Vishal Maharaj is working on his Ph.D. degree at The University of Texas (Austin) His current research involves the investigation of the devevelopement of sedimentary fill within minibasin provinces through applicatons in physical modeling experiments and subsurface data analysis in deep-water Morocco and Gulf of Mexico. Dr. Lesli Wood is his adviser.

Project Summary

The main objective of this research is to revisit the existing models in mini-basin fill evolution and to create a broader understanding of the influence of local and regional tectonics on fill timing, architecture, and sedimentology, especially as it applies to reservoir distribution in provinces of regional substrate variability. Existing models are reviewed, and while they provide an ongoing framework, they are in need of revisiting in light of annual advances in our understanding of deep marine processes, deposit complexity, and depositional system behavior in deep marine settings.

In this research a three-phase approach is adopted, and includes: (1) physically modeling submarine flow behavior under conditions of varying topographic relief; (2) examining deep water fills in salt basins of the Gulf of Mexico that have evolved in settings undergoing active transition from low topographic relief to high topographic relief; and (3) examining deep water fills in salt basins undergoing extremely rapid subsidence, an example cited from offshore Morocco (Maharaj and Wood, 2010).

Problem and Hypothesis

Gulf of Mexico-centric models of mini-basin fill development (*e.g.*, Satterfield and Behrens, 1990; Pulham, 1993; Holman and Robertson, 1994; Prather *et al.*, 1998; Rowan and Weimer, 1998; Booth *et al.*, 2000; Prather, 2000; Winker and Booth, 2000, Sinclair and Tomasso, 2002) have become the foundation for exploring and identifying strategic deep-water hydrocarbon reserves. These models suggest a process dominated by sediment-driven-subsidence accommodation tied to eustatic sea-level changes along the margin. Wood (2006) suggested that such a process might vary dramatically in the more distal mini-basin systems of the Gulf of

Mexico, where basins are farther removed from the influences of eustatically-driven shelf edge sediment supply changes. Also, little is known about the physical processes through which mini-basins fill relative to the topography created by underlying mobile salt despite the abundance of subsurface data.

My hypothesis is that mini-basins will show systematic changes in the geometry and morphology of the fill strata as conditions vary temporally and spatially. Such changes allow us to predict fill character based on turbidity current and bathymetric topography conditions, or vice versa. By consequence, I seek to address pitfalls in the established models of mini-basin development using techniques in physical modeling to investigate mini-basin fill architecture, and to assess the ability to apply those learnings toward understanding subsurface datasets from minibasins developed in offshore Gulf of Mexico and Morocco.

Project Execution

To test my hypothesis and address the aforementioned limitations and discrepancies, I attempt to revisit the existing but limited and rather outdated models in mini-basin fill evolution. In so doing, I intend on creating a broader understanding of the influence of local and regional tectonics on fill timing, architecture and sedimentology, especially as it applies to reservoir distribution in provinces of regional substrate instability. The first phase of physically modeling flow behavior under conditions of varying topographic relief is currently being performed at the Jackson School of Geosciences Morphodynamics Laboratory at the Pickle Research Campus, UT Austin (Fig. 1). The modeling shall incorporate investigating turbidite flows into a model mini-basin varying conditions of controlled subsidence and sediment supply between each run. Secondly, an integrated subsurface analysis of the Lobster mini-basin dataset from Ewing Bank 873, Gulf of Mexico, will incorporate a 3-D seismic dataset, several well logs, core and paleontological data. The Lobster mini-basin is shelf proximal and was subject to the secondary affects of eustacy (*i.e.*, sediment flux, changes in marine current conditions, etc.) during its evolutionary development (Fig. 2). Thirdly, A similar subsurface study will be carried out in a salt basin from the Safi Haute Mer permit area of offshore Morocco undergoing extremely rapid subsidence, in the absence of large extra-basin sediment volumes (Fig. 3). The 3D seismic dataset used for this study is the result of re-processing two overlapping surveys in the offshore Safi Haute Mer (SHM) block, offshore Morocco.

Finally, observations and interpretations from each phase component will be combined to determine the significance of the input sediment delivery systems relative to the position of the mini-basin on the slope, the preserved cross-sectional geometries and implications for predicting potential facies distribution to assess hydrocarbon reservoir potential within mini-basin provinces.

