

**P1            ROLE OF VSP MEASUREMENT IN INVESTIGATION OF ANISOTROPY OF GEOLOGICAL MEDIUM.**

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**РОЛЬ ВСП В ИССЛЕДОВАНИИ АНИЗОТРОПИИ ГЕОЛОГИЧЕСКОЙ СРЕДЫ.**

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**Abstract**

Azimuthal and multicomponent measurements of vertical seismic profiling VSP 3C are the most useful tool, from among current seismic methods, to the investigation of the anisotropy of the geological medium.

Velocity and polarization analysis of azimuth multicomponent VSP 3C wave fields are the basis for determining the direction and the quantitative evaluation of the anisotropy.

**Аннотация**

Азимутальные и многокомпонентные измерения ВСП 3С – самый надежный метод исследования анизотропии геологической среды.

Анализ скоростей и поляризации волновых полей в многокомпонентном азимутальном ВСП являются основой для определения направления и количественной оценки анизотропии

**Introduction**

The exact recognition of geological space around the well is very essential, especially when we deal with the complicated geological formation and the specificity of occurrence of sedimentary basins, i.e. small deposits and in small thickness, often multilayer. At present the most effective method permitting to recognize the state of the orogen before drilling of well are seismic explorative works. However, considering the difficulties and limitations on which this method is based, during explorative and processing works on areas about the complicated tectonic build, causes that eventual data we receive not with such exactitude and the resolution if it is awaited.

The help in this matter can be a measurement of the vertical seismic profiling (VSP), which from the specificity of measurement, should complement the seismic research, especially then, when the higher resolution of measurement is necessary to the exact understanding of build and nature of the deposit. Measurement VSP make the fundamental platform in integration and the calibration of wellbore profiling with the seismic wave-field, making possible the exact transformation from depth domain to time domain and vice versa. The measurement of VSP of the type zero-offset makes possible the precise adjustment and correlation of seismic and geological horizons. Implementing to

seismic survey of additional information contained in wave field of VSP, allow on restoration of high frequencies, necessary to the description of geological formation about the high degree of the detailedness.

Following modern literature [John C. Owusu et al., 2009, Pevzner R. et al., 2009, Grechka V., 2007], many materials can be found documenting advantages resulting from carried out research of VSP 3C in versions zero-offset and offset namely: the exact, directional the anisotropy recognition of physical and petrophysical parameters in wellbore zone and near neighbourhood of well, model building of speed-stratified, verification of the interpretation geological-facies and riddance of artifacts on geological and seismic sections It is proper to mark that these measurements can make the essential participation in recognition of deposits about the low permeability, so called *tight gas*.

### Anisotropy of VSP 3C measurement

The geologic called centre is anisotropic if the physical characteristics measured in the given point are relative to the direction. This direction-dependence is well-known and qualified as seismic anisotropy. The most simple form of the anisotropy is well-known as the transverse (transverse isotropy – TI) isotropy. This type of the anisotropy TI found a wide use in research seismic-geology [Macbeth C., 2002, Thomsen L., 1986.].

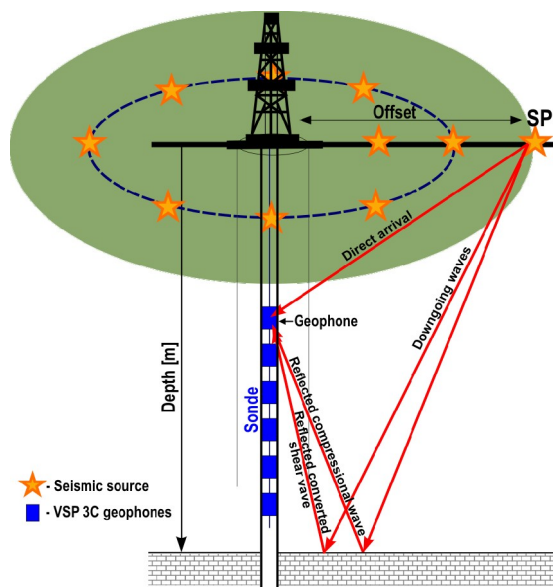
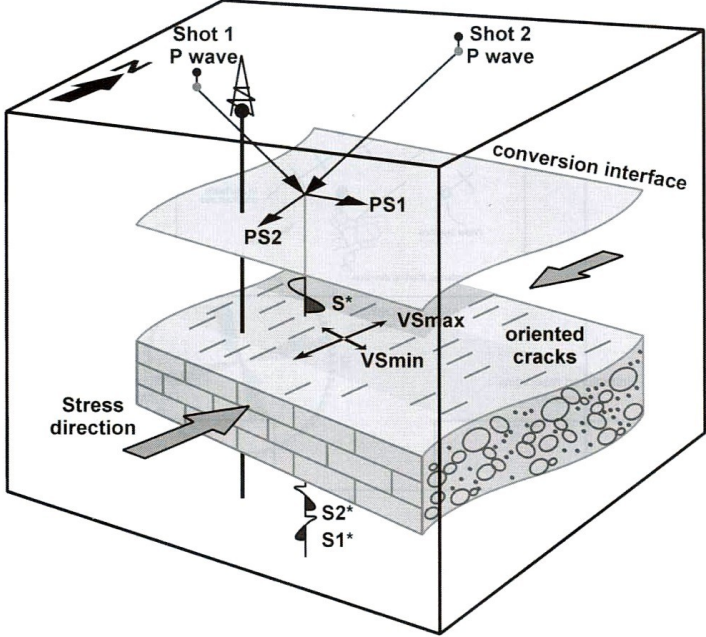


Fig. 1. The schema of the azimuth-stabilized measuring-arrangement in the method VSP 3C (the multi-offset VSP) together with the regard of the geometry of the propagation of seismic waves.

