIC TRACES CLASSIFICATION

Automatic seismic traces classification through K-means classification algorithm

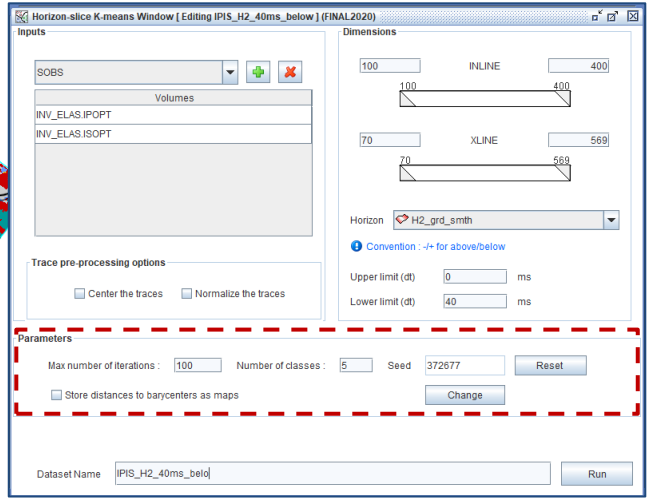
New



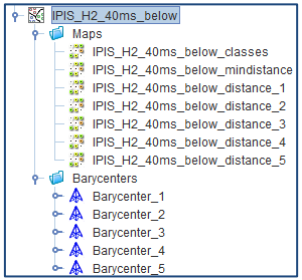
5 classes k-means classification results

Changing the seed allows to change the barycenter initialization, to check the stability of the output zonation map

+ Classification according to different volumes (seismic, impedances, lithology probabilities…) in the time window around a horizon.



Output run and its resulting items

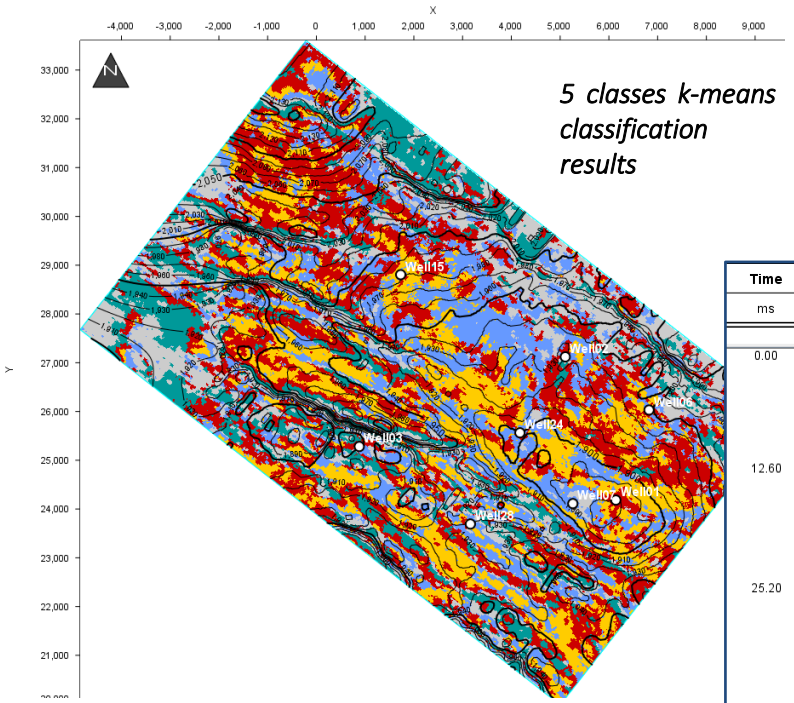


The process reaches the convergence when the barycenters are stable or when the maximum number of iterations is reached.

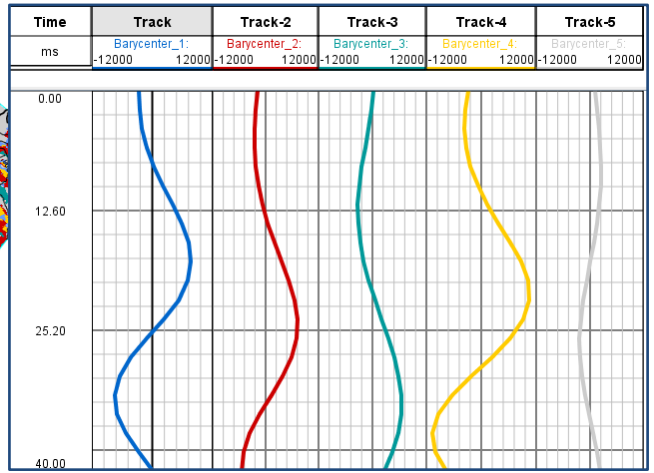
UNSUPERVISED SEISMIC TRACES CLASSIFICATION

Automatic seismic traces classification through K-means classification algorithm

New



5 classes k-means classification results



Interpretation of seismic classes with analysis of the typical response of each class (barycenters) and available information (structure iso-lines, wells, ...)

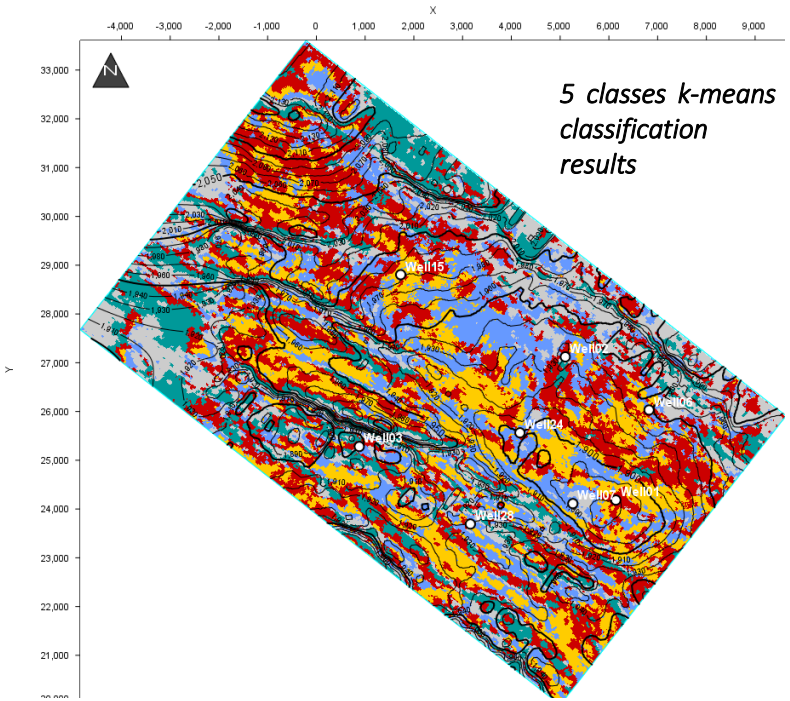
Grey/turquoise seismic facies corresponds to **faults and noisy or low-quality seismic areas,** including the edges of the survey

Red/yellow/blue facies correspond to different seismic responses associated to the carbonate platform

UNSUPERVISED SEISMIC TRACES CLASSIFICATION

Automatic seismic traces classification through K-means classification algorithm

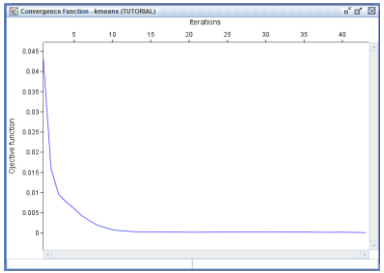
New



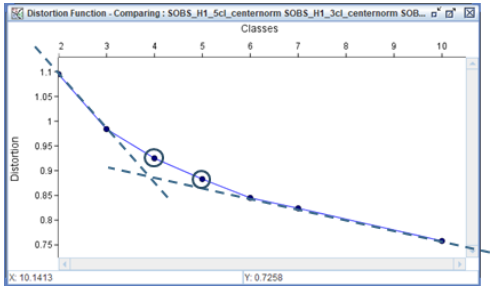
5 classes k-means classification results

DECISION SUPPORT THROUGH MACHINE LEARNING TOOLS

Select the appropriate number of classes and control the resulting classification



Convergence function should reach a plateau / a targeted convergence rate



Distortion function can be used to suggest number of classes based on the inflexion(s) of the curve

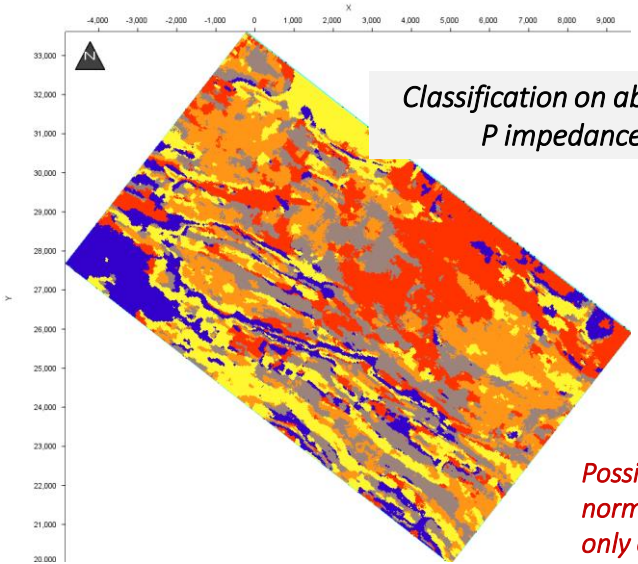
UNSUPERVISED SEISMIC TRACES CLASSIFICATION : PRE-PROCESSING

Automatic seismic traces classification through K-means classification algorithm

New

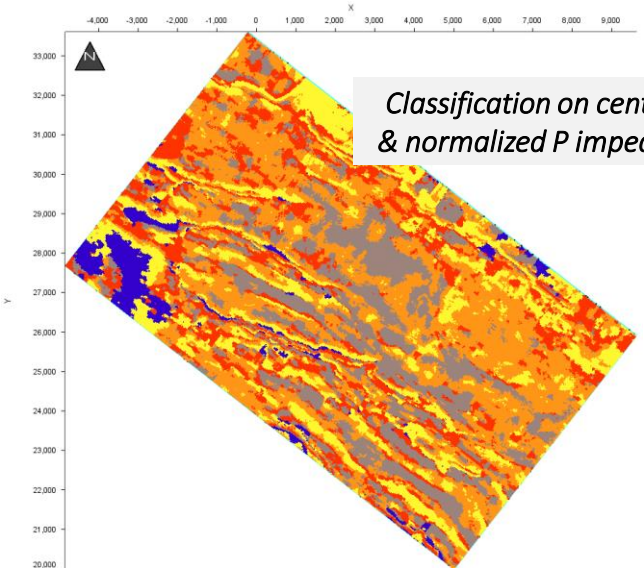
Can be applied to any kind of input data

