

TECHNICAL SPECIFICATIONS



InterWell

Seismic inversion
and reservoir characterization

Software Presentation

InterWell is Beicip-Franlab's seismic inversion and reservoir characterization software. Available on Windows and Linux platforms.

InterWell unified workflow offers the following key stages:

- Seismic data conditioning and QC
- Multi-well wavelet estimation and multi-cube well-to-seismic calibration
- Prior impedance modeling for elastic parameters
- Deterministic acoustic/elastic inversion
- VTI deterministic elastic inversion
- Acoustic/elastic geostatistical inversion
- Multi-component, azimuthal and 4D inversion workflows
- Dedicated matrix and fracture characterization workflows

Functionalities & Algorithms

SEISMIC DATA CONDITIONING AND QC

- NMO correction and stacking of migrated gathers
- Residual NMO Misalignment correction between angle stacks using a volumetric analysis and optimization method
- Generation of cube-to-cube cross-correlation, noise maps, and more QCs

MULTI-TRACE COHERENCY ANALYSIS

- Estimation of seismic signal, noise and seismic bandwidth
- Statistical estimation of wavelet amplitude spectrum
- Performed in constant time window or along an horizon

WELL-TO-SEISMIC CALIBRATION

- Well conditioning, time/depth conversion, impedance computation
- Hybrid approach for wavelet estimation (statistical and deterministic)
- Multi-well wavelet extraction and optimization
- Time shift estimation through envelop of intercorrelation
- Wavelet phase & energy determination via multi-trace & multi-well analysis
- Variable phase and amplitude wavelet estimation using a least square optimization method
- Inter-bed multiple modeling option to detect multiple generator and maximize calibration accuracy
- Flexible editing of calibrated wells location and time-shift
- Energy normalization map from wells using several interpolation methods

MULTI-CUBE CALIBRATION

- Well-to-seismic calibration and determination of optimal well position taking into account different single-volume calibration sessions

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

Creation of an a priori distribution of impedance and density

- Well data interpolation along structural and stratigraphic features
- Modeling of low frequency component using seismic velocity data
- Possibility to use an external prior model or to derive a new prior model from a previous inversion result

DETERMINISTIC INVERSION

Acoustic and Elastic seismic inversion with Bayesian approach

Inversion products: IP, IS, RHO, synthetic seismic, reflection coefficients and residuals seismic for each angle stack

Additional available elastic parameters: Poisson Ratio, Vp/Vs Ratio, LambdaRho, MhuRho, Intercept and Gradient

Taking into account data quality and influence by tuning inversion parameters:

- Parameterization of inversion algorithm using prior uncertainty assessments
- Balancing the influence of input seismic data volumes
- Optimization through a multi-channel conjugated gradient method
- Monitoring of inversion cost function
- Inversion on full-cube, sub-cube or around a surface
- Fast full-seismic option available

Advanced inversion capabilities

- HPC capabilities to minimize computing time
- Inter-Bed Multiple Modeling (IBMM) technology to attenuate the impact of multiples from a contaminated dataset on the inversion results
- Laterally variable wavelet energy
- Integration of VTI (Rüger) anisotropy model for enhanced inversion results

AZIMUTHAL INVERSION

Complete sequential multi-azimuth inversion workflow

- Determination of isotropic and anisotropic contributions
- Assessment of horizontal anisotropy parameters via statistical ellipse fitting

TIME-LAPSE 4D JOINT INVERSION

- A priori warping using a multi-channel correlations method
- Physical warping integrating P-waves cinematic and impedance variations
- Multi-vintage acoustic and/or elastic post- and/or pre-stack inversion

MULTICOMPONENT JOINT INVERSION

Complete workflow for multicomponent (PP, PS, SV, SH) inversion

- Scaling law computation for the different domains

- Multicomponent post- or pre-stack inversion

GLOBAL STOCHASTIC INVERSION

- Use of direct stochastic sequential simulations
- Global optimization technique based on the trace-to-trace mismatch between real and synthetic seismic
- Possibility to use deterministic inversion results as secondary variable
- Possibility to use external distributions to constrain the simulations
- Uncertainty analysis through the analysis of several simulations

