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Supplementary Materials for

Curiosity at Gale Crater, Mars: Characterization and Analysis of the Rocknest Sand Shadow

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Published 27 September 2013, *Science* **341**, 1239505 (2013)
DOI: 10.1126/science.1239505

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Supplementary Text

Calculation of mineral compositions from their unit-cell parameters

The chemical compositions of the major mineral phases found in the Rocknest sediment fines were determined by relating their refined unit-cell parameters (Table S1, from (*20*)) to those published in the literature (*22*). The figures below show the unit-cell parameter versus chemical composition plots used to estimate the elemental compositions of olivine, plagioclase, augite and pigeonite (Table 3) and their empirical chemical formulas (Table S2).

Olivine

The Mg-content of olivine was obtained from the variation of Mg-content versus the unit-cell volume using data from the fayalite-forsterite join (Fig. S1). The least-squares equation for the number of atoms of Mg per formula unit (Mg#) as a function of the unit-cell volume is:

$$Mg\# = -0.0578V + 17.801$$

Plagioclase

The refined unit-cell parameters provided information on the composition of plagioclase feldspar along the Ca-Na join. High-Ca feldspars are characterized by a *c* unit-cell parameter that is double that of lower-Ca feldspars; therefore, our data were restricted to the lower-Ca feldspars. Variations in Ca-content with unit-cell parameters are given in Fig. S2a, S2b and S2c. Fig. S2a shows that the *b* unit-cell parameter is not suitable for determining composition; therefore *c* and α were selected to determine the chemistry.

$$Ca\# = 157.0882779c^2 - 2251.2412721c + 8065.692 \text{ (Fig. S2b)}$$
$$Ca\# = 0.6896416\alpha^2 - 130.2226916\alpha + 6147.38751 \text{ (Fig. S2c)}$$

Augite

Mg-content can be obtained from the variation of the *b* unit-cell parameter (Fig. S3a).

$$Mg\# = -9.8029b + 88.509$$

Fe/Mg content as a function of β has two sets of well-determined trends, that of Ca# = 1.0 and Ca# = 0.8 (Fig. S3b). Regressions of Mg-content for these two trends are:

$$Mg\# = 0.9157\beta - 95.956 \text{ (Ca\# = 1.0)}$$
$$Mg\# = 1.3719\beta - 144.74 \text{ (Ca\# = 0.8)}$$

Substituting the value of Mg# determined from *b* produced β equal to 105.761° for the Ca# = 1.0 trend and β equal to 106.145° for the Ca# = 0.8 trend. Linear interpolation, using our value of β, gives Ca# = 0.75. The value for Fe# = 2 - Mg# - Ca#.

Pigeonite

The Mg-content of pigeonite can be obtained from the *b* unit-cell parameter (Fig. S4a).

$$Mg\# = -8.9762b + 81.195$$

The Mg-Ca content as a function of unit-cell volume, V, has two sets of well-developed trends, that of Fe# = 1 and Fe# = 0 (Fig. S4b). Regressions of Mg-content for these two trends are:

$$Mg\# = -0.0471V + 21.148 \quad (Fe\# = 1)$$
$$Mg\# = -0.0254V + 12.572 \quad (Fe\# = 0)$$

Substituting the refined unit-cell volume from the Rocknest pigeonite gave Mg# = 0.89 for the Fe# = 1 trend and Mg# = 1.65 for the Fe# = 0 trend. Linear interpolation, using the Rocknest pigeonite Mg# estimated from *b* (1.13), gives Fe# = 0.68. The values for Ca# = 2 - Mg# - Fe#.

