Slaking

Slaking is the breakdown of large, air-dry soil aggregates (>2-5 mm) into smaller sized microaggregates (<0.25 mm) when they are suddenly immersed in water. Slaking occurs when aggregates are not strong enough to withstand internal stresses caused by rapid water uptake. Internal stresses result from differential swelling of clay particles, trapped and escaping air in soil pores, rapid release of heat during wetting, and the mechanical action of moving water.

In contrast to slaking, tests for aggregate stability measure how well soil withstands external destructive forces, such as the splashing impact of raindrops. Both poor aggregate stability and slaking result in detached soil particles that settle into pores, and cause surface sealing, reduced infiltration and plant available water, and increased runoff and erosion.

These photos were taken from fields near Davis, California. The soil contains clay with slight to moderate swelling potential. Left: Soil aggregates were collected from a field used to produce dry beans in rotation using organic management. Soil organic matter helps the aggregates resist slaking. Right: Soil aggregates collected from a conventional walnut operation are much less stable and burst apart when rapidly wetted. The walnut orchard is cultivated frequently, which destroys plant residue and prevents accumulation of organic matter.

Factors Affecting

Inherent - Slaking is affected by wetting rate, soil water content, soil texture, type of clay, and organic matter. Slaking is increased by fast wetting rates, particularly when soil is initially dry. Moist aggregates slake less readily than air-dry aggregates because they have already completed some or all of their swelling and some pores are already filled with water. The pressure of entrapped air is the primary factor for causing slaking of loamy soils, while clay is associated with slaking caused by soil swelling.

Slaking is influenced by the presence of smectitic clays, such as montmorillonite, that shrink when dry and swell when wet. Soil water forms part of the structure of these clays. Montmorillonite can swell 25 times more than kaolinite. The presence of even small quantities of smectites in kaolinitic soils can dramatically affect slaking, soil dispersion and surface sealing. Soils with high shrink-swell potential are common in the central region of the United States (see Figure 1).

Fast wetting of high clay soil increases the extent of differential swelling and volume of entrapped air in pore space that create internal stress and break aggregates apart. Compared to the effects of raindrop splash on external breakdown of soil aggregates, slaking plays the primary role in particle detachment and surface sealing of clay soils with otherwise stable structure.

Conversely, clay in association with organic matter acts as a cementing agent to bind soil particles together. Organic matter also influences the rate at which water is absorbed by soil and increases the soil's resistance to stress caused by wetting.

Dynamic - Soil organic matter promotes aggregate formation and stability of bound aggregates. Repeated tillage prevents accumulation or results in loss of organic matter and causes soil aggregates to breakdown into finer particles. Since loss of organic matter reduces aggregate stability, slaking increases as organic matter decreases.

Relationship to Soil Function

Slaking indicates the stability of soil aggregates, resistance to erosion and suggests how well soil can maintain its structure to provide water and air for plants and soil biota when it is rapidly wetted. Limited slaking suggests that organic matter is present in soil to help bind soil particles and microaggregates into larger, stable aggregates.

Problems with Poor Function

Slaked soil particles block soil pores, form a soil crust, reduce infiltration and water movement through soil, and increase runoff and erosion. Small aggregates produced by slaking settle together resulting in smaller pore spaces than where present with larger aggregates. Pore volume may be reduced and the ability of plants to use water stored in pore spaces may be altered.

Conservation practices that lead to slaking include:

- Conventional tillage methods that disturb soil and accelerate organic matter decomposition,
- Burning, harvesting or otherwise removing crop residues, and
- Using pesticides harmful to soil organisms that cycle organic matter and promote aggregation.

Soil samples collected from 20 year old conventional till corn and perennial bluegrass sod systems were saturated with water and allowed to dry. Note the soil crusting in the low organic matter conventional till sample compared to the abundance of stable aggregates in the high organic matter perennial sod sample. Photo courtesy Ray R. Weil, University of Maryland.

Avoiding Slaking

Conservation tillage systems, such as no-till, reduce slaking by reducing soil disturbing activities that break aggregates apart and accelerate decomposition of organic matter. No-till and residue management lead to increased soil organic matter and improved aggregate stability and soil structure, particularly when cover crops or sod-based rotations provide an additional source of residue.

Conservation practices that minimize slaking include:

- Conservation Crop Rotation
- Cover Crops
- Prescribed Grazing
- Residue and Tillage management

Measuring Slaking

The Slake or Soil Stability Test is described in the Soil Quality Test Kit Guide, Section I, Chapter 9, pp. 20 - 21. See Section II, Chapter 8, p. 72 for interpretation of results.

Reference: Herrick JE, Whitford WG, de Soyza AG, Van Zee JW, Havstad KM, Seybold CA, Walton M. 2001. Field soil aggregate stability kit for soil quality and rangeland health evaluations. Catena 44:27-35.

Specialized equipment, shortcuts, tips:

This test allows 18 samples to be evaluated in the field at one time using 2.5 cm diameter sieves, with 1.5 mm openings, fitted in holders made of PVC pipe.

Time needed: Approximately 10 minutes per batch

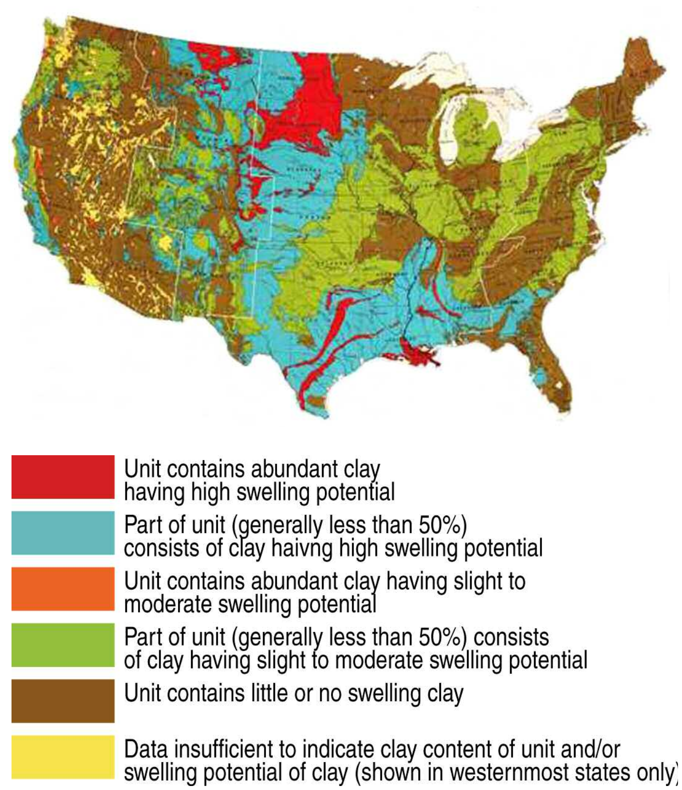

Figure 1. Map of the continental United States showing location of high swelling potential clay. Presence of shrink-swell clay contributes to soil slaking.