FLUID EXPULSION, HABITABILITY, AND THE SEARCH FOR LIFE ON MARS. Dorothy Z. Oehler[1] and Carlton C. Allen[1]. [1]NASA-Johnson Space Center, Houston, TX 77058. dorothy.z.oehler@nasa.gov, carlton.c.allen@nasa.gov.

Introduction: Habitability assessments are critical for identifying settings in which potential biosignatures could exist in quantities large enough to be detected by rovers. Habitability depends on 1) the potential for long-lived liquid water, 2) conditions affording protection from surface processes destructive to organic biomolecules, and 3) a source of renewing nutrients and energy. Of these criteria, the latter is often overlooked. Here we present an analysis of a large "ghost" crater in northern Chryse Planitia [1] that appears to have satisfied each of these requirements, with several processes providing potential sources of nutrient/energy renewal [1-2]. This analysis can serve as a model for identifying other localities that could provide similarly favorable settings in which to seek evidence of life on Mars.

Crater Description and Geologic Setting: A 120 km-diameter crater in northern Chryse Planitia (centered at 34°N, 37°W) is located in the path of major outflows from the Hesperian floods (Fig. 1). It is also located within an approximate zone of predicted, fine-grained, distal-facies sediments from the outflow floods (Fig. 2) [4]. This crater is filled with sediment and its rim is subdued as if partially eroded (Fig. 3). This type of crater has been termed a "ghost" or "stealth" crater.

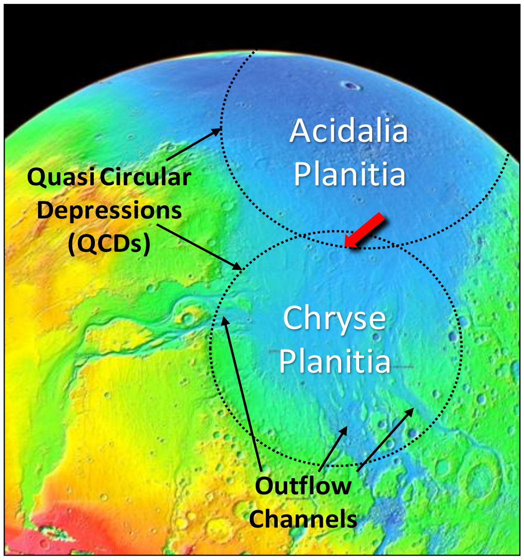

Fig. 1. Regional setting of ghost crater. MOLA basemap (courtesy of Google Mars). Quasi-Circular Depressions (QCDs) [3]. Arrow points to ghost crater.

The rim of the crater is defined by large (1.5-4 km-diameter), variably-shaped knobs with rounded bases (Fig. 4). The crater fill is characterized by polygonally fractured material that is associated with hundreds of smaller (0.4-0.9 km-diameter), high-albedo, circular mounds (Fig. 5).

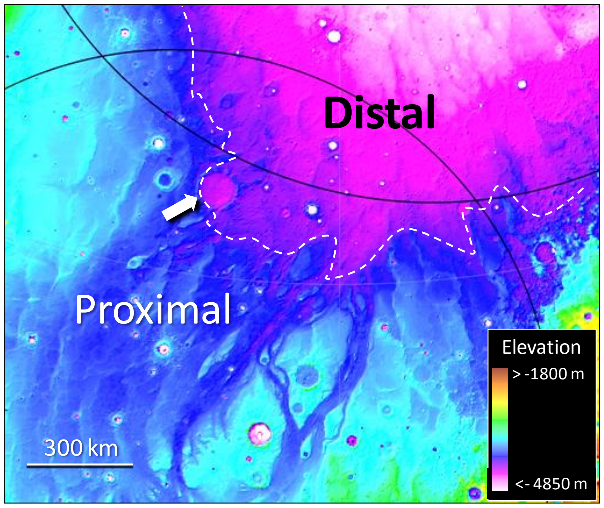

Fig. 2. Predicted facies. Stretched MOLA basemap. Black arcs are portions of Chryse & Acidalia QCDs [3]. White arrow points to ghost crater. Dashed line shows approximate boundary between proximal and distal facies.

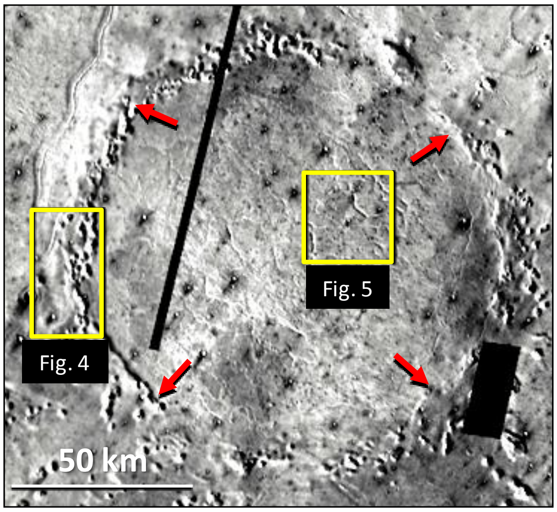

Fig. 3. Ghost Crater. THEMIS Daytime IR basemap. Rectangles show areas of Figs. 4 and 5. Arrows point to subdued rim.

