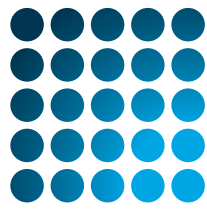


Ice Drilling



ICECUBE

Background

The IceCube project at the South Pole has transformed a cubic kilometer of ice into the world's weirdest and largest telescope. Light sensors in the ice track particles from outer space that pass through the Earth. Most of these amazing messengers known as neutrinos pass right by without being seen. A few unlucky ones hit the nucleus inside an atom near the IceCube detector. When this happens, a new particle is produced. It gives off a small amount of light that can be seen with very sensitive electronic eyes. There have been 86 holes melted in the ice at the South Pole, each about 60 centimeters in diameter, and 2450 meters deep! Each hole produces about 200,000 gallons of water. A string of 60 electronic eyes is placed in each water-filled hole. The water refreezes locking the eyes in place.

The IceCube project uses hot water to melt holes in the ice. It takes about 40 hours to melt one hole at the South Pole. Your job for this activity is to see how long it takes to melt a hole in your ice block. While you are doing this, think about why the holes are melted in the ice rather than being made with a mechanical drill. Which do you think is faster? How could you test your ideas?

Directions

1. Cut the milk jugs just below the handle as shown.
2. Fill milk jugs with water and freeze at least overnight, preferably over the weekend if time allows.
3. Remove the plastic so that you have a clear ice block; running warm water over the plastic works nicely.
4. Place ice blocks in baking pan to catch any water.
5. Measure the height of the ice block.
6. Fill pitchers and spray bottles with warm water.
7. Measure the temperature of the water.
8. Have students experiment by squirting the ice blocks with the syringes and spray bottles and seeing how long it takes to melt a hole through the ice.
 - Does the temperature of the water matter?
 - Is it better to squirt the water slowly or as quickly as possible?
 - Does the rate at which you squirt the water change the diameter of the holes?
 - Does the type of 'drill' make a difference? Are there other drills that you think would work better?



Discussion

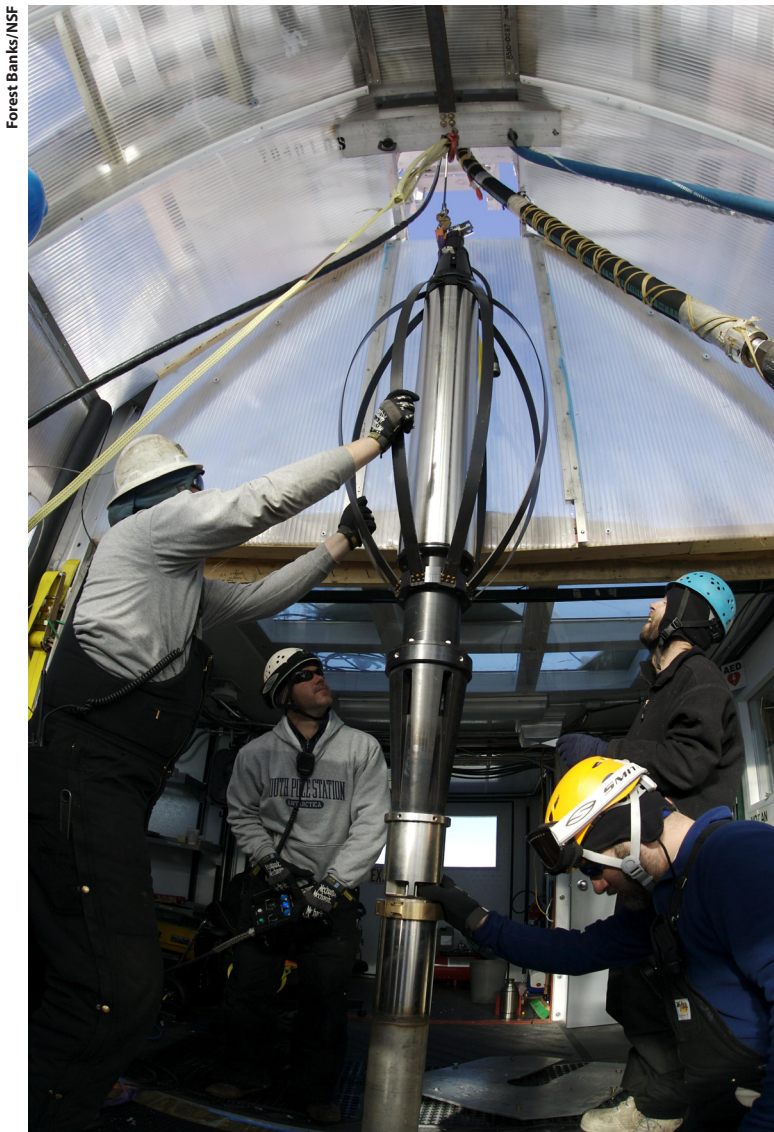
- Did you think it would be easy or hard to drill through ice only using water?
- What tools did you expect to use to drill through the block of ice?
- How much warm water did you think it will take to make a hole through your block?
- What tools work best? How fast did you drill? At that rate, how long would it take to drill down 2,500 meters at the South Pole?
- If it takes 40 hours to make one hole at the South Pole, how do you think they keep the water hot?
- Where do they get the water to drill the holes at the South Pole?
- Which is more dense, water or ice? If you melt ice all the ice that was originally in your jug, and pour just this water back into the jug, will the jug be full, be under-filled, or will there be excess water?

Extensions

- Monitor the temperature of the runoff water exiting the hole and compare to the starting water temperature from the syringe or spray bottle. How much heat did the water lose?
- Put chunks of different material on top of the ice blocks (rock, iron, a coffee cup filled with hot water, etc) What happens? Which does more melting?
- Calculate the thermal energy of the ice block and the thermal energy of the pitcher of warm water. How many pitchers of warm water would it take to melt all the ice?
- Run a bare wire over the ice block, and hang heavy weights on either end. Explain what you see happening.
- Have a race to drill a hole; the teacher should use salt water.

Notes

- It is best to have no more than four students to a block of ice.
- A small waste basket also works well to make the blocks of ice as long as you have enough room to freeze it.
- Syringes can be found at local pharmacies or ordered from medical supply companies.



Forest Banks/NSF



Lavel Baque/NSF (2)



Left: IceCube drillers prepare the hot water drill.
Above: Experimenting with hot water drilling at an IceCube outreach event.