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Interactive comment on "Extension and Inversion of Salt-Bearing Rift Systems" *by* Tim P. Dooley and Michael R. Hudec

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This manuscript uses analog models to investigate the tectonic inversion of salt-bearing extensional grabens. While models of tectonic inversion exist in the literature, some of them including polymer (=salt) layers, the ms. by Dooley and Hudec has the novelty of incorporating a subsalt deformable section, which aims to provide analogues for the compressional structure of pre-salt basements, often a poorly resolved problem in compressed rift systems. In comparison to other published models of compressional systems with multiple "salt" décollement levels (e.g. Couzens et al. 2003 –a paper that should be referenced), Dooley and Hudec's models incorporate early episodes of extensional deformation, which feature synkinematic sedimentation to produce salt migration and diapiric structures (later submitted to compression). No surprise that in the

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models there is a marked decoupling between the subsalt and suprasalt units, which puts a warning on the subsurface interpretation of little exhumed, natural inverted rift systems, as the High Atlas of Morocco that is taken as a reference field case. After the early cartoons by Letouzey et al. in 1995, for moderately inverted salt-bearing rifts with no seismic information very often we are tempted to keep in place the parent normal faults (even if reactivated) that we infer as early triggers of observed salt diapirs. The analog models by Dooley and Hudec are welcome in that they remind us that as shortening increases, the connection between the diapirs and the parent faults is likely to be lost. This is likely to be the case in the High Atlas (although with the available data so far it is hard to tell), but also must happen in other basement-involved, salt-detached thrust systems as the northern Pyrenees, where we argued for largely decoupled and displaced salt walls in contrast to autochthonous diapir models (e.g. Labaume and Teixell, Tectonophysics, accepted). The inversion models by Dooley and Hudec provide inspiring images for such natural examples, if the model sand is accepted as a valid analog for crystalline or (non-horizontal) slate basements. Further challenges to the application to natural cases may come, as the authors explicitly recognize, from the tricky simulation of fault-inversion by faulted sand, which most commonly fails to reproduce fault weakening and reactivation. The ms. reads well and is appropriately illustrated, and deserves publication in Solid Earth with minor revision. When analyzing the cross-sectional views of model 1, I had some trouble understanding the inversion features of the subsalt pile, as in Fig. 9 the inverted graben is not so evident (I mean, I did not get an appreciation of how subsalt faults were inverted). Not until I saw Fig. 10 that I got a clear idea (Fig. 14 also helped). The authors may want to consider presenting the uncompressed profiles before actually showing the compressed ones, which in fact represent one step further of an evolution. I also wondered what would happen if there was no salt fringe out of the modeled rift, as actually happens in many natural cases. Fringes cause the post-salt extension to be more diffuse that the first-phase graben system. What happens in basement in this case? On the other hand, Fig. 12 is a very nice polymer (=salt) volume illustration, which shows similarities to those obtained from natural salt cases after 3D seismic data. Note that minibasins are not always flanked by outward-vergent thrusts as written in line 367 (Fig. 9), which is interesting. Another interesting result is that after shortening, fault footwalls remain broadly inflated (beyond local diapirs). If applicable to nature, this suggests that, counterintuitively, some minibasins may be actually underlain by highest subsalt relief. The application of the model results for the High Atlas cases is preliminary; certainly more analogies can be explored by further work. A natural continuation of the models presented could be including intervening horsts without salt between salt-bearing grabens. I believe that this happens in parts of the High Atlas, such as the Mouguer massif – would that impede major decoupling and translation? The Azag minibasin as drawn looks indeed tilted in a post-depositional stage (although the analog models do not get that much rotation), but note that cases like that are lagged by the absence of subsurface data: there is little control about the stratal geometry at depth and one tends to complete sections in a conservative way. Again, analog models may help in showing the viability of geometric interpretations that may be adopted.

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