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Link between the deep structure of the Norwegian continental margin and the location of the Storegga Slide, based on 3D gravity and thermal modelling

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We investigate the density and temperature distribution of a geometrically well-constrained 3D model of the Norwegian passive continental margin.

According to results of the 3D gravity modelling, high-density bodies had to be included in the lower crust of the western Møre and Vøring basins. The two largest lower crustal high density bodies show the same left lateral offset along the Jan Mayen Lineament as observed in the upper crustal layers. No high density body is required along the Jan Mayen Lineament. In addition, 3D gravity modeling indicates a less dense upper mantle beneath the oceanic crust at the Norwegian passive margin, than below the continent. Furthermore, a local wedge of light mantle extending along the Jan Mayen Lineament points to higher upper mantle temperatures and/or compositional changes beneath the lineament than in the adjacent parts of the continental domain. A compositional cause for the lower densities in the oceanic upper mantle and along the Jan Mayen Lineament could be related to the incomplete melt extraction during break-up, i.e. some melt trapped in the upper mantle beneath the lineament, while the majority of the melts rose to the lower crust where they produced the high-density underplated layers beneath the Vøring and Møre Basins.

The obtained 3D density-model has been further evaluated by thermal modelling. Results of 3D thermal modelling indicate that the continental lithosphere is warmer than the oceanic lithosphere in the upper few km. This trend inverts with increasing depth. At 50 km depth, the lithosphere beneath the ocean is about 400°C hotter than beneath the continent. These higher temperatures in the oceanic mantle should cause a density

reduction compared to the (colder) continental mantle due to the thermal expansivity of the constituting rocks. Therefore, a local wedge of light mantle extending along the Jan Mayen Lineament can be partially explained by higher mantle temperatures beneath the lineament than in the adjacent parts of the continental domain. However, this is strongly dependent on the shape of the lithospheric base beneath the lineament which was used as a lower boundary condition for the 3D thermal modelling, and therefore needs additional investigation.

In summary it can be stated that lower crustal and mantle differentiation in physical properties between the oceanic and continental domains is considerable. This is espessialy prominent beneath the Jan Mayen Lineament and could play an important role during the recent evolution of the Norwegian continental margin, causing strain and stress localization in area, where important changes of structure and composition of the crust and mantle are present. Thus, it may not be a coincidence that the giant Storegga Slide occurred in this area.