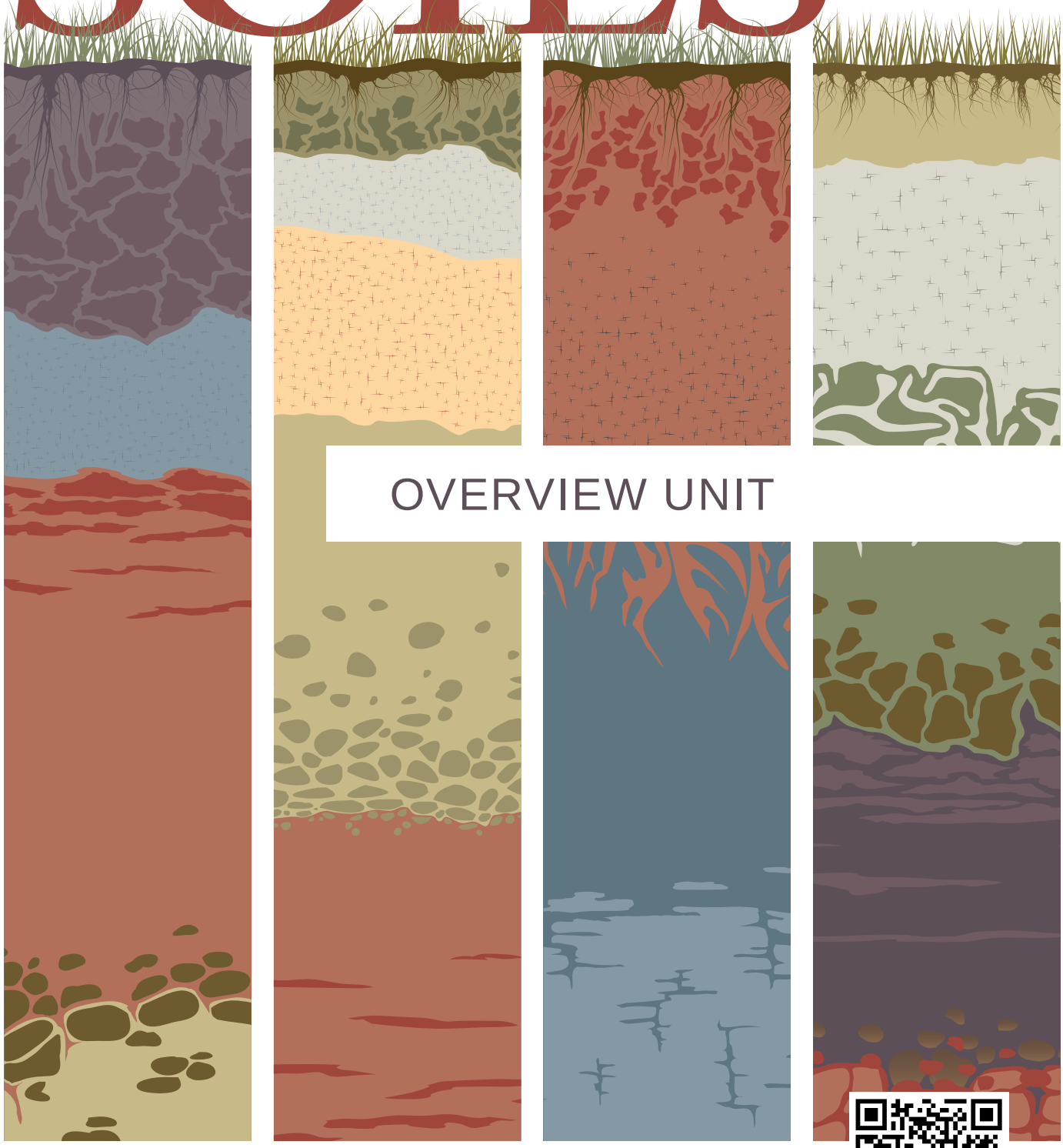
SOILS



OVERVIEW UNIT

SSSA
Soil Science Society of America

www.soils.org

Scan to visit the Soils Overview Unit webpage to access this pdf and links to the referenced documents.

