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Recurring Slope Lineae and Future Exploration of Mars

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Recurring slope lineae (RSL) on Mars may be evidence for the seasonal flow or seepage of water on relatively warm slopes. RSL are narrow (<5 m), relatively 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 [McEwen et al., 2011, Science]. RSL often follow small gullies, but no topographic changes have been detected via 30 cm/pixel images from HiRISE on MRO. The fans on which RSL terminate have distinctive color and spectral properties in MRO/CRISM, but lack distinctive water absorption bands [Ojha et al., 2013, GRL]. The first group of confirmed RSL appear and lengthen in the late southern spring through summer from 48° - 32°S latitude, favoring equator-facing slopes—times and places with peak surface temperatures ranging from >250 K to >300 K. Over the past Martian year we have monitored active RSL in equatorial (0°-15°S) regions of Mars, especially in the deep canyons of Valles Marineris [McEwen et al., 2014, Nature Geoscience]. These equatorial RSL are especially active on north-facing slopes in northern summer and spring and on south-facing slopes in southern spring and summer, following the most normal solar incidence angles on these steep slopes. More recently we have confirmed RSL near 35°N in the low-albedo and low-altitude Acidalia Planitia. All RSL locations have warm peak daily temperatures (typically >273 K at the surface) in the seasons when RSL are active, and occur on steep, rocky, low-albedo slopes. However, most times and places with these properties lack apparent RSL, so there are additional, unseen requirements. We do not know what time of day RSL are actively flowing. Seasonal variation in the atmospheric column abundance of water vapor does not match the RSL activity. Seasonal melting of shallow ice best explains the RSL observations, but the origin and replenishment of such ice is not understood, especially in the tropics. Laboratory experiments are consistent with two key MRO observations: (1) that seeping water darkens basaltic soils but may only produce weak water absorption bands undetectable in ratio spectra after partial dehydration during the low-humidity middle afternoon conditions when MRO observes; and (2) the flows are more linear than under terrestrial conditions and do not erode channels under Martian atmospheric pressures [Masse et al., 2014, LPSC]. No dry process is known to create such slowly creeping seasonal flows. The potential for equatorial water activity creates new exploration opportunities, to search for extant life, as well as challenges such as the definition of special regions for planetary protection.