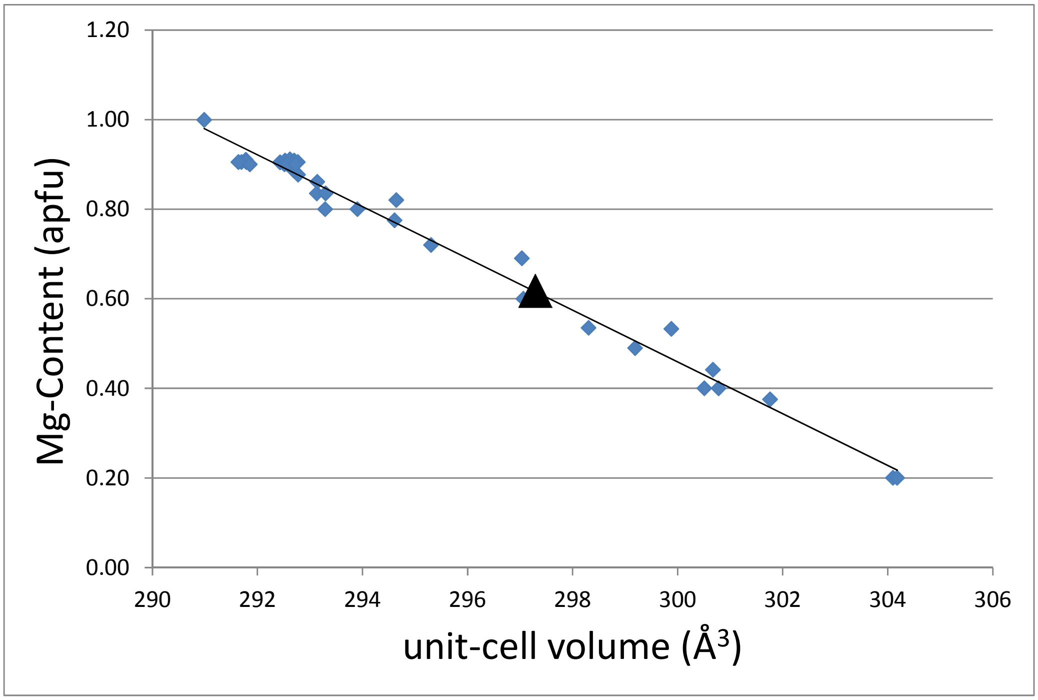

Fig. S1.
Mg-content of Fa-Fo olivine as a function of unit-cell volume. The black triangle represents the Rocknest olivine, indicating a composition of Fo 62.

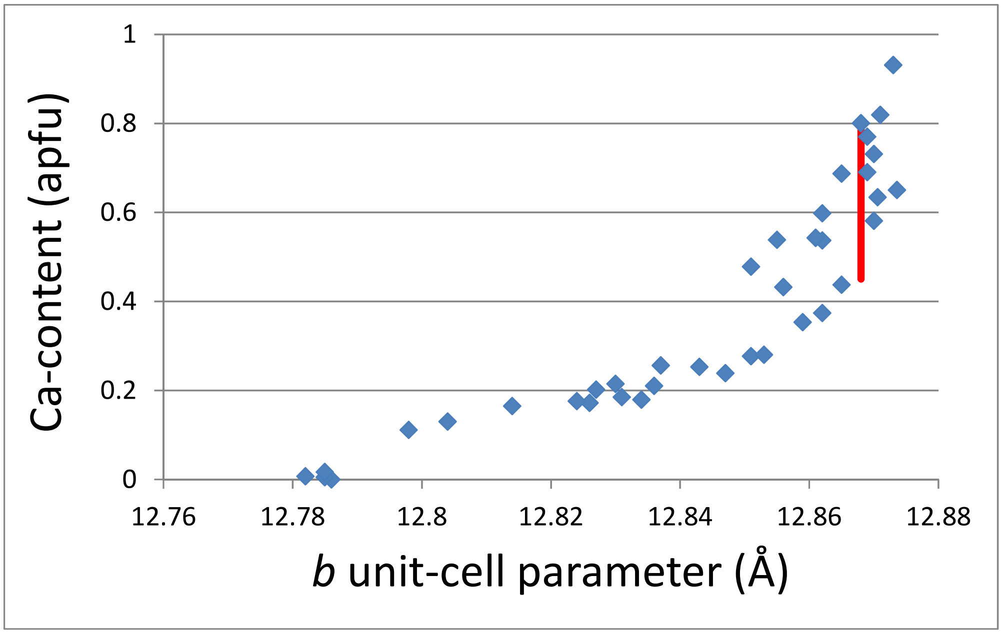

Fig. S2a

Ca-content of K-free plagioclase as a function of the *b* unit-cell parameter. The large scatter of data provides an error estimate of 12%.

