MINERAL PREFERRED ORIENTATION AND PROPERTIES OF ROCKS FROM SOURCE AREA OF EARTHQUAKES: COMPREHENSIVE STUDY BY NEUTRON DIFFRACTION AND ULTRASONIC ANALYSIS

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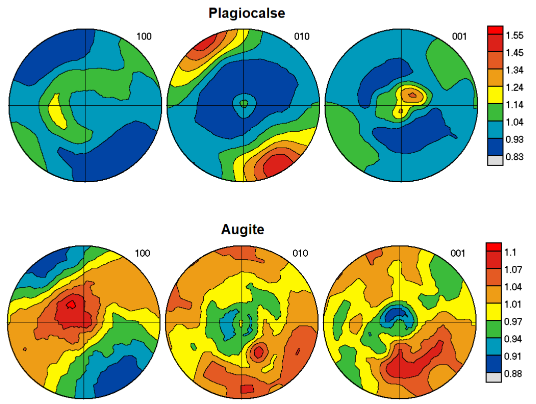
The elastic behaviour of rocks in the Earth's crust is generally anisotropic, with the degree of anisotropy mainly determined by the mineral textures (all minerals are anisotropic with respect to the propagation velocities of the P- and S waves) and the crack fabric (e.g., Ivankina et al., 1996). As rocks in the deep crust are not directly accessible, estimation of the elastic constants on surface equivalents in the laboratory can provide required information, e.g., to estimate the elastic wave velocities for the processing of geophysical data, to explain seismic structures, to verify velocity versus depth relationships or to describe the changing influence of the crack fabric in dependence on depth.

Although cracks may persist to great depths, their influence decreases rapidly with depth and the elastic constants largely depend on the crystal lattice and, therefore, on the mineral textures.

The study will be based on cores from Indian deep boreholes drilled to the source zone of the Koyna-Warna seismic area – classical area of induced earthquakes that recur regularly in this area for over 50 years. The great majority of the earthquakes are located in the granitic basement rocks underlying the Deccan flood basalt pile. These basalt and dominantly granite, granite-gneiss and migmatitic gneiss; cores are extracted from depths up to 1500 m (Fig.1).

Fig.1. Extracted core specimens of the depth of 477 m, 464 m and 314 m from the two boreholes PHAN and KHA.

The complex investigation was based on laboratory neutron diffraction and ultrasonic measurements. Neutron diffraction will be applied for the determination of the mineral crystallographic preferred orientations of samples and will be carried out using the time-of-flight texture diffractometer SKAT at the beamline 7A pulsed reactor IBR-2 at JINR (Dubna, Russia) (e.g., Fig.2).We have measured the degrees of crystallographic preferred orientation in basalts and granite, and determined the texture-related contribution to their acoustic anisotropies (P-waves) (Fig.3).



Fig, 2. Pole figures of major minerals obtained from neutron texture measurements of sample PHAN. Stereographic projection, pole density contours are in multiples of random distribution (m.r.d.).

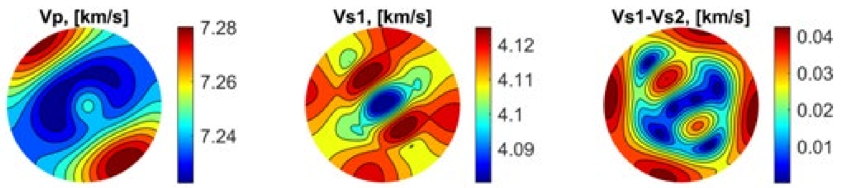


Fig 3. Calculated anisotropic distributions of elastic wave velocities in sample PHAN.

The experimental P-wave will be done using special equipment at the Institute of Geology Academy of Sciences of the Czech Republic (Prague, Czech Republic) (e.g., Fig.4).

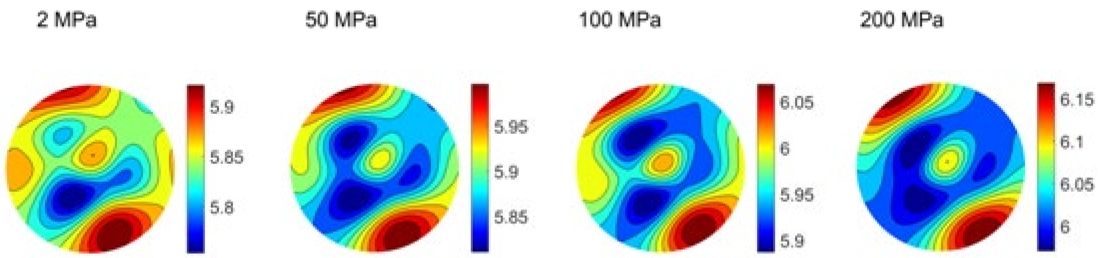


Fig. 4. 3D distributions of measured P-wave velocities in studied samples at different confining pressures. Stereographic projection.

As a result, elastic behavior of basalt PHAN and KHA2 samples are significantly differ from those of granite KHA1 sample. But commonly the elastic properties depend mainly on crystallographic textures of rock-forming minerals. Preferred orientations of plagioclase grains are almost the same for basalt samples what allows to permit the similar texture formation processes within basalt layer. As for the granite KHA1 sample, it is complex volume mineral composition evidences for the various deformation history of rocks below the basalt layer.

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[1] T.I.Ivankina, I.Yu.Zel, T.Lokajicek et al. (2017) Elastic anisotropy of layered rocks: ultrasonic measurements of biotite gneiss versus texture-based theoretical predictions (effective media modeling). Tectonophysics. 712-713, 82-94.