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Deep structure of the northern North Sea and adjacent areas according to regional-scale 3D density and thermal modelling

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To analyse the regional configuration of the crystalline crust within the northern North Sea and adjacent areas of the continent, a lithosphere-scale 3D structural model has been constructed in the frame of the Crustal Onshore-Offshore Project (COOP project). Construction of the 3D model has been carried out using recently published/released data. For upper part of the model, all available data were merged into the following layers: sea water, the Cenozoic, the Upper Cretaceous, the Lower Cretaceous, the Jurassic, the Triassic, the Upper Permian (Zechstein) salt, Upper Permian clastics/carbonates and, finally, the Lower Permian-pre-Permian sedimentary rocks. Configuration of the crystalline crust and the Moho topography have been constrained by the published interpretations of deep seismic lines. The lithosphere-asthenosphere boundary has been compiled from previously published data.
To evaluate the internal structure of the crystalline crust, a 3D density modelling has been carried out by use of the software IGMAS+ (the Interactive Gravity and Magnetic Application System). According to the 3D density modeling, the crystalline crust of the study area consists of several layers. Within the upper crystalline crust, gabbro to anorthositic rocks have been included into the 3D model along the western coast of Norway. In addition, a low-density (2627 kg/m3) upper crustal layer is modelled beneath the Horda Platform. The next upper crustal layer is characterized by regional distribution and has a density of 2670 kg/m3. The modelled middle crust of the study area contains four layers with similar densities around 2700 kg/m3. The lower crust consists of three layers. The deepest crustal layer is the high-density lower crustal layer (3060 kg/m3) which corresponds to the high-velocity layer. This layer thickens strongly beneath the Norwegian-Danish Basin and the eastern part of the East-Shetland platform. The obtained Moho is strongly uplifted beneath the Central and Viking grabens whereas the lithosphere-asthenosphere boundary is relatively shallow beneath the western part of the model area.
The next step of the analysis was the 3D thermal modelling. Results of thermal modelling within the upper part of the 3D model indicate that the mainland is generally colder than the basin areas. This regional trend of temperature is mostly related to the low thermal conductivity of sediments which increases heat storage within the areas covered by thick sediments. This thermal effect is especially pronounced within the Central and Viking grabens, the East Shetland and Norwegian-Danish basins where the thickness of the sedimentary cover is highest. At great depths (70-100 km) the temperature distribution roughly reflects the configuration of the lower thermal boundary which is represented by the base of the lithosphere.