CRATER FLOOR FRACTURES: PROBES INTO HABITABLE MARTIAN ENVIRONMENTS. R. J. Thomas[1] and B.M. Hynek[1,2], [1] LASP, University of Colorado, Boulder, CO 80309, USA, [2] Department of Geological Sciences, University of Colorado, 399 UCB, Boulder, CO 80309, USA. Rebecca.thomas@lasp.colorado.edu

Introduction: Over 400 Martian impact craters have floor materials that have been cross-cut by fractures, often long after crater formation [1]. These fractures form by a number of processes, but in a sizable subset, interaction of near-surface water or ice with a localized or regional magmatic intrusion is indicated [1,2,3]. The late formation and aqueous/volcanic genesis of the floor-fractures give them strong potential for exposing biosignatures dating from a range of periods in Mars' history. Specifically:

1. Where fractures form in the floor of a crater that underwent aqueous infilling in the Noachian (~4.1–3.7 Ga), they can create a deep cross-section through sediments within which early biosignatures may be preserved.
2. Where aqueous fluids welled up through floor-fractures in the Hesperian to Amazonian (<3.7 Ga), any material deposited at the surface may contain signatures of extant (at that time) life in deep aquifers. Potentially warmed by magmatic heat, these aquifers may represent the prime habitable environment during this more recent period when surface conditions were less clement.

We analyzed numerous floor-fractured craters in Margaritifer Terra, a region of Mars with a long history of aqueous activity, for evidence that biosignature exposure and preservation at floor-fractures is feasible, and for the presence of hydrated minerals indicative of past habitable environments.

Margaritifer Terra (34 to 14°W, -13 to 5°N) lies east of Valles Marineris and south of Mars' global crustal dichotomy. It consists of ancient (middle Noachian) highland terrains [4] that are cross-cut by extensive regions of chaos, where the surface is broken up into many slumped and angled blocks. The chaos is thought to have formed during a period of intense aqueous outflow activity in the Hesperian, possibly triggered by regional magmatic intrusion related to Tharsis volcanism [2,4,5].

We have investigated the morphology and stratigraphy of numerous floor-fractured craters here using mid-resolution CTX [6] and high-resolution HiRISE [7] images from the Mars Reconnaissance Orbiter (MRO) in order to assess whether fractures have exposed ancient Noachian sediments, and/or sourced outflow of later aqueous fluids. We have also used targeted hyperspectral data from MRO's CRISM spectrometer [8] and thermal inertia data from THEMIS on Mars Odyssey [9] to investigate the mineralogy and physical properties of units within each crater to determine whether these sediments are of a type consistent with formation under habitable conditions.

Results: We have identified several impact craters where fractures up to 1-km-deep cross-cut thick sedimentary infills, at some of which we have detected hydrated minerals (phyllosilicates) in the exposed units. Additionally, within several craters there is morphological evidence for erosion of older floor deposits by fluids sourced from the fractures, and for deposition at fracture margins (Fig. 1). Together, these observations indicate that floor-fractured craters here are excellent probes into ancient surface and Hesperian-aged deep habitable environments and should be considered candidate landing sites for future astrobiological missions to Mars.

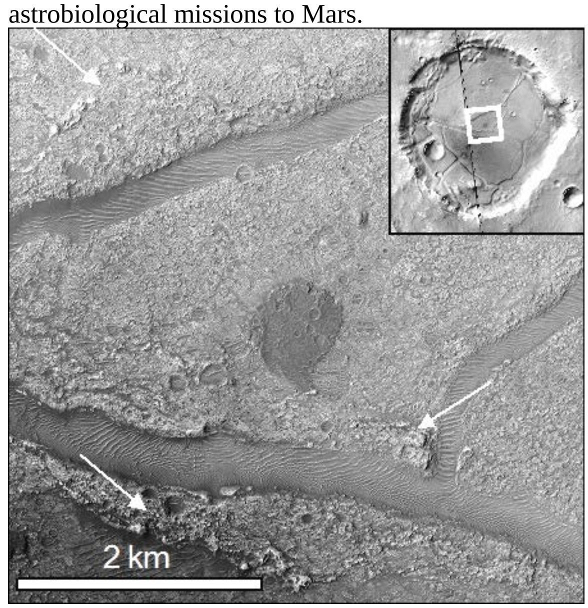

Fig 1. Raised units (white arrows) along fractures in the floor of an unnamed crater at 18.3° W, 10.6° S within which biosignatures could potentially be preserved.

References: [1] Bamberg, M. et al. (2014) *PSS 98*, 146-162. [2] Rodriguez, S. et al. (2005) *JGR: Planets*, 110: E06003. [3] Sato, H. et al. (2010) *Icarus, 157*, 362-372. [4] Tanaka et al. (2014) *SI Map 3292*. [5] Chapman, M. & Tanaka, K. (2002) *Icarus, 155*, 324-339. [6] Malin, M.C. et al. (2007) *JGR: Planets, 112*, E05S04. [7] McEwen, A.S. et al. (2007) *JGR: Planets, 112*, E05S02. [8] Murchie, S. et al. (2007). *JGR: Planets, 112*, E05S03. [9] Christensen, B. et al. (2004) *SSR, 110*, 85-130.