

# A NEW APPROACH:

## *In Situ Brine Spill Remediation Methods*

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Photo by Aaron Klaustermeier  
Soil Science Dept. NDSU



# What needs to be done to remove the sodium and other salts?

## Three step process in remediation

- 1) Restore water flow
- 2) Leach sodium with calcium salts
- 3) Leach calcium based salts



Photo by Aaron Klaustermeier  
Soil Science Dept. NDSU

## Leaching Efficiencies

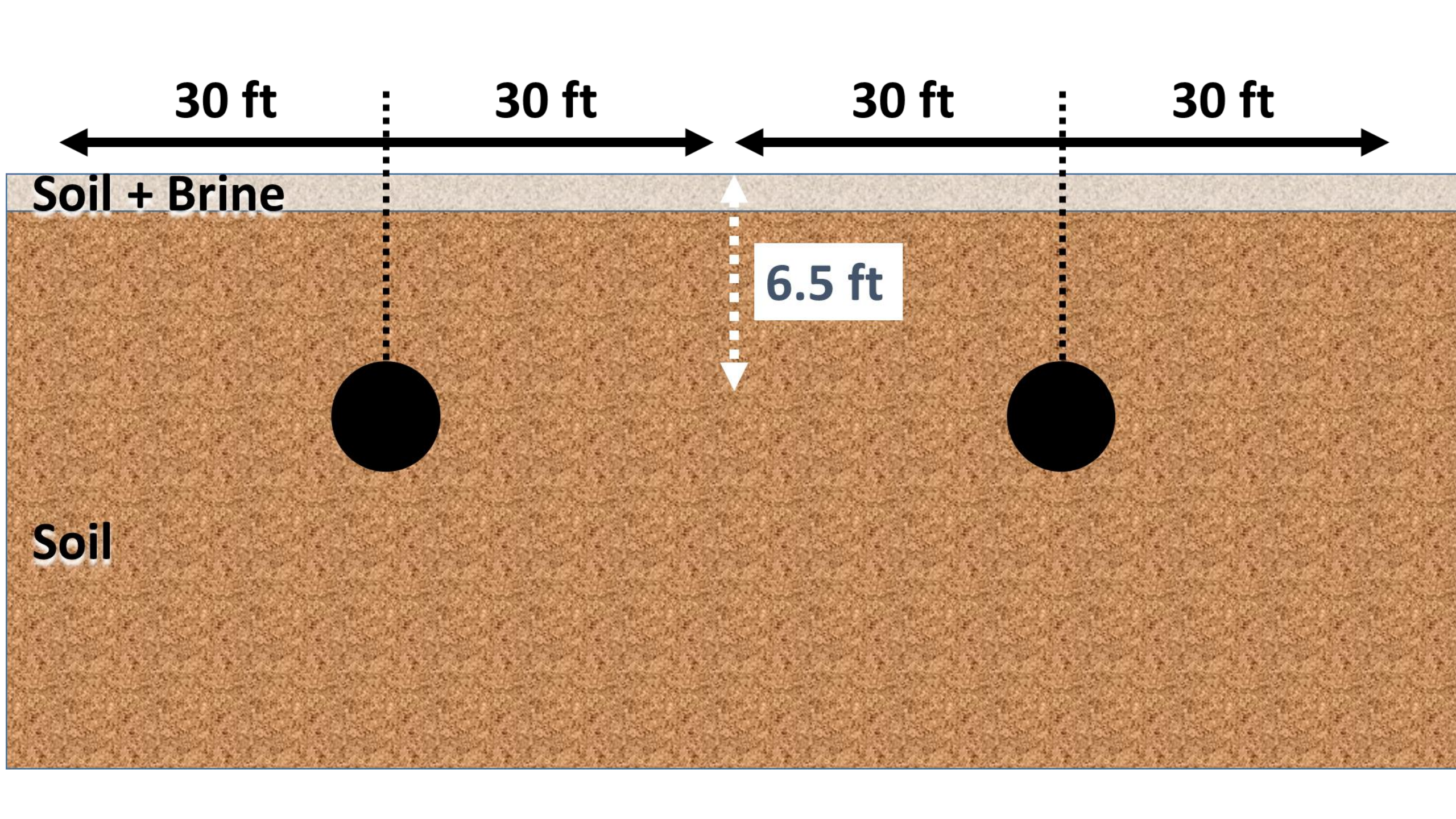
- How long will it take to successfully leach brine out of a soil profile with the addition of chemical amendments?

We need an estimate based on theory

**Solute Travel-time Estimates for Tile-drained Fields: III. Removal of a Geothermal Brine Spill from Soil by Leaching<sup>1</sup>**

