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Lower crustal seismic velocities and seismicity in the northern Alpine foreland: II. Geodynamical interpretation.

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The distant northern Alpine foreland is characterized by a highly reflective lower crust with P-velocities from 6.2 to 6.6 km/s in the depth range between 15 km and 32 km, near the Moho. In the near-Alpine foreland a reduced Vp (6.2km/s on average) and a loss of reflectivity have long been reported, based on controlled-source seismology experiments. In the same region, earthquakes are observed throughout the crust to reach a maximum depth just above the Moho near the Alpine front. Within the central Alps, where the Moho reaches up to 50 km, however, no earthquakes have been detected in 30 years below 20 km depth. Based on surface heat flow and rheological considerations, the low Vp velocities in the lower crust of the near Alpine foreland cannot be attributed to increased temperatures at depth. Based on new petrophysical results on metapelites (experimental and theoretical) we propose a new hypothesis to explain the above observations. According to our model, the lower crustal seismicity below the near-Alpine foreland results from dynamic loading (bending) of the European continental plate by the Alpine orogenic slab in combination with relatively low temperatures that we expect outside the Rhinegraben area. Dehydration reactions in metapelite around 580˚C at lower crustal levels could be the cause of the observed reduction in Vp-velocity and the loss of reflectivity. By extrapolation of our petrophysical results we may first speculate that the deepest earthquakes just above the Moho, close to the Alpine front, can be triggered by dehydration reactions. Secondly these reactions have reached completion when the lower crust finally enters the Alpine suture zone, and the material reaches ductile conditions due to the given stress and temperature conditions. In our model this can cause the shutoff of lower crustal seismicity beneath the central Alps.