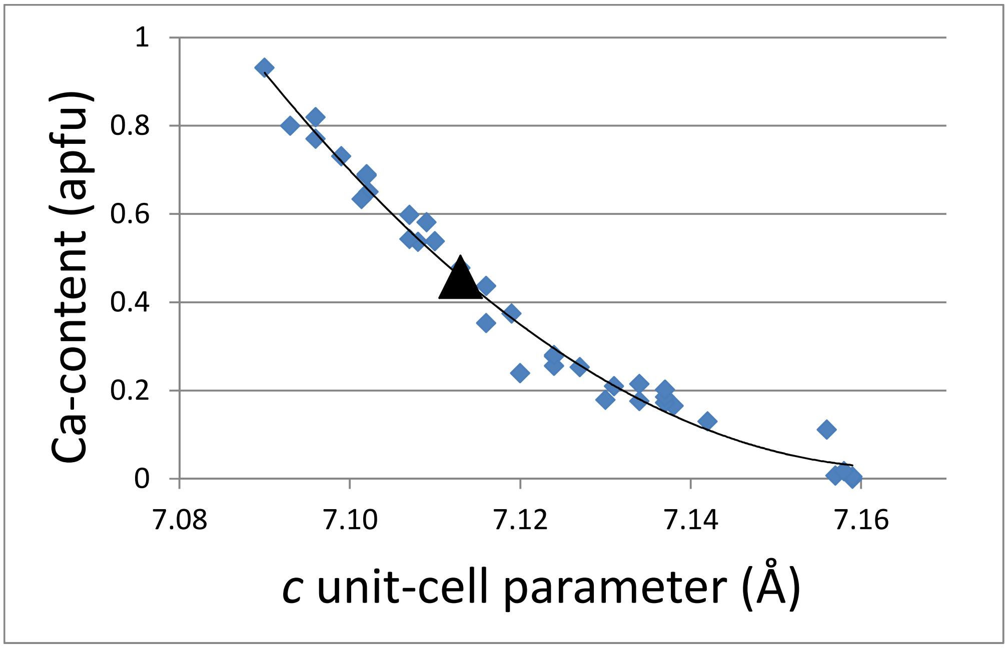

Fig. S2b

Ca-content of K-free plagioclase as a function of the *c* unit-cell parameter. This trend provides a lower bound on the amount of Ca (black triangle denotes Rocknest data).

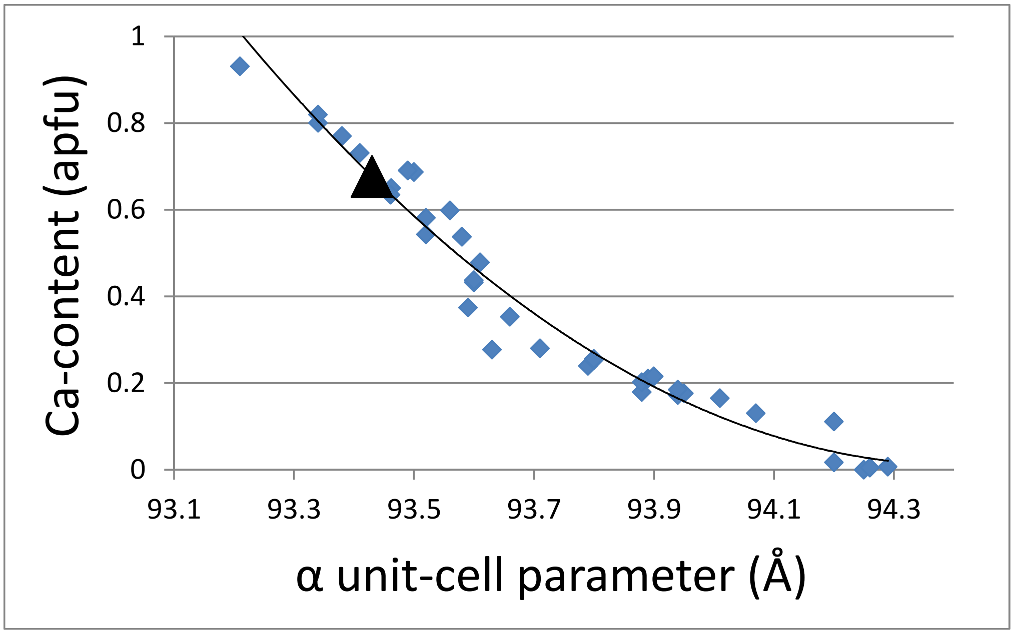

Fig. S2c

Ca-content of K-free plagioclase as a function of the α unit-cell parameter. This trend provides an upper bound on the amount of Ca (black triangle represents the Rocknest plagioclase).

