Dr. Julian Bosch
Microbiologist
Anaerobic Degradation Group
IGOE - Institute of Groundwater Ecology
Tel.: ++49 89 / 3187 -2581
FAX: ++49 89 / 3187 -3361
e-Mail: julian.bosch@helmholtz-muenchen.de

Helmholtz Zentrum München
German Research Centre for Environmental Health (GmbH)
Ingolstädter Landstr. 1
85764 Neuherberg, Germany
www.helmholtz-muenchen.de

Scientific Report for FIMIN - Short Visit Grant 3150

Purpose of the visit

Major aim of my short visit at the group of Prof. Dr. John Lloyd was technology transfer. Dr. Lloyd has a publication record indicating him to be one of Europe's leading experts in the synthesis, characterization and application of iron oxides in microbial iron reduction research (e.g. GCA Vol. 73, 4004-4022). Techniques like High-Res TEM, XRD and XPS are all brought together in his work to gain subtle insights into microbial reduction processes. I work on the very same research field, but my work suffered from the insufficient characterization of my iron oxides. Therefore, the purpose of the visit was to learn methodological and analytical skills from Dr. Lloyd's group. The aim was to increase my choice of methods, to gain a deeper understanding in their opportunities and limitations, and to test some of Dr. Lloyd's analytics on my iron oxide samples.

After the visit, the newly acquired technologies and skills will be implemented into the work of my home institute. I am currently employed by the EU-research project AquaRehab, and the aim of my work package therein is to apply iron oxides in the oxidation of aromatic groundwater pollutants. So my institute and my work will benefit from the transferred knowledge long-term.

A secondary aim of my research visit was to sort out the potential for scientific cooperation with Dr. Lloyd and his group, as we work on very close topics.

Description of the work carried out during the visit

I followed Dr. Lloyds Postdocs and PhD-students during their laboratory work. This included the preparation of anaerobic media, preparation of ferrihydrite, harvesting of cell suspensions, preparation of experimental anoxic batch cultures, cell lysing, preparation of iron oxide samples for Transmission electron microscopy (TEM), and preparation of iron oxide samples for Mösbauer spectroscopy.
I was introduced to Mösbauer spectroscopy, Energy dispersive X-Ray Spectroscopy (EDX, and X-ray photoelectron spectroscopy (XPS), and applied my own samples to TEM and the attached Selected Area Electron Diffraction (SAED).
I gave a talk on my recent research and discussed it with the members of Dr. Lloyd's group, and made several bilateral discussions with individual members, especially Dr. Victoria Coker and Dr. Richard Cutting, about current research topics and opportunities for future collaborations.

Description of the main results obtained

The practical participation in the laboratory work led to a broadened perspective on the methods applied in geomicrobiological research. Although the major techniques like e.g. the treatment of Geobacter cells during medium inoculation, or cell harvesting, resemble the methods already applied in my home institute very much, I could observe many minor deviations in methods and also media composition. For instance, Geobacter cells are exposed to oxygen during cell harvesting in Dr. Lloyds group, while our group maintained anoxic conditions, and batch cultures are generally performed in different culture vessels. Compared to my home group, the lab organizations with the attached analytical facilities allowed a convenient and streamline workflow. This overview of the laboratory techniques applied in Dr. Lloyds group acted like a calibration with an external standard for me and assured me of many of our own methods, while giving inspiration for optimization. Additionally, I obtained a full list of the cultivation media used in Dr. Lloyds group and will calibrate our own media with that list.
The introduction into Mößbauer spectroscopy and XPS resulted in an overview on how I will integrate these techniques into my future experiments. In General, the combination of TEM, XPS, SAED, EDX, Mössbauer spectroscopy and conventional X-Ray diffraction will result in a full assessment of iron oxide samples as applied in my research. Core composition, surface composition, elemental composition, shape, size, crystal structure and redox state can be fully measured and documented.
TEM pictures and SAED patterns of nanohematite and nanoferrihydrite (applied in Bosch et. al, AEM 2010, Vol. 1, p. 184-189) revealed the different crystal shape and structure of these iron oxides (Fig. 1). While hematite displays clear crystal lattices and a distinct SAED pattern even as a nanosized particle, ferrihydrite appears amorphous. However, from the nanohematite crystal size, I can now assume that these particles form nanosized clusters of multiple particles, as the size measured by Dynamic light scattering was 123 nm. This would have delivered an additional basis for discussion in my AEM paper, and shows the potential these techniques have in geomicrobiology. I will now try to integrate all these techniques into my further research and the research of my home group.

