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Thermal History inferred from large scale geodynamic processes, Outer Vøring basin, Norway

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The Outer Vøring basin is the onset of a complex volcanic margin evolution. It is part of the post Caledonian North Atlantic rift system. We focus on the southwestern part of the basin, near the Jan Mayen fracture zone. This area is characterized by a transition between two volcanic margin segments (Vøring and Møre basins) in a transform context.

The margin has endorsed at least five successive rifting phases before breakup. The breakup itself was probably initiated further south before aborting. In this area, the underplating processes seem to have been rather limited whereas intrusive volcanic bodies seem to be widespread. Another specificity of this area is the drifting, along the Jan Mayen Fracture zone, of the aborted Aegir Oceanic Ridge which has maintained the spreading axis very close to the Vøring basin. Moreover, basin tertiary inversions makes it difficult to decipher the late subsidence history.

Two 2D geological cross-sections have been modeled. One on a dip 1050 km long cross-section, running NNW-SSE, from the Norwegian coastline to the deep ocean basin towards the Kolbeinsey Ridge axis. The other cross section is 300 km long and run SW-NE, from the oceanic crust to the middle of the Vøring basin. The analysis relies on an in-house TotalFinaElf procedure called TRAPS (Transfer in Petroleum Systems). The workflow allows a combined structural geology expertise using Geosec2D® for a palinspastic restoration and a geodynamical expertise using MARGE (in-house software) for lithospheric thermo-mechanical processes modeling.

The thermo-mechanical evolution of the margin through its geological history is described. Both large scale deformation linked to lithospheric stretching and thinning, and small scale deformation within the basin are accounted for. The thermal stress endorsed by the sediments is inferred from the detailed geological scenario used. Regional calibration data (bathymetry, gravity and heat flow) along with exploration wells data (temperature and maturity) are used to validate the thermal scenario. A sensitivity study of timing and magnitude of sediments maturation is addressed with regard to the impact of the individual geological processes and associated uncertainties.