JoVE: Science Education

Determination of the Moisture Content of a Soil

--Manuscript Draft--

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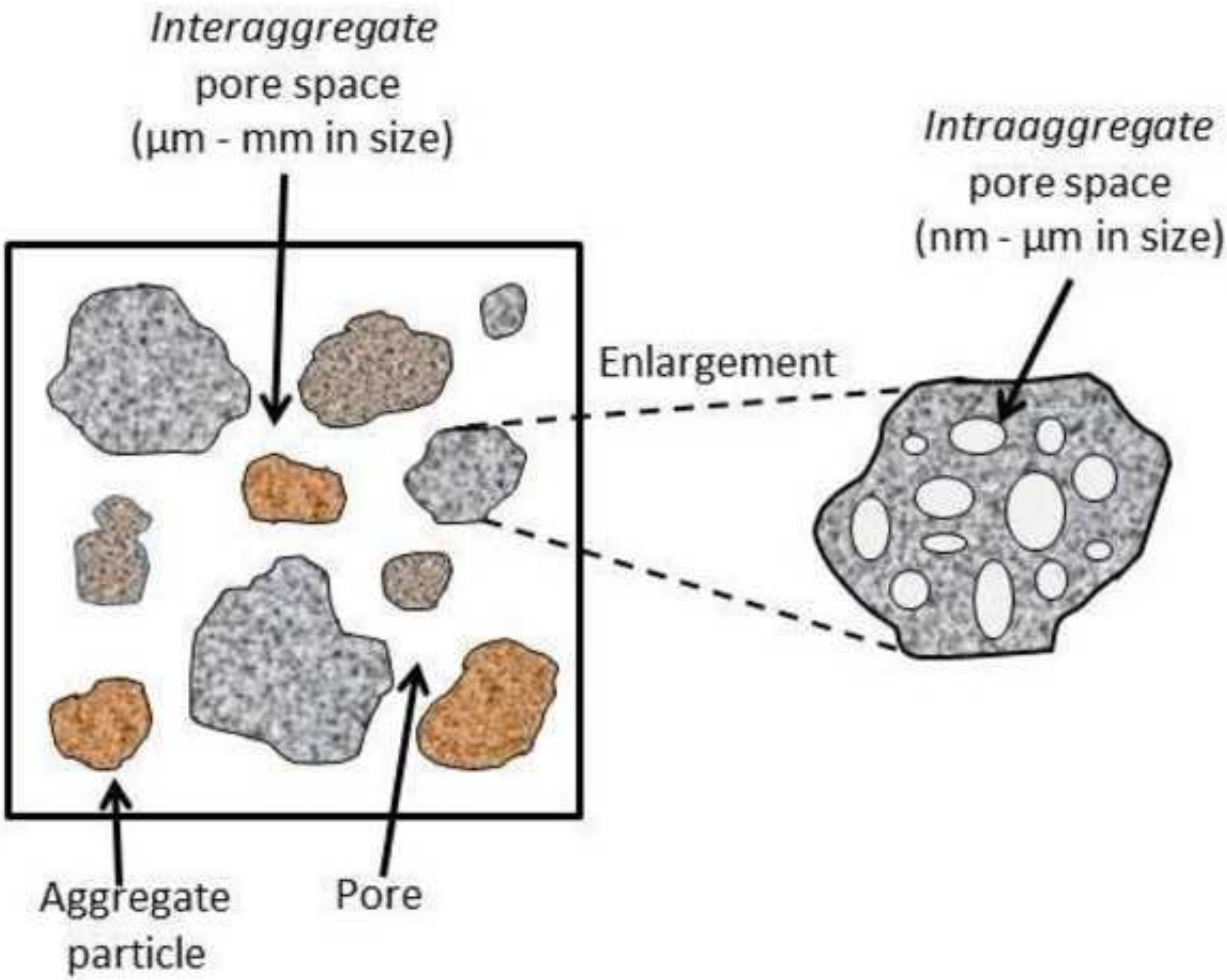

