SCIENCE FILE

Diamonds yield Earth's deepest secrets

Chemical clues in giant gems suggest the planet has metal far down in its mantle.

DEBORAH NETBURN

Some people see a giant diamond and think: I want that. Geologist Evan Smith sees a giant diamond and thinks: I'd like to study that.

"Some of the diamonds I've looked at are probably worth multiple millions of dollars, but I'm not wowed by the price tag as much as by the fact that they come from so deep in the Earth," he said.

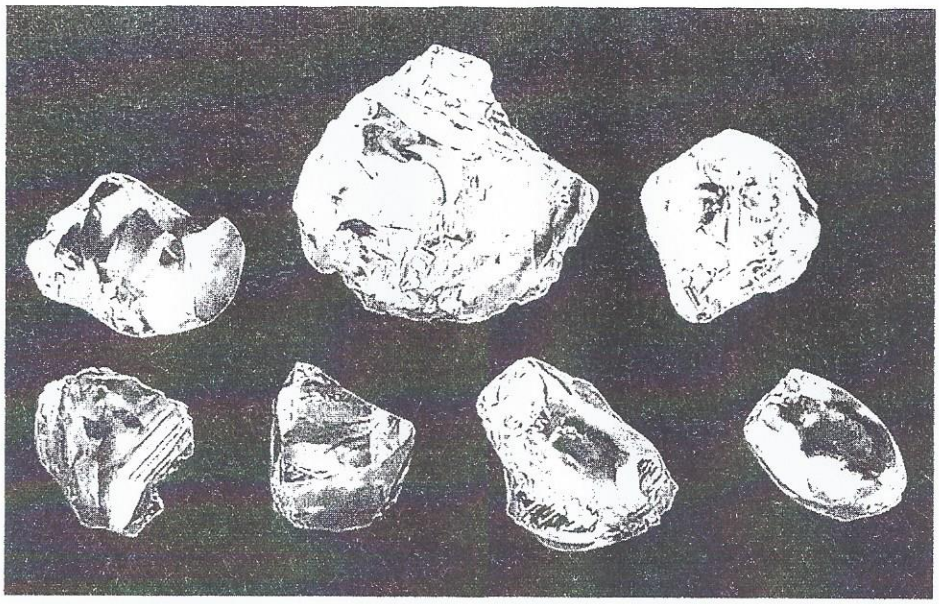
Smith is a research fellow at the Gemological Institute of America in New York City, where he has been studying a rare type of diamond known for being exceptionally large, especially pure and outrageously expensive.

These unusual diamonds — including the 3,106-carat Cullinan diamond, which is part of the Crown Jewels of England — have long been thought to have formed in different circumstances than most other diamonds on our planet.

In a paper published in Science, Smith confirms this hypothesis and reveals the first physical evidence that the Earth's deep mantle is peppered with metal.

"We usually think of this layer as being just rocky material, but these diamonds are telling us that it's not just rocks down there," he said.

Scientists' knowledge of the deep Earth is limited, in part because they have never been able to see it for themselves.



ROBERT WELDON AND GEM DIAMONDS L

UNCUT DIAMONDS from the Letseng mine in Lesotho. Non-diamond material embedded inside large gems, seen by aficionados as imperfections, give scientists hints about layers of the Earth too deep to explore.

"We can drill holes, but that's limited to just a few miles," Smith said. "In terms of getting physical pieces of rock from there, that's really out of the question."

Most diamonds come from depths of 90 to 120 miles beneath the Earth's surface, Smith said. The only reason they are accessible to us today is because they traveled up through the crust millions of years ago, carried along by rare and powerful volcanic eruptions.

But chemical clues culled from the Cullinan diamond and others like it suggest they were forged at even greater depths than most diamonds — about 224 to 446 miles beneath our feet.

Diamonds themselves don't reveal much about their place of origin, Smith said. So in order to learn about the chemical environment of the deep Earth, he had to look for tiny bits of non-diamond material that got embedded inside these special, super-deep diamonds when they formed. Scientists call these inclusions.

Most diamond aficionados consider inclusions imperfections, but to Smith they are the most valuable part of the gem.

"Studying a diamond's inclusions tells you where it came from and how it formed," he said.

But finding inclusions in Cullinan-like diamonds is not easy.

The first hurdle is simply that it's hard for most scientists to get their hands on diamonds of this size. Because they are so rare and worth so much money, they usually wind up in the hands of royalty or the uber-rich, not geologists investigating the Earth's inner layers.

Smith surmounted this obstacle by teaming up with the Gemological Institute of America, a nonprofit organization that works to uphold the public trust in gems and jewelry in part by diamond grading.

"This is the perfect place to find rare diamonds because of the stream coming through here for grading," Smith said. "A big part of the study was looking at the ones coming through, and borrowing them for a few hours to observe them with a microscope."

The other challenge is that these types of diamonds don't have many inclusions, which means you have to look at a lot of them to find ones that have useful chemical information.

Through patience and perseverance, Smith eventually analyzed 53 inclusions in these rare diamonds.

Smith's work suggests that these extra-large diamonds form from a liquid that includes iron, nickel, carbon and sulfur as well as trace amounts of other materials.

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>
> — EVAN SMITH, geologist speaking about rare diamonds

And because some of those materials are possible only at extremely high pressures, Smith concludes that these diamonds formed at tremendous depths in the Earth's mantle.

Together, these two observations suggest that there is metal deep in the mantle.

"It's something that has been predicted based on theories and experiments, but now we have physical evidence of this deep metallic iron in the Earth," Smith said.

But Smith's work with giant diamonds isn't over yet.

In the future, he'd like to determine what other elements are found in the metal soup out of which the diamonds formed, and to see if analyzing the chemical fingerprint of the carbon or sulfur trapped in the diamonds might tell him where those materials come from.

"We're just kind of getting started here," he said.

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1) Based on the title of this article, what do you think it is about?

2) What 3 characteristics do the diamonds in the study share?

3) How many carats is the Cullinan diamond and who owns it now? a_____ b_____ (2 pts.)

4) How deep in the earth do most diamonds form? a_____ to b_____ miles. (2 pts.)

5) How do the diamonds get to the surface?

6)Between what ranges of depth did the large diamonds form? a_____ to b_____miles. (2 pts)

7) What is an inclusion?

8) How many inclusions were found in the diamonds studied?

9) The liquid that formed these diamonds contained what other elements?

10) What was the date of this article?

Bonus: Add together the following answers and total the values of those responses!

#3a, 4b, 6a, 8, & 10 (month and day only)