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Interplay of Tectonics and Sedimentation: Evolution of Passive Margin Basins decoupled on Salt Sediments

J. Adam, C. Krezsek, S. King, D. Grujic

Salt Dynamics Group, Department of Earth Sciences, Dalhousie University, Halifax, Nova Scotia, B3H 4J1, Canada (j.adam@dal.ca)

Passive margin sedimentary basins that develop on salt substratum are characterized by a highly variable tectono-sedimentary history and a complex structural evolution. In this brittle-ductile system the basin evolution can be strongly decoupled from the underlying basement. The complex basin architecture and related fault and salt structures are dominantly controlled by gravity-driven extension, syntectonic sedimentation and salt-mobilisation. Consequently, passive margin salt basins are a prime target to investigate the coupled processes and feedback mechanism between tectonics and sedimentation in a brittle-ductile system.

The Salt Dynamics Group utilises 4D modelling with scaled physical experiments consisting of granular/viscous materials to simulate the structural evolution and migration of depositional centers on mobile substratum under varying sedimentation patterns. Fault kinematics, surface deformation and subsidence are monitored by high-resolution 2D/3D optical strain monitoring techniques (PIV-Particle Imaging Velocimetry). The experimental displacement and strain data are similar to results from numerical modelling and enable a direct comparison of analogue and numerical techniques. 3D structural models are built from model sections with commercial seismic interpretation software to provide insights in the architecture of the linked salt-controlled depocentres. The integration of structural interpretation with experimental fault strain data allows the reliable 3D fault correlation and the mechanical analysis of complex fault systems.

The experiments reproduce realistically the complex 3D structures of natural systems including crestal grabens, landward and seaward dipping roller structures, triangular-shaped reactive and active diapirs, turtle structures, canopies, and allochthonous salt

detachments. The tectonic evolution is strongly controlled by sedimentation. Individual sub-basins and their deep-water compressional belts are coupled spatially and temporally and are characterized by lateral and temporal migration and highly variable and localized subsidence patterns. Our results show that a strong relation exists between sedimentation, rate of extension and dominant structural styles.

Mechanical fault concepts and seismic interpretation templates derived from physical simulations and PIV strain monitoring can significantly improve our understanding of continental margin evolution.