

Table 1. Recalculated Martian Fines Composition Based on Recalibration of Mars Pathfinder APXS Analyses of Soils^a

	Na ₂ O	MgO	Al ₂ O ₃	SiO ₂	P ₂ O ₅	SO ₃	Cl	K ₂ O	CaO	TiO ₂	Cr ₂ O ₃	MnO	Fe ₂ O ₃
MP(Waenke)	1.1	8.5	7.8	41.5	1.3	6.7	0.5	0.7	6.4	1.0	0.3	0.5	21.8
MP(Foley)	2.7	7.3	10.0	40.8	0.8	6.0	0.9	0.5	5.9	0.8	0.3	0.3	21.7
MP(fines)	2.1	7.9	8.9	41.1	1.0	6.3	0.7	0.6	6.2	0.9	0.3	0.4	21.8
V(fines)		6.0	7.9	46.6		7.2		0.8	6.3	0.7			19.5
Global dust	2.1	7.0	8.4	43.9	1.0	6.8	0.7	0.7	6.3	0.8	0.3	0.4	20.7

^aMartian fines composition is measured in wt.% oxides. Mars Pathfinder soil averages of *Waenke et al.* [2001] and *Foley et al.* [2003], indicated by MP, include all reported soil analyses except A8 (cemented soil). All Pathfinder analyses were normalized to 98% to allow for unanalyzed water (estimated ~2 wt% [*Biemann et al.*, 1977; *Yen et al.*, 1998]). MP(fines) is an average of the MP(Waenke) and MP(Foley) values. V(fines) is an average of all Viking 1 analyses of fines (C-1, C-6, C-7, C-8, C-9) from *Clark et al.* [1982]. All Viking analyses were normalized to 94.5%, to allow for unanalyzed Na₂O, P₂O₅, Cr₂O₃, MnO (average Pathfinder values were assumed) and 2% water. Global dust is an average of MP(fines) and V(fines).

al., 2000] from TES. The surface type 1 spectral end-member has been interpreted as unaltered basalt characterized by high deconvolved abundances of plagioclase and clinopyroxene [*Christensen et al.*, 2000a; *Bandfield et al.*, 2000; *Hamilton et al.*, 2001]. The surface type 2 spectral end-member has been variously interpreted as unaltered basaltic andesite or andesite [*Bandfield et al.*, 2000; *Hamilton et al.*, 2001] or as partly altered basalt [*Wyatt and McSween*, 2002; *Morris et al.*, 2003]. The andesitic composition is characterized by high deconvolved abundances of plagioclase and high-silica volcanic glass [*Bandfield et al.*, 2000; *Hamilton et al.*, 2001]. The partly altered basalt is characterized by high modal abundances of plagioclase and a variety of alteration phases (sheet silicates, silica coatings, and palagonite) and low modal pyroxene [*Wyatt and McSween*, 2002; *Morris et al.*, 2003]. Detectable abundances of hematite [e.g., *Christensen et al.*, 2000b], orthopyroxene [e.g., *Hamilton et al.*, 2003; *Bandfield*, 2002], and olivine [e.g., *Clark et al.*, 1982; *Hamilton et al.*, 2003; *Bandfield*, 2002] have also been identified in regional and local occurrences where surface type 1 compositions dominate surface units. The identification of these phases may represent unique surface lithologies (i.e., dunite), or higher abundances of each phase in a basaltic surface unit (i.e., olivine-bearing basalt). Here we focus on surface type 2, as a huge expanse of andesite (versus altered basalt) would significantly influence the bulk composition of the Martian crust.

[21] The initial ambiguity in interpreting the surface type 2 lithology from deconvolved TES mineral abundances arose because volcanic siliceous glass (a major component of andesite) was shown to be spectrally similar to some alteration phases (sheet silicates, amorphous silica coatings, and K-feldspar) over the spectral ranges used in deriving the TES surface spectral end-members [*Wyatt and McSween*, 2002]. Absorption features between 500–550 cm⁻¹ in laboratory spectra can be used to distinguish well-crystalline clay minerals from high-silica volcanic glass; however, this region was excluded by *Bandfield et al.* [2000] while deriving the TES spectral end-members because the CO₂ atmosphere of Mars is largely opaque near this spectral region [*Wyatt and McSween*, 2002]. Significant quantities of well-crystalline clay minerals are not indicated by near-infrared observations using Mariner 9 ISM data [*Murchie et al.*, 2000] or telescopic observations [*Blaney et al.*, 2003], and work by *Ruff* [2003] examining the 500–550 cm⁻¹ region in non-atmospherically corrected TES spectra points to the lack of spectral absorption features indicative of well-crystalline clays. However, these studies do suggest that poorly crystalline clays and/or other alteration phases

may be permissible, and recent work [*Morris et al.*, 2003; *Ruff and Christensen*, 2003] has shown palagonites and zeolites to be spectrally similar to high-silica glass. Some highly shocked feldspars (maskelynites) are also spectrally similar to high-silica glass [*Johnson et al.*, 2002]. The original interpretation of the high-silica glass spectral end-member as a primary volcanic glass [*Bandfield et al.*, 2000] was also shown to be too limited, as deconvolved modal abundances of the natural surface of a terrestrial flood basalt suggested it could also represent an amorphous high-silica alteration product [*Wyatt and McSween*, 2002]. Analyses by *Kraft et al.* [2003] have further shown that the addition of high-silica alteration coatings on basalts results in a surface that is spectrally similar to andesite.

2.5.2. Distributions of Surface Compositions

[22] A global view of the distribution of surface type 1 and type 2 materials is shown in Figure 6. The distribution of the surface type 1 (basalt - green) unit is restricted to the southern highlands and Syrtis Major regions of Noachian or Hesperian age and to a few local occurrences in the northern

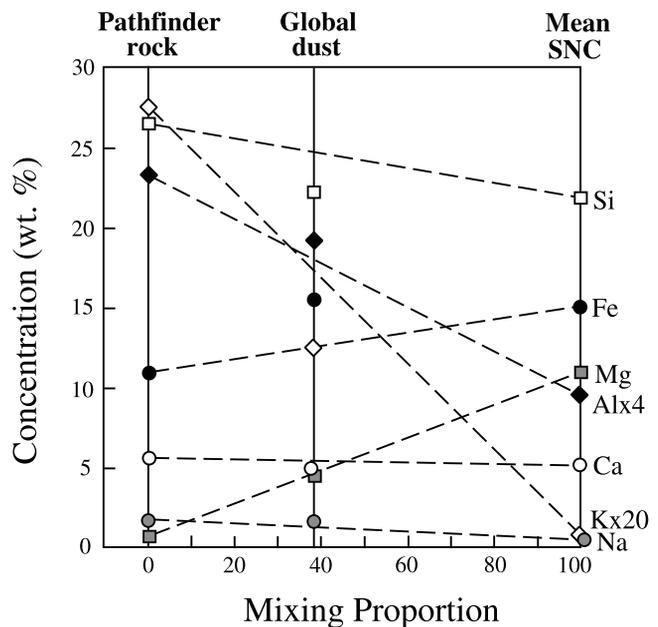


Figure 5. Two-component mixing diagram, testing the hypothesis that Martian fines (global dust) formed by combining basaltic (SNC meteorite) and andesitic (Mars Pathfinder dust-free rock) components. The best fit for dust (Table 1, salt-free) has significant discrepancies in silicon, iron, and potassium.