FROM HABITABILITY TO HABITAT – THE CURRENT KNOWLEDGE LEAPS AND GAPS IN THE SEARCH FOR BIOSIGNATURES ON MARS. N. A. Cabrol[1,2] and the SETI Institute NAI Team [1]SETI Institute Carl Sagan Center, 189 Bernardo Ave, Suite 200, Mountain View, CA 94043. Email: ncabrol@seti.org and Nathalie.A.Cabrol@nasa.gov. [2]NASA Ames, Space Science Division, MS 245-3, Moffett Field, CA 94035-1000.

Introduction – As the landing site for Mars 2020 is being selected, intellectual leaps (e.g., habitability *vs.* habitats), and data and knowledge gaps exist in the approach to biosignature detection. For instance, searching for evidence of past or present life requires the ability to (a) identify *habitats*; (b) understand the role of climate fluctuations, cycles, and transitions at *scales that matter at the habitat level* when current data only allows us to characterize broad environments and major climate tipping points – except at the three rover landing sites; (c) consider the likely role of *habitat fragmentation* early in the history of Mars [1-2] and what it could mean for the search of a biological record; and (d) identify conditions that favored biosignatures preservation. For lack of new orbital assets, most of these gaps will not be filled by the time Mars 2020 lands, which will result in significant ground operation time being spent trying to solve where habitats could be located and how to reach them, rather than documenting them.

Environmental Habitability *vs.* Habitat – While environmental habitability defines the range of conditions making a planet, or a specific environment, suitable for life as we know it, habitats are defined by their occupants at the species level [3]. On Earth, where life is distributed at global scale, some species may occupy habitats covering most of a given domain (e.g., land, sea, forest), while others, such as extremophiles, may only be found, e.g., on very specific slope exposures, rock types, sedimentary textures, or in association with unique mineralogies. Terrestrial habitats, thus, can range from megascale regions to microscopic areas.

As we transition from the characterization of past habitability to the search for biosignatures, the focus must accordingly shift from habitable environments to the identification of habitats. This shift in intellectual framework must be accompanied by a change in exploration strategy. While characterizing habitability is about understanding *where* to search, searching for life and its habitats requires to understand first *what* to search for, which provides guidance for *where* and *how* to search. In the case of Mars, recent data [4] show that extreme conditions might already have prevailed early in the Noachian. Therefore, any type of life on Mars should be considered extremophile by terrestrial standards. Further, the combination of extreme climate variability and global climate decline (e.g., aridification, extreme radiation, high temperature variability) would have led to habitat fragmentation and most likely, to the hyperspecialization of microorganisms in response to very specific habitat conditions. As a result, biosignatures are probably associated with micro-niches and oases in localized (micro) environmental conditions, all of them very specific to each region to be explored. In that perspective, our current planning toolkit for the selection of candidate landing sites (i.e., orbital data and broad knowledge of habitability) is poorly adapted to the new exploration goal. Data at relevant spatial scale and spectral resolution are only available at the three rover landing sites and, unless we choose to go back to one of them [5], localized habitats mean that the knowledge acquired at these sites will only be partially transferable to the selection and exploration of a new site.

Detection Thresholds – Habitat and biosignature detection demands an understanding of the scales, resolution, and detection thresholds necessary to bridge orbital and ground data in order to (a) optimize life-seeking strategies, (b) identify methods to improve existing datasets, and (c) better support upcoming and future missions. This is the goal of the ongoing SETI Institute NAI project. Here, we will present an overview of the results from our 2016 field campaign at four Mars analog sites in Chile: Salar Grande (evaporitic basin); Salar de Pajonales (ancient lake); Laguna Lejia (evaporating lake); and El Tatio (volcanic/hydrothermal system). At these sites, our team explored extreme microhabitats and biosignatures with remote and *in situ* capabilities (e.g, imagery, mineralogy, chemistry, composition) equivalent to current orbital and ground assets on Mars, several instruments analog to those onboard Mars 2020 and ExoMars, and scale/resolution "bridging" capabilities (e.g., drones). Data are giving us a first order quantification of the leap in scales and resolution, and the type of approach, it will take to optimize the planning of life-seeking missions, and the detection of microhabitats and associated biosignatures.

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