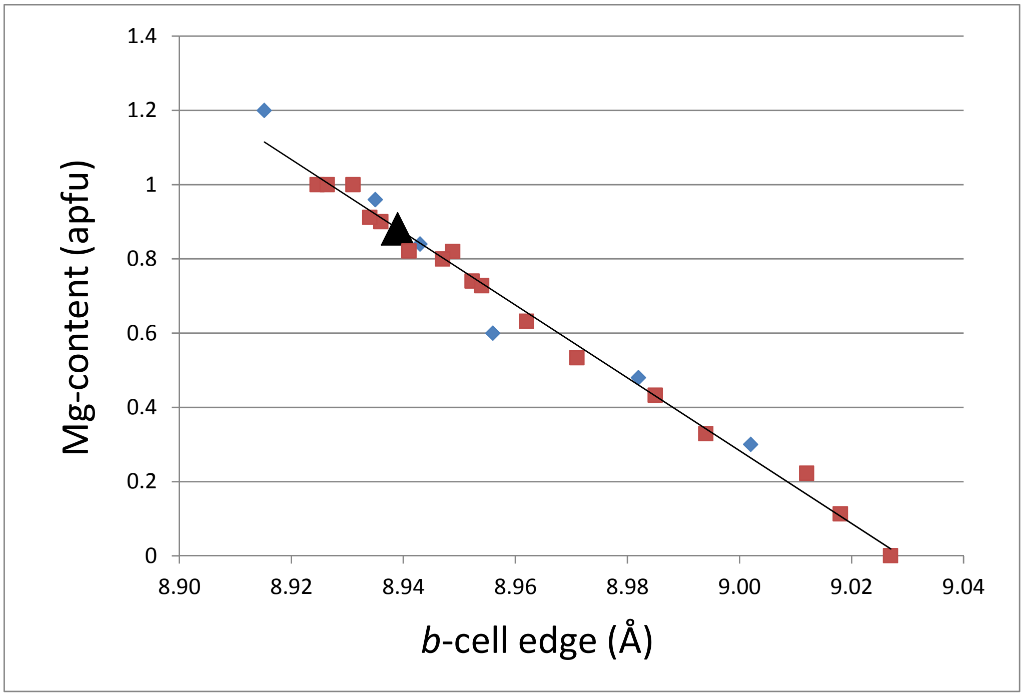

Fig. S3a

Variation of Mg-content with *b* unit-cell parameter in augite. Blue diamonds represent samples with Ca# = 0.8 and red squares are Ca# = 1. The black triangle represents the Rocknest augite – corresponding to a Mg# of 0.88.

