Abstract:

The Upper Cretaceous, Campanian Chimney Rock Tongue is exposed in a dip-oriented, ca 15 km long outcrop belt in the Flaming Gorge area, Utah/Wyoming. The Chimney Rock Tongue has three distinct stratigraphic intervals: (1) wave-dominated delta deposits, (2) mixed-energy estuary deposits as an incised valley fill, and (3) tide-dominated estuary deposits.

The wave-dominated delta succession, ca 95 m thick, consists of eastward-prograding clinoforms. The clinoforms are dominated by wave deposits, but in places sediment-gravity flow and mass transport deposits, as well as fluvially-dominated mouth-bar deposits occur. Tops of the individual clinoforms are locally cut by distributary channels. The distributary channels are filled with fluvial and tide-influenced fluvial deposits. Tops of the youngest deltaic clinoforms are severely eroded by a subaerial unconformity that can be walked-out across the whole outcrop belt for 15.5 km. The subaerial unconformity cuts down at least 30 m across the outcrop belt. The unconformity is locally marked by roots (locally calcite filled), calcite concretions, limonite precipitation, and motilling.

An estuarine succession onlaps the unconformity in the landward and lateral directions, indicating that the estuary was confined in an incised valley. The estuarine succession, ca 30 m thick, consists of tide-influenced fluvial channels, bayhead deltas, inner-estuarine tidal bars, central basin mudstones, flood-tidal deltas, estuary-mouth barrier deposits, and tidal inlet deposits. The inner-estuarine tidal bars consist of fluvially derived, but tidally-rectified sands with ubiquitous single and double mudstone drapes. The wave-generated estuary-mouth barrier indicates wave dominance in the estuary mouth. This distribution of tide and wave deposits indicates that the estuarine succession is of mixed-energy type. The mixed-energy estuary succession is regressive, except for the very top of the succession that is regressive within the inner-estuarine setting. This latter suggests in situ filling of the incised valley.

The third and uppermost stratigraphic unit, ca 60 m thick, consists of three transgressive-regressive units in an overall aggradational setting. The transgressive-regressive units consist of tide-influenced fluvial deposits, tidal flat and marsh deposits in inner-estuarine reaches, and upper-flow-regime tidal flat and tidal sand-bar deposits in outer-estuarine reaches. The transgressive-regressive units, 16-26 m thick, are based by tidal ravinement surfaces, and indicate flooding and consequent in situ filling of the river mouths.

The transition from a wave-dominated delta to a mixed-energy estuary and then to a tide-dominated estuary suggests an apparent process-regime change from wave-dominance to tide dominance triggered by a relative sea-level rise. The tidal influence was, however also present during the deposition of the wave-dominated delta succession, as seen by the tide-influenced fluvial infill of the distributary channels. Thus, the tidal influence did not switch off when the depositional system changed from deltaic to estuarine. Nor did the wave influence switch off, as the estuary mouth was wave-dominated in the mixed-energy estuary. Instead, the effect of tides was locally increased. Due to valley incision and later drowning, as the inner areas of the valley were protected from waves. The tidal range, however, increased, as the mixed-energy estuary was replaced by a tide-dominated estuarine system, commonly assigned to macrotidal settings. This process-regime change occurs after the incised valley was filled, and the tide-dominated estuaries occupied river mouths in a high subsidence regime.

Key lessons:
1. The Chimney Rock Tongue is a regressive-transgressive shoreline complex, and contains a wave-dominated delta succession, overlain by a mixed-energy estuary complex, and a tide-dominated estuary complex.
2. The volume of tide-generated deposits increases across the regressive-transgressive transgressive facies change from wave-dominance to tide dominance is interpreted to reflect shoreline configuration change due to erosion and later flooding of an incised valley. Other than a process-regime change in the estuary, a mixed-energy estuary with a wave-dominated estuary mouth and tide-dominated inter-estuary occupied and filled the incised valley. After in situ filling of the incised valley, a process-regime change occurred as the tidal range increased to macrotidal. The river mouth was occupied by tide-dominated estuary and experienced severe tidal influence.
3. The aggradational, 60 m thick tide-dominated estuarine succession accumulated at high rates of flexural and dynamic subsidence.