Physical modelling of the Jurassic to Cretaceous evolution of the Scotia margin salt tectonics system

Cody MacDonald[1], Clarke Campbell[1], Jonathan Cribb[1], Juergen Adam[2,1] and Mladen Nedimovic[1,3]

[1]*Department of Earth Sciences, Dalhousie University, Halifax, Nova Scotia B3H 4J7, Canada*
[2]*Department of Geology, Royal Holloway University of London, Egham, Surrey, TW20 0EX, UK*
[3]*Lamont-Doherty Earth Observatory of Columbia University, Palisades, New York, 10964, USA*

Unsatisfactory results from the latest round of hydrocarbon exploration in the deepwater slope of the Scotian margin demonstrate the need for a better understanding of both the tectono-stratigraphic framework of the Scotian Basin and the evolution of its individual sub-basins. Salt tectonic features in the north-central sub-basins which comprise salt subprovinces III and IV (Shimeld, 2004), e.g. Sable, Abenaki and Laurentian areas, indicate variable rift basin geometries and variable tectono-sedimentary environments with high rates of sedimentation and progradation during the Jurassic and Early Cretaceous. Success in future petroleum exploration will therefore greatly depend on our ability to accurately interpret the role this variable depositional system had on the salt tectonics history in the sub-basins and the region as a whole.

The Salt Dynamics Group at Dalhousie University is using scaled analogue models consisting of silica sand and silicone rubber to simulate coupled salt tectonic processes and depositional systems in passive margin settings. Models extend from the shelf to the deepwater slope and basin, with parameters scaled to the Scotian margin. Basin evolution is simulated from initial salt mobilization in the early post-rift stage to the allochthonous salt nappe formation at the modern margin. With a series of systematic experiments, we have investigated the role of (1) sedimentations pattern and rates and (2) variable basement morphologies with thick salt. From our experimental results, we are developing structural and mechanical concepts to support seismic interpretation at the Scotia margin and other passive margins affected by salt mobilization. These concepts include: (1) passive downbuilding of sediments as the dominant mechanism for initial salt mobilization in the landward portion of rift basins with thick salt, (2) basement floor morphology influenced salt thickness as the dominant factor controlling the efficiency of basinward autochthonous salt mobilization into allochthonous canopy and nappe systems, and (3) early salt evacuation and initial salt-withdrawal welding dependence on the timing and extent of allochthonous nappe advancement into the deepwater basin from a forced progradation of sediments onto an inflated autochthonous basinward salt complex.

With detailed study of seismic data planned for the next phase of our work, the new concepts we have developed will make it possible to refine basement structure and its effect on the evolution of salt-related structures and depositional systems at the Scotian margin from early Jurassic to Cretaceous. Analysis of seismic data will also enable us to refine our modelling procedures to ensure accuracy, allowing for realistic results of future Scotian margin scaled models. Our final goal is a model that holds true to observed structures comprised within the Scotian margin that will document kinematic evolution and aid in structural interpretation. Accurate interpretation will be useful for targeting salt-controlled depocenters and basins formed by very high sedimentation rates, and thus potentially sand-prone zones and structures.