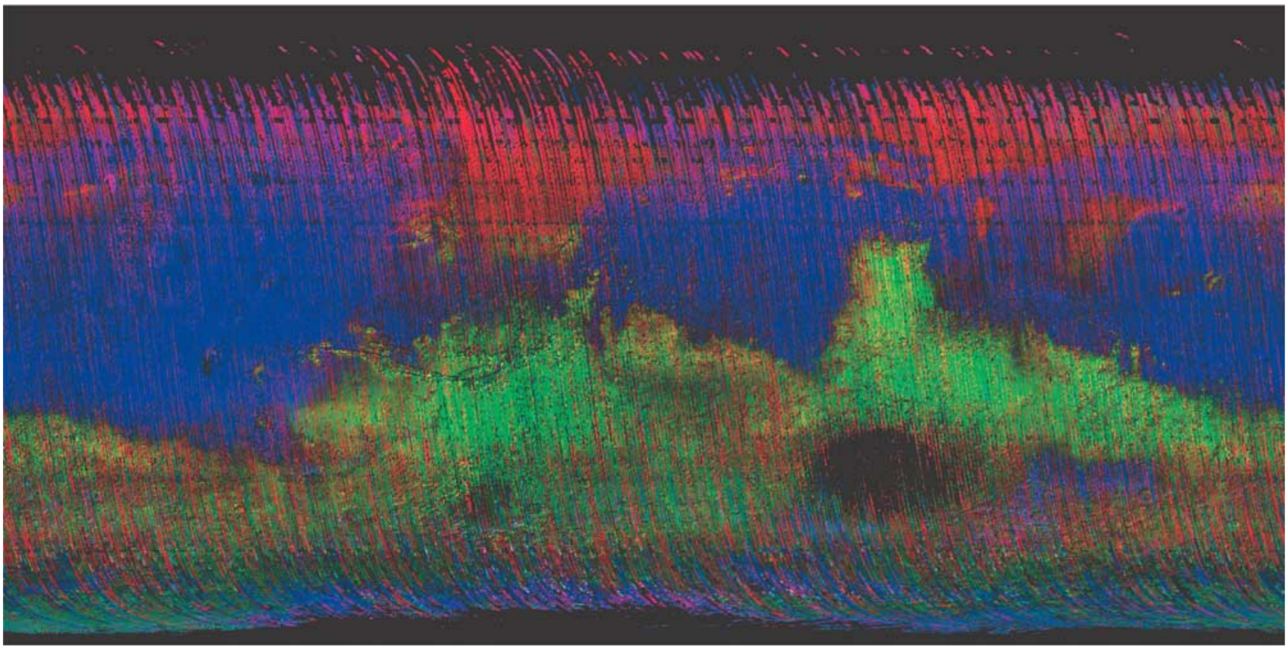

Figure 6. Global simple cylindrical projected TES image of the distribution of surface type 1 (green) and surface type 2 (red) materials on Mars, overlaid on a 128 pixels/deg MOLA DEM. The highest concentration of surface type 2 materials is in the northern lowlands, generally corresponding to the Vastitas Borealis Formation. Blue pixels represent dust-covered regions.

plains [*Bandfield et al.*, 2000; *Rogers and Christensen*, 2003]. The surface type 2 unit (andesite and/or altered basalt - red) displays the highest concentrations in the younger Amazonian-age northern lowlands regions of Acidalia Planitia and the circumpolar sand seas [*Bandfield et al.*, 2000; *Rogers and Christensen*, 2003]. These materials in the northern lowlands have been mapped as the Vastitas Borealis Formation [*Scott et al.*, 1987]. Surface type 2 compositions are also present in moderate abundances, or mixed with surface type 1, throughout the low-albedo southern highlands. Blue pixels in Figure 6 represent regions covered by a blanket of dust which prohibits spectral analysis of sand and rock compositions. The distribution of the highest concentrations and largest extents of the two surface spectral units is thus split roughly along the planetary topographic dichotomy separating the ancient, heavily cratered crust in the southern hemisphere from younger lowland plains in the north.

[23] It is important to note that a single interpretation of surface type 2 spectra may not be warranted everywhere on Mars. THEMIS data from Mars Odyssey show adjacent volcanic units of surface type 1 and 2 materials within the Nili Patera caldera [*Ruff and Christensen*, 2003]. These units have high thermal inertias and probably represent outcrops of lava and/or tuff. For these units an igneous origin, involving successive eruptions of basaltic and andesitic magmas, is a reasonable interpretation. Elsewhere, deposits of sediments with surface type 2 spectra may be more plausibly interpreted as partly weathered basalt. For example, *Wyatt et al.* [2003] described deposits of surface type 1 sand dunes on the floors of large craters in Oxia Palus, adjacent to surface type 2 materials on the downwind sides of the crater walls. In this case, surface type 2 can be readily explained as a finer-grained fraction (containing some alteration materials) winnowed by winds from the coarser basaltic sediment on the crater floor.

2.6. Density of the Crust

[24] Using MGS MOLA data, new models of the relationship between gravity and topography [*Turcotte et al.*, 2002] and admittance techniques [*McGovern et al.*, 2002; *McKenzie et al.*, 2002] suggest densities of 2.95–3.15 g/cm^3 for parts of the elastic lithosphere of Mars. *Turcotte et al.* [2002] have argued that the crust is volumetrically equivalent to the elastic lithosphere, although other models suggest a thinner crust [*Zuber et al.*, 2001; *Nimmo*, 2002]. The inferred density is significantly higher than that estimated for the Earth's continental crust ($\sim$2.75 g/cm^3), which has an average composition of andesite. Although the Martian crustal density appears to be inconsistent with a dominantly andesitic crust, it might be consistent with hydrous magmatism, which could produce dense pyroxenitic cumulates in the lower crust [*Muentener et al.*, 2000], perhaps resembling the ALH84001 orthopyroxenite.

[25] Thermal and compositional buoyancy forces in the mantle source regions of basaltic magmas cause them to ascend and erupt on planetary surfaces. On Earth, mid-ocean ridge basalts accumulate as much as several kilometers below the level of neutral buoyancy (estimated at 100–400 m), suggesting that magma density may not control ascent once the magma reaches the shallow crust [*Hooft and Detrick*, 1993; *Ryan*, 1993]. Ultimately, buoyancy is likely to control ascent at deeper levels, but compositions of the most common magmas from mid-ocean ridges indicate that eruption controls are complex [*Grove et al.*, 1993; *Michael and Cornell*, 1998] and not solely a function of density contrast [*Stolper and Walker*, 1980]. Thus it may be unrealistic to use SNC magma