Exploring Meteorite Mysteries

Lesson 7 — Crater Hunters

Objectives

Students will:

- observe impact craters on Earth and other solar system bodies.
- discuss geologic forces that have removed most of the evidence of the impacts on Earth.
- locate impact craters using longitude and latitude.
- search maps for potential impact sites.
- create a field work plan to investigate possible craters.

Background

Impact craters are geologic structures formed when a meteorite, asteroid or comet smashes into a planet or other solid body. All the terrestrial planets and satellites have been bombarded throughout their history. To us the most obvious examples of these impacts are the craters on the Moon. If the Moon is visible, craters are visible. You can only see the very large craters or basins with the naked eye. Lunar craters were not described until after Galileo used one of the first telescopes to look at the Moon. Modern binoculars help to make the craters on the Moon very obvious.

On the Earth, dynamic geologic forces have erased most of the evidence of its impact history. Weathering, erosion, deposition, volcanism, and tectonic activity have left only a small number of impacts identifiable. Approximately 140 terrestrial impact craters have been identified. These impact craters range from about 1 to over 200 kilometers in diameter and from recent to about two billion years in age.

“Where do they come from?”

About This Lesson

After viewing slides of craters on other planets, the Moon, and Earth, students will locate impact craters on Earth using longitude and latitude and various maps. Students will locate potential sites of impacts, and plan the necessary research to verify their observations.

Vocabulary

impact crater, longitude, latitude, weathering, erosion, deposition, volcanism, tectonic, terrain, geophysical, ejecta, tektites, vaporize

About This Activity

Part 1 - Students look at other bodies in the solar system to see that there has been a history of impacts in the entire inner solar system. Focusing on Earth, students discover that there are not many obvious craters. They locate craters on a map using longitude and latitude.

Part 2 - Without seeing pictures of the craters, students describe the craters using name, age, size, terrain, etc. The crater photographs are then shown to allow comparison with the students' descriptions of the craters.

Materials for Activity A

- ❏ slide projector and screen
- ❏ Slide Set, Impact Craters
- ❏ maps of North America or the world with longitude and latitude designated (pg. 7.4)
- ❏ Craters on Earth Data Chart *(pg. 7.3, one per group or transparency)*
- ❏ pen/ pencil
- ❏ Student Sheet for Activity A, Part 2 *(pg. 7.5, one per student)*

Lesson 7 — Crater Hunters

Activity A: "Where Are the Craters on Earth?"

Procedure

Advanced Preparation

1. Gather materials.
2. Read lesson background.
3. Review slides.

Classroom Procedure - Part 1

1. Show slides of Mercury, Venus, Moon, Mars.
2. Discuss how these bodies are alike and how they are different, focusing on cratering.
3. Ask "Where are the craters on Earth?" Show slide of Meteor Crater only.
4. Each student (or pair of students) is given a map of North America or the world.
5. Hand out (or put on overhead) the Craters on Earth Data Chart and designate the impact craters to be used (teacher may limit the number to be plotted).
6. Students plot designated craters using the longitude and latitude data, varying dot size according to crater diameter.
7. If Part 2 will not be completed, the final slides of Earth impact craters may be shown at this time.

Classroom Procedure - Part 2

In this advanced activity students consider geologic processes like faulting, weathering, and glacial activity.

1. Distribute Student Sheets.
2. Based on the age, size, name, and terrain, students write a description or make a sketch of what they think the crater shapes would look like.
3. Show the slides of the craters and have students describe craters again and compare to the previous descriptions.

Questions

1. Where are the craters on Earth?
2. What happened to the craters on Earth?
3. What are some differences between Moon craters and Earth craters?
4. Compare several Earth craters. How are they alike and different?

Craters on Earth Data Chart

Activity A, Part 1 "Where Are the Craters on Earth?"

