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Aqueous outcrops at Libya Montes, Mars: A close eye on morphology and mineralogy

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We present the results of a photogeological mapping, morphological and spectral analyses of a geologically diverse region at the border of Libya Montes and Isidis Planitia that were applied using coordinated analyses of mineralogy from CRISM images and surface features from HiRISE and CTX images, as well as topographical information from HRSC DTMs. The Libya Montes are part of the southern rim-complex of the Isidis impact basin on Mars. The region is characterized by pre-Noachian and Noachian aged highland rocks alternating with multiple sedimentary units of Noachian to Amazonian age, some of them heavily dissected by dense valley networks. The region experienced a complex history of impact, volcanic, tectonic, fluvial and aeolian modification processes resulting in the geology observed today.
The geological history of the region as revealed by the analysis comprises an emplacement of olivine-rich lava onto ancient basaltic bedrock, which was later covered by pyroxene-rich caprock. This latter extended top unit might either represent lava layers, presumably originating from the Syrtis Major province, or indurated mud flows emplaced by mud volcanism. The analyses suggest that the ancient bedrock has been partially altered to Fe-/Mg-smectites through hydrothermal alteration (presumably triggered by the Isidis impact) and/or hydrous alteration caused by fluvial activity. These clays feature a variety of morphologies and stratigraphical exposures. Some outcrops of the Fe-rich and Mg-rich smectites are intermixed with carbonates in places. The carbonate detections suggest aqueous alteration that is associated with Mg-/Fe-rich fluids under a CO_2-rich atmosphere. Al-smectite have also been detected in morphologically diverse outcrops and may have been formed later via alteration of pyroxene-bearing caprock. The variability in phyllosilicates and presence of carbonates implies a changing alteration environment.