COMPARISON OF MÖSSBAUER SPECTRA OF SOILS FROM GUSEV CRATER AND MERIDIANI PLANUM.

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Introduction: One of the strengths of Mössbauer spectroscopy is its ability to distinguish between the different oxidation states of iron in minerals. Such information is very useful in the determination of the degree of weathering of a planetary surface. Comparison between the mineralogy and oxidation state of the soils at Gusev and those at Meridiani lends insight into the processes that shaped the Martian surface.

Methods: Data on selected soils from the PDS site were processed using *MERView* [1] and folded, in keeping with general conventions in this discipline. To improve statistics, data from all acquisition temperatures were added together for each measurement. As noted in [2], fits to such data should be compared with parameters corresponding to Mössbauer spectra of candidate phases that were acquired at the temperature midpoint of the data set. In addition, data from sols where the same area was studied were also added together. Data were fit using an implementation of the software described in [3].

Results: A summary of the Mössbauer parameters of selected soils is shown in Tables 1 and 2. All spectra are consistent with the presence of Fe^{2+} and Fe^{3+} in octahedral coordination, and in addition display one or more magnetically-split sextets due to some iron oxide. Only the paramagnetic doublets are shown here.

The results are somewhat surprising. Although there is much evidence for the well-mixed nature of the Martian regolith [4, 5], there is not only a clear difference between the two sites, but a marked variability within a site. In particular, the Gusev soils have 55%-68% Fe^{2+} (before *f*-factor correction), and the Meridiani soils show a much larger range of 47%-79%. Note that this variation would not be detected by the APXS, which "sees" only the total Fe contents. The variation in Fe^{2+} may be due in part to the effect of the hematitic spherules, but the soils from Meridiani studied here were specifically chosen to have relatively low amounts of iron oxides (most were chosen from the "basaltic soils" of [6]), and the Fe^{2+} proportion does not appear correlated with the percentage of iron in the sextet(s). More likely, this is due to differences in regional geology of the two sites, which might be expected to produce variations in rock type, mineralogy, and bulk composition.

Table 1. Mössbauer results for Gusev data sets

Sol	Site	δ^*	Δ^*	Area**
14 (bright)	$^{[6]}Fe^{2+}$	1.17	2.89	25.9
	$^{[6]}Fe^{2+}$	1.16	2.16	40.9
	$^{[6]}Fe^{3+}$	0.35	0.98	27.0
47	$^{[6]}Fe^{2+}$	1.15	2.89	25.9
	$^{[6]}Fe^{2+}$	1.13	2.15	37.3
	$^{[6]}Fe^{3+}$	0.43	0.65	21.4
68+ 69+ 70 (bright)	$^{[6]}Fe^{2+}$	1.16	2.92	22.1
	$^{[6]}Fe^{2+}$	1.16	2.17	35.4
	$^{[6]}Fe^{3+}$	0.37	0.93	33.5
74 (dark)	$^{[6]}Fe^{2+}$	1.16	2.87	27.3
	$^{[6]}Fe^{2+}$	1.13	2.18	40.9
	$^{[6]}Fe^{3+}$	0.45	0.67	14.8
77	$^{[6]}Fe^{2+}$	1.17	2.96	36.1
	$^{[6]}Fe^{2+}$	1.15	2.11	18.7
	$^{[6]}Fe^{3+}$	0.51	0.69	29.4
167	$^{[6]}Fe^{2+}$	1.17	3.09	26.1
	$^{[6]}Fe^{2+}$	1.15	2.18	37.9
	$^{[6]}Fe^{3+}$	0.37	0.97	20.0
260+ 261	$^{[6]}Fe^{2+}$	1.16	3.02	23.0
	$^{[6]}Fe^{2+}$	1.14	2.18	37.5
	$^{[6]}Fe^{3+}$	0.39	0.84	26.9
316+ 317	$^{[6]}Fe^{2+}$	1.16	2.91	26.1
	$^{[6]}Fe^{2+}$	1.14	2.17	37.2
	$^{[6]}Fe^{3+}$	0.41	0.77	25.1
342+ 343	$^{[6]}Fe^{2+}$	1.16	2.91	28.6
	$^{[6]}Fe^{2+}$	1.15	2.17	36.7
	$^{[6]}Fe^{3+}$	0.39	0.90	16.0

The range of isomer shift and quadrupole splitting values for the Fe^{2+} doublets, both at Gusev and Meridiani, is small, suggesting that they represent the same species in all cases shown here (Figure 1). There is a larger variation in the parameters of the Fe^{3+} doublet, but it is difficult to say how much of this difference is due to different mineralogy, and how much is due to effects of the overlap of the larger Fe^{2+} doublets on the fitting of the smaller Fe^{3+} doublet.

