Soft X-Ray Microscopy of Precipitates Resulting from Reductive Dissolution of Hematite by *Shewanella alga* BrY

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INTRODUCTION

Hematite and other iron oxide minerals can be dissolved by iron-reducing bacteria under anaerobic conditions. The resulting suspensions from hematite dissolution experiments with *Shewanella alga* BrY [1] contained aggregates of solids with dimensions less than 1 μm under phase contrast optical microscopy. The composition, structure, oxidation state, and distribution of these aggregates is unknown. Imaging these suspensions with soft-X-Ray microscopy allows the examination of the sizes and shapes of these precipitates. In addition, by imaging above and below the iron edge, it is possible to determine which of the solids contain iron. The purpose of this preliminary study is to obtain images of these precipitates and to examine the iron distribution.

METHODS

Synthetic hematite crystals were dissolved by *Shewanella alga* BrY in anaerobic tubes [1]. The initial concentration of hematite was 1.65 g/l (7.2 mM Fe(III)). Macroscopic observation of the tubes suggested that the hematite had been totally dissolved. These tubes were transported to the Center for X-ray Optics soft-X-Ray microscope XM-1 (Beamline 6.1.2) [2] at the Advanced Light Source (ALS). Samples were removed from the anaerobic tube by syringe, and 2 μl of the suspension was placed between two 120nm thick Si_3N_4 windows.

PRELIMINARY RESULTS

Images of the suspensions (Fig. 1) show bacteria surrounded by a lattice of material, probably a biofilm. In another image (Fig. 2) precipitates with diverse morphologies are present. It is possible to obtain a map of the iron distribution. This procedure requires images to be taken below and above the iron edge. The dark shapes that appear on the image taken above the iron edge should appear on the image taken below the iron edge only if they contain iron. Three pairs of these images are shown in Figure 3. Most of the dark shapes shown at 705 eV are present as bright shapes when imaged at 696 eV. This suggests that most of the shapes do contain iron. However, there are some dark shapes in the middle and left pairs which do not appear to contain iron. Surface plots of the mass and iron distributions are shown in Figure 5. These plots show that spatial distributions of mass and iron are similar but not identical. Two broad shapes at the top and bottom of the mass distribution are missing in the iron distribution.

The next step in this research is to obtain spectroscopic data (micro-XAS) and elemental analyses to determine the oxidation state and spatial distribution of the iron species, local atomic structure, and composition. Crystals, if present, could be the minerals vivianite, siderite, or magnetite.

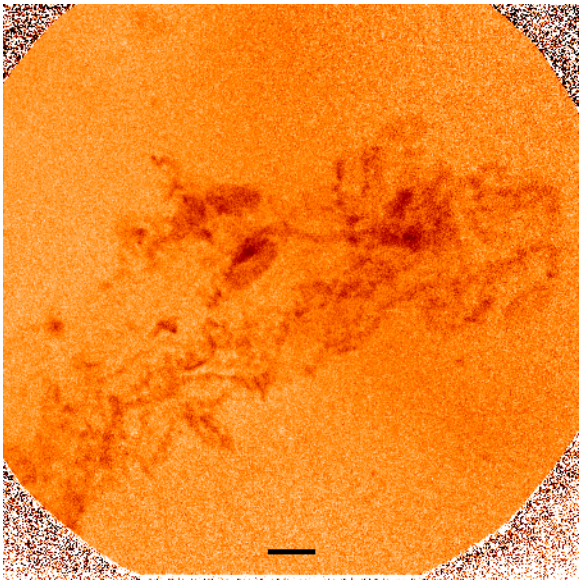

Figure 1: Bacteria, bar is 1 µm.

