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Soils and climate: redness and weathering as indicators of mean annual precipitation

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Paleosols can be used as archives of past changes of climate and landscapes, but their interpretation has to be based on modern analogies such as Budyko's law of soil zonality. These can be very useful if the respective processes of soil formation are sufficiently well understood. However, some soils such as the Terra Rossa or Red Mediterranean Soils, that are widespread at the fringes of the steppes and deserts, are still disputed with regard to their genesis and environmental significance. In particular, there is no agreement whether they resemble current environmental conditions, or are inherited from climates or sediments of the past. In this context, a remarkable change of the color of surface soils can be observed when driving from the city of Irbid in Jordan towards the east. Soil color apparently changes slowly, but steadily from dark red to yellow colors. However, attempting to express these color changes in numerical form is challenging, and it seemed questionable whether color is indeed connected with soil weathering intensity, or an optical illusion. However, a systematic comparison of different approaches of calculating soil redness found that the CIELAB-color system is suited for numerical expressions of soil redness and performs better than the Munsell charts. Along the investigated transect in Jordan, soil color seems strongly connected with weathering intensity, since various weathering indicators point to a steady increase of soil development with moisture. This suggests that such indices can well be used in semi-arid areas of 250-600 mm of mean annual precipitation. A very strong correlation of magnetic enhancement and rainfall indicates that the investigated soils are forming in equilibrium with current climatic conditions, and regressions based on this gradient might be suited for estimating paleorainfalls recorded by buried paelosols. It seems therefore that surface Terra Rossa soils in Jordan can be in equilibrium with current climate conditions, and regressions calculated on the basis of current soil properties might be suited for estimating past environmental conditions recorded by buried paleosol. However, determining the time-frames and climatic sensitivity of changing soil properties remain important challenges for a successful integration of paleosols with other climate archives, and the presence of Vetusols can make determinations of calibration regressions difficult.