ACTIVE MODERN MARS: WHAT IS HAPPENING ON THE SURFACE TODAY? A. S. McEwen[1], [1]University of Arizona, Tucson, USA (mcewen@lpl.arizona.edu).

Summary: Mars is alive, with some surprisingly active surface processes (Figure 1). Aside from activities such as impact cratering and dry mass wasting found on all planetary bodies, these activities may be largely due to the fact that Mars has an atmosphere. The seasonal CO_2 frost drives a range of activity, including formation of gullies, and eolian processes are very active. There is little evidence for internal magmatic activity, unless the putative methane detection is confirmed and shown to have this origin. The Recurring Slope Lineae (RSL) might be explained by water seeps, but remain puzzling. High-resolution orbital and landed monitoring over the past 7 years has dramatically improved our understanding of current processes, but the RSL demonstrate that we still lack some basic understanding about active processes on Mars today.

Impact Cratering: Over 400 new impact sites, with before-and-after (usually by MRO/CTX) and MRO/HiRISE followup images, have been documented as of April 2014 [1-2]. The present-day crater production function is only ~4x lower than model predictions for 4-40 m craters. Most of these small bolides break up in the thin Martian air, creating crater clusters, and provide information on bolide properties [3]. A special class of new impacts expose bright "excess" ice [4]. This clean ice is important to understanding recent climate change and/or near-surface water vapor distribution, and is a valuable resource to potential human explorers. However, this excess ice may be tens of millions of years old [5], and it is difficult to explain how it survived many cycles of high obliquity.

Mass Wasting: Landslides, rolling/bounding boulders, and dry grain flows are common on Mars and other planets. Slope streaks (dust avalanches) represent a unique type of mass wasting on Mars [6]. A role for water in forming or triggering slope streaks has been proposed, but failed the prediction of seasonality [7]. A slump associated with RSL in Valles Marineris was discovered in early 2014 (Figure 2). Frost-aided mass wasting is discussed below.

Eolian processes: At the 7th International Mars Conference, the extent of bedform movement by winds in the low density Martian atmosphere was unknown, a limitation of resolution and temporal baseline of previous orbital experiments. Analysis of HiRISE images over the last ~4 Martian years shows that many ripples and dunes on Mars are moving, some with rates and fluxes comparable to those on Earth [8]. Understanding eolian processes in turn helps to identify locations where organic material is most likely to be recently exposed and not yet broken down by radiation [9]. Monitoring rover tracks has provided new insights into eolian processes on Mars [10].

Seasonal defrosting: Springtime sublimation of seasonal CO_2 frost, a process that doesn't occur on Earth, produces a suite of un-Earth-like processes and landforms [11-13]. Summer images from different martian years are compared to search for changes that might be the result of active erosion by the outgassing. After 4 years, there are many changes in sand dunes but not in landforms such as "spiders".

Mass wasting aided by CO_2 frost (gullies): Seven years ago there were only 3 known sites of gully activity [14]. Now there are >40 documented active sites on rocky slopes and hundreds on sand dunes [15]. Previous ideas about how most gullies form on Mars have been overturned by MRO observations of their association with seasonal CO_2, including sliding dry ice blocks creating linear gullies on dunes [16]. It now appears possible that gullies are formed entirely by currently active processes, and do not require climate change.

Recurring Slope Lineae: RSL are narrow (<5 m), dark markings on steep (25°-40°) slopes that appear and incrementally grow during warm seasons over low-albedo surfaces, fade when inactive, and recur over multiple Mars years [17-18]. They are especially common is the southern mid-latitudes and in Valles Marineris [19]. The observations can be explained by the seasonal flow or seepage of water, but the origin and replenishment of the water is not understood. A dry process that is not understood is also possible. RSL are often associated with small gullies, and might carve gullies via a process that does not involve CO_2 frost.

Glacial/Periglacial processes: Polygons are ubiquitous in middle to high latitude terrains, investigated in situ by the Phoenix mission [20], and inactive glacial flows are common in the middle latitudes [21]. Sublimation landforms such as "scallops" are common in some regions [22]. No evidence for active changes in these landforms have been described from HiRISE repeat imaging, except on the polar caps, although the image analysis is far from complete.