Azimuth-stabilized and multiple measurement of the perpendicular seismic profiling VSP 3C are a most useful tool, from among current seismic methods, to the investigation of the anisotropy of the geologic medium – fig.1. Azimuthal variation of traveltimes, amplitudes and attenuation coefficient of reflected waves can provide valuable information about anisotropy associated with natural fracture systems.

Measurement VSP 3C for different azimuths let on the exact observation of changes of amplitudes and dynamics of the wave-field of oblong waves P and transverse S. Calculated intervallic speeds from times of first ascensions of waves oblong and transverse underlie is the valuation of the quantitative anisotropy of the geologic space [R. Pevzner, 2009; B.A. Hardage, 2000]. With the good example of the utilization of azimuth-stabilized measurement VSP 3C in the option offset, the multi offset to the analysis and markings of directions fracturing across the analysis of the polarization of transverse waves, the high-frequency component S1 and low frequency S2, is the article introduced by N. Barton in Journal of Seismic Exploration, 2007 – fig.2. The author relates the anisotropy examined in the micro scale on drilling cores with performance of seismic measurement VSP 3C in the macro scale.



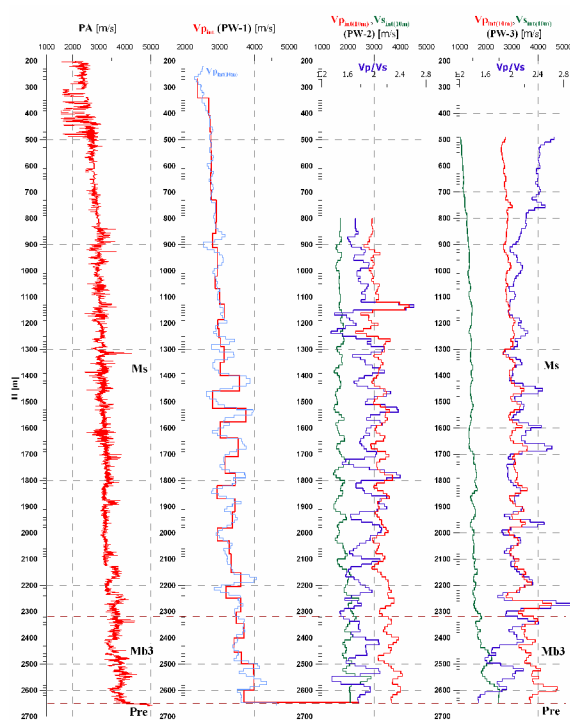
**Fig. 2.** The canvassing of offset measurement VSP 3C. The conversion of the wave P to PS – the polarization of the wave PS on quick S1 and slow S2.

The wave power transverse propagates in the form of twitches of particles in surfaces of normals to the direction of the wave. The presence of the anisotropy with the transverse symmetry TI, causes that the wave power is divided transverse on two components with vibrations of particles polarized parallel and perpendicularly to the surface of the propagation of the wave. So propagating two transverse waves, by the geologic centre is controlled by the amplitude and the direction of the anisotropy. Analyses of movements of small parts of transverse waves in the form of images of the polarization, are an important indicator under examination and the interpretation of the anisotropy of the geologic centre [C. Macbeth, 2002; L. Thomsen 1986].

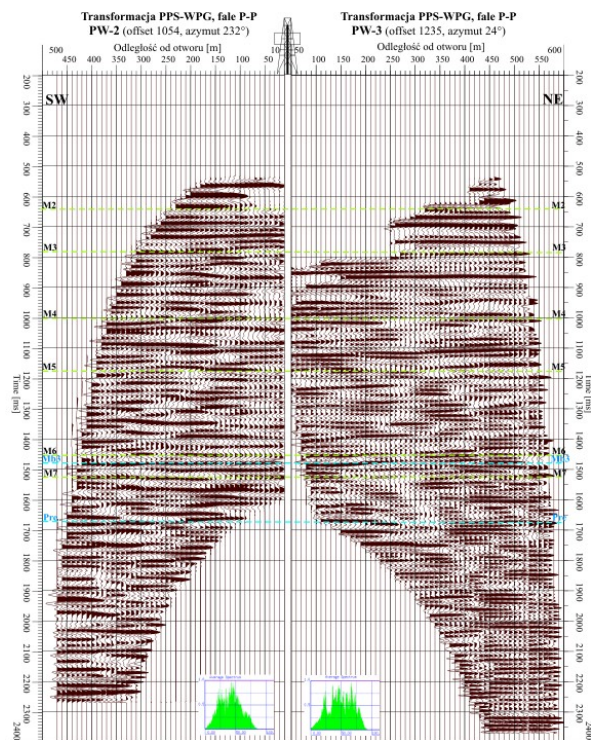
## Case study

The executed wellbore seismic research in the B-1 well, located in the region of the pre-Carpathian depression, to the west from Przemyśl, made possible thorough investigation of changes of seismic mappings in wellbore zone and in near distance from the B-1 well, coming to 650m on the direction SW-NE. Received results confirmed the legitimacy of exercise of measurement VSP which makes the essential element in the complex of geophysical and seismic data interpretation.

Calculated velocity models of PW-2 and PW-3 showed a significant difference between the averaged velocity of compressional waves – amount 150m/s between the rate of share waves velocities averaged 220m/s, which could indicate a water of Miocene deposits, lying to the north-east of the B-1 well – fig. 3, 4.



**Fig. 3.** Sonic log correlation with the interval velocity models of VSP for different shot point – PW-1, PW-2, PW-3.



**Fig. 4.** The composition of VSP-CDP transform for P-waves from two different shot point – PW-2, PW-3.

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