THE BARRINGER METEORITE CRATER

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Teacher Key 3: Observing Impacts

The observations described by students will be dependent on their ability to start and stop the video as instructed, as well as their attentions to detail.
This key is only a guide to what they should be describing. Answers will vary and should provide a forum for discussion!

A: A Red Drop of Water in Slow Motion

It's important to understand that the water drop simulation is an example of a strengthless target; rocks have more strength.

Technically, none of the waves in this water drop simulation are shock waves. Shock waves cause a near-immediate change in the properties of the medium, for example pressure. These waves are much too slow to be doing that. The idea here is for students simply to observe that a wave is propagated (normal ripples like throwing a rock in a pond)

0:02 - moment of impact;

0:03 - material (water) ejected up in a column (in a real impact this is called the ejecta curtain); a wave appears

0:04 - ejected material (the circular column) begins to collapse on itself; drops fall back down; wave moves out

0:05 - column collapses in the center

0:06 - crater forms with uplift in the center; more waves evident

0:08 - tall central peak rises; waves move out from the center; red drops continue to fall

0:12 - reaches highest point, looks round at the tip; waves spread out

0:16 - central peak collapses again; red drop appears to re-form

0:19 - red drop hits the surface again

0:22 - very small central peak rises again

0:25 - central peak collapses quickly

B: Asteroid Hitting Land

There are a few unnatural things happening in both the land and ocean impacts due to the setup of the simulations. Sometime between 7 and 8 seconds, the nice, hemispherical wave (in these simulations, the shockwave), appears to get a bump in the middle – this is because there's a "bottom" to the simulation and the wave is reflecting off of it. On a planet this wouldn't happen.

Later in the simulations there's an extra "poof" of purple looking material– this is probably also a reflection of material bouncing off of the simulation boundary.

The white color in the simulations is probably the most shocked material- very hot gases/vapor. (Hot atmosphere, not target material).

The numbers (0,50…) are kilometers, showing the scale of the simulation.

0:40 - moment of impact

1:00 - materials melt & vaporize, some materials broken up but still solid; excavation of crater

3:00 - crater is getting larger as more material is melted, vaporized and ejected; wave is seen below the crater

5:00 - crater bigger, material is ejected farther out; wave is expanding out

7:00 - crater is larger, material ejected is higher and farther out; wave appears bent.

9:00 - lots of melt still in the crater; ejected material off the screen

12:00 - less material in the crater; more ejected out

C: Asteroid Hitting the Ocean

Water evaporates in the simulation. Although not necessary for this activity, you may explain that water has a large specific heat (takes a lot of energy to heat it up one degree compared to something else), and it has a low temperature where it reaches a vapor, so it will be more likely to vaporize than a target of only rock.

0:40 - moment of impact

1:00 - excavation of crater; material is melted and vaporized

3:00 - lots of melt and vaporization of materials; materials are ejected out

5:00 - crater is larger, lots of melt; more material ejected; wave appears under the crater

7:00 - lots of vaporization and melt; ejected material is higher and farther out; wave appears bent

9:00 - more vaporization, melt, and ejecta

12:00 - material continues to be melted, vaporized and ejected still farther out

Reflections

1. Explain what happens to the impactor in each of the simulations – were the results the same? Why or why not?

Water drop appears to re-form after it hits the surface though this is likely different water droplets.

Both land and ocean impactors melt and vaporize.

2. Describe any differences you observed in the size of the craters in each of the simulations.

As the red drop falls, you see a hole appear, but then it disappears until the drop re-forms and falls again. You never really see a crater because the water isn't strong enough to hold the shape.

In the land and ocean, the craters continue to get larger as material is ejected out.

3. Was the action of the ejected material the same or different in the water drop simulation compared to the land and ocean? Explain your answer.

The water drop created a column of ejected material that collapsed on itself.

In the land and ocean, the amount of material ejected out continues to increase. In these simulations the crater is still ejecting material, and doesn't run out to the end where material falls down to the surface and the crater excavation is complete.

4. Was the movement of waves the same in all simulations? Explain your answer.

In the water drop simulation, the waves appear to rebound (due to the motion of the medium and the surface).

In the land and ocean simulations, they continue to expand out in all directions (until they appear to bend).

5. Were the angles of impact the same in all simulations?

No, the water drop came straight down. In the land and ocean simulations it came in at a 45˚ angle.

6. Scientists use models to help us understand what happens to materials as the result of an impact. How did these simulations help you to understand impacts?

Answers will vary

7. All models have limitations. Name one thing these simulations could not do.

Answers will vary

Slideshow: Stages of Crater Formation by Dr. Carolyn Ernst

Video: "Stages of Crater Formation"
http://www.barringercrater.com/education/how_craters_are_formed/crater_stages.php

Listen to how the scientist Dr. Carolyn Ernst describes the stages of an impact event. Take notes on the 3 stages and new vocabulary.

1. **Compact/Compression Stage - Projectile Impacts Target**

   rarefaction - the release wave of energy from impact

   ejecta- the material thrown out of crater from impact

2. **Excavation Stage - Materials Pushed Downward and Outward**

   ejecta curtain- the ejecta rising up above the surface

   transient cavity - the hole formed from the initial impact

3. **Modification Stage - Settling of Materials, Erosion**

   ejecta blanket- the thrown materials covering the ground surrounding the impact site

   breccia - broken rock from impact