W. A. JURY AND L. V. WEEKS<sup>2</sup>





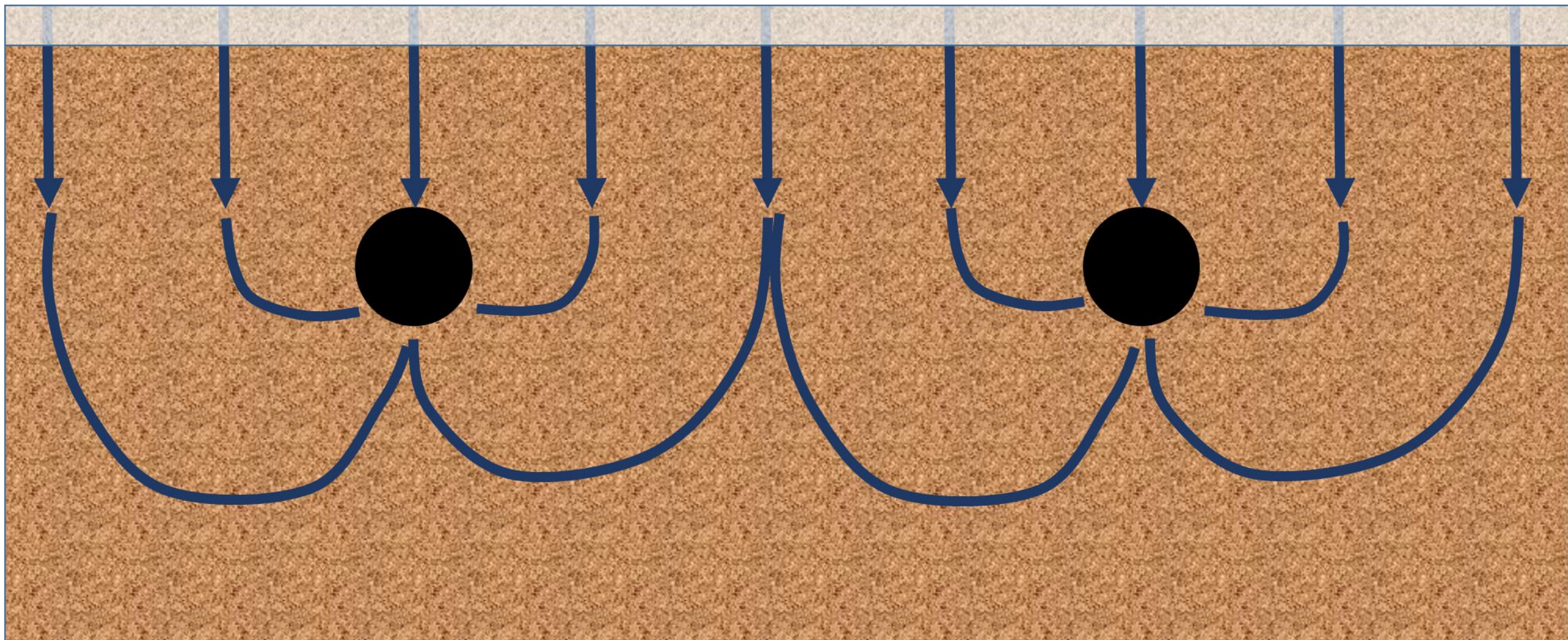


**Sandy Loam**  
*Constant ponding of gypsum sat. water*

**Years**  
 $3\frac{3}{4}$        $\frac{1}{2}$

**Days**  
**10**

**30 ft**



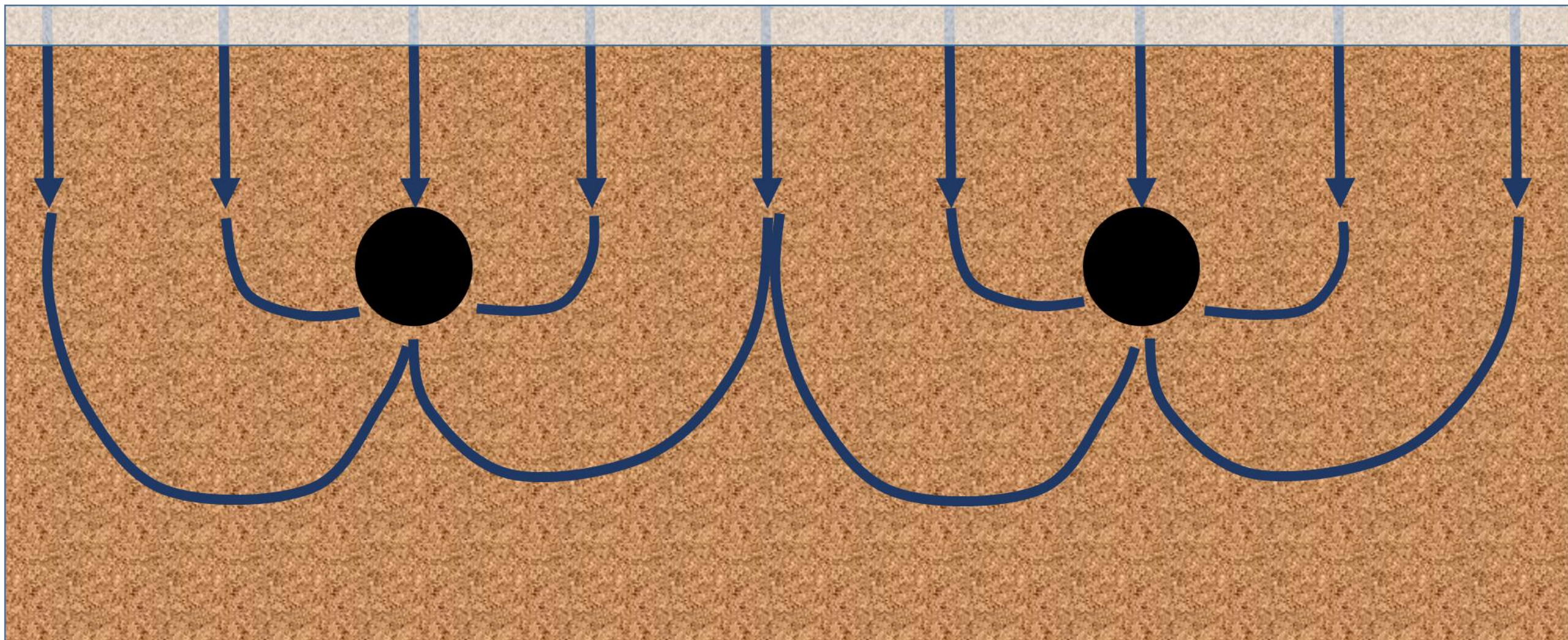


