Geophysical Research Abstracts, Vol. 8, 05963, 2006
SRef-ID: 1607-7962/gra/EGU06-A-05963

Reflection seismic image of a large mafic batholith - The ESTRID 2005 profile

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The study area of the project ESTRID (Explosion Seismic Transects around a Rift In Denmark) is the Mesozoic sedimentary Danish Basin, which is located close to the margin of the Precambrian Baltic Shield within the former Baltica Plate. Extensional regimes and intensive magmatic activity is believed to have occurred in the area during the late Carboniferous and early Permian. It is known that large intrusions produce significant heat influx that may have strong influence on subsequent basin formation and subsidence.

The primary target of the ESTRID project is the structure of middle-lower crust and the features of the Moho in the area of the Silkeborg Gravity High (central Denmark). The main core of the ESTRID project is two seismic surveys recorded in central Jutland during spring 2004 and autumn 2005. The 2004 acquisition was along a 160 km long refraction/wide-angle E-W oriented profile across the peninsula. The following campaign in 2005 was along a 185 km long combined refraction/wide-angle – reflection profile oriented approximately N-S. The reflection part of the profile is 110 km long and 4 x 760 recording sites were used to record the seismic signals from 94 shot points. The charges were of 15-25 kg TNT and placed in 15 m deep boreholes along a straight line. The major challenge of the 2005 project was the location of the profile in densely populated areas, which was solved by using a GIS program to find the best straight line with the optimal safety distance to buildings, electric installations, water supplies and telecommunications.

Interpretation of the refraction data, by seismic tomography and ray tracing, shows a high velocity zone ($>$6.5 km/s) with its top located at about 11 km depth underneath Silkeborg. It is interpreted as a magmatic intrusion of possibly gabbroic composition.

Variability in the character of the reflection from the Moho (PmP) is also observed in the area. A “ringing” PmP is seen approximately below the intrusive body and may be related to a layered structure at the crust-mantle boundary. However, surprisingly, there is no lower crustal reflectivity in the data.

We present a preliminary processing of the 2005 reflection data. The signal-to-noise ratio in the recordings is in general very good. Reflected seismic energy from different intra-crustal boundaries and the Moho discontinuity are easily recognized along the profile. The distinct structure in the southern part of the profile is the southern flank of the Ringkøbing-Fyn basement high. The structure in the centre of the profile is interpreted as an intrusive body. We model this body as the direct cause of the pronounced Bouguer gravity anomaly of +50 mGal in the Silkeborg area. The volume of the intrusive body is estimated to be at least 40.000 km^3. An intrusion of such dimensions has certainly affected the temperature field and the basin formation of the area.