Chemical and Physical Stability of Calcareous Sands Used for Putting Green Construction

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Purpose:

1. To examine changes in particle size distribution, hydraulic conductivity, and calcium carbonate chemistry in calcareous sands used for putting green construction.
2. To qualitatively examine mineralogical properties of calcareous sands with scanning electron microsopy, both prior to and following weathering.
3. To survey existing golf courses of varying ages for variations in physical and chemical attributes of the greens mix.

Start Date: 1998
Project Duration: 3 years
Total Funding: $55,342

A calcareous sand can be defined as any sand that contains at least 1% $CaCO_3$ (calcium carbonate, or calcite) by weight. These sands exist in various places around the U.S. and the world, and are often used for construction of golf course putting greens and other sand-based root zone media. However, their use is discouraged because of suspected, yet unconfirmed, problems associated with their long-term stability.

It is suspected that calcareous sands may break down, resulting in restricted or plugged pore space. The result of this is poor drainage, restricted rooting due to root zone saturation, and eventually severe thinning or death of the turf. To date, there are no reported systematic investigations into the occurrence or cause of this problem.

Two primary approaches are being used in this project: (1) controlled studies using simulated golf green profiles to study the weathering process of these sands, and (2) a field survey which involves collection of intact cores from putting greens constructed with calcareous sands, with subsequent examination of the physical and chemical properties of these soil cores.

Dr. Eric Miltner, Washington State University, discusses the methods used to test calcareous sands with members of the USGA Turfgrass and Environmental Research Committee.

Our objectives are to determine (1) if the use of calcareous sands results in eventual failure of the putting green to support healthy plant growth and playability, and (2) to determine the mechanism of this process, and if current management practices contribute to the problem.

Work during the past year has focused on examining the mineralogical properties of calcareous sands. Samples have been collected from across North America over the past three years. It has been determined that the samples collected range in calcite content from 0 to 100%. The majority of the samples contain less than 10% calcite by weight. Examination by scanning electron microscopy (SEM) reveals two different categories of calcite structure in these sands. Highly calcareous sands (70% calcite or greater) consist of discrete grains of calcite, mixed with silica particles.

Sands with less than 10% calcite are comprised of quartz or silica grains with small deposits or coatings of calcite on the grains. Samples containing 30 to 40% calcite have a combination of the two. This may be significant because the two different forms of calcite may react and weather differently in the field.

A series of laboratory experiments have been conducted using PVC columns to simulate putting green profiles. In the most recent study, the effect of phosphorus on calcium carbonate chemistry was evaluated. Phosphorus is involved in many chemical reactions in the soil, some of them resulting in the formation of highly insoluble calcium phosphate minerals.

Acid added to calcareous sand demonstrates potential chemical instability.

Results indicate that calcite is dissolving due to acidification, as has been shown in previous experiments. However, we did not see differences between an unamended sand and sands amended with phosphorus. This will be explored further by analyzing specifically for calcium phosphate minerals and testing sands with different calcite contents.

Summary Points

- They have used scanning electron microsopy to identify if calcium is a coating on the sand or present as a distinct mineral (calcite).
- Highly calcareous sands (>70% calcite) consist of discrete calcite grains, mixed with silica.
- Sands with less than 10% calcite are comprised of quartz or silica with small deposits of calcite on the grains.
- Samples containing 30 to 40% calcite have a combination of the two. This may be significant because the two different forms of calcite may react and weather differently.