Geophysical Research Abstracts
Vol. 18, EGU2016-18511-1, 2016
EGU General Assembly 2016
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Weathering, diagenesis, and pedogenesis in Paleocene-Eocene paleosols from the Bighorn Basin, WY: evidence from environmental magnetism

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Environmental magnetism of loessic soils and recent paleosols has proven to be a useful tool in the reconstruction of climatic conditions in Quaternary systems. However, it remains unclear how applicable these tools are in more ancient systems where diagenetic and surficial weathering processes may act to alter the original assemblage of magnetic minerals. Here, we evaluate the magnetic properties of nine paleosols that span the Paleocene-Eocene Thermal Maximum (PETM ∼55 Ma) in the Bighorn Basin, WY. Each paleosol layer has been sampled from both drill core and outcrop exposure. Outcrops in this system are exposed to a pervasive weathering front, which is observed to alter sediment color in the upper 25 meters of drill cores. Importantly, these nine paleosol layers occur in the core far below this pervasive weathering front and are presumably unweathered. Our results show a consistent increase in both magnetic remanence measured between 100 – 1000 mT and a quantitative redness index in outcrops relative to equivalent core sediment. We suggest these patterns indicate the production of pigmentary hematite in outcrops as a result of oxidative weathering processes. There is no clear affect of weathering on the low-coercivity mineral component. However, comparison of the low-coercivity component with pedogenic magnetite in modern soils suggests that additional diagenetic processes may act to alter low-coercivity minerals irrespective of surface weathering. Despite these alterations, magnetic enhancement ratios for paleosol B-horizons show strong correlations with independent geochemical paleoprecipitation estimates across the PETM, derived from the same paleosol B-horizons. This suggests that magnetic minerals and bulk geochemistry record similar information about pedogenesis and that more work should continue to pursue environmental magnetism as a tool in reconstructing paleoclimate in ancient terrestrial systems.