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EXPERIMENTAL AND TEXTURE-DERIVED ELASTIC PROPERTIES OF PRINCIPAL ROCKS FROM THE TRANSALP SEISMIC TRAVERSE

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The TRANSALP research program includes seismological investigations along a traverse across the Eastern Alps. Most effort was put on the recording of a 340 km long near-vertical reflection seismic profile between Munich and Venice. For the understanding of the observed seismic structures, accompanying laboratory investigations of the elastic rock properties are required. The elastic properties of rocks have been confirmed to be anisotropic in the general case (see review by SIEGESMUND, 1996), they mainly depend on the lattice preferred orientations (textures) of the rock-forming minerals and the crack fabric (porosity). In order to obtain the most complete information on elastic rock anisotropy and its controlling parameters, the following experiments have been performed on various rock samples from the central part of the seismic profile:

- Complete compressional (P-, V_p-) wave velocity measurements at various confining pressures up to P_{conf} = 200 MPa. A better approximation of the crustal conditions can be achieved since cracks are more or less competely closed.
- Complete compressional wave velocity measurements on dry and water-saturated samples at atmospheric pressure. Since the compressional wave propagation velocities in air and water are diffent, the difference patterns represent a quantitative measure of the crack (pore space) distribution.
- Neutron texture measurements on the same specimens in order to calculate the compressional wave distributions from the mineral textures. The modelled velocity distributions are not affected by the other fabric parameters (like porosity) and therefore represent an upper velocity limit.

The P-wave velocity distributions measured at P_{conf} = 200 MPa approximate the texture-derived patterns, however, the velocities are generally lower at P_{conf} = 200 MPa (~ 0.3 km/s). The observed anisotropies $A = (V_{p\,max} - V_{p\,min})/V_{p\,max}$ range from 1% ~ 9% (texture-derived) and 5% ~ 16% (P_{conf} = 200 MPa). Highest anisotropy values are observed for monophase carbonate samples, whereas the P-wave anisotropies of polyphase gneisses are very low. The differences between both these velocity distributions confirm, that the P-wave anisotropies are not only texture-controlled. Since in most cases the minimum velocities parallel the normal to the main rock foliation, it seems that the observed velocity differences are somehow related to the foliation. The difference patterns between dry and water-saturated samples show a maximum parallel to the foliation normal, *i.e.*, the foliation plane represents the preferred plane of crack generation (accumulation of pore space). If any fluid-filled pore space should be possible at large depths, it is expected that the rock foliation controls its spatial distribution.

Seismic reflections originate from contrasts of acoustic impedance $Z = V_p\, r$ (r: density) between adjacent rocks and may be described by the reflection coefficient $R_c = (Z_1 - Z_2)/(Z_1 + Z_2)$. Considering mean velocities of the velocity distributions (*i.e.*, neglecting anisotropy), the maximal possible reflection coefficients are $R_{c\ max}$ = 0.11 (texture-derived) and $R_{c\ max}$ = 0.13 (P_{conf} = 200 MPa). Assuming that the foliations of adjacent rocks run parallel to the geological interface, the minimal velocities should be used for the calculations. In this case, the maximal possible reflection coefficients are $R_{c\ max}$ = 0.11 (texture-derived) and $R_{c\ max}$ = 0.14 (P_{conf}= 200 MPa), *i.e.*, changes are minor. Geological interfaces with such high reflection coefficients are easily visible in seismic cross sections. However, most hypothetical interfaces are characterized by much lower reflection coefficients and the question arises, whether they are sufficiently large to cause detectable reflections or not. From the anisotropy data presented, it may be inferred that discordant layering at the interface should produce stronger reflections, although the observed P-wave anisotropy is rather weak. It may be also speculated, whether fluids may be responsible for pronounced reflectors in the seismic sections.

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References

SIEGESMUND, S. (1996): The significance of rock fabrics for the geological interpretation of geophysical anisotropies. – Geotektonische Forschungen, **85**, 1–123.

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