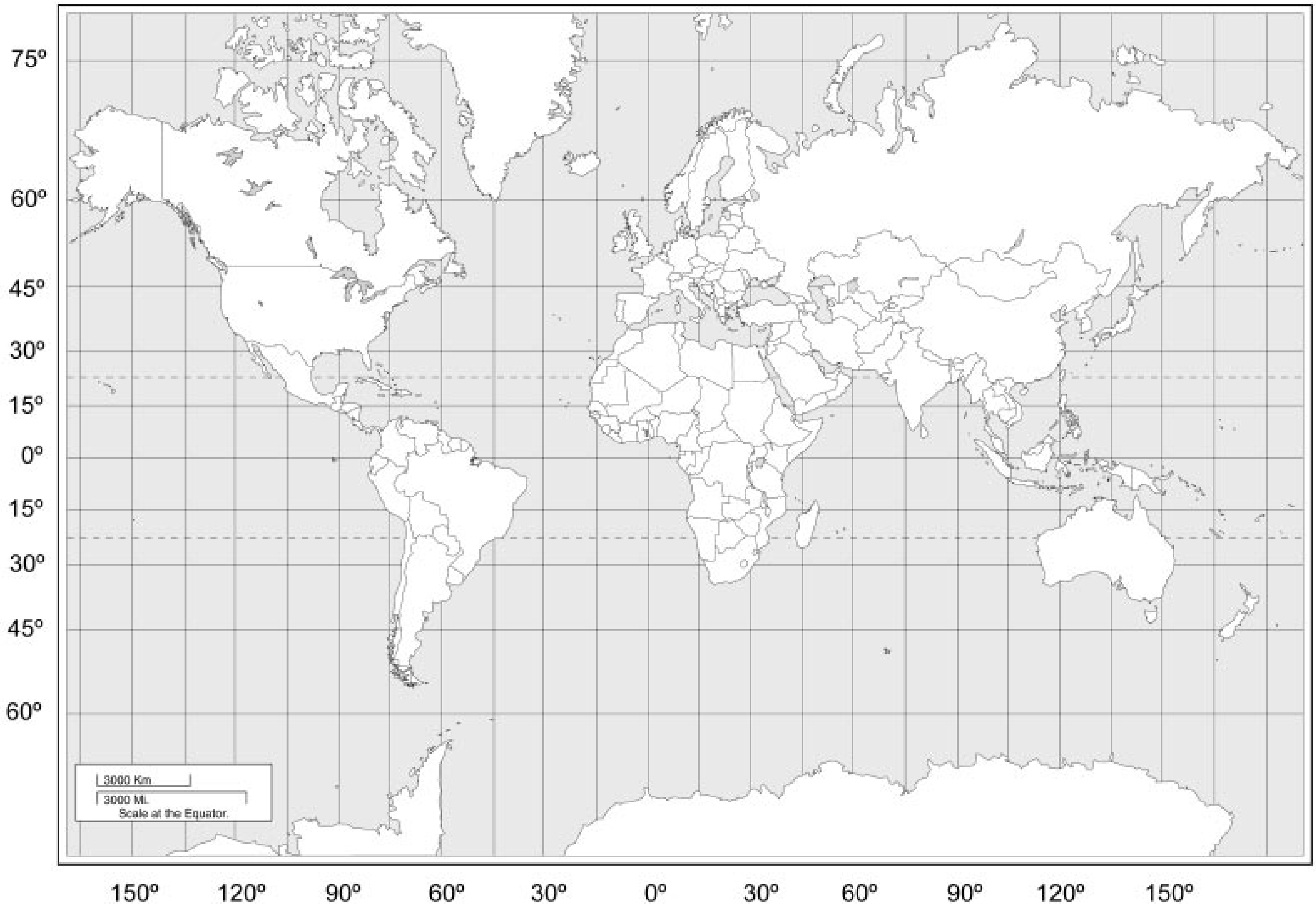
Crater	Latitude	Longitude	Diameter (km)	Age (yr)
Meteor Crater, Arizona	35°N	111°W	1.2	50,000
*Manicouagan, Canada	51°N	69°W	70-100	212 million
Middlesboro, Kentucky	37°N	83°W	6	< 300 million
*Clearwater Lakes, Canada	56°00'N	74°07'W	22	290 million
	56°15'N	74°30'W	32	290 million
Pilot Lake, Canada	60°N	111°W	6	440 million
Chicxulub, Mexico	23°N	90°W	200	65 million
Sierra Madera, Texas	31°N	103°W	13	100 million
Vredefort, South Africa	27°S	28°E	140	1.97 billion
Sikhote Alin, Russia	46°N	135°E	breakup	46 years
Ramgarh, India	25°N	77°E	5.5	unknown
*Spider, Australia	17°S	126°E	13	< 600 million
Grover Bluff, Wisconsin	43°N	90°E	6	< 500 million
Red Wing Creek, N. Dakota	48°N	104°W	9	200 Million
Odessa, Texas	32°N	102°W	0.2	<50,000
Kentland, Indiana	41°N	87°W	13	< 300 million
Manson, Iowa	43°N	95°W	3	65 million ??
Wells Creek, Tennessee	36°N	88°W	14	200 million

**Craters used in Activity A - Part 2*

Lesson 7 — Crater Hunters

Crater Hunters Map

Activity A, Part 1 “Where Are the Craters on Earth?”



Student Sheet: Activity A

Activity A, Part 2 "Where Are the Craters on Earth?"

Procedure

1. Use a detailed physical map or atlas to locate the craters listed below; note important information on the chart.
2. Fill in a description of the surrounding terrain, especially consider the geology of the area, etc.
3. Considering all the information on the chart, write a description of what you think the craters look like.
4. View the pictures of the craters and write your second descriptions based on the pictures.
5. Compare the descriptions.

