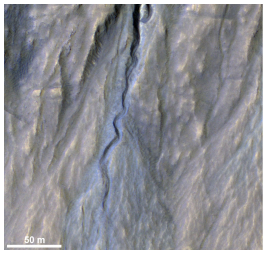
Future Mars Exploration: The Present is the Key to the Past

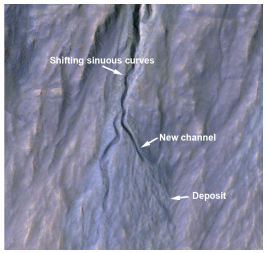
Colin M. Dundas[1], Shane Byrne[2], Matthew Chojnacki[2], Ingrid J. Daubar[3], Candice J. Hansen[4], Alfred S. McEwen[2], Lujendra Ojha[5], Ganna Portyankina[6]

[1]U.S. Geological Survey, Astrogeology Science Center, 2255 N. Gemini Dr., Flagstaff, AZ, USA (cdundas@usgs.gov), [2]University of Arizona, [3]JPL/Caltech, [4]PSI, [5]Johns Hopkins University, [6]University of Colorado.

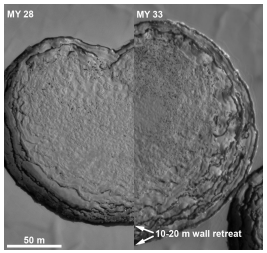
Why study current activity?

- **Surface activity is producing substantial changes on the surface that reshape modern geomorphology. *(Primarily relevant to MEPAG Goal III.A1)***
- **Current activity leads to new understanding of processes, some of which are unique to Mars. *(Goals II.A4, III.A1)***
- **We need to understand these processes to properly interpret landforms and determine their implications for recent climate. *(Goals II.B2, II.B3, III.A1, III.A3)***
- **We are just starting to learn how Mars works in the present. What are we missing about the ancient past? How would current processes be reflected in the rock record? *(Goals II.C2, III.A1, III.A3)***
- **Observing rates of change allows better understanding of the ages of landforms. *(Goal III.A2)***
- **Current activity is closely linked to understanding habitability and Special Regions. *(Goals I.A1, I.B1, IV.B3)***
- **This poster focuses on surface changes, but these are closely tied to atmospheric processes. *(Goal II.A4)***

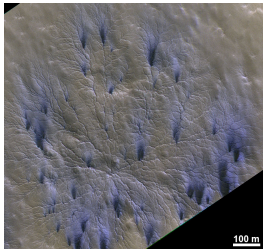




Gully activity [1] is widespread and seasonally controlled, occurring in conjunction with frost. Changes include major channel incision, debris flow-like deposits, and initiation of new gullies [2-3]. Counter to expectations before monitoring studies, it is possible that gullies do not indicate past liquid water.



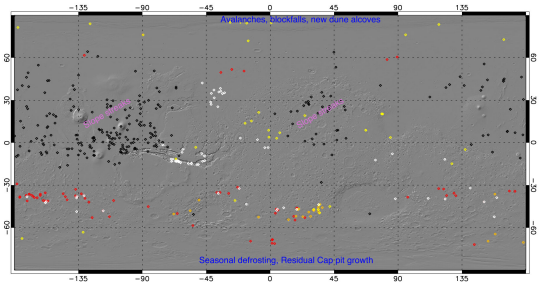
Swiss Cheese pits in the residual CO_2 cap are expanding [4], but the sign of the mass balance and implications for century-scale climate change are not clear [5].



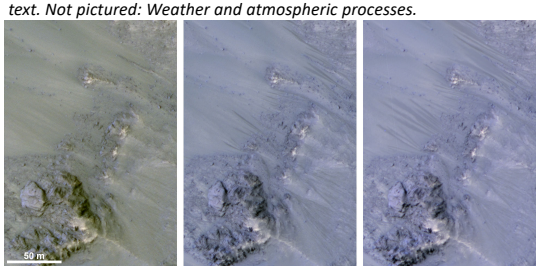
Vast fields of CO_2 vents occur every spring [6]. This process is creating new araneiform landforms [7] and also provides information on surface winds.

