PROPERTIES OF MARTIAN HEMATITE AT MERIDIANI PLANUM BY SIMULTANEOUS FITTING OF MARS MÖSSBAUER SPECTRA

D. G. Agresti[1], I. Fleischer[2], G. Klingelhöfer[2], and R. V. Morris[3]
[1]Dept. of Physics, University of Alabama at Birmingham, Birmingham, AL 35294-1170, USA (agresti@uab.edu)
[2]Institut für Anorganische Chemie und Analytische Chemie, Johannes Gutenberg Universität, Staudinger Weg 9, 55128 Mainz, Germany (fleischi@uni-mainz.de)
[3]NASA Johnson Space Center, ARES Mail Code KR, 2101 NASA Parkway, Houston, TX 77058, USA

Introduction. Mössbauer spectrometers [1] on the two Mars Exploration Rovers (MERs) have been making measurements of surface rocks and soils since January 2004, recording spectra in 10-K-wide temperature bins ranging from 180 K to 290 K. Initial analyses focused on modeling individual spectra directly as acquired or, to increase statistical quality, as sums of single-rock or soil spectra over temperature or as sums over similar rock or soil type [2, 3].

Recently, we have begun to apply simultaneous fitting procedures [4] to Mars Mössbauer data [5-7]. During simultaneous fitting (simfitting), many spectra are modeled similarly and fit together to a single convergence criterion. A satisfactory simfit with parameter values consistent among all spectra is more likely than many single-spectrum fits of the same data because fitting parameters are shared among multiple spectra in the simfit. Consequently, the number of variable parameters, as well as the correlations among them, is greatly reduced.

Here we focus on applications of simfitting to interpret the hematite signature in Mössbauer spectra acquired at Meridiani Planum, results of which were reported in [7].

The Spectra. We simfit two sets of spectra with large hematite content [7]: 1) 60 rock outcrop spectra from Eagle Crater; and 2) 46 spectra of spherule-rich lag deposits (Table 1). Spectra of 10 different targets acquired at several distinct temperatures are included in each simfit set. In the table, each **Sol** (martian day) represents a different target, $\mathbf{N_S}$ is the number of spectra for a given sol, and $\mathbf{N_T}$ is the number of spectra for a given temperature. The spectra are indexed to facilitate definition of parameter relations and constraints. An example spectrum is shown in Figure 1, together with a typical fitting model.

Results. We have shown that simultaneous fitting is effective in analyzing a large set of related MER Mössbauer spectra. By using appropriate constraints, we derive target-specific quantities and the temperature dependence of certain parameters. By examining different fitting models, we demonstrate an improved fit for martian hematite modeled with two sextets rather than as a single sextet, and show that outcrop and spherule hematite are distinct. For outcrop, the weaker sextet indicates a Morin transition typical of well-crystallized and chemically pure hematite, while most of the outcrop hematite remains in a weakly ferromagnetic state at all temperatures. For spherule spectra, both sextets are consistent with weakly ferromagnetic hematite with no Morin transition. For both hematites, there is evidence for a range of particle sizes.

Table 1. Indexing for spectra of lag spherule deposits.

	Temperature (K)										
Sol	**195**	**205**	**215**	**225**	**235**	**245**	**255**	**265**	**275**	**285**	$\mathbf{N_S}$
46		1	2	3	4	5	6	7	8		**8**
52							9	10			**2**
73							11	12			**2**
97						13					**1**
222		14	15	16	17	18	19				**6**
368							20	21	22	22	**3**
415	23	24	25	26	27	28	29	30	31	32	**10**
419									33	34	**2**
420									35	36	**2**
445	37	38	39	40	41	42	43	44	45	46	**10**
$\mathbf{N_T}$	**2**	**4**	**4**	**4**	**4**	**5**	**7**	**6**	**6**	**4**	**46**

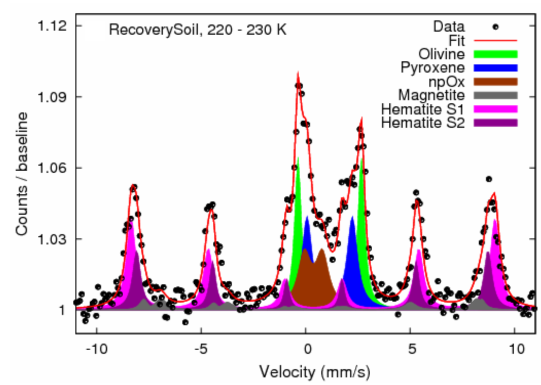

Figure 1. Spectrum acquired for the spherule-rich target "RecoverySoil_Cure" (Sol 445) between 220 K and 230 K (spectrum number 40 in the simfit set). Model parameters were derived from the simfit. (Figure after Ref. [7].)

References

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