ENVIRONMENTAL DYNAMICS OF THE EZ: A PRIORITY FOR SCIENCE AND RESOURCE EXPLORATION. P. G. Conrad[1], J. E. Bleacher[1], and P. van Susante[2], [1]NASA Goddard Space Flight Center, Code 699, Greenbelt, MD 20771 Pamela.G.Conrad@nasa.gov, jacob.e.bleacher@nasa.gov, [2]Michigan Technological University, Houghton, MI 49931 pjvansus@mtu.edu.

Introduction: The mineralogy and geochemical character of the exploration zone (EZ) only tells part of the story about how habitable the martian environment will be for human explorers and possibly other accompanying Earth life. There are physical aspects to the martian environment that are also important factors—diurnal variation in ground and air temperature, cosmic radiation, solar flux, wind velocity and variability, atmospheric pressure cycles, surface stability with respect to hardness, slope, porosity, permeability, magnetic character and electrostatic charging are examples.

From the perspective of resource exploration, the prospecting, discovery and potential for exploitation of resources is also dependent on both chemical and physical factors, so it is prudent to develop an approach for exploration that also includes a comprehensive plan for baseline and continued monitoring of both chemical and physical environmental dynamics as the human explorers invariably alter the exploration zone, even if only minimally.

We propose to interrogate the potential sites from the perspective of the ease with which the integrated set of environmental monitoring measurements can be deployed in semi-permanent array at intervals around the exploration zone, with outward looking observation posts that extend the data set to include data relevant to human safety and environmental preservation at larger spatial scales. Examples of candidate measurements for those outposts are slope stability (on crater walls or other proximal slopes), oncoming dust storms and coronal mass ejection (CME) events, galactic cosmic radiation (GCR) and water-table monitoring.

Rather than advocating for a specific site at this time, we propose analysis of environmental dynamics as part of the process for site high grading downstream. We will apply our measurement approach and site analysis using a few crater sites studied for previous mission landing site consideration.

Specific Measurements for the EZ: Because of the existing datasets from Mars Science Laboratory's meteorological instrument suite REMS [1] and what will have been acquired by ESA's ExoMars [2] and NASA's Mars 2020 [3] missions (as well as potential TBD precursors), we have a good idea of the range of meteorological measurements that are relevant to the characterization of environmental dynamics. Ground and air temperature, relative humidity, atmospheric pressure, and variation of ionizing (background galactic cosmic rays, ultraviolet, etc.) radiation are key measurements to make at a frequency of at least a few minutes per hour. Dust characterization and the presence and heading of dust devils are another, as is the approach of dust storms.

An upward looking observatory for tracking tau and other astronomical observations would also be important for understanding relationships between the dynamical elements of the environment.

Because of the nearly ubiquitous observation oxychlorine species with their oxidative power, and the effect of redox environment on both the preservation potential for biosignatures and on the processing approach for resources, the monitoring of surface chemistry at some TBD interval would be an important element for determining the mechanism for formation and distribution of the oxychlorine phases that will affect the science, ISRU and mission safety (for both humans and hardware) in the EZ.

Human or robotic measurement? Both scientific and ISRU exploration efficiency in the exploration zone will be improved if the sites under consideration can be evaluated with respect to determining the ratio of automated robotic measurement to human measurement. If the human explorers do only those things for which they are needed and a high proportion of exploration measurements can be conducted either completely or semi-autonomously, mission objectives are most likely to be achieved. Crater environments with relatively fewer navigation hazards in the EZ allow micro-rover surveying as a first pass to characterizing the geologic environment. An EZ with an easily traversable perimeter allows rapid deployment of environmental monitoring and communications hardware packages. So exploration zones within craters such as those that were high-graded during the recent Mars 2020 landing site workshop [4] can be situated and placement of environmental dynamics measurement packages and approaches for their use are described by considering craters studied for 2020 and earlier missions such as Gale, Jezero and Eberswalde as example sites for demonstrating the approach of using environmental dynamics monitoring as an additional mechanism for synthesis of science and ISRU objectives as a ranking tool for the sites.

The ISRU rubric requirement for less well-consolidated material must be placed next to a science requirement for in-place exposures of rock units from which to understand the stratigraphy of the EZ as well as safe landing locations with a stable rock foundation. Relatively easy access to ice or liquid water is another ISRU rubric requirement that is at odds with planetary protection (PP) considerations. The careful distribution of work between robotic and human explorers could enable the seemingly conflicted rubric requirements to be resolved.

Planetary Protection: A significant amount of attention is being paid to PP considerations, and abstracts and presentations from a recent NASA workshop on human exploration and planetary protection can be found at [5]. Modeling environmental dynamics from the straw man measurements we suggest may provide input to planetary protection due diligence, particularly as regular measurement of relative humidity and mapping the distribution of brine deliquescence of frost formation [6,7] can be useful in predicting areas for more frequent PP witness measurements within the EZ.

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