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Processes and rates of formation defined by modelling in alkaline to acidic soil systems in Brazilian Pantanal wetland

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ABSTRACT

Within a soil system, it is generally difficult to relate the observed secondary phases and their spatial distribution to past or current processes. Geochemical modelling can help to identify present-days processes and to quantify formation rates if the system is sufficiently constrained. Here we used the PHREEQC model for this purpose, applying it to soil alkaline to acidic soil systems in the Nhecolândia area. A large amount of data was available, but scientific questions remained opened. We carried out a complementary field study to clarify a key point necessary for modelling, confirming the disconnection between two types of groundwater, perched, alkaline and deep, acidic. Our simulations showed that the observed soil system corresponds to the current biogeochemistry and that paleoclimatic genetic hypotheses are unnecessary. We found that the ridge soil formation rate ranges from 396 to 638 kg ha⁻¹ y⁻¹, depending on hypotheses. We showed that the downslope soils act as buffers to store labile species during the dry season, allowing alkalinity to be maintained from one year to the next. At least 125 y were necessary to obtain downslope alkaline lakes, and this alkaline nature can quickly disappear after changing drainage conditions. We explained how hyperacidic horizons (pH < 4) can neighbor alkaline horizons (pH > 10) with a sharp contact. When correctly informed, geochemical modelling appeared as an effective tool to answer questions about soil processes.