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Outcrop to nano-scale examination of Late Paleozoic paleosols to constrain climate and environmental indicators

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Abstract

Fine-grained sedimentary lithologies can be challenging to characterize but often preserve vital environmental indicators. We used cm-scale outcrop description, bulk geochemistry, and micro- to nano-scale automated mineral identification (SEM) and characterization analysis to investigate attributes of paleosols in the central Appalachian basin. Paleosols were selected that developed under varying climatic conditions of the latest Pennsylvanian (earliest Permian?) Late Paleozoic Ice Age.

In the upper Casselman Fm., paleosols exhibit redoximorphic texture (in a suspect spodosol?) with cm-scale slickensides and weak ped development, with mineralogy that includes small amounts of gypsum, barite, and pyrite within the predominantly illite matrix. A histosol “underclay” in the Casselman shows nodular calcite within an illite matrix that is cross-cut by micro-veins of gypsum. In the overlying Monongahela Fm., within interbedded clastic and carbonate lacustrine deposits is a composite vertisol with large vertic structures and gilgai microtopography. The vertisol contains carbonate nodules in an illite/quartz matrix with disseminated dolomite and rare pyrite. Upward in the Monongahela Fm., lacustrine carbonates of the Benwood Member show evidence for pedogenesis, such as rootlets and auto-brecciation/fracturing, and weak argillan development. These carbonate paleosols show successive upward decrease in illite and quartz content, with carbonate minerals becoming increasingly dolomitic. Microfabrics and mineralogical relationships indicate a primary origin of the dolomite.

The integration of soil macro- and micro-morphology along with mineralogy provides more comprehensive climatic and environmental indicators for this succession, and reflects a transition from paleosol interaction with sulfate-rich water toward interaction with more alkaline water over time.

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