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The influence of small amounts of supercritical H_2O on the physical properties of rocks

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In the last years the relevance of fluids in active tectonic settings has become more and more apparent. In particular, the concept of earthquake-triggering by "dehydration embrittlement" due to fluid release during dehydration and an increasing pore fluid pressure is discussed intensively. Nonetheless, little is known about the petrophysical signature of fluid-rock systems at high confining pressures.

To study the influence of fluids on the physical properties of rocks we performed ultrasonic experiments and measurements of the electric conductivity on encapsulated cores of low porosity amphibolite and serpentinite. The experiments were conducted in an internally heated gas-pressure vessel at 900 MPa and up to 700°C: For serpentinite, characterised by interlocked grain boundaries, we deduce intrinsic temperature derivatives ($\delta \mathrm{v}/\delta T$) of -0.60 and -0.46 m/($s \cdot K$) for P and S waves, respectively. The onset of antigorite decomposition is marked by a sharp decrease of velocities above 600°C. In contrast, on encapsulated amphibolite, characterised by euhedral grains, $\delta \mathrm{v}_p/\delta T$ are 3-5x higher than intrinsic data from the literature. Between 23-400°C, $\delta \mathrm{v}_p/\delta T$ vary between -1.09 to -1.64 m/($s \cdot K$) and seem to be inversely related to the original sample porosity. As these observations were made far below dehydration conditions, they are probably caused by water at grain boundaries, an increasing pore fluid pressure, and hence the dilation of isolated pores, as no significant change in electric conductivity was noticed in that temperature range. Between 400-550°C we observe a dramatic increase of the electric conductivity, accompanied by a time-dependent increase of velocities. This is attributed to hydrofracturing followed by a reduction of the pore space due to precipitation of minerals along grain boundaries and/ or the expulsion of the fluid phase.

Our results show, that already ppm amounts of water can affect the elastic properties of rocks enormously. Nonetheless, a quantification of the influence of fluids on the

physical properties of a rock is problematic yet, as it seems to be strongly dependent on its microstructure.