Basin-scale stratigraphy and stratigraphic architecture: using Jurassic Tank to understand large-scale stratigraphic controls.

Geology 320: Sedimentology and Stratigraphy

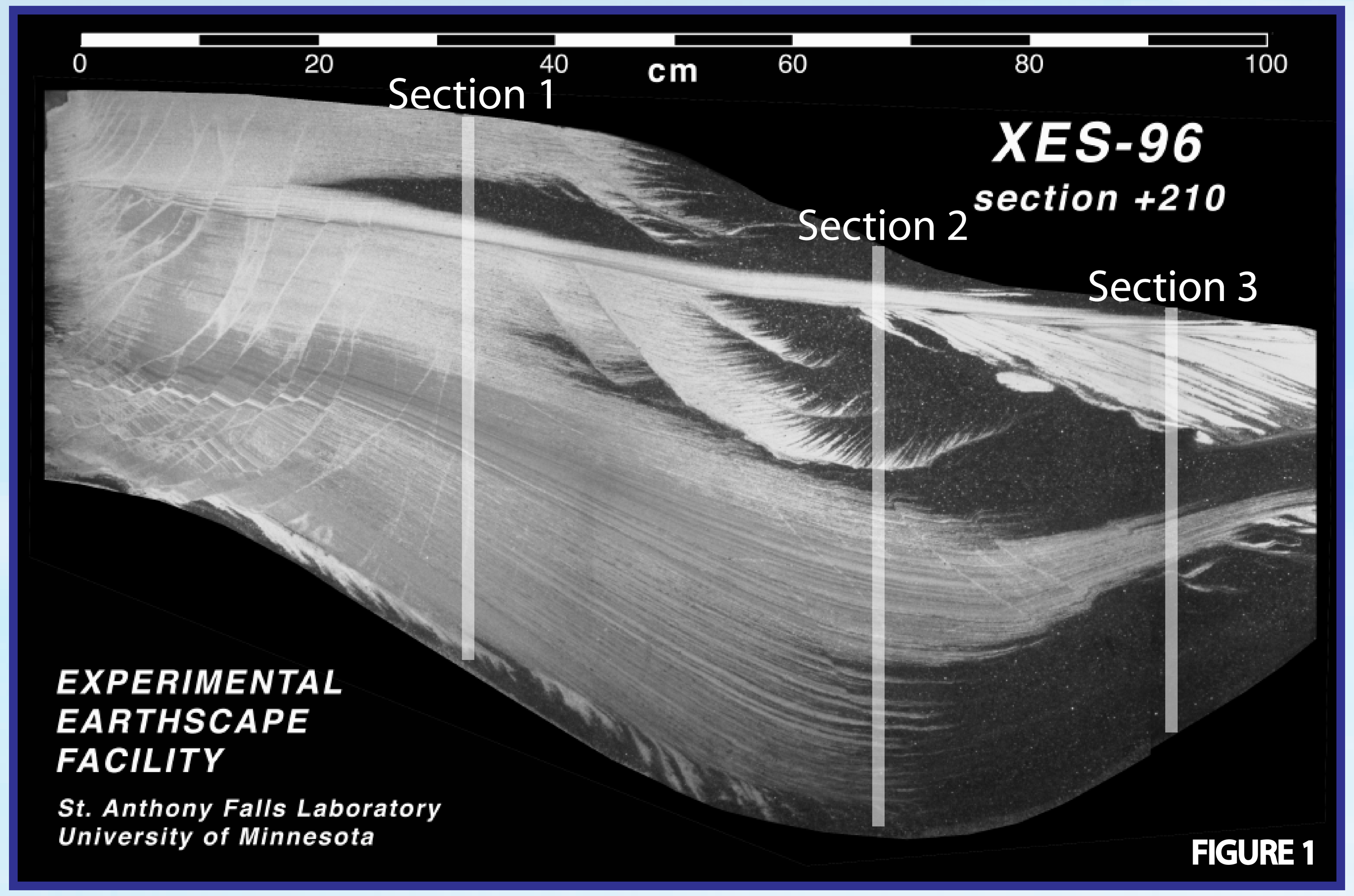
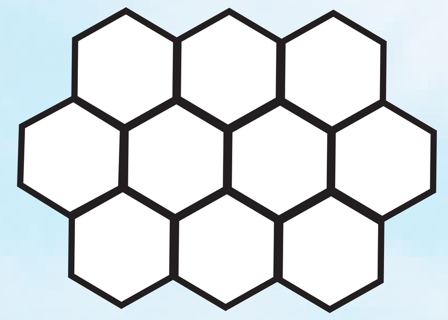


