

# Proximal to Distal Changes of Thin Lacustrine Deltas in the Ancient and Modern

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## Abstract

The Green River Formation in Uinta Basin, Utah holds the largest in-place lacustrine oil-shale in the world. Though thermally immature throughout most of the basin, refining current understanding of possible migration pathways and potential reservoir geometries endemic to large, lacustrine environments—from both modern and ancient systems—is important for continued exploration in Uinta Basin and other ancient lacustrine systems. Lacustrine deltas call for careful interpretation as they are distinct from their marine counterparts. Lacustrine delta-fronts are dominated by shallow, low-relief sandy channels which drive sheet-sand deposition basin-ward. Furthermore, lake base level can change meters over short time scales (100s of years) leading to high-frequency progradational and retrogradational sequences. In the Eocene Middle Green River Fm. in Uinta Basin, we have observed proximal-to-distal changes in channel architecture of lacustrine units. In the most proximal region of the Middle Green River Fm., located in the Sunnyside Quarry, Utah, the Sunnyside Delta member is composed of thick (10s of meters) channels which are sharp based, highly amalgamated, planar and trough cross-bedded sandstone units with large (5-10m) high-angle lateral accretion surfaces. Following the Sunnyside Delta Member downdip relative to main paleo-flow direction (NW) into the Cottonwood Canyon the channels increase in number and change geometries, becoming smaller in size (2-5m) with higher aspect-ratios (width to depth). The channels still have cross-stratified beds but alternate with structureless and rippled beds. 10-15 km further to the NW, in 9 Mile and Argyle canyons, the regressive units are dominated by tabular structureless beds with occasional meters thick channels. The most distal packages of the Middle Green River Fm. are along Highway 191, about 40 km from

thick, proximal channels. These distal packages are mainly lacustrine shales with thinly bedded, occasionally channelized, laterally extensive sandstone beds. The channelized nature of lacustrine deltas is linked to high river discharges, frequent channel bifurcations and avulsions, and lack of wave or tides in the basin. The modern Neales Delta in Lake Eyre, SE Australia formed into Australia's largest endorheic basin which has rapid base-level fluctuations (100s of years). We posit that the Neales Delta serves as a modern analog to the "Sunnyside Delta" in the Middle Green River Fm. The Neales distributary channel belt has a sinuous planform with a low aspect-ratio and high relief (bankfull depth of ~4m). This main distributary channel-set quickly radiates into tens of distributive channels that lose relief (~2m). The distal reaches of the Neales Delta (delta front) are composed of numerous interconnected unconfined channels which produce < 1m relief, forming lake delta-front sand sheets which infill the shallow Lake Eyre.