

SEDIMENTS AND THE CHEMICAL COMPOSITION OF THE UPPER MARTIAN CRUST. B. C. Hahn¹ and S. M. McLennan², ¹Department of Earth & Planetary Sciences, University of Tennessee, Knoxville, TN 37996 (bhahn1@utk.edu), ²Department of Geosciences, Stony Brook University, Stony Brook, NY 11794-2100 (scott.mclennan@sunysb.edu).

Introduction: For Earth, many past studies have used sediment compositions to help constrain estimates of the composition of the terrestrial upper continental crust [1,2]. Weathering, sedimentary transport, and deposition naturally sample a wide array of source rocks with the resultant chemistry being an efficient mixture of source terrains. However, significant partitioning of the major elements occurs among distinct sedimentary lithologies through various aqueous processes. Accordingly, sediment chemistry alone is not the most reliable means of determining bulk major element composition of the upper continental crust, and major element abundances are thus determined using weighted averages of major rock provinces. Averages of sedimentary rock chemistry do provide a good proxy for the relatively insoluble trace element abundances found in the continental crust.

For Mars, phyllosilicates, sandstones, an assortment of evaporates, and most recently, carbonates have been detected in varying amounts at various locations around the planet through remote sensing and in situ rover observations [3-6]. However, the dominant sedimentary products that have been recognized and characterized to date are the martian dust and basaltic loose regolith or soils. Chemical alteration is mostly local and often confined to the very near rock surfaces, as would be expected in a water-limited weathering environment. As such, while there is some addition of altered components such as sulfates, the martian soils are a largely unaltered and unfractionated representative of the primary lithologies from which they have been derived (**Figure 1, right**) and therefore generally preserve the bulk chemistry of those sources.

After carefully screening soil samples from all landing site measurements, renormalizing to a S- and Cl-free composition, and adjusting for a meteoritic component [7], the estimate for the bulk chemistry of the upper martian crust is listed in **Table 1 (right)**. Martian sediments only sample the upper crust and, as such, chemical composition estimates may not be applicable to the total martian crust.

References: [1] Taylor S. R. and McLennan S. M. (1985) *The Continental Crust*, Blackwell, Oxford, UK. [2] Condie K. C. (1993) *Chem. Geol.*, 104, 1-37. [3] Bibring J. P. et al (2005) *Science*, 307, 1576-1581. [4] Grotzinger et al (2005) *EPSL*, 240, 11-72. [5] Arvidson et al (2008) *JGR*, 113, 2008JE003183. [6] Ehlmann et al (2008) *Science*, 322, 1828-1832. [7] Yen et al (2006) *JGR*, 111, 2006JE002797. [8] Yen et al (2005) *Nature*, 436, 49-54.

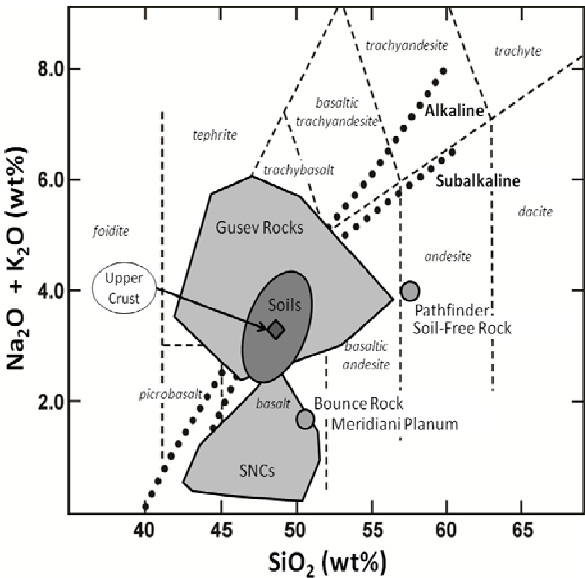


Figure 1: TAS classification diagram of Martian sediments and selected APXS landing site rock analyses. Calculated average upper crust plots in the basalt field just below the subalkalic fractionation line. Martian soils plot within the cluster of Martian rock measurements SNC analyses indicating they represent a physical mixture of primary sources without extreme chemical fractionation [8].

Table 1. Unscreened/screened average soil compositions and renormalization corrections

	Unscreened		Screened		Screened and
	value	SD	value	SD	Renormalized
SiO ₂	45.7	9.7	45.7	1.9	49.0
TiO ₂	0.89	0.2	0.89	0.2	0.95
Al ₂ O ₃	8.87	2.1	9.58	1.0	10.3
FeO	18.6	6.3	17.5	2.9	18.8
Cr ₂ O ₃	0.35	0.1	0.37	0.1	0.40
MnO	0.31	0.1	0.34	<0.1	0.34
MgO	7.88	1.9	8.52	1.6	9.13
CaO	6.02	1.4	6.36	0.6	6.82
Na ₂ O	2.44	0.7	2.67	0.5	2.86
K ₂ O	0.41	0.1	0.45	0.1	0.48
P ₂ O ₅	0.93	0.7	0.84	0.1	0.90
Ni (ppm)	540	220	500	130	305 (ppm)
Zn (ppm)	310	160	310	160	310 (ppm)
SO ₃ ^{**}	6.94	5.7	5.92	1.8	
Cl ^{**}	0.67	0.2	0.70	0.2	
Σ	100.0		100.0		100.0

^{**}Screened SO₃ and Cl averages are subtracted from the Screened soil average and renormalized to 100%