FIGURE 1

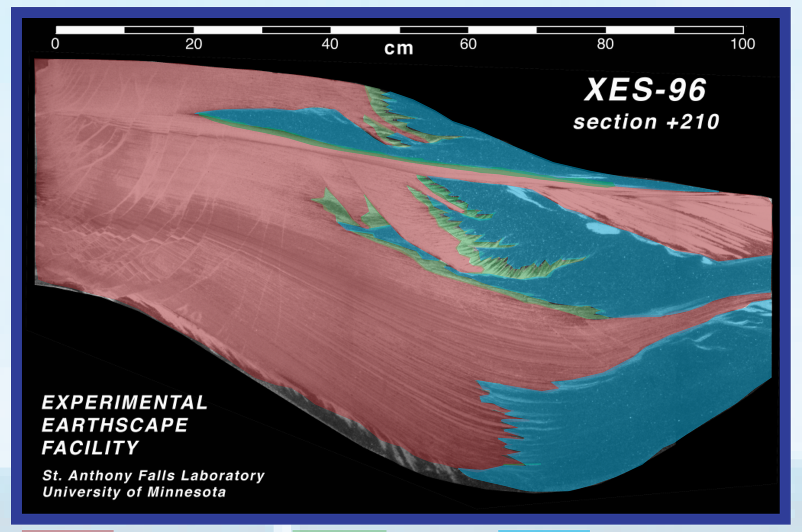
Jurassic Tank: Located at St. Anthony Falls Laboratory, JT is used for experiments that wish to test the effects of the three primary basin controls: subsidence, base level, and sediment supply. The base of the tank consists of hexagonal funnels filled with gravel and is covered with a rubber membrane. Subsidence is controlled by precise measurements that release gravel from the funnels. Base level is controlled by an ocean sucker and a weir. Sediment supply rates are controlled by an infeed system.

Example of the surface of an experimental delta basin similar to JT. The same material was used in this experiment (sand and less-dense coal to simulate real world sediment densities). The surface of the delta responsible for the deposition of figure 1 looked similar to this.

Hexagonal floor of Jurassic Tank



Lithofacies



Subaerial Beach Subaqueous

Depositional Environments

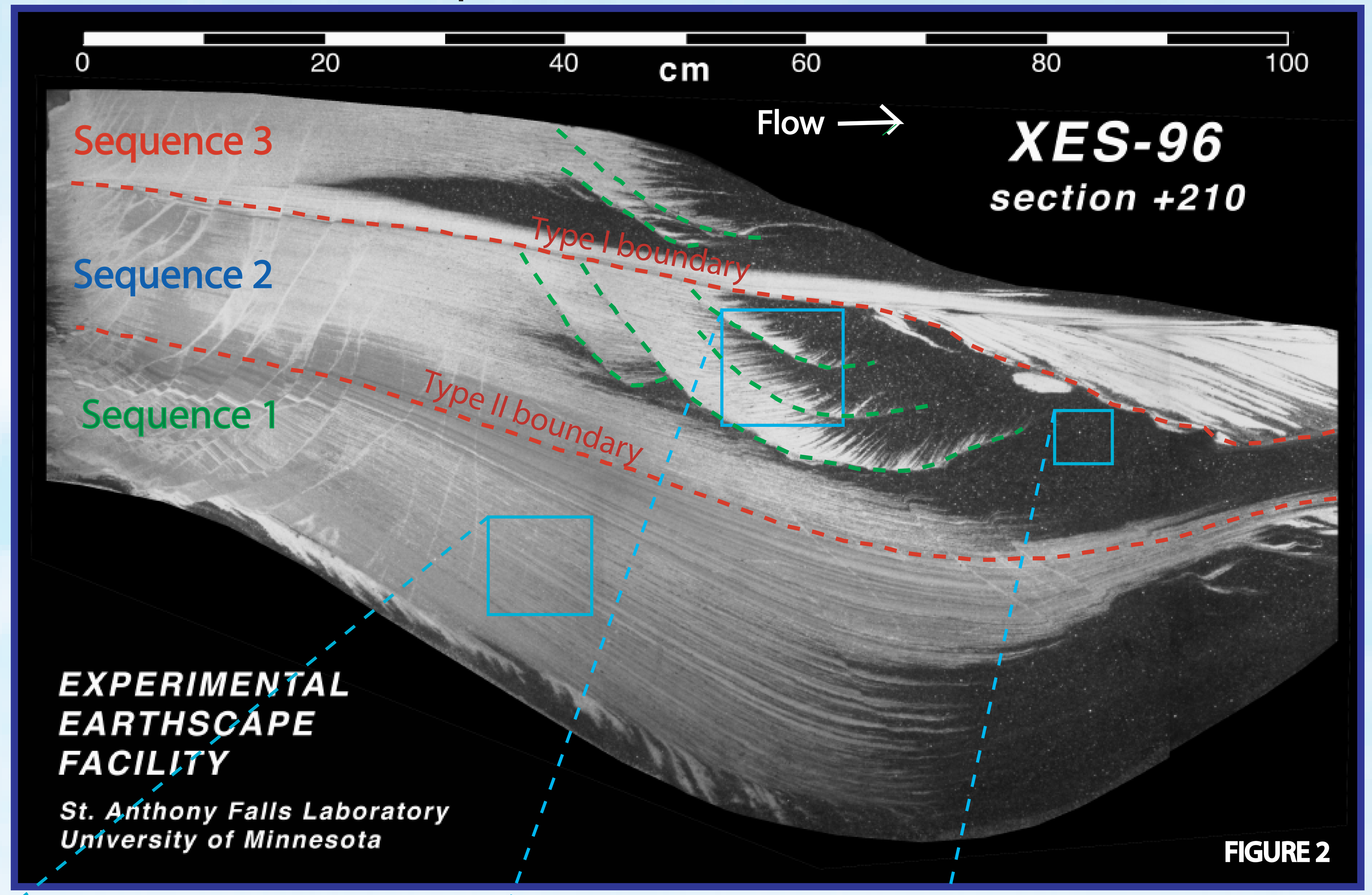
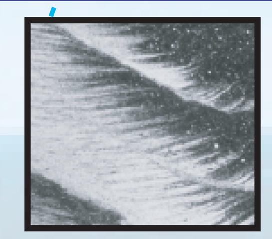
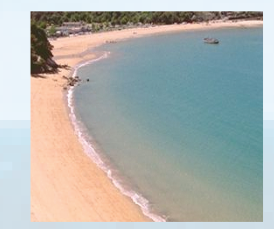
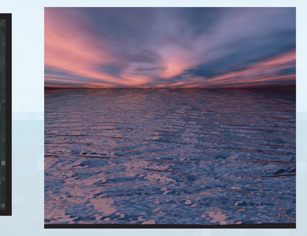


