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Origin of the large subsidence at Eastern Barents Sea basins: insights from density-isostatic modelling and dynamic modelling.

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Very large subsidence, with up to 20 km thick sediment layers, is observed in the eastern basins of the Barents Sea. Subsidence started in Early Palaeozoic and finished at mid-Cretaceous. The subsidence history is marked by an acceleration of subsidence in Permo-Triassic times. The observed gravity signal suggests that the eastern Barents Sea is in isostatic balance and indicates that a mass excess is required in the lithosphere to compensate for the observed large subsidence. One of the most convincing candidates for this mass excess is the presence of denser than normal rocks in the crust beneath the basins. These denser rocks may result from phase changes in the lower crust triggered by increased pressures and temperatures during shortening and buckling of the crust - mantle lithosphere system.

This hypothesis is firstly evaluated using density models of continental lithosphere computed along seismic transects crossing the eastern Barents Sea. The density distribution of crustal rocks is given by pressure, temperature, and composition dependent phase change models. Based on the local isostasy hypothesis, the subsidence and the gravity signal are then computed and compared to the observations along the seismic transects. Several models are run with varying crustal composition (mafic vs felsic). The results indicate that the presence of a dense lower crustal root can explain the present-day basin geometry and observed gravity anomalies.

These conclusions are further tested using thermo-mechanically coupled dynamic modelling based on the finite element method. The model consists of a crust - mantle lithosphere characterized by non-linear temperature and pressure dependent visco-elastic-plastic rheologies. Rock density depends on pressure and temperature dependent phase changes. The mechanical model is coupled with a thermal model taking into account heat advection and diffusion. Sedimentation and gravity are taken into account. Shortening boundary conditions are applied on vertical sides of the model resulting in buckling of the crust. Several models are run for different values of the main controlling parameters, crustal composition, crustal thickness, thermal structure of the lithosphere, and sedimentation. Results 1) confirm the conclusions of the isostatic study present day gravity anomaly and basin geometry are best explained by the presence of a dense body in the lower crust and 2) this model allows to successfully simulate the observed history of subsidence at Eastern Barents sea basins.