- Raw seismic, pre-processed 3D volumes, enhanced seismic after inversion, Reflection Coefficients
- Several volumes can be considered simultaneously in the process (P and S impedance, etc…)



Classification on absolute P impedance

Possibility to center and normalize the traces to focus only on the shape of traces



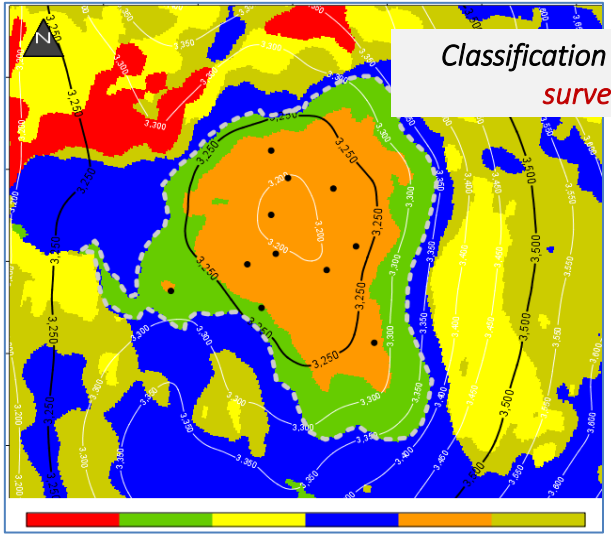
Classification on centered & normalized P impedance

UNSUPERVISED SEISMIC TRACES CLASSIFICATION : LIMITED TO A POLYGON

The unsupervised seismic traces classification can be performed on cropped horizons

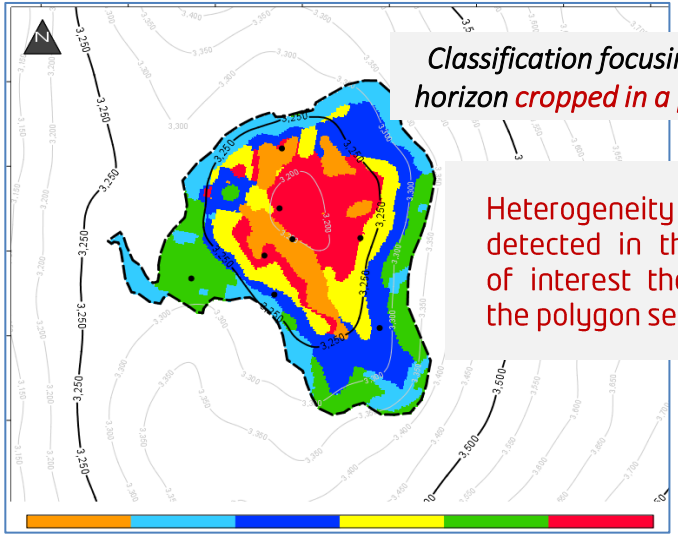
New

Polygons, imported or created in InterWell, allow to edit the horizons.



Classification using full survey

6 classes classification



Classification focusing on a horizon cropped in a polygon

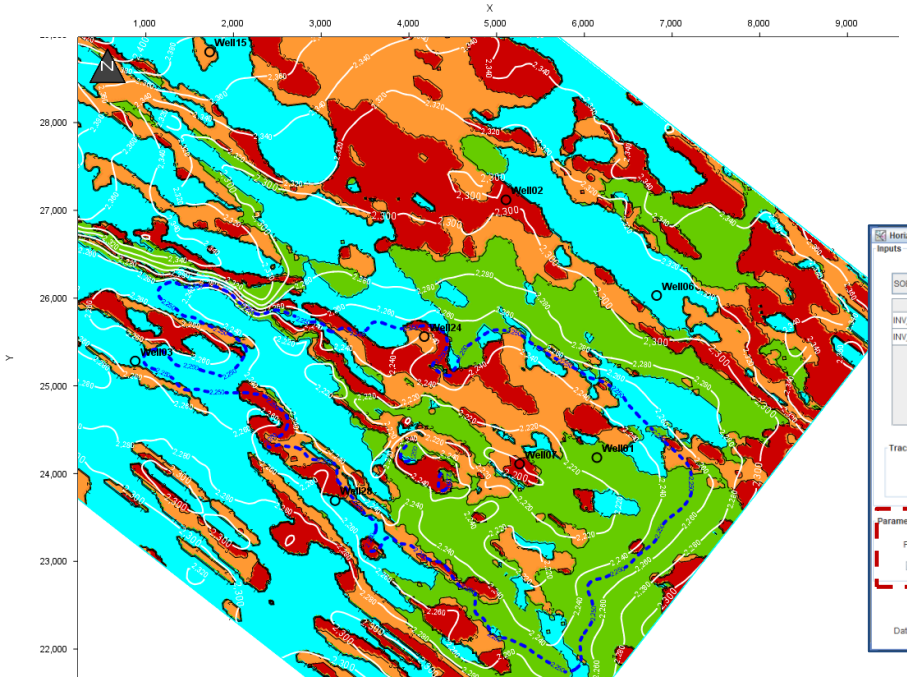
Heterogeneity detected in the area of interest thanks to the polygon selection.

6 classes classification

SUPERVISED SEISMIC TRACES CLASSIFICATION

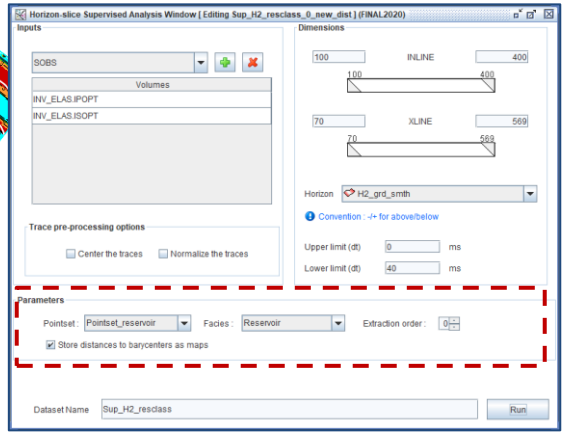
Seismic traces classification driven by key reservoir properties

New

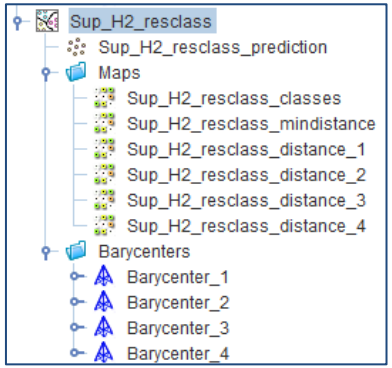


Zonation map with structure iso-lines (white) and OWC (blue)

Build classes based on the information available at wells and use them as training samples to support the classification of the seismic traces



Output run and its resulting items

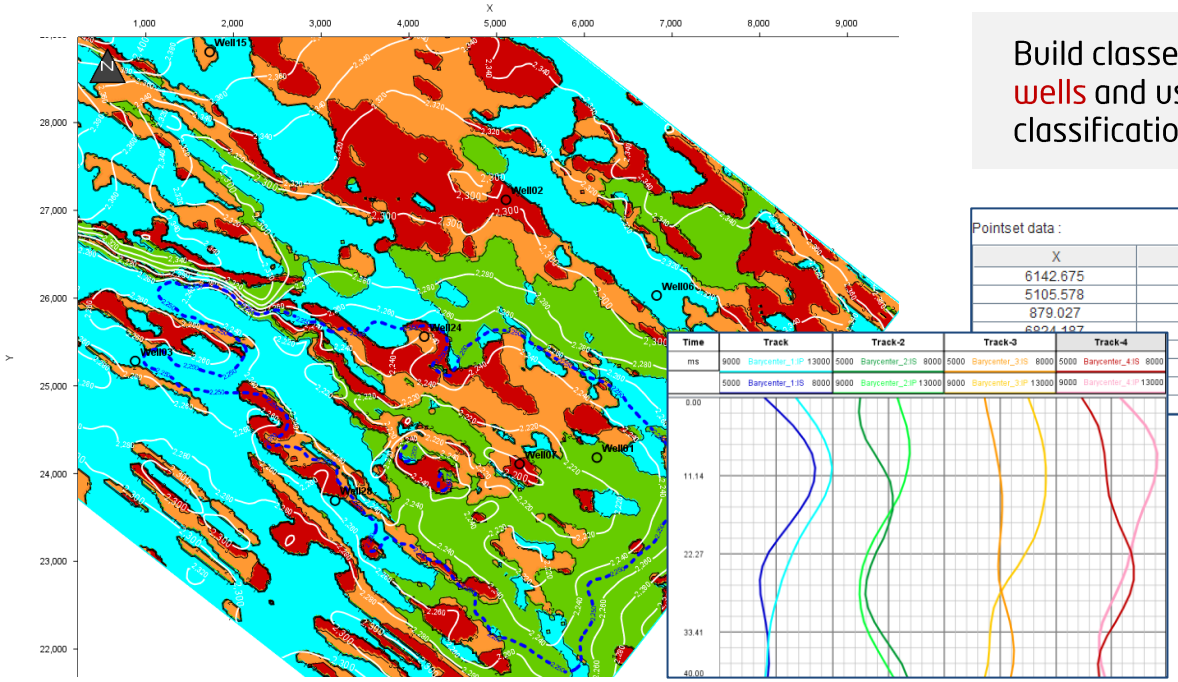


*The barycenters are induced by the pointset column informed as the **facies**. The **extraction order** increase may provide more stability to the classes, considering more traces to compute the barycenters.*

SUPERVISED SEISMIC TRACES CLASSIFICATION

Seismic traces classification driven by key reservoir properties

New



Zonation map with structure iso-lines (white) and OWC (blue)

Build classes based on the information available at wells and use them as training samples to support the classification of the seismic traces

Pointset data :

X	Y	NAME	Reservoir	Prediction
6142.675	24183.182	Well01	2	2
5105.578	27119.114	Well02	4	4
879.027	25282.103	Well03	1	1
[illegible]	26030.061	Well06	1	1
[illegible]	24110.543	Well07	4	4
[illegible]	28805.95	Well15	3	3
[illegible]	25562.197	Well24	3	3
[illegible]	23691.926	Well28	1	1

Assess the feasibility and robustness of the classification through the restitution statistics and the typical traces representing the barycenters.

