FACIES ARCHITECTURE OF THE WESTERN JEZERO DELTA: IMPLICATIONS FOR LAKE HISTORY. Michael M. Tice, Abigail C. Allwood, Joel A. Hurowitz, 1Department of Geology & Geophysics, Texas A&M University, College Station, Texas, USA, mtice@geos.tamu.edu, 2Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA, abigail.c.allwood@jpl.nasa.gov, 3Department of Geoscience, Stonybrook University, Stony Brook, New York, USA, joel.hurowitz@stonybrook.edu.

Introduction: Jezero Crater, the Mars 2020 landing site, contains abundant evidence that it was filled by a lake during the Late Noachian [1], including several inlet channels, an outlet channel, and a small (∼10 km wide) wedge of sedimentary rock on the western margin of the crater (Fig. 1A) interpreted as deltaic deposits [2-4]. Strata exposed on the eastern cliff margin of these deposits dip increasingly to the east with elevation above the crater floor, consistent with Gilbert-type delta front and prodelta geometries [2]. In addition, sedimentary facies exposed on the top of the wedge have been interpreted as fluvial to coastal deposits formed in the delta top [3, 4]. We reevaluate these facies interpretations to show that much of the western Jezero delta formed under deeper-water conditions than previously thought. We suggest that the delta records both lake highstand conditions (∼100 m water depth) and the final emptying of the lake.

Methods: We re-examined deposits in the western Jezero delta using HiRISE mosaics and digital terrain models produced as part of the Mars 2020 mapping effort [5]. We defined sedimentological facies from features visible at 1:10000 scale and constructed geologic cross sections by estimating the elevations of contacts between facies along the eastern cliff, in a 1-km-diameter crater on the delta, and in a late-stage incised valley cutting the delta from the western inlet.

Facies Descriptions and Interpretations: Four informal facies were identified in association with the western delta (Fig. 1): from stratigraphic base to top they are the basin facies, the slope toe facies, the slope facies, and the fluvial facies. We do not interpret relationships with other crater margin/floor units here.

Basin facies. This facies comprises light-toned layers with gently anastomosing dark-toned layers. When overlain by slope toe facies, the basin facies is pervasively soft-sediment deformed, faulted, injected upwards in dikes, or all three (Fig. 1H), indicating that it was not lithified during deposition of deltaic sediments. We interpret the basin facies as (hemi)pelagic sediment deposited contemporaneously with the delta.

Slope toe facies. This facies comprises packages of predominantly dark-toned rock with discontinuous lenses of light-toned rock; packages are divided by thin, gently dipping light-toned layers (Fig. 1G). Contacts with the overlying slope facies are gradational. The presence of isolated light-toned material in otherwise continuous bedded rocks suggests delivery of some sediment along preferential transport pathways or channels. We interpret the slope toe facies as distal slope deposits including unconfined turbidity current deposits and subaqueous channel lobes.

Slope facies. This facies comprises packages of interbedded, gently to moderately dipping dark- and light-toned layered rock; packages are divided by thin, gently dipping light-toned layers. Within packages, layers are smooth and commonly truncate against one another or against package-lining layers. In relatively flat horizontal or low-slope exposures, bedding relationships suggest the presence of channel-filling deposits and associated levees (Fig. 1C,D) as well as sigmoid accretionary structures with internal erosional or slump surfaces (Fig. 1E,F). We interpret this facies as proximal to medial slope deposits including subaqueous turbiditic channels and river mouth bars.

Fluvial facies. This facies comprises blocky, apparently massive deposits divided into gently curving channel bodies or channel complexes (Fig. 1B), some of which are traceable along almost the entire distance from the delta top to the modern delta edge cliff. These bodies migrate laterally and stack vertically, forming a ≤20-m-thick resistant unit that upholds cliffs throughout the western delta. Contacts with the slope facies are abrupt. The abrupt lower contact and the continuous nature of the channel bodies suggests that they formed by lateral migration or avulsion across a fluvial plain or fan, not as a result of environmental backstepping during lake transgression. Their resistance to erosion and blocky weathering pattern suggest that they may be relatively coarse-grained. We interpret this facies as fluvial, likely braided stream, deposits.

Deltaic Architecture and Depositional History: The slope facies is up to 50 m thick across the center of the delta but pinches up against the fluvial facies along the southwestern and northeastern margins. This is consistent with overall sediment transport from west to east and into the deepest part of the crater. Along the delta margins, the fluvial facies contacts the slope toe facies at the same elevation as the contact with the slope facies in the delta center. This relationship is inconsistent with significant fluvial downcutting, and implies that this contact is not a major erosional unconformity. Instead, the contact formed when the lake.
emptied more rapidly than sediment accumulated, and the fluvial facies was deposited when the lake was either much shallower or no longer present. From inlet to delta margins, the contact between the fluvial and slope facies dips basinward at ~3° (average from cross sections), consistent with our interpretation that the fluvial facies was deposited as braided streams running down the exposed delta slope. Later more intense fluvial activity cut down through all facies noted here and formed incised channel valleys in the upper delta.

River mouth bar deposits within the slope facies formed under water depths of ~10 m. Subaqueous channel deposits within this facies could have been deposited under a wide range of depths. However, slope facies rocks are exposed in incised channels near the crater rim up to 60 m in elevation above bar deposits (Fig. 1A), implying lake level variations of ~50 m.

**Conclusions:** The overall delta facies architecture suggests deposition during deltaic progradation and subsequent lake emptying. Structures within the slope facies provide further evidence of changes in lake depth. It is not clear whether these changes resulted from a major lake filling or smaller transgressive/regressive cycles. Conflicting facies interpretations between this model and previous models of the western Jezero delta [2-4] will be testable with surface observations of sedimentary structures and bedding relationships by the Mars 2020 rover. Interpretation of the slope facies as sublacustrine has important implications for biosignature search strategies.


**Figure 1.** Western Jezero delta facies. Structures in (B-H) are exposed at oblique angles to inferred bedding, exaggerating thicknesses. A) Western delta with outlines showing locations of (B-H). Star is location of highest identified slope facies. B) Fluvial facies. Note low sinuosity channel bodies traceable over kilometers. C) Slope facies: turbiditic channel and levee complex. D) Line drawing from (C) showing aggrading channel levees, onlapping channel fill, and flat unconfined flow deposits. E) Slope facies: river mouth bar. F) Line drawing from (E) showing sigmoid accretionary body with internal erosion surfaces. G) Slope toe facies: isolated light-toned lenses in dark-toned bedded rock interpreted as channel lobes. H) Basin facies: soft sediment deformation and sedimentary dikes at contact with slope toe facies.