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Integrated basin modeling – linking lithosphere and sedimentary basin processes

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Simulating sedimentary basin formation and evolution requires multi-scale and multi-physics numerical models. Multi-scale, because lithosphere processes (e.g. thinning, flexure, heat transfer) and sedimentary basin processes (e.g. sedimentation, compaction, maturation) need to be resolved. Multi-physics, because thermal, structural, and infill modeling needs to be coupled. Regardless of their complexity, numerical models are only as good as the input and reference data on which they are based. A key fitting parameter in basin modeling is the seismically observed stratigraphy. We present an algorithm for the automated inversion of basin stratigraphy for crustal stretching, mantle stretching, and paleobathimetry. The method is based on the coupling a 2-D thermotectonostratigraphic forward model to an inverse scheme that updates the model parameters. The forward model solves for lithospheric thinning, flexural isostasy, sediment deposition, sediment compaction, transient heat flow and mineral phase transformations. The inverse model updates the crustal and mantle thinning factors and paleo-water depth until the input stratigraphy is fitted to a desired accuracy. Both models combined allow for automated sedimentary basin reconstructions.

The potential and robustness of this method is demonstrated through two case studies. In the first case study, we apply the presented algorithm to the well studied Viking Graben, North Sea. This study demonstrates how multiple datasets (e.g. stratigraphy, well temperature, vitrinite reflectance) can be integrated into the automated inversion. The second case study addresses the structural and thermal evolution of a passive margin (Voring basin, Norwegian Sea) and illustrates the feedbacks between ‘deep’

lithosphere and ‘shallow’ sedimentary basin processes.