*Sandy Loam*  
*Constant ponding of gypsum sat. water*

**Years**  
106      3.5

**Days**  
10

**60 ft**





*Clay*

*Constant ponding of gypsum sat. water*

30 ft



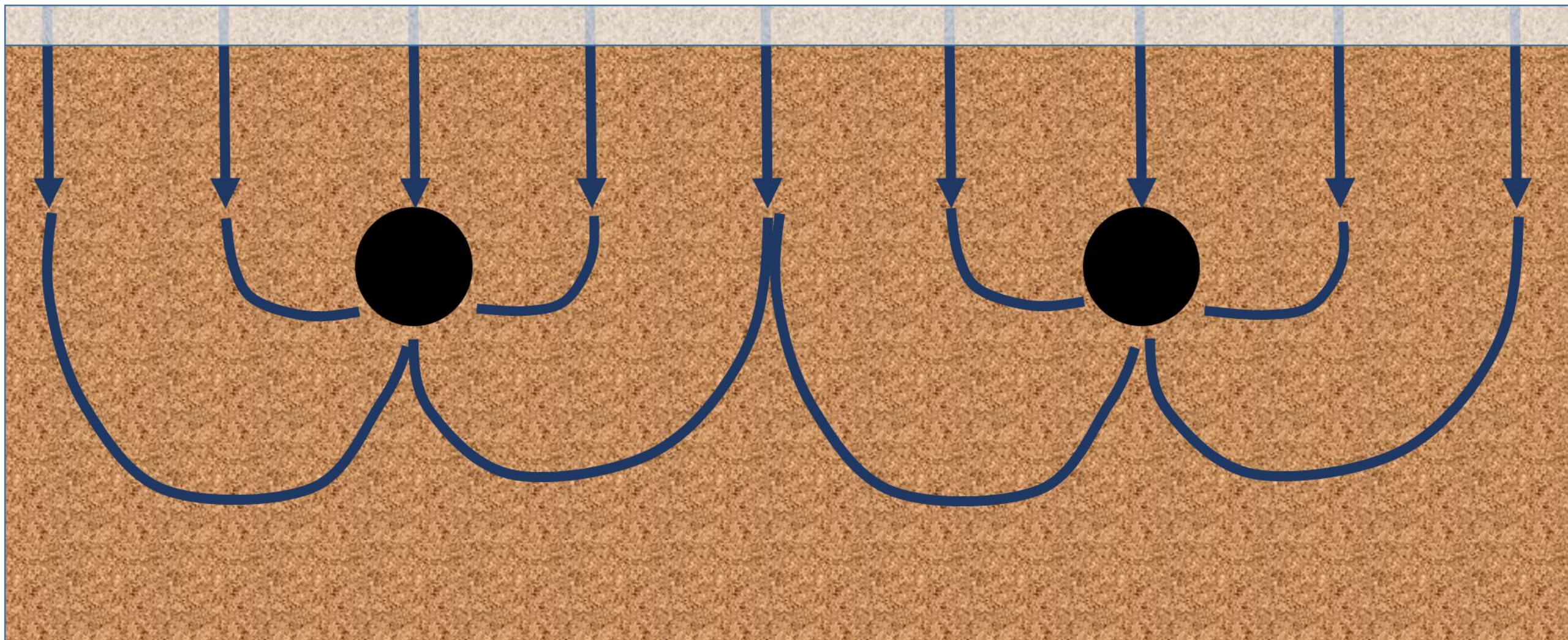
Years

Days

115

