

JOINT RESEARCH PROJECT

FINAL REPORT
For Japan-Korea Joint Research Project

AREA	1. Mathematics & Physics
	2. Chemistry & Material Science
	3. Biology
	4. Informatics & Mechatronics
	<input checked="" type="checkbox"/> 5. Geo-Science & Space Science
	6. Medical Science
	7. Humanities & Social Sciences

1. Research Title:

Characterization of Microbially Fe(III) Reduced Smectite By Transmission Electron Microscopy (TEM)

2. Term of Research: From 1/7/2009 To 30/6/2011

3. Total Budget

a. Financial Support by JSPS: Total amount: 2,273.5 thousand yen

1st Year 573.5 thousand yen 2nd Year 1,200 thousand yen

3rd Year 500 thousand yen

b. Other Financial Support : Total amount: 0 thousand yen

4. Project Organization

a. Japanese Principal Researcher	
Name	Toshihiro KOGURE
Institution / Department	The University of Tokyo / Department of Earth and Planetary Science, Graduate School of Science
Position	Associate Professor
b. Korean Principal Researcher	
Name	Jinwook Kim
Institution / Department	Yonsei University / Department of Earth System Sciences
Position	Associate Professor

c. List of Japanese-side Participants (Except for Principal Researcher)

Name	Institution/Department	Position
Jun Kameda	The University of Tokyo / Department of Earth and Planetary Science, Graduate School of Science	Researcher
Takuya Umezome	The University of Tokyo / Department of Earth and Planetary Science, Graduate School of Science	Master Student
Katsuaki Watanabe	The University of Tokyo / Department of Earth and Planetary Science, Graduate School of Science	Researcher
Tomoya Kato	The University of Tokyo / Department of Earth and Planetary Science, Graduate School of Science	Master Student
Taiga Okumura	The University of Tokyo / Department of Earth and Planetary Science, Graduate School of Science	Doctor student
Hyejin Kim	The University of Tokyo / Department of Earth and Planetary Science, Graduate School of Science	Master student

d. List of Korean-side Participants (Except for Principal Researcher)

Name	Institution/Department	Position
Jinah Ryu	Yonsei University / Department of Earth System Sciences	Master student
Taehee Gu	Yonsei University / Department of Earth System Sciences	Master student
Buyabat Naran	Yonsei University / Department of Earth System Sciences	Mater student
Hyuk-Chae Kang	Yonsei University / Department of Earth System Sciences	Master student
Hyu-Chae Kang	Yonsei University / Department of Earth System Sciences	Master student
Soyoung Kim	Yonsei University / Department of Earth System Sciences	Master student

5. Number of Exchanges during the Final Fiscal Year*

a. from Japan to Korea

*Japanese fiscal year begins April 1.

Name	Home Institution	Duration	Host Institution
Toshihiro Kogure	University of Tokyo	3 days	Yonsei University
Hyejin Kim	University of Tokyo	3 days	Yonsei University
For Final Fiscal Year(FY2011)		For Final Fiscal Year(FY2011)	
Total: <u> 2 </u> persons		Total: <u> 6 </u> man-days	
Numbers of Exchanges during the past fiscal years			
FY2009: Total <u> 3 </u> persons			
FY2010: Total <u> 1 </u> persons			

b. from Korea to Japan

Name	Home Institution	Duration	Host Institution
For Final Fiscal Year(FY2011)		For Final Fiscal Year(FY2011)	
Total: <u> 0 </u> persons		Total: <u> 0 </u> man-days	
Numbers of Exchanges during the past fiscal years			
FY2009: Total <u> 1 </u> persons			
FY2010: Total <u> 1 </u> persons			

6. Objective of Research

The objective of this research in the proposal was to build up the international research network with Professor Jinwook Kim of Geomicrobiology Lab., Yonsei University, Korea and our Electron Microscopy Lab., The University of Tokyo, to propose the biotransformation model, particularly to answer the microbial processes contributing to the reductive reaction (Fe(III) to Fe(II)) of smectite, one of the most abundant clay minerals on the earth. Furthermore, the data base will be constructed for preparing the long term proposal of microbe-mineral interaction.

Besides, as another theme after starting the research, we started collaboration to investigate the influence of bacterial organisms to form calcium carbonate deposits in geothermal environment like hot springs. By observing the microstructures in calcium carbonate minerals using advanced electron microscopic techniques and isotope analyses, the characteristics and/or evidences of biologically induced mineralization will be investigated.

Unfortunately the first topic (biological reduction of smectite) had to be almost abandoned because the equipments in Kim's Lab, Yonsei University could not be ready to prepare the specimen for reductive reaction of smectite during the period. Hence, we have focused on only the second topic in this research. The collaboration for this research was conducted well and several important and interesting results have been obtained during these two years.

7. Methodology

1) Specimens

Calcium carbonate precipitates were collected from La Duke hot spring, a circumneutral geothermal feature on the shoulder of U.S. Highway 89 approximately 5 miles north of Gardiner, MT (45.1° N 110.8° W) in 2009 by Prof. Jinwook Kim. The samples were placed in Whirl-Pak bags, and stored on ice during transport to the laboratory where they were stored at -4 °C until analyzed. Water temperature and pH were measured at the sampling areas described above at the time of sample collection (June 9, 2009) using a thermometer and pH paper. The water temperature and pH varied from 60 - 65 °C and 7-8, respectively. Water was collected for stable isotope analysis of dissolved inorganic carbon (DIC)

2) Physical analyses

A subsample of the precipitates was thawed, dried and then gently crushed using a mortar and pestle. The dried material was then analyzed by X-ray diffraction (XRD). Another subsample of solids was thawed and washed in distilled water, air dried and embedded in epoxy resin. After curing, the resin blocks were sliced, deposited on glass slides and examination by optical microscopy. Another subsample of thawed solids was dried and coated with a 5 nm-thick Pt-Pd film and examined by scanning electron microscope (SEM) using a Hitachi S-4500 SEM with a field-emission electron gun operated at 5 kV. Samples containing areas of interest based on SEM examination were prepared as ultrathin sections using a focused ion beam (FIB) system with a micro-sampling function (Hitachi FB-2100) and examined by transmission electron microscopy (TEM, JEOL JEM-2010 at 200kV). Samples were also subjected to electron energy loss spectroscopic (EELS) analysis.

3) Stable isotope analysis

The carbon isotope composition of the DIC of the spring water was determined by analyzing the solid phase SrCO₃ that formed when the ammonium-SrCl₂ solution was mixed with the hot spring water. The carbon isotope compositions of the mineral samples were determined using the classical method of McMCre (1950). All carbonate samples were analyzed at 90 °C on an isotope ratio mass spectrometer (IRMS) equipped with an automated IsoCarb system at McMaster University.