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Ultrasonic monitoring of hydromechanical processes

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Fluids released by metamorphic reactions are regarded to be intimately linked to a number of geological and geophysical processes in subduction zones. The thermal structure of a subduction margin, its rheological behaviour, and especially the position of its seismogenic zone are strongly influenced by the presence of fluids and their pressure state. As the migration of fluids in the Earth is a transient process on various temporal as well as spatial scales, it is hard to observe with geophysical methods in nature, especially in depths exceeding 10 - 20 km.
To study dehydration processes and the influence of the development of a pore pressure on the elastic properties of rocks we performed ultrasonic experiments on encapsulated *(undrained)* cores of a number of various rock types (amphibolites, mica gneiss, diasporite, serpentinite). The P wave velocities were deduced in an internally heated gas pressure vessel up to temperatures T of 700 °C at a confining pressure of 900 MPa. The experiments were complemented by microstructural analyses of pre- and post-run samples in order to document textural changes related to fluid interactions.
For the different rock types the T-dependent velocity reduction of the undrained samples varies in a wide range between an almost intrinsic value of $\sim$ 1 %/ 100 K for a serpentinite and up to 2.5 %/ 100 K for an amphibolite. For samples with a strong T-dependent elastic behaviour, multiple cycles of time-dependent decreasing and re-increasing velocities were resolved. These observations indicate variations in the pore-fluid pressure related to changes in the porosity and permeability of the rock. They are interpreted as an alternation of pore dilation during the development of a high pore pressure followed by fluid expulsion and pore compaction after hydraulic fracturing. Our results show that the magnitude of velocity decrease depends on several concomitant factors, such as the quantity and distribution of fluid, and textural characteristics (grain size, grain shape, nature of grain contacts), which interact in a complex way.