McLAUGHLIN CRATER AS A CANDIDATE LANDING SITE FOR HUMANS ON MARS. J. R. Michalski[1,2], P. B. Niles[3], B. Sutter[3], and M. S. Bell[3]. [1]Planetary Science Institute, Tucson, AZ. [2]Natural History Museum, London, UK. [3]NASA Johnson Space Center, Clear Lake, TX, USA.

Introduction: McLaughlin Crater is an ancient (Noachian) Martian impact crater located at 337.6E, 21.9 N, just south of the dichotomy boundary. This site should be considered for future landed exploration because: a) it is located at the boundary of three types of scientifically important terrain that will yield key results about the geological evolution and habitability of Mars; b) it contains surfaces where radiometric dating can be related to age dates estimated from crater counting, c) it contains volatile-rich rocks that will not only yield interesting results regarding ancient atmospheric chemistry, but will also be high quality, accessible targets for ISRU, and d) the site within the crater provides a flat, low-risk and low-elevation landing zone, which will facilitate landing large payloads on Mars.

McLaughlin Crater is a Noachian impact crater that contained a deep (~500 m) lake >3.8 Ga [1]. Evidence for the existence of an ancient lake comes from the presence of channels in the east crater wall which terminate above the crater floor, the presence of what is likely a delta in the same location, and the observation of layered subhorizontal clay and carbonate rocks in the crater floor. The lake was almost certainly fed by crustal fluids, and therefore the deposits could provide insight into deep biosphere habitability.

The clays and carbonates on the floor of the crater are overlaid by a datable, dark airfall deposit that is likely volcanic ash. And, this airfall deposit is overlaid by ejecta from Keren Crater, on the southern wall of McLaughlin, as well as debris flows derived from the interior wall of McLaughlin Crater. The ash layer itself is a datable unit of regional extent. Also, radiometric dates of a large suite of igneous grains in the ejecta would give an indication of how much extremely ancient material in in the crust and to what degree thermal events have affected interpreted ages. Lastly, ridged plains outside McLaughlin, which are of regional extent of likely igneous in nature, provide another target of interest for radiometric dating.

The ejecta and debris flows within McLaughlin Crater are also interesting scientifically because they contain blocks of deep crustal materials with very strong spectral absorptions associated with carbonates and likely serpentine, which likely formed in habitable conditions in the Martian subsurface before behing exhumed by impact and collapse. Some of the debris flows within McLaughlin seem to have occurred suaqueously [1], which is interesting because it implies rapid burial – a favorable scenario for the preservation of biomarkers.

The McLaughlin site contains many potential advantages for ISRU. The *average regional* H_2O-content estimated from GRS data is ~5-6% from both GRS data [2] and infrared data [3]. There are at least two types of mineral resources detectable from orbit, and both of these targets display extremely strong infrared absorptions (which likely translates to relatively high abundance of these phases). One target is hydrated Mg-rich carbonates in the southern part of the crater floor. HiRISE images show that these materials are located within blocky ejecta and debris flows. Therefore, an advantage is that the rocks to not need to be "mined" – they can simply be loaded for transport because they are found in fragmented blocks. Phyllosilicates are also found in both the ejecta and layered deposits in the crater. These include several types: a) dioctahedral smectites (probably yielding more water at lower T), b) triocthaedral smectites (higher water yield of hydroxyl) and c) serpentine (less water content than smectite).

McLaughlin Crater is located at the boundary of three regional terrains: a) the ancient Noachian crust to the south, b) the northern plains to the west, and c) the Mawrth Vallis deposits to the east and north (Figure 1). An evaluation of slopes in and around the crater suggest that it should be possible to exit the crater via the north or northeast routes and therefore, a long-term presence at this site will allow for exploration of all three categories of terrain. However, the most important science and resource targets of interest are located within the crater. The Landing zone (LZ) could be located in any number of positions on the crater floor in order to provide closer access to resources or to science targets. In the proposed position, the 25 km^2 LZ is located on the ash deposit. On the western boarder of the LZ is a debris flow deposits of likely subaqueous origin. On the east and south sides of the LZ are the lacustrine, layered clay deposits. An excellent exposure of >50 m of clay-carbonate lacustrine deposits is located ~10-15 km from the proposed LZ.

