Iron reduction and formation of magnetite-organic complex nanoparticles by *Clostridium* sp.

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The microbial reduction of ferric iron [Fe(III)] may have a key role in the iron cycle of aquatic environments and influence the mineralization through the exchange of nutrients and trace metals between sediments and the overlying water [1]. The objectives of this research were to investigate iron reduction and synthesis of magnetite by iron-reducing bacteria (mainly *Clostridium* sp.), and to characterize the mineralogical and surface chemical properties of the biogenic magnetite nanoparticles.

The iron-reducing bacteria were enriched from intertidal flat sediments in S. Korea. In order to investigate the favorable conditions for magnetite biomineralization via iron reduction, the bacteria were grown with poorly crystaaline iron-oxides such as akaganeite and ferrihydrite as electron acceptors, and glucose, lactate, and pyruvate as electron donors. Mineralogical characterization was performed by XRD and TEM-EDS analyses. UV-vis, FT-IR and XPS analysis were used for chemical characterization of the biogenic minerals.

The iron-reducing bacteria (*Clostridium* sp.) reduced akaganeite and ferrihydrite via glucose fermentation, and transformed them to more stable phases such as magnetite. The biogenic magnetite nanoparticles had around 10 nm in size and were spherical in shape. Unlike chemically synthesized magnetite, the biogenic magnetite was coated with organic matter containing an abundance of reactive carboxyl groups (-COOH). Moreover, the magnetite-organic complex nanoparticles immobilized albumin on top of the carboxylic groups located on the particles' surfaces and showed the that biogenic magnetite has high potential for serving as a useful and applicable material in relevant medical technologies.

These results indicate that the iron-reducing bacteria (*Clostridium* sp.) transform akaganeite and ferrihydrite to magnetite via glucose fermentation, and such microbial processes may facilitate simple preparation of functional magnetite-organic complex nanoparticles which have benefits for biomedical applications.

[1] Fredrickson *et al* (1998) *Geochim. Cosmochim. Acta* **62**, 3239-3257