16

300





*Clay*

*Constant ponding of gypsum sat. water*

**60 ft**



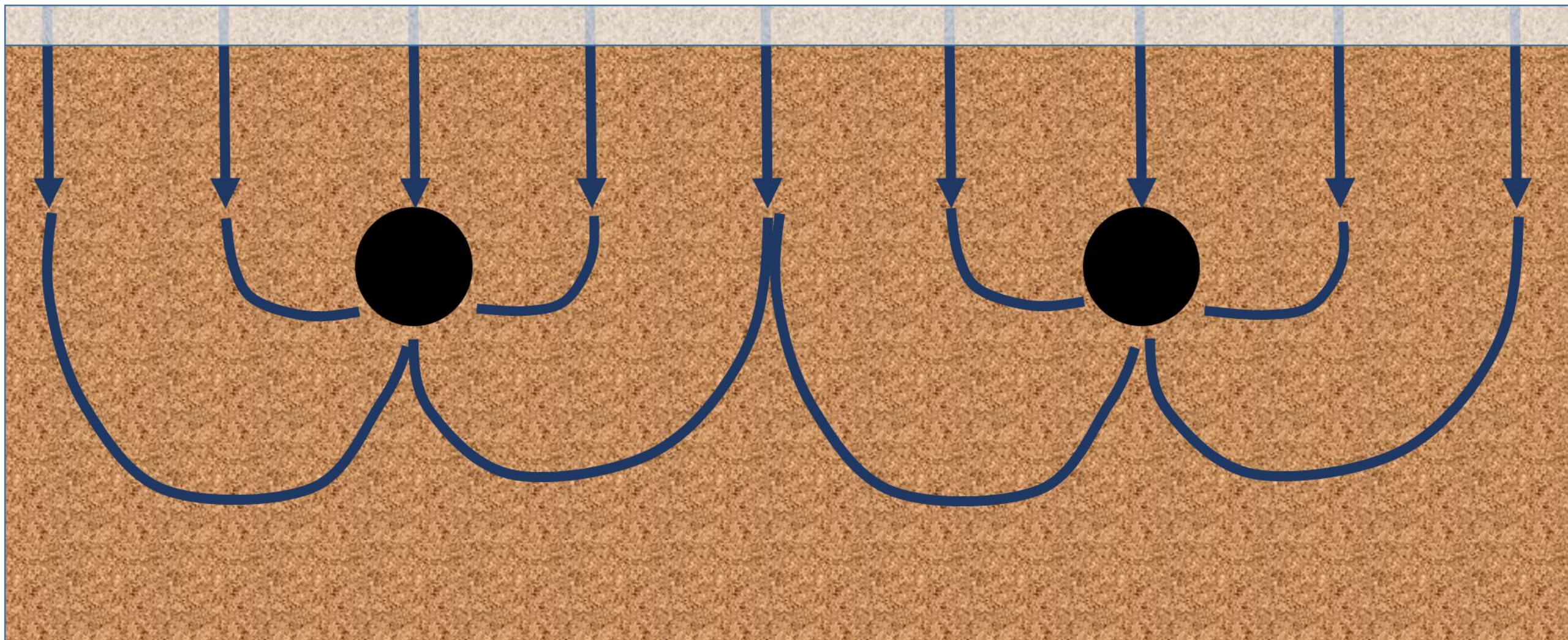
**Years**

**Days**

**3,300**

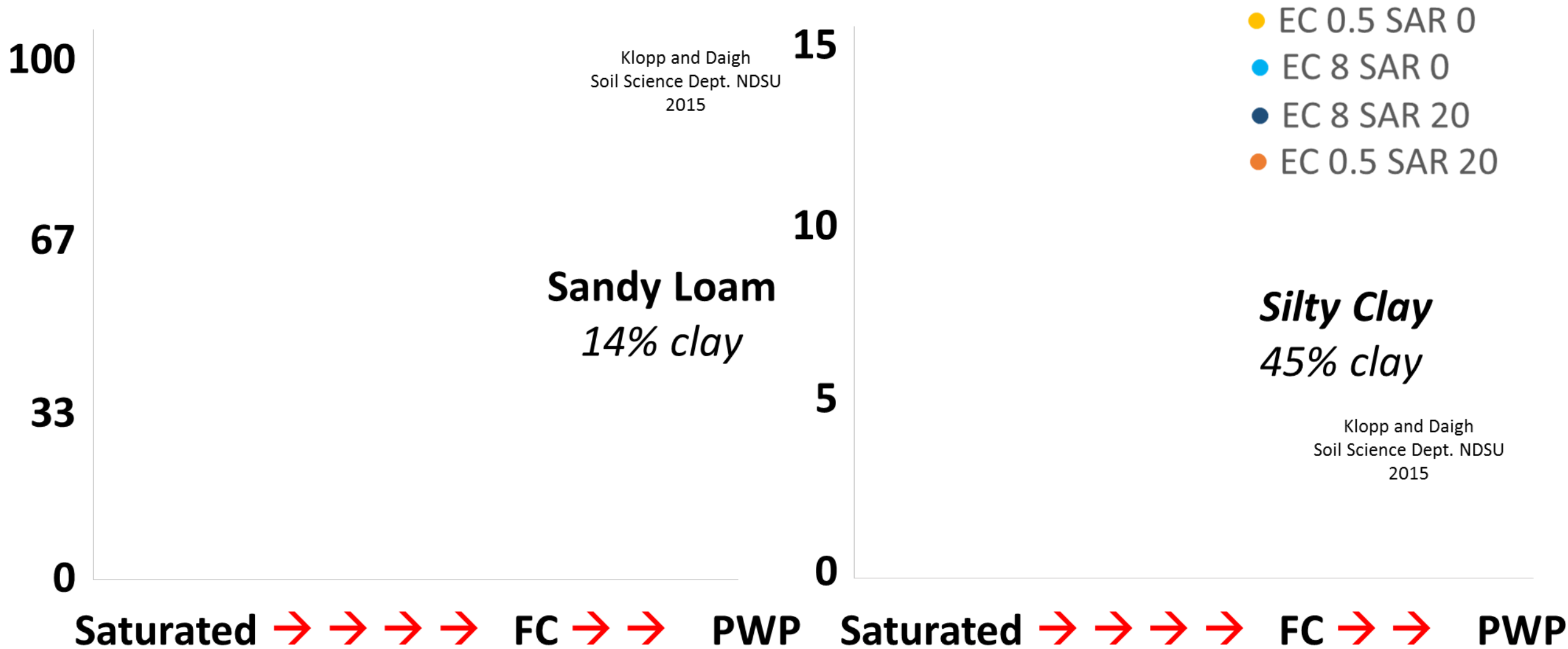
**107**

**300**



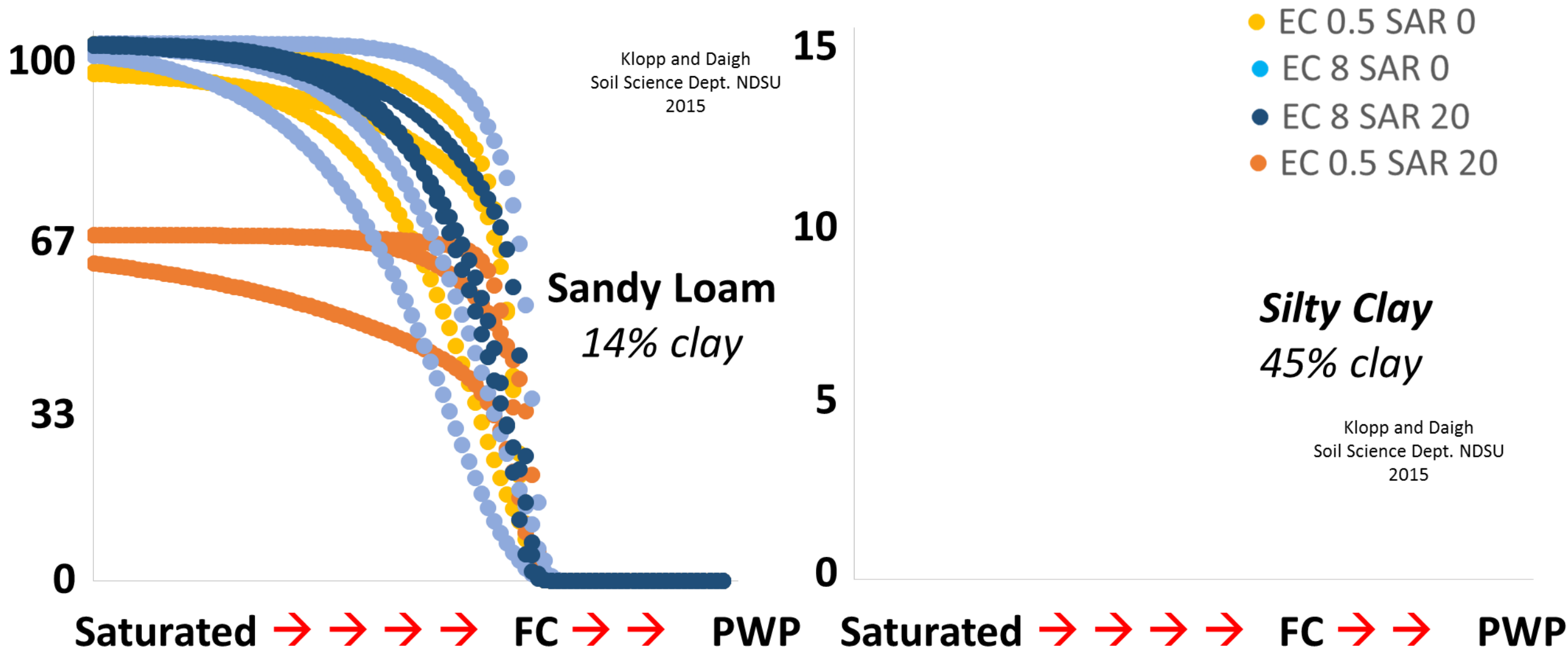


