Petrophysical Properties and Origin of Oriented Porosity in Eclogites with Different Microstructure

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The principal aim of this study is investigation of the origin of porosity that slow down experimentally measured P-waves velocity through rock sample. Traditional explanation of the observed slowing down of velocity is existence of "microfractures". However, there are other phenomenon in minerals and rocks of the same width as "microfractures" (2–40 nm) that could have the same effect. In case of studied eclogites, they could be cleavage planes of clinopyroxenes, boundaries between mineral grains. Usual fractures in garnet were not considered in this study, as they are randomly oriented.

P-wave velocity measurement has been carried out by means of the pulse transmission technique using two electroacoustic transducers. The technique has been modified for spherical samples having 50 ± 0.1 mm in diameter investigated by equipment designed for ultrasonic sounding of rock samples (Pros and Babuška, 1968) at confining pressures up to 400 MPa (Pros et al., 1998). The technique allows measurement of P-wave velocity in any selected direction (except the area near vertical axis of rotation) with the same accuracy. In practice, the measurements are conducted on the net dividing the sphere in steps of 15° defining 132 independent measuring directions. The measurement of P-wave velocity starts at atmospheric pressure conditions and continues through several levels of increasing confining pressure (commonly 10, 20, 50, 100, 200 MPa) up to 400 MPa, which is the limit confining pressure for the apparatus. Spatial distribution of "microfractures" has been established by subtraction of velocities measured at 400 MPa from those measured at 0.1 MPa. This procedure is described in details in Špaček et al. (this volume). An orientation of main cleavage planes (110) of clinopyroxen was carried out by measurement of lattice-preferred orientation by EBSD method. The distribution of grain boundaries has been defined by digitizing of microstructure from microphotographs of thin-section. Digitized outlines of grains are statistically treated in PolyLX (Lexa, 2001)program resulting in quantitative microstructural analysis in two dimensions.

Three samples of eclogite with different microstructural characteristics that refer to different metamorphic and deformational record have been studied. The first sample (SNW3) comes from the Newlands kimberlite pipe and belongs to the population of mantle xenoliths that were taken to the surface by kimberlite eruptions. Eclogite is coarse-grained with equilibrated microstructure and the size of garnet and clinopyroxen grains range between 0.5 and 1.0 cm. The temperature of equilibration was estimated to 1060–1100 °C (Gurney and Menzies, 1998). The second sample (T122) comes from ultramafic body surrounded by Blansky les granulite body in the Bohemian Massif. The clinopyroxen is dynamically recrystalized at the boundaries of original coarse-grains forming core and mantle microstructure. New, recrystalized grains of omphacite are slightly elongated and their size is ranging between 0.03 to 0.15 mm. Grain size of porphyroclasts is ranging between 0.5 to 2.5 mm. Size of garnet grains is ranging between 0.8 to 3.5 mm having slightly elongated shapes. The equilibration temperature of this eclogite is about 1000 °C (Dudek and Fediukova, 1974). The third sample (JK1b) comes from lens of eclogite presented in anatectic ontogenesis of Czech part of the Erzgebirge Mountain. Clinopyroxen is dynamically recrystallized to fine-grain matrix of 70 microns in average size and shows elongated grains (axial ratio between 10 and 20) that define mylonitic foliation. Garnet grains have idiomorphic shapes with the size ranging between 0.05 to 0.3 mm. Temperature of equilibration of this eclogite range between 600° and 650 °C and peak metamorphic pressure was estimated on 2.6 GPa (Klapová et al., 1998).

All samples show weak anisotropy of P-wave velocities, and coeficient of anisotropy k range between 1.84 % to 5,35 %. The latter value is slightly higher than values observed in eclogites by Bascou et al. (2001). Maximum and minimum velocity of P-waves range between 8,1 to 8,4 km/s, and 7,7 to 8,05 km/s, respectively.

At maximum confining pressure, all samples show belt of directions of maximum velocities oriented parallel to macroscopic foliation, while a minimum is oriented perpendicular to the foliation. The formation of high velocity belt at the maximum confining pressure is probably produced by latice-prefered orientation of clinopyroxens. Subtraction of velocities between minimum and maximum confining pressures in the samples T122 and JK1b show two areas characterised by directions of maximum diference. The first field is oriented perpendicular to foliation and the second one is oriented oblique to foliation and fit well with orientation of the main clinopyroxene cleavage. Thus ,in these examples, it is suggested that the observed slowing down of velocities at low confining pressures is due to open space along grain boundaries and main cleavage planes in clinopyroxene.

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