EGU24-17959, updated on 14 Oct 2024
https://doi.org/10.5194/egusphere-egu24-17959
EGU General Assembly 2024

Assessing the geometry and topology of a fault network along the Northern North Sea rift margin: insights from broadband 3D seismic reflection data

Edoseghe Edwin Osagiede[1,2], Casey Nixon[1], Rob Gawthorpe[1], Atle Rotevatn[1], Haakon Fossen[1], Christopher A-L. Jackson[2], and Fabian Tillmans[1,4]
[1]Geodynamics and Basin Studies (GBS) Group, Department of Earth Science, University of Bergen, Allegaten 41, 5007, Bergen, Norway (edoseghe.osagiede@uib.no)
[2]Department of Earth Science & Engineering, Imperial College, Prince Consort Road, London, SW7 2BP, United Kingdom
[4]Present Address: Equinor ASA, Sandslivegen 90, 5254 Sandsli, Norway

Recent advances in seismic reflection acquisition and processing technologies have led to a general improvement in the resolution of seismic reflection data, allowing for better imaging of subsurface structures, particularly fault networks. Leveraging high-resolution, broadband 3D seismic reflection data from the northern North Sea, we, for the first time, investigate how the geometrical and topological properties of the Late Jurassic normal fault network vary spatially along the rift margins. We also discuss the factors that may have influenced the spatial variability of the rift fault network properties. Our results reveal that normal faults closer to the North Viking Graben exhibit dominant N-S and NE-SW strikes that are sub-parallel to the graben axis and associated step-over zone, whereas those farther from the graben, exhibit an additional NW-SE strike, resulting in a complex fault network. We identify two broad topological domains within the fault network: 1) dominated by isolated (I-) nodes, partially connected (I-C) branches, low fault density, and connectivity, and 2) dominated by abutting (Y-) nodes, fully connected (C-C) branches, moderate to high fault density and connectivity. These topological domains correlate with previous sub-division of the rift margin in the northern North Sea into platform and sub-platform structural domains, respectively. There is also a positive correlation between the spatial variability of the fault orientations, density, and connectivity, highlighting the relationship between normal fault network geometry and topology. We conclude that variation in the amount of relative strain, the presence of pre-existing structures, accommodation zone- and fault damage zone-related deformation are among the main factors that influence the spatial variation of fault network properties both at a regional and local scale. This study provides a new, but complementary way of characterising large-scale structural domains in rift systems. Additionally, our assessment of fault network topology provides important insights into the connectivity of rift-related normal faults, which have implications when considering the integrity of structural traps and subsurface fluid flow related to hydrocarbon and geothermal reservoirs, and CO2 storage.