Results Analysis

AUTOMATED DEDICATED QC

- **Wells**
 - Sections with customizable well projection
 - Automatic display for comparison between initial logs and inversion results
 - Available for blind wells testing
- **Wavelets**
 - Display of the envelop of inter-correlation functions between observed and synthetic traces (time-shift detection)
 - Cross-plots and histograms integrating all wells or sub-sets of wells for optimizing the time shift, the phase and the energy
 - Mapping of estimated parameters and corresponding correlations of observed vs. synthetic trace, to check the accuracy of the estimated parameters in the vicinity of the wells / intersections
 - Correlation coefficient, Phase, Time Shift and Energy maps around wells
 - Average calibration attribute maps (multi-cube calibration)
 - Wavelet and corresponding phase & amplitude spectrum
 - Display of multiple wavelets, comparison of amplitudes spectra, available for multi-cube stability analysis or input versus inversion results QC
- **Sections**
 - Automatic combined sections display showing a user-defined selection among inversion results, input seismic and prior models
- **Cross-plots**
 - Cross-plots between inverted parameters such as IP vs. IS (or calculated V_p/V_s or PR), and between inverted traces and well logs.
- **Maps**
 - Fast and accurate extractions of various attributes along/between horizon(s)
 - Display of isolines over any map view
 - Design of arbitrary lines stored as a survey data

SEISMIC CHARACTERIZATION TOOLS

Comprehensive set of functionalities and attributes

- **Filters**
 - Available for horizons and seismic data
- **Advanced calculator**
 - Available for horizon and seismic data
- **Seismic data QC**
 - Noise maps and energy maps
 - Using a constant time window or around an horizon
- **Inversion QC**
 - Cross-correlation maps between two sections/ volumes
 - Energy ratio maps between two sections/volumes
 - Noise maps before/after inversion
- **Frequency analysis on maps**
 - Minimum, maximum, dominant frequency, analysis at -6dB or -10dB
 - Spectral decomposition
- **Statistics maps extraction**
 - Average, minimum, maximum, variance, standard deviation, RMS
 - Available around one horizon or in an interval defined by two horizons
 - Possible use of threshold to derive proportion maps in an interval
- **Fast-track AVO analysis**
 - R0-G cross-plots and direct highlight on seismic data

RESERVOIR SEISMIC CHARACTERIZATION AND SEISMIC CONSTRAINTS GENERATION

Complete workflow for reservoir characterization from inversion results

- Dominant lithology prediction using discriminant analysis
- Generation of volumes of dominant lithology and associated probabilities of good assignment
- Post-processing of the probabilities using cube cut-off analysis
- Fracture characterization through multi-attribute workflow

- Assessment of continuous key reservoir properties (TOC, porosity, VSH) using multi-variate analysis
- Trend modeling to derive maps of key reservoir properties combining inversion results and well data

DEDICATED CHARACTERIZATION OPTIONS FOR ADVANCED WORKFLOWS

- Ellipse fitting for anisotropy intensity and orientation quantification in azimuthal workflows
- 4D effects quantification modules
- Discriminant and multi-variate analysis
- Characterization from geostatistical inversion results to capture uncertainties in reservoir properties

Data Management

InterWell integrated survey migrator automatically ensures compatibility with databases and runs from previous versions.

DATA IMPORT/EXPORT

- 2D/3D seismic, velocity, and anisotropy data in SEG-Y and binary files format
- 2D/3D seismic gather 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, and pointsets in ASCII format
- Wavelet in ASCII format
- 2D/3D anisotropy parameters and attribute data
- Direct connection with EasyTrace database for transfer of well data, tables and external distributions

DATA EDITING AND QC

- Well data edition for log curves, markers, TD laws and trajectories through dedicated modules
- Horizon edition through various gridding, smoothing, merge options
- Data extraction and calculators for wells, maps, sections and volumes
- Automated QC displays on wells, maps, sections and volumes
- Variogram computation on maps

Extensions & Customization

Based on the open Java™-based INT platform (<http://intviewer.net/products/intviewer.html>) allowing a high level of customization and extensions

- Powerful and flexible GUI
- Based on the open source Netbeans Rich Client Platform (RCP) for creating and managing plugin functionality
- Existing plug-ins available among spherical divergence correction, Butterworth filter, binning 4D.
- Interoperability with Python and the Seismic Workbench

System Requirements

- **Operating System:**
 - PC Windows 7 and Windows 10
 - PC Linux 64 bits RedHat6 or RedHat 7 or compatible
- **RAM:** 16 GB or more (minimum: 8 GB)
- **CPU:** x86 and x86-64 processors
- **Graphics board:** NVIDIA recommended (or any graphic card compatible with OpenGL)



Beicip-Franlab Headquarters
232, avenue Napoléon Bonaparte
92500 Reuil-Malmaison - France
Tel.: 33 1 47 08 80 00
Email: info@beicip.com

BeicipFranlab
An IFP group company