

Molecular speciation of particulate macronutrients in leachates from agricultural soils

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Managing the loss of essential macronutrients from soils to mitigate eutrophication requires adequate understanding of the nature and properties of mobilised nutrients from arable land. Colloids and nanoparticles leached from agricultural land represent major sources of potentially bioavailable nutrients [1] and are known to exhibit high mobility in the environment [2].

Despite significant research efforts geared towards the understanding of environmentally harmful nanoparticles like gold and silver, accurate knowledge of essential nutrients in colloids and nanoparticles, like nitrogen, phosphorus (P), potassium, calcium, magnesium and sulfur (S), is limited.

We combined multi-elemental synchrotron X-ray fluorescence (XRF) microscopy with multivariate spatial co-localisation analysis and X-ray atomic absorption near-edge structure (XANES) spectroscopy at the P and S K-edges, to study the speciation of P and S in two fractions of leached particles, >0.45 and <0.45 μm respectively, collected from five tile-drained agricultural sites in Sweden.

S K-edge XANES showed that particulate S in the leachates existed predominantly as organic S, rather than inorganic S (sulfate). Furthermore, XRF microscopy showed significant co-localisation of P with S in leached particles. P K-edge XANES confirmed that organic P, followed by P adsorbed to surfaces of aluminium-bearing particles and calcium-bound P (mostly as apatite) were the most common forms of P leached from the soils.

Iron-bound P was less common in the leachates than expected, calling for further research into the behaviour of iron-bound particles in soils.

1. Uusitalo, R.; Yli-Halla, M.; Turtola, E., *Water Res.* **2000**, *34* (9).
2. Gottselig, N.; Bol, R.; Nischwitz, V.; Vereecken, H.; Amelung, W.; Klumpp, E., *Vadose Zone J.* **2014**, *13* (7).