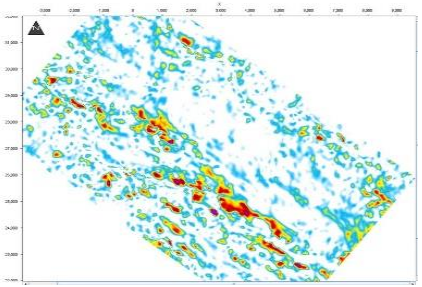
Perform your seismic fracture characterization with a new InterWell workflow

Each attribute brings **specific fracture information** along with **some noise** inherent to its computation, requiring a multi-attribute characterization workflow. A zone identified as fractured **by several attributes** can be considered fractured with **high confidence**.

New

Step 1

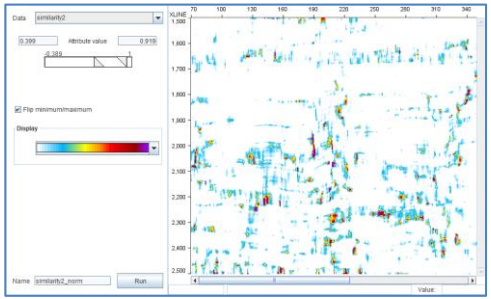
Attribute computation



About 20 available attributes to compute and **combine,** pre-selected thanks to **Beicip-Franlab experience**, in **maps or volumes.**

Step 2

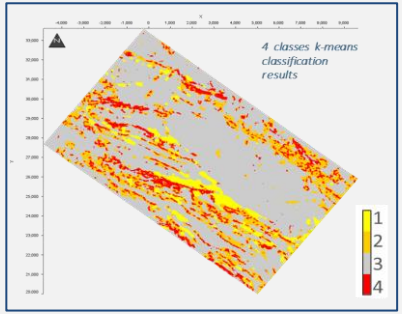
Attribute normalization



Dedicated **normalization module** to **dynamically condition the seismic attribute** while choosing the **minimum/maximum** to focus on the fracture detection only.

Step 3

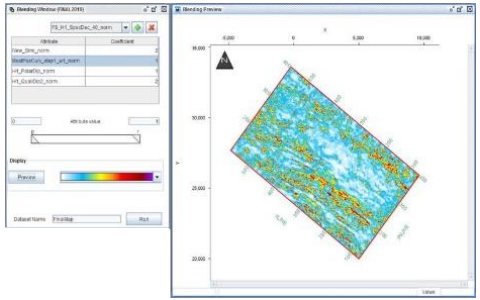
Attribute k-means



The **attribute k-means module** partition the study area to **classify** the zones according the attributes response. One output **zone** has therefore a **typical attribute response** to interpret.

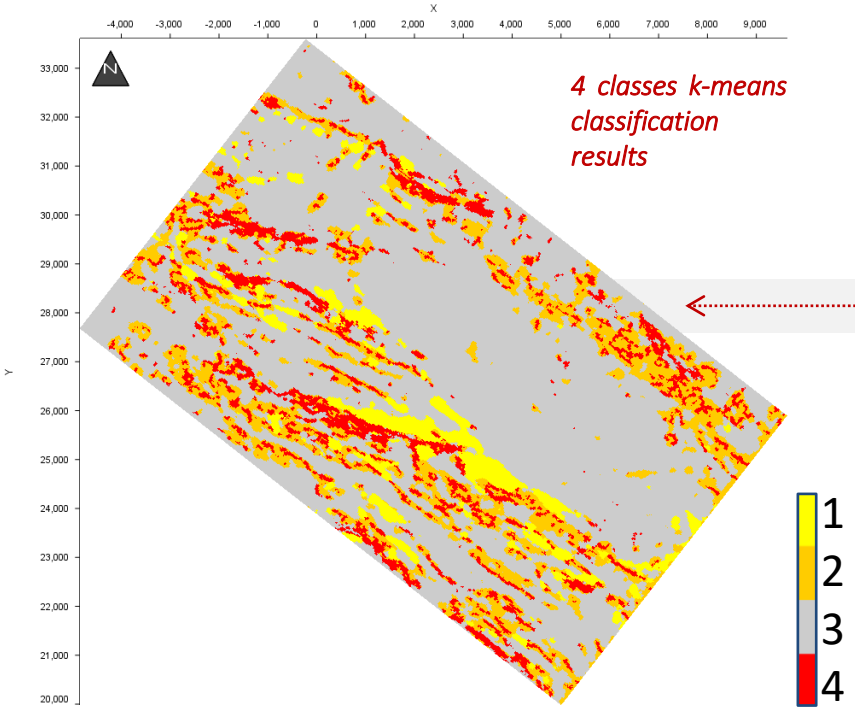
Step 4

Attribute blending



The **attribute blending module** allows to combine **with different weights** the fracture attributes/clusters to be sure to capture all the common information while reducing the noise.

Automatic seismic traces classification through K-means classification algorithm



4 classes k-means classification results

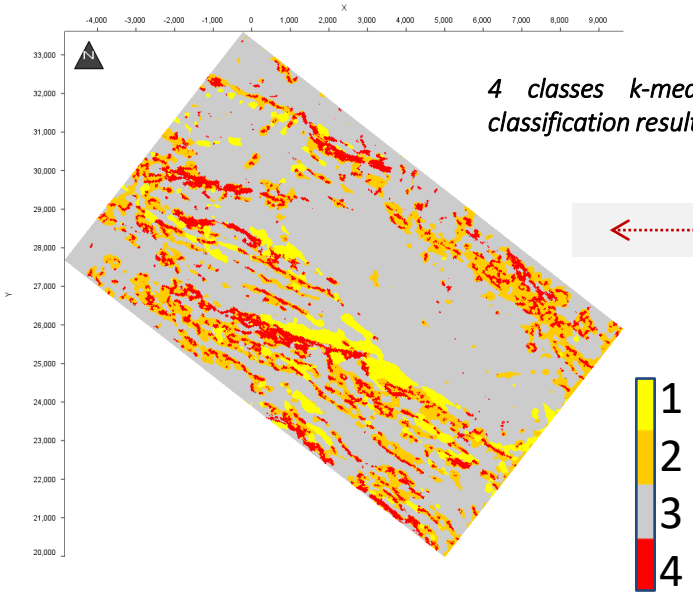
The same methodology can be applied to perform a statistical clustering based on fracture attributes values to highlight the fractured areas

	Cluster	MostPostiveCurvature...	PolarDip_norm	QualityDip_norm	SimilarityDIPHorizon_...
1	1	0.426	0.518	0.103	0.11
2	2	0.039	0.017	0.521	0.128
3	3	0.022	0.012	0.036	0.034
4	4	0.058	0.034	0.497	0.605

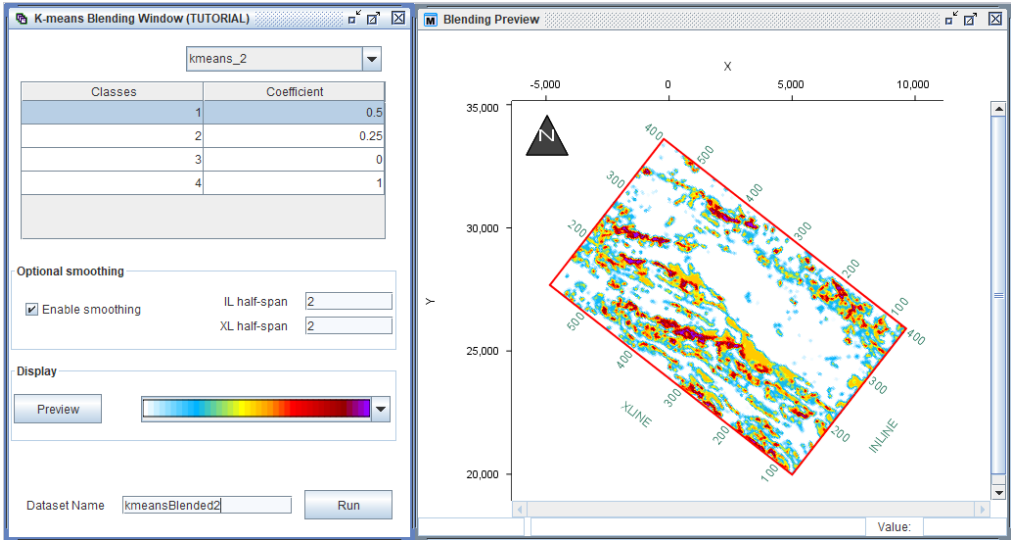
Interpret the detected clusters in terms of fracture index based on the original attributes' values (here, high values associated to presence of discontinuities)

ASSIGN A COEFFICIENT TO EACH CLASS

Assign a coefficient to each class to design a meta-attribute, synthetic of the fault/fracture network



4 classes k-means classification results



Available preview of the map before computation and optional smoothing

InterWell

Release 2021.1

What's new in time-depth conversion ?

