Geophysical Research Abstracts
Vol. 16, EGU2014-15108-1, 2014
EGU General Assembly 2014

Deep crustal structure of magma-rich passive margin as revealed by the Northeast GreenlandSPAN™ 2D seismic survey and airborne Full Tensor Gradiometry

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The objective of our project was to integrate the results from the Northeast GreenlandSPAN™ 2D seismic survey with newly acquired airborne Full Tensor Gradiometry (FTG) and Magnetic potential field data over the Danmarkshaven Ridge area, NE Greenland. The potential field data were constrained by 32 long offset pre stack depth migrated seismic profiles selected from the Northeast GreenlandSPAN™ survey. The results provide a new insight in the deep crustal architecture of the Greenland passive margin. They also shed a new light on crustal-scale deformation and igneous activity in a magma-rich continental margin.

The structural data set is based on the integrated interpretation of 2D seismic data and FTG data, which was further supplemented by the airborne magnetic data plus the gravity and magnetic shipborne data. 2D gravity and magnetic forward modelling was used for testing geological/seismic models against the potential field data. A regional Moho grid derived from 3D gravity inversion was as a starting point and reference for the 2D modelling. The resultant horizons from the 2D potential fields models were subsequently gridded to help create a 3D structural model. The computed residual signal from the 3D model, the difference between the observed gravity and the forward calculated model response, allowed the accuracy of the structural interpretation to be tested.

The area is dominated by three structural trends: (1) N-S to NNE-SSW, (2) WNW-ESE, and (3) NW-SE. The first trend is represented by Early Cretaceous normal faults defining the Danmarkshaven Ridge whereas the second set of structures corresponds to the WNW-ESE oriented right-lateral strike slip faults. The third structural trend is delineated by the NW-SE oriented Greenland Fracture Zone (GFZ). Importantly, a distinct step in the COB suggests post-break-up reactivation of the GFZ with left-lateral kinematics. There is a good match between the modelled Moho and the GFZ suggesting its continuation within continental shelf as a transfer zone. High density bodies form a major continuous chain following the axis of the Danmarkshaven Ridge. The second biggest train of high density bodies parallels the GFZ being placed directly to the south.

The eastern margin of the Danmarkshaven Ridge represents the transition zone between normal continental crust to the west and stretched transitional crust to the east, the boundary that is oriented parallel to structural grain. There is also less apparent across strike variation of crustal structure that is separated into two domains: (1) southern domain with relatively shallow Moho, thin upper Palaeozoic and extensive Cretaceous sediments, and (2) northern domain with deeper Moho and the very thick upper Palaeozoic. The southern domain clearly correlates with the Thetis Basin whereas the northern domain corresponds to the Danmarkshaven Basin. The susceptibility variation shows that the entire southern part of the study area is a high susceptibility terrain. A realistic assumption is that high susceptibility reflects volcanic rocks both extruded on top Cretaceous and intruded within basement. Farther north, high susceptibility domains are restricted to three bodies elongated parallel to structural grain.