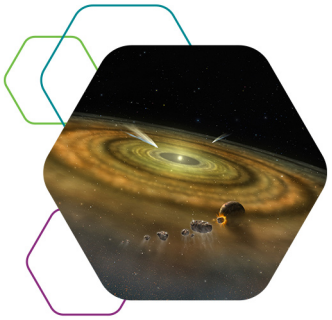

FACILITATOR GUIDE

Craters

Learning objectives

- Studying the surface of a planet or moon can reveal its history and composition.
- Impact craters form when a meteorite collides with the surface of a moon or planet (or other body in space).
- Scientists use tools to find and observe craters and learn more about the geologic processes on planets, moons, asteroids, and other worlds.

Materials

- 12-inch by 9-inch shallow container
- 3 lb white play sand
- Iron filings in container
- Whitener powder detergent (such as OxyClean™) and MDS sheet
- Safety goggles
- Marbles (3) in three sizes (small, medium, large)
- Angular gravel pieces (3) in three sizes (small, medium, large)
- Ultraviolet flashlight
- Tongs
- Magnetic applicator tool
- Activity and facilitator guides
- Information sheets
- *Tips for Leading Hands-on Activities*

The Explore Science toolkit comes complete with all necessary materials for this activity. Materials are also readily available to create or restock activity kits. Graphic files can be downloaded from www.nisenet.org.

Safety

This activity includes mixing detergent into the sand/iron mix. The mix should NEVER be ingested. The detergent powder can be an eye irritant if small particles become airborne (see MDS for more safety information). The activity uses a very small amount of the detergent, but we do recommend that the facilitator and participants wear eye protection.

Advance preparation and clean up

- Pour the sand into the bottom of the container, then sprinkle a little detergent over one small area of the sand (a hidden landscape feature). Sprinkle iron filings over the top of everything to create a very thin, yet visible, layer.
- Practice resetting the mixture beforehand. To reset the sand/iron mixture when the layers become too heavily combined, use the magnetic applicator tool to separate the iron filings from the sand. Drag the tool through the sand to collect iron at the tip. Release the iron filings back into their container by pulling the black rod up and out of the clear sleeve. This lifts the magnet away from the collected filings. You can do this a few times.
- You DO NOT need to completely reset the bucket after each visitor group. You can just keep adding a layer of iron filings to the surface as needed. You can also add a little more detergent after several visitor groups if you notice that the detergent is mixing too much with the sand.
- Be aware that the magnetic applicator tool reset can be a distraction from the primary hands-on crater activity, so you may choose to do this out of sight of visitor groups.
- When you're done, snap the lid onto the container, and store the mixture for future use. You should never need to completely dispose of the sand/detergent/iron mixture.
- All three materials in the mixture (sand, iron filings, detergent) can be easily cleaned up with a vacuum, should the activity make a mess on the floor.

Notes to the presenter

At the start of an interaction, you can ask guests what they know about craters or if they know where they can find craters. What planets or moons have craters? Share that the craters we refer to in this activity are *impact craters*. They form when an object, like a meteorite, hits the surface of a planet or moon.

For their first marble drop, encourage participants to start from a height of 1 meter, or 3–4 feet, above the surface of the sand. You should be able to get 2–3 impacts before needing to do a quick reset by removing the marbles, shaking the container, and sprinkling on more iron filings.

Suggest that participants compare the craters they make to the pictures of craters on other worlds. Can they find features that look similar? Use the UV light to see if participants can find hidden features in the "soil." Sometimes the features are more pronounced under the light. There might be a hidden crater or a change in the soil type. The light reflecting off the detergent in the sand could represent hidden water! Play around with the how you lay down the detergent and how you connect what visitors can discover with current NASA crater science. Refer to the information sheets for additional stories and examples.

This is a different version of what might be a familiar activity! This activity focuses on the tools used to observe craters, but young children may be more interested in the process of creating craters. The Astronomical Society of the Pacific has an activity specifically designed for pre-K aged children, in which they make predictions and observations of craters formed by dropping balls of different sizes and materials into a tub of flour. See a video of this activity in action here: https://vimeo.com/186278017

Difficult concepts

The term “crater” is used to describe a few different geologic features. Craters can form from either an explosion, collapse, or impact. When asked for an example of a crater, many people think of Crater Lake in Oregon. While it does share many features with impact craters, Crater Lake was actually formed when the top of a volcano collapsed after a volcanic eruption. It did not form from a meteorite impacting the surface of Earth.

People may wonder why Earth seems to have fewer craters than the Moon or other solar system objects. While Earth is more likely than the Moon to be impacted by asteroids or meteors due to the larger gravitational force between them, those bodies from space often burn up in Earth’s atmosphere. The Moon doesn’t have an atmosphere like Earth and therefore more craters are formed at its surface. Earth’s atmosphere and the planet’s ongoing weathering processes—like erosion—effectively erase craters over time, while on the Moon craters stay on the surface, creating a record of the history of impacts.

The rate of crater formation both on Earth and on the Moon was higher in the distant past than it is now.

Staff training resources

Refer to the *Tips for Leading Hands-on Activities* sheet in your activity materials.

- An activity training video is available at vimeo.com/245834831
- A content training video is available at vimeo.com/245835335
- The NISE Network has a curated list of programs, media, and professional development resources in the NASA Wavelength Digital Library that directly relate to the toolkit. These resources can be viewed and downloaded from nasawavelength.org/users/nisenet.

Credits and rights

This activity is a classic demonstration and exists in many forms. NISE Net's adaptation is based on the NASA Guide Lite eClips activity, Exploring Craters. Retrieved from: https://nasaeclips.arc.nasa.gov/teachertoolbox/guidelites

Image of Copland impact crater on Mercury courtesy NASA/Johns Hopkins University Applied Physics Laboratory/Carnegie Institution of Washington.

Ultraviolet image of craters on the Moon produced by the Lyman Alpha Mapping Project courtesy NASA's Goddard Space Flight Center and SSERVI.

Image of craters on the Moon's south pole; artist's rendering of Lunar Reconnaissance Orbiter; and image of craters on the Moon courtesy NASA's Goddard Space Flight Center.

Image of Barringer crater, *Shane Torgerson,* licensed under Creative Commons Attribution-Share Alike 3.0 Unported https://commons.wikimedia.org/wiki/File:Meteorcrater.jpg

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