FIGURE 1 Pore space in a soil

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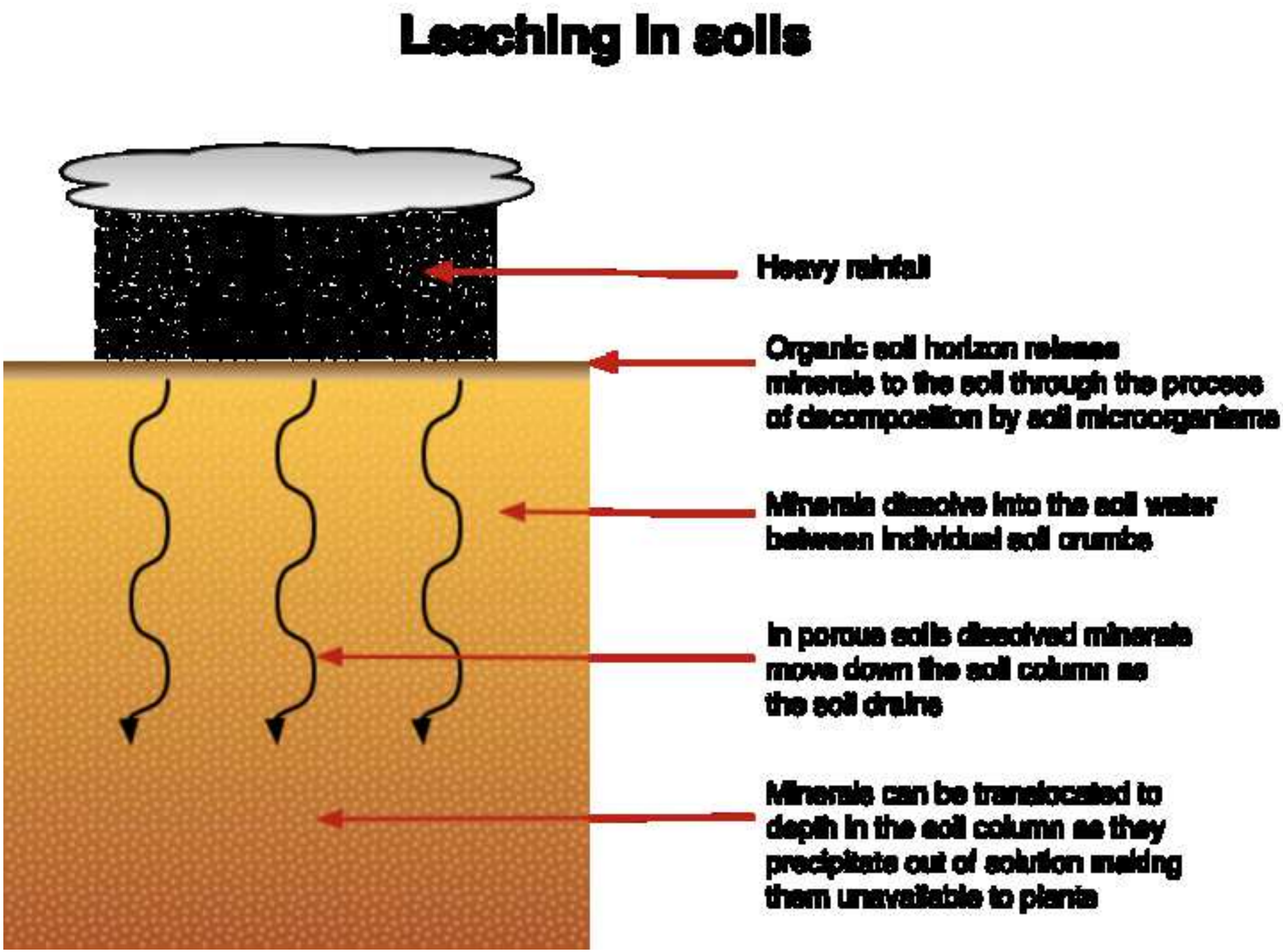

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Corresponding Video Article Title: Determination of the Moisture Content of a Soil

Overview: Soils normally contain a finite amount of water, which can be expressed as the "soil moisture content." This moisture exists within the pore spaces in between soil aggregates (inter-aggregate pore space) and within soil aggregates (intra-aggregate pore space) (Fig. 1). Normally this pore space is occupied by air and/or water. If all the pores are occupied by air, the soil is completely dry. If all the pores are filled with water, the soil is said to be saturated.

In outdoor natural environments, water is added to soil via rainfall or deliberate irrigation of plants. In either case, soil moisture increases as more pores become filled with water at the expense of air. If all the pores become filled with water, excess water will now leach (move downward, figure 2) through continuous soil pores, until the rain or irrigation ceases. Leaching will continue until the water films within the pores are held by the surface tension of soil colloids against the force of gravity. Such a situation is referred to as the soil being at "field capacity" with respect to soil moisture. A soil at field capacity has pores partially filled with air, surrounded by soil moisture films. Normally a soil at field capacity is optimal for plant growth and aerobic soil microorganisms, since both air and water are available. In contrast, a saturated soil will create waterlogged anaerobic conditions that can kill plants and suppress aerobic soil microbes, while stimulating anaerobic microbes.

