Geophysical Research Abstracts
Vol. 18, EGU2016-799, 2016
EGU General Assembly 2016

Numerical Modelling of multi-stage basin inversion in the western Barents Shelf

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Numerical modeling of inversion induced by different regional tectonic forces from Late Triassic to Miocene is presented. Our goal is to predict strain and stress pattern evolution and to test the observed tectonic inversion events in the western Barents Sea. We used a finite-element numerical code, namely ANSYS™, to simulate stress and fault slip patterns and four 2-D thin plate modelling setups with different boundary conditions were constructed. We assumed four different regional events: Late Triassic to Early Jurassic E-W compression presumably connected to westward translation of Novaya Zemlya (Model 1), Late Cretaceous NE-SW directed far field stresses (Model 2), dextral megashear between Greenland and the Barents Sea Shelf in Early Eocene (Model 3) and NW-SE Atlantic ridge push from Miocene to present-day (Model 4). Model 1 results show a strike-slip regime along the central segment of the Thor Iversen Fault Complex and the Troms-Finnmark Fault Complex. Compressive regimes along the Måsøy and Hoop fault complexes favor development of inversion structures in the study area during Late Triassic to Early Jurassic. Simulated stress patterns in Model 2 suggest a clockwise stress rotation along the Bjørnøyrenna Fault Complex and the Ringvassøy – Loppa Fault Complex and pronounced stress deflections along the Asterias Fault Complex. These modeled stress deflections support tectonic inversion during Late Cretaceous-early Tertiary along the corresponding fault complexes. The results obtained in Model 3 suggest that the interior of the western Barents Sea was not severely influenced by Early Eocene North Atlantic opening/shearing. Stress rotations are modelled along the Senja Fracture Zone and Hornsund Fault Complex which separate the study area into two different rheological domains. The results suggest that Early Eocene sea floor spreading caused stress partitioning along the Senja Fracture Zone. The observed inversion structures may be related to local effects. The results of Model 4 appear to be in agreement with the observed NW-SE compression, expressed as folds and reverse faults in the study area (e.g. Ringvassøy – Loppa, Bjørnøyrenna, Leirdjupt and Asterias fault complexes). Results of all four models suggest presence of compressive structures along the major fault complexes of the western Barents Sea. Our analysis suggests that significant strike-slip motion is also expected.