

# TECHNICAL SPECIFICATIONS



## InterWell™

Seismic Inversion & Characterization  
Time Depth Conversion

## Software Presentation

InterWell™ is a software edited by Beicip-Franlab, available on Windows and Linux platforms, covering:

- Seismic deterministic and geostatistical inversion
- Seismic matrix and fracture characterization
- Reservoir monitoring through 4D inversion and its characterization
- Time-depth conversion

## Seismic Inversion

### SEISMIC DATA CONDITIONING AND QC

- Map extraction on Gathers (fold, min/max angle along horizon, etc.)
- Gathers conditioning, including NMO correction, mute picking, filters, trim statics and more
- Stacking migrated gathers (according to incidence/azimuthal angle ranges)
- Residual NMO misalignment correction between angle stacks using a volumetric optimization method
- Automatic QC in maps with templates

### MULTI-TRACE COHERENCE ANALYSIS

- Estimation of seismic signal, noise and seismic bandwidth
- Statistical estimation of wavelet amplitude spectrum

### WELL-TO-SEISMIC CALIBRATION

- Well conditioning, time/depth law design, impedance computation
- Hybrid approach for wavelet estimation (statistical and deterministic)
- Time shift estimation through envelop of intercorrelation
- Wavelet phase & energy determination via multi-trace & multi-well analysis
- Variable phase analysis for complex wavelets
- Inter-bed multiple modeling option to detect multiple generator and maximize calibration accuracy
- Flexible edition of calibrated wells location and time-shift
- Energy normalization map from wells using several interpolation methods
- AVO well-to-seismic calibration and best compromise of optimal well locations considering several single-volume calibration sessions, using statistical analysis of calibration quality maps

### PRIOR IMPEDANCE MODELING

#### Structural framework

Building a geological framework for guiding the prior model and the inversion

- Integration of horizons and deposit modes
- Definition of macro-units for parameter mapping
- 3D dip analysis from seismic data to define the inversion correlation lines

#### Prior model for elastic parameters

- Well data interpolation along structural and stratigraphic correlation lines
- Modeling conditioning using seismic velocity data
- Possible use of a prior model derived from a previous inversion result or from any other free seismic attribute

### DETERMINISTIC INVERSION

Acoustic and Elastic seismic inversion with Bayesian approach

Inversion products: IP, IS, RHO, synthetic seismic, reflection coefficients and residuals for each angle-stack, Poisson Ratio,  $V_p/V_s$  Ratio,  $\text{LambdaRho}$ ,  $\text{MhuRho}$ , Intercept and Gradient

- Parameterization of inversion algorithm using prior uncertainty assessments
- Balancing the influence of input seismic data volumes
- Optimization through a multi-channel conjugated gradient method and inversion cost function visualization
- Fast full-seismic option available (sparse-spike inversion)
- HPC capabilities to minimize computing time

#### Advanced inversion capabilities

- Inter-Bed Multiple Modeling (IBMM) technology to attenuate the impact of internal multiples from a contaminated dataset
- Laterally variable wavelet energy
- Integration of VTI (Rüger) anisotropy model to enhance inversion results

### AZIMUTHAL INVERSION

- Determination of isotropic and anisotropic contributions through sequential deterministic inversions
- Assessment of horizontal anisotropy parameters via ellipse fitting
- Dedicated map view with arrows to display orientation attributes

### TIME-LAPSE 4D JOINT INVERSION

- Vintage alignment with different methods (correlation-based, impedance alignment, horizon-based, combined approach)
- Physical warping integrating P-wave cinematic and impedance variations
- Multi-vintage post- and/or pre-stack joint inversion

### MULTICOMPONENT JOINT INVERSION

- Scaling law computation for the different domains
- Multicomponent post and pre-stack joint inversion (PP, PS and optionally SH, SV wavefield domains)

### GLOBAL STOCHASTIC INVERSION

- Variogram analysis and automatic fitting
- Direct stochastic sequential simulations to fit complex distributions
- Global optimization technique based on the trace-to-trace mismatch between real and synthetic seismic
- Deterministic inversion results as secondary variable (optional)
- External distributions to constrain the simulations (optional)
- Uncertainty analysis through the analysis of several simulations and several scenarii using a multi-seed approach
- Lithology/facies and continuous property characterization adapted to geostatistical inversions to capture the final 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, direct highlight in sections

## LITHOLOGY OR FACIES PREDICTION

- Dominant lithology prediction using discriminant analysis or neural network, providing a lithology volume and good assignment probabilities
- Test the prediction accuracy to select the best hyperparameters
- Dedicated module for nested supervised analysis application
- Post-processing of the probability volumes using cube cut-off analysis, removing the uncertain areas from the final results

## CONTINUOUS PROPERTY PREDICTION

- Assessment of continuous key reservoir properties through empirical laws (linear, quadratic...) by facies or according to their probabilities
- Assessment of continuous key reservoir properties through a least square optimization and various 2D/3D input volumes
- Test the prediction on the training data to identify the best model (linear, quadratic), get the optimized formula and the RMSE
- Randomly isolate test data from training samples to avoid overfitting

## SEISMIC CLASSIFICATION

- Horizon-slice extraction and unsupervised trace classification using clustering algorithm (k-means) to output a zonation map, including optional input pre-processing (normalization and centering)
- 3D Principal Component Analysis to evaluate attribute dependency, determine factors for attribute reduction and filtering
- 3D unsupervised classification using a free number of attributes or factors
- Convergence rate, class number selection QC, robot trace analysis
- Supervised seismic facies analysis to output a user-driven zonation map

## GEOBODY EXTRACTION AND ANALYSIS

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

## SEISMIC FRACTURE CHARACTERIZATION

- A large panel of 3D and map attributes to highlight the faults/fractures (coherence-based, geometrical or instantaneous 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 maps of key reservoir properties combining characterization results and well data using co-kriging or residuals kriging

# Time Depth Conversion

## VELOCITY DATA ANALYSIS

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

## 3D VELOCITY MODELING

- Single or multiple functions along TWT, according to a structural framework (interval or average model)
- Multiple average velocity maps extrapolation, associated to key horizons
- Flat or structure-based log extrapolation (interval or average velocity)
- Raw velocity model processing: merge and filtering

## VELOCITY CALIBRATION

- Automatic error computation (TVD and velocity) between raw velocity model and well markers and TD laws (or horizons)
- Error extrapolation and its application to perfectly fit the well data



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## 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

# 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), 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
  - Trace extraction along well trajectory from any volume within the study
- **Maps**
  - Horizon edition through gridding, smoothing, polygon-based edition and multi-horizon merge options
  - Display of isolines over any map view
  - Property visualization combined with a structural horizon in 3D
- **Volumes**
  - Volume processing Toolbox featuring filtering (standard or dip-oriented), 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
- **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,
  - Customizable cross-plots and table generation from well logs and markers

# Extensions & Customization

Based on the Java-based INTViewer (<http://intviewer.net/products/intviewer.html>) and Netbeans IDE platforms allowing a high level of customization

# System Requirements

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