

Martian Soil Doesn't Exist

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Topic: Conditions of planetary regolith and modifications needed to have soil for plant growth.

Objective: Students will identify characteristics of planetary regoliths and produce arguments for the suitability for plant growth.

Grade Level: 5-8

Subject: Science

Prep Time: 15 minutes (if not using simulants, additional time needed if setting up simulant experiments based on the number of simulants used)

Suggested Duration: 120 mins

Materials:

Internet-connected device

Chart paper (or digital recording method)

The Martian: Classroom Edition by Andy Weir (**ISBN 9780804189354**)

Optional resources depending on lesson components used:

Regolith simulants (see resources section for links to possible sources)

Seeds

Materials needed for regolith formation labs linked in Explore section-

Graham crackers

Mini donuts

Strainers

Microscope

Boxes

White bread

Wheat bread

Vocabulary:

Lander

Regolith

Rover

Sedimentary rock

Simulant

Soil

NGSS Standards:

MS-LS1-5 Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

*MS-LS2-5 Evaluate competing design solutions for maintaining biodiversity and ecosystem services.**

MS-LS2-2 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

MS-LS1-6 Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

MS-LS2-4 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Resources:

[Ellen Stofan Magnitude Live-](#)

- 2:05-2:07- Can we garden on Mars?
- 2:09- organic amendments
- 2:11-2:16- Simulants and Basalt/Types of Rocks

<https://www.lpi.usra.edu/publications/reports/CB-1063/RedMars2.pdf>

Sources of regolith simulants:

[The Martian Garden](#)

[UCF Exolith Lab](#)

Prior knowledge:

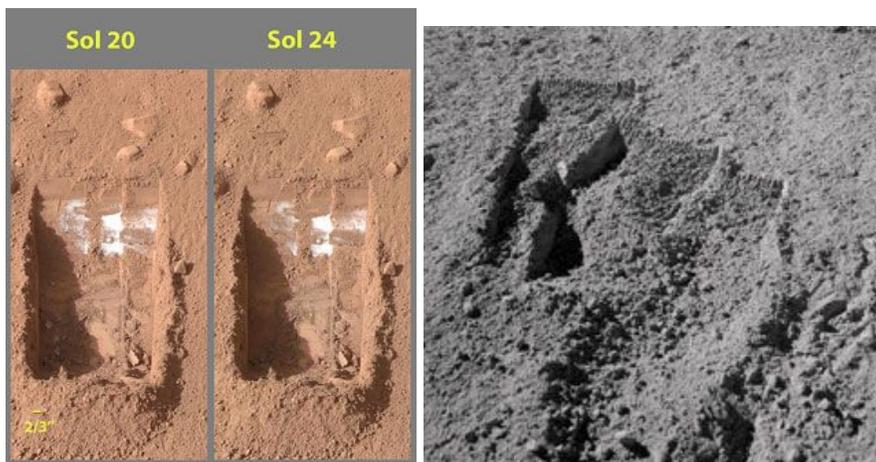
Students should be familiar with the planets of the Solar System, and have had experience with growing plants.

Engage:

1. Ask students -
 - a. What is Mars like?
 - b. What makes Mars different from Earth?
 - c. Why would growing plants on Mars be important?
 - d. What do plants need to grow?
2. Record answers on a Mars KWL (Know, Want to know, Learned) chart
3. Introduce the term "regolith." (Regolith is, essentially, dirt- it is small pieces of rock material, generally found on the surface of a solar system object.)
4. [Watch Ellen Stofan on Magnitude Live explain "Gardens on Mars"](#)

Explore:

1. The astronauts on board the International Space Station have been growing plants for many years now. One of these experiments, VEGGIE, has even produced some food for the astronauts to eat.
<https://www.youtube.com/watch?v=y9aR2-7sOjg>
2. **Ask students:** What variables might we need to test to know how to grow plants in regolith?
3. **Ask students:** What is regolith like? If you have some available, use your senses to make observations. If you don't have any available, use the following pictures to describe the regolith.



Images from https://isru.nasa.gov/Resources_from_Regolith.html

4. **Have students research:** How is regolith formed on Earth? Mars? Moon?
 - a. https://www.nasa.gov/pdf/146860main_Making_Regolith_Educator.pdf
 - b. https://www.nasa.gov/pdf/180567main_ETM.Regolith.Formation.pdf
5. **Ask students:** What do we need to know about regolith in order to plan an experiment?
6. Add new information to Mars KWL Chart

Explain:

1. [Watch Ellen Stofan on Magnitude Live explain "Simulants and Types of Rocks"](#) (2:11-2:16)
2. Compare two regolith simulants in the table below:

Table source: <https://sciences.ucf.edu/class/exolithlab/>

Oxide	Jezero Delta Simulant Wt.%	Mars Global Simulant Wt.%
SiO ₂	44.2	45.57
TiO ₂	0.2	0.30
Al ₂ O ₃	11.3	9.43
Cr ₂ O ₃	0.3	0.12
FeO _T	9.5	16.85
MnO	0.1	0.10
MgO	25.9	16.50
CaO	3.5	4.03
Na ₂ O	1.9	3.66
K ₂ O	0.3	0.43
P ₂ O ₅	0.6	0.37
SO ₃	2.1	2.63
Total	100.0	99.99
Particle Size Range:	0-1 mm	0-1 mm
Mean Particle Size (by volume):	38 μm	105 μm

3. What difficulties could this present to plants? ([for more information on plants growing in regolith](#))
4. Create a VENN diagram or double bubble map comparing Earth and Mars

Elaborate:

1. [Watch Ellen Stofan on Magnitude Live explain "Organic Amendments"](#) (2:09-2:11)
2. What amendments (changes or additions) could we make to regolith to turn it into soil?
3. Why would each of these amendments help make soil for plant growth?

Evaluate:

1. Design an experiment! If you have the resources, perform your experiment. If you don't, maybe someone else does and can test it! Could they create their own "Martian Gardens, Moon Gardens"? Gale Crater: Sedimentary processes. What does that mean about the regolith?
2. Which versions were most successful? What do you think that means?

Extension/support:

1. Compare to other regoliths (lunar? Other areas of Mars?)
2. <https://www1.villanova.edu/university/sites/magazine/summer-2018/mars-fertile-ground.html>
3. <https://ui.adsabs.harvard.edu/abs/2020AAS...23521201E/abstract>
4. [Examine the 8 possible landing sites for the 2020 Perseverance mission](#). Why do you think Jezero crater was selected as the final choice?