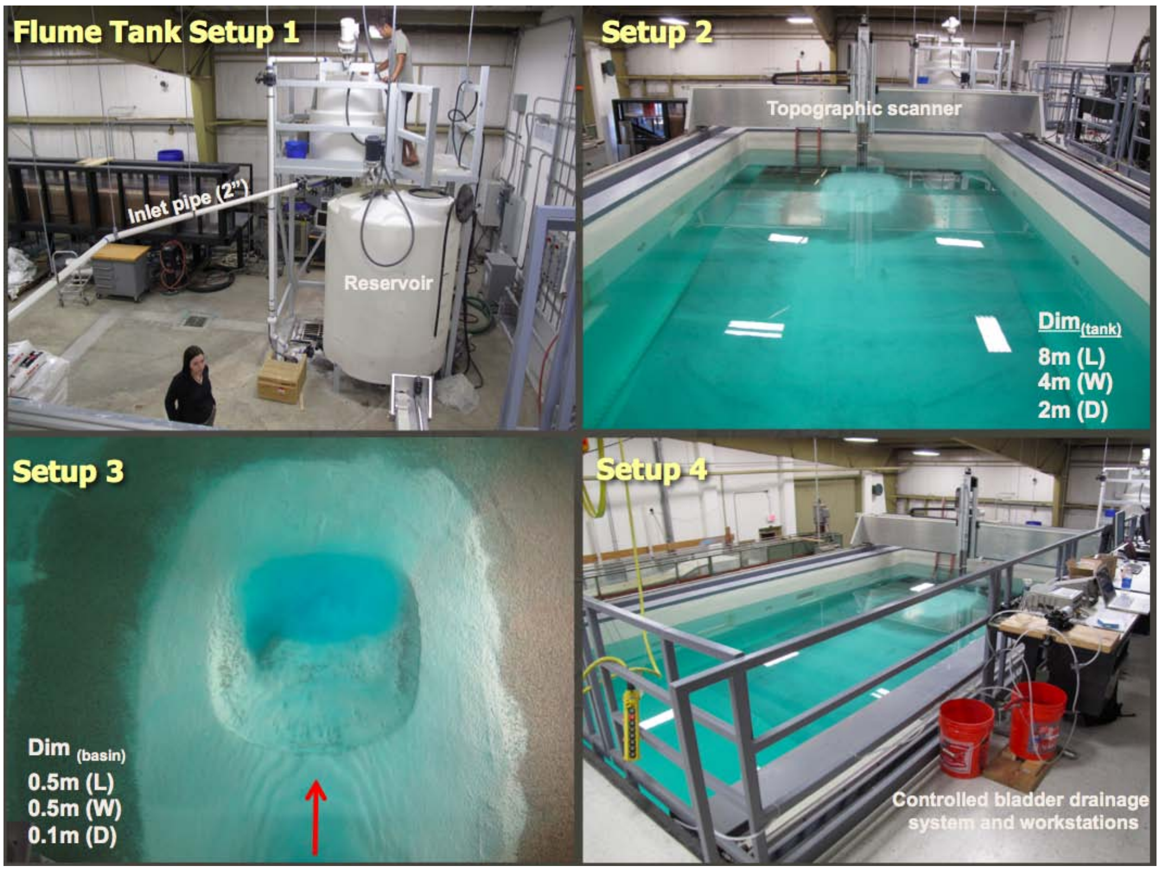

Figure 1. Experimental setup of model mini-basin in the Morphodynamics Laboratory at the University of Texas at Austin. Shown are the input reservoir setup, the model mini-basin within the flume tank and the controlled bladder drainage system for subsiding the basin through time. Turbidite flow input conditions and mini-basin subsidence are all controlled and can be measured at high-resolution.

