TES OBSERVATIONS OF CHRYSSE AND ACIDALIA PLANITIAE: MULTIPLE WORKING HYPOTHESES FOR DISTRIBUTIONS OF SURFACE COMPOSITIONS. M. B. Wyatt\(^1\), J. L. Bandfield\(^2\), H. Y. McSween, Jr.\(^1\), P. R. Christensen\(^2\), and J. Moersch\(^1\).\(^1\)Dept. of Geological Sciences and Planetary Geosciences Institute, University of Tennessee, Knoxville, TN 37996-1410 (mwyatt1@utk.edu). \(^2\)NASA Goddard Space Flight Center, Greenbelt, MD, 20771, \(^3\)Dept. of Geological Sciences, Arizona State University, Box 871404, Tempe, AZ, 85287-1404.

**Introduction:** Atmospherically corrected thermal emissivity data from the Mars Global Surveyor (MGS) Thermal Emission Spectrometer (TES) have been used to identify two unique global surface units \([1,2,3,4]\). The Surface Type 1 and 2 lithologies are divided roughly along the planetary dichotomy which separates ancient, heavily cratered crust in the southern hemisphere from younger lowland plains in the north \([2,5]\). Higher-resolution mapping has revealed a transitional band of both surface compositions occurring in the low-albedo regions of Chryse and Acidalia Planitiae. We examine the distribution of Surface Type 1 and 2 lithologies in this local area and fit observations into multiple working hypotheses describing the origin of these materials.

**Geologic Setting:** Chryse and Acidalia Planitiae are surrounded by the glacial terrains of Tempe, Xanthe, and Arabia Terra and Lunae Planum (Figure 1). Chryse Planitia makes up the southern portion of a basin with elevations ranging from 0 to -2000 m and grades north into Acidalia Planitia with elevations decreasing to -4000 m. Several large outflow channels (Ares, Simud, and Tiu Valles) empty into Chryse Planitia \([6]\) and eventually grade into broad relatively smooth plains further north in Acidalia Planitia. Chryse and Acidalia Planitiae landforms and surface materials have been variously interpreted as subaerially emplaced mass flows \([6]\), catastrophic flood deposits \([7]\), and coastal marine/lacustrine sediments \([8]\).

**Surface Compositions:** Average TES spectra were deconvolved using the global martian surface and atmospheric spectral end-members \([2,3]\) to derive compositions in Chryse and Acidalia Planitiae. Atmospherically corrected TES spectra \([3,4]\) were constrained by low atmospheric dust and water-ice opacities, warm surface temperatures, and low emission angles. The Surface Type 1 spectral end-member has been previously interpreted as a largely unweathered basaltic composition characterized by high abundances of plagioclase and pyroxene \([1,2,9]\). The Surface Type 2 spectral end-member has been interpreted both as an andesitic composition \([2,9]\) (high modal plagioclase and volcanic glass, low modal pyroxene) and as partly weathered basalt \([10]\) (high modal plagioclase and alteration phases, low modal pyroxene).

**Mapped Distributions:** Figure 2 shows the regional distribution of Surface Type 1 (green) and 2 (red) lithologies in Chryse and Acidalia Planitiae. Blue pixels on the TES composition map represent areas covered by fine-grained bright dust which blankets the surface and prohibits spectral analysis of sand and rock compositions. Yellow pixels indicate mixing of Surface Type 1 and 2 materials.

Surface Type 1 dominates the southern highlands of Xanthe Terra and southern Arabia Terra while Surface Type 2 dominates northern Acidalia Planitia. Both surface types coincide well with observed low-albedo regions despite the higher uncertainty with Surface Type 2 due to random and systematic noise inherent in this spectral signature. A mixing/transition from Surface Type 1 to Surface Type 2 (south to north) compositions is observed in low-albedo regions marking the southern extent of Acidalia Planitia and north-eastern extent of Chryse Planitia (dashed oval).

Figure 3 shows average atmospherically corrected \([3,4]\) spectral signatures of surface materials within the mixing/transition band compared with materials to the north. Within the band, surface components contain a broad, flat absorption between \(\sim 800-1000 \text{ cm}^{-1}\) and absorption through \(\sim 200-500 \text{ cm}^{-1}\). North of the band, surface components contain a more V-shaped absorption between \(\sim 800-1000 \text{ cm}^{-1}\) and more uniform slope between \(\sim 200-500 \text{ cm}^{-1}\). Linear deconvolution of these spectra using the Surface Type 1 and 2 end-members reveal the surface spectrum from within the band is dominated by a Surface Type 1 component \((\sim 60 \text{ vol.}%)\), however with a significant contribution of Surface Type 2 material \((\sim 40 \text{ vol.}%\)). The reverse is seen to the north with the surface spectrum dominated by a Surface Type 2 component \((\sim 66 \text{ vol.}%\)) with a significant contribution of Surface Type 1 material \((\sim 34 \text{ vol.}%\)).

**Multiple Working Hypotheses:** The distributions of Surface Type 1 and 2 materials, combined with the andesite and weathered basalt interpretations for the Surface Type 2 lithology, allow for several possible explanations to describe the history of sedimentation in Chryse and Acidalia Planitiae.

**Andesite and Basalt.** Subaerially emplaced mass flows \([6]\) or flood deposits \([7]\) could explain the observed mixing band of Surface Type 1 (basalt) and Surface Type 2 (andesite) compositions. Material transported to the north by large outflow channels into Chryse and Acidalia Planitiae originated toward the
south of highlands, which is dominated by basaltic materials. The basalt-dominated mixing band marking the southern extent of Acidalia Planitia and northeastern extent of Chryse Planitia could represent the maximum extent of sediment transport for these channels. The dust covered region between this band and the basalt dominated southern highlands would thus also be dominated by basaltic materials. The andesite in central Acidalia is interpreted as regionally indigenous volcanic material that is partly covered and mixed with basaltic sand transported from the south.

**Weathered Basalt and Basalt.** Geomorphic contacts previously interpreted as ancient shorelines [8] have recently been examined with high-resolution MOLA data and have been found to approximate an equipotential line [11]. Shoreline contacts in Chryse and Acidalia Planitiae coincide very well with the transition zone between Surface Type 1 (basalt) and Surface Type 2 (weathered basalt) [10]. The transition between the two surface types could mark the southern extent of alteration caused by large bodies of standing water in the northern lowlands. The basalt dominated band and large volume of weathered basalt in central Acidalia are both interpreted as indigenous materials reflecting a progression of more advanced alteration of basalt towards deeper water levels.

**Summary:** The gradational boundary of Surface Type 1 and 2 materials in Acidalia and Chryse Planitiae may represent either (1) an influx of basaltic sediment from the southern highlands, deposited on andesitic volcanics, or (2) incompletely weathered basalt marking the geographic extent of submarine alteration of basaltic crust.


Figure 1: Viking composite image of Chryse and Acidalia Planitiae and surrounding regions.

Figure 2: TES composition map showing regional distribution of Surface Type 1 (green) and 2 (red) lithologies in Chryse and Acidalia Planitiae. Blue pixels represent areas covered by fine-grained bright dust and yellow pixels indicate mixing of surface types.

Figure 3: Average atmospherically corrected spectral signatures of surface materials within the mixing/transition band compared with materials to the north.