



Release and transport dynamics of colloidal phosphorus in a small agricultural catchment

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Colloids (1~1000 nm) have been widely suggested as important carriers of phosphorus (P) in agricultural soils. This suggestion is, however, so far based on colloids extracted from laboratory soil solutions, with no direct field evidence. Here, we conducted the first field monitoring study of colloidal P (P_{coll}) release and transport dynamics in a small agricultural headwater catchment located in Western France, during one hydrological year. Results evidenced that P_{coll} is an important fraction of the total dissolved P (TP) fraction (<0.45micron) in both soil and stream waters from this catchment (mean=39%). However, a decrease in the proportion of P_{coll} was observed along the soil-stream continuum, suggesting either retention of part of the released P_{coll} during transport or a dilution by deep groundwater with low P_{coll} concentrations. The proportion and composition of P_{coll} were studied in detail along two soil transects (K and G), and in the stream immediately adjacent to them. A spatial consistency was found in the proportion of P_{coll} which were comparatively higher in soil and stream waters from transect K (mean=52% and 32%, respectively), as compared to transect G (mean=42% and 19%, respectively). A detailed survey of the P_{coll} composition revealed a major difference between soil waters from transects G and K, the colloids being equally composed of colloidal-MRP (molybdate-reactive P) and colloidal-MUP (molybdate-unreactive P) in transect G, as against mainly in the form of colloidal-MUP (mean=70%) in transect K soil waters. However, this difference was not observed in corresponding stream waters, in which P_{coll} was mainly in the form of colloidal-MUP (mean=75%), thereby suggesting the likely preferential retention of MRP-rich colloids at the soil-stream interface. Concentrations of P_{coll} were relatively stable throughout the hydrological year in transect G soil waters, except as regards a peak occurring in phase with a Fe(II) release peak. Interestingly, this peak was not transferred to the stream, suggesting again the occurrence of a retention process at the soil-stream interface. In samples from transect K, concentrations of P_{coll} were more variable in both soil and stream waters, which could be due in part to higher analytical uncertainties as the concentrations of TP were very low in most samples from this transect. Considering all soil and stream water samples, a negative correlation was found between the proportion of P_{coll} in TP and the P:Fe ratios in <0.45micron filtrates (r=0.497). Concentrations of P_{coll} were also found to correlate with total anion (r=0.627) and DOC concentrations (r=0.859), suggesting a potential influence of the soil properties and local groundwater chemistry on P_{coll} concentrations. Overall, this study confirms that P_{coll} is an important fraction of the TP released in agricultural soils and that this fraction can be efficiently transported to streams by shallow groundwater flow. It also indicates that the composition of the released P_{coll} may vary in space and time and that retention processes probably occur at the soil-stream interface with the potential of modifying the composition of the P_{coll}.