Thank You

Thank you to our SSSA members and K-12 educators who worked diligently to develop this unit. This project was successful as a result of their efforts and dedication to tell the story and the science of soil.

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Overview

Goal: The lessons in this unit provide students with a basic understanding of the fundamentals of soil science through the integration of disciplinary core ideas, science and engineering practices, and crosscutting concepts in the lessons, investigations, and activities.

Grade Level: 6-8

Unit Layout: The lessons in this unit capitalize on the wealth of teaching resources found on the K-12 education websites of the Soil Science Society of America. The Soils 4 Kids (http://www.soils4kids.org/), Soils 4 Teachers (http://www.soils4teachers.org/), and International Year of Soils (https://www.soils.org/IYS) websites contain numerous resources that can be combined to create a unit focused on soils, or taken separately to enhance other sciences units to include soil science. The unit includes six "Parts" key to the field of soil science and to middle school science. Each Part includes learning objects, teacher background information, student information, and selected lesson resources to support learning. These parts, like the selected teaching resources, may be used individually or combined to create a unit. A Glossary of Terms can be found on the Soils 4 Teachers website (http://www.soils4teachers.org/).

Key Next Generation Science Standards (NGSS) Disciplinary Core Ideas: Soil science is a cross-disciplinary topic, and listed below are the key middle school (grades 6-8) disciplinary core ideas that include the topic of soils. Key science and engineering practices and crosscutting concepts addressed in the unit are identified in each component of the unit with the lessons and activities. Visit the Next Generation Science Standards website (http://nextgenscience.org/) for detailed information on the NGSS.

Earth & Space Science

- ESS2.A: Earth Materials and Systems
- ESS2.C: The Roles of Water in Earth's Surface Processes
- ESS2.D: Weather and climate
- ESS3.A: Natural Resources
- ESS3.B: Natural Hazards
- ESS3.C: Human Impacts of Earth Systems

Life Science

- LS2.A: Interdependent Relationships in Ecosystems
- LS2.B: Cycles of Matter and Energy Transfer in Ecosystems
- LS2.C: Ecosystem Dynamics, Functioning, and Resilience

Physical Science

- PS1.A: Structure and Properties of Matter
- PS1.B: Chemical Reactions
- PS3.D: Energy in Chemical Processes and Everyday Life

Enduring Understandings:

- Soils are dynamic and always changing
- Soil is not dirt
- Soils play an essential role in ecosystems
- Soils are essential to life

Essential Questions:

- How do soils sustain life and influence life as abiotic and biotic factors in an ecosystem? (Part 1)
- What are the five soil formation factors (ClORPT) and how do they contribute to the formation of soil? (Part 2)
- What are the characteristics that differentiate a soil from other soils (i.e. particle size/texture, structure, color, profile) and how do these characteristics contribute to soil quality and function? (Part 3)
- What are the challenges of ensuring soils are sustained into the future, and how can we address those challenges? (Parts 4)
- How do soils contribute to society: the products we use, places we live? (interdisciplinary) (Part 5)

Part 1: Soils Sustain Life Overview/Introduction

Water, air, and soil are basic to life on this planet but of the three, soil is the least understood. It is a complex warehouse of matter and living things that are necessary for life whether it be micro-organisms that decompose our wastes, clay for our buildings, nutrients for plants, mineral resources for industry, or just a solid footing for our feet and everything else. Besides, there is interplay of various scientific principles at work in the soil from water purification to heat transfer, from oxidation-reduction reactions to ion exchange, and so on. Of course, we must not forget that our breakfast, lunch and dinner derive from the soil in one way or the other. Soil truly sustains life.

Objective: To provide an overview of soils to begin to develop an understanding of what soil is and its connections to life.

Teacher Notes: This Part of the Unit provides an overview of soils and their role in sustaining life. The selected content includes the fundamental concepts related to soils, all of which will be developed in greater detail in other Parts of the Unit.

