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The development of rock magnetic proxies for paleoclimate reconstruction.

A thesis
submitted to the faculty of the graduate school of the University of Minnesota by

Christoph Eberhard Geiss

In partial fulfillment of the requirements for the degree of Doctor of Philosophy

Advisor:

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Abstract

Many geologic and limnologic processes that can affect the magnetic properties of lake sediments are influenced by shifts in climatic conditions. They cause changes in concentration, particle-size distribution and composition of magnetic minerals. These changes have to be measured indirectly by a combination of rock magnetic techniques because most magnetic grains are too small to be observed directly. A study of three glacial lakes in Illinois and Minnesota shows that sediment-magnetic parameters agree well with the paleoclimatic information obtained through pollen, diatom and ostracod studies and allows for the construction of a conceptual model that links paleoclimatic change to sediment-magnetic variations:

In the early postglacial stage of lake development the magnetic properties of the sediment reflect the magnetic composition of the source material. Subsequently, a forested watershed and humid interglacial conditions result in lower erosion rates and high rates of organic productivity. The influence of terrigenous material decreases and the sediment magnetic properties are characterized by a fine-grained component of authigenic SD and SP magnetite. Erosion of magnetically enhanced soil material can lead to lake sediments enriched in fine and ultrafine-grained maghemite. Low lake levels and fluctuating water tables during dry periods result in the reductive dissolution of ferrimagnetic minerals that can affect older sediments to considerable depth (several meters). Subaerial weathering can cause the formation of secondary antiferromagnetic hematite. Loess deposition during dry periods can have a similar effect on the sediment magnetic properties. Holocene sediments are often characterized by high sedimentation rates and high concentrations of magnetic minerals. Because of their young age, these sediments are little affected by reductive dissolution and tend to be finer grained than older deposits.

The sequence of climatic change in southern Illinois as reconstructed from these sites agrees well with previous studies. Correlation with a speleothem record from Crevice Cave, Missouri, however, offers two alternative age models for the probable timing and duration of interglacial conditions in the Midwestern United States.

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