Crater	Location and Terrain	Description *(based on info)*	Description *(based on picture)*
Spider Crater *Size* 13 km dia. *Age* < 600 million yr.			
Manicouagan *Size* 70-100 km dia. *Age* 212 million yr.			
Clearwater Lakes *Size* 22 km and 32 km diameter *Age* 240 million yr.			

Longitude and Latitude for each crater can be found on Craters on Earth Data chart page 7.3.

Student Background: Activity B

Scientists perform extensive field and laboratory research before they are able to verify that a geologic feature is an impact site. Ideally the scientists are looking for round structures, however geologic forces may have distorted the crater shape through faulting or other movement associated with plate tectonics. Ice, water, and wind, through weathering and erosion processes, have caused great changes in craters. Some craters have been filled with water, or completely covered by soil or water, and have no surface evidence. They may initially be identified by remote testing of materials below the Earth's surface (geophysical studies).

Some of the clues that help scientists identify large impact sites are found in the physical condition of the structure. In addition to the crater's round shape, they look for layers of rock that have been turned over at the edge of the crater. A large uplift or mountain at the center is also common in impact craters. Highly fractured rocks are usually found at impact sites but they could be interpreted as being associated with other non-impact geologic processes. However, scientists find shatter cones, which are highly shocked rocks with distinct structures, only at areas stressed by huge impacts. Investigations usually identify large amounts of excavated material deposited around and in the craters. This material is called ejecta and may form thick layers of breccia, a mixed broken rock material. To verify the location and origin of these deposits requires extensive research, including drilling. Sometimes a large volume of impact melted rock is found in and around the craters. Some melted rock is frequently thrown far from the impact. These small glassy masses, which were aerodynamically shaped when they were molten, are called tektites. Very small ones are microtektites. They are very good indicators of large impacts.

Another way to get important information about an impact is from chemistry. The impact-melted rock sometimes contains melted meteorites. By careful laboratory research, scientists can detect very small amounts of rare elements that are more abundant in meteorites. These chemical signatures are very important in meteorite research. To find a meteorite sample would be the best discovery! Unfortunately this does not happen frequently. Meteorites may completely vaporize during the impact process, or they may be removed by erosion.

Early geologists misinterpreted some impact craters. Scientists reported Meteor Crater in Arizona as a volcanic crater. The Chicxulub site on the Yucatan peninsula was also wrongly reported. Early oil explorers misinterpreted extensive deposits around the Chicxulub area. Scientists now know that the material is ejecta from a huge impact and not of volcanic origin.

Considering the geologically active crust that erases craters, and all the research necessary to verify the origin of impact craters, it is not surprising that only around 140 have been identified so far. But it is likely that more will be found.

Lesson 7 — Crater Hunters

Activity B: Crater Hunters

Objectives

Students will:

- develop criteria for identifying craters on Earth.
- search maps for potential impact sites.
- create a fieldwork plan to investigate possible craters.

Background

See Student Background (pg. 7.6), also see background information in Lesson 16, pg. 16.2.

Procedure

Advanced Preparation

1. Gather materials.
2. Read background information.
3. Prepare sample crater if desired.

Classroom Procedure

1. Read and discuss background information. Review observations made in Part A of this lesson. Re-show slides if desired. Brainstorm an example crater and investigation if necessary.
2. Divide class into teams of two to four students.
3. Assign each team a different map area to observe, looking for any feature that might be the site of an impact. Allow students to be very creative in choosing the possible sites. Specific sites are not important. They are likely to choose obviously round structures such as lakes in Canada, Hudson Bay, the Gulf of Mexico, the Aral Sea in Uzbekistan (former Soviet Union), Lake Okeechobee in Florida, and Lake Victoria in Africa.
4. Students plan geologic field investigations and laboratory tests that might be done to verify that their designated crater is or is not an impact site. Report in outline form or see the proposal idea below.
5. Students write a short “proposal” asking for support money to conduct their research. They will need to explain and justify the planned research. Consider time, travel, personnel, laboratory expenses, and data gathering.

About This Activity

In teams students view physiographic maps of North America or another part of the world. They try to find a possible impact site based on circular shape and other features observed in the slides of impact craters on Earth. The teams will then develop a plan to do field research, listing the data they could collect and the tasks they could perform to help them verify if the formation is an impact site.

Materials for Activity B

- ❑ Student Background (pg. 7.6)
- ❑ large physical maps of any region of the world, one per team
- ❑ paper and pencil

Teacher notes for field investigations

Ask students “What would you look for at the site to help prove that you have found the remnants of an impact?” Possible answers might be:

- look for meteorites
- map the geologic formations looking for: a basin shape, overturned rim layers, possible uplift in the central crater region, multiple ring structures (see Lesson 6)
- look for minerals changed by impact shocks
- look for melted rocks
- test deposits associated with the debris from the crater, looking for elements that are much more abundant in meteorites (i.e., Iridium).