Teacher Background Document(s)/Reading:

- Overview Document: www.soils.org/files/about-soils/soils-overview.pdf
- Soil Basics webpage: www.soils4teachers.org/soil-basics
- January IYS Video "Soils Sustain Life:" https://youtu.be/vDL6F6GkAzI
- Soil Biology webpage: www.soils4teachers.org/biology-life-soil
- NRCS Soil Health for Educators: https://www.nrcs.usda.gov/conservation-basics/natural-resource-concerns/soils/soil-health/soil-health-education-and-outreach

Student Background Document(s)/Reading:

- Overview Document: www.soils.org/files/about-soils/soils-overview.pdf

Links to Activities:

- Tea4Science: www.soils4teachers.org/files/s4t/lessons/lesson-plan--tea4science.pdf
- Insects in Soil: https://www.soils4teachers.org/files/s4t/lessons/berlese-funnel.pdf
- How Much Soil is There? https://www.soils.org/files/s4t/lessons/lesson-plan-how-much-soil-is-there.pdf

NGSS Connections: The following elements of middle school NGSS disciplinary core ideas (DCIs), science and engineering practices (SEPs), and crosscutting concepts (CCCs) may be addressed in this Part of the Unit. Combined to create three-dimensional (DCI + SEP + CCC) learning builds proficiency in these elements, and the associated performance expectations.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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Part 2: Soil Formation – Introduction to ClORPT

(Climate, Organisms, Relief, Parent Material, Time)

Soil formation is a process that requires concurrent action of **cl**imate, **o**rganisms, **r**elief, **p**arent material and **t**ime, or ClORPT for short. ClORPT is responsible for the development of soil profiles and chemical properties that differentiate soils. Without ClORPT there will be no soil. Weathering takes place when environmental processes such as rainfall, freezing and thawing act on rocks causing them to dissolve, fracture or break into pieces.

ClORPT then acts on the rock pieces, marine sediments and vegetative materials to form soils. The rocks and other base materials from which soil develops, referred to as parent materials, may have been transported from one place and deposited in another by glaciers, wind, water, or gravity. Temperature and precipitation influence the rate at which parent materials weather, dead plants and animals decompose, and affect the chemical, physical and biological relationships in the soil. Plants and animals influence the formation and differentiation of *soil horizons*, and together with soil organisms speed up the breakdown of large soil particles into smaller ones. Relief or landform position describes the shape of the land (hills and valleys), and the direction it faces makes a difference in how much sunlight the soil gets, how much water it keeps, and how deep or stable the soil is.

All these factors act together over very long time to produce soils, as a result, soils vary in age. The length of time that soil material has been exposed to the soil-forming processes makes older soils different from younger soils.

Overall Objective: To understand the five factors responsible for soil formation.

Teacher Notes: This Part of the Unit could stand alone as a mini-unit given its detail into the five soil forming factors.

Teacher Background Document(s)/Reading:

- Soil Formation: http://www.soils4teachers.org/formation
- Soil Formation: http://www.missouricareereducation.org/doc/soilsci/SRLesson2.pdf
- NRCS Soil Formation & Classification: https://www.nrcs.usda.gov/resources/education-and-teaching-materials/soil-facts#formation

Student Background Document(s)/Reading:

- Soil Formation: http://www.soils4teachers.org/formation

Link to Activity:

- Chef's Challenge video: https://www.youtube.com/watch?v=NCJcNxZVuSY

Activities for Each Factor

Climate

Objective: Understand how climate influences soil formation

Links to Activities:

- Climate and Temperature: www.earthsciweek.org/classroom-activities/climate-and-temperature

Organisms

Objective: Understand how organisms influence soil formation

Links to Activities:

