FIELD INVESTIGATION GUIDE

What Holds Soil Together?

Investigate soil aggregates.

INVESTIGATING QUESTION

BIG IDEA

- Healthy soil isn't just loose dirt. It's made up of tiny particles that are naturally glued together into stable clumps called aggregates.
- These aggregates help soil resist erosion, improve water infiltration, and support healthy plants.

QUICK FACTS:

Investigation Time
- 10–15 minutes

Reset Time
- 3-5 minutes

Audience
Grades 4–Adult
Families
Community Events
Professional Development

Group Size
Up to 20 when working in pairs

Learning Goals

PARTICIPANTS WILL:

- Observe how different soils react when submerged in water.
- Understand what soil aggregates are.
- Discover the connection between soil biology and aggregate stability.
- Connect aggregate stability to erosion, infiltration, and water quality.

Slake Test

EQUIPMENT CHECKLIST

□ 20 slake tubes

□ 10 aggregate samples from healthy soil

□ 10 aggregate samples from conventionally tilled soil

□ Water container

□ Observation sheets

□ Timer

□ Magnifying lenses

QUICK SETUP

Estimated time: 5 minutes

1. Fill each slake tube with clean water to the appropriate level.
2. Pair the tubes and label them Sample A and Sample B.
3. Select similarly sized, air-dried soil aggregates from each management system.
4. Gently place one aggregate on the support platform in each tube.
5. Keep the soil samples above the water until participants have observed them and made predictions.
6. Place paired tubes at each group station.
7. Set out timers, observation sheets, magnifying lenses, and towels.
8. Display the Brooke QR sign.

You're ready to investigate.

HOSTING GUIDE

OPENING CONVERSATION

Hold up two identical-looking clumps. Ask:
"Which one do you think will stay together?" Most people honestly don't know.
Then ask: "What do you think is holding soil together?"
You'll hear:

- roots rocks
- clay moisture

Very few people say: "Soil biology." Now they're ready.

DURING THE ACTIVITY

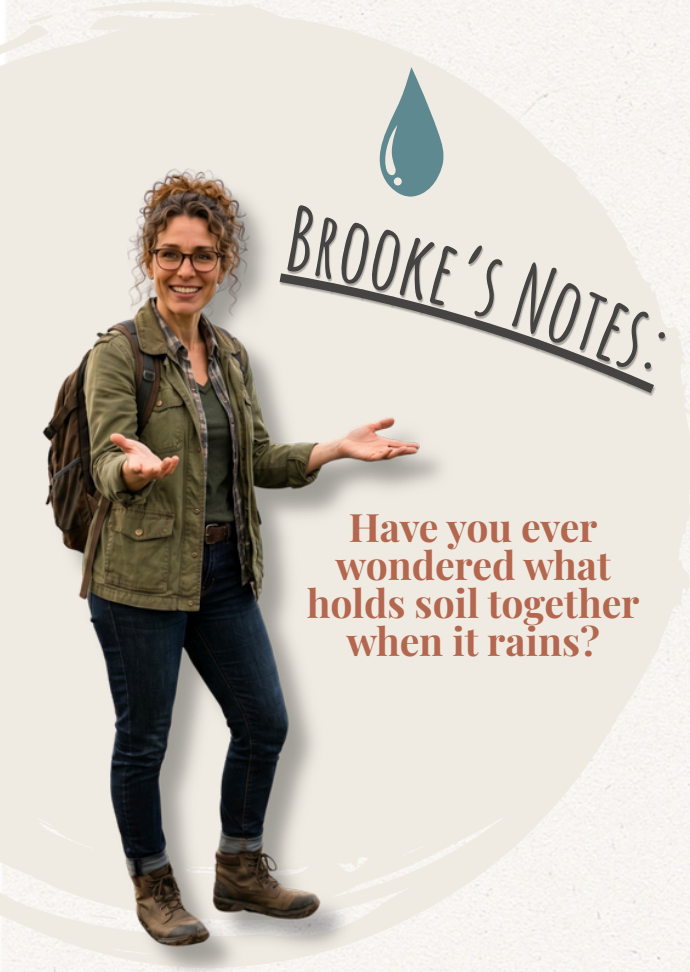
Each group receives:
Sample 1 (Healthy soil)
Sample 2 (Conventional soil)
Do not specify which sample is healthy or conventional.
Ask them to: Look closely. Describe: color, texture, smell size

Predict: Which one will survive underwater?
Then...
Submerge both simultaneously.
Don't say anything.
Just let them watch.

QUESTIONS TO ASK

Encourage observations: Use "I notice..." instead of "It is..."
Examples: (tiny particles floating away, bubble, cloudy water, soil remaining intact, cracks forming, pieces breaking off)

What did you observe?
What do you think caused that?
"What surprised you?"
What questions do you still have?



BROOKE'S NOTES

At first glance, these two soil clumps may have looked almost the same. But once they were placed in water, the difference became easier to see.

Healthy soil is made of tiny particles joined together into clumps called aggregates. Living roots feed bacteria, fungi, and other soil organisms. As those organisms grow and work, they produce natural glues that help hold the soil together. Fine roots and fungal threads also help bind the particles into stronger clumps.

Stable aggregates protect the tiny pore spaces inside the soil. Those spaces allow air and water to move through the ground and give plant roots room to grow.

When soil aggregates break apart easily, the loose particles can clog pore spaces, form a crust at the surface, or be carried away by runoff.

What we are seeing in these tubes is more than a clump of soil staying together. We are seeing evidence of how the soil has been built—and how it may respond when real rain falls on a field.

