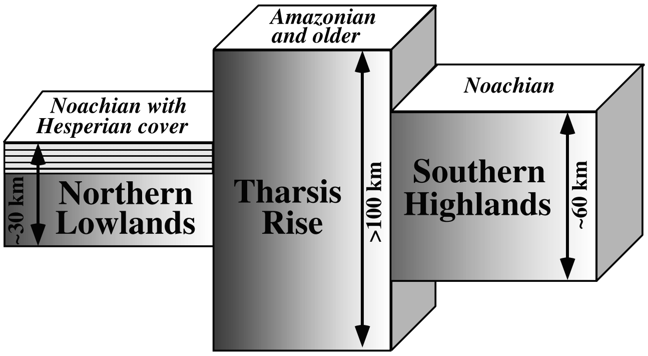

Figure 1. Schematic illustration of major subdivisions of the Martian crust. The exposed southern highlands and the basement beneath the Hesperian cover in the northern lowlands are of Noachian age. Volcanism associated with the Tharsis plume produced a very thick crust and extended into the Amazonian period. Crustal thickness estimates are from *Solomon and Head* [1982] and *Zuber* [2001].

recent enough to host these rocks. Attempts to locate specific launch sites for Martian meteorites using TES spectra have not been successful [*Hamilton et al.*, 2003], because Tharsis, Elysium, and perhaps other young volcanic terranes are mantled by thick blankets of dust. Earlier studies concluded that visible/near-infrared (VISNIR) spectra of dark regions (without dust cover) on Mars were similar to basaltic shergottites [*Mustard et al.*, 1997]. However, VISNIR spectra are primarily sensitive to the presence of ferromagnesian minerals, and the similarity in this case refers to pyroxene compositions rather than to the bulk mineralogy.

[11] The apparent absence of rocks other than basalts or their plutonic derivatives among young Martian meteorites suggests that the crust comprising the young volcanic centers is basaltic. However, the fact that many Martian meteorites are partial cumulates demonstrates that fractionation did occur, possibly yielding more silicic residual magmas. Attempts to constrain lava rheologies, and thereby infer lava compositions, from the eruption styles of Tharsis and Elysium volcanoes allow a wider range of magma compositions [e.g., *Zimbelman*, 1985; *Catermole*, 1987; *Baloga et al.*, 2003], but these models suffer from ambiguities related to magma effusion rate, crystallinity, and other factors that influence flow rheology.

[12] Although SNC meteorites have provided critical insights into the timing of crust formation and the geochemical nature of the mantle source region after early crust extraction, they are not samples of the ancient crust and thus cannot provide direct information on its composition. Later in this paper, we will introduce evidence that the ancient crust is distinctly different from Martian plume magmatism as revealed by SNCs.

2.2. Crustal (?) Reservoir Sampled by Shergottite Magmas

[13] The parental magmas for basaltic and olivine-phyric shergottites sampled two distinct geochemical reservoirs. Correlations between initial radiogenic isotope ratios ($^{87}Sr/^{86}Sr$, $^{143}Nd/^{144}Nd$, $^{176}Hf/^{177}Hf$) and fractionations of rare earth elements (REE) could indicate incorporation

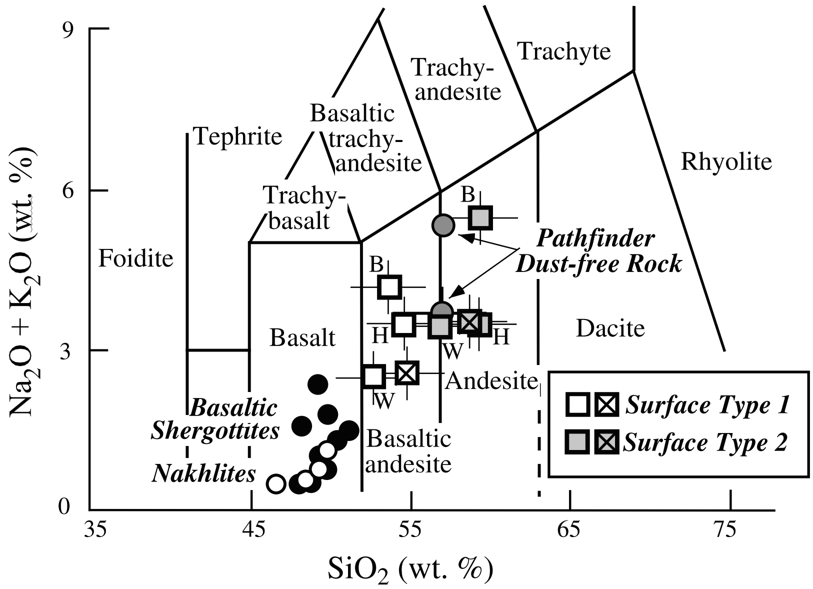

Figure 2. Total alkalis versus silica classification diagram for volcanic rocks [*Le Bas et al.*, 1986], showing the compositions of basaltic shergottites (including olivine-phyric shergottites) and nakhlites [*Lodders*, 1998; *Dreibus et al.*, 2000; *Folco et al.*, 2000; *Rubin et al.*, 2000; *Barrat et al.*, 2002; *Taylor et al.*, 2002; *Imae et al.*, 2003], two calibrations of the Mars Pathfinder dust-free rock (point with lower alkalis from *Waenke et al.* [2001], point with higher alkalis from *Foley et al.* [2003]), and MGS-TES-derived chemical compositions (Table 4) for surface types 1 and 2 of *Bandfield et al.* [2000] (B), *Hamilton et al.* [2001] (H), *Wyatt and McSween* [2002] (W), and our new estimates based on an extended spectral range (X-boxes). The same symbols are used in subsequent diagrams.