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Lower crustal seismic velocities and seismicity in the northern Alpine foreland: I. Observations and petrophysical experiments.

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Recent advances in petrology and experimental measurements of ultrasonic waves on rock samples provided new insight in the interpretation of seismic properties and earthquake hypocenter distribution within and outside the Alpine region. The near Alpine northern foreland is characterized by a lower crust with relatively low P-wave velocities around 6.2 km/s and a seismic activity down to Moho depths. This is at first a contradiction, since normally low velocities in the lower crust are correlated with high temperatures, while deep crustal earthquakes suggest a brittle regime at lower crustal levels associated with relatively low temperatures. To address this incompatibility we have chosen to measure seismic velocities of metapelites under pressure-temperature conditions of the middle to lower crust. We selected metapelites because they are among the most common rock types of continental crust and possibly constitute a significant part of lower crust. Metapelites are rich in quartz and hydrous minerals (e.g. biotite, muscovite, chlorite). They are thus good candidates to investigate dehydration reactions and phase transitions of the middle to lower crust.

Here we report on results of petrophysical experiments with metapelitic rocks, in terms of seismic velocity variations with increasing temperatures (up to 750 ˚C) and pressures(up to 400MPa). Near a temperature of 580˚C (at 400 MPa), using the Perplex_X software, we predicted a dehydration reaction that produced water. This should reduce Vp (if water cannot escape) or increase slightly the Vp (if water can escape). After the experiments peacking at 750˚C we observed a small amount of water indicating that a dehydration reaction has occurred. At a temperature of 675˚C (at 400 MPa) the

alfa-beta quartz transition caused an abrupt increase in Vp (up to 12%, in a rock with 14% anisotropy). Application of our results to the Alpine region (presumably at higher pressure conditions) suggests that the observed low velocities and deep earthquakes in the lower crust can be promoted by dehydration reaction or by partial melt in deep seated metapelites.