



Ancient Impact Turned Part of Earth Inside-Out

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posted: 12:25 pm ET
04 June 2004

A space rock the size of a large mountain hit 1.8 billion years ago and dredged up part of Earth's lower crust, essentially turning a bit of the planet inside out, a new study concludes.

Earth's upper crust is about 22 miles (35 kilometers) thick. Scientists have debated how deeply into the crust the shock wave from a large asteroid could penetrate. All the way to the next layer, it appears.

The evidence comes from a crater in Sudbury, Ontario. Most of the crater was long ago folded into the planet or eroded away. But a section is exposed, revealing minerals and other features that can be compared to more recent craters that are more intact. From all this, scientists gleaned clues to the catastrophic impact.

It appears an asteroid about 6 miles (10 kilometers) wide hit the planet at more than 89,000 mph (40 kilometers per second).

"The impact punched a hole to the very base of the crust and the meteorite itself was probably vaporized," said University of Toronto geologist James Mungall, who led the study. Much of the heating and damage is done by a shock wave that compresses material ahead of the impacting object.

A plume of superheated rock from deep down surged upward and landed on top of the impact site, creating the melt layer visible today.

In a telephone interview, Mungall explained that in the top layers of the Sudbury structure, his team found relatively high concentrations of iron, nickel and platinum, stuff that is more common in the lower crust of the planet than in the upper crust (the elements exist in just trace amounts in both regions). The lower crust sits atop Earth's mantle, which surrounds the core.

"Since it ended up on top, it effectively inverted the layering of the crust," he said. "It had not really been appreciated that large impacts would selectively move material from the bottom of the crust up to the top."

The top layers were also relatively depleted of zirconium, uranium and other elements that tend to show up in other impact sites that only involved melting of the upper crust.

The results were detailed in the June 3 issue of the journal *Nature*.

Mungall's team also found an enrichment of iridium in the overlying layer at the Sudbury complex, which was already thought to be part of an impact crater. Iridium is commonly associated with extraterrestrial rocks and is a strong indicator of an impact. The crater was initially more than 125 miles (200 kilometers) wide.

The study was funded in part by the Ontario Geological Survey and the Geological Survey of Canada.