PROPOSAL FOR RIOMAR RESEARCH 2010-2012

RioMAR Research
RioMAR Research continues to focus on (a) the river mouth, the delta and its ability to deliver sediment out onto the shelf and to the deepwater slope beyond the shelf break, and (b) the sedimentary lithology and architecture of the outer shelf, the shelf edge and of the entire shelf-margin prism. Our work emphasizes the process linkage between shelf, slope and basin floor as shown in Figure 1 below.

Research continues to cover modern sedimentary environments, numerical and physical modeling of sediment transport and deposition, and sedimentological stratigraphic interpretation of outcrop, well and seismic data. This spread of methods is possible because 4 PIs (Plink-Bjorklund, Mohrig, Olariu and Steel) and up to 10 graduate students are involved in RioMAR. Although we deliver year-end summary sheets (mini-posters), student theses and reports/papers of the main work tasks, the project results are also continually added to the RioMAR website throughout the project year.

Results 2008-9
During the current phase of RioMAR (2008 and 2009) we have provided 12 research reports/papers and 5 student theses in 2008, and for year end 2009 there will be another set of products on concepts of hyperpycnal flow, backwater effects at river mouths, channels of Mississippi River delta, the distal Castlegate Sandstone problem, Baltic tide-dominated deltas, autogenic and allogenic shelf-delta growth, Fox Hills-Lewis shelf margin, Pliocene Orinoco Delta research, initial Karoo Margin results and tabulated global rates of progradation/aggradation of shelf margins.

Field Seminars
We will continue to provide at least one field seminar pr year for sponsor companies. In 2010 we plan to run a seminar to view current work on the Mississippi Delta.
RIOMAR PROPOSAL FOR 2010 AND 2011

Consortium Fee: The yearly fee will continue to be $30,000

Research on Modern Systems

1. *Stratigraphic model for growth of mouth-bar complexes*: Time series of bathymetric surveys plus shallow core will be collected from 3 mouth-bar complexes on Wax Lake delta, Louisiana, to define sedimentation and erosion patterns associated with river floods, tidal reworking, and large storms. These measurements will be integrated to develop a facies model that quantifies processes controlling the compartmentalization and heterogeneity in actively prograding mouth-bar complexes. *Students J. Shaw and V. Smith* (Mohrig)

2. *New facies model for incisional deltas*. Many deltas have distributary channels that are deeper than the deltaic deposits themselves are thick. In these systems, delta progradation is accompanied by channel incision into pre-existing substrate. We are using bathymetric and sedimentation data from Atchafalaya and Mississippi distributary channels to guide the construction of a facies and sequence stratigraphy model for deltaic systems dominated by erosional surfaces that are equal to and greater than mean deposit thickness. *Students J. Nittrouer and J. Shaw* (Mohrig)

Figure 2.
Flume Experiments

3. *Initiation and growth of submarine channels connected to shelf-edge deltas.* Laboratory experiments defining environmental processes controlling the development and filling of slope channels on the uppermost continental slope (Fig. 3). We will pay particular attention to defining the variables that affect the 1) incision of gullies and channels into the slope surface, and 2) transport of sand to deep water settings. Successive topographic maps will define evolution of channelized patterns cut into the slope surface, as well as subsequent filling of these forms. Sediment sampling following each experiment will define grain-size and grain-sorting patterns associated with the slope channels. *Students A. Fernandes and A. Peyret.* (Mohrig).

![Initial Experimental Surface](initial_surface.png)

*Figure 3.*

Production of submarine gullies and channels by turbidity currents in the laboratory. Gullies and channels are cut into an erodible substrate (arrows above). Eroded material is transported by currents as suspended load and bed load.

Seismic interpretation

4. *Comparative infill architectures of well confined and weakly confined submarine channel systems.* A deepwater, 3-D seismic dataset will be used to develop criteria for distinguishing depositional architecture created by turbidity currents that were wholly contained in submarine valleys or canyons from partly contained currents infilling channels that are shallow relative to current thickness. This study will therefore explore the depositional consequences of high-relief erosional topography versus coevally evolving constructional levees. *Student A. Fernandes.* (Steel/Mohrig)

5. *Avulsion model for deep rivers in coastal zones.* Present models for avulsive channels on alluvial surfaces describe avulsion conditions as a function of local surface slope or channel superelevation. These models do not apply to many
lowland river networks where channel depths substantially greater than total overbank relief. A new model must be developed for this common system type. We are using seismically mapped channel patterns and channel fills from the Quaternary Mississippi River delta to guide construction of a new model of channel avulsion for deep rivers on low-relief surfaces. D. Mohrig.