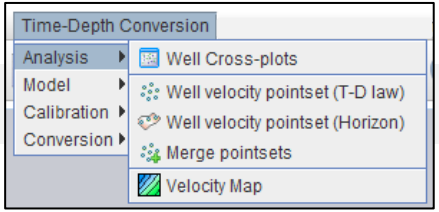
TIME-DEPTH CONVERSION OVERVIEW

The module is organized in four menus: Analysis, Model, Calibration, Conversion

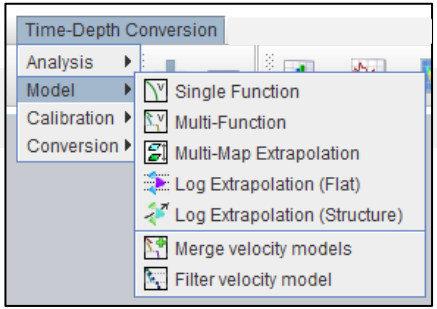
Time-Depth Conversion

Top menus contain all possible actions to build a 3D velocity model perfectly honoring **all data sources** (T-D laws, markers, horizons, seismic velocities).

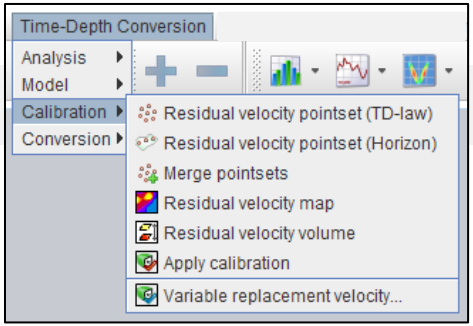
Analysis



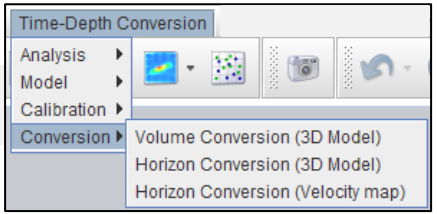
Model



Calibration

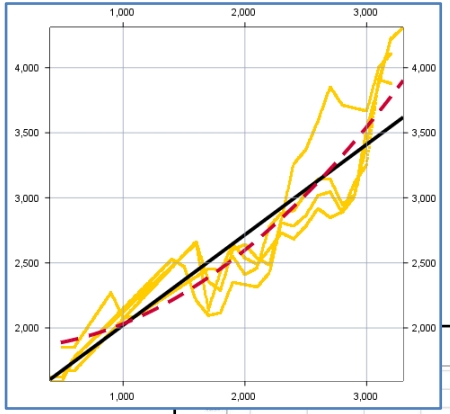


Conversion



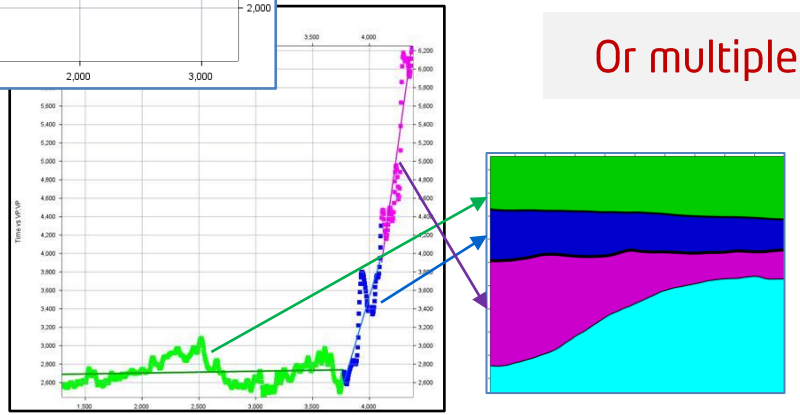
The actions are associated to icons consistent with the data identification in the survey tree.

TIME-DEPTH CONVERSION STRATEGY #1 : USING FUNCTION(S)



Calibrate one single velocity = f(time) function from wells

Direct computation of an average or interval velocity model using a global trend (linear or quadratic) derived from wells' **time-depth laws or logs** using cross-plot module.

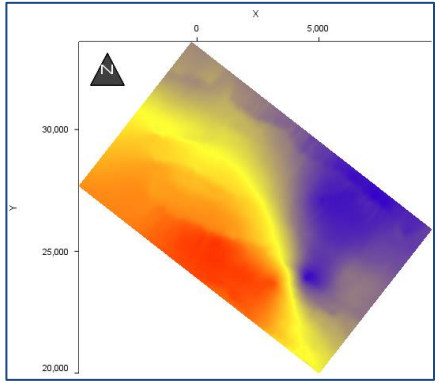


Or multiple functions for different stratigraphic intervals

Analyze velocity vs. time relationships **per stratigraphic interval** and assign adjusted trends (or constant value) to the corresponding unit in the structural model.

Obtained function models can then be processed and calibrated to perfectly fit the data

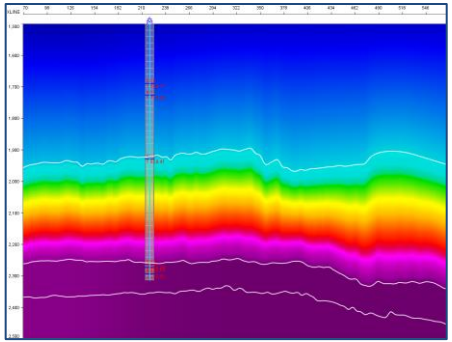
TIME-DEPTH CONVERSION STRATEGY #2 : USING MAP(S)



Fast-track horizon conversion available using a single velocity map

Velocity maps can be obtained from pointsets derived from well and/or horizon tie-points through interpolation or kriging, with optional constraint map (such as the TWT horizon).

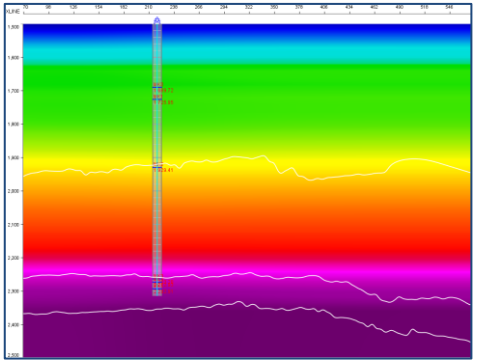
And several maps can be used to generate a velocity model



Combine multiple maps built at different horizons to generate a unique **multi-map velocity model** that can be used for 3D conversion, ensuring a **direct bijection** of a **target interval** comprised between key horizons.

Multi-maps models can be built honoring all wells (using TD laws or horizon-marker tie point)

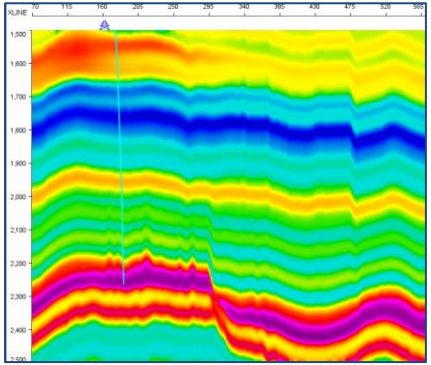
TIME-DEPTH CONVERSION STRATEGY #3 : USING LOG(S)



Perform flat interpolation of average velocities

Neutral infilling of average velocity model relying on well information only, that can be used to obtain a first and **unbiased view** in depth domain.

Or structure-driven interpolation of interval velocities

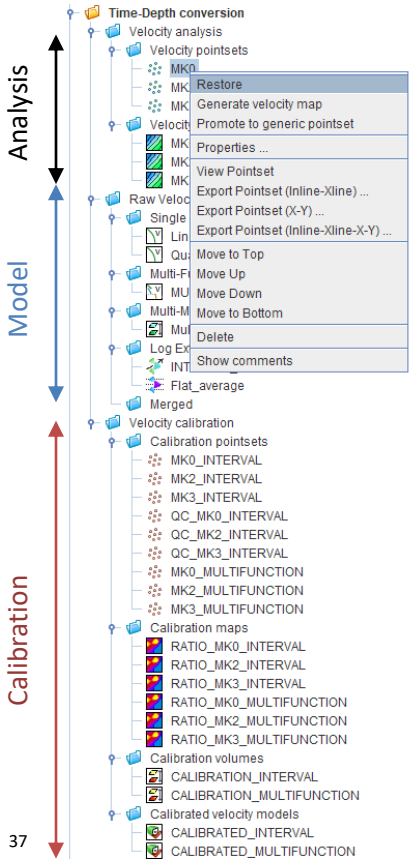


Allows a **very good match** between the interval velocity model and the **structure** as interpreted from the seismic horizons.
Can be combined with **seismic velocities** to provide a weighted **background trend** to the interpolation and extrapolation of well logs.

Obtained velocity models can then be processed and calibrated to perfectly fit the data

TIME-DEPTH SUB-TREE

Time-depth conversion sub-tree



The Time-Depth conversion sub-folder contains 3 data types :

Time-Depth conversion

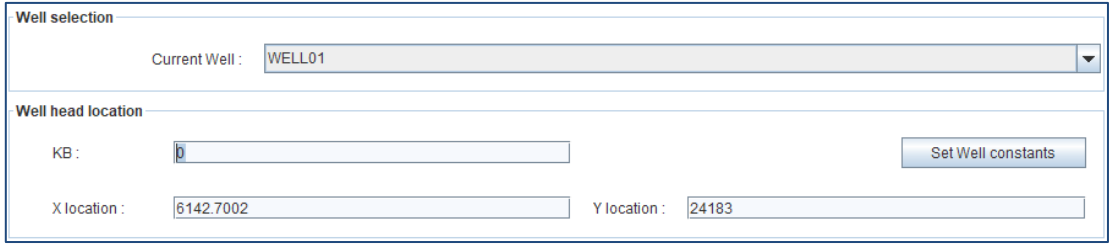
- **Pointsets (labelled geo-localized data);**
- **Maps (velocity maps or residual maps);**
- **Volumes :**
  - Raw velocity models;
  - Merged velocity models;
  - Calibration volumes;
  - Calibrated velocity models.

All the data can be **restored** (opening of its module with the parameters used), **visualized** (X-Section, maps, 3D View), **commented**, **exported**.

Velocity models can be promoted to standard volumes in InterWell to be used for different purposes (angle-stack generation, a priori model building…).