- Tea 4 Science: www.soils4teachers.org/files/s4t/lessons/lesson-plan--tea4science.pdf
- Measuring Soil Microbial Activity: www.glbrc.org/education/classroom-materials/measuring-soil-microbial-activity
- Do the Rot Thing – A Teacher's Guide to Composting Activities: http://cwmi.css.cornell.edu/compostingintheclassroom.pdf
- Collect Soil Bugs using a Berlese Funnel: www.soils4teachers.org/files/s4t/lessons/berlese-funnel.pdf
- Winogradsky Column: (recommended for high school, but can be adapted to middle school):

  www.hhmi.org/biointeractive/winogradsky-columns-microbial-ecology-classroom

Relief

Objective: Understand how landscape influences soil formation

Links to Activities:

- Going, Going, Gone?: https://www.soils.org/files/sssa/iys/nsta-l10-going-going-gone.pdf

Parent Material

Objective: Understand how parent materials influence soil formation

Links to Activities:

- Making Sedimentary Rocks: www.windows2universe.org/teacher_resources/teach_makerock.html
- Finding Slope: www.soils4teachers.org/files/s4t/soil-slope-act.pdf

Time

Objective: Understand how time influences soil formation

Links to Activities:

- SSSA's Soil Formation (scroll down to Soil Formation): www.soils4teachers.org/lessons-and-activities/teachers-guide/soil-formation

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Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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Part 3: Characteristics of Soil

There are trees and they are different -- there is the Oak, Maple, Birch, Spruce, etc. So also are soils. Each soil has an identity and they are determined by such characteristics as color, texture (proportions of sand, silt and clay particles), structure, profile, etc. that set them apart from each other. For example, sand is coarse while clay is fine, like powder, and there are dark-colored soils and red soils. These characteristics which give each soil its identity are inherited from the parent material (see Part 2) from which the soil developed and can also evolve through the impact of ClORPT, the five factors acting to produce soil. As a result of these characteristics, not all soils can perform the same function, for example, installation of on-site wastewater treatment or simply growing corn.

Soil Texture

Objective: Understanding sand, silt, and clay as properties that determine soil (textural) character and identify soil texture by feel.

Teacher Background Document(s)/Reading:

- Powerpoint presentation with basic information about soil texture: www.soils4teachers.org/files/s4t/lessons/texture.ppt
- Handout describing soil texture with information on how to use a soil triangle: www.soils4teachers.org/files/s4t/lessons/soil-texture.pdf

Links to Activities:

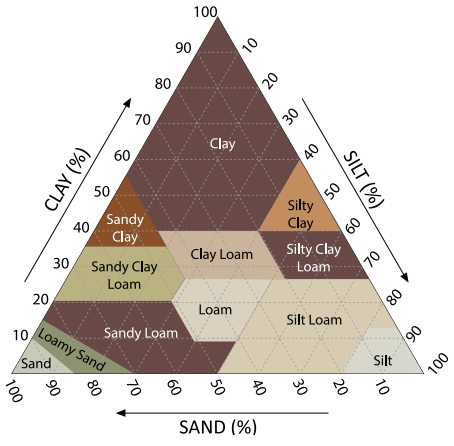
- Soil Texture – Jar Method (This is a demonstration that can be converted into a student activity.) www.soils4teachers.org/files/s4t/texture.pdf
- Soil Texture – Texture by Feel https://www.soils4teachers.org/files/s4t/In-Service%20Materials/soil-texture-test.pdf

Soil Structure

Objective: Recognize that soils are made up of solids and spaces that ascribe "shapes" to soil. Understand the basics of different arrangements and aggregations of soils.

Links to Activities:

- Soil Glue: https://www.soils4teachers.org/files/s4t/In-Service%20Materials/soil-glue.pdf



Soil Color

Objective: To familiarize themselves with the typical colors of soils and the factors that lead to those colors.

Teacher Background Document(s)/Reading:

- Powerpoint presentation with basic information about soil color: www.soils4teachers.org/files/s4t/lessons/color.ppt

Links to Activities:

- M&Ms Are Just Like Soil - Understanding Soil Color: www.soils4teachers.org/files/s4t/mm-color.pdf

Soil Profile

Objective: Recognize that soils have horizons and how the horizons are different from each other.

