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Extent and timing of hydrologic activity in the Gale Crater region of Mars

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Deltaic deposits are important for constraining the hydrologic history of Mars as they occur globally and require sustained liquid surface water to form. Of particular interest are deltas along the martian crustal dichotomy as these were previously interpreted to have formed in a global ocean. A high concentration of these previously mapped deltas occurs in and near Gale Crater, where recent orbital and rover data has shown that multiple generations of lakes likely existed. Here we use updated visual and topographic data to further probe whether deltas in the Gale crater region (∼1000 km east and west of Gale) formed contemporaneously to deltas within Gale and to what extent they record past water bodies.

We investigated 24 candidate deltaic landforms, twelve of which have been characterized in previous studies. Deltas were differentiated from other depositional features, such as alluvial fans and landslide deposits, based on their arcuate form, low-gradient tops, and steeply-dipping fronts. They also tended to originate from short, stubby, v-shaped valleys with amphitheater-shaped terminations. Delta front elevations were found to vary by ∼2620 m, ranging from -3980 m to -1360 m. The deltaic deposits were rarely isolated, rather they typically were clustered in groups of 2 to 5 deltas. In each of these groups the deltas generally had similar front elevations to one another; within ∼30 to 200 m range. Using delta front elevations as water level proxies, we found evidence for several distinct enclosed basins into which these features formed. We also performed crater counting on these features, and our probability-based model suggests these features are most likely late-Noachian in age. While several of these deltas did not correspond to an enclosed basin, these data suggest that most dichotomy deltas in the Gale region record large lakes, not a global ocean, which has significant implications for the timing and size of Mars' past global hydrosphere.