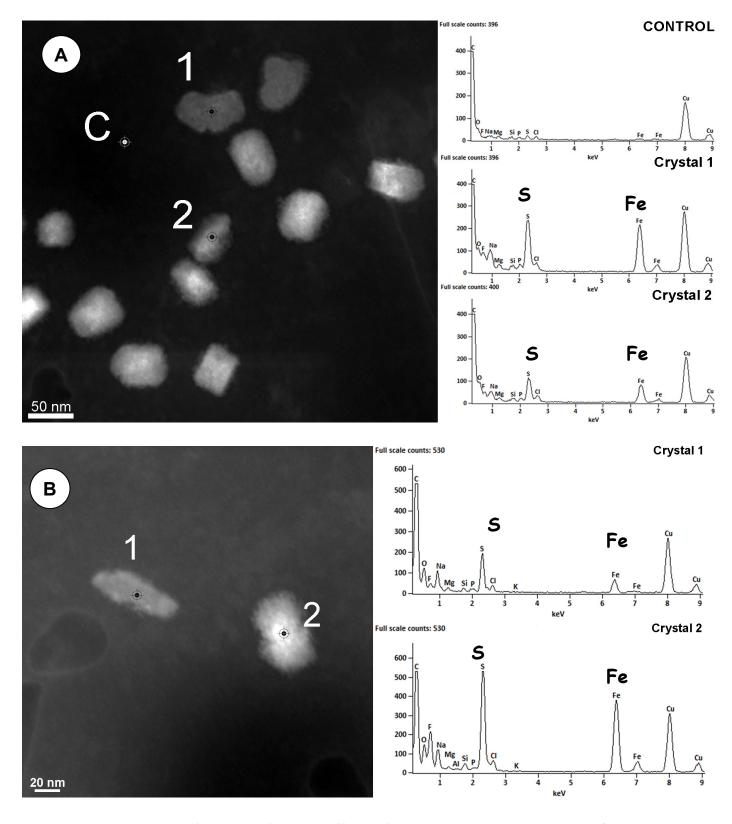
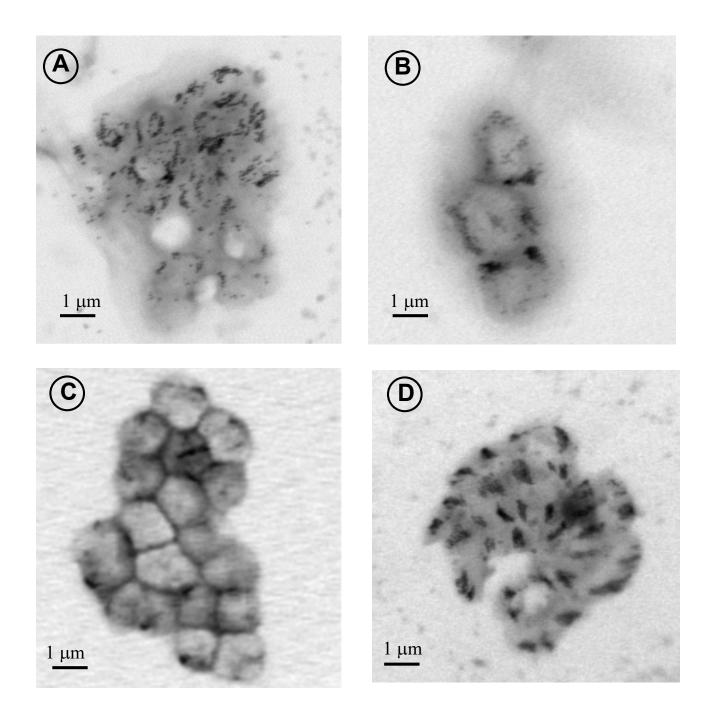


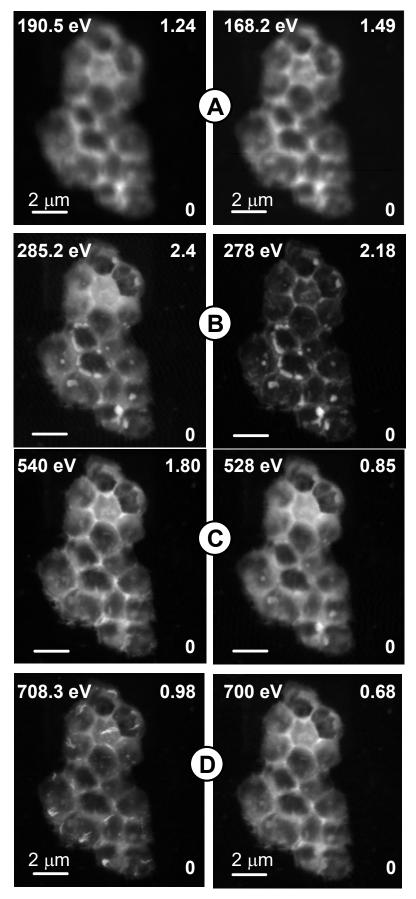
**Fig.S-1.** (A) STXM image of  $Fe_3S_4$  nanoparticles at 710 eV. (B) The S 2p, O 1s and Fe 2p XAS spectra of the  $Fe_3S_4$  nanoparticles.



**Fig. S-2. (A)** STEM image and energy dispersive X-ray (EDX) spectrum of two magnetosomes (A1, A2), compared to a control (panel A, point C), inside the MMP, but off magnetosomes. The Cu lines are from the TEM grid. **(B)** EDX analysis showing that the elemental composition in elongated (B1) and pleomorphic magnetosomes (B2) in the MMP are similar. (Salton Sea)



**Fig.S-3. (A)~(D).** STXM transmission images of four MMPs recorded at 708.3 eV. Of the four MMPs, the one shown in Figure S-2C was selected for detailed XAS study and the one in Figure S-2D was selected for detailed XMCD magnetic study. (Araruama Lagoon)



**Fig.S-4.** STXM OD images of an MMP at **(A)**190.5 / 168.2 eV, **(B)** 285.2 / 278 eV, **(C)** 540 / 528 eV and **(D)** 708.3 / 700 eV. The difference of these pairs are plotted in Figures 5A - 5D. (Salton Sea)