THE SOUTHWEST MELAS BASIN: IN SITU EXPLORATION OF A DELTAIC-LACUSTRINE SYSTEM AND CANDIDATE MARS 2020 LANDING SITE. J.M. Davis[1], R.M.E. Williams[2], C. Quantin[3], C.M.Weitz[2], L. Edgar[4], G. Dromart[3], and P.M. Grindrod[5]. [1]University College London, London, UK; joel.davis.09@ucl.ac.uk, [2]Planetary Science Institute, Tucson, AZ, USA, [3]Université de Lyon, France, [4]USGS, Astrogeology Science Center, Flagstaff, AZ, [5]Birkbeck, University of London, UK.

Introduction: The southwest Melas basin (SWM) is one of eight remaining landing sites for NASA's upcoming Mars 2020 Rover mission [1] undergoing detailed site characterization studies as part of the landing site evaluation process. The number of candidate landing sites will be decreased to four or less at the third landing site workshop scheduled for early February 2017.

The Mars 2020 Rover mission aims to characterize former habitable environments and to collect samples of potential astrobiological interest [2]. The proposed SWM landing site is located in a closed-basin along the southwestern Melas wallrock, and contains a 50 m section of potential lacustrine deposits and deep subaqueous fans, as well as hydrated silica deposits. Here, we state the science case and proposed targets of investigation for SWM as a deltaic-lacustrine landing site for the Mars 2020 Rover.

Site Background: No landed spacecraft has ever explored Mars' Valles Marineris canyon system and SWM is an exceptionally well-preserved record of equatorial aqueous processes. The basin is widely recognized to have hosted a range of fluvial and lacustrine environments in the early Hesperian over a period of at least several centuries [e.g., 3- 7].

Central to this interpretation is evidence for a valley-fed, ~ 30 x 10 km palaeolake that was present in the eastern half of the basin [3, 6]. The basin contains a >50 m section of laterally extensive layered deposits, interpreted as lacustrine, which include possible clinoform structures, and an array of sedimentary fans, interpreted as alluvial, deltaic, and deep subaqueous in origin [4-6]. Recent work suggests that there were at least two lake-filling highstands [6]. In addition, several hydrated silica deposits have also been found using CRISM data, which may be hydrothermal in origin [8].

2020 Science Criteria: The main objectives of the 2020 mission are (1) to characterize accessible, geologic sites that were formerly habitable, and (2) cache a series of samples of geologic and astrobiological interest [2]. Therefore, the optimal site must have (1) sedimentary deposits associated with long-lived, habitable environments; (2) shielding from irradiation; and (3) abundant sample sites to maximize sampling potential. The highest biosignature preservation potential (BPP) is associated with low-energy, long-lived, water rich environments [9]. SWM is unique among the candidate landing sites for the 2020 Mars Rover in meeting all of these criteria.

Regions of Interest: Two high-priority regions of interests (ROI, areas ~1 km^2) have been defined for the landing site within the 10-km diameter landing zone (employing terrain relative navigation, TRN; Figure 1). Because the ROIs are centrally located in the landing zone, traversability simulations performed by Mars 2020 engineers demonstrate that both ROIs can be reached in a traverse of a few kilometers from any landing spot, leaving ample margin within the baseline scenario of 12 km drive distance over 85 sols.

ROI #1 is within an erosional window into the basin deposits revealing some of the stratigraphically lowest rocks [4, 6]. Exposures show fan deposits interfingered with layered deposits [6]. These fans have attributes analogous to terrestrial submarine fans (finger-like distributaries with high junction angles) [4]. Layered beds that encircle the basin and shallowly slope toward the basin center are interpreted as lakebed deposits [3, 6, 11]. Rover science campaigns in ROI #1 would present an opportunity to sample material emplaced in deep water conditions that has only been recently exhumed [10]. The depositional setting and erosion history are two factors that enhance the BPP of rocks in ROI #1.

ROI #2 has enigmatic hydrated silica present in isolated, light-toned exposures, of which there are several throughout the basin. Stratigraphic relationships indicate this opal post-dates the deposition and erosion of the layered deposits, and therefore documents late-stage aqueous activity within the basin, perhaps as a primary precipitate from solution, a diagenetic alteration product, or a replacement mineral [6, 8]. In situ investigation would provide important sedimentary context and allow different formation hypotheses to be tested.

In addition to the two ROIs, there is a diversity of rocks to explore in SWM. Additional targets and science objectives include (1) shallow water deltaic deposits; (2) basaltic Valles Marineris wall rock transported into the basin via landslides and debris flows (i.e., potentially dateable rock, [6]); (3) airfall deposit that may include volcanic ash [8]; (4) craters with exposed stratigraphy; (5) insight into the wider sedimentary tectonic processes within Valles Marineris; (6) sulfate deposits (outside ellipse; [5]); and (7) during the extended mission(s), the possibility of exploring the drainage basin by venturing upslope to the source material via traversable routes.