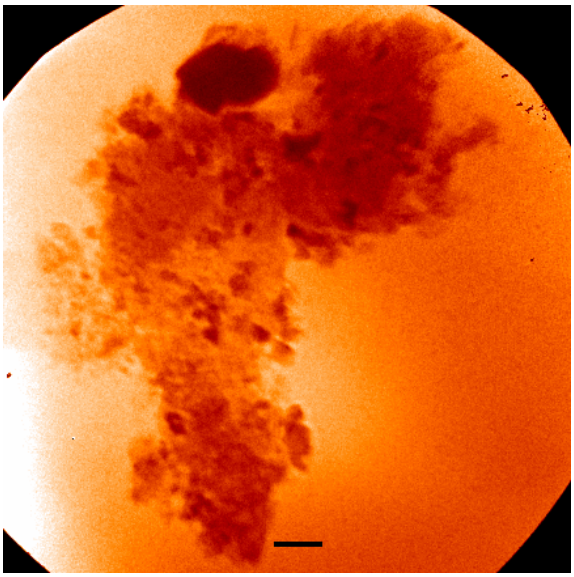

Figure 2: Precipitates, bar is 1 µm.

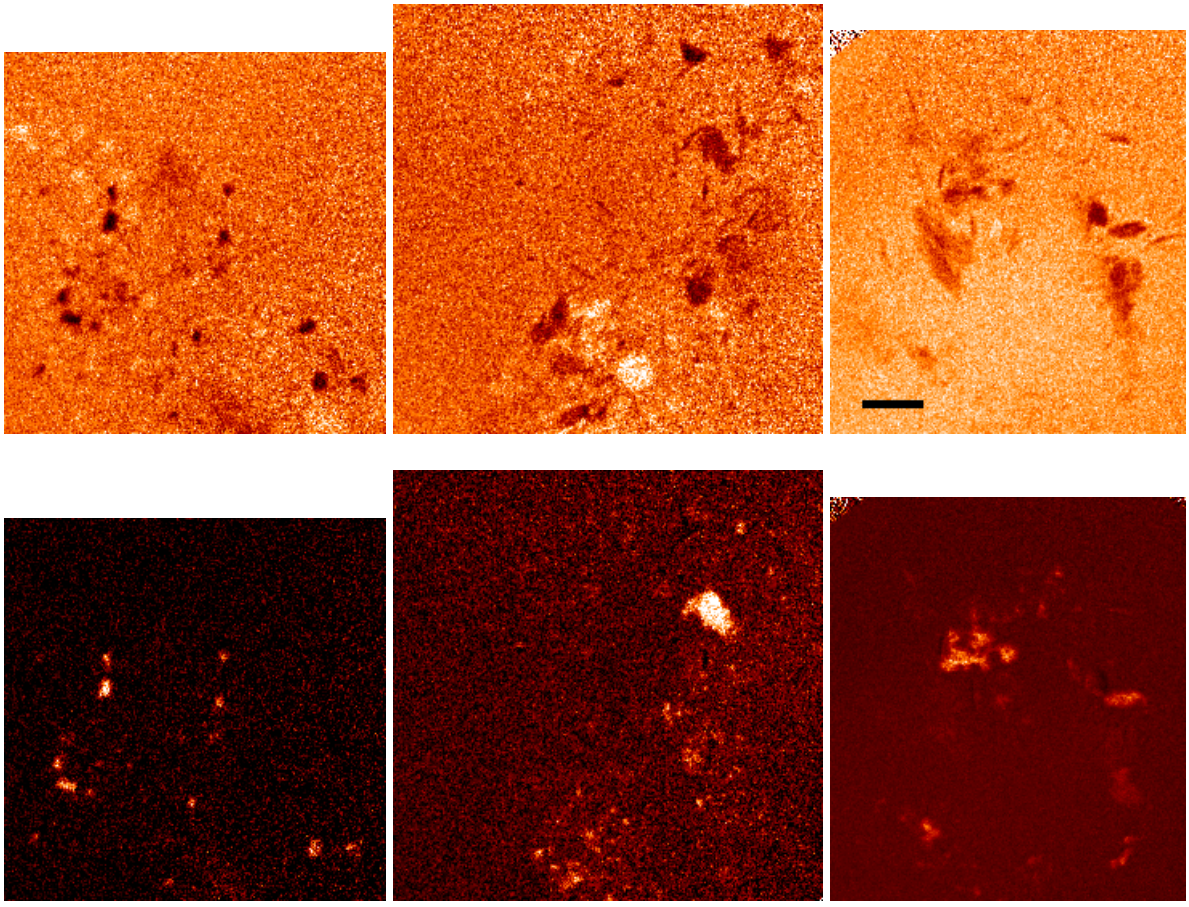

Figure 3: Mass (top; 705 eV) and iron (bottom, 705 eV) distributions; bar is 1 µm.