# Water Movement in Soil (inches per day)



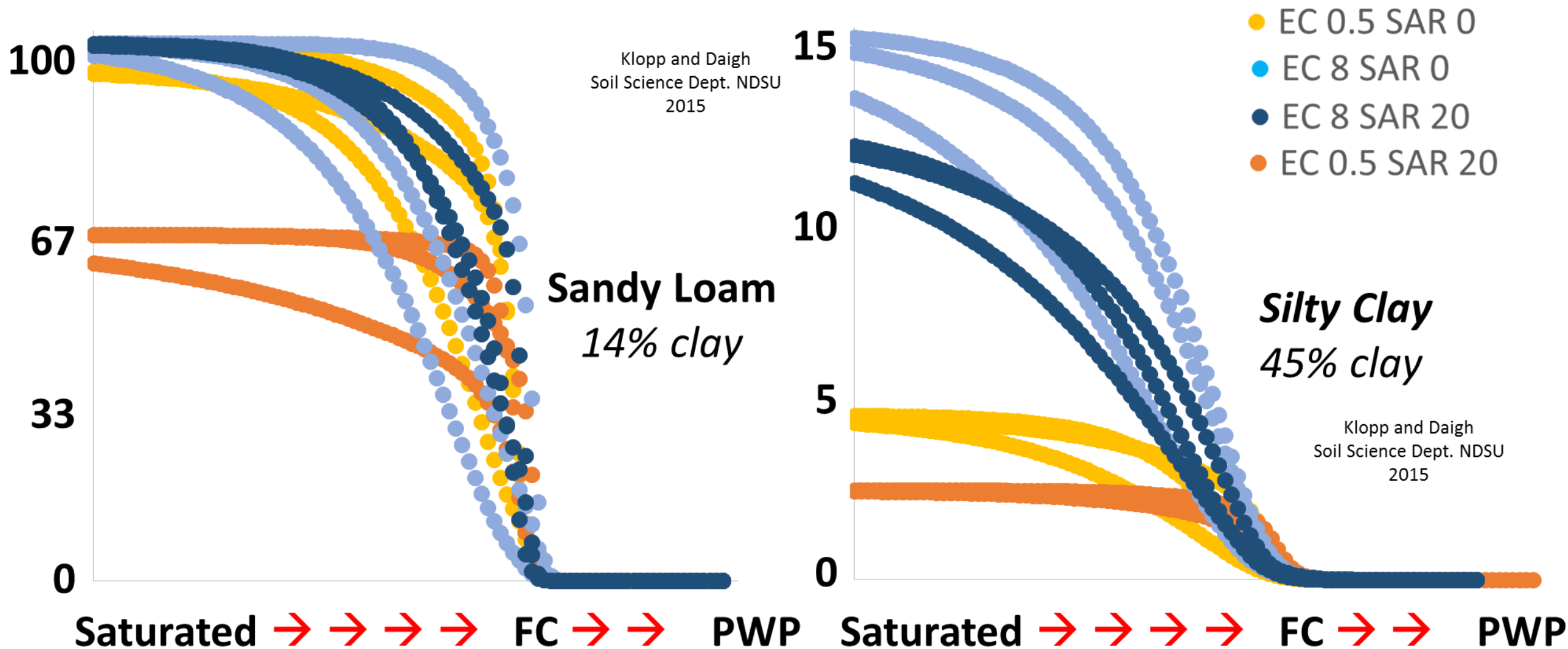


# Water Movement in Soil (inches per day)





# Water Movement in Soil (inches per day)





# Are there any other options?