**Interpretation of outcrop and subsurface strata**

6. **Avulsion models for the lobes of river- and wave-dominated deltas; shelf versus shelf-edge settings.** There is need to (1) develop avulsion models for wave-dominated deltas to complement what we already know about the processes and time scale of lobe shifting in river-dominated deltas, and (2) better document the avulsion of river deltas in ancient successions. In addition, we need to know whether avulsion is still important when the delta arrives at the shelf edge, as this is critical for understanding the sites of developing upper-slope channels and gullies. In some systems the formation of upper-slope channels and gullies are linked to delta distributaries, whereas in others shelf-edge deltas fill previously-formed incisions. These delta-avulsion models and the possible linkage to upper-slope conduits are also important input when correlating larger-scale regressive-transgressive cycles on the shelf. The work will be done using existing data from the Danube, Godavari and Mississippi delta systems, and testing with an extensive well database from the Fox Hills deltas on the Cretaceous shelf of Washakie Basin, Wyoming. C. Olariu, and I. Olariu.

7. **Stratigraphic model for Karoo IceHouse shelf-edge deltas.** The recently started work with Karoo shelf and shelf-edge deltas (Fig. 3) will continue. Emphasis is being placed on dip and strike variability of the feeder deltas, as the extensive outcrops in Karoo (Fig. 4) lend themselves to 3-D reconstructions better here than in Spitsbergen or Trinidad. We are particularly interested in the impact that the Icehouse climate had on the sediment delivery system. For example, we have noted an absence of transgressive sand-rich estuarine deposits that are common in the transgressive compartments of shelf cycles in Spitsbergen and Washakie Basin (GreenHouse setting). Another aspect of this research is the mapping of possible linkage between the shelf-edge deltas (and delta regime) and upper-slope gullies/channels. We are keen to work an analogous seismic dataset for this type of margin, and hoping that a sponsor company may make this possible. Students J. Dixon and J. Leva-Lopez (Steel); students M.Bubb +AN Other (Plink-Bjorklund).
8. *Tyee Basin Infill, Oregon.* The Eocene Tyee Fomation preserves an extensive set of shelf-slope-basin floor clinoforms that are of interest to RioMAR because they host very large sand-rich fans in a convergent-margin setting. We hypothesize that a combination of the tectonics and Greenhouse setting is responsible for the unusually high sediment supply and fan size. Current work is focusing on the character of the delta-supply system, and on defining the basin-infilling clinoforms. **Student M. Santra (Steel).**

9. *Completing the Deltaic Database.* As part of our work of developing defining criteria for the identification of wave-, river- and tide-dominated deltas in the stratigraphic record we are studying the Twenty-Mile deltas of N. Colorado (Fig. 5). We have additional data on deltaic sequences from Spitsbergen (clinoforms 8, 14, 15, 16, 17), from Karoo (Kookfontain), from Wyoming (Haystack Mountains, Fox Hills), from Utah (Panther tongue, McCourt, Brooks and Chimney Rock), from Colorado (Iles) and from Trinidad (Fishing Pond, Mayaro, Cedros, Guayaguayare and Cruse). These numerous deltaic successions provide a potential not only to develop defining criteria for the ancient delta types, but to provide comparative datasets on grain size, bed thickness (there is increasing interest among sponsors for data on ‘thin beds’), sand/mud ratio, and extent of mud beds. In developing this database we will emphasize the change in the above parameters when the deltas are sited on the outer shelf and shelf-edge areas. Twenty-Mile Deltas: **Student J. Leva-Lopez (Steel); Delta Database: I. Olariu, Plink-Bjorklund, C. Olariu, Steel**
10. **Stratigraphic models for clastic shelf-margin architecture.** We have now accumulated data for the basic architectural element (regressive-transgressive shelf-transit cycle) of shelf margins, as well as for the longer-term architecture of the entire shelf-margin sediment prism. The time scale of the deltaic ‘element’ (cross shelf progradation) is commonly ca.100-300ky, and 1-5my for larger-scale margin architectures of the Spitsbergen (Eocene), Washakie Basin (Maastrichtian), Orinoco (Pliocene) and Karoo (Permian) systems. We are particularly interested in how the shelf-edge trajectory of a number of margins is ‘broken’ into flat and rising segments on a time scale of < 1my (Fig. 6). This segmentation will be investigated as it has implications for alternating phases of sediment storage on the shelf and sediment bypass to the deepwater slope.

**R. Steel, P. Plink-Bjorklund and C. Olariu.**