However, there is reason to believe that this difference is real. When the soils are divided into "bright" and "dark" by the characterization of [5], the Fe^{3+} peaks separate nicely into two groups (Figure 2.). This suggests a fundamental distinction between

Table 2. Mössbauer results for Meridiani data sets

Sol	Site	δ*	Δ*	Area**
11	$^{[6]}Fe^{2+}$	1.16	2.90	27.8
	$^{[6]}Fe^{2+}$	1.13	2.19	41.4
	$^{[6]}Fe^{3+}$	0.43	0.67	15.2
25 (bright)	$^{[6]}Fe^{2+}$	1.15	2.88	13.7
	$^{[6]}Fe^{2+}$	1.15	2.20	33.2
	$^{[6]}Fe^{3+}$	0.39	0.78	39.1
26	$^{[6]}Fe^{2+}$	1.16	2.93	23.9
	$^{[6]}Fe^{2+}$	1.16	2.16	36.7
	$^{[6]}Fe^{3+}$	0.38	0.93	24.6
60 (bright)	$^{[6]}Fe^{2+}$	1.15	2.88	21.4
	$^{[6]}Fe^{2+}$	1.16	2.18	36.1
	$^{[6]}Fe^{3+}$	0.37	0.86	36.1
78	$^{[6]}Fe^{2+}$	1.16	2.90	24.4
	$^{[6]}Fe^{2+}$	1.14	2.17	44.1
	$^{[6]}Fe^{3+}$	0.46	0.76	17.5
90 (bright)	$^{[6]}Fe^{2+}$	1.15	2.87	20.8
	$^{[6]}Fe^{2+}$	1.14	2.17	36.8
	$^{[6]}Fe^{3+}$	0.39	0.80	27.5
165+ 166+ 167 (dark)	$^{[6]}Fe^{2+}$	1.16	2.90	26.3
	$^{[6]}Fe^{2+}$	1.13	2.19	47.9
	$^{[6]}Fe^{3+}$	0.46	0.65	14.6
237+ 238 (dark)	$^{[6]}Fe^{2+}$	1.16	2.89	30.3
	$^{[6]}Fe^{2+}$	1.12	2.18	48.4
	$^{[6]}Fe^{3+}$	0.46	0.71	17.5
246+ 247+ 248	$^{[6]}Fe^{2+}$	1.16	2.89	33.7
	$^{[6]}Fe^{2+}$	1.14	2.17	43.2
	$^{[6]}Fe^{3+}$	0.44	0.76	17.7

*δ and Δ are given in mm/s and B_{hf} in T. **Area (in %) is given only for the paramagnetic phases, not including the area of the magnetically-split sextet also present, which area was at most 15% of the total.

the mineralogy of the "bright" and "dark" soils that is subtly reflected in the Mössbauer parameters. As noted in [5] and [8], this may well be due to the presence of higher S in the brighter soils, and resultant mineralogical variations. Our Mössbauer data certainly support the idea proposed by [5] that the bright dust is globally distributed.

Discussion. Mineral identification in these soil samples is still under discussion [7]. However, based on the relative uniformity of their Mössbauer parameters (and disregarding the hematitic spherules that are probably currently being weathered out of the Meridiani bedrock), it seems likely that Fe-bearing mineralogy in the bulk of the soils at Gusev and Meridiani is similar. The majority of mineralogical variations appears to be represented by variations in the Fe^{3+}-bearing minerals at the two different sites.

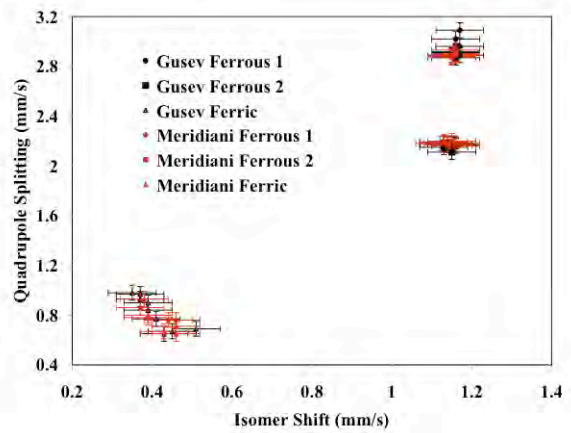

Figure 1. Mossbauer parameters for soils from the two different MER landing sites. The two ferrous doublets and the ferric doublet are clearly distinguished. There is a small spread in the ferrous 1 values from Gusev, and a much larger spread in the ferric values, uncorrelated with site.

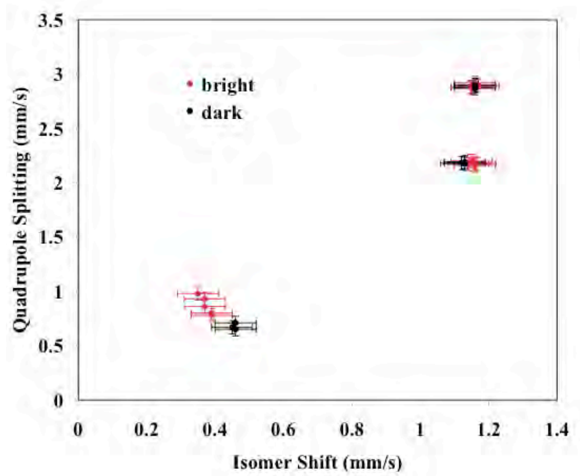

Figure 2. Mössbauer parameters for bright and dark soils from both landing sites. The spread in ferric values here appears strongly correlated with the soil type.

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