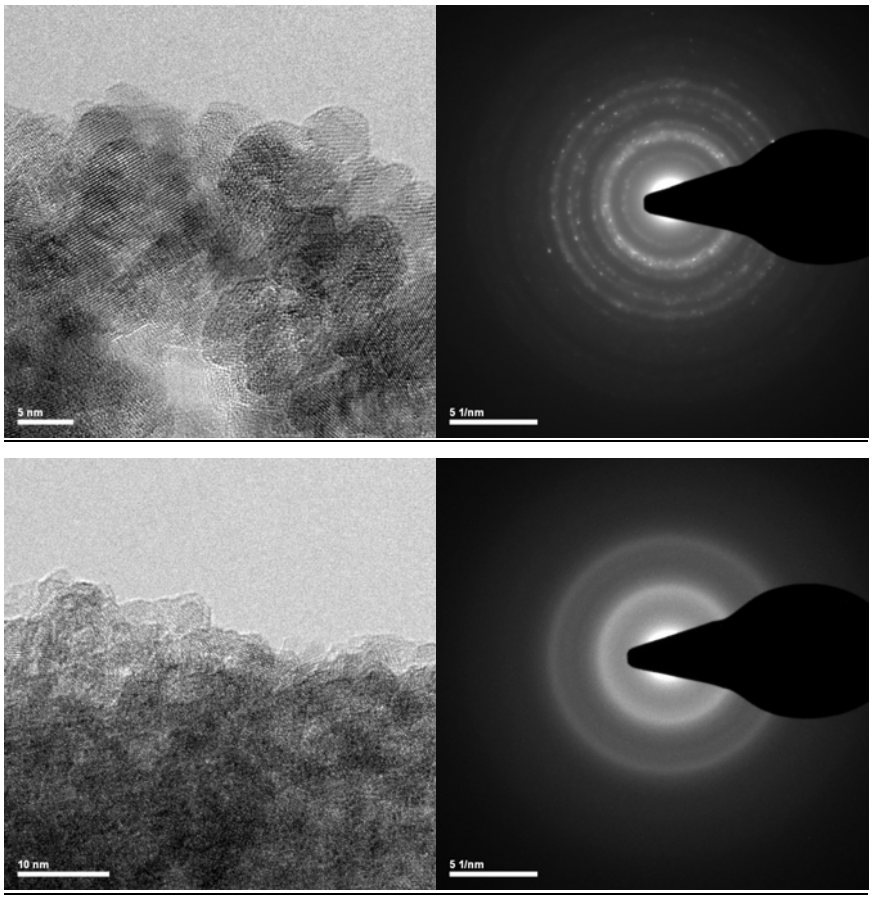

Fig. 1. TEM-pictures (left) and SAED patterns (right) of nanohematite (upper) and nanoferrihydrite (lower)

Future collaborations with host institution

Dr. Lloyd has a set of powerful methods at his disposal. I agreed with him and members of his group on further collaboration. At present, I am planning a set of experiments, which all require a detailed analysis of the involved iron oxides. A major proportion of this will be done at the labs of Dr. Llyod, who will then act a co-author.

Projected publications to result from the grant

Experiments leading towards publication are currently in planning. All joint publication of Dr. Lloyd an my home institute will acknowledge the ESF grant.