THE APPLICATION OF MAGNETIC SUSCEPTIBILITY TO UNRAVELING SEDIMENTATION HISTORIES IN STREAM VALLEYS OF THE MID-ATLANTIC PIEDMONT, UNITED STATES

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In the eastern United States, Mid-Atlantic Piedmont stream banks consist of 1-5 m stacks of buff-colored fine-grained sediment overlying a relatively thin, dark-gray/black organic-rich horizon, which in turn overlies a veneer of quartz-rich gravels on bedrock (Walter and Merritts, 2008). Radiocarbon ages (n>100) measured on organic material from the lower pre-settlement hydric soil indicate that wetland environments, not streams, dominated Piedmont valley bottoms for 8-11 ka until the onset of European settlement. We attribute the widespread deposition of fine-grained sediments to an increase in base level caused by the ubiquitous construction of milldams during the 18th and 19th centuries, and to the gradual filling of millponds with eroded upland soil during periods of intense land clearing and agriculture.

Magnetic susceptibility is an excellent delineator of hydric soils, as reduced Fe-compounds have low magnetic susceptibility (MS) values (Grimley and Vepraskas, 2000). Conversely, high MS values are characteristic of oxidized soils caused by anthropogenic activities, such as burning for charcoal or land clearing (Ketterings et al., 2000). Soil color is also greatly influenced by oxidation states of iron and manganese, where more subdued shades of gray and black are generally considered characteristic of water-saturated, anaerobic conditions (Brady and Weill, 2008). Magnetic susceptibility has also been used to understand prehistoric and historic erosion processes (Dalan and Banerjee, 1998).

Depth-vs.-MS profiles of our stream banks invariably reveal that the pre-settlement hydric soils possess low, nearly zero, MS values, and that post-settlement deposits are 10 to 50 times the pre-settlement values. These post-settlement “legacy sediments” maintain high MS values to the top of the section, and frequently display several MS spikes that can be > 100 times pre-settlement values. These spikes might be due to relatively short-lived pyrotechnologies, such as iron smelting, lime sintering or coal burning. Microscopic analyses reveal an upward increase in charcoal particulates that mirrors the pre- to post-settlement increase in magnetic susceptibility, suggesting that fly ash (e.g., due to land clearing or iron smelting) might be the cause of the high MS spikes. Sediment geochemistry shows an increase in environmental trace metals commonly associated with industrial activities and fossil fuel combustion towards the top of legacy sediment stacks.

Magnetic susceptibility, environmental magnetism, legacy sediments

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