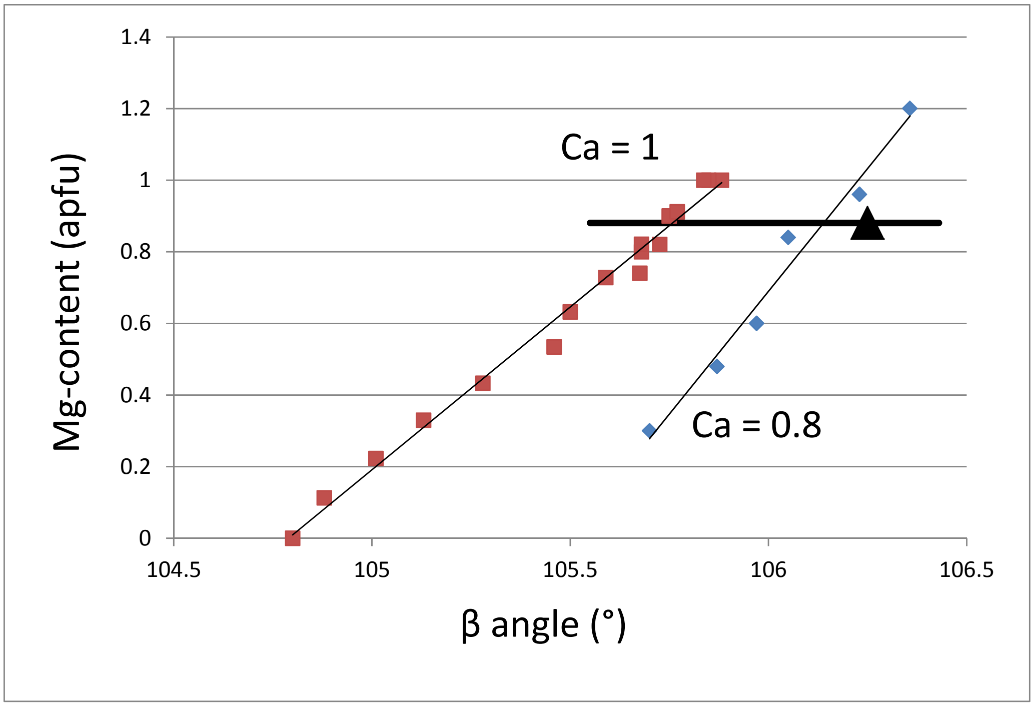

Fig. S3b

Ca-content in augite obtained by scaling the separation between the two trends of Mg-content versus β angle at Ca# = 1 (red squares) and Ca# = 0.8 (blue diamonds). The black triangle represents the Rocknest augite Mg-content at the refined β angle and corresponds to Ca# = 0.75.

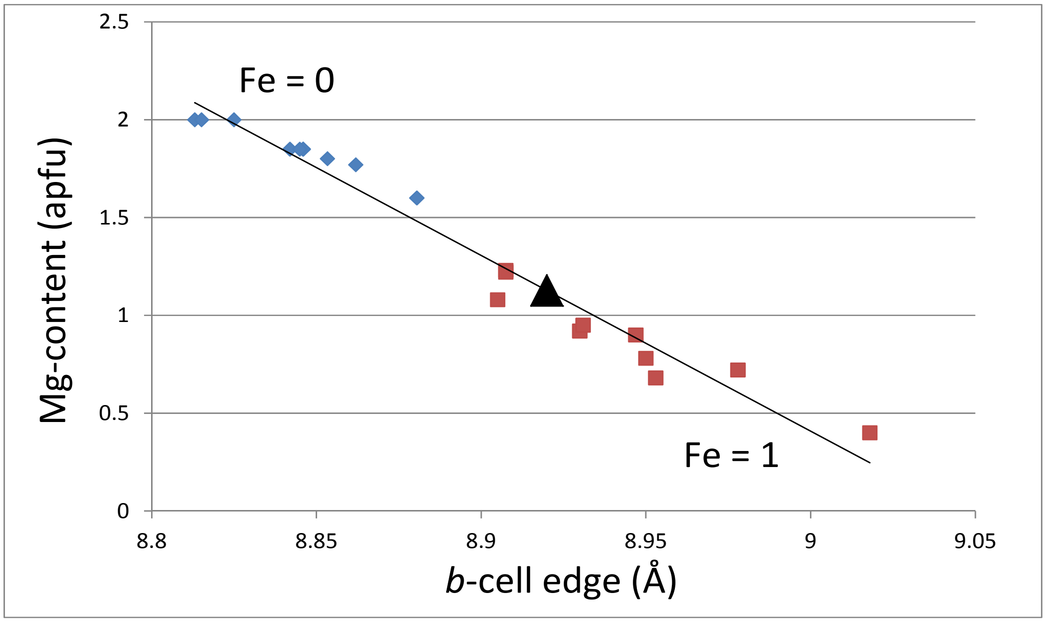

Fig. S4a

Variation of Mg-content with *b* unit-cell parameter in pigeonite. Blue diamonds represent Fe# = 0 and red squares are Fe# = 1. The estimated Mg# of the Rocknest pigeonite is 1.13 and is marked with the black triangle.

