

P-wave velocity anisotropy measurements of high grade metamorphic rock with the three-dimensional velocity measurement technique

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Three-dimensional P-wave velocities (V_p) were determined in order to examine relationships between P-wave velocity anisotropy and rock fabric. The samples measured are an amphibolite and two types biotite amphibolites collected from the early Paleozoic Luzow-Holm Complex in East Antarctica. The biotite amphibolite-I has lower degree of c-axis concentration of biotite (CCB), whereas the biotite amphibolite-II is characterized by higher degree of CCB. Measurements of V_p were carried out on a cubic sample by using the pulse transmission technique with a piston-cylinder apparatus (Yokohama National University) up to 1.0 GPa and 400 C. We developed a new design of talc-high pressure cell which enable us to make simultaneous measurement of three-dimensional P-wave velocities and velocity anisotropy. Three pairs of transducers were mounted on opposite sides of six planes on a sample cube. Based on macroscopic examination of visible fabric elements of the rock, the compressional axis was set to correspond to the direction of maximum c-axis concentration of hornblende. The results show that P wave velocity anisotropy of three samples rapidly decreased with increasing pressure from 0.1 GPa to 0.6 GPa (for the amphibolite from 6.4 to 5.0, for the biotite amphibolite-I from 17.3 to 6.8 and for the biotite amphibolite-II from 37.2 to 5.4 %, respectively). At 1.0 GPa and 25 C all samples show comparable V_p anisotropy (5.0, 6.5 and 5.9 %). At 1.0 GPa, velocity anisotropy of the two biotite amphibolites considerably increase in a temperature range from 25 C to 400 C (the biotite amphibolite-I: from 6.5 to 9.0, the biotite amphibolite-II: from 5.9 to 13.3 %). The V_p values significantly depend on temperature. With elevating temperature, the biotite amphibolite-II shows larger velocity reduction than the biotite amphibolite-I. This is partly attributed to thermal expansion of the rock sample. In summary, the data indicate that the degree CCB mainly control P-wave velocity anisotropy of rocks studied. This is supported by the previous studies on the single crystal of biotite that velocity along c-axis is extremely low comparing with other axes.