The Mars Utah Rover Field Investigations (MURFI) [1] was a rover deployment and commanding field test intended to demonstrate the capacity of the UK Space Agency (UKSA) in collaboration with international partners to deploy a rover analogue mission and carry out a geologically focused traverse.

Here we report on the science conducted during the “in sim” parts of the mission. These observations build on the current working hypotheses (CWH) made during orbital geological assessment of the “landing ellipse” (described in [2]) and is guided by the strategic framework for the mission (described in [1]).

Preliminary Landing Site Assessment. We conducted a preliminary study in line with an “ExoMars-like” mission aim (e.g., 4, 5) using a set of “Mars-equivalent” data sets [2]. From the reconnaissance photo geological map (Figure 1) we developed the following CWH and identified science targets to be tested by the in-situ operations.

1. Resistant outcrops represent a lithified sediment unit of either aeolian, volcanoclastic or fluvial origin. Accessible for study in flat rock locations.
2. The layered scarps represent some geochemically variable strata of a material weaker than the resistant outcrops; possibly mudstones, clays or marls.
3. The anomalously bright regions (white/less Fe²⁺) are possibly an end member of the layered formation.

Traversability, Mapping and Localization (TML) In any rover mission it is imperative to know where the rover is both relative to science targets and potential hazards. To achieve this, we used the following localization and target naming protocols.

Localization. This was achieved on two scales. Firstly, for distal localization we used 360 PanCam [6] panoramas and PanCam single frame images to triangulate between pairs of orbital identifiable features that were vertically aligned in rover imagery. Secondly for proximal localization we used a combination of Pro3D [7] meshes created from PanCam mosaics and polar projected 360 PanCam mosaics to explore outcrops and to characterize the drive surface.

Naming convention. Features large enough to be identified from remote sensing analysis were given non-genetic names (e.g., “Big Mesa”) that persisted, where possible, through surface operations (Figure 2). Features and targets identified from rover data were named randomly after UK towns/villages with a population less than 10,000 residents (e.g., “Wimblington”).

In-mission Observations. During the 9 Sol mission and ~120 m traverse the following observations and working hypotheses were made.

1. The loose float rocks that are found on the plains are compositionally immature and poorly sorted, with rounded pebble fragments observed up to 2-3 cm in diameter. They are likely water-lain sediments from laterally unconfined modern flood event(s).
2. The resistant formation is observed capping ridges and as piles of rubble at the base of scarps (e.g.,
Big Mesa, Wimblington, and Cransford). The resistant formation appears to be made up of lithified, indurated sediment and has likely protected much of the layered formation beneath from erosion.

(3) Within the resistant formation (Figures 3 & 4), cross-stratified and planar bedding are visible, as well as recessive interbeds (Figure 3). This suggests that much of the resistant formation is a finely-beded sandstone, either fluvial or aeolian in origin, which cannot be determined without grain size measurements. Fluvial sandstones would, however, be consistent with the CWH from orbital mapping [2]. The recessive interbeds could be eroded mudstones or fine-grained sandstones.

Figure 3: HRC tile of Cransford, a finely-beded sandstone with recessive interbeds.

Figure 4: HRC mosaic of Big Mesa, made up of the resistant formation (top, coarse material) and the layered formation (colored material).

The drill site. After 8 days, in line with mission objectives [1], we identified a location to drill for the following reasons:

(1) If Painswick Patch/Skinningrove were mudstones, they would then be an ideal environment for biomarker preservation and concentrating organic material, making them good sites for drilling.

(2) Poddington (Figure 5), part of the Skinningrove area, was selected as the drill site for the rover for both scientific and accessibility reasons.

(3) Loose pebbles and detrital quartz grains (modern, surficial deposits and weathering products) were present on the material surrounding the drill site. Poddington was chosen as the drill site to avoid the larger pebbles, which could pose a hazard to the drill.

Figure 5: Poddington, part of Skinningrove