Impact Crater Investigation

Natural Disasters

Name ______________________________

Group ______________________________

These photos of impact craters from Earth and Moon show some common features. The Moon's Copernicus Crater (see

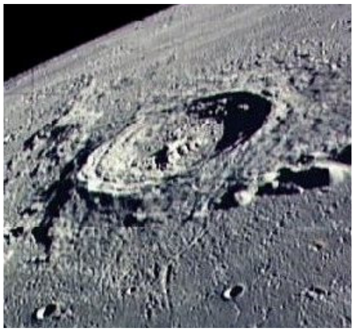

Figure 1 - Copernicus Crater, Moon, with central uplift and terraced walls

Figure 2 - Barringer Crater, Arizona, with raised rims

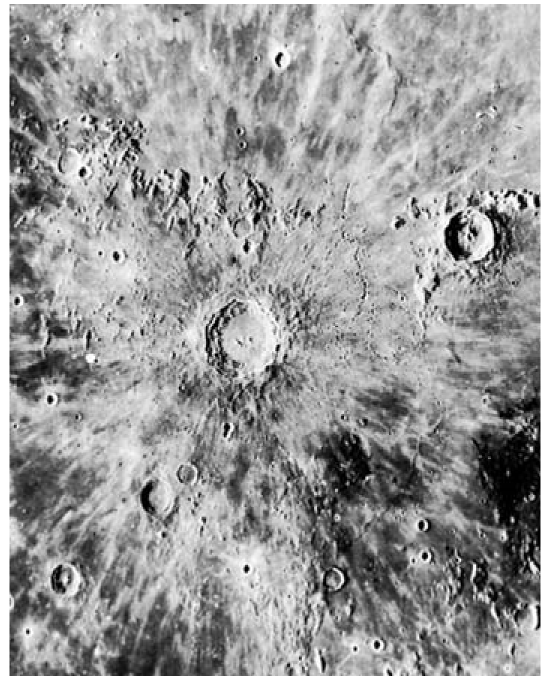

Figure 3 - Copernicus Crater, Moon, showing rays

Fig. 1) is an example of **central uplift**, resulting from a splash-like rebound of material just after the impact. You can also make out **terraced walls**, which form soon after impact as gravity causes the steep walls to slump downward and inward, typically forming a series of concentric terraces.

Barringer Crater, Arizona's **raised rims** (Fig. 2) formed when the impact blasted the edges of the crater upward and outward, flipping the rock layers over.

Figure 3, again of Copernicus Crater, displays **rays** emanating outward in all directions. Rays form when **ejecta** (ejected material) are thrown across the landscape immediately after impact. Evidence suggests that ejecta from Mars craters may be the source of Martian meteorites which have landed on Earth.

Obviously, very large **bolides** (large asteroid or comet impactors) create large craters on impact, such as the 180 km wide Chicxulub Crater in Yucatan, Mexico, formed by a bolide at least 10 km in diameter. This event at the boundary between the Mesozoic and Cenozoic Eras correlates with the extinction of many species, including the dinosaurs.

But what about factors other than size? State 3 hypotheses on the back of this sheet, then begin your investigation.

PROBLEM: In this investigation, your group will determine whether bolide mass (density) or velocity are most influential in determining the diameter, depth, and ray length of craters.

MATERIALS: cake pan, flour, dry tempera paint, sieve / sifter, heavy-duty garbage bag, same-size balls (aluminum, steel, brass, lead), balance, safety goggles, meter stick, metric ruler, graphing software

PROCEDURE:

1. Find the masses of the aluminum, steel, brass and lead balls to the nearest tenth of a gram. Record this on one of four "Data Charts" (begin with an impactor height of 30 cm.). Also, convert masses to kg., then calculate KE for each.
2. Place the pan inside the bag on the floor.
3. Fill the pan with flour to a depth of 5 cm.
4. Level the flour by gently tilting and tapping the pan. Lightly sieve the dry paint over the flour just enough to cover.
5. Put on goggles, then drop the aluminum ball into one corner of the pan from 0.3 m height. Measure and record the crater diameter and depth, and average of all ray lengths if any, to the nearest tenth cm. Always make a note of any other features observed.
6. Repeat step 5 for each of the other balls, dropping them into a different part of the pan.
7. Remove the balls and smooth the flour in the pan, adding additional paint to the surface.
8. Repeat steps 5, 6 and 7 twice more for a total of three trials for each ball.
9. Repeat steps 5 through 8 but use a height of 0.9 m. and a new data sheet.
10. Repeat steps 5 through 8 using a height of 2.0 m (new data sheet).
11. Using your graphing software (Excel, Logger Pro or Graphical Analysis), set up charts to record the average data. Then have the program make graphs showing the effect of mass on crater diameter, crater depth and ray length, as well as the effect of velocity on crater diameter, crater depth and ray length.

HYPOTHESIS 1: State a testable hypothesis describing the effect of mass on crater diameter, depth, and ray length.

HYPOTHESIS 2: State a testable hypothesis describing the effect of velocity on crater diameter, depth, and ray length.

HYPOTHESIS 3: State a testable hypothesis describing whether mass or velocity has a greater effect on crater diameter, depth, and ray length.

CONCLUSION:

1. State a conclusion describing, if possible, the relationship between variables for each hypothesis.
   Conclusion 1:

   Conclusion 2:

   Conclusion 3:

2. Note your calculated values of Kinetic Energy (KE) for each of your masses. Explain your results in conclusion 3 taking into account the formula for Kinetic Energy = KE = 0.5 (mv^2).

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ROLE

Data Chart for (circle an impactor height)

30 cm. (v = 0.242 m/s) 90 cm. (v = 0.420 m/s) 2 m. (v = 0.626 m/s) 6m (v = 1.084 m/s)

		Trial 1	Trial 2	Trial 3	Total	Average
Aluminum mass = ______ KE = 0.5 (mv^2) =	Crater Diameter					
	Crater Depth					
	Average Ray Length					
Steel mass = ______ KE = 0.5 (mv^2) =	Crater Diameter					
	Crater Depth					
	Average Ray Length					
Brass mass = ______ KE = 0.5 (mv^2) =	Crater Diameter					
	Crater Depth					
	Average Ray Length					
Lead mass = ______ KE = 0.5 (mv^2) =	Crater Diameter					
	Crater Depth					
	Average Ray Length					