THE NATURE AND LOCATION OF THE UPPER GEDIZ VALLIS RIDGE BASAL CONTACT IN GALE CRATER, MARS. S. A. Wilson1, J. M. Davis2, W. E. Dietrich3, R. M. E. Williams4, L. M. Thompson5, C. M. Fedo6, A. B. Bryk1, J. A. Grant1, E. Kite1, A. N. Rudolph1. 1Center for Earth and Planetary Studies, Smithsonian National Air and Space Museum, 6th at Independence SW, Washington, DC, 20560, Washington, DC (wilsons@si.edu). 2Imperial College London, Berkeley, CA. 3Planetary Science Institute, Tucson, AZ. 4Univ. of New Brunswick, Fredericton NB E3B 5A3 Canada. 5Univ. of Tennessee, Knoxville, TN. 7The Univ. of Chicago, Chicago, IL. 8

Introduction: The Mars Science Laboratory Curiosity rover is exploring landforms within Gale, a 154 km diameter crater located near the global dichotomy boundary (5.3°S, 137.7°E). Since the crater formed in the Early Hesperian [e.g., 1-2], episodes of aqueous activity dissected the interior crater walls and formed valleys, many of which terminate in alluvial fans or deltas on the crater floor [e.g., 2-6]. Several canyons including Gediz Vallis incise into Gale’s central mound, Aeolis Mons (informally named Mt. Sharp) [e.g., 7-9].

Gediz Vallis (GV) is a valley on the north slope of Mt. Sharp that is ~800 m-wide, ~75 meters deep [8-9] and ~10 km long [7] (Fig. 1). A ~100 m-wide, ~2.1 km long ridge on the floor of GV is confined by channel banks in the upper reaches of the valley [8]. The upper GV ridge (uGVR) transitions to the lower GV ridge (IGVR) where it broadens out onto the Greenheugh pediment [9] (Fig. 1). The current erosional relief of the GVR varies from ~5 to ~70 m [8, 9]. The uGVR is consistent with an inverted fluvial and (or) debris flow system that fed the larger remnant fan deposit [e.g., 2, 8-12]. A section of the uGVR was recently interrogated by the Curiosity rover and the preliminary observations and interpretations are reported here.

Background and Motivation: Analysis of widely distributed sedimentary outcrops by Curiosity confirmed the presence of long-lived fluvial and lacustrine environments within Gale [13-16]. As Curiosity climbs along the Mt. Sharp Ascent Route (MSAR), the rover continues to acquire detailed views of the uGVR [17-18], providing a unique opportunity to study a deposit that may record evidence for late-stage fluvial or debris flow activity in Gale. The formation age of the GVR is possibly related to the timing of late fluvial activity in Gale, such as may have occurred on the upper Peace Vallis fan [e.g., 5], and may correlate with late activity on some fans elsewhere on Mars [19]. Therefore, the nature of the GV deposits and their relationship to other landforms should provide insight into the late-stage climate and habitability of the planet.

Curiosity is traversing along the east side of the uGVR and took a short detour near the base of the ridge to conduct contact science at “Region B” [20] (Fig. 1) to determine the location and nature of the stratigraphic contact between the uGVR and the surrounding bedrock using Mastcam and ChemCam RMI images. Questions we hope to address include: Does the uGVR preserve evidence of flow events, and if so, how many? What is the nature of the bedrock at the boundary? Broadly, we aim to assess what process(es) were involved in the formation and modification of the GV system, define the role of water (amount, duration, timing), and to constrain the climate and depositional environment.

Figure 1. HiRISE draped over topography showing the upper Gediz Vallis ridge (uGVR, black dashed line) on the floor of Gediz Vallis (GV). Channel banks (blue dotted lines) occur in the upper reaches of GV, and the broader valley incises into the northern slope of Mt. Sharp. Perspective view looking toward the south.

Observations and Inferences: Approaching the “Region B” contact science site. Based on tonal variations in HiRISE imagery and associated topography from HiRISE DTM, we predicted that the basal contact between the uGVR and the underlying Mt. Sharp bedrock group correlated to the topographic break in slope (white dashed line in Fig. 2a). Cross-sections perpendicular to the uGVR permit the possibility of either a flat depositional surface or, more likely, a V-shaped gully that focused down-slope transport.

At the “Region B” contact science site. Closer imagery at this topographic break in slope revealed
outcrops of the light-toned Mt. Sharp bedrock (yellow arrows in Fig. 2b) were exposed further up on the ridge but were noticeably absent in the upper sections (above the yellow dashed line in Fig. 2b). The lower portion of the ridge (between white and yellow lines, Fig. 2a) occurs at a break in slope and correlates to a section of shallow uGVR debris overlying Mt. Sharp bedrock. In general, the uGVR lacks evidence of veins or alteration, and appears unholithified. There is no apparent evidence of diagenesis or alteration into the underlying Mt. Sharp group bedrock near the “Region B” contact science site.

Possible in situ uGVR deposits. Poorly sorted rocks make up most of the uGVR and there is a dearth of obvious embedded or in situ material. Near the potential basal contact where the Mt. Sharp group rocks start to disappear (Fig. 2b), however, one unusual, crudely stratified outcrop appears distinct in Mastcam (Fig. 2c) and ChemCam RMI (Fig. 2d) images. This outcrop or block appears to be slightly finer grained and potentially gravel rich (Fig. 2d inset) and might correlate to in situ uGVR material. If so, this material would be above the basal contact.

Preliminary Conclusions and Future Work: The basal contact between the uGVR and the underlying Mt. Sharp bedrock is not obvious or easily identified at the “Region B” contact science site. The basal contact is higher on the ridge than where Curiosity visited (yellow lines indicate proposed contact in Figs. 2a, 2b) so the remnant uGVR deposit in the vicinity of “Region B” is not as thick as initially thought. Moreover, the uGVR deposits likely extended significantly beyond their present-day extent, both laterally and vertically [9].

The uGVR deposits are loosely consolidated and we do not observe veins crossing into the uGVR, evidence for diagenesis, or an alteration front into the underlying bedrock. These observations suggest that there has not been significant groundwater flux through the system or deep burial after the deposition of the uGVR.

The occurrence of an erosional channel structure that is likely buried at “Region B” may be exposed upslope in an area soon to be explored by Curiosity [18]. Curiosity will traverse up to and past this inflection point in the ridge where we can compare the internal stratigraphy along the uGVR.