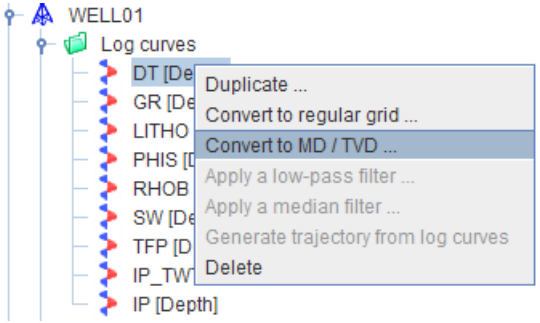
DEVELOPMENT ON WELLS TO PREPARE THE WORKFLOW

Handling well constants and interactive trajectory update

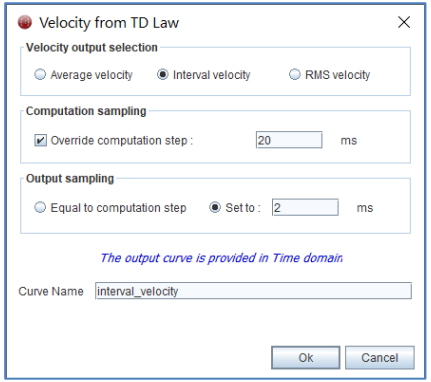


The well database has been updated to handle MD/TVD conversion and KB constant, consistently with the targeted “Depth” for the workflow.

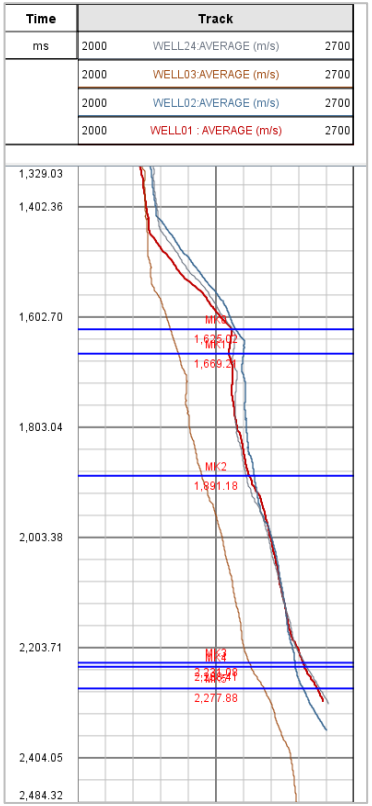
Handling MD/TVD conversion



Compute velocities from TD law



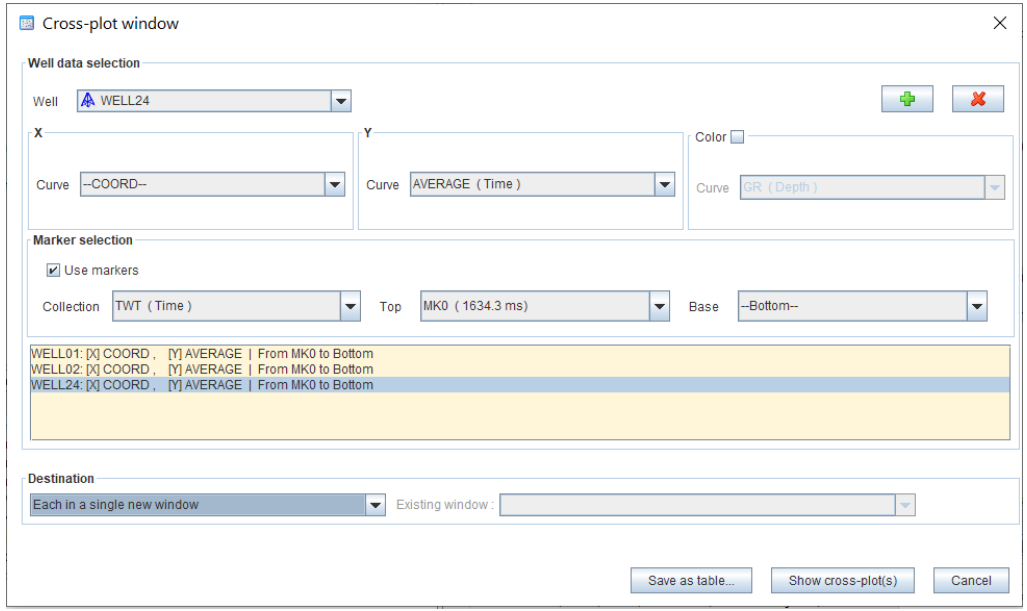
Average velocity comparison

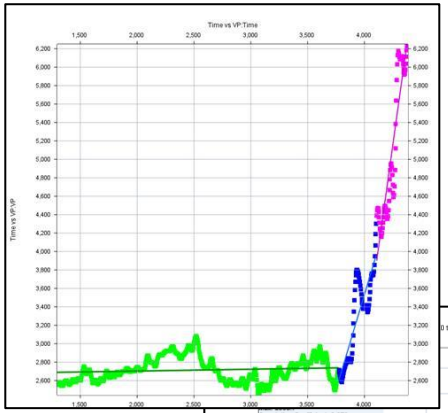


EVOLUTION OF THE CROSS-PLOT MODULE

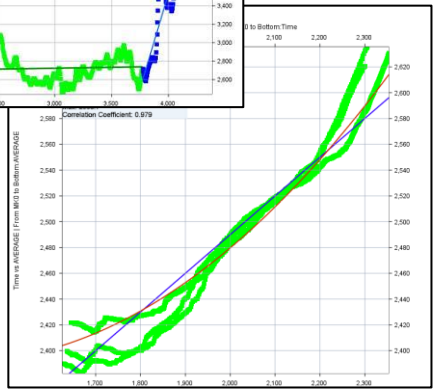
Evolution of the existing cross-plot module to handle **the coordinates as a curve**, as well as **the markers** to target **specific intervals**. This development is also useful for **seismic characterization**.

Cross-plot module



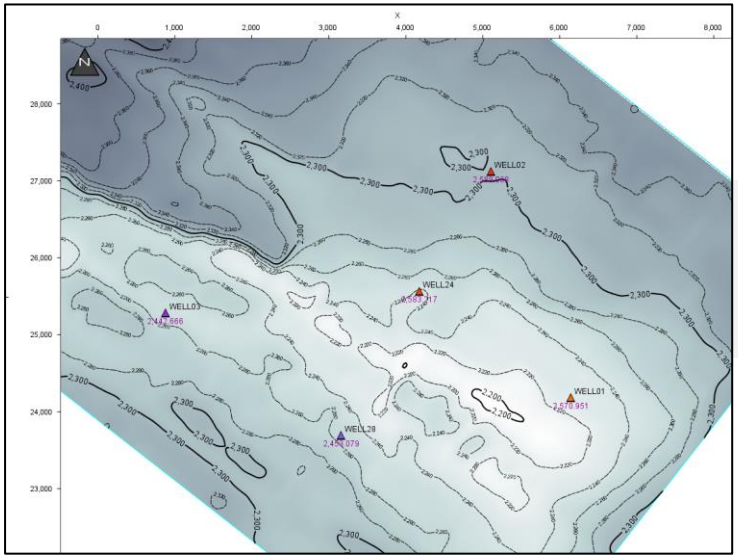


Example : trend between markers

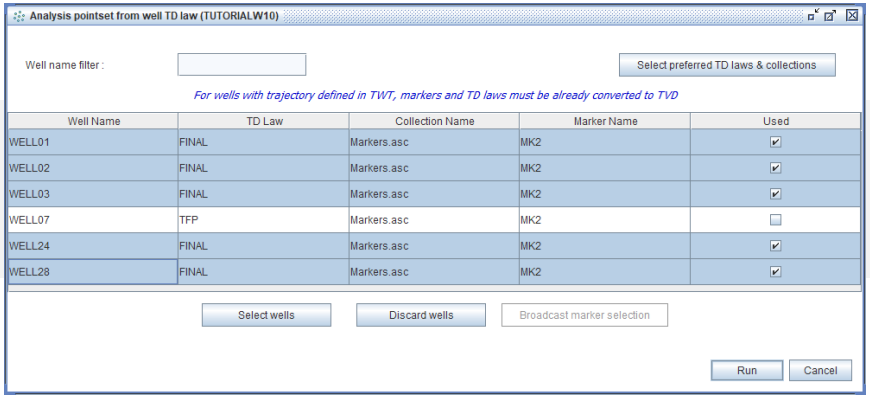


Example : average velocity trends on wells, supporting linear or polynomial trends

POINTSETS AS A KEY DATA FOR ANALYSIS AND CALIBRATION



Compute velocities from TD law



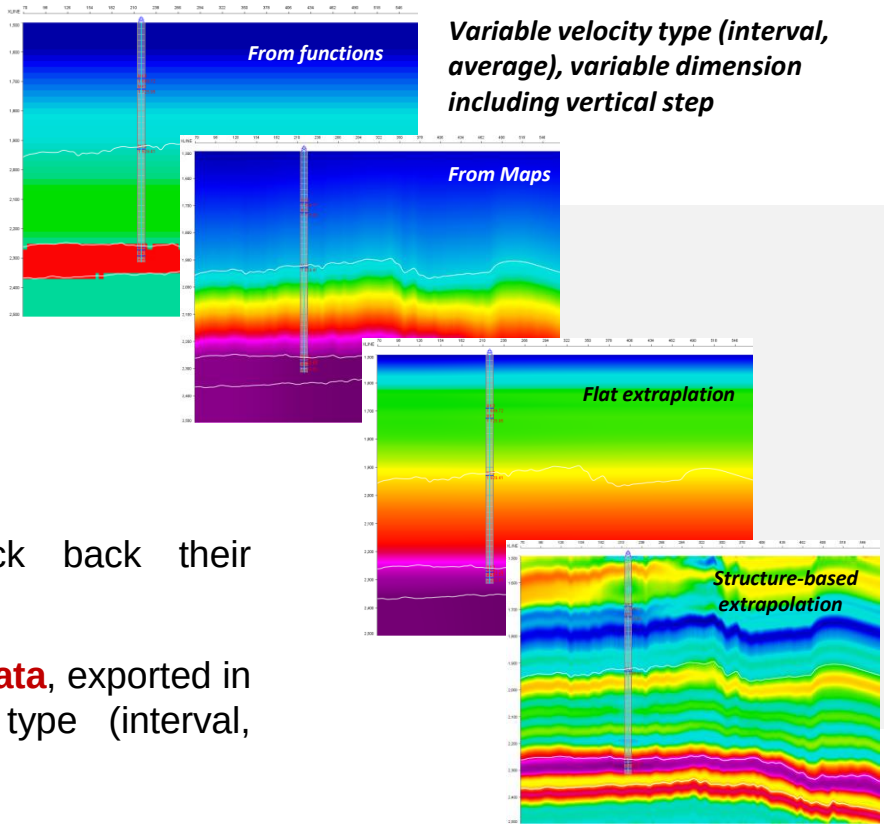
The pointset data, geo-localized and labelled locations, formerly introduced in InterWell to support **seismic characterization**, has a key role in the time-depth conversion workflow as points tied during both **velocity analysis** and **velocity model calibration**.

