Field dependent decrease of magnetic susceptibility in superparamagnetic grains

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Magnetic susceptibility of a given material characterizes how the magnetic material reacts to the change in its magnetic environment. When magnetic grains get small enough so they become superparamagnetic, the magnetic susceptibility becomes strong function of both the frequency and amplitude of the applied magnetic field. In order to study this effect magnetic material must be available that contains well distributed non interacting grains with narrow grain size distribution. Such material has been discovered in Yucca mountain area (Nevada). A unit in the Tiva Canyon Tuff that was quickly quenched and reheated, allowing formation of multiple grains with uniform grain size distribution.
Interestingly we observed that this material's susceptibility decreases with increasing amplitude of the field. Such observation was only detectable for larger frequencies (>2 kHz).

Synthesized nano-magnetic particles were made such that samples of basaltic composition were made by first quick quenching (generation of multiple nucleation sites) followed by reheating (precipitation of actual magnetic carriers). This material showed similar susceptibility decrease with alternating field amplitude.

We interpret these measurements as following. Due to large frequency the individual small grains induce electrical currents along their surfaces whose magnetic field opposes the applied field and therefore with larger ambient field amplitude the grains do not experience the applied field in its full extent. This behavior can be utilized by relating the susceptibility decrease to the conductivity of the silicate material in which the oxide grain is residing.