VSP data processing by High Definition Seismic (HDS) technology using UNIVERS software

GEOVERS Ltd, Moscow, 2021 http://geovers.com Processing and interpretation services

- Checkshot VSP
- Zero-offset VSP (the nearest SP)
- Offset VSP
- Walkaway
- 2D/3D VSP
- 2D+VSP, 3D+VSP (combined observation systems)

Functional capabilities

- Designing of VSP acquisition system, uphole velocity survey.
- Quality control, signal to noise ratio evaluation for different frequency intervals.
- Detailed velocity model estimation in the neighborhood of the borehole.
- Multicomponent (3C) high resolution (1-250 Hz) wavefield processing.
- Getting of detailed distribution of acoustic impedances in an opened part of the section and beneath the bottom of the borehole.
- Zero-phase deconvolution of surface reflections from VSP primary reflections.
- Detailed lithologic and stratigraphic correlation of surface reflections to well logs.
- Estimation of rocks fracture and cracks orientation.
- Estimation of the absorbing characteristics of media.
- Seismic imaging using migration procedure.
- Construction geo-stratigraphic model of media and structural maps on the basic of reflecting borders.

Uphole velocity survey (micro seismogram log)



Wavefield and first break hodograph

Velocity model estimation

VSP processing flow



Correction by reference geophone





Bottomhole geophone signal before (A) and after (B) correction.

Polarization determination and orientation of vector wavefield to PRT-component system



Predictive deconvolution on source VSP wavefield (vertical component)



Kinematic processing



Selected reflections as a result of model based dynamic processing



Lithology, LOG-data, VSP reflectivity and acoustic impedance, quality-factor

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Precise tie of CDP section to LOG via VSP



Линия приведения кривых ГИС - устье скважины. Вертикальные глубины от устья скважины. Альтитуда устья - 88,56 м.

Tying of CDP and VSP data



Prediction below bottom of well



S-waves anisotropy evaluation for rocks fracture and cracks orientation estimation





Comparison of down converted waves along horizontal components X-red and Y-blue selected from VSP wavefield at rotation of coordinate system by 15 degrees step

Qualitative subtraction from VSP wavefield of downgoing share waves makes it possible to detect azimuthal anisotropy of velocities near the well. Anisotropy may be caused by presence of vertical cracks.

Tying of offset VSP section, reflectivity and LOG data



Схема расположения пунктов взрыва ВСП: ПВ1: удаление 1119.5м, азимут 26°12'27,3"

Offset VSP sections and mapping



High-resolution section of acoustic impedances



Conclusions

VSP, within the High Definition Seismic technology, allows to achieve the following objectives:

- P- and S-waves velocities (interval, average, layer), vertical hodographs, anisotropy, impedances estimation as a result of optimizing inversion of first breaks from all shots (zero-offset VSP, offset VSP, walkaway cases).
- Selection of P and S primaries with high resolution (1-250 Hz) as a result of modelbased vector wavefield separation.
- Evaluation of reflective characteristics in borehole environment.
- Surfaces seismic waveform evaluation, correction and resolution increasing.
- Identical correlation of LOG data, VSP and surface seismic provides tying of reflections on the surface to the lithological section.
- Geological section prediction bellow bottom of well.
- Vertical fracture analysis in borehole environment by qualitative extraction of downgoing S-waves and estimation of anisotropy of share wave velocities.
- Detailed sections of borehole environment construction in the direction of offset shot points as a result of P and S upgoing waves migration. Minor faults isolation.
- Structural imaging.