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Numerical models of basin inversion constrained by plate reconstructions

Susanne J.H. Buiter (1), O. Adrian Pfiffner (2), Trond H. Torsvik (1)

(1) Centre for Geodynamics, Geological Survey of Norway, Leiv Eirikssons vei 39, 7491 Trondheim, Norway (susanne.buiter@ngu.no), (2) Institute of Geological Sciences, University of Bern, Baltzerstrasse 1-3, 3012 Bern, Switzerland

We investigate the inversion by shortening of extensional sedimentary basins under constraints imposed by tectonic plate reconstructions. Plate reconstructions document the formation and closure of ocean basins and quantify the associated displacement rates. Subduction and subsequent continent-continent collision may shorten and even completely invert half-graben basins on passive margins. Milder inversions can be expected due to stresses caused by local plate reorganisations (e.g., Triassic inversions in Eastern Australia) or transmission of compressional stresses from collision zones further away (e.g., Tertiary inversions in the North Sea).

We use a two-dimensional finite element method to model (1) extensional basin formation, (2) post-rift sedimentation and tectonic quiescence, and (3) subsequent shortening. The strength of the basin area and its extensional faults relative to the surroundings mainly determines the ease with which basins may be inverted. Here the duration of the post-rift phase, the velocity of extension, the distribution of heat-producing elements and thermal conductivity, and strain-weakening of shear zones all play a role. We specifically focus on the effects of the time duration between extension and inversion, the composition and thickness of post-rift sediments, the strength of syn-rift sediments, strain-rates, and crustal rheology. We use plate tectonic reconstructions to constrain the extension velocities, the time between extension and inversion, and the shortening velocities.

Our model shear zones strain-weaken in the extension phase and are easily reactivated upon shortening. These inherited shear zone-weaknesses overprint effects of the duration of the post-rift phase. In natural examples inverted basins with different time

lags between extension and inversion may also look remarkably similar. Examples are the Permian basins inverted in the Triassic in Eastern Australia and in the Cenozoic in the North Sea. The thickness of the post-rift cover does not play a major role in our models. Inversion structures are clearly influenced by the inherited extensional basin geometry whereby symmetric basins develop symmetric inversion structures.