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Letter to the Editor

Comment on "Dependence of Near-Surface Magnetic Susceptibility on Dust Accumulation Rate and Precipitation on the Chinese Loess Plateau" by Porter et al.

The recent paper by Porter et al. (2001) represents a major step forward in the understanding of modern magnetic susceptibility (MS) variations on the Chinese Loess Plateau and the relation of environmental factors and dust influx to MS. Porter et al. (2001) make it clear that only modern soil, uncontaminated by the S0 paleosol or L1 loess and undisturbed by human activity (plowing), was sampled. This is an excellent strategy for studying modern soils and the relationship of those soils to magnetic susceptibility and factors that control magnetic susceptibility. To a great extent, this sampling strategy has succeeded as indicated by the uniform manner in which susceptibility values increase from the northwest to the southeast across the Loess Plateau.

There is one aspect of the paper which I believe is not justified by either the data or the model presented by the authors: that is the conclusion regarding the dependence of MS on windblown dust and not on pedogenesis. In their abstract, Porter et al. (2001) state "that 84% of the loess MS variance is dictated by the diluting effect of dust. . . "(p. 271). They arrive at this conclusion through a relatively straightforward model of MS based on the distance downwind from the northwest corner of the study area (*L*) which is related to changing susceptibility values (as *L* increases, MS increases), variations in loess thickness (*T*), and a pedogenic index (PI). After estimating the value of several constants (α, MS_0, and PI) by minimizing the squared differences between measured and predicted values of MS, they calculate MS_{dust} values with no pedogenic influence, that is their Eq. (2) without the PI/*T* term or their Eq. (3). A regression of these predicted versus measured values yields their Eq. (4) with an r^2 of 0.84. This value of r^2 is the basis of their conclusion that dust rather than pedogenesis is the principal factor controlling MS.

Three problems result from their use of regression techniques and the application of r^2. First, r^2 describes the amount of variance in the dependent variable explained by the equation containing the independent variable (Freund and Littell, 1991, p. 23, #2). This means that 84% of the variance in $MS_{predicted}$ is explained by $MS_{measured}$ in their Eq. (4), *not* as they suggest that 84% of the measured MS values are explained by their predicted values. Second, Porter et al. (2001) have used r^2 to link cause and effect. Statistics books routinely caution about the use of the correlation coefficient (*r*) or r^2 to link cause and effect. As one textbook notes (Witte, 1993, p. 147) "A correlation coefficient, regardless of the size, never provides information about whether an observed relationship reflects a simple cause/effect relationship or some more complex state of affairs." Hence, a high r^2 may result from causality or from other factors related to the measured variables. Third, all regression techniques assume that the independent variables are not related or correlated to each other. Clearly that assumption is violated by the use of *L*, which is correlated not only to *T*, but also to environmental factors such as mean annual precipitation (MAP) and mean annual temperature (MAT). Therefore, the incorporation of *L* into the equation does not truly eliminate the effect of the environmental variables MAP or MAT on MS. At the beginning of the paper and in numerous figures Porter et al. (2001) demonstrate there is a complex interrelationship between the variables and acknowledge how difficult it is to assess the effect of a single variable on MS—clearly the "complex state of affairs" described above.

Some of the data generated by Porter et al. (2001) may, however, prove useful for estimating the relative influence of pedogenesis on measured MS values. Porter et al. (2001) estimate the value of MS_{dust} to range from near 0×10^{-8} m^3/kg at the northwestern margin of the Loess Plateau to 49×10^{-8} m^3/kg at the southern margin of the plateau. These are perfectly reasonable estimates for the minimum L1 MS values upon which the equation is based. It is important to note that minimum L1 values are thought to occur at times when MAP and MAT are minimal (Maher, 1998). It is not until the pedogenic influence is included in their formula that the maximum predicted value of MS approaches the maximum measured value of MS today ($\sim 200 \times 10^{-8}$ m^3/kg). Hence an alternate interpretation of their results would be that only about 25% of the MS signature is the result of dust (the $\sim 0–49 \times 10^{-8}$ m^3/kg range estimated by their MS_{dust} equation), whereas the remaining 75% is the result of pedogenesis (the $\sim 0–200 \times 10^{-8}$ m^3/kg range estimated by the equation including PI).

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