Advantages of SWM Deltaic-Lacustrine Site: SWM is not a "go to" site; the rover will be landing on and driving over high-value (potentially organic-rich) science targets regardless of the traverse. Lacustrine deposits cover >90% of the SWM landing zone, ensuring ample sampling opportunities of high BPP material. Importantly, the basin deposits were formerly buried and are exhumed, with ideal BPP sampling sites in erosional windows [4], or at the base of scarps where exposure time to radiation has been minimized [12]. An assessment of the rock erosion rate indicates it is high enough at SWM that radiolysis would have insufficient time to destroy complex organic matter, bolstering confidence in the preservation potential of SWM relative to other candidate landing sites [9].

Furthermore, the thick stratigraphic section exposed would also present an opportunity to sample rocks from different periods and formerly habitable environments ranging from deep subaqueous to near-shore settings. The southwest Melas basin is an ideal exploration zone for the Mars 2020 mission's scientific objectives given the high BPP of lacustrine deposits, the excellent stratigraphic exposure and well-defined geologic context. With short transit distances and the abundance of rocks from habitable environments, the mission will be devoted to hypothesis testing using the scientific payload, rather than traversing to science targets, yielding a suite of scientifically rich specimens for further detailed study in terrestrial labs. Landing in SWM is an opportunity to explore Valles Marineris and search for biosignatures in a high preservation locale.

References: [1] Williams et al., 2015, Mars 2020 Landing Site Workshop, Arcadia, CA; [2] Mustard et al., 2013, Report of the Mars 2020 Science Definition Team; [3] Quantin et al., 2005, *JGR* 110 E12S19; [4] Metz et al., 2009, *JGR* 114 E10002; [5] Dromart. et al., 2007, *Geology* 35 363-366; [6] Williams and Weitz, 2014, *Icarus* 242 19-37; [7] Davis et al., 2017, *LPSC XLVIII* Abstract #1991; [8] Weitz et al., 2015, *Icarus* 251 291-314; [9] Summons et al., 2011, *Astrobiology*, 11(2) 157-181; [10] Kite and Mayer, 2016 *in press*, *Icarus;* [11] Davis et al., 2015, *LPSC XLVI* Abstract #1932. [12] Farley, K. A., 2014, *Science*, 343 (6169).

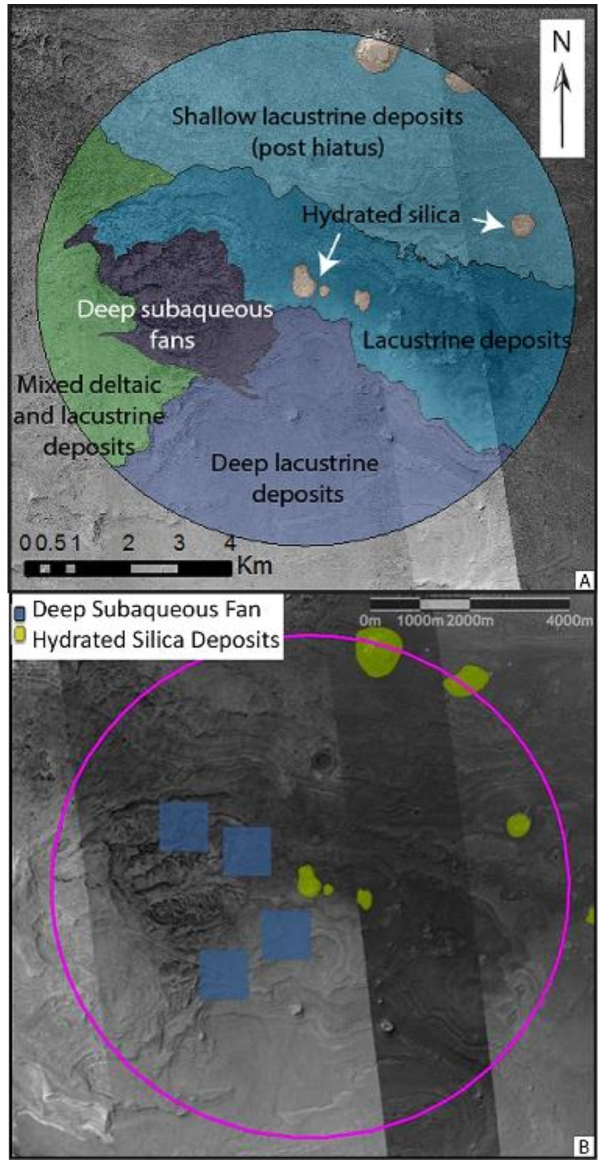

Figure 1: **A)** Map of inferred depositional environments for deposits within the 10-km diameter landing zone. **B)** Examples of ROI #1 are marked by blue boxes and occurrence of hydrated silica deposits, ROI #2) are mapped in yellow.