Sedimentation in an Ephemeral Fluvial-Lacustrine Inland Delta - Umbum Creek, Lake Eyre, Central Australia

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Modern depositional analogues that quantify the distribution of facies types create essential datasets that aid in the development of reservoir models for comparable ancient subsurface deposits. The fluvial-lacustrine Umbum Creek delta provides a quantitative dataset on the spatial and vertical facies distribution with an emphasis on the distribution of flow units and barriers, within ephemeral fluvial systems, potentially useful for reservoirs in the Caspian Sea, North Sea and Algeria.

Located in an extreme arid zone, Umbum Creek flows into the western side of Lake Eyre, central Australia. With a catchment area providing infrequent flooding events as the dominant fluvial transport mechanism, high flow regime bedding structures predominate within the meandering channel and anastomosing chute channel/splay bar complexes, which migrate downstream. Surface mapping of the floodplain, meandering channels, anastomosing chute channel/splay bar complexes, delta mouth bars (middle ground bars), and the delta front provide the dataset for a two-dimensional facies model of the delta system. The third dimension is explored via push core and auger holes that will be dated by OSL (optically stimulated luminescence) and TL (thermoluminescence) dating techniques to unravel the stratigraphic relationships between individual packages. The dataset will then be used to produce aspect ratios and meaningful semi-variograms for industry reservoir modeling.

Low-level aerial photography, field observations, surface mapping and trenching indicate that upstream of the first bifurcation, vegetation appears to be the major controlling factor on the location of in-channel bars, with large trees anchoring the head of each large-scale elongate bar (a few meters high, tens of meters wide and 100s of meters long), and creating a shadow effect downstream allowing deposition of sandy and silty sediments. Within splay bar complexes, smaller scale shadow bars (decimeters tall, a few meters wide and several meters long) also occur from similar processes, with shrubs anchoring the head of each bar and interfering climbing ripples occurring in the shadow zone. Within the channels and chute channel/splay complexes grain-size varies from large coarse gravel to mud, but most are coarse-medium sand and generally moderately sorted. Vertical grain size variations reflect the fluctuating magnitude of previous flood events.

The delta front itself is free of vegetation and comprises coarse-fine sand and silt. The sediments are deposited in sheets that appear to initially gently dip uphill as part of an amalgamated mouth bar complex. Trenches excavated on the delta front show packages of coarsening-upward (bars) and fining-upward (channels) profiles 10s of cm thick, with each profile the result of individual flood events or pulses during sustained floods. The delta front is well sorted, but there are commonly poorly sorted surficial gravel lags that appear to have been dumped by debris flow processes and subsequently winnowed by eolian processes. Stratigraphically, the first two meters of the delta front comprise alternating sand and clay units. The uppermost sandy unit overlies an extensive brown clay unit (prodelta), which overlies an older sandy unit resting on a blue clay unit (lacustrine maximum flooding surface).

Ongoing investigations of the delta and channel systems aim to provide an improved understanding of sequence stratigraphic relationships between sediments, switching of delta lobes, and quantitative studies of the depositional elements.