

Fault kinematic and Mesozoic paleo-stress evolution of the Hoop fault complex, Barents Sea

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The Hoop fault complex is an extensional fault system characterized by a series of multiscale half- and full-grabens trending NNE-SSW, NE-SW and E-W, and transfer zones striking ENE-WSW. In a joint collaboration between OMV Norge and Schlumberger Stavanger Research, the tectonic history of the Hoop area was assessed. A dense fault network was extracted from 3D seismic data using a novel workflow for mapping large and complex fault systems. The characterization of the fault systems was performed by integrating observations from (1) fault plane analysis, (2) geometrical shapes and crosscutting relationships of the different fault sets, (3) time-thickness maps, and (4) by establishing the relative timing of the tectonic events on key seismic lines orthogonal to the main fault strike azimuths.

At least four successive extensional tectonic events affecting the Hoop fault complex have been identified in the Mesozoic. The first tectonic event is characterized by an Upper Triassic extensional event with an E-W trending maximum horizontal paleo-stress direction (Phase 1). This event led to new accommodation space established as a set of full-grabens. The grabens were orthogonally crosscut during the Middle Jurassic by a set of NNE-SSW striking grabens and half-grabens (Phase 2). Phase 3 was inferred from a set of E-W striking reactivated normal faults sealed by the Upper Jurassic-Lower Cretaceous sequence. In the Lower Cretaceous, the general trend of the maximum horizontal paleo-stress axis of Phase 2 rotates clockwise from NNE-SSW to NE-SW (Phase 4). This stress rotation induced the reactivation of Phase 2 and Phase 3 normal fault sets, producing west-dipping half-grabens/tilt-block systems and transtensional fault zones.

A comparison between our results and the Mesozoic regional-scale tectonic events published for the Atlantic-Arctic region agrees with our reconstructed paleo-stress history. This implies that the Hoop fault complex is the result of far-field forces exerted on the plate boundaries.