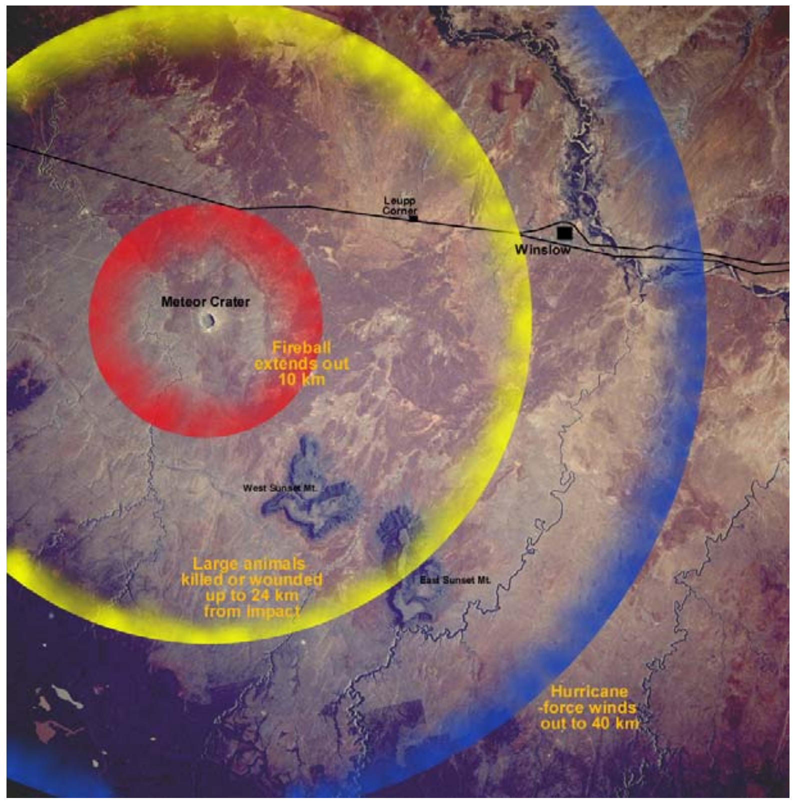
Impact Crater Morphology Names ____________________________________

Impact craters are formed when objects from space impact a solid object (like a planet or moon). The impact itself can have a dramatic impact on that planet (especially Earth). Meteorites have been blamed for most of the mass extinctions that appear in the fossil record.

When a meteorite crashes into the Earth, the very large kinetic energy of the object is transformed onto thermal energy, sound energy, seismic energy, and kinetic energy of objects that become airborne because of the impact. If you were near a large impact, the thermal shock wave would fry your brains before you knew what happened.

The meteorite that crashed into Arizona 50,000 years ago was about 150 feet in diameter. Objects this size impact the Earth about once every 5,000 years or so. If you were within 2 miles of this impact, you would have been pummeled to death by large iron and rock debris (however, this would be the LEAST of your worries). The shock wave would extend outwards with 600 mph winds within 3 miles of the impact, and hurricane force winds outwards to 15 miles. Loaded with projectiles (trees, etc), your chance of survival would not be good. Then there is the thermal shock wave, which would incinerate anything in it's path out to 7 miles from the impact.

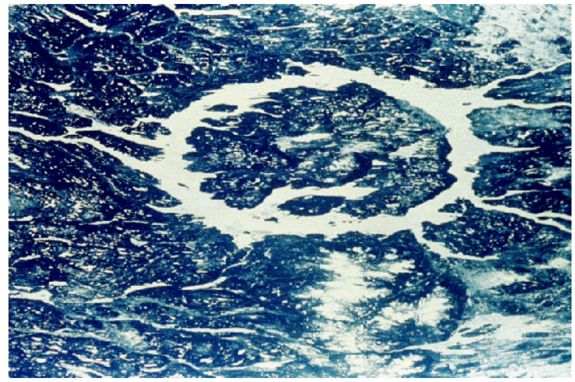


You can imagine what would happen if a meteorite this size impacted downtown Los Angeles. Millions of people would die, and trillions of dollars in damage would occur. Here in the San Gabriel Valley (13 miles away), we would see a bright flash of light, followed by 100 mph winds, and temperatures in excess of 150 degrees for a time. Not fun!

