

## Macro- and micro-magnetic properties of maghemite nano-minerals

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The differences between the macroscopic and microscopic magnetic properties of granular, rod, and tubular nano-maghemites were studied. The macroscopic magnetic properties of the different nano-maghemites were all ferrimagnetic by using a superconducting quantum interference device (SQUID). However, the coercive magnetic field and magnetization were in the orders of grain < tube < rod and grain > tube > rod, respectively, which indicated that the crystal shape influenced macroscopic magnetic properties. A magnetic force microscope (MFM) was used to observe the microscopic magnetic structures; the samples were all magnetic in multiple domains, but the form and distribution of these domains were different. However, the domain information of nano-maghemites calculated from SQUID results suggested that all specimens were pseudo-single domains. This indicates that the crystal morphology had a significant effect on magnetic properties of these nano-maghemites owing to their different magnetic-domain structures. MFM can be used to detect minute magnetic-properties that are imperceptible to macroscopic measurements. Thus, it is a tool with potential development in earth science.

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