Phosphate sorption by acidic soils

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For acidic soils, it is assumed that the sorption of phosphorus (P) by the hydrous oxides of iron (Fe) and aluminium (Al) binds added P, and that the reverse reaction controls the concentration of P in runoff from pasture swards. Therefore, understanding the contribution of different soil properties to P sorption, and the interactions among their effects, may lead to new ways to control the concentrations of P in runoff. The surface properties of the hydrous oxides of Fe and Al are well known, as is the selectivity of oxalate solutions in extracting them. Our interests include the drivers of P runoff from grass swards and indices of P runoff; consequently we explored the variation in P sorption (P_{sorp}) among 42 acidic surface soils as a function of the combined effects of pH and of oxalate-extractable Fe (Fe_{ox}), Al (Al_{ox}) and P (P_{ox}). The soils studied varied widely in these properties: Fe_{ox} (280–4300 mg/kg), Al_{ox} (180–3780), P_{ox} (50–372) and pH (4.0–5.3). All variables other than pH were log_{10} transformed to stabilise variance. Multiple linear regression modelling showed that all four explanatory variables significantly ($P<0.01$) affected $log_{10}P_{sorp}$ and that collectively they explained ~94% of the variation in log_{10} P_{sorp} among the soils. The coefficients of the explanatory variables decreased in the order: log_{10} Al_{ox} > $log_{10}Fe_{ox}$ » $log_{10}P_{ox}$ > pH. And as predicted from chemical principles, the signs of the coefficients of $log_{10}Al_{ox}$ and $log_{10}Fe_{ox}$ were positive, whereas those for $log_{10}P_{ox}$ and pH were negative. Though the effects of some of these properties on P_{sorp} have been documented, to our knowledge this is the first time that their combined effects have been demonstrated. We are in the process of assembling similar data for other soils to test the model and will present the results at the Workshop. The modelling is suggestive of a greater role for the hydrous oxides of Al than of Fe in the rapid initial sorption of phosphate by acidic soils. It also suggests a mechanism for the effect of P buffering on the relation between agronomic soil tests and the concentration of P in runoff that is the subject of another contribution to the Workshop from our group.