NUMERICAL MODELING OF PASSIVE MARGIN SALT TECTONICS: EFFECTS OF SEDIMENT PROGRADATION AND MARGIN TILTING

On many passive continental margins, including the Nova Scotia margin, the tectonic evolution of the sediments is dominated by salt tectonic related structures. We investigate the finite deformation that develops in passive margin salt basins using 2-D plane-strain finite element modeling experiments. We address the general stability problem of a brittle (plastic) material of laterally varying thickness overlying a viscous substratum (e.g., salt) and present results of finite deformation experiments designed to investigate the development of passive margin salt basins in response to sediment progradation and margin tilting.

Salt mobilization is caused by a pressure gradient produced by the laterally varying thickness of the overlying sediments. This induces a basinward Poiseuille flow in the salt. If the pressure differential is sufficiently large, the overburden becomes unstable and fails, forming landward extensional structures (e.g., minibasins) and basinward contraction and the system adopts a Couette style of flow.

Model results show that sediment progradation over a salt substratum causes basinward salt evacuation and the formation of folds and allochthonous salt structures as the salt overthrusts its depositional limit. Rapid progradation results in incomplete salt evacuation beneath the shelf, and basinward salt flow eventually stops as the prograding sediment wedge overtakes the advancing salt structures. Slow progradation causes more efficient salt evacuation and welds form beneath the shelf. The shelf evolution depends on the degree to which sediments fill the extensional minibasins. If sediments bypass the shelf, diapirs form beneath the shelf, whereas sediment filling of the shelfal minibasins inhibits diapir growth beneath the shelf.

Salt mobilization is also influenced by margin tilting. Models which incorporate a low angle of basinward tilt (i.e., < 2 degrees) indicate that tilting acting alone may destabilize the salt-overburden system, or that tilting enhances the progradational instability.

Such models may provide a better understanding of the controls on the evolution of passive margin salt basins and their dynamics, and hence provide better insight into hydrocarbon trap formation and maturation, for example.