FIGURE 2


Subaerial environment

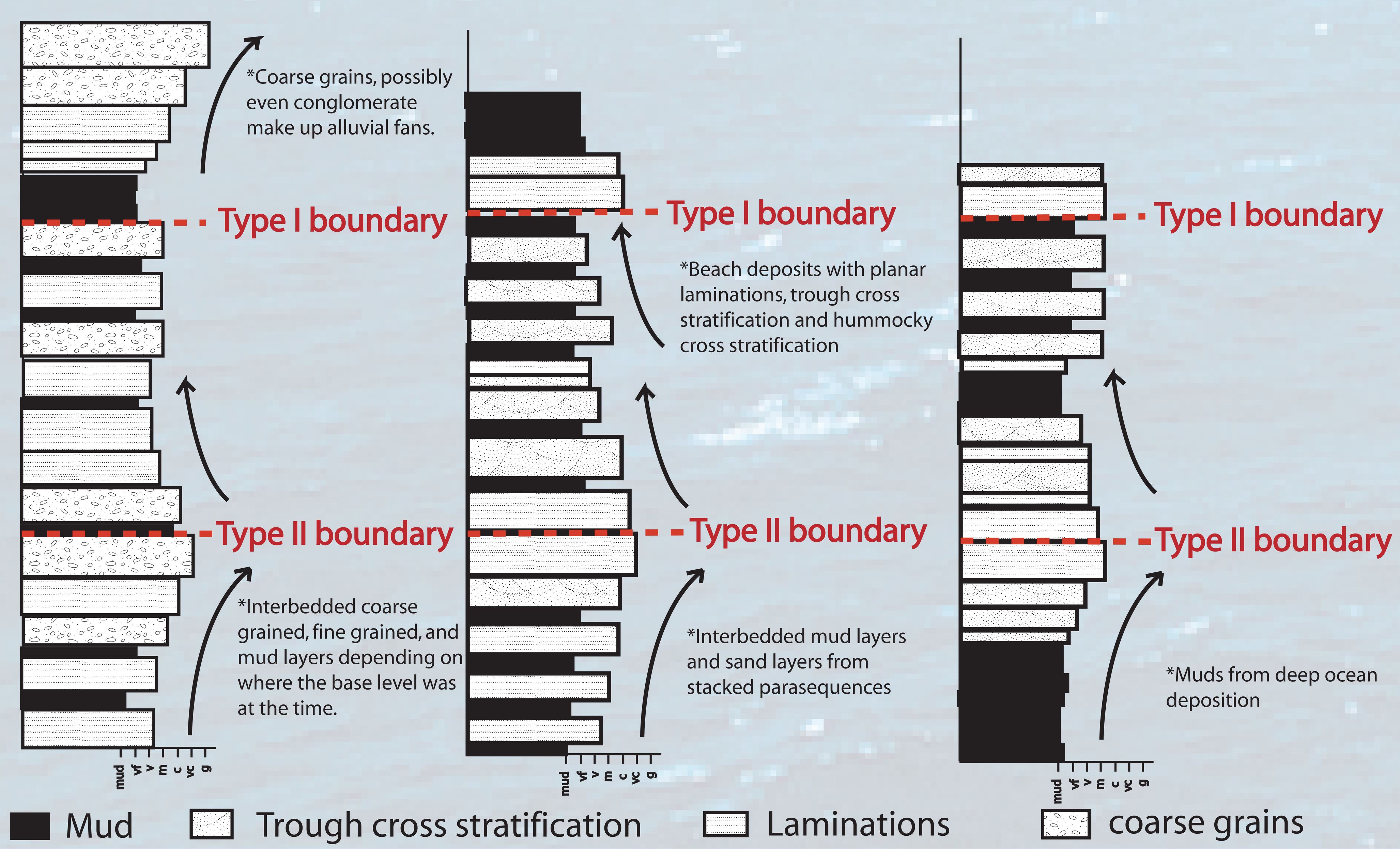



Beach/shelf environment

Deeper subaqueous environment

Stratigraphic Sections



*The stratigraphic sections above show general trends within the basin. Type I and Type II boundaries can be correlated between each section. Arrows indicate general-coarsening upward or fining-upward trends. The fining-upward trend between the Type I and Type II boundaries in section 2 repeats many times. Each smaller trend is bounded by the listric normal faults shown in figure 2. Small erosional contacts separate many of the parasequences. The Type I boundary is characterized by a major erosional contact.

* Base level was the only basin architecture variable that was changed throughout this experiment.

Sequence 1: Sedimentation rates and subsidence rates were kept constant and the base level gradually decreased. Many parasequences are found within the overall sequence. The drop in base level caused the beach lithofacies to prograde towards the basin. The sequence boundary occurs when base level reached its low stand and formed a Type II sequence boundary. There is no major erosional event at the end of this sequence. The faults within the stratigraphy are secondary and result from the continuous subduction.

Sequence 2: Above the Type II sequence boundary, base level began to rise. This causes the beach lithofacies to transgress. The beach aggraded after transgression. Notice the varying angles of the beach lithofacies. This lithofacies is bounded by listric faults. As faulting down dropped the beach deposits, accommodation space increased allowing for further deposition. Downstream beach deposits came later in the sequence of events. Base level was slightly dropping allowing the beach to move farther downstream. The top of this sequence is bounded by a Type I sequence boundary.

