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Effects of sorption in the lower unsaturated zone on the storage and transport of ions in recharge to ground water, southern New Jersey

A field-based approach for determining sorption in the lower unsaturated zone (between the root zone and the capillary fringe) and its effect on the storage and transport of ions in recharge to ground water has been demonstrated for a small (8 km^2) agricultural watershed in the Coastal Plain of southern New Jersey. These sediments typically are quartzose, acidic (pH 3.9-6.8 standard units), iron- and kaolinite-rich, and organic-matter poor. Moisture-content and chemical-concentration data obtained from 14 paired unsaturated-zone-core and shallow-ground-water samples were used to estimate the mass flux of chemical constituents across the water table and sorption coefficients (K_d). The selectivity order of the K_d values for cations is consistent with the expected selectivity order based on charge density (for example, $Na^+ > Mg^{++} > Ca^{++}$ for sands). Although calculated sorption coefficients were greater for cations than for anions (cation sorption coefficients were 4 to 10 times greater than those calculated for NO_3^-), sorption has a substantial effect on the transport of anions through the unsaturated zone. In particular, average K_d values for NO_3^- were 0.22 L/mg for sands and 0.62 L/mg for finer grained sediments. This result indicates that the lower unsaturated zone in the study area is a large reservoir for nitrogen as nitrate. Models that do not account for sorption will result in underestimates of nitrogen storage and overestimates of contaminant transport rates. Such predictions would lead to overly optimistic expectations for natural cleansing in this watershed and in other, similar settings.

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