Its generation is automatic through **dedicated modules**. The input parameters are stored to be accessed/modified during the project.

VELOCITY MODELING ACCORDING TO YOUR DATA

The velocity model can be generated :

- From a single velocity function ;
- From several functions according to units;
- From several velocity maps according to units;
- From flat logs extrapolation;
- From logs extrapolation according to a framework.



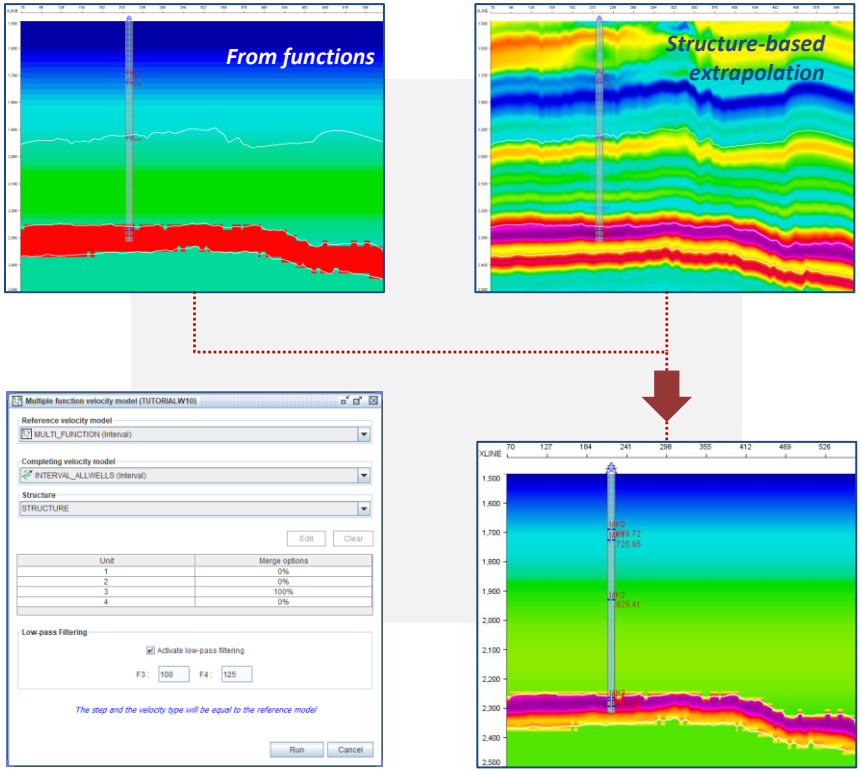
Variable velocity type (interval, average), variable dimension including vertical step

The models can be **restored,** to check back their **parameters,** and **quickly updated**.

The models can be **visualized** as **a seismic data**, exported in SEG-Y or converted to another velocity type (interval, average, RMS).

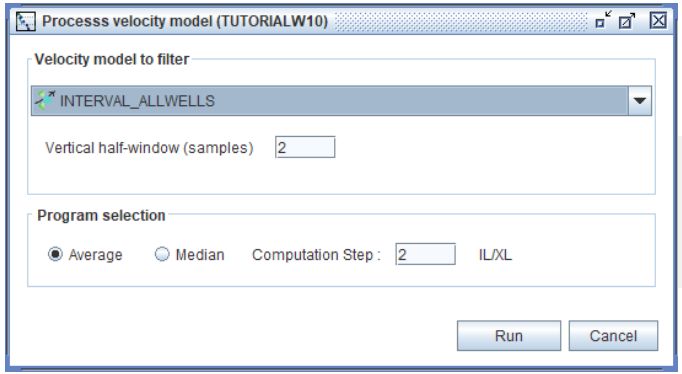
MERGING VELOCITY MODELS TO COMBINE APPROACHES

- **The velocity models can be merged to :**
  - Integrate a seismic velocity data;
  - Combine different velocity modeling approaches.
- The merged models can be **restored** to check back their **parameters** or **quickly updated.**
- A **merged model** can be merged again with another volume to iteratively **enrich** the final velocity model.

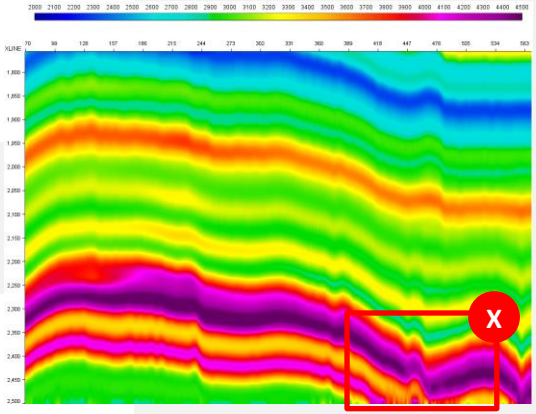


The models can also be **modified** by InterWell volume processing tools, then reintroduced at any time in the time-to-depth conversion workflow.

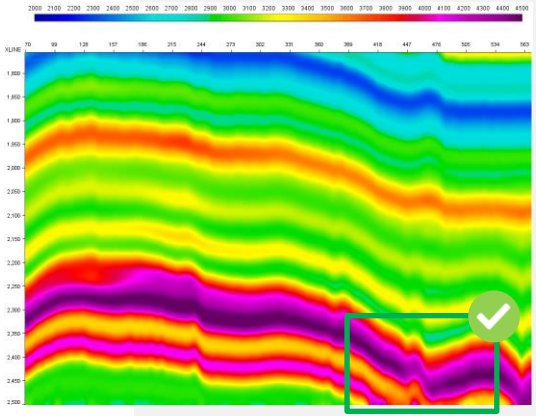
FILTERING VELOCITY MODEL



Raw velocity model (m/s)



Filtered velocity model (m/s)



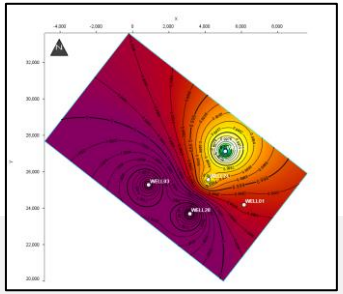
- Some methods or merges can introduce **abrupt changes** which should be removed in order to avoid **artifacts** in the converted volumes or horizons.
- The **filter** (3D median or average) allows to smooth the volume to **erase** these changes. The obtained model keeps its **key characteristics** (replacement velocities, velocity type…) and can be restored.

CALIBRATION WORKFLOW : FROM RAW TO CALIBRATED VELOCITY MODEL

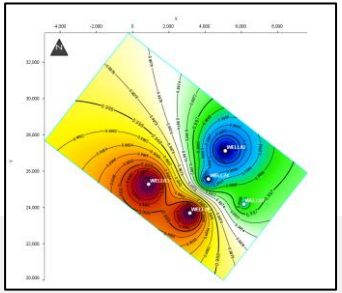
Calibration point extraction and correction maps

Automatic calibration point extraction and **highly customizable** calibration map extrapolation.

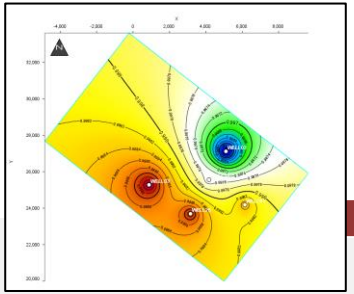
Level 1



Level 2



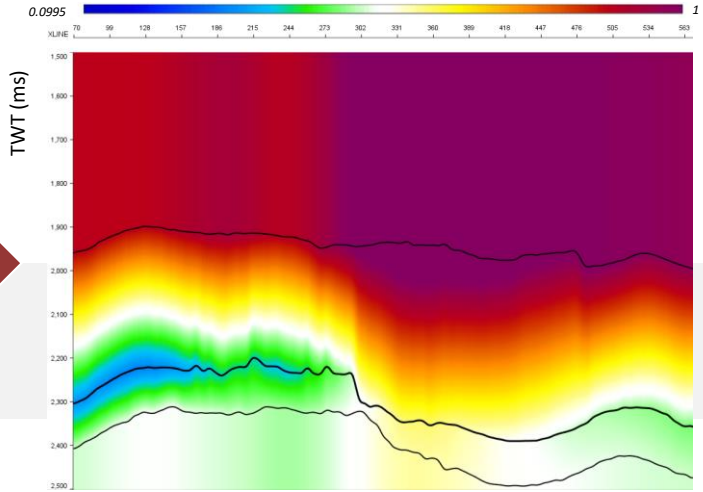
Level 3



Correction volume generation

Average velocity **extrapolation** through a **structural framework.**

Velocity Correction (in ratio)



Calibrate velocity models for a perfect match with the well markers

CALIBRATION : VELOCITY FROM MODELS AND WELL DATA

Compare velocities from TD law with velocity from models

Calibration pointsets from well TD Law (TUTORIALW10)

Reference velocity model : INTERVAL_ALLWELLS

Well name filter :

Select preferred TD laws & collections

For wells with trajectory defined in TWT, markers and TD laws must be already converted to TVD

Well Name	TD Law	Collection Name	Marker Name	Used
WELL01	FINAL	Markers.asc	MK0	☑
WELL02	FINAL	Markers.asc	MK0	☑
WELL03	FINAL	Markers.asc	MK0	☑
WELL07	TFP	Markers.asc	MK0	☐
WELL24	FINAL	Markers.asc	MK0	☑
WELL28	FINAL	Markers.asc	MK0	☑

