



InterWell™
From seismic to decision

Software Presentation

InterWell™ is a software solution developed by Beicip-Franlab, available for Windows and Linux platforms. It provides:

- Deterministic and geostatistical seismic inversion
- Seismic matrix and fracture characterization
- Reservoir monitoring via 4D inversion and characterization
- Time-depth conversion

Seismic Inversion

SEISMIC DATA CONDITIONING AND QUALITY CONTROL

- Conditioning of gathers and quality control, including NMO correction, mute picking, F-K filtering, trim statics, and more
- Stacking of migrated gathers (by incidence/azimuthal angle ranges) in PP, PS or depth domains
- Correction of Residual NMO misalignment between angle stacks using volumetric optimization

MULTI-TRACE COHERENCE ANALYSIS

- Estimation of seismic signal, noise, bandwidth and zero-phase wavelet

WELL-TO-SEISMIC CALIBRATION

- Well conditioning, time/depth law design, impedance computation
- Well and seismic conditioning, hybrid wavelet estimation (statistical and deterministic), phase analysis, and calibration optimization using multi-trace and multi-well analysis
- AVO well-to-seismic calibration and optimal well location selection, using statistical analysis of calibration quality maps across multiple single-volume sessions

PRIOR IMPEDANCE MODELING

- Defining correlation lines using horizons and deposit models
- Defining macro-units for parameter mapping
- 3D dip analysis from seismic data to establish correlation lines
- Interpolating well data along structural and stratigraphic correlation lines
- Conditioning models using seismic velocity data
- Option to use prior models derived from previous inversion results or other seismic attributes

DETERMINISTIC INVERSION

Acoustic and Elastic seismic inversion using a Bayesian approach
Inversion products include IP, IS, RHO, synthetic seismic, reflection coefficients and residuals for each angle-stack, Poisson Ratio, V_p/V_s Ratio, $\Lambda\text{m}\delta\text{b}\rho$, $\text{M}\mu\text{R}\rho$, Intercept and Gradient

- Inversion algorithm parametrization based on prior uncertainty assessments
- Balancing the influence of input seismic data volumes
- Optimization via multi-channel conjugated gradient method and inversion cost function visualization
- Fast full-seismic option available (sparse-spike inversion)
- High-performance computing capabilities, cluster compatible
- Inter-Bed Multiple Modeling (IBMM) technology to reduce internal multiples from a contaminated datasets
- Laterally variable wavelet energy
- Integration of VTI (Rüger) anisotropy model for improved inversion results

AZIMUTHAL INVERSION

- Determining isotropic and anisotropic contributions via sequential deterministic inversions
- Assessing anisotropy (intensity and orientation) through ellipse fitting
- Dedicated map view with arrows to visualize orientation attributes

TIME-LAPSE 4D JOINT INVERSION

- Prior warping using a multi-channel correlation method
- Physical warping integrating P-wave kinematics and impedance variations
- Multi-vintage post- and/or pre-stack joint inversion

MULTICOMPONENT JOINT INVERSION

- Registration law design (time-based, horizon-based and imported) followed by optimization based on a semblance-based method.
- Multicomponent pre-stack sequential inversion (PP, PS, SH, or SV)
- Bi-, Tri-, and Quadri-joint multi-component pre-stack inversion (PP, PS, SH and SV).
- Cross-domain conversion using registration laws.

GLOBAL STOCHASTIC INVERSION

- Nested variograms with optional anisotropy
- Direct stochastic sequential simulations to fit complex distribution fitting
- Global optimization based on the trace-to-trace mismatch between real and synthetic seismic data
- Optionally use deterministic inversion results as secondary variables
- Optionally constrain simulations with external distributions
- Uncertainty analysis via multiple simulations and scenarios using a multi-seed approach
- Lithology/facies and continuous property characterization tailored for geostatistical inversion to capture the property uncertainties

Seismic Characterization

AVO ANALYSIS

- R0-G estimation on volumes from raw or RNMO corrected data
- R0-G cross-plot from maps or volumes with direct highlighting in sections

GEOBODY EXTRACTION AND ANALYSIS

- Connected bodies extraction from any volume, with direct access to body sizes and well inter-connectivity analysis
- Automatic computation of top, bottom, thickness and aspect ratio from any detected bodies

SEISMIC FRACTURE CHARACTERIZATION

- Extensive library of 3D and map attributes to highlight the faults/fractures (coherence, dip or amplitude-based attributes)
- Dedicated and interactive attribute scaling module (3D or map)
- Map attribute clustering (k-means) to identify typical fault/fracture responses
- Volume or map attribute blending to synthesize the analysis as a Seismic Fracture Index map

SEISMIC CONSTRAIN MAP FOR GEOMODELING

- Trend modeling to derive key reservoir properties maps by combining characterization results and well data using co-kriging or residuals kriging

PORE PRESSURE PREDICTION

- Estimation of pore pressure from seismic velocities using Eaton's method assessing the identification of overpressure zones

