Mars as a "natural laboratory" for studying surface activity on a range of planetary bodies
A white paper planned for the upcoming Decadal Survey on Planetary Science and Astrobiology
Submitted to MEPAG meeting 38 for advertisement to the Mars community

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Intended General Content

This white paper aims to

- Establish that Mars is currently a planet with an active surface (important as that enables direct observation of present-day activities and relevant environmental conditions).
- Identify and describe the many areas in which studies of Mars' environmental conditions and processes enable the testing/refinement of models of analogous processes on other planetary bodies (such as within the outer solar system and icy/ocean worlds).
    - Current focus is on surface activity (hence "surface" presently being in the title), but we might bring in other types of present-day activity (e.g., seismic or upper atmospheric activity).
    - Current focus is on wind and frost (sublimation especially) driven surface activity, but this could be expanded (e.g., cratering).
    - Current focus is also on present or recent past (i.e., under climate variations due to obliquity shifts, but within the Amazonian) conditions and active processes, but this potentially could be expanded.
- Outline how the large amount of contextual information available for Mars coupled with models derived from Earth, Mars, laboratory, first principles, etc. can be used to develop or test fundamental physics models that extend across different planetary conditions (e.g., gravity, atmospheric density, frost and atmospheric composition).
- Based on the above, prioritize the science questions and/or measurements that would best advance planetary process studies (for Mars, other specific planetary bodies, or for fundamental physics).

This white paper will focus on science questions and needed measurements. High-level description of mission/instrument concepts may be included, but only to (1) establish feasibility to acquire high-priority measurements in the next decade and (2) identify key technology gaps (e.g., small lander technologies) where NASA investment would provide important benefits. Any mentioned mission/instrument concepts will not be prioritized, discussed with specific advocacy, or described in detail (but we could reference relevant mission/instrument concept white papers where more details could be found).

Desired Contributions

Diniega expects to do the bulk of the writing and has ample information based on past work by her and colleagues, but welcomes any co-authors/editors as well as co-signers once a full draft is together. Some areas where more input is especially welcome are in:

- **Identifying the analogous processes for which Mars can be used (perhaps uniquely/optimally) as the basis for comparative planetary, and what planetary bodies would be compared.** Contributors who study relevant landforms/processes but don't identify as specifically Mars scientists are especially welcomed to ensure a comprehensive and accurate survey of analogous

processes and comparative planetology targets – in and potentially outside of our solar system! Having coauthors with a wide range of expertise and community identities will also help us convey the main points of the white paper to a broad audience.

- **Describing how the existing broad observational data for Mars (in space, time, and dataset type) provides a more holistic "systems" perspective that helps develop and test process models in a way and to a level that is unique (outside of Earth).** Due to having decades of observations and so many observation types (including observations that fill gaps identified in previous observations or that are prompted by results of previous studies), Mars is unique in solar system bodies with respect to the:
    - Extrapolation and interpolation within models of climate, process, geologic history – across time- and spatial-scales – that has been and can be done.
    - Level of detail/refinement in science investigations.

  Additionally, due to the high-resolution observations, ability for repeat imaging, and a growing temporal baseline for change/activity detection, we have a unique ability on Mars to directly characterize activity, processes, and relevant environmental conditions.
- **Identifying key measurements that would advance understanding of features seen on other worlds or that are expected to be seen, and enable conclusive testing of fundamental physics models.**

General Schedule

Serina Diniega plans to complete a draft of this white paper by the end of May, then put the draft out for additional feedback from the community and to solicit for signatories.