Links to Activities:

- A Soil Profile: www.soils4teachers.org/files/s4t/soilprofilelessonplan.pdf
- Dig Into Soil: www.earthsciweek.org/classroom-activities/dig-soil

Rhode Island State Soil: Naraggansett

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Part 4: Soil Degradation & Environmental Sustainability

Soil is a natural resource and like all natural resources it can be misused, contaminated, or degraded. Soil degradation can be due to natural and/or human-induced processes. Degradation may be as simple as the creation of gullies due to surface water runoff or may be extensive as in industrial pollution resulting in massively contaminated soils such as those classified as Superfund sites. A soil contaminated with heavy metals or crude petroleum cannot be used for recreation or grow food. An overused recreation field subsequently washed away by erosion requires intervention and protection from future damage. So, whether on a small or large scale, soils need to be protected from degradation and environmental pollution so that they can provide their assigned services and functions now and long into the future. The consequences soil degradation and pollution are loss of productive topsoil, flooding, landslide, loss of wildlife that used to depend on the land, etc. To prevent these, there are many conservation practices available to protect soils form degradation and pollution.

Objective: Soil is susceptible to degradation and needs to be protected and managed using various methods of conservation to ensure environmental sustainability.

Teacher Background Document(s)/Reading:

- Human and Soil Interactions: www.soils4teachers.org/human-soil-interactions
- What is desertification and what can be done to prevent it?: https://soilsmatter.wordpress.com/2015/11/01/what-is-desertification-and-what-can-be-done-to-prevent-it/

Student Background Document(s)/Reading:

- Desertification and the American Dust Bowl (discussion questions for the video "Black Blizzard"): www.pbs.org/video/dust-bowl-dust-bowl-black-blizzards/

Links to Activities:

- Erosion Model: www.soils4teachers.org/files/s4t/erosion-model.pdf
- How much is Soil Worth: https://utah.agclassroom.org/matrix/lesson/148/
- Keeping Soil in it's Place: https://utah.agclassroom.org/matrix/lesson/22/
- Liquefaction Activity:https://www.soils.org/files/s4t/lessons/lesson-plan-liquefaction-in-soil-types.pdf
- Combating Desertification - Saving our Topsoil: www.soils.org/files/sssa/iys/unesco-desertification-activities.pdf
- Rain and Soil: www.soils4teachers.org/files/s4t/rain-and-soil-lesson.pdf
- Fall of the Leaning Tower: www.pbs.org/wgbh/nova/education/activities/2611_pisa.html
- Soils in the Amazon: www.pbs.org/journeyintoamazonia/teacher_soil.html

Dust Bowl: USDA-NRCS

Erosion Model: soils4teachers.com

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Leaning Tower of Pisa

Part 5: Soil is Inter-disciplinary; Soil Science is an Applied Science

The soil has something for everyone. If you like chemistry, physics, biology, or ecology, you will find many applications in soil because the soil is complex and has many processes, reactions, and life interactions taking place in it. Discover how soil pH affects the concentrations (or availability for plant use) of elements like calcium, phosphorus, potassium, etc., or discover the amazing life of microorganisms, insects and animals in soil and the role they play in biodegradation. In addition, the soil holds carefully-preserved secrets waiting to be unearthed by the archeologist, provides clay for the artist, yielded the first antibiotic for medicine, and continues to support production of healthy food for exploding world population. For many cultures, their existence rests on soil for building mud houses, growing food, and producing great treasures of art.

Objective: Soils are foundational to many fields of science and serve many purposes for humans. Soils research requires the integration of many fields of science, the results of which have practical applications for many fields such as agriculture, manufacturing, and recreation, etc.

Teacher Notes: The content for this part of the unit reminds students how important soils are to so many aspects of our lives. The year 2015 was the International Year of Soils, and the year-long celebration included monthly themes. With each of these themes there is a video and a set of classroom activities selected to support the content of the videos. Use these links to explore the many applications of soils in our lives.

