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Salt movements and faulting of the overburden – can numerical modeling predict the fault patterns above salt structures?

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Salt deformation has been the topic of numerous studies through the 20th century and up until present because of the close relation between commercial hydrocarbons and salt structure provinces of the world (Hudec & Jackson, 2007). The fault distribution in sediments above salt structures influences among other things the productivity due to the segmentation of the reservoir (Stewart 2006). 3D seismic data above salt structures can map such fault patterns in great detail and studies have shown that a variety of fault patterns exists. Yet, most patterns fall between two end members: concentric and radiating fault patterns. Here we use a modified version of the numerical spring-slider model introduced by Malthe-Sørenssen et al.(1998a) for simulating the emergence of small scale faults and fractures above a rising salt structure. The three-dimensional spring-slider model enables us to control the rheology of the deforming overburden, the mechanical coupling between the overburden and the underlying salt, as well as the kinematics of the moving salt structure. In this presentation, we demonstrate how the horizontal component on the salt motion influences the fracture patterns within the overburden.

The modeling shows that purely vertical movement of the salt introduces a mesh of concentric normal faults in the overburden, and that the frequency of radiating faults increases with the amount of lateral movements across the salt-overburden interface. The two end-member fault patterns (concentric vs. radiating) can thus be linked to two different styles of salt movement: i) the vertical rising of a salt indenter and ii) the inflation of a 'salt-balloon' beneath the deformed strata.

The results are in accordance with published analogue and theoretical models, as well as natural systems, and the model may - when used appropriately - provide new insight into how the internal dynamics of the salt in a structure controls the generation of fault patterns above the structure. The model is thus an important contribution to the understanding of small-scale faults, which may be unresolved by seismic data when the hydrocarbon production from reservoirs located above salt structures is optimized.

References

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