Revealing the role of microbial activity in the acquisition of NRM in aquatic sediments -- Insights from redeposition experiments

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Sedimentary rocks and sediments preserve continuous records for reconstructions of geological events. Magnetic records are among the most concerned sedimentary records across disciplines due to their application in synchronizing cores. In particular, the natural remanent magnetization (NRM) is of great interest as the derived relative paleointensity (RPI) reconstruction can provide high-resolution geochronological frameworks on a global scale. Despite the extensive application for decades, however, the underlying mechanisms of how paleomagnetic records are acquired and preserved in sediments are only partially understood. Moreover, with the biogenic magnetite, known as magnetofossils, being widely identified in sediments, questions about their effects on RPI reconstructions are posed given their unique properties with respect to the detrital magnetic components. With these questions in mind, we designed redeposition experiments to investigate how magnetofossils acquire remanent magnetization in fresh sediments. The dominant magnetic component of the sediments is single domain magnetite, presumably magnetofossils, accounting for ~87% of the magnetization in these sediments. The redeposition experiments were performed with such sediments in their original form whereby the living microorganisms (mainly non-magnetic bacteria) are preserved. We documented two major novel features of the acquisition behaviors in our experiments. First, the acquisition of these sediment particles after deposition is more effective than previously estimated. Second, the acquired remanent magnetization is unstable in a zero field. We discover that these features are associated with the microbial activities, and can be well explained by a bioturbation-driven acquisition model. It suggests that bioturbation plays an appreciable role in modulating the paleomagnetic records in sediments. This finding has a strong implication for improving RPI reconstructions in future.

Keywords: Natural remanent magnetization, sediment, bioturbation