SUPPLEMENTAL INFORMATION

SUPPLEMENTAL MATERIALS AND METHODS

Energy dispersive X-ray (EDX) spectrometry, and electron energy loss spectroscopy (EELS) analyses of *M. magneticum* AMB-1 grown in different divalent metal ion concentrations.

TEM studies were conducted on two microscopes; FEI CM200 field emission gun (FEG-)TEM equipped with a Gatan Imaging Filter (GIF 200) and an FEI Tecnai F20 FEG-TEM fitted with a Gatan Orius SC600A camera and an Oxford Instruments INCA 350 EDX System with an 80 mm² X-Max SDD detector.. EELS was acquired in diffraction mode (image coupled) with FEI CM200 and EEL spectra were acquired with an energy resolution of 0.8 eV and a dispersion of 0.3 eV/channel, which allowed the collection of the Fe *L* edge and either the Mn, Cu or Co *L* edge in the same spectrum. Gatan Digital Micrograph software was used to remove the background from the spectrum and to quantify the ratio of Mn, Cu or Co to Fe. The quantitative analysis of the EDX spectra of the magnetite crystals containing Mn and Cu by FEI Tecnai F20 FEG-TEM was undertaken using the Oxford Instruments INCA EDX software. This used the Cliff-Lorimer method to determine Mn or Cu to Fe ratios using the relative amounts

of signal for each element in conjunction with each elements sensitivity k-factor.

SUPPLEMENTAL TABLE 1

TEM-EDX and EELS analyses (metal atom %) of individual magnetite crystals in *M*.

magneticum AMB-1 grown in the presence of Mn^{2+} (1 mM), Cu^{2+} (20 μ M) and Co^{2+} (40

μΜ).

	Mn 1 mM		Cu 20 µM		Co 40 µM
	Mn/(Fe+Mn) × 100 (%)		Cu/(Fe+Cu) × 100 (%)		Co/(Fe+Co) × 100 (%)
Particles	EDX	EELS	EDX	EELS	EELS
1	2.1		15.1		
2	2.4		7.7		
3	4.6		13.3		
4	2.9		19.9		
5	1.7		15.0		
6	2.1		18.1		
7		3.9		10.7	2.9
8		3.2		19.2	2.2
9		1.7		23.1	3.7
10		2.4		20.7	3.1
11		1.6		11.7	2.7
12		3.4		12.7	3.6
Avg. \pm SD	2.6 ± 1.1	2.7 ± 0.9	14.9 ± 4.2	16.4 ± 5.2	
Total Avg. ± SD	2.7 ± 1.1		15.6 ± 4.6		3.0 ± 0.9

*Every particle was chosen from different cells in the same condition. The samples in the presence of Co^{2+} were evaluated with only EELS because of the overlap of the Fe K β and

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the Co Ka EDX peaks.

SUPPLEMENTAL FIGURE



Sup. Figure1

Transmission electron micrographs of magnetotactic bacteria grown in the presence

of Mn (1 mM), Co (40 μ M), and Cu (20 μ M) ions, respectively.

Scale bar shows 500 nm.





Sup. Figure2

Magnetization versus field (M-H) curve measurements of *M. magneticum* AMB-1

cells grown in the presence of Mn^{2+} , Cu^{2+} , and in its absence (control) at 10 and 200

K. Inset: Magnified M-H curves.