Summary

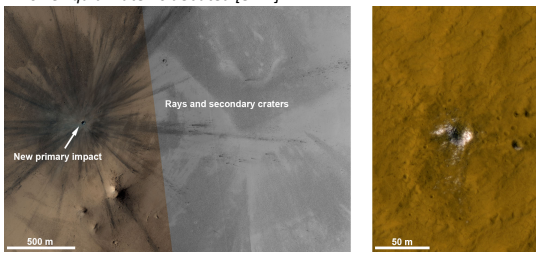
- **Present-day Mars has diverse, extensive surface changes. Surface activity occurs planet-wide.**
- **Understanding current activity is fundamental science for understanding surface processes.**
- **Sustained orbital monitoring combined with *in situ* studies are needed to further this objective.**



Locations of active gullies (red) and dune gullies (orange) [3], sand movement (yellow) [12], RSL (white) [11], and new craters (black) [14] are shown. Slope streak and polar process regions are indicated by text. Not pictured: Weather and atmospheric processes.



Recurring Slope Lineae are abundant and active, but whether they involve liquid water is debated [8-11].

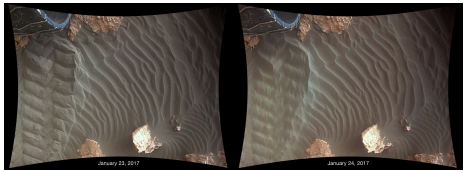


Hundreds of new impact craters have been detected [1, 14]. Factor-of-several differences between the observed and predicted fluxes could be due to field secondaries or to changes in the impact rate [15]. New craters also serve as probes of mid-latitude ice [16], a key subject for future exploration and possible in situ resource utilization.

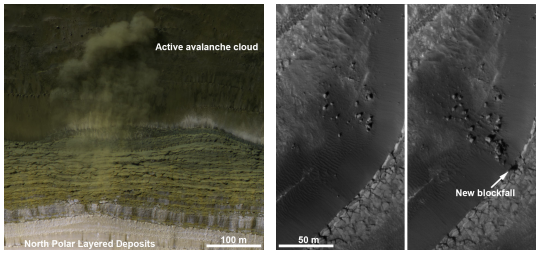
Necessary Observations and Measurements

1. **Sustained and improved monitoring of changes of all types—*expand the change record and capture currently undetected rare events and gradual long-term changes.***
2. **Volume measurements—*determine material fluxes and estimate integrated effects over time.***
3. **Seasonal and geographic distribution of activity—*controls on different types of process and which landforms they can affect.***
4. **Better temporal resolution—*fundamental behavior of processes.***
5. **Local environmental conditions triggering activity—*fundamental controls on processes.***

1–3 are best studied by orbital instruments (particularly the sustained presence of HiRISE-class or better imaging, but also data on atmospheric and frost conditions), while 4–5 would benefit from *in situ* study. The Next Orbiter recently studied by MEPAG would be well-suited to studying surface changes.



Sand dunes and ripples are migrating planet-wide [12], an observation that has led to new discoveries about how saltation works on Mars [13]. (PIA21143, NASA/JPL-Caltech/MSSS)



Avalanches and blockfalls are frequent on the North Polar Layered Deposits [17], causing substantial slope retreat.

There is more activity on Mars than can be shown in one poster: dust devils and their tracks regularly change surface albedo [18]. Regional-scale albedo changes are also common [19]. Tens of thousands of new slope streaks form every year in dusty regions [20]. Weather and atmospheric processes are beyond the scope of this poster, but studies of active atmospheric escape have unlocked the history of atmospheric evolution [21], and the Martian atmospheric is dynamic, and variable from year to year [22].

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