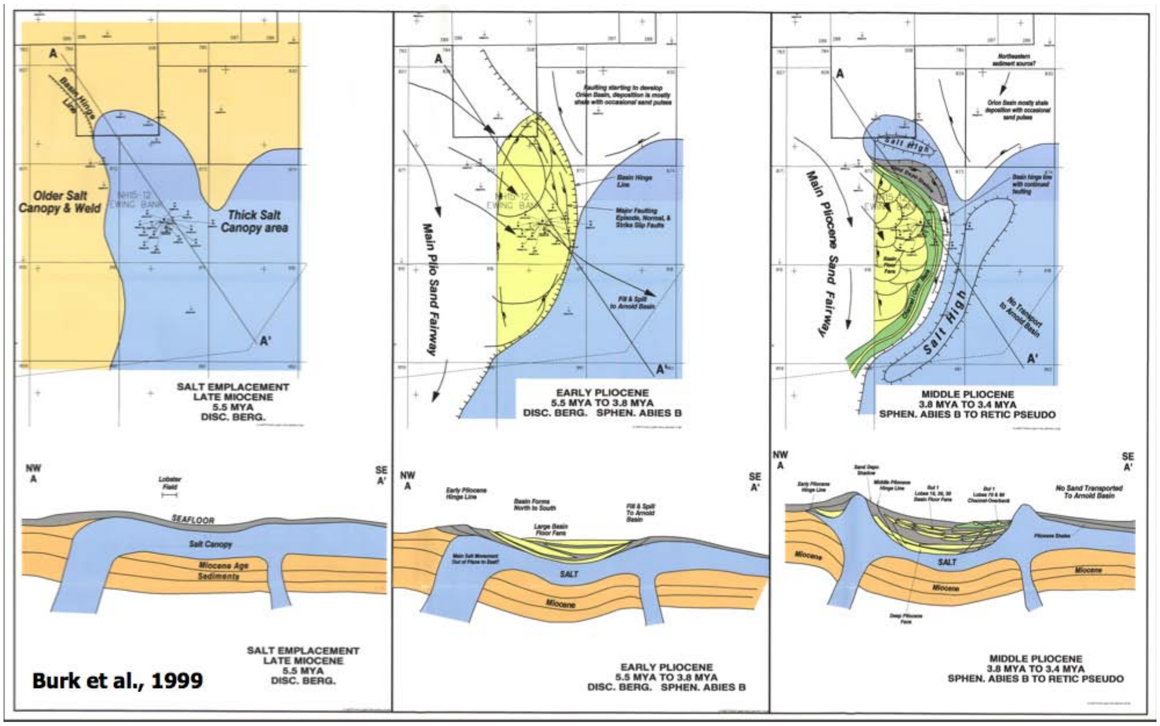

Figure 2. Evolutionary model of the Lobster mini-basin, located in the Ewing Bank Block 873, Gulf of Mexico (From Burk et al., 1999). Topographic confinement due to salt diapirism increases from the Late Miocene to the Middle Pliocene, and has implications for sediment partitioning as accommodation is developed.

Significance of Proposed Study

Mini-basin provinces are economically relevant in that many of the individually vacated, high accommodation "pods" constitute focal points for the deposition of siliciclastic sediment in deepwater slope settings. Some of these siliciclastic deposits in turn serve as excellent reservoirs for hydrocarbons. To date the majority of models explaining minibasin fill processes have been derived from study of well developed (deep) supra-salt features. However, we now know that older mini-basins in the Gulf of Mexico seldom reach such sediment confining depths. Therefore, there is a need to understand the manner in which fills evolve or don't under different degrees of confinement. Results of such work have implications for exploration in sub-salt settings, including the older Cretaceous through Eocene Gulf of Mexico fills. Through an improved understanding of the fill histories within mini-basins we can improve our knowledge of how these basins form and the processes that influence their fill, as well as improve our estimates of the timing and the volumes of sediment which make their way through this complex series of sinks onto the abyssal ocean seafloor. More specifically, by using the methodology outlined in this study, a better understanding of the process by which minibasins fill with mud and sand will substantially improve:

1. The understanding of quantitative spatial and temporal relationships between turbidite currents and the confining topography they encounter as they make their way to the ocean floor.

2. The stratigraphic distribution of these sediments within confined mini-basin settings, and the nature by which hydrocarbon reservoir-quality rock terminate on basin margins.

3. The ability to identify the location of such reservoirs in deepwater locations with sparse subsurface data, as well as locating optimal areas for exploration in frontier deepwater regions.