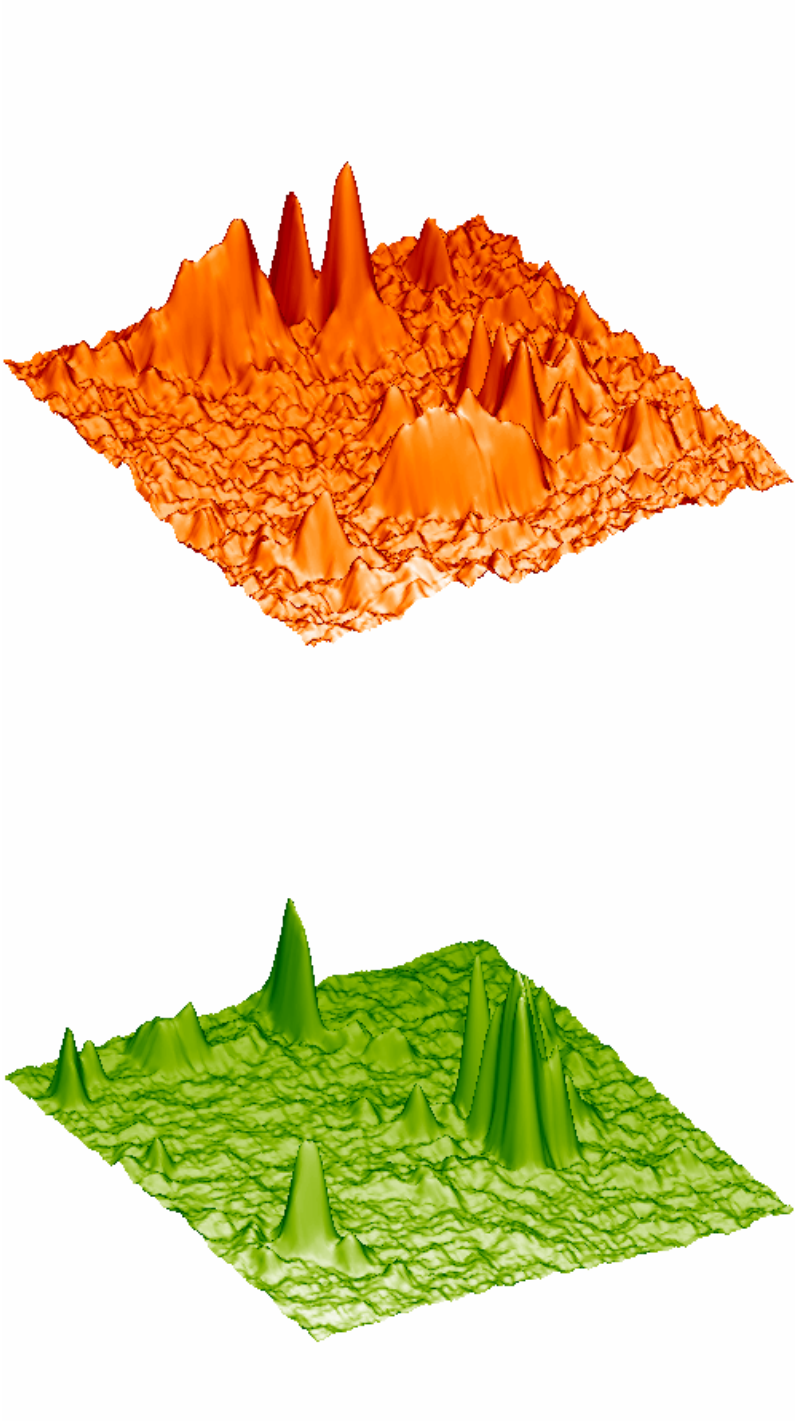

Figure 4: Surface plots of mass (705 eV; top) and iron (696 eV; bottom).

ACKNOWLEDGMENTS

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REFERENCES

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