WHERE EPHEMERAL FLUVIAL SYSTEMS TERMINATE ONTO A PLAYA: THE TERMINAL SPLAY COMPLEXES OF LAKE EYRE, AUSTRALIA. EARTH ANALOGUES FOR MARTIAN DELTAS?

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Introduction: Putative deltaic systems on Mars are a primary target for future robotic missions to Mars as they provide excellent potential sedimentary environments for signatures of life. However, interpreting sediment depositional bodies as deltas that developed at the margins of lacustrine systems is not straightforward. Prior to selecting future landing sites, we require detailed information on potential Earth analogues of martian deltas. Here, we analyze the morphology and sedimentology of sediment bodies formed at the terminations of ephemeral river systems and consider their potential as martian sedimentary analogues.

Lake Eyre setting: Lake Eyre is the world's fifth largest playa and depocentre for a 1.14 million km^2 dryland continental interior basin. Around the playa margin, ephemeral fluvial systems terminate in fan-shaped sedimentary deposits, called 'Terminal Splay Complexes' (TSCs). The northeastern rivers are mud-dominated, characterized by extensive catchments and receive the highest precipitation from tropical cyclones in far-northern Australia, whereas rivers in the western part are sand-dominated, have smaller catchments and comparatively little precipitation. These TSCs are used as a modern analogue for a number of ancient dryland fluvial-lacustrine sandstone successions and hydrocarbon reservoirs. The sedimentology of five Terminal Splay Complexes have been described, but these have only recently been compared in a way which enables some key conclusions to be drawn regarding their characteristics. Here, we present these conclusions alongside a new summary model for the sedimentology of TSCs.

Terminal Splay Complex systems: It is proposed that the morphology and sedimentology of Terminal Splay Complexes can be categorized into two groups: Confined and Unconfined. Confined TSCs contain well-developed channels in the proximal region, and amalgamated unconfined splay lobes in the distal reaches. The sedimentology of Unconfined TSCs is similar to that found in the distal reaches of Confined TSCs. Unconfined TSCs are a complex of amalgamated splay lobes, with flow at low discharges being generally concentrated between bars and splay lobes; they do not contain channels with well-defined banks or in-channel bars, as occur in the proximal-medial reaches of the Confined TSCs. The sizes of the studied Lake Eyre TSCs range from 80 km^2 to 0.1 km^2, with grain sizes ranging from clay to gravel. Confined and Unconfined TSCs cannot be grouped according to TSC area, catchment area or grain size. TSC area is not related to catchment area, although it appears that TSC width scales to the width of the fluvial channel at the TSC apex. This is unsurprising considering the spatial and temporal variability and discontinuity typical of ephemeral rivers, and could provide a useful predictive tool for geological modeling. Using these observations, the classification of TSCs within the context of splays and alluvial fans will be explored.

Relationship to fluvial discharge: In addition to an understanding of TSC geomorphology, understanding temporal variability in dryland systems is critical for usefully applying modern analogues to the geological record. Temporal variations on a short time-scale (tens to hundreds of years) include fluvial discharge and lake filling events during dry phases. These can result in wave and wind-tide reworking of sediments, producing characteristic wave and tidal sedimentary structures amongst an ephemeral fluvially-dominated deposit. Due to the ephemeral nature of sedimentation in these systems and low slopes, discrete lobes will be active during small discharge events which may have differing sediment characteristics to each other, and the TSC will accrete laterally as it progrades. Over longer time-periods, prolonged lake-level highstands during wet phases may result in the deposition of lacustrine muds over the TSC, and the sub-aqueous deposition of fluvially-sourced sediments may produce shallow lacustrine delta facies. These temporal variations in sedimentary processes have major implications for understanding the internal architecture characteristics of TSCs.

Mars analogues: We compare the Lake Eyre Terminal Splay Complexes to putative crater-lake deltas on Mars. We consider first the large-scale planform morphostratigraphy as observed in partially exhumed deposits. We then analyze HiRISE images draped on HiRISE DTMS to analyze stratigraphic elements and compare these to predicted stratigraphy in the TSCs in Lake Eyre.