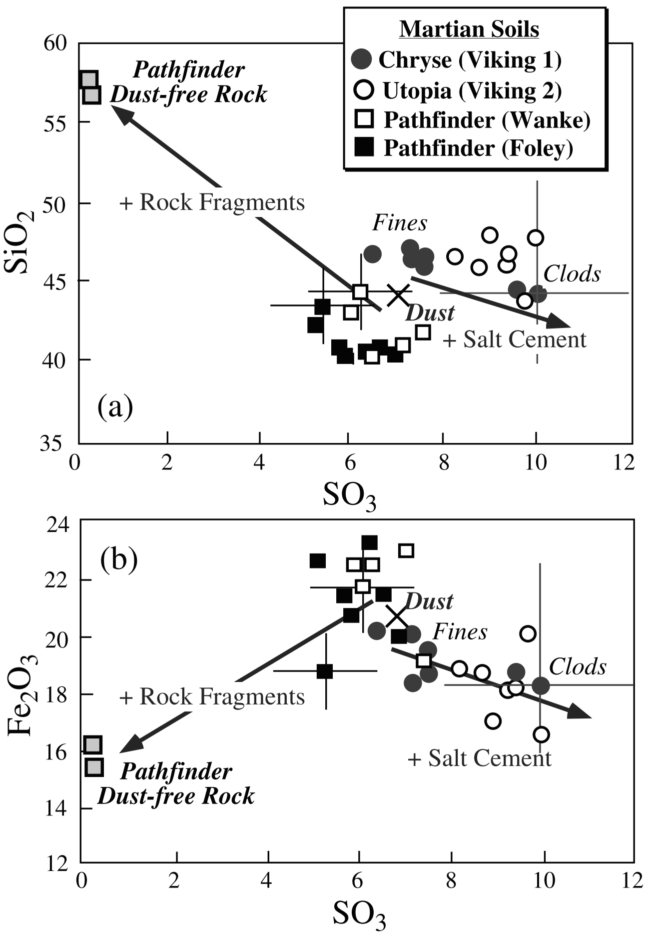

Figure 4. Variation diagrams illustrating the global dust composition (X), as well as the effects of admixed andesitic rock chips in Pathfinder soils and sulfate salt cement in Viking soils. The calculated dust composition (Table 1) may represent a nearly common chemical component at the Pathfinder and Viking 1 sites. Representative error bars are shown for several soil analyses from the Viking 1 and Pathfinder sites.

might represent a weathered rock surface. Under terrestrial weathering conditions silica is usually leached from basalt, but some basalts exposed to semi-arid conditions develop hydrous, silica-rich coatings [*Farr and Adams*, 1984; *Crisp et al.*, 1990]. Altered silicic coatings on Pathfinder rocks would be consistent with their photometric properties, which may imply varnished rinds [*Johnson et al.*, 1999]. *Bishop et al.* [2002] developed a model for the formation of Martian rock varnish, involving chemical reactions between rocks and the dust that settles on them. *Foley et al.* [2003] noted that plots of alkalis versus sulfur in Pathfinder rocks show considerable scatter, perhaps suggesting mobilization of soluble elements during weathering. APXS alpha mode analyses of oxygen [*Foley et al.*, 2003] suggest that the Pathfinder dust-free rock contains more oxygen than can be accounted for by stoichiometric combination with its cations. The excess oxygen in Shark, the rock with least dust cover, is equivalent to 3.3 ± 1.3 wt.% H_2O, assuming that half the iron is ferric. This water abundance is very high for igneous rocks, and may be more consistent with the hypothesis that Pathfinder rocks have weathered, hydrous coatings.

2.4. Martian Surface Fines as Proxies for Crust Composition

[17] The pervasive dust that covers the Martian surface is thought to have been globally homogenized by winds [e.g., *McCord et al.*, 1982], which may account for the compositional similarity of soil deposits at landing sites separated by thousands of kilometers [*Clark et al.*, 1982; *Waenke et al.*, 2001]. Fine-grained sediments are commonly used to estimate the composition of the Earth's crust [*McLennan and Taylor*, 1984], and surface fines might likewise provide a critical constraint on compositions of the dominant crustal rocks on Mars.

[18] Originally, the compositional similarity between Viking soils and basaltic shergottites was cited as evidence that the soils formed from basalts [*Toulmin et al.*, 1977]. Following the discovery of rocks having andesitic compositions by Mars Pathfinder, a number of workers reinterpreted Pathfinder and Viking soil compositions as mixtures of basaltic (SNC) and andesitic materials in roughly equal proportions [*Larsen et al.*, 2000; *Morris et al.*, 2000; *Waenke et al.*, 2001]. At face value, this would seem to be evidence for the existence of significant amounts of silicic crust. Such a model presumes that soils formed by mechanical weathering of rocks, without significant chemical modification.

[19] Alternatively, analyzed Martian soils could represent mixtures of a common (globally homogenized) dust component with varying amounts of local (andesitic) rock particles at the Pathfinder site and with sulfate cements at the Viking sites [*McSween and Keil*, 2000]. Because the Pathfinder APXS analyses of soils have recently been recalibrated [*Waenke et al.*, 2001; *Foley et al.*, 2003], we have replotted these compositions to see if the trends noted by *McSween and Keil* [2000] persist (Figure 4). The recalibrated Pathfinder soil analyses are not as readily interpreted as dust with admixed local rock (Figure 4), but it is still possible to estimate an average soil composition from uncemented Pathfinder and Viking soils. This composition, which we assume represents the global dust, is presented in Table 1 (the calculation procedure and assumptions are also described in Table 1) and shown by Xs in Figure 4. The common dust composition itself can be modeled as basalt that has undergone a moderate degree of chemical weathering [*McSween and Keil*, 2000]. Various chemical weathering mechanisms (palagonitization, hydrothermal alteration, reactions of rocks with acid fog formed by volcanic exhalations) have been suggested as possible origins for Martian soils (summarized by *Bell et al.* [2000]). However, the hypothesis that the global dust may have formed by simple mixing of basaltic and andesitic components does not seem to be tenable, given the mismatch for silicon, iron, and potassium in mixing calculations (Figure 5).

2.5. Thermal Emission Spectroscopy of the Crust

2.5.1. Surface Compositions

[20] Two distinct global surface spectral signatures have been identified in low-albedo regions on the Martian surface [*Christensen et al.*, 2000a; *Bandfield et al.*, 2000] using atmospherically corrected thermal emissivity data [*Smith et