Automated reconstruction of the Vøring volcanic margin incorporating non-extensional processes

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The Vøring Margin offshore Norway is a typical example of volcanic passive margin. The evolution of the inner Vøring Margin is well explained by standard models of lithosphere extension (McKenzie, 1978). Basin modelling tools based on the assumption of lithosphere extension then satisfactorily simulate the tectonic and thermal evolution of the inner margin.

However, models of extension fail to reproduce key observations at the outer (volcanic) domain of the Vøring Margin. These specific observations include uplift at time of breakup, the presence of SDRs and magma additions at the base of the lower crust usually referred as the lower crustal body and interpreted as magma underplating or highly intruded lower crust. Additional, non-extensional processes are required to satisfy these observations.

Excess magmatism and uplift of the outer margin during the breakup time has been explained by the arrival of the hot Icelandic mantle “plume” (Skogseid et al., 2000) or by other sublithospheric processes such as small-scale convection (van Wijk et al., 2001). Melt retention in the asthenosphere has also been proposed to explain uplift at passive margins (Quirk & Rüpke, 2018). At last, mantle phase transitions caused by pressure and temperature changes in the mantle during extension may contribute to uplift (Simon & Podladchikov, 2008).

These processes must be included in the basin modelling procedure to reliably simulate the evolution of the volcanic margin.

We use the Tecmod2d modelling suite (Rüpke et al., 2008) to simulate the tectono-thermal evolution along two crustal transects crossing the Vøring Margin. Tecmod uses an automated inversion scheme approach. Processes such as magmatic underplating, melt retention, mantle phase transitions, and differential thinning can be taken into account.

We test various tectono-thermal models of the margin evolution that incorporate or not these processes. Models incorporating a plume emplaced at Eocene time and taking into account magmatic processes (melt retention and magmatic underplate) satisfactorily reproduce the
specific observations of the outer (volcanic) margin. This result backs the contribution of the hot Iceland plume on the evolution of the Voring Margin.

References


