
Introduction. As a result of Spirit’s 1.3 km of traverse within the 30,000 m² area surrounding Home Plate, and its examination of multiple outcrops with its Athena Instruments [1], there is now sufficient information to prepare a field geologic map in modest detail of what is arguably representative of the lithologic complexity of many older highlands type terrains on Mars. This work also provides a working context of field relations for understanding the results of Spirit’s in situ studies at Home Plate. Four bedrock units and three disconformities are recognized across which there are significant changes in chemistry, alteration, lithology, and emplacement. High silica/sulfate have been detected mostly in the lowest stratigraphic unit exposed along the axis of breached antiform arrangement of bedding that surrounds Home Plate.

Mapping Method. As with terrestrial reconnaissance geologic mapping, extrapolations of sampled outcrops and contacts were mapped into unvisited surrounding areas through correlation of the bulk unit characteristics at multiple outcrops and the results of proximal remote sensing (Pancam, Navcam, Hazcam, mini-TES). The locations of contacts were supplemented with inspection of stereopairs based on HiRISE images acquired at differing emission angles (PSP_001513_1653, “left” and PSP_001777_1650, “right”) [2]. In some instances, no in situ information is yet available (e.g., south of Home Plate) and these are areas that will require testing by future traverses.

Geologic Units, Home Plate Region. The following geologic units are based on in situ (APXS, MB, MI) investigation and rover-based remote sensing of outcrops and mantles along Spirit’s traverse. Letters indicate corresponding unit on the geologic map (Fig. 1).

Surficial Deposits. Many of the surficial deposits have been in production and erosion over significant geologic time. In some respects they represent an unconformable unit subject to alteration, indurations, and stripping similar to bedrock units, in places responsible for preservation of bedrock outcrops. In order of increasingly recent activity these are:

Aeolian ripple bed forms and ridges (A2). Field Interpretation: Oriented accumulations of sand-sized materials transported through saltation. Landslide materials (L). Chutes and steams of debris on hill slopes characterized by lobate termini and, where exposed, finely laminated outcrops [10]. Field Interpretation: Coher-
Blocky Deposits of Mitcheltree Ridge (Bm). Scattered, locally concentrated, blocks and cobbles of resistant vesicular basalt along ridge tops, such as Mitcheltree Ridge, the top of Home Plate, and the base of local slopes. Includes blocks bearing chilled basal textures and planar zones of low vesicularity. Field Interpretation: Location of clusters represents low area where rubbized outcrops have concentrated. The diversity of megascopic textures is consistent with disintegration of formerly coherent dikes or sheets and accumulations of vesicular basaltic flows and agglomerates, exposing the top, middle, and bottoms of local basaltic sections.

Upper Home Plate (R). Cross-laminated basaltic sandstone 1 to 1.5 m thick occurring as a resistant cap on Home Plate and surrounding residual ridges and peaks. Field Interpretation: “Fossil” drifts deposited disconformably on unit B (below) originally collected in local lows now inverted by deflation. Lower Home Plate (B). Deposits 1 to 2 m thick constituting most of the slopes and open surfaces around Home Plate and beneath surrounding ridges, consisting of coarsely-bedded lapilli and ash-sized materials, locally alternating in sequence between the two size ranges. Possible bomb-sag structure in lower member on the northwest edge of Home Plate [7]. In Low Ridge, a prominent ledge separates upper (B2) and lower (B1) members. The basal contact with underlying unit D is identified with a lapilli tuff (“King George Island”) of particularly uniform-size range. Field Interpretation: Tuffs erupted from potentially local volcanic center(s).

Valley floor outcrops (D). Granular to “nodular” outcrops of relatively light-toned material in valleys floors and areas surrounding the base of Home Plate. From in situ and remote sensing analysis these tend to have high silica and/or sulfate contents, as well as nanophase iron oxides and hematite. Some areas bear mineralogical similarity to thermal sinter deposits [8]. Interpretation: An unknown protolith either altered in situ or deposited by warm, silica rich waters in a pre-existing material at a disconformable contact prior to or after burial of the disconformity. General confinement to the lowest unit suggest the former, but (a) emplacement by downward percolation of fluids and entrapment at a disconformable contact or, (b) lateral confinement of hydrothermal-type fluids to antiformal axes are also possible. Unknown (U). Materials and outcrops not examined. Terrain morphology differs in HiRISE images from the terrains examined during traversed. Field Interpretation: Possibly equivalent to unit D, but may be a lower unsampled unit.

Discussion. Geologic cross sections may be constructed based on the detailed contact locations; relief derived from rover stereo ranging, and reported attitudes [9] of exposed layered outcrops (Fig. 2). It is proposed that the valleys and plains adjacent to Home Plate expose the lowest geologic unit encountered during Spirit’s mission. Erosional breaching along the axis of the antiformal attitude of bedding around Home Plate, together with the relatively poor induration of unit D, accounts for the deep exposures and the prevalence of high silicate/sulfate drifted fines.

Units with characteristics similar to the upper unit of Home Plate appear pervasive in the lower elevations of the Columbia Hills where they are preserved by overlying basaltic units and are anomalously thick in small depressions, now topographically inverted. Exposure of the geologic section has been facilitated by up to 14 m of vertical ablation in surroundings. The thickening at Home Plate could be due to accumulation in an existing depression.

Figure 2. A. View south along the axis of the valley west of Home Plate (2PP742EFFANCYLW7P2361L777) showing the location of Spirit at “Troy”. The line represents the valley profile derived from Navcam ranging along an east-west azimuth. B. Proposed geologic section based on correlation of lithologies visited during the course of the regional traverse.

Conclusions. The high sulfate and high silica compositions around Home Plate are largely restricted to the visited exposures of the lowest observed unit (D). Many of these are loose granular sands [11], but more indurated outcrops occurred along the valley margins east of Home Plate. Three hypotheses are proposed: The loose sulfate/silica-rich sands (1) were transported into low areas and locally re-cemented relatively recently, (2) are exposures of a highly altered unconformity subsequently overlain by local pyroclastic deposits, and (3) are laterally discontinuous fumarolic zones cross-cutting the substrate and confined to the area immediately surrounding Home Plate (antiform axis?) and similar regional structures. Variations on these include possible downward percolation and concentration at the top of unit D, rather than pervasive subaerial alteration along the top of unit D. Although Home Plate bears many similarities with hydrothermal structures on Earth, a more thorough traverse of the regions lying south, including the anomalous crater and butte landforms (Goddard and von Braun) will be required to validate that analogy. Confirmation of the stratigraphy and the inferred map units in the areas lying along the way are also essential.