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How does clay move and accumulate in sand root zones?

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- A column study will be conducted in 2018. The objectives of the study are to determine how water chemistry and construction practices influence clay movement in two-tiered sand putting greens.
- Columns are currently being constructed, and leaching events and measurements will begin in early 2018. A preliminary study helped inform column construction methods and hone XRF scanning methods.
- The results from this study will improve our understanding of how soil and water chemistry interact to influence performance of engineered turf soils.

In 2017, we documented thin layers of clay that had formed in 9-year old putting greens in a Mississippi golf course (paper available here: Catena- Clay Lamellae Paper). This observation led us to study how clay moves and accumulates in two-tiered sand putting greens. We will construct columns to the recommendations of the USGA (2004), and amended them to contain 0, 1, 3, or 5% clay by weight. These ranges were selected to be above and below the recommended cutoff of <3% clay-sized particles for new putting green construction. Columns will be leached with either 0.1 or 1 pore volume of water for a series of repeated leaching events. The entire study will be replicated using two different water sources (CaCl-based or NaCl-based) to study how water chemistry influences clay movement.

After each leaching event, x-ray fluorescence (XRF) is being used to measure the clay content (using Fe as a tracer) inside columns in 2.5 cm depth increments. To take these measurements, we constructed an autosampler stand to position the columns for automated XRF analysis (see this video for more details: https://www.youtube.com/watch?v=iJzYzuITz44). The stand allows for scanning while columns are rotating, producing an extremely accurate way to measure average clay content at different depth increments inside columns (Fig. 1). This stand is the first of its kind and offers a new way to study soil formation.

In addition to XRF measurements, air permeability will be measured to document changes in pore space resulting from clay movement. The columns will be photographed regularly to visually document clay accumulation, and at the end of the study, the columns will be split vertically and dissected to measure clay concentrations in 2.5 cm depth increments to further validate XRF clay measurements. A subset of columns with accumulations of clay will be analyzed using a micro-CT x-ray scanner, which produces 3-D models of soils and allows for calculation of pore space in 50 µm depth increments. Leachate will be collected from each column throughout the study period, and a mass balance of clay will be produced to document how clay responded to leaching treatments.

In a preliminary study, a column was constructed with 1% clay by weight and leaching events was conducted with 0.1 pore volumes of CaCl-enriched water. After seven leaching events, compared to the baseline clay distribution, leaching resulted in an accumulation at three inches, and a possible redistribution of clay from 4-10 inches down to 11 inches (Fig. 2). These preliminary data are proof-of-concept and show that XRF can accurately show clay movement in the columns.

The results of this research could help aid future construction recommendations for putting greens. The findings will also improve our understanding of how soil and water chemistry interact to influence performance of engineered turf soils.