Select wells | Discard wells | Broadcast marker selection

Conversion parameters

SRD 0.0 Replacement velocity 2240.0

Run | Cancel

Extrapolate the differences or the ratio as maps

Residual pointset extrapolation window (TUTORIALW10)

Pointset MK0_INTERVAL [INTERVAL_ALLWELLS]

Create residual map | Create ratio map

Selected	Well	Velocity Ratio
☑	WELL01	1
☑	WELL02	1.019
☑	WELL03	0.978
☑	WELL24	1.011
☑	WELL28	0.978

Select data | Unselect data

Interpolation method

Inverse distance

Gridding with anamorphosis

Kriging | Set mean value 0

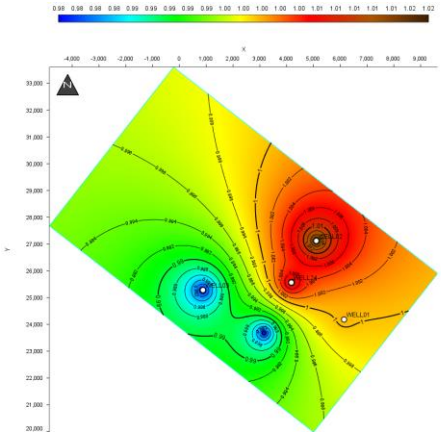
Kriging contrain

Constraint map Select

Variogram model Edit (empty) QC

Run | Cancel

Ratio map for a given level



Automatic statistics as a pointset to get the ranges of the velocity differences or ratios

Pointset global statistics :

Column	Minimum	Maximum	Average	Standard deviation
Well TVD	2743	2963	2849.4	71.92
Model TVD	2743.333	3003.017	2860.035	79.721
Delta TVD	-40.017	0	-10.635	11.753
Well Velocity	2442.666	2583.217	2523.636	60.611
Model Velocity	2442.962	2602.951	2532.921	67.413
Delta Velocity	-34.686	0	-9.285	10.16
Ratio Velocity	0.987	1	0.996	0.004

Pointset data :

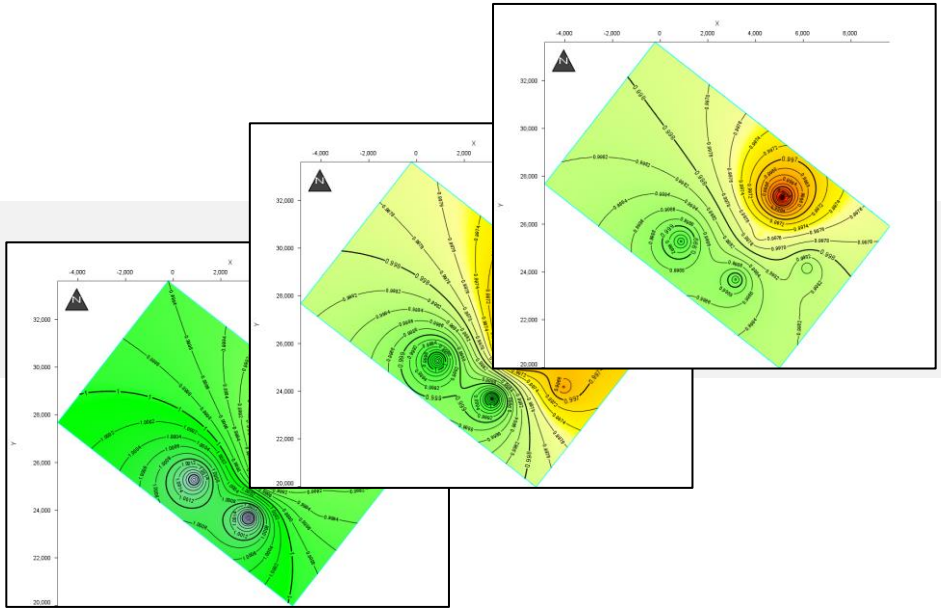
X	Y	Well Name	Marker Name	Well TVD	Model TVD	Delta TVD	Well Velocity	Model Velocity	Delta Velocity	Ratio Velocity
6142.7	24183	WELL01	MK3	2868	2871.998	-3.998	2570.951	2574.535	-3.584	0.999
5105.4	27119	WELL02	MK3	2963	3003.017	-40.017	2568.265	2602.951	-34.686	0.987
878.4	25282	WELL03	MK3	2743	2743.333	-0.333	2442.666	2442.962	-0.296	1
4174.5	25562	WELL24	MK3	2897	2904.394	-7.394	2583.217	2589.81	-6.593	0.997
3157.5	23692	WELL28	MK3	2776	2777.435	-1.435	2453.079	2454.347	-1.268	0.999

High parametrization level :

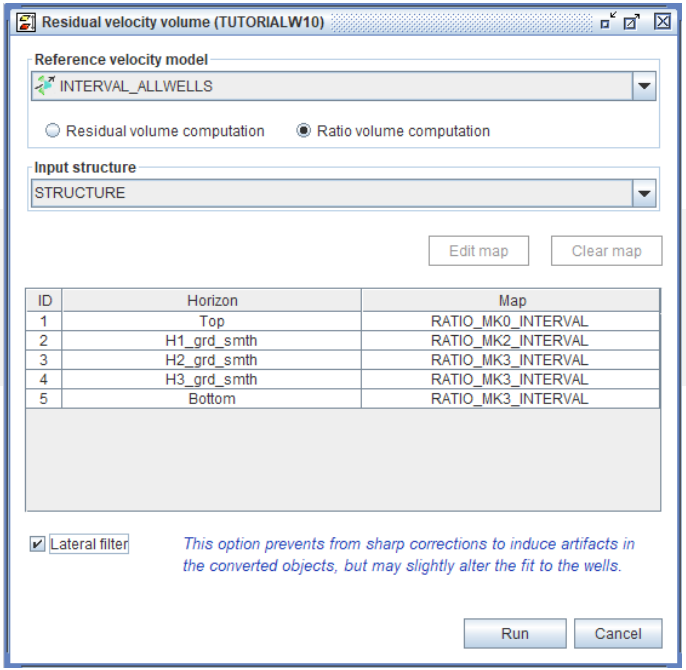
- *Different algorithms for extrapolation.*
- *Kriging (with or without mean value), collocated co-kriging.*
- *The variogram definition allows punctual or regional correction.*

CALIBRATION : FROM RAW TO CALIBRATED VELOCITY MODEL

Ratio map for horizons/unit limits

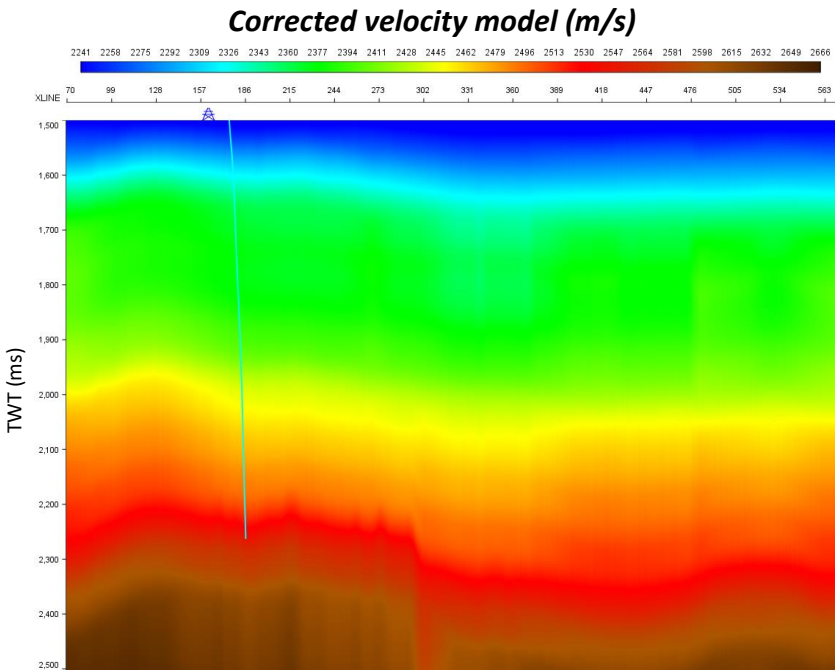


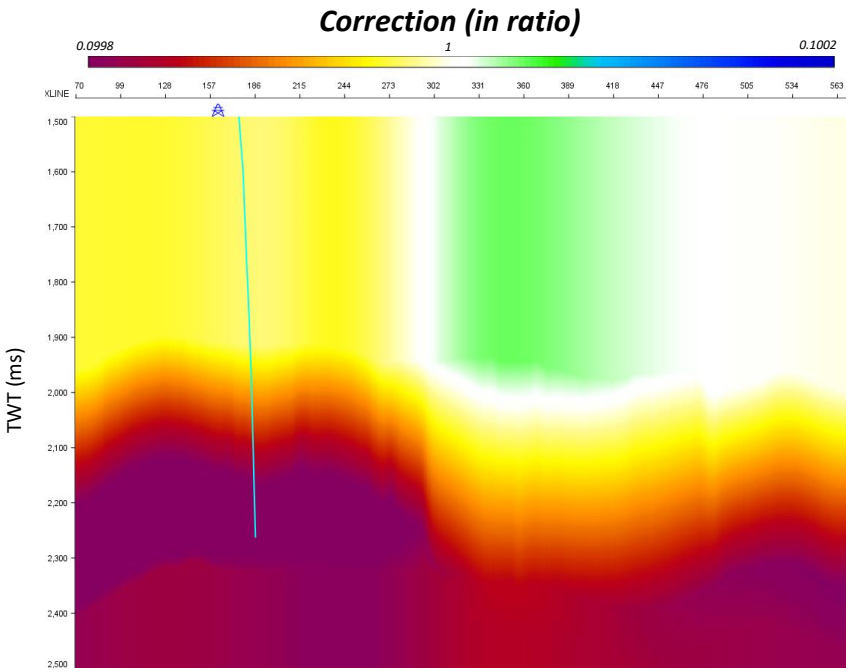
Calibration map assignment



The correction to be applied to the 3D model is populated according to the **structural framework**. Each map is assigned to a unit limit. A same map can be assigned to **several units**.

