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Continental extensional related intrusion and underplating in the Danish Basin: Evidence from the seismic project ESTRID

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The crust and uppermost mantle below the major positive gravity anomaly in central Denmark, known in literature as the Silkeborg Gravity High (SGH - 40-50 mGal), is investigated using controlled source seismic data. Three major seismic investigations were carried out between 2004 and 2006, with the aim of defining the velocity structure of the crust and upper mantle below the Jutland Peninsula.

We present results of modelling of seismic refraction data along the two profiles ESTRID-1 and ESTRID-2 to define the shape and size of the high velocity intrusion, which causes the gravity anomaly of the SGH.

The length of the intrusion in the E-W direction is shown to be at least 80 km, while the width in the N-S direction is of the order of 25-35 km. The estimated minimum volume of the intrusion is about 40000-45000 km^3, and the approximate thickness is 16–20 km. The seismic velocity within the intrusion varies from 6.8 km/s at the top (12 km depth) to 7.2–7.7 km/s at the Moho level (30-31 km depth). Comparison with existing databases infers a gabbroic-noritic composition of the intrusion, with olivine-rich phases at depth and more plagioclase-dominated phases at shallower levels.

Below the central part of the intrusion, the Moho reflectivity is very weak, due to the small velocity contrast between the lowermost crust (7.7 km/s) and the upper mantle (7.9–8.0 km/s). The seismic data also show a “ringing” Moho along the profiles. The coda trailing the main PmP reflection is about 1.0 seconds long and is composed by 4–5 wavelets. We demonstrate that this feature is caused by a layered transition zone between 30 and 35 km depth, where high-velocity layers of mantle affinity (8.0–8.1 km/s) alternate with layers of lower crustal velocities (6.8–7.2 km/s).

The characteristics of the lower crustal layering giving rise to the PmP coda are modelled by matching synthetic seismograms to the observed data. The synthetic seismograms are calculated by the 3D reflectivity method for 1D models, which constrain the nominal layer thickness to 100 - 500 m after frequency filtering. 2D full waveform modelling of the seismic sections infers a minimum layer thickness of 250 m and a maximum layer thickness of 500 m. The total length along the profile of this layered transition zone is around 30 km.