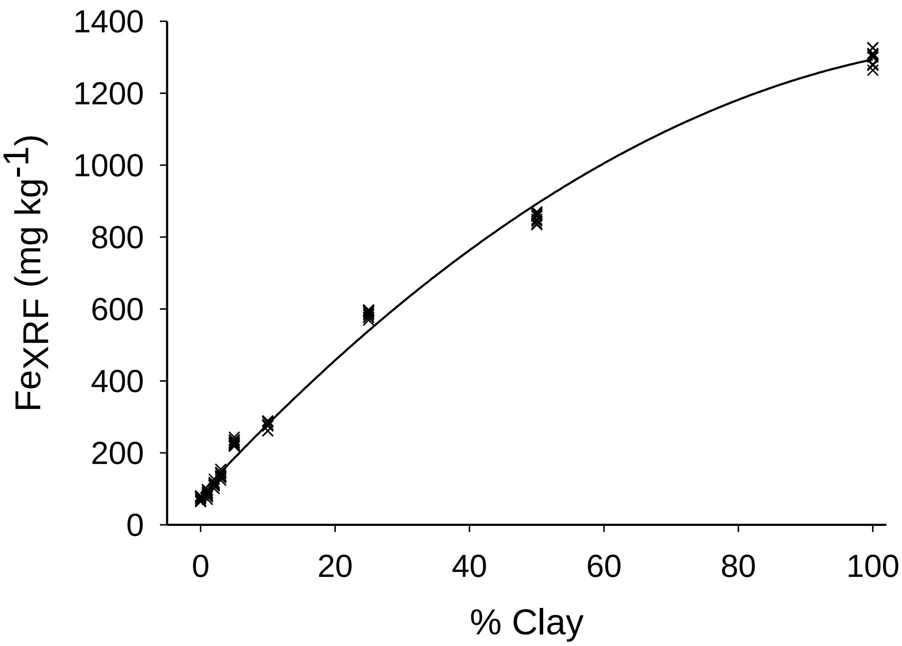

Figure 1. Calibration of an automated XRF stand with soil standards of known clay concentration. Iron is used as a tracer for clay. Each sampling cluster on the graph above actually contains data points from 10 separate scans. This robust method will allow us to track clay movement very accurately.

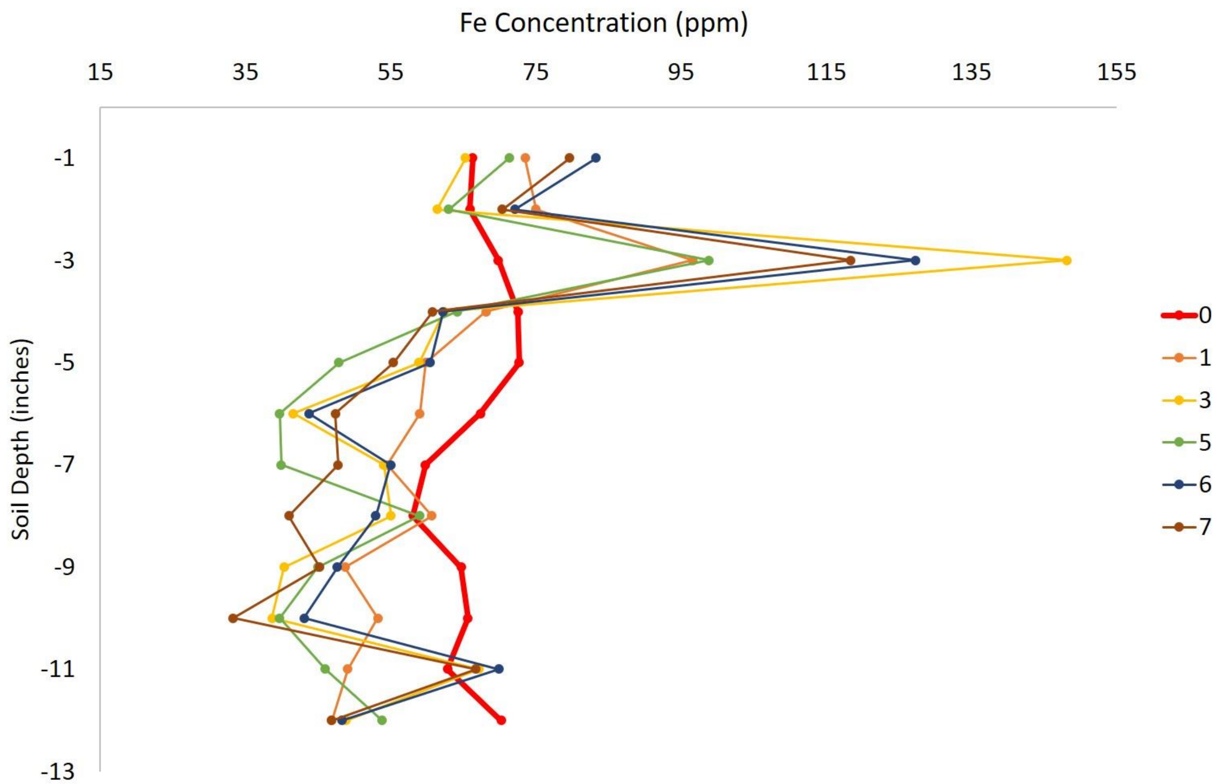

Figure 2. Clay distribution by depth as affected by seven consecutive leaching events. The column contained 1% clay by weight and each leaching event was done with 0.1 pore volumes of CaCl-enriched water. Compared to the baseline clay distribution, leaching resulted in an accumulation at three inches, and a possible redistribution of clay from 4-10 inches down to 11 inches. These preliminary data are proof-of-concept and show that XRF can accurately show clay movement in the columns.