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) distinctively 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:
Figure 3: A close-up of the feeder gully (HiRISE ESP_019988_1750_RED)

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 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 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.