Physical modelling of the initial salt mobilization and salt tectonics in late syn-rift and post-rift basins with application to the Early to Late Jurassic Abenaki and Sable subbasins, Scotian Margin

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Unsatisfactory results from the latest round of hydrocarbon exploration in the deepwater slope of the Scotian Margin exhibits an inadequate understanding of the tectonic and sedimentary framework of the shelf-slope-basin transition. Problems associated with the geology in this area are associated with complex salt deformation beneath the shelf and slope, which is documented by features that record highly variable tectono-sedimentary environments with high rates of sedimentation and progradation during the Jurassic and Early Cretaceous. The incomplete geological understanding of the Scotian Basin is attributed to the deficiency of scientific drill holes and acoustic shadowing from the complex salt structures present in the substrata. Particularly, the imaging problems hamper the structural interpretation of basement morphology beneath the rift-related salt basins. It is crucial to improve the understanding of the tectonic and sedimentary evolution as related structures are a major contributor to the determination of petroleum reservoirs, migration, and traps.

To address these problems innovative 3D physical simulation methods and structural modelling techniques were coupled with interpretation of public seismic data of offshore Nova Scotia. Dynamically scaled analogue models consisting of materials like silica sand and silicone rubber simulate sedimentation, salt mobilization and deformation of the brittle overburden sediments and ductile salt. The presented set of experiments systematically investigates the control of different rift-related basement morphologies on the structural and depositional evolution during the two stage development of initial salt mobilization. Recently published results from regional seismic analysis of salt structures along the Scotian Margin emphasize the importance of basement morphology of the rift-related salt basins at the Scotian Margin and variable sedimentation patterns and rates during the Jurassic and Early Cretaceous as main control factors of the salt tectonic domains. Similar to salt mobilization at passive margins, the silicone in the experiments is mobilized by incremental model sedimentation in the shelf and landward salt basin areas due to differential loading. Subsequent basinward flow of the silicone causes early landward extensional and basinward compressional deformation in the overburden. The thin-skinned deformation due to this silicone mobilization and migration of depositional centres in the model shelf-to-slope sedimentary sequence is fully quantified with 3D optical strain monitoring techniques (Particle Imaging Velocimetry), a technique which uses particle recognition to quantify incremental and finite strain.

The first results and preliminary interpretations show that basement morphology does affect structural evolution during initial salt mobilization and is a major control in the types of structures present in autochthonous salt and overlying sediments. Basement geometry is also found to control the extent of down-dip allochthonous salt sheets and the respective structures present.