Estimation of S, F, Br and Cl Fluxes at Mid Ocean Ridges

T. KAGOSHIMA[1*], Y. SANO[1], N. TAKAHATA[1], J. JUNG[1], H. AMAKAWA[2], AND H. KUMAGAI[3]

[1]Atmosphere and Ocean Research Institute, the University of Tokyo, Chiba, Japan (*correspondence: kagoshima@aori.u-tokyo.ac.jp)
[2]National Taiwan University, Department of Geoscience, Taipei, Taiwan
[3]JAMSTEC, Kanagawa, Japan

Introduction

It is known that superficial volatile elements of the Earth have been accumulated mainly by degassing from the solid Earth. Studies that used noble gases as tracers have been conducted to investigate the degassing history of the Earth, which suggests that the significant degassing occurred in the early Earth [1, 2]. Carbon and nitrogen fluxes were well documented in literatures, and they provided other constraints on the hypothesis of degassing history [3, 4]. It is important to study the degassing history of the Earth from the mantle based on the other volatile elements, thus we measured sulfur (S), fluorine (F), bromine (Br) and chlorine (Cl) concentrations trapped in vesicles in mid-ocean ridge basalts (MORBs) and back-arc basin basalts (BABBs) and compared them with helium-3 (^{3}He) concentrations to estimate their fluxes from the mantle.

Analysis

Approximately 1 g of fresh glassy aliquots were picked up from MORB and BABB glasses and were put in a stainless-steel crusher with 1-2 cm^3 of distilled aqueous sodium hydroxide (1-4 mol/L) and a stainless-steel ball. The alkali solution was frozen at the temperature of liquid nitrogen (77K). When the crusher was shaken up and down, the glassy aliquots were crushed together with the frozen solution by the stainless-steel ball. Highly reactive elements including S, F, Br and Cl were extracted from vesicles of glasses by mechanical fracturing and immediately dissolved into a small portion of melted alkali solution. While helium (He), not dissolved into the solution, was introduced into a vacuum line and purified, then helium-4 (^{4}He) intensity and ^{3}He/^{4}He ratio were measured by a VG5400 mass spectrometer. S, F, Br and Cl concentrations in the alkali solution were measured by ion chromatography (Dionex-320).

Results and Discussion

Concentrations of volatile elements trapped in vesicles were (4 – 31) × 10^{-15} mol/g for ^{3}He, (20 – 430) × 10^{-9} mol/g for S, (60 – 5000) × 10^{-9} mol/g for F, (5 – 1300) × 10^{-9} mol/g for Br and (160 – 450) × 10^{-9} mol/g for Cl. Under an assumption that the samples in this study represent typical MORBs, global fluxes of S, F, Br and Cl were estimated using mole ratios X/^{3}He of the samples and the ^{3}He flux of 1060 mol/yr from the mantle [5]. These estimated fluxes from mid ocean ridges will be discussed in comparison with those from volcanic arcs.

References

[1] Ozima (1975) *GCA* **39**, 1127-1134. [2] Graham (2002) *Rev. Min. Geochem.* **47**, 247–317. [3] Marty and Jambon (1987) *EPSL* **83**, 16-26. [4] Sano et al., (2001) *Chem. Geol.* **171**, 263–271. [5] Lupton and Craig (1975) *EPSL* **26**, 133-139

Magnetism of Individual Magnetosomes in Magnetotactic Bacteria

SAMANBIR S. KALIRAI[1*], KAREN P. LAM[1], DENNIS A. BAZYLINSKI[2], ULYSSES LINS[3], ADAM P. HITCHCOCK[1]

[1]McMaster University, Chemistry and Chemical Biology, kaliras@mcmaster.ca (* presenting author)
[2]University of Nevada, Las Vegas, Life Sciences
[3]Universidade Federal do Rio de Janeiro, Microbiologia Geral

Magnetotactic bacteria (MTB) synthesize chains of intracellular, membrane-bound, single crystals of magnetite or greigite in the 30-80 nm size range, an exquisite example of biomineralization. We used Scanning Transmission X-ray Microscopy as a chemically and magnetically sensitive probe to investigate the magnetism of individual magnetosomes and thereby study the mechanism of magnetosome biomineralization. The Fe $L_{2,3}$ X-ray magnetic circular dichroism (XMCD) of cultured cells of *Candidatus* Magnetovibrio blakemorei (MV-1) has the same shape and intensity as abiotic magnetite indicating that the magnetic moment of the magnetosomes is nearly saturated (Fig. 1) [1,2].

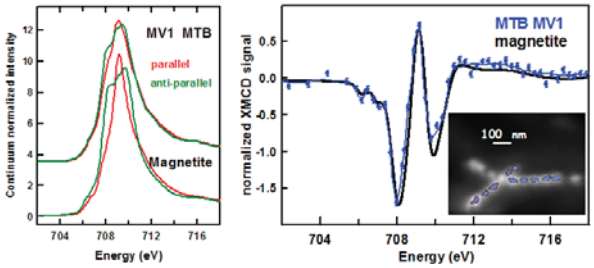

Figure 1: (Left) Fe L_3 and **(Right)** Average XMCD spectrum of magnetosome chains (dots) from two magnetosome chains (see inset) compared to the XMCD of magnetically saturated abiotic magnetic (black). The average magnetosome magnetic moment is 3.6(2) μB [2], 0.93(6) of that of magnetite [3].

Many cells of MV-1 show characteristic gaps between magnetosome chains that occasionally yield intracellular chain orientation reversals. In these gaps there is a reasonably strong Fe L_3 signal very similar to that of magnetite, but without XMCD. These are possibly the result of incomplete or defective magnetite biomineralization and thus may provide insights into the mechanism of chain formation and alignment as well as biogeochemical factors affecting magnetosome chain growth. We will report our recent XMCD-STXM findings of this phenomena and the implications with respect to the mechanism of chain formation.

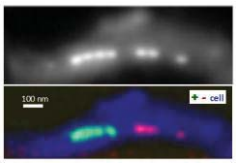

Figure 2 (Upper) Average of all Fe L_3 images of a single MV-1 cell. **(Lower)** Composite of parallel (green) and antiparallel (red) XMCD and the pre-Fe L_3 signal outlining the cell (blue)

[1] Lam et al. (2010) *Chem. Geol.* **270** 110-116. [2] Kalirai et al. (2012) *Chem. Geol.* in press. [3] Goering et al. (2007) *J. Magn. Magn. Mater.* **310**, e249–e251. [4] Research supported by NSERC, Canada Research Chair, CFI. Work performed at the Canadian Light Source, supported by CFI, NSERC, CIHR and U. Saskatchewan.