Machine Learning

CONTINUOUS PROPERTY PREDICTION

- Estimation of continuous key reservoir properties using empirical laws (linear, quadratic, etc.) by facies or probability
- Estimation via least squares optimization using up to three 2D/3D input volumes
- Model testing on training data to identify the best fit (linear, quadratic), with optimized formula and RMSE calculation
- Random isolation of test data from training samples to prevent overfitting

LITHOLOGY OR FACIES PREDICTION

- Dominant lithology prediction via discriminant analysis or neural networks, generating lithology volumes and assignment probabilities
- Prediction accuracy testing for optimal hyperparameter selection
- Dedicated module for nested supervised analysis
- Post-processing of probability volumes using cube cut-off analysis to exclude uncertain areas from the final results

DIMENSIONALITY REDUCTION

- 3D Principal Component Analysis to assess attribute dependency, determine factors for attribute reduction and filtering

SEISMIC CLASSIFICATION

- Horizon-slice extraction and unsupervised trace classification using clustering algorithms (k-means) to generate zonation maps, with optional input preprocessing (normalization and centering)
- 3D or map-based unsupervised classification with customizable attribute selection
- Quality control for convergence rate and class number selection, typical trace analysis
- Supervised seismic facies analysis for user-defined zonation maps

SELF-ORGANIZING MAPS (SOM)

- Unsupervised and semi-supervised SOM for seismic attribute clustering, visualization, and prediction
- Supports both discrete and continuous prediction: modules can estimate continuous property distributions as well as discrete facies classification
- Semi-supervised SOM enables disabling neurons distant from training data to enhance prediction accuracy
- 3D k-means class reduction, convergence control, and class number selection quality control
- Interactive topology view for exploring neuron grids, labels, or weights, with direct cursor interaction on seismic sections

Time-Depth Conversion

VELOCITY DATA ANALYSIS

- Calculation of velocity (average, RMS, interval) from calibrated time-depth laws
- Cross-plots of velocity versus Z-axis to identify trends
- Automatic extraction of average velocity from well markers and time-depth laws or horizons, with extrapolation (inverse distance, kriging, co-kriging, etc.)

3D VELOCITY MODELING

- Single or multiple functions along TWT, based on a structural framework (interval or average models)
- Extrapolation of multiple average velocity maps linked to key horizons
- Flat or structure-based log extrapolation (interval or average velocity)
- Raw velocity model processing: merging and filtering

VELOCITY CALIBRATION

- Automatic error calculation (TVD and velocity) between raw velocity models and well markers or time-depth laws (or horizons)
- Error extrapolation and its application to achieve an optimal fit with well data

CONVERSION

- Conversion of a horizon with a velocity map
- Conversion of a horizon or volume from time to depth or depth to time, with:
 - A raw or calibrated velocity model defined either in depth or time
 - A raw velocity model with its correction
- Flexing module to adjust volumes to new horizon sets

Data Management

DATA IMPORT/EXPORT

- Supports multi-survey definition (2D/3D)
- 2D/3D seismic data (depth and time), in SEG-Y and binary files format, velocity data in SEG-Y, binary and ASCII formats
- 2D/3D seismic gathers in SEG-Y format
- Well data in LAS format (3.0), in depth and time domains, with automatic projection on 2D lines
- Horizons, maps, tables, wavelets and pointsets in ASCII format
- 2D/3D anisotropy parameters and attribute data
- Direct connection with EasyTrace™ database to transfer well data and tables
- Survey migrator for database compatibility with previous versions

DATA VISUALIZATION, EDITION AND QC

- Wells
 - Sections with customizable well projection
 - Well data edition for log curves, markers, TD laws and trajectories through dedicated modules
 - Log curve calculator and log preparation for inversion and TD conversion
 - Lithology view in well window and seismic sections
 - Trace extraction along well trajectory from any volume within the study
- Maps
 - Horizon edition: gridding, smoothing, polygon-based cut and merge
 - Display of isolines over any map view
 - Property visualization combined with a structural horizon in 3D
- Volumes
 - Volume processing Toolbox including filtering (with optional seismic dip), scaling, resizing and more capabilities
 - Volume calculator and volume edition based on horizons
 - Section view in Inline, CrossLine and arbitrary lines. Design of arbitrary lines stored in the study
 - Frequency analysis (minimum, maximum, dominant frequency) or spectral decomposition in maps
 - Time constant or horizon-based extractions on volumes : average, minimum, maximum, variance, correlation, standard deviation, RMS, facies proportion/ samples according to cut-offs
- Age viewer
 - Interactive stratigraphic scanner with synchronized section/map views and dynamic age-based horizon.
- Wavelets
 - Display of multiple wavelets, comparison of amplitudes and phase spectra
 - Wavelet copy and reassignment to another volume
- Cross-plots
 - Cross-plots between volumes, horizons/maps, table and pointset columns, well logs using markers

Python connection

A Python toolbox providing unlimited scripting capabilities and seamless connectivity to the InterWell database for both data reading and writing

Specifications

- Operating Systems: Windows 10/11 (64 bits), or Linux RedHat 6, RedHat 7, RedHat 8 and RedHat 9 (64 bits)
- RAM: 16 GB or more
- CPU: x86 and x86-64 processors
- Graphics board: NVIDIA GPU highly recommended (compatible with OpenGL)



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