

LETTER

**In situ monitoring of lepidocrocite bioreduction and magnetite formation by reflection
Mössbauer spectroscopy**

**ASFAW ZEGEYE,* MUSTAPHA ABDELMOULA, MUHAMMAD USMAN, KHALIL HANNA,
AND CHRISTIAN RUBY**

Laboratoire de Chimie Physique et Microbiologie pour l'Environnement, LCPME, UMR 7564, Institut Jean Barriol, CNRS-Nancy Université,
405 rue de Vandoeuvre, 54600, Villers-lès-Nancy, France

ABSTRACT

The miniaturized Mössbauer spectrometer (MIMOS II) was used to monitor in situ the mineralogical transformation of lepidocrocite (γ -FeOOH) in a *Shewanella putrefaciens* culture under anaerobic conditions using methanoate as the electron source. Magnetite was the only biogenic mineral formed during the course of the incubation. The analysis of the biogenic mineral by transmission electron microscopy (TEM) revealed cubic-shaped crystals with a relatively homogeneous grain size of about 50 nm. After one day of incubation, the departure from stoichiometry, δ , of the biogenerated magnetite was very low ($\delta \sim 0.025$) and rapidly reached values close to zero. Such low values of δ were not obtained for magnetite synthesized inorganically when Fe^{3+} in the form of γ -FeOOH was reacted with stoichiometric quantities of soluble Fe^{2+} and OH^- . The experimental setup used in this study could be replicated in field experiments when assessing the formation of magnetite in modern geological settings as its formation is suspected to be caused by a strong bacterial activity.

Keywords: MIMOS, magnetite, stoichiometry, biomineralization