LOOKING CLOSER

LOOKING CLOSER WITH BROOKE

The next time you see exposed soil, look closely.

Can you find:

- Soil that forms small, rounded crumbs?
- Soil that looks powdery or crusted?
- Roots growing through soil clumps?
- Earthworm holes or pieces of plant residue?
- Muddy water leaving a garden, field, or construction site?
- Soil beneath living plants compared with nearby bare soil?

Living roots feed soil life. Soil life builds aggregates. Aggregates protect pore spaces. Pore spaces help water soak in.

FIELD INVESTIGATION

OBSERVATION SHEET

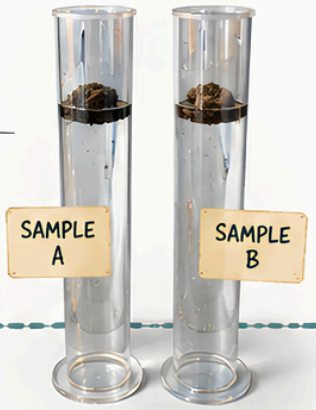
WHAT HOLDS SOIL TOGETHER?

Slake Test

Name(s): _____

Date: _____

Location: _____



BEFORE THE INVESTIGATION

LOOK CLOSELY

Without touching the samples, what do you notice?

	Sample A	Sample B
Color		
Shape		
Size		
Texture		

MAKE A PREDICTION

Which sample will stay together longer in water?

☐ Sample A ☐ Sample B ☐ They will behave the same.

Why do you think that?

_____

_____

_____

DURING THE INVESTIGATION

Watch carefully. Use your senses like a scientist.

SAMPLE A

- ☐ Tiny particles begin floating away
- ☐ Water becomes cloudy
- ☐ Air bubbles appear
- ☐ Cracks begin forming
- ☐ Pieces break off
- ☐ Soil stays mostly together
- ☐ Other: _____

SAMPLE B

- ☐ Tiny particles begin floating away
- ☐ Water becomes cloudy
- ☐ Air bubbles appear
- ☐ Cracks begin forming
- ☐ Pieces break off
- ☐ Soil stays mostly together
- ☐ Other: _____

TIP: The changes might be slow at first. Keep watching for a few minutes!

COMPARE THE SAMPLES

Which sample stayed together longer?

○ A ○ B ○ About the same

Which sample made the water cloudier?

○ A ○ B ○ About the same

Which sample lost more soil?

○ A ○ B ○ About the same

THINK LIKE A SCIENTIST

Why do you think the two samples behaved differently?

_____

_____

_____

What do you think was helping hold one sample together?


☐ Roots


☐ Earthworms


☐ Fungi


☐ Tiny soil organisms


☐ Plant residue


☐ Something else: _____

THE REVEAL!

Now your host will tell you which sample came from:

- ☐ Soil managed for soil health (living roots, cover crops, reduced tillage)
- ☐ Conventionally tilled soil

Did the results surprise you?

Yes A little No

Why?

_____

_____

BROOKE'S CHALLENGE

The next time you're outside... Can you find:


☐ Bare soil


☐ Living plants growing


☐ Earthworm holes


☐ Crop residue covering the soil


☐ Muddy runoff after a rain


☐ Soil that looks crumbly, not powdery

"Healthy soil leaves clues. Look for soil that is covered, rooted, alive, and able to stay together when water arrives."
–Brooke

EVIDENCE → EXPLANATION

What did you OBSERVE?

_____

_____

What do you think CAUSED that?

_____

_____

What questions do you still have?

_____

_____

Great Scientists Ask Great Questions!

RESEST CHECKLIST

- □ Discard used soil aggregates.
- □ Empty water from slake tubes.
- □ Rinse tubes with clean water.
- □ Remove any remaining soil particles from the support platforms.
- □ Refill tubes with clean water (if preparing for the next group).
- □ Set out fresh Sample A and Sample B aggregates.
- □ Restock observation sheets.
- □ Return magnifying lenses.
- □ Wipe table and surrounding area.
- □ Straighten Brooke QR sign.

TROUBLE SHOOTING

Both samples fall apart quickly

Possible causes:

- Soil aggregates were collected while too wet.
- Aggregates were broken during collection.
- Samples were not naturally formed aggregates.
- Both samples came from similar management systems.

Discussion Opportunity

"Soil structure develops over time. Different soils and management histories can influence aggregate stability."

Both samples remain intact

Possible causes:

- Aggregates are exceptionally stable.
- Soil contains higher clay content.
- Samples are too large to show differences quickly.

Discussion Opportunity

"Let's keep watching. Some aggregates break down more slowly than others."

Participants don't notice a Difference:

Ask participants to look more closely.

Can they see:

- Water becoming cloudy?
- Tiny particles falling?
- Small cracks forming?
- Air bubbles escaping?
- Differences in water clarity?

Encourage them to compare both tubes side by side.

Particpants Finish early:

Invite them to:

- Compare magnified soil aggregates.
- Guess which sample came from healthier soil.
- Discuss what practices might build stronger aggregates.
- Compare photographs of fields using different management systems.

This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under agreement number 2023-38640-39573 through the North Central Region SARE program under project number YENC24-222. USDA is an equal opportunity employer and service provider. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and should not be construed to represent any official USDA or U.S. Government determination or policy.

These materials were developed with support from:

SWCD

SARE Sustainable Agriculture Research & Education

WI DNR

Extension UNIVERSITY OF WISCONSIN-MADISON MANITOWOC COUNTY

LAND & WATER CONNECT US

Slake Test