2015
International
Year of Soils

- International Year of Soils homepage: www.soils.org/iys
- International Year of Soils videos: www.soils.org/iys/monthly-videos
- International Year of Soils activities: www.soils.org/iys/monthly-activities/

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Soil supports most life on Earth and is the basis of food, feed, fuel, forages, fiber, and even some pharmaceuticals.

Soil plays a vital role in sustaining human welfare and assuring future agricultural productivity and environmental stability. Soil Science provides us with a valuable understanding of the physical, chemical, and biological properties and processes essential to such a complex ecosystem.

The Soil Science Society of America, a professional organization of soil scientists, is pleased to provide resources to teachers and students on essential soil topics for use in the classroom!

Soils4Teachers.org

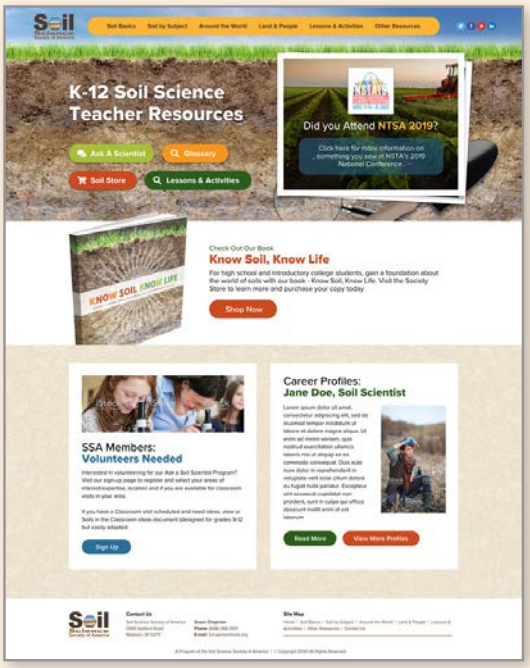
The popular www.soils4teachers.org website includes content across many topic areas, and the lessons and activities feature has been transformed into a searchable database! Search features include topic, grade level, NGSS standards, type of activity and more. Activities can be put into digital binders for easy download/ printing and all content is vetted by soil scientists.

Content areas include:

- Soil Basics
- Soil by Subject
- Soils Around the World (including State Soil Booklets)
- Land & People
- Lessons and Activities

Other great features include:

- Activities demonstrated at NSTA
- Earth Science Week Kit contributions
- Ask a Soil Scientist discussion board
- Careers in Soil Science profiles



– new content and features!

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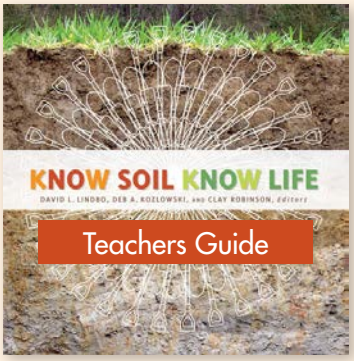
Discover More ... in the World of Soils

Know Soil Know Life Teachers Guide

Know Soil Know Life, written for the high school and introductory college-level student, provides a deep dive into soil science topics including physical properties of soil, soil formation, soil biology, chemical properties of soil, soil classification/survey/interpretations, environmental science/conservation/land use management, soils and biomes, soils and society, and careers in soil science. To enhance the educational value, an accompanying teacher's guide has been developed to adapt the content to the classroom. This teacher's guide includes:

- NGSS standards addressed
- Chapter summaries
- Learning Objectives
- Enduring Understandings/Big Ideas
- Essential Questions
- Key Points
- 5 E's of Inquiry-Based Science
- Chapter Powerpoints
- Associated Activities



Dig It! The Scoop on Soil

We're excited to debut a new poster on the basics of soil for classrooms! This unique poster is 2-sided (introductory on one side and more advanced on the other) and content includes:

- What is soil and why is it important,
- Particle size,
- Soil horizons/profile,
- Soil formation factors, and the
- Changing nature of soil

Printable copies are available at www.soils4teachers.org/posters.

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