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# Insights into Permian Pedogenesis and Climate: Magnetic Stratigraphy of Four Stacked Paleosols, Lower Permian (Wolfcampian) Roca Shale, Central Kansas: Abstract

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## ABSTRACT

This study focuses on the rock magnetic character of four stacked paleosols (P1 at base, P4 at top) in the Lower Permian (Wolfcampian, Council Grove Group) Roca Shale exposed near Manhattan, Kansas.

Magnetic characterization of Quaternary soils has proven a valuable tool for evaluating climatic conditions and pedogenic processes, yet no systematic study of pre-Quaternary soils has been undertaken. The Roca paleosols are protosols, vertisols, calcic vertisols, and calcisols. Cross-cutting relationships and superposition principles suggest that macro- and micro-climatic conditions evolved as soil formation progressed. In particular: 1) in P2, clasts of the lower (vertic) part are entrained in the upper (calcic, leached) part suggesting a shift from subhumid to semiarid; and 2) in P3 and P4, carbonate nodules have argillic coats that are at times overlain by (hematitic) ferrans, suggesting climate transitions from semiarid to subhumid back to semiarid.

Rock magnetic data provide further insight into pedogenesis and climate. A preserved magnetic signature is suggested by: l) distinct magnetic susceptability, natural remanent magnetization (NRM), anhysteric remanent magnetization (ARM) and isothermal remanent magnetization (IRM) in B, Bt, Bk, E, and R horizons; and 2) carbonate nodules and adjacent subangular blocky structure which preserve the same susceptability trends. Overall, susceptability ranges from <2.0 to 11.6 x 10{-8}m{3}/kg, but within P2, P3, and P4, there is a general upwards decrease. PI contains upwards increasing susceptability. These changes correspond to a shift in S-ratios (IRM[0.3T]/SIRM) ratios from ~0.9 to ~0.4, reflecting a possible change from magnetite to hematite upwards through the paleosol profile. NRM values range from almost 1 x 10{-8}`to 5 x 10{-5} Am{2}/kg. NRM/susceptability and SIRM/susceptability ratios (proxies for ferrimagnetic vs. paramagnetic contributions to susceptability) decrease from PI to P4 and the position of the highest ratio within each paleosol profile is lowered from the B (P1) to top Bt (P2) to base Bt (P3, P4) horizons.

Rock magnetic data and field observations suggest that weathering intensity increased through time from the development of P1 to P3 (P3 represents the most leached and oxidized paleosol profile), but decreased during development of P4. The oxidizing conditions prevalent in upper soil horizons led to increased lessivage in these intervals and subsequent concentration of clays and iron oxides in lower, less oxidizing horizons. Gleyed intervals are characterized by (SD?) magnetite.

The results of this study show that coupled field observation and rock magnetic characteristics of pre-Quaternary paleosols potentially will yield significant climatic and pedogenic information.

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