Looking Towards Curiosity’s Canyon Path: a 4 km Sequence of Gully, Debris Deposits, and Fan/deltas which are Bordered by a Sloping Bedform-capped Plain and Crossed by Lake Shorelines.

W. E. Dietrich, M. C. Palucis, T. Parker, D. Rubin, M. A. de Pablo, D. Z. Oehler, and N. T. Bridges. 1Department of Earth and Planetary Science, University of California, Berkeley, CA, bill@eps.berkeley.edu and mpalucis@berkeley.edu, 2Jet Propulsion Laboratory, Pasadena, CA, timothy.j.parker@jpl.nasa.gov, 3U.S. Geological Survey, Santa Cruz, CA, geology.dr@gmail.com, 4Univers. de Alcalá, Spain miguelangel.depablo@uah.es, 5Johnson Space Center, Houston, TX, dorothy.z.oehler@nasa.gov, 6Appl. Physics Lab, Laurel, MD, nathan.bridges@jhuapl.edu.

Introduction: The Curiosity Rover is headed towards layered outcrops that appear to be rich in phyllosilicates and sulphates [1] with the expectation of an eventual ascent up Mt. Sharp. One likely will take the rover up a well-defined canyon. Inspection of CTX and HiRISE imagery and topography (5 m contour intervals) reveal a rich geomorphic sequence that may be encountered during the journey.

Observations: Figure 1 shows an oblique view of Gale, possible lake shorelines based on previously observed delta forms [2] and the location of the canyon. Figure 2 is a map of the geomorphic features. The sequence is about 4 km long and begins with a gully which has cut an ~1 km long slightly sinuous path along a ~11% slope. The incised gully transitions to a boulder-rich crudely stratified deposit (Figures 3-6) that forms a relatively narrow ridge (roughly 5% slope) that spreads downslope 650 m (green outline Figure 6). The transition from gully to deposit is roughly coincident with an inferred lake level (Figure 2). The deposit in turn transitions to a wider, steep-sided deposit, which appears to spread and radiate topographically into a fan/delta-like form (red shading Figure 6). The front of this deposit corresponds to an inferred paleolake level (Figure 2). The front descends about 120 m over about 500 m to a lower distinct delta form etched with what appears to be inverted distributary channels (orange shading Figure 6). The delta slope is 10%. The lowest deposit (yellow shading Figure 6) extends another 540 m and may preserve strata deposited by large-scale bedforms. This sequence is bordered by a nearly uniformly sloping plain (about 13% slope) distinctly etched with strata deposited by well-defined regularly spaced bedforms.

Interpretations: The slope, boulder abundance and crude stratification suggest that the deposits exiting the gully were transported by debris flows. There appears to be a stacked sequence of fan/delta deposits from oldest at the lowest elevation and progressively younger towards the gully. Two of the transitions correspond to previously mapped paleolake levels. If this is a backstepping sequence it provides key evidence of a history of rising lake levels that occupied Gale Crater.

References:

Figures:
Figure 1: Yellow, green and blue lines mark the elevations that match delta forms that would be associated with paleo-lakes [2]. Multicolored lines mark fan/delta features off of Mt. Sharp shown in Fig 2.

Figure 2: Geomorphic map of canyon. The yellow and green lines correspond to possible delta heights to the west shown in Fig 1.. The magenta line outlines a gully and the blue line might mark a former channel path. The green-red-orange-yellow outlines mark a succession of fan/deltas. The white line outlines a uniformly sloping surface capped by strata deposited by bedforms. Figures 1 and 2 are based on CTX data displayed by Google Earth.
Figure 3: A close-up of the feeder gully (HiRISE ESP_019988_1750_RED)

Figure 5: 5 m contour interval map of canyon and distal deposits (sequence of fan/deltas shown in Figure 6 highlighted in yellow here). North is towards top of map. Derived from HiRISE imagery.

Figure 4: HiRISE ESP_019988_1750_RED showing boulder deposit at the downstream end of the gully that leads to the first of the four possible fan/deltas.

Figure 6: Four distinct depositional phases that may record fan/delta deposits, color-coded from apparently oldest (yellow) to youngest (outlined in green). Sharp curving ridges may record distributary channels.