CALIBRATION : EXAMPLE FOR A SECTION





The correction modifies the 3D velocity model to **ensure the match** between wells and the seismic data. A version of the workflow is also available to **derive pseudo-velocities** from **wells** and **horizons (flexing).**

CALIBRATION : AN EFFICIENT TOOL FOR QC OR REVIEW

*Automatic velocity statistics of well velocities and model velocities **before** calibration*

Pointset global statistics :

Column	Minimum	Maximum	Average	Standard deviation
Well TVD	1940	1967	1950.976	10.419
Model TVD	2246.026	2338.321	2288.821	19.8
Delta TVD	-371.321	0	-337.845	18.837
Horizon-based Velocity	2020.917	2066.68	2048.14	15.231
Model Velocity	2366.741	2435.008	2402.704	24.27
Delta Velocity	-384.59	0	-354.564	18.68
Ratio Velocity	0.841	0.866	0.852	0.007

Pointset data :

X	Y	Well Name	Marker Name	Well TVD	Model TVD	Delta TVD	Well Velocity	Model Velocity	Delta Velocity	Ratio Velocity
6142.7	24183	WELL01	MK0	1941.88	2288.408	-346.528	2066.281	2435.008	-368.728	0.849
5105.4	27119	WELL02	MK0	1967	2338.321	-371.321	2037.286	2421.876	-384.59	0.841
878.4	25282	WELL03	MK0	1945	2246.026	-301.026	2049.537	2366.741	-317.205	0.866
4174.5	25562	WELL24	MK0	1961	2288.57	-327.57	2066.68	2411.902	-345.222	0.857
3157.5	23692	WELL28	MK0	1940	2282.778	-342.778	2020.917	2377.993	-357.075	0.85

*Automatic velocity statistics of well velocities and model velocities **after** calibration*

Pointset global statistics :

Column	Minimum	Maximum	Average	Standard deviation
Well TVD	1940	1967	1950.976	10.419
Model TVD	1940.769	1969.055	1952.519	10.746
Delta TVD	-2.098	0	-1.543	0.549
Horizon-based Velocity	2020.917	2066.68	2048.14	15.231
Model Velocity	2021.719	2068.627	2049.761	15.355
Delta Velocity	-2.233	0	-1.621	0.579
Ratio Velocity	0.999	1	0.999	0

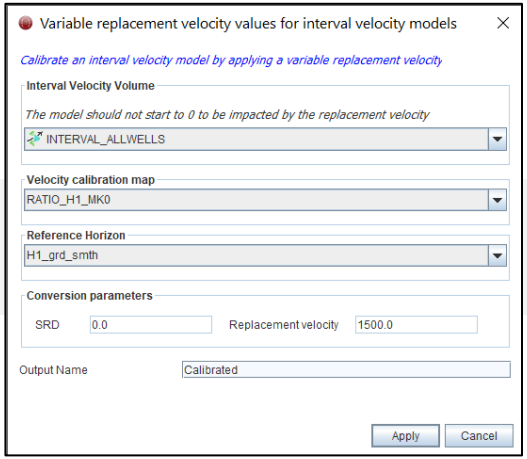
Pointset data :

X	Y	Well Name	Marker Name	Well TVD	Model TVD	Delta TVD	Well Velocity	Model Velocity	Delta Velocity	Ratio Velocity
6142.7	24183	WELL01	MK0	1941.88	1943.978	-2.098	2066.281	2068.513	-2.233	0.999
5105.4	27119	WELL02	MK0	1967	1969.055	-2.055	2037.286	2039.414	-2.128	0.999
878.4	25282	WELL03	MK0	1945	1945.943	-0.943	2049.537	2050.53	-0.993	1
4174.5	25562	WELL24	MK0	1961	1962.848	-1.848	2066.68	2068.627	-1.948	0.999
3157.5	23692	WELL28	MK0	1940	1940.769	-0.769	2020.917	2021.719	-0.801	1

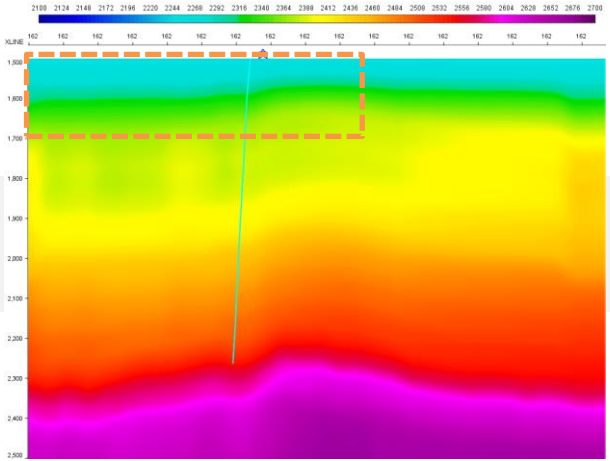
The calibration process can also act as a QC (after calibration), or as a review or an update of an existing model after newly drilled wells.

CALIBRATION : VARIABLE REPLACEMENT VELOCITY

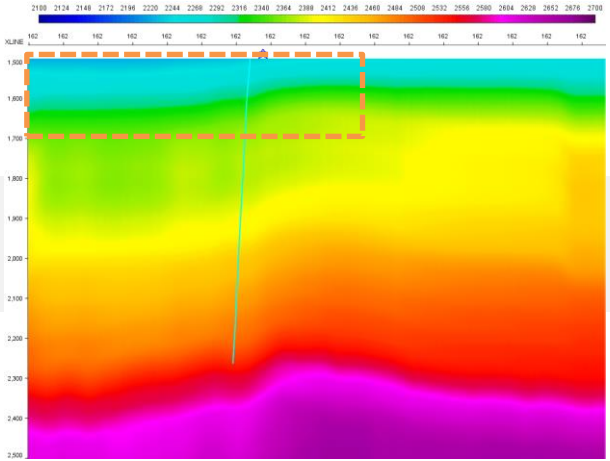
If an **interval velocity model** does not begin at 0ms TWT, a **constant replacement velocity** allows a first estimation of the average velocity of the missing part of the model. In some cases, the errors observed during the calibration, especially for the shallowest levels, **may be assigned to the first unmodelled layer**.



Average velocity from the raw velocity model (m/s)



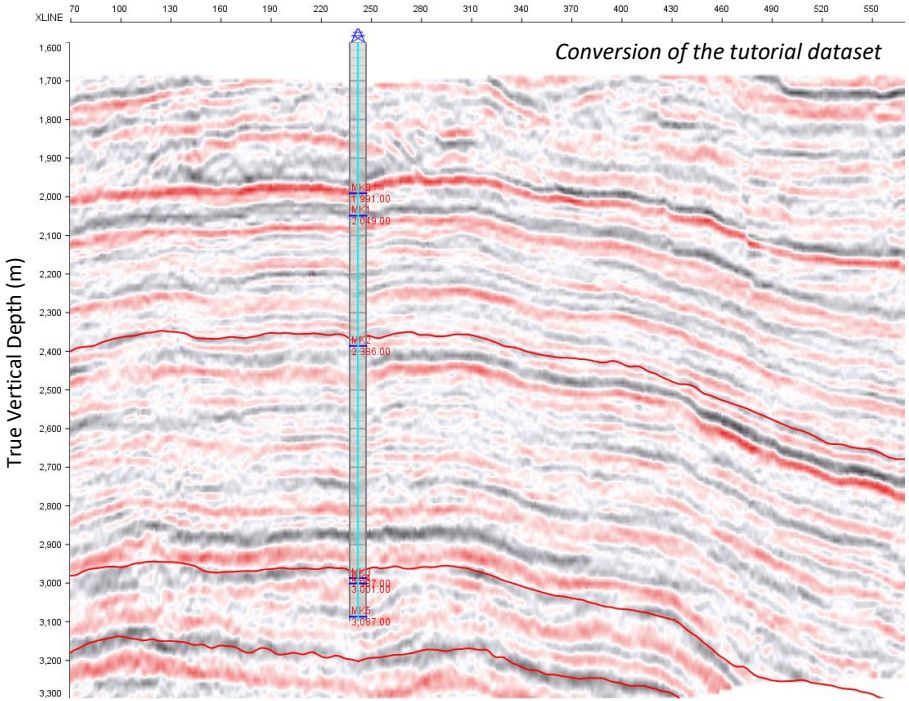
Calibrated average velocity model (m/s)

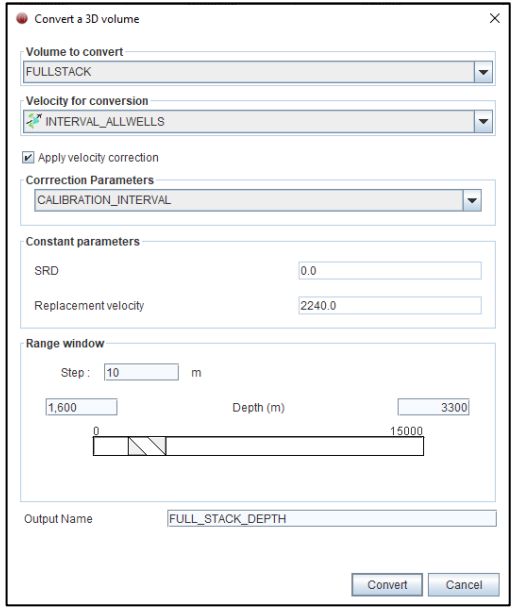


The module **recomputes an average velocity model**, optimizing the replacement velocity **considering the calibration map at the reference horizon level**, transferring **the error to the missing first layer only**. If recomputed, the **interval velocity from the calibrated model** is the **same as the original model**.

CONVERSION : VOLUMES AND HORIZONS

The **conversion process** can be performed on any seismic or horizon in InterWell. The compatibility between the data domains is checked during visualization. The **velocity maps** can also be used to directly convert the horizons.





Either the final volume or the raw volume and the correction can be selected. The correction contains the update of the new wells.

For further information, please contact your regional office or visit www.beicip.com

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Tel: +33 1 47 08 80 00	Tel: +973 17 21 11 50	Tel: +7 495 966 20 66	Tel: +55 21 9 8254 5000	Tel: +1 281 293 85 50	Tel: +52 9931 46 10 63