Environmental Magnetism of Cave Deposits

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Caves are deep time archives of environmental conditions at the surface. Traditional paleoclimate proxies, such as oxygen and carbon isotopic ratios, are preserved within actively growing carbonate speleothems and can be constrained in time using high-resolution 230Th geochronology. While these isotopic speleothem proxies have revolutionized paleoclimate studies, here we discuss the use of magnetic measurements to constrain changes in the flux of Fe-bearing minerals (their composition, concentration, and magnetic grain size distribution) within the context of environmental change.

Fe-bearing minerals can occur within speleothems due to a variety of transportation and nucleation & growth mechanisms. Drip waters carry trace concentrations of Fe-bearing minerals from overlying soils and dissolved and eroded bedrock. Flood waters that temporarily fill a cave passage will leave behind thin films of silt- and clay-sized sediment, some of which contain Fe-bearing minerals. Some minerals, such as goethite, are thought to nucleate and grow in pore spaces in the overlying rock and to be deposited via dripwater onto actively growing stalagmites. Alternatively, changes in the Eh and pH conditions of groundwater as it equilibrates with the open air environment of a cave may cause dissolved Fe to nucleate and grow goethite directly on the surface of carbonate speleothems. Thus, while the incorporation of Fe-bearing minerals into speleothems is primarily a function of surface environmental conditions, including precipitation patterns, mean annual temperature, and pedogenic productivity, secondary processes within a cave environment can also contribute to Fe-minerals in speleothems.

Here we present some promising examples of how the magnetic properties of Fe-bearing minerals preserved within speleothems can provide environmental information on short (e.g., decadal) and long (e.g., millennial) timescales that is independent and complementary to existing paleo-environmental proxies.

Keywords: Caves, Speleothem, Paleoclimate, Soil, Environmental magnetism, Magnetic properties

