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Various Mineral Magnetic Responses to Pedogenesis in Aerobic Soil of Contrasting Weathering Intensity

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Many previous studies have successfully used magnetic parameters to decode paleoclimatic evolution. For example, magnetic susceptibility (χ) of the yellow/brown loess/paleosol sequences from the Chinese Loess Plateau is a proxy indicator of the East Asian summer monsoon. However, it is complex when magnetic parameters of strongly weathered red soils reflect the paleoclimatic characteristic. To accurately decode the effect of diverse weathering intensity on magnetic response to pedogenesis in red soils, we carried out detailed rock magnetic and geochemical analyses on a strongly weathered red soil sequence in the Bose Basin of subtropical southern China. Our results combining with previous studies on loess and underlying red clay deposits from the loess Plateau suggest that magnetic responses to pedogenesis in aerobic soils varied with different weathering conditions. A transformation of ferrihydrite → SP maghemite → SD maghemite → hematite observed by Torrent et al. (2006) may be the main magnetic response of aerobic soil to pedogenesis with various rate of each step corresponding to different weathering intensity. For loess deposits exhibiting scarce weathering, the main pedogenic magnetic mineral is fine-grained maghemite despite of small percentage of pedogenic hematite, which resulted from much more faster rates of ferrihydrite formation and ferrihydrite to maghemite transformation than that of maghemite to hematite alteration. As the weathering becomes strong, maghemite to hematite transformation intensifies, but it still keeps positive correlation between hematite and fine-grained maghemite. Paleosol and Xiashu loess deposits are belong to this type. When the weathering becomes intensively strong, such as the Bose sequence of this research, hematite and maghemite conversely correlates due to the extremely fast rate of maghemite to hematite conversion. This model can explain the complexity of magnetic parameters' environmental implication for soils exhibiting contrasting weathering. Except for distinct weathering intensity, we also find that some special climate, such as seasonality, can lead to the fast formation of hematite from maghemite. Understanding weathering degree and special climate condition which soils demonstrate is essential when magnetic variation refers to paleoenvironmental evolution.