Evaluation of phosphorus sediment remobilization in the Anllóns River (NW Spain) using pH–stat kinetic leaching procedures

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Anthropogenic inputs of phosphorus (P) into river waters have in some cases increased the P concentrations to excessive levels. Sediments play a key role in the P cycle in river systems, acting as sinks for soluble P but also as P sources, depending of the environmental conditions. In previous works, P was identified as a major pollutant of the Anllóns River. The main P sources were the effluents of a wastewater treatment plant and agricultural activities in the basin. The knowledge of P geochemical dynamics in the Anllóns River is relevant considering that the Anllóns River sediments also contain high geogenic As concentrations (up to 265 mg/kg), which can be released into the water column due to displacement by P, thus increasing health risks. In this work, the remobilization kinetics of P from bed sediments of the Anllóns River is studied employing pH-stat leaching procedures in conjunction with geochemical modeling. Four sediments differing in their location, properties and P concentration (ranging between 434 and 1600 mg/kg) were subjected to pH-stat leaching at pH 4 and pH 10 during 96 hours. The results obtained showed that P release was promoted (between 14 and 26 times) at alkaline pH in comparison to acid pH. At pH_{stat} 4 the percentages of P released ranged between 0.3 and 5% of total P, whereas at pH_{stat} 10 they reached up to 46% of total P. The greatest relative P mobility was observed in the sediment containing the highest As concentration, although the percentages of As that were simultaneously released were low (~7%). The kinetic study showed that at acid pH the P release profiles were characterized by an initial rapid P release, followed by a continuous decline, a behavior which can be indicative of readsorption and/or precipitation processes. In contrast, at alkaline pH the kinetic profiles were characterized by a rapid P release in the first 24 h, followed by a slow release process, visualized as a plateau in the kinetic profiles. This behavior was adequately described (r^2 = 0.951–0.998) by a "two-pool" model, which considers a "labile" and a "slowly labile" operational P pools in the sediment. It is noteworthy that P and As –examined in a previous work- exhibited similar release behavior and similar kinetic profiles at both pH values, reflecting the similarities in chemical properties of both elements. The low amounts of P released at pH_{stat} 4 suggest that P is mainly associated with stable phases of the sediment, such as Fe oxyhydroxides, which are scarcely dissolved at this pH value. On the other hand, P release at alkaline pH was significatively (p <0.01) and positively correlated with the dissolved Fe, Ca, Mn and organic matter. This behavior can be indicative of desorption of strongly adsorbed P by the increased concentration of hydroxyl ions and/or dissolution of organic matter, with the concomitant release of its associated elements. The results obtained let us to conclude that alkalinization promotes both the amounts and rate of P mobilization from Anllóns River sediments and that a strong interaction between P and As is expected under these conditions.