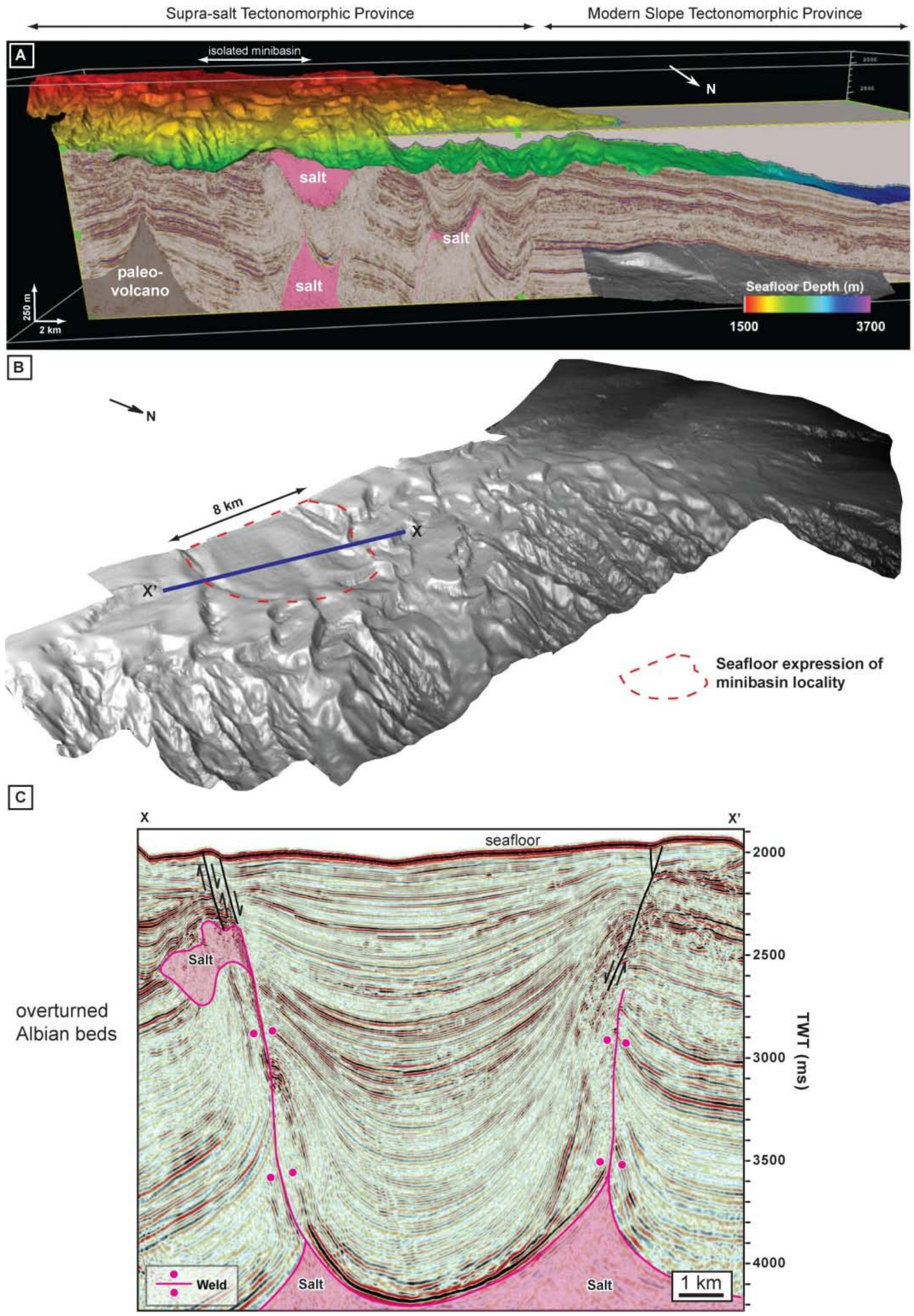

Figure 3. (A) Seismic dip section from the Safi Haute-Mer dataset, offshore Morocco with superimposed seafloor structure map. (B) a structure map, shown in three dimensions, completed on the Moroccan seafloor illustrates the relationship between the isolated mini-basin under investigation (outlined in red) and the rest of the 3D seismic volume; and (C) an arbitrary seismic cross section (X-X') shows the 3 kilometers of stratigraphy preserved within the subsiding mini-basin. Interpreted salt structures are outlined and shaded pink.

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