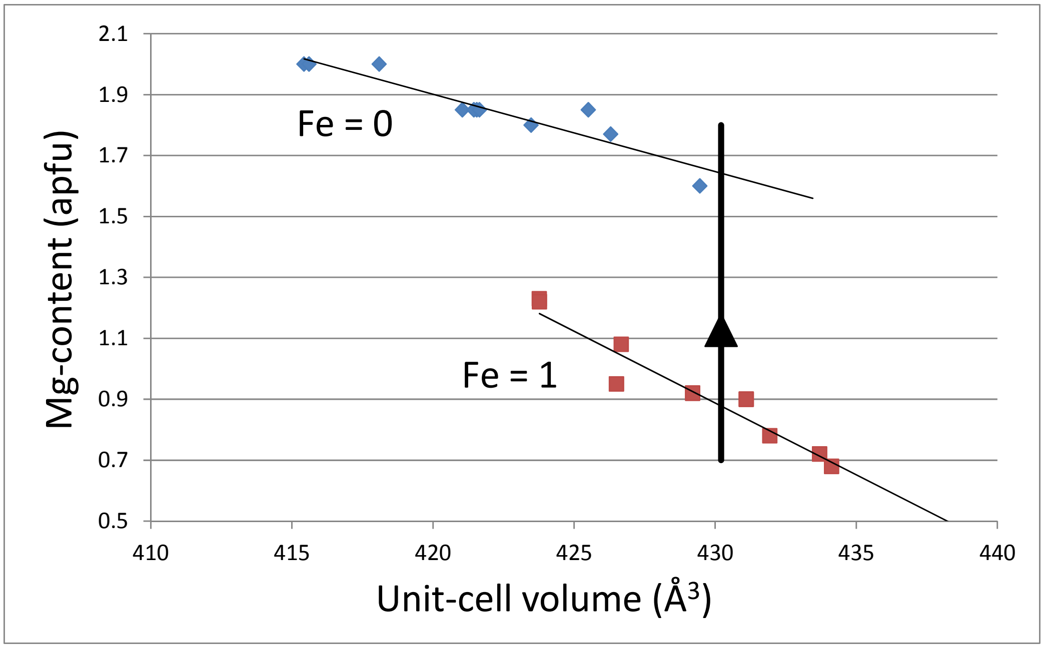

Fig. S4b

Fe-content in pigeonite - from the Mg-content determined above and scaling between the trends of samples with no Fe (blue diamonds) and Fe# = 1 (red squares), the Rocknest pigeonite is estimated to contain 0.68 apfu Fe.

Table S1.

Wt. % and refined unit-cell parameters of the major crystalline phases in Rocknest (20).

Mineral	Wt.%	2σ	*a* (Å)	*b* (Å)	*c* (Å)	α (°)	β (°)	γ (°)
plagioclase	40.8%	2.4%	8.177(6)	12.868(9)	7.113(5)	93.43(4)	116.26(2)	90.13(3)
forsterite	22.4%	1.9%	10.327(7)	6.034(7)	4.771(5)	90	90	90
augite	14.6%	2.8%	9.782(9)	8.939(9)	5.269(7)	90	106.25(9)	90
pigeonite	13.8%	2.8%	9.652(9)	8.92(1)	5.254(7)	90	108.0(1)	90

Table S2.
Oxide wt. % compositions of the crystalline mineral phases present in the <150 µm size fraction of Rocknest sediment

	augite	olivine	plagioclase	pigeonite	magnetite	hematite	ilmenite	sanidine	quartz	anhydrite	Total
SiO_2	53.58	36.49	53.81	53.36	0	0	0	64.76	100	0	48.66
TiO_2	0	0	0	0	0	0	52.65	0	0	0	0.37
Al_2O_3	0	0	29.50	0	0	0	0	18.32	0	0	13.04
FeO	11.85	33.16	0	21.69	87	100	47.35	0	0	0	13.95
MnO	0	0	0	0	0	0	0	0	0	0	0.00
MgO	15.81	30.35	0	20.22	0	0	0	0	0	0	11.17
CaO	18.75	0	11.78	4.73	0	0	0	0	0	41.19	9.30
Na_2O	0	0	4.91	0	0	0	0	0	0	0	2.11
K_2O	0	0	0	0	0	0	0	16.92	0	0	0.36
SO_3	0	0	0	0	0	0	0	0	0	58.81	0.82
Component	0.146	0.224	0.408	0.138	0.021	0.011	0.009	0.013	0.014	0.015	

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