References: [1] Michalski, J. R. et al. (2013). Nature Geoscience, 6. 133-138. [2] Feldman, W. C., et al. (2004), JGR 109, E09006. [3] Milliken, R. E. et al. (2007). JGR 112, E08S07

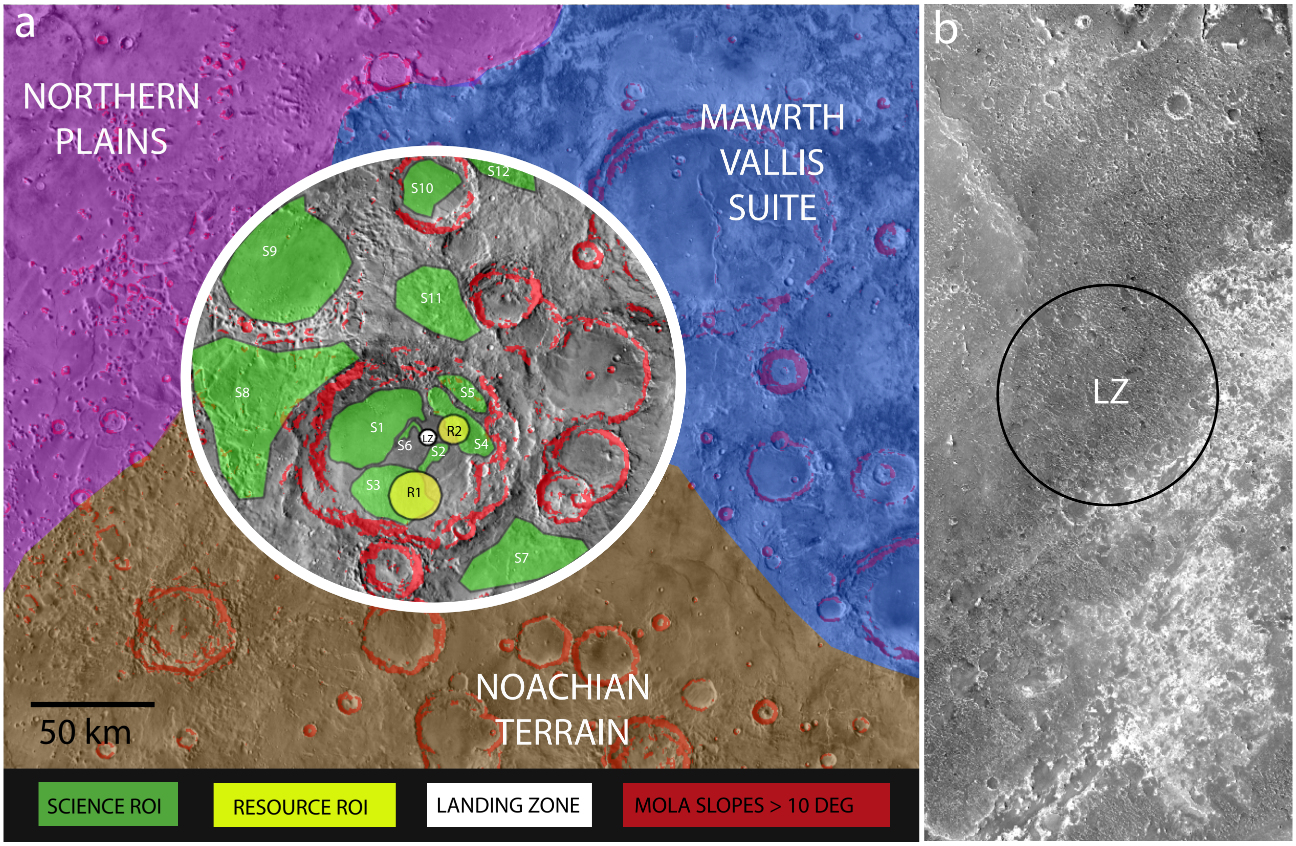

Figure 1: Exploration zone located within McLaughlin Crater, which was a ~500 m-deep lake in on Mars >3.8 Ga (a). Lacustrine deposits contain abundant clays and carbonates of interest for both science anc resource utilization. The elevation of the landing zone is -5.1 km. There are many possible locations of a landing zone (LZ) on the crater floor. CTX data (b) show a high resolution view of the proposed landing zone (image is 10 km wide).

Table 1: ROI characteristics for McLaughlin Crater site.

EXPLORATION ZONE: McLAUGHLIN CRATER AND SURROUNDING TERRAIN	
ROI	
R1	Blocks of hydrated carbonates (already fragmented)
R2	Smectitic clay minerals (both dioctahedral and trioctahedral clays)
S1	Datable airfall igneous unit with regional extent; same as in Mawrth
S2	Thick section of layered Noachian lacustrine carbonates and clays
S3	Ejecta and debris flow with large sampling of deep crustal igneous and hydrothermal materials. Key for both igneous petrology and deep biosphere. Igneous materials are likely datable.
S4	Delta deposits in ~500 m-deep Noachian lake
S5	Channels in crater wall
S6	Likely subaqueous debris flow deposits
S7	Datable igneous surface: ridged plains
S8	Pyroclastic deposits
S9	Northern plains deposits
S10	Datable surface, likely igneous
S11	Altered ejecta; deep crustal materials
S12	Mawrth Vallis clays