Current Activity on the Martian Surface: A Critical Scientific Objective for Future Exploration

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Summary of white paper content:

One of the major discoveries of the last decade of Mars exploration is the extent and importance of contemporary surface activity. Although some examples were known at the time of the last Decadal Survey, it is now clear that surface activity is widespread, frequent, and substantially reshaping the modern surface. Observed activity on the surface include hundreds of new impact craters, planet-wide aeolian changes including dust lifting and sand movement, diverse seasonal defrosting processes, polar surface changes, and a variety of slope processes at all latitudes. The latter include gully flows, Recurring Slope Lineae, slope streaks, rockfalls, and polar avalanches. Theory suggests that additional surface processes are likely to be active but not yet detected, such as sublimation or modification of subsurface ice, and seismic activity is known but its geomorphic effects are not yet determined.

This white paper will summarize current knowledge and open questions about active surface processes. It will discuss the necessity of understanding the driving processes, many of which have no terrestrial analog and were not predicted a priori. Without this knowledge, there is a critical gap in our understanding of Mars. This gap also propagates back in time; the processes currently shaping the surface were active in the past as well. Without understanding these processes, we will struggle to project their roles in the past. This applies to both recent climate cycles due to orbital and obliquity changes, recorded in geomorphic features and ice deposits, and to long-term secular changes as Mars became colder and drier. The former is of high interest to the Mars polar and climate science communities and encapsulated in the ICE-SAG report; the latter is vital to interpreting observations of the ancient rock record by rovers such as *Curiosity* and *Perseverance*.

Surface activity is fundamentally coupled to the lower atmosphere, and studying each is critical to understanding the other. Surface changes can expose subsurface materials for further study, particularly important for accessing less-degraded organic materials. Understanding current activity is also needed for human exploration and planetary-protection questions. Liquid water has been considered as the driver for several active processes; although dry models also exist, some processes are still considered markers of candidate Special Regions. Surface activity may also be a driver of environmental issues of concern for future human missions, and some forms of surface activity could even pose hazards to astronauts.

This white paper will conclude with a discussion of needed observations for the next decade, laying the groundwork for addressing the high-priority science questions raised here.

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Involvement sought: Additional coauthors welcome with specific contributions to the text; all co-signatories are welcome.