The meteor crater is the most well-preserved impact crater on the Earth. This is because it happened fairly recently and is located in an arid desert (minimal erosion). Even so, scientists did not universally believe the crater was from an impact until 1963. Up until that time, it was thought that (by some) that the crater was formed by a volcanic steam explosion. Once it was proven to be an impact crater, other craters were discovered around the Earth.

Examples of Impact Craters

Canada


Siberia


Namib Desert

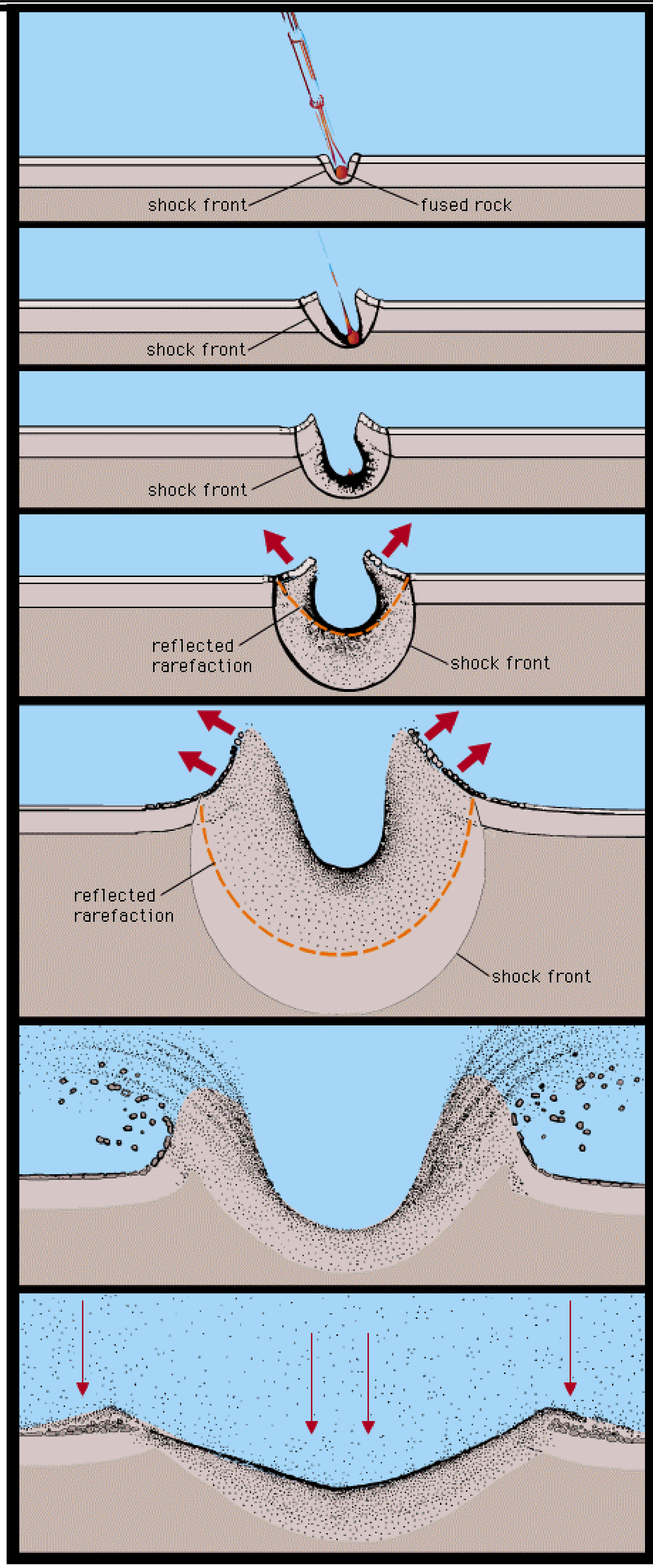

New Quebec


Australia


Arizona

Names ____

How is a crater formed? This diagram says it all:



Notice that the rocks are overturned as the material is ejected from the crater. Also note that the crater is much larger than the size of the meteorite.