Consider a sample of moist soil within a container such as a beaker. The weight of the moist soil consists of the weight of the dry soil particles plus the weight of the water within the soil. If more water is added to the soil, the wet weight of the soil increases. The dry weight of the soil particles within the sample is fixed i.e., one weight which is the dry weight. In contrast, there are an infinite number of wet weights, depending upon how much water is added to the soil. Because of this, when doing lab experiments with soil, the moisture content of the soil is normally expressed on a dry weight basis, because the dry weight is constant over time, whereas the moist or wet weight can change over time. When expressing the results of an experiment such as the nutrient content of a soil, use of the dry weight basis provides standardization of the final result.

~~**Objective:**~~

~~To determine the moisture content of a soil sample on a dry weight basis.~~

Procedure:

First Period:
Materials needed for the first period of the experiment are 120 g of fresh soil, an oven preheated to 105° C, a benchtop balance (±0.01 g), and 2 aluminum weighing dishes.

~~**Materials**~~
~~120 g fresh soil~~
~~gravity convection oven preheated to 105° C~~
~~benchtop balance (±0.01 g)~~
~~2 aluminum weighing dishes~~

1.1 Weigh ~~each one~~both of the aluminum dishes.

Comment [A1]: Adding a plant and its roots might be helpful to show how leaching makes minerals unavailable.

Comment [ILP2]: Don't think this would help

Comment [A3]: What are water/ moisture films?

Comment [ILP4]: Thin layers of water

Comment [A5]: Were you thinking of have the materials listed in the video itself? If so, please put into a prose format.

Comment [DM6]: Andrew, if you want to get rid of this (Materials) altogether we're fine with it. Same with the Materials for the 2nd period.

1.2 Aliquot approximately 50 g of moist soil into each aluminum dish and reweigh the dishes. Hence, the moist weight of the soil sample is now known.

1.3 Dry the soil overnight at 105° C in the ~~gravimetric~~ oven.

> **Comment [A7]:** Provide some information about the gravimetric oven.

> **Comment [ILP8]:** Regular oven would work

Second Period:

Materials needed for the second period of the experiment the soil and aluminum dishes from the first period, and a benchtop balance (±0.01 g).

~~**Materials**~~
~~soil and aluminum dishes from Period 1~~
~~benchtop balance ((±0.01 g))~~

2.1 Remove the dishes from the oven and allow to cool.

2.2 Reweigh the dishes plus the oven dry soil. Now the weight of the dry soil is known.

Results:

Calculate the soil moisture content for each of the replicate samples using the following equation:

% moisture content (MC) = $\frac{\text{weight of moist soil } (M) - \text{weight of dry soil } (D)}{\text{weight of dry soil } (D)}$
(dry wt. basis)

> **Comment [A9]:** Is there a reason you don't put the total (water and dry soil) weight in the denominator? Is this standard practice for soil moisture calculations?

> **Comment [ILP10]:** Yes – please read the Introduction

Example Calculations:

M = 102g
D = 90g

∴ % MC = $\frac{102-90}{90} = \frac{12}{90} = 0.133$

MC = 13.3%

If we add 5g of water, new M = 107 and D still equals 90

∴ % MC = $\frac{107-90}{90} = \frac{17}{90} = .189$

New MC = 18.9%

Applications:

Knowledge of the moisture content of a soil on a dry weight basis is useful in a number of ways. For example, if we are doing experiments with soil and wish to amend a soil sample with a known concentration of ammonium fertilizer, say 50 µg/g, then the moisture content on a dry weight basis must be determined. If we did the calculation on a wet weight basis, the amount of fertilizer to be added would depend on the moisture content (and therefore the moist weight) of the soil sample. Likewise if we wish to grow plants in pots, we would need to know the moisture content in order to make sure that the soil isn't too dry (not enough moisture for plant growth) or too wet (waterlogged and anaerobic). In a field situation, knowledge of the soil moisture content can prevent excess irrigation and leaching of soil nutrients.

Legend:
Figure 1: Pore Space in Soil
Figure 2: Leaching in Soils (http://creativecommons.org/licenses/by-sa/3.0/legalcode)