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Approximation of P-wave velocity anisotropy by three-axis ellipsoid

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Laboratory research on rock fracturing process substantially contributes to the study of rock heterogeneity and to its changes in dependence on actual stress state. The spatial distribution of microfractures is examined by means of localization of induced seismoacoustic events foci. Accuracy of localization depends on the velocity model used. Determination of velocity anisotropy and its application helps in more precise localization. The simplest approach for estimation of this anisotropy is based on the ultrasonic sounding in two or three mutually perpendicular directions. On the other hand, there are more sophisticated methods using ultrasonic sounding in many directions under the condition of confining hydrostatic pressure. These methods also allow the precise determination of anisotropy orientation; however they are technically demanding and applicable only to spherical samples.

A new method was developed for the determination of magnitude and orientation of velocity anisotropy of cylindrical samples. The method is based on processing of ultrasonic sounding monitored by the sparse net of sensors based on three-axis ellipsoid approximation. The uniaxial loading experiment of anisotropic and heterogeneous rock material (migmatite) was used for the method demonstration. The accuracy of microfracture localization is used to prove the validity of anisotropic velocity model used. The proposed method can be also applied to other heterogeneous geomaterials and various configurations of sparse measurement nets.