The amount of energy released is simply a function of its kinetic energy (mass and velocity). Remember the formula $KE=½mv^2$. Velocity is a bigger factor than the mass. We will test this out later.

It turns out that if you are still reading this, if you are asked to draw a circle, draw a triangle instead. This may come in handy later.

Objects like the Arizona meteorite only have regional effects – there is no global effect. However, a larger object like the "Dinosaur killer" (about 7 miles wide) can have worldwide effects. The meteorite would at first cause an increase in temperature globally. This would be followed by an "impact winter" caused by sulfate particles shot into the Earth's atmosphere, which would block the sun's energy and cause temperatures to plummet.

PLEASE ANSWER THE FOLLOWING QUESTIONS

1. What would the kinetic energy of a meteorite if its mass was 5.6×10^{33} kg and had a velocity of 5.2×10^{4} m/s?

2. If a meteorite 150 feet in diameter impacted 10 miles from where you were standing, what effects would you feel?

3. Looking at the pictures of different craters, would the angle at which the meteorite hit make a difference in the shape of the crater (you can assume that most impacts are not from straight on, but from an angle).

4. Why is the Arizona crater so well preserved?

EXPERIMENTATION: Making impact craters

For this experiment, you will need to obtain a container, a metric ruler, flour, a calculator, cocoa powder, and two “meteorites” of different masses.

Setup:

1. Place about 8cm of flour into your container. Do not compact the flour, but shake and tilt the pan to make an even surface.

2, Sprinkle a thin layer of cocoa powder on top of the flour, so that very little if any of the flour is visible. The layer needs to be as thin as possible.

3. Place your container in a location where spilled flour will not make a mess.

Procedure:

1. Hold the small meteorite directly above the center of the container at a height of 1.0 m. Drop the small meteorite. If you can remove your meteorite without messing up the crater, you can do so now; otherwise, measure everything that you can with the meteorite in place before removing. Record the following information in your data table.

A. Mass of small meteorite
B. Height dropped from (in m).
C. Calculate the kinetic energy of the meteorite

$$v = \sqrt{2gh}$$

$g = 9.8 m/s^2$, h=height in meters. Then,

$$KE = \frac{1}{2}mv^2$$

v = velocity from previous formula, m = mass in kg.

D. Diameter of meteorite (in mm)
E. Diameter of crater formed (in mm)
F. Depth of crater formed (in mm)
G. Draw the shape of your crater.
H. Distance from center of crater to farthest ejected material (flour).
I. Height of rim (if any) around crater in mm (measure from flat ground, not bottom of crater).
J. Number of ejecta rays present.
K. Draw a circle in the lower left corner of the last page of your data tables.

Repeat the above procedure at heights of 2m and 6m.
Then repeat all of the above with the large meteorite.

DATA TABLE

Light Meteorite										
Height (m)	Mass (kg)	Calculated Velocity (m/s)	KE (J)	Diameter of Meteorite (mm)	Diameter of Crater (mm)	Depth of Crater (mm)	Distance to farthest ejected mat'l (mm)	Height of rim (mm) (N/A = No Rim)	# of ejecta rays	Sketch shape of crater
1.0m										
2.0m										
6.0m										

DATA TABLE

Heavy Meteorite										
Height (m)	Mass (kg)	Calculated Velocity (m/s)	KE (J)	Diameter of Meteorite (mm)	Diameter of Crater (mm)	Depth of Crater (mm)	Distance to farthest ejected mat'l (mm)	Height of rim (mm) (N/A = No Rim)	# of ejecta rays	Sketch shape of crater
1.0m										
2.0m										
6.0m										

TEACHER NOTES

Equipment needed:
4 tubs or aluminum baking trays
Enough flour to fill 3 inches each tray
Enough Cocoa Powder for many applications
4 marbles
4 golf balls
4 metric rulers
Measuring Tape (6m)
Measuring Tape (2m)

Draw crater morphology – ejecta blanket, rays

ANSWERS:
1. 7.6×10^{42} J
2. Hurricane force winds, high heat.
3. No. All craters are circular
4. Recent impact (50,000 years), located in arid region (little erosion).