Sequence 3: This sequence begins just above the Type I sequence boundary. This boundary shows where a major erosional event took place. Base level dropped below the shelf-slope break, causing this major erosional event. The coarser sediment located on the right side just above this boundary prograded as a result of dropping base level and was eroded from alluvial deposits from sequence 2. As base level rose, the beach lithofacies transgressed. This shows that subsidence was not the changing factor because for the flooding surface to occur, base level must rise. Uplift causes base level to rise, but simulating base level rise is not possible in Jurassic Tank. After the beach lithofacies completely transgressed, base level dropped, causing progradation of the delta. Just as in sequence 2, listric faulting separated beach lithofacies. The faulting occurred because sediment was deposited on finer grained, more compacted sediment, allowing for brittle deformation to occur.

Subaerial environment: This environment is located in each of the sequences. Avulsing channels erode and transport sediment to the beach and subaqueous environment. Erosion is the dominant process in this area. The subaerial component of fan deltas are called alluvial fans. These areas are exposed as base level decreases and deposited when base level is higher.

Beach/shelf environment: Deposition of coarser sediment is located here. Homo- and hyper-pycnal flows are responsible for deposition. Erosion is dominated by waves. Sedimentary features include both planar and low-angle laminations, trough cross stratification, and hummocky cross stratification. Bioturbation most likely occurs in this zone (skolithos ichnofacies).

Deeper subaqueous environment: Located near the outer shelf and the continental slope. Sediment is transported to this region by larger currents, turbidity flows, and slowly settles to the ocean floor. Fine muds with the occasional sand make it out to this region. Submarine fans, the underwater equivalent to the alluvial fan, are located at the mouths of submarine canyons. Most sediment is transported through these canyons.

References: Boggs Jr., Sam. 2001. Principles of Sedimentology and Stratigraphy. 3rd Edition.