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Organic phosphorus and carbon in soil particle size fractions – A global meta-analysis

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Although it is well known that phosphorus (P) strongly sorbes to mineral surfaces, the role of organic P (OP) in the formation of organo-mineral complexes and in stabilization of soil organic matter is not yet well understood. Therefore, the aim of this study was to gain insights into the sequestration of OP and organic carbon (OC) in soils and soil particle size fractions. For this purpose, I analyzed the distribution of OP, OC and inorganic phosphorus (IP) among particle size fractions depending on the geographical location of the soils, land use, and soil depth based on published data. The clay size fraction contained on average 8.8 times more OP than the sand size fraction and 3.9 and 3.2 times more IP and OC, respectively. The finding that OP is more strongly enriched in the clay size fraction than OC highlights the high capacity of OP compounds to compete for binding sites in soil. The OP concentrations of the silt size and clay size fractions were both negatively correlated with mean annual temperature of the sites ($R2=0.30$ and 0.31, respectively, both $p<0.001$). The OC:OP ratios of the silt and clay size fraction were negatively correlated with latitude ($R2=0.49$ and 0.34, respectively, both $p<0.001$). Yet, the OC:OP ratio of the clay size fraction changed less markedly with latitude than the OC:OP ratio of the silt and the sand size fraction, which can be attributed to strong sorptive stabilization of OP in the clay size fraction. The OC concentrations of all particle size fractions were significantly ($p<0.05$) lower in croplands than in the adjacent soils under (semi-)natural vegetation. In contrast, the OP concentration was only significantly ($p<0.05$) decreased in the sand size fraction due to land-use conversion. In conclusion, the study shows that OP is more strongly enriched in the clay size fraction than IP and OC, which can be attributed to the higher capacity of OP than of OC to compete for binding sites in soil. The strong sorption of OP to mineral surfaces makes soil OP less vulnerable to land-use conversion than OC and seems to compensate for latitude-dependent differences in the C:P ratio of plant litter inputs to soils. Thus, taken together, the study suggests that OP is more persistent in soil than OC and that it might play an important role in the formation of organo-mineral complexes, and thus in the stabilization of soil organic matter.