Deep crust hints meteoritic impact

Scientists who recently compiled a map of density distributions in the crust under North America report that a circular feature stretches 2,800 kilometers across the northern part of the continent. At the very least, the gravity anomaly data leading to the map reveal a fundamental feature of the continent's crust. But the circular feature's age and similarity to impact scars on the moon and other planets suggests that it may have formed after a meteorite struck the earth early in its history.

The feature is not a visible crater, but its origin may be related to a swarm of meteorites that bombarded the moon and other planets in the solar system about 4 billion years ago. Until then, it is thought, no land masses marred the earth's watery face. In what they cautiously call a "hypothesis" the scientists speculate that an impact 3.9 to 4.0 billion years ago may have triggered evolution of the ancient continental shields. The work was done by John Klasner of Western Illinois University in Macomb, William Cannon of the United States Geological Survey and Klaus Schulz of Washington University in St. Louis.

The idea that the earth also endured a period of large-scale bombardment by meteorites early in its history is far from new. Until now, however, the earth's crust revealed no evidence of such activity. If impacts did occur, subsequent movement of continents, thermal activity, mantle convection, weathering and erosion were thought to have obscured or destroyed impact scars.

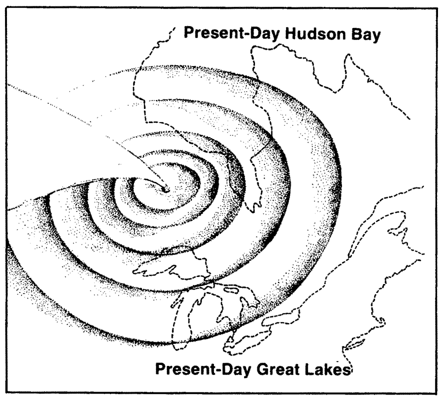
"The pattern is not simply a reflection of surface geology, but a distinctive signature" on the lower part of the crust, Schulz said. A circular pattern enhanced by concentric rings radiates from the feature's center. The surface geology also bears out a circular motif: Younger rocks, about 1.8 to 2.4 billion years old, rest in the zone of gravity anomalies second from the feature's center, while some of the oldest known rocks, about 3.8 billion years old, are found at the edge of the outer ring.

"One analogy that came to us was the maria basins on the moon or any of the other major impact scars on other planets," Schulz said. Like the terrestrial feature, maria basins, or ringed lunar basins, are associated with gravity anomalies and fracture patterns with rings going outward from the centers. The analogy is not exact, Schulz said, because the earth's crust evolved differently from the moon's.

The terrestrial feature is centered over the Superior Province of the Canadian Shield. It extends north from Hudson Bay, which presents its own gravity anomaly that overprints the deeper feature, south into Michigan. On the east it is bounded by the Grenville rocks along Canada's coast, and extends west into Saskatchewan.

Earlier geologic models by Schulz and Paul Weiblen of the University of Minnesota, and by Richard Grieve of the Department of Energy, Mines, and Resources in Ottawa, Canada, suggest that a meteorite impact that could form a crater 1,000 kilometers or more in diameter would have fractured the crust and could produce a gravity anomaly such as that observed over the Canadian Shield. The original crater underlying the North American feature, scientists think, may have been 850 to 1,400 kilometers in diameter. The most intense and long-lived thermal activity would have occurred in the fractured crust and within the innermost ring, while areas outside the region would have cooled and stabilized sooner after the impact than melted material near the center. This would explain the difference in ages of rocks associated with the ringed zones.

"The earth is a very strange planet because it is the only planet that we know of that has continents," Grieve told SCIENCE NEWS. If one accepts that premise, he said, the impact idea has merit. "The impact disrupts the crust of the earth locally, adds energy, produces a big thermal anomaly,



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and allows you to concentrate a lot of geological activity in a small area, leading to continental growth. ... A crustal feature like this one across North America might reflect the original presence of a large impact basin."

Schulz said the feature had not been recognized before simply because no one had taken the time to assemble the gravity data for North America. The next step, he said, is to study gravity maps of other continents to learn if any display similar features. So far, he said, response to the idea has been mixed. Some colleagues are excited by possible evidence that impacts by large bodies influenced earth history. Others are "highly skeptical" because the hypothesis borders on catastrophism. "This doesn't destroy the uniformitarian concept of how earth processes operate, but we are starting to realize that single or very short-lived events can occur that can have a profound effect," he said. Scientific papers presenting the data in detail are being reviewed prior to publication. The research is funded by Washington University and the USGS. —*C. Simon*

Bridges over troubled waters

Every time it rains it rains, if not pennies, particles of copper — as well as nickel, iron, zinc, chromium and lead — into bodies of water under highway bridges. Lead, with the highest toxicity and concentration, has state and federal highway officials most concerned. In one lake near Orlando, Fla., 13.5 kilograms each year are dumped from a