Polar processes: Active polar surface processes include seasonal changes [23], year-to-year changes in residual caps [24-25], halos [26], avalanches [27-28], pits [29-30], and CO_2 v. H_2O [31]; summarized by [32].

Tectonics: No topographic changes associated with active tectonics have been described, but there is certainly active mass wasting of steep scarps, and new scarp formation must occur on some timescale [33-35].

Magmatism: No evidence for active volcanism, magmatism, of hydrothermal activity has survived the peer-review process, except for the atmospheric methane reports, if those are actual detections and if the C has a magmatic origin [36]. There is evidence for geologically very recent (<10 Ma) volcanism [37-38], so lava will erupt again in the future.

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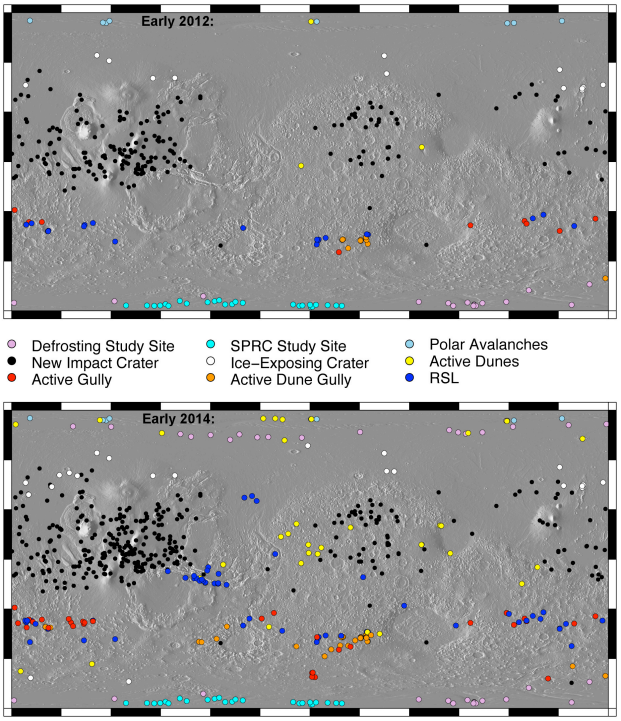

Figure 1. Progress in discovering, characterizing, and understanding active surface phenomena is accelerating as more repeat coverage and a longer temporal baseline are realized by MRO's continued observations. Figure shows locations for 9 categories of active surface processes in early 2012 (top) and 2 years later (bottom).

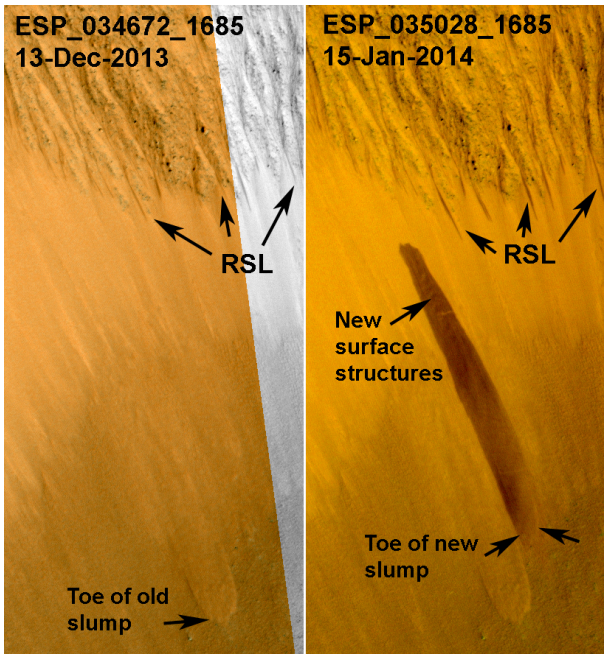

Figure 2. Mars continues to surprise us. These HiRISE images show a new dark streak and topographic slump below active RSL in Melas Chasm, the first topographic changes seen in association with RSL. (Resolution reduced 4x.)