From Space to Earth: Meteor Crater

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Teacher Key: Battle for Impact Theory

Instructions

View the "Weighing the Evidence" slideshow: https://youtu.be/Xx-dwxKPGDc

"Weighing the Evidence" Slideshow Questions

Grove Karl Gilbert

1. When Grove Karl Gilbert analyzed the Barringer Meteor Crater in 1891, what assumptions did he make about the resulting evidence from an impact crater?

- iron impactor (meteorite) was roughly same size as resulting crater
- huge meteorite buried under crater floor detectable with magnets
- less material ejected outside hole than the capacity of the hole

2. What did he find?

- small iron meteorites
- lack of volcanic rocks
- no magnetic pull
- similar amount of ejecta as cavity of crater

3. What did he conclude about the crater's origins?

- Not from an impact – volcanic origin

4. What part of his theory was wrong?

- the meteorites were symmetrically dispersed with the crater, not randomly distributed
- the meteorite was smaller and created more of an impact than he had imagined, vaporizing on impact.
- No explanation for why no volcanic rocks in area.

5. Why was he mistaken?

- He could find no evidence of a large meteorite buried under the surface

Gilbert believed in **gradualism** (the hypothesis that evolution proceeds chiefly by the accumulation of gradual changes) as did most scientists of the time, and wasn't ready to accept that a sudden event could cause such a change to Earth's surface.

6. What part of his theory was right?

- no meteorite under the surface

Daniel Barringer

1. When Daniel Barringer presented his pro-impact arguments to the 1906 and again in 1909 to the Academy of Natural Sciences in Philadelphia, what pieces of evidence did he present? (Slideshow states these quickly so you may want to replay 4:30 to 4:52 several times.)

- finely pulverized silica
- magnetic iron oxide in shape of shale balls
- random mixture of meteoritic materials and ejected rocks in symmetrical pattern around crater
- overturned rock beds
- absence of volcanic rocks in vicinity

2. What part of this theory was wrong?

- meteorite was much smaller
- destroyed on impact
- both above mistakes are based on his misunderstanding about the amount of energy released at extremely high-speed impacts

3. Why was he mistaken?

- He thought the crater would be about the same size as the hole. He didn't take into account the effect of speed on the impact.

- He thought there would be a huge chunk of meteorite under the surface. He didn't understand that the heat and shock generated from the impact blasted the impactor to small fragments.

- He was also hoping to make money by mining it, so he had a vested interest in finding such a rock. In addition he persuaded many of his friends and members of his social circle to invest (not an impartial observer - his whole family fortune was invested in the mining venture, and if he had admitted he was wrong, he could have destroyed his reputation and social standing)

4. What part of his theory was right?

- The crater was formed from an impact.
- meteor impacts make circular craters
- the evidence of shocked rocks, meteorites, and overturned rock beds were due to the impact

Scientific Discoveries: What scientific discoveries helped the scientific community conclude that the crater had an impact origin? Describe 3 discoveries.

1. 1907 Gifford: Force of the impact -Meteorite vaporized on impact, most impact angles result in circular crater

2. 1907 Merrill: Metamorphosed sandstone at Barringer Crater formed from meteorite impact

3. 1928 Moulton: Calculated the amount of energy generated from an impact event and concluded impacts are smaller than previously assumed and created such energy that the meteorites were vaporizing on impact

4. 1960s Scientific Community: Craters are round and the craters on the moon are mostly from an impact origin.

5. 1963 Shoemaker: proved shock transformation of quartz into coesite and stishovite is result of meteorite impact (or nuclear blast)

Full Class Reflection on the scientific process, on the strengths and weaknesses of the scientists' thinking about the crater.

Strengths - observation, data collecting, experimenting/modeling

Weaknesses - assumptions about the Earth's surface, biased toward conclusion

What is revealed about scientific thinking? When we do experiments or make assumptions, what should we be mindful of? (This is the big AHA moment!!!)

The great challenge is to be objective toward the subject and open to new ideas that may contradict our assumptions. This is an ongoing challenge for all scientists… to not believe everything they assume and continuously look at evidence to confirm or revise their positions.