**Ca<sup>2+</sup> Amendment**



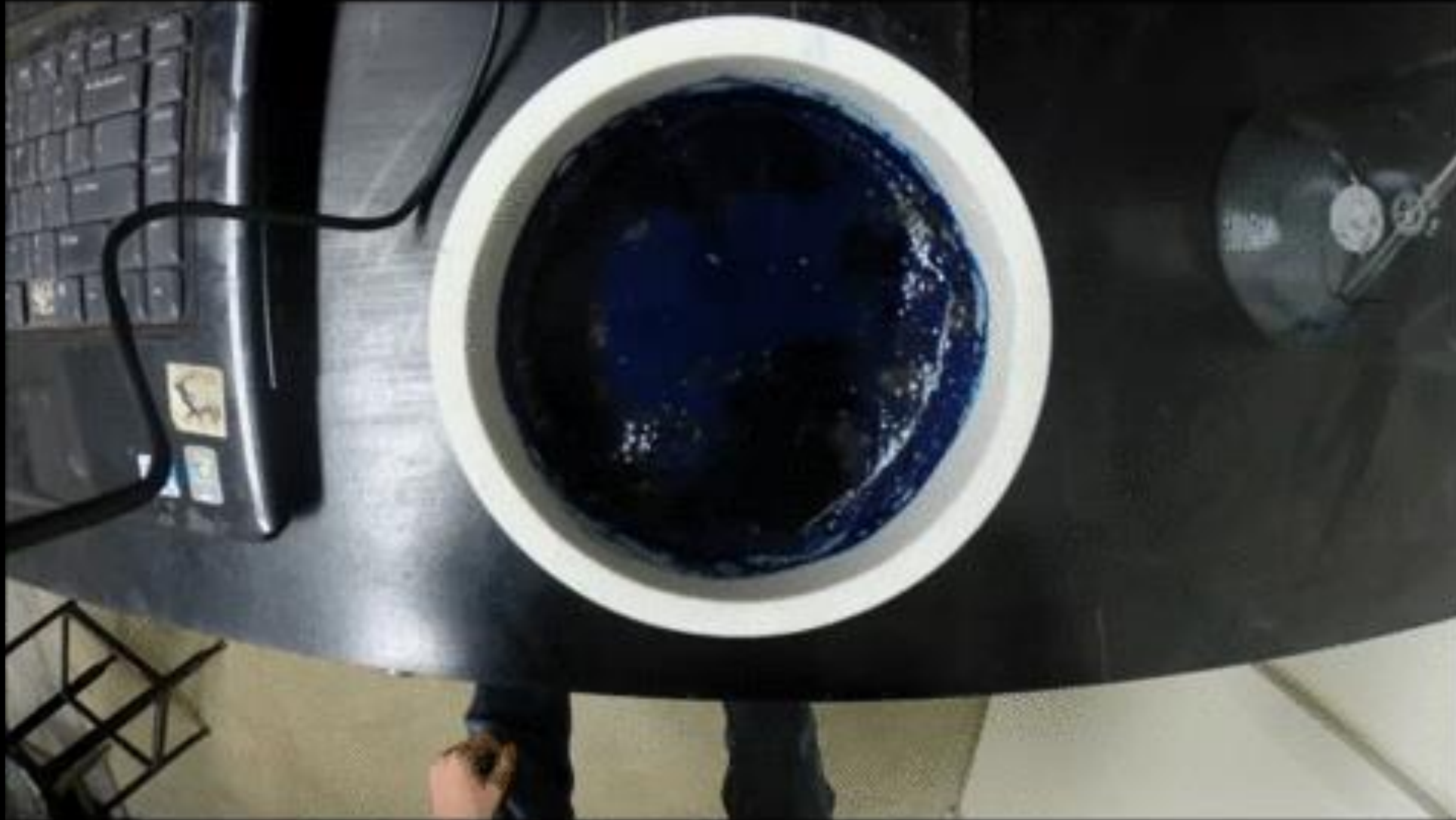
**Topsoil Excavation**





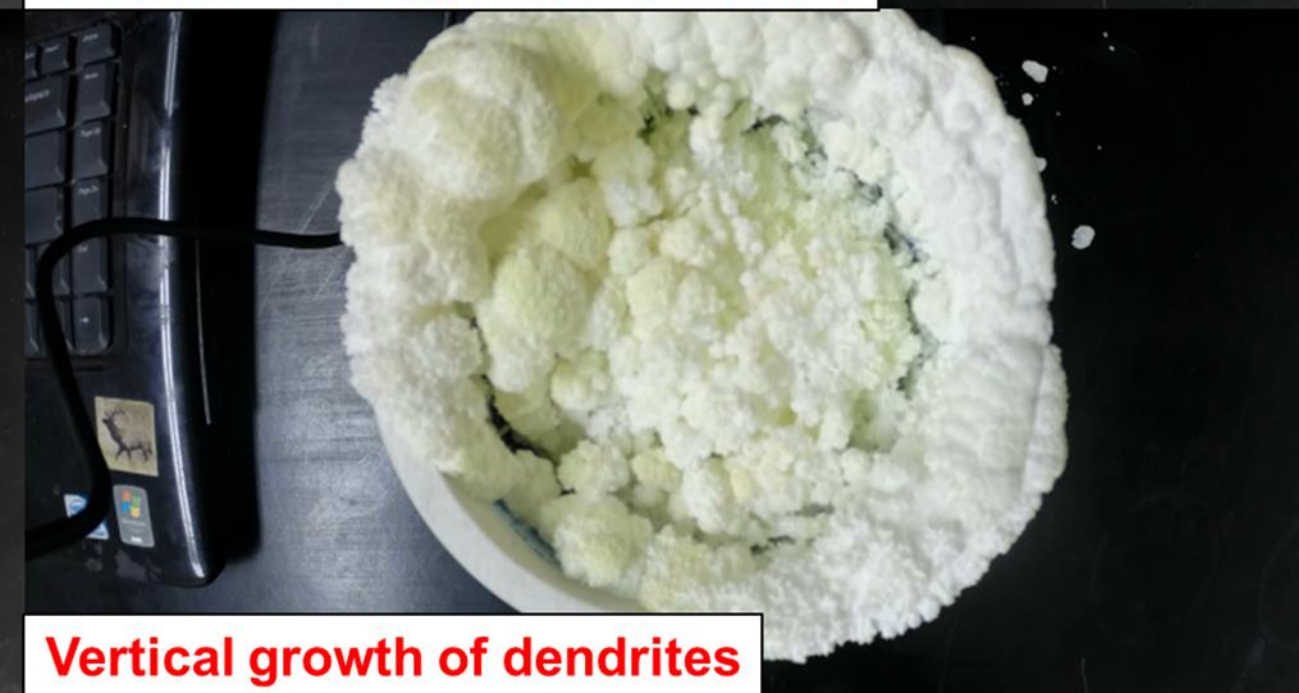
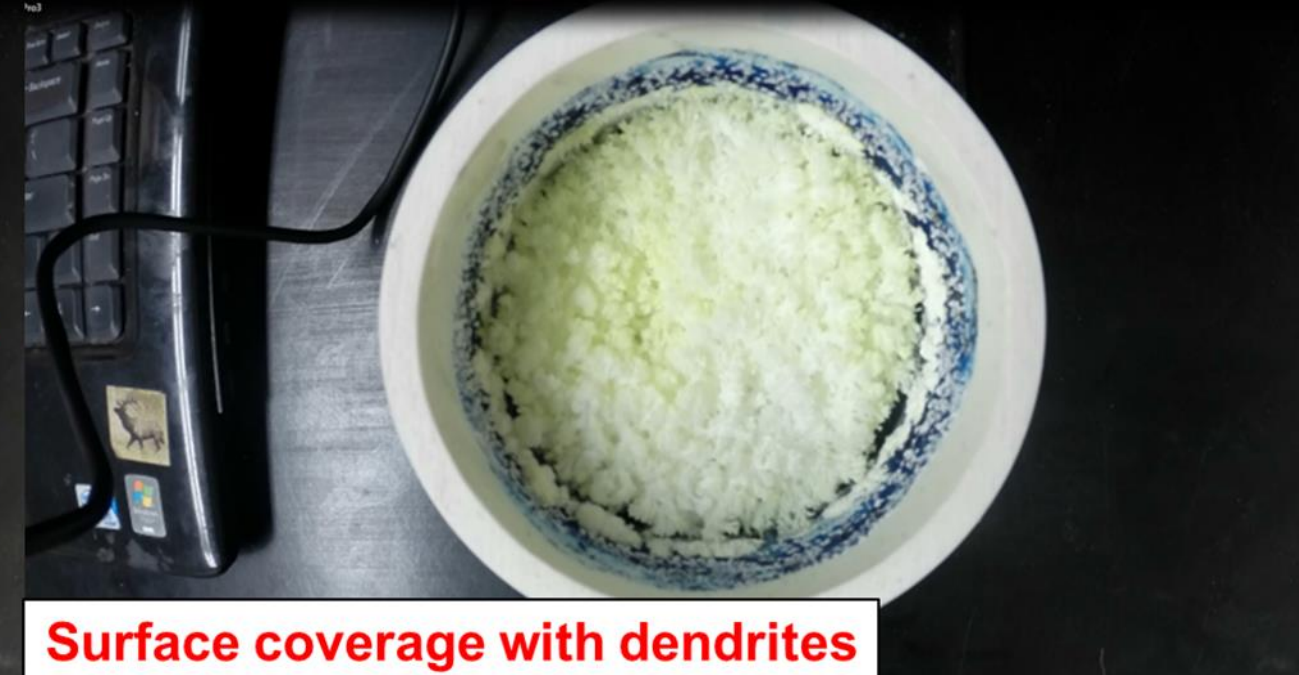
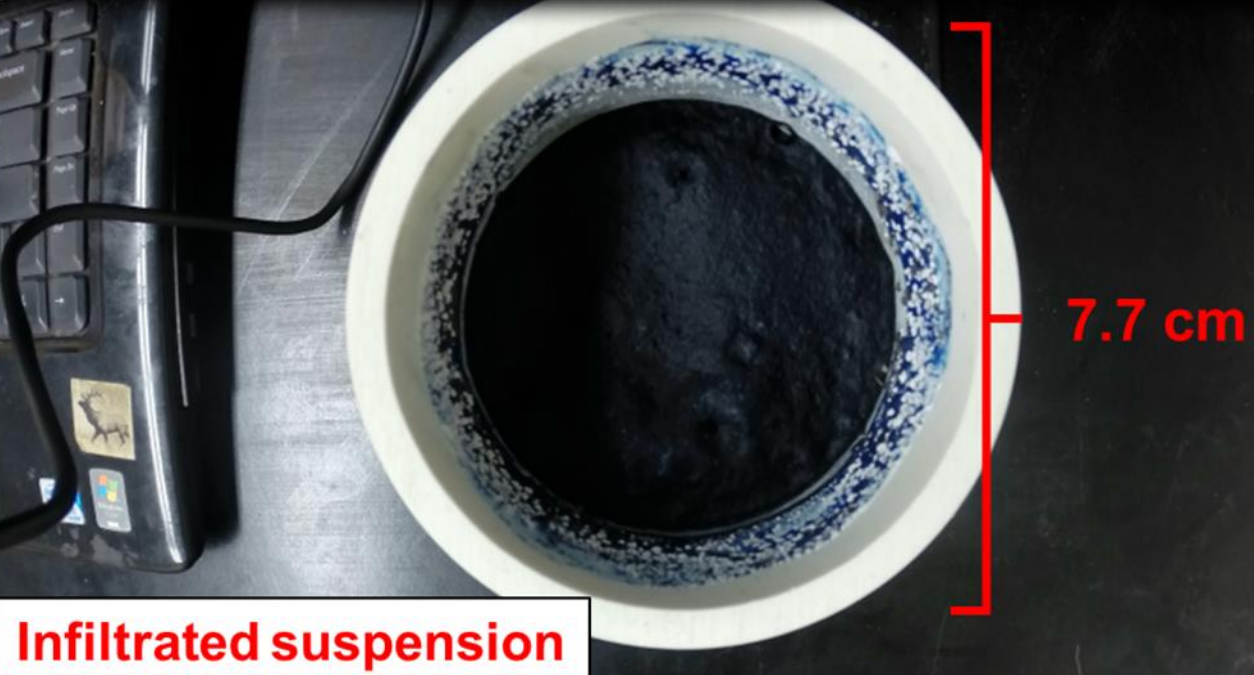
Photo by Aaron Klaustermeier  
Soil Science Dept. NDSU