Discussion: The large size of this crater and its location combine to provide especially favorable conditions for habitability. The crater diameter (> 100 km) is in the range suggested to result in significant impact-related hydrothermal circulation [5-7]. The rounded knobs at the crater rim would be consistent with that possibility. The crater sits in the lowlands, where upwelling of late Noachian/early Hesperian ground waters has been suggested from hydrologic

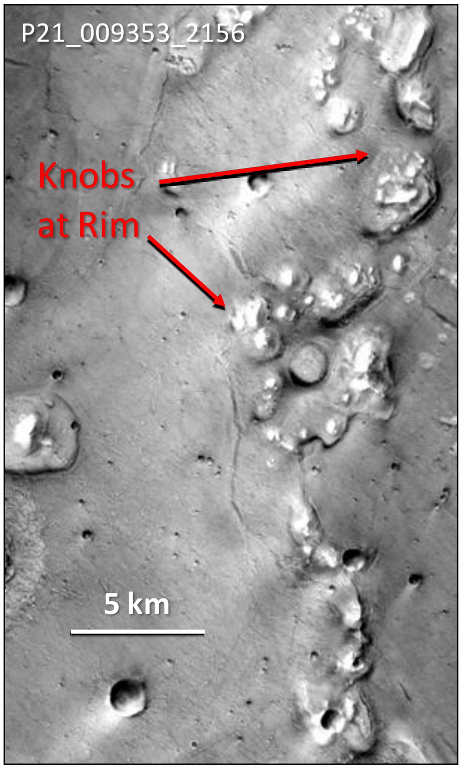

Fig. 4. Context Camera (CTX) image of the crater rim illustrating rounded knobs. Location shown on Fig. 3.

modeling [8]. Such upwelling could have contributed to fluid flow up the impact-related fractures, providing a renewing source of nutrients for potential life in the crater. The crater is also located in the path of the Hesperian floods (Fig. 1), and a crater lake could have filled from combined hydrothermal activity, upwelling, and fluvial runoff. It has been proposed that hydrothermal circulation in martian craters > 50 km in diameter would be sufficient to keep crater lakes from freezing for thousands of years [5]. A lake in this crater, therefore, might have been long-lived.

The location of the crater within the predicted distal facies of outflow sedimentation (Fig. 2) suggests that crater-filling sediments would be fine-grained. Those sediments could have entrapped organics, as potential organic materials would have been concentrated by sedimentary processes along with the fine-grained fraction of sediments. Such fine-grained sediments could have protected organic biomolecules from destruction by processes on the surface of Mars [4].

The polygonal fractures and smaller mounds within the crater fill are suggestive of significant fluid flow within the crater. On Earth, kilometer-scale polygonal faults are often associated with fluid injections in fine-grained, marine sediments [9]. In addition, the mounds within the crater fill have been compared to terrestrial mud volcanoes [10], which would also imply processes of fluidized injection to the surface. The potential for

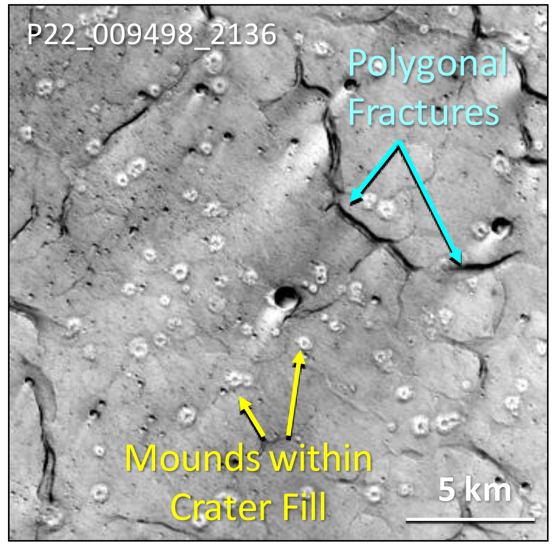

Fig. 5. CTX image of crater fill illustrating polygonal fractures and mounds. Location shown on Fig. 3.

fluid migration from the subsurface to surface - by both impact-related hydrothermal processes and fluid expulsion related to development of polygonal fractures and associated mounds – provides several opportunities for nutrient/energy renewal to potential life in the near surface or surface.

Conclusions: This analysis illustrates the importance of geologic context in evaluating habitability. Because of the size and geologic setting of this crater, fluid activity and possibly a crater lake could have been relatively long-lived, possibly existing from the time of initial impact to the time of polygon- and mound-formation. Nutrient and energy renewal could have been provided by fluid flow associated with development of the polygonal fractures and mounds as well as by upwelling and impact-related circulation. Burial of either *in-situ* or transported biosignatures in the predicted fine-grained fill could have aided preservation of organic biomarkers.

This is the type of location with enhanced habitability, where potential life might have thrived. It is also a location where organic biomarkers of that life could have been both concentrated and preserved.

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