



**Fig. 3.** Meter-scale textures of probable sulfate-bearing layers and overlying smectite-bearing layers. (a) and (b) are from site 3 (see Fig. 2c for context); (c) is from site 2 (context in Fig. 2b). All panels have the same scale and have been rotated  $\sim 180^\circ$  so that the downslope direction is toward the bottom. Red lines mark approximate mineralogic boundaries inferred from CRISM maps in Fig. 2b and c. (a and b) are from HiRISE ESP\_013229\_2050, (c) from ESP\_014007\_2030.

McKeown et al., 2009; Noe Dobrea et al., 2010), then these should have precipitated elsewhere in salts or oxides (Milliken et al., 2009). Especially on Mars, Ca-sulfate is the least soluble of the expected salts (Tosca et al., 2008) and therefore could have precipitated in the lower horizons at Mawrth Vallis while more soluble salts—including the Mg/Fe sulfates that appear to dominate many equatorial layered deposits (e.g., Gendrin et al., 2005; Roach et al., 2009; Bishop et al., 2009a)—were transported elsewhere either initially or after subsequent dissolution (Milliken et al., 2009). Even if bassanite in Mawrth Vallis formed only from the Ca liberated from smectite interlayer sites, leaching of the uppermost  $\sim 50$  m (Wray et al., 2008; McKeown et al., 2009) of layered deposits  $\sim 50\%$  nontronite by volume (Poulet et al., 2008b) could have formed a  $\sim$ meter-thick layer of pure bassanite. If additional Ca was leached from primary silicates and/or other minerals are present in the bassanite-bearing unit (both likely), then its thickness could be greater. This hypothesis could be tested by future *in situ* observations of the Al-clay, Fe/Mg-clay, and sulfate-bearing layers; in particular, major element chemistry and microscopic textures would constrain whether the Al-clay horizons could have been the source of cations that combined with sulfate in solution to form the observed salts.

The detection of bassanite ( $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$ ) in Mawrth Vallis ( $23^\circ\text{N}$ ) is of interest to global studies of Ca-sulfates on Mars. Previously, gypsum ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ) has been found in circumpolar dunes at  $\sim 80^\circ\text{N}$  (Langevin et al., 2005) and in Columbus crater at  $29^\circ\text{S}$  (Wray et al., 2009); preliminary reports of gypsum in equatorial layered deposits (e.g., Gendrin et al., 2005) have been refuted by subsequent analyses (Noe Dobrea et al., 2008; Kuzmin et al., 2009; Bishop et al., 2009a), although Ca-sulfates may be present in one portion of Noctis Labyrinthus (Mangold et al., 2010). Both Mars Exploration Rovers have also found evidence for Ca-sulfates, for which the orbital and surface remote sensing data are most consistent with anhydrite ( $\text{CaSO}_4$ ) in both the rocks of Meridiani Planum at  $2^\circ\text{S}$  (Clark et al., 2005; Glotch et al., 2006) and the bright soils of the Columbia Hills at  $15^\circ\text{S}$  (Johnson et al., 2007; Lane et al., 2008). Collectively, these observations suggest a general trend of increasing Ca-sulfate hydration with latitude, as might be expected if relative humidity and/or surface temperature are controlling the hydration state. However, the slow kinetics of Ca-sulfate hydration state changes under Mars-like conditions may prevent equilibration with the atmosphere (e.g., Vaniman et al., 2008, 2009), as appears to be the case for martian Mg-sulfates (Roach et al., 2009).