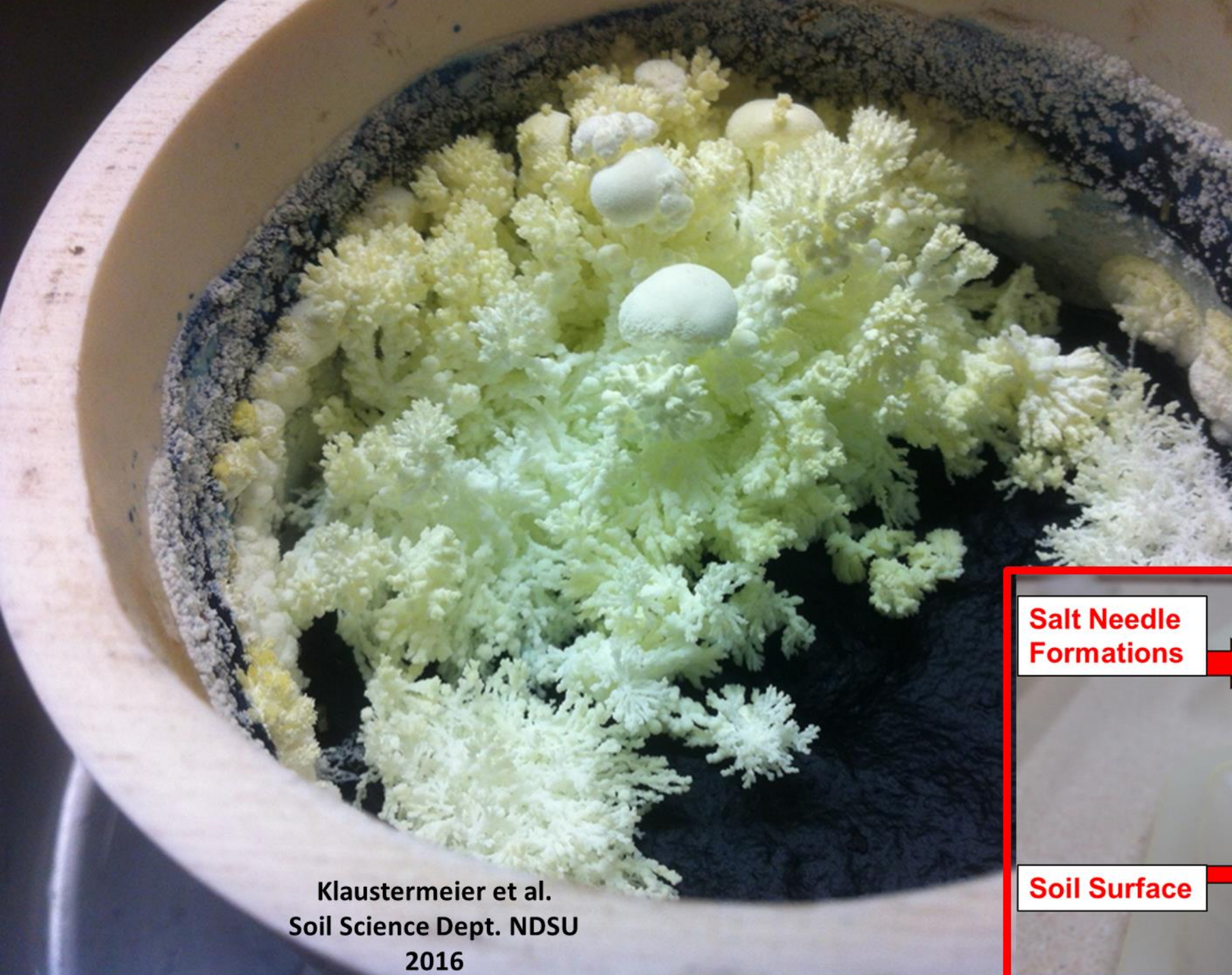


Klaustermeier and Daigh  
Soil Science Dept. NDSU  
2016









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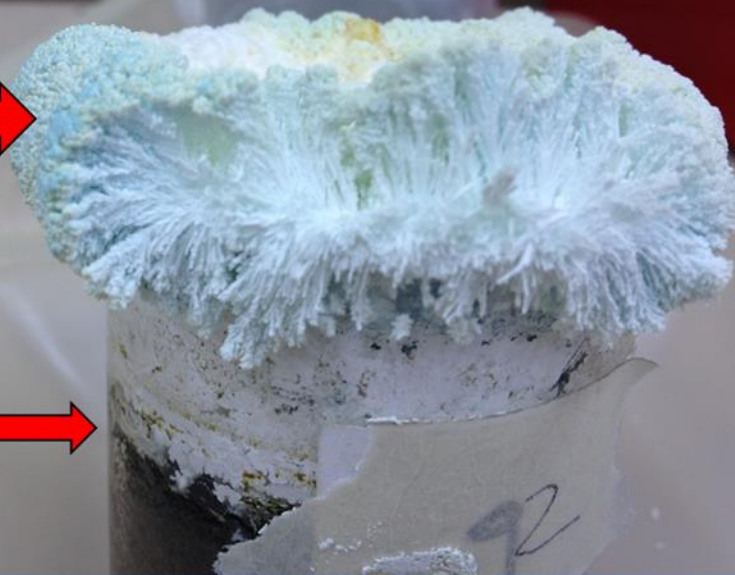
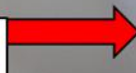


**Cemented Salt Crust  
without crystallization inhibitor**

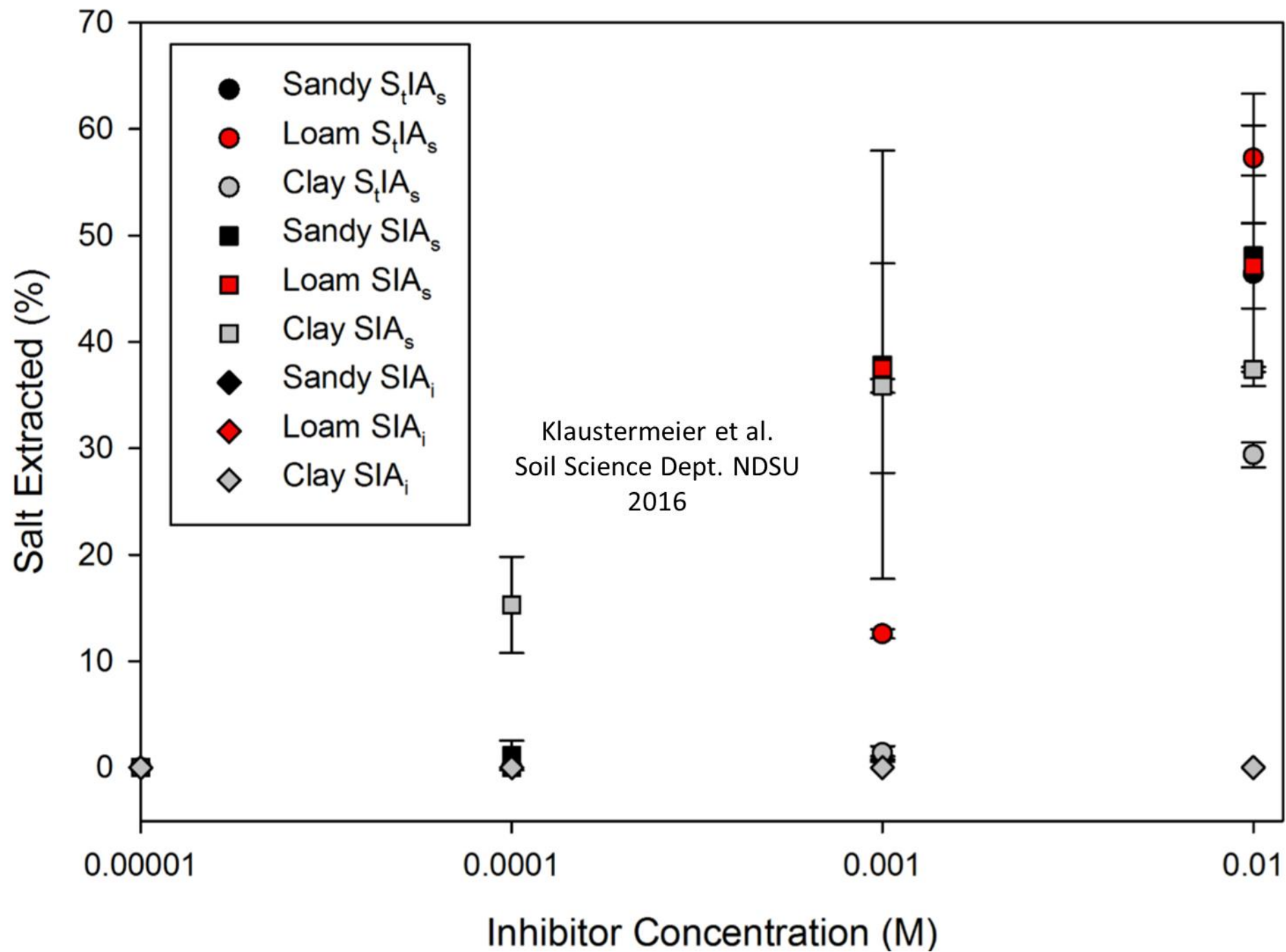
**Salt Needle  
Formations**



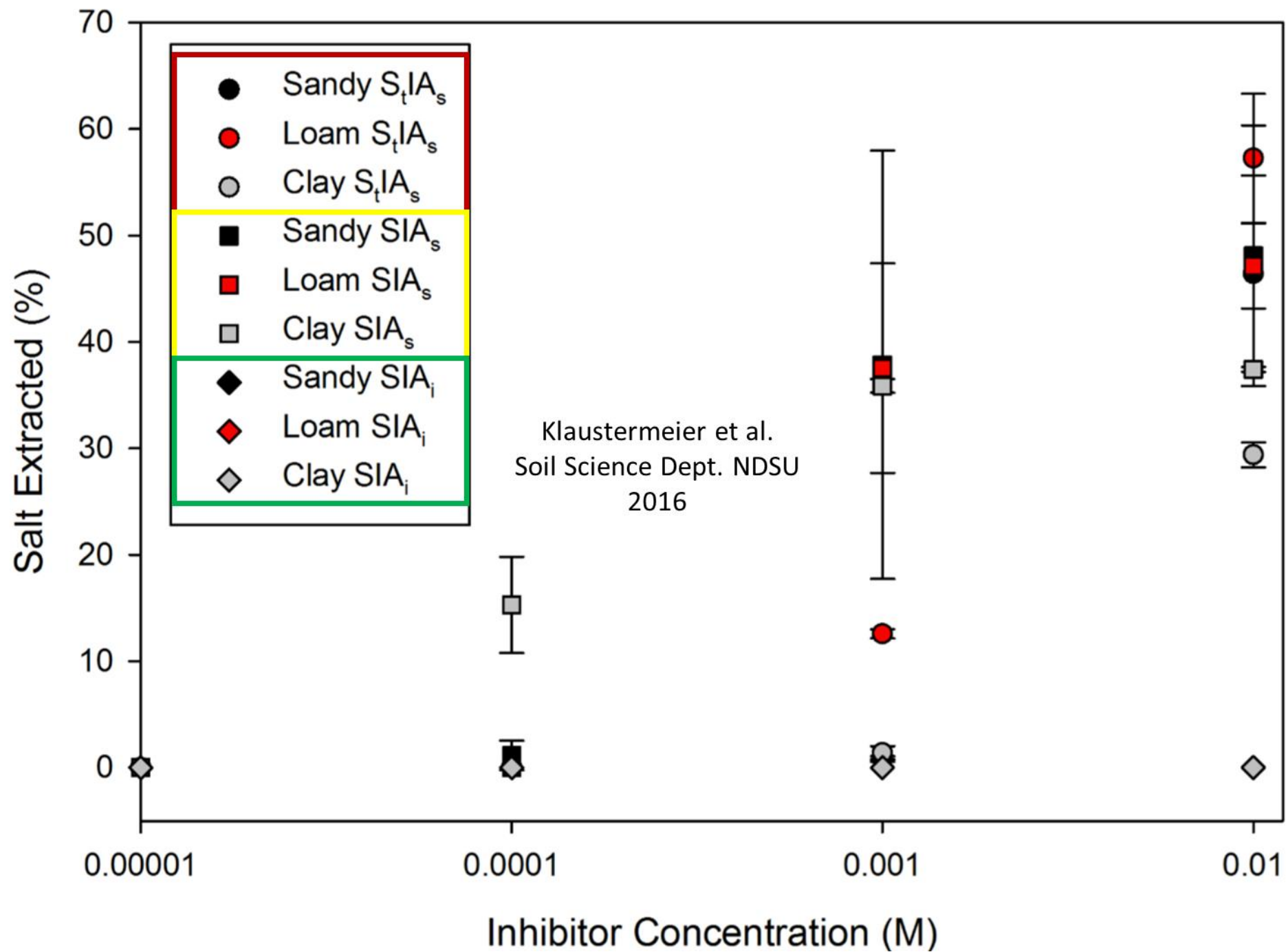
**Soil Surface**



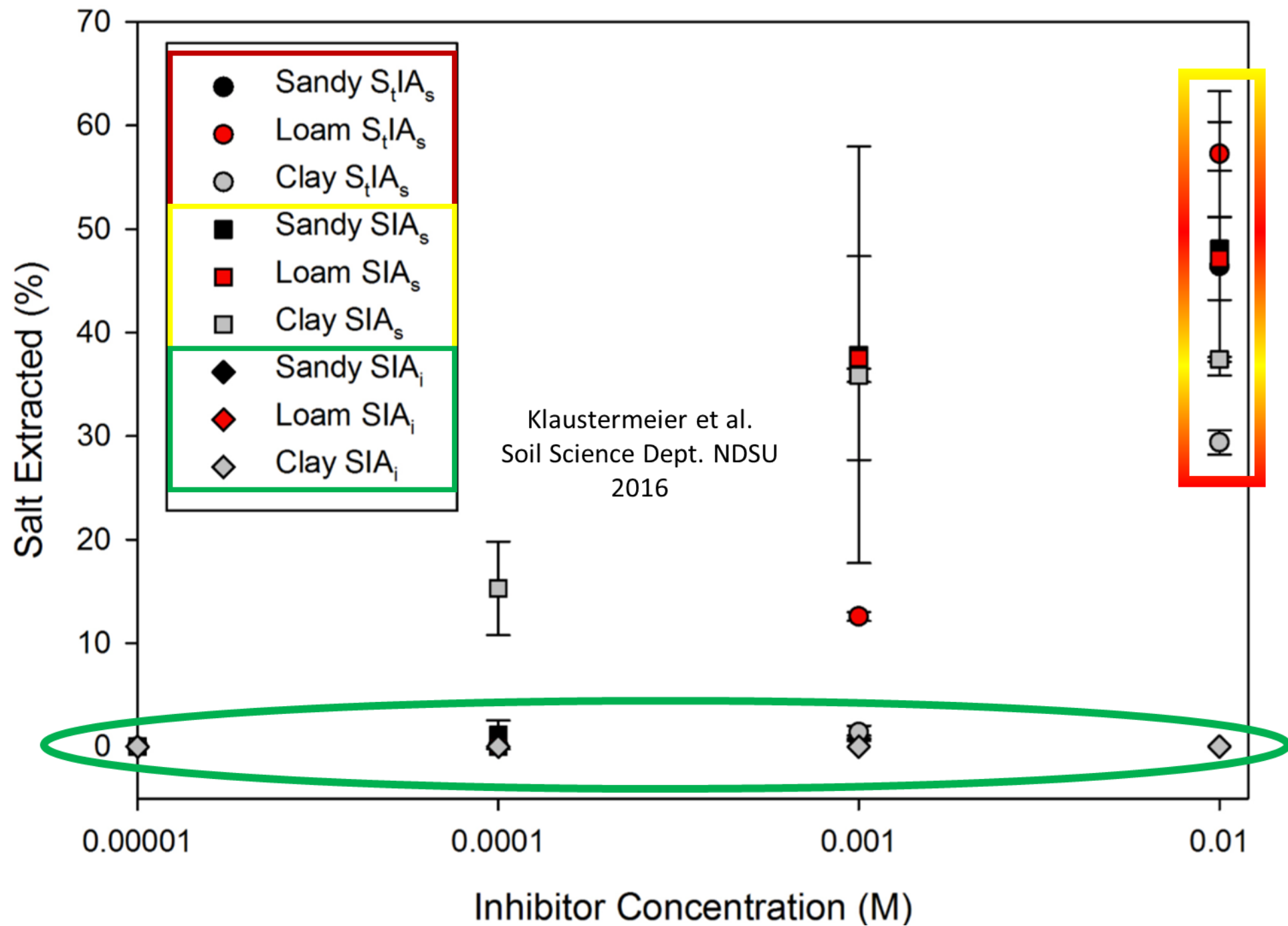














## Agricultural & Environmental Letters

### Research Letter

# Approaching Brine Spill Remediation from the Surface: A New In Situ Method

Aaron L. M. Daigh\* and Aaron W. Klaustermeier

#### Core Ideas

- In situ remediation of brine spills is possible via surface extraction of salts.
- A crystallization inhibitor allowed for 29 to 57% of salts to be harvested from the soil surface.
- Methods for surface extraction of salts can aid in expediting brine spill remediation timelines.

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**Abstract:** Well drilling for energy resources innately produces brine waters. These brines often contain sodium in the 10,000 to >100,000 mg L<sup>-1</sup> range. In situ soil remediation of brine spills traditionally consists of diluting salts with organic materials and then infiltrating divalent cations. This leaching technique can require years to centuries, as a function of soil clay content, to remove salts from the root zone. We present a new in situ remediation method that extracts salts from the soil surface and expedites remediation. Surface application of a crystallization inhibitor (ferric hexacyanoferrate) to brine-contaminated soils followed by an evaporative flux resulted in dendritic crystal growth above the soil surface. This process allowed easy harvest of 29 to 57% of salts within 7 d without mechanical disturbance to the soil. Future studies should include loading-rate optimization, in-field testing, evaluation of reaction product fate and transport, and identification of other amendments to rapidly extract salts.

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