Anomalous Vp/Vs in highly pressurized rocks: Evidence for anisotropy or mafic composition?

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Anomalously high seismic P- to S-wave velocity ratios (Vp/Vs) have been observed in subduction zones, in locations where varieties of earthquakes and slips are expected to occur. From qualitative laboratory knowledge of rocks Poisson’s ratio, these results were interpreted as evidence of near-lithostatic pore fluid pressure. Because most laboratory data did not document such high Vp/Vs values, these were further linked to additional constrains of anisotropy or the dominance of minerals of very high intrinsic Vp/Vs, e.g. mafic rocks. However, does high Vp/Vs necessarily imply anisotropy and/or mafic composition?

Recently, the measuring frequency (f) was shown to play a major role on rocks’ resulting Poisson’s ratio, so that usual laboratory results (at f = 1 MHz) might not directly transfer to field ones (at f = 1 Hz). From this consideration, we investigate Vp/Vs of a variety of crustal rocks in the elastic regime relevant at the field scale, the undrained elastic regime. Accounting for rocks dispersive properties, this work aims to show that:

- In the laboratory, in isotropic rocks, one might attain Vp/Vs values as high as the anomalous ones observed in subduction zones.
- No mineralogical control is needed for such high Vp/Vs values, which could be consistent with the inherent mineral variability in different settings across the globe.
- High pore fluid pressure is a major parameter, but not alone: such high values cannot be achieved without very high degree of micro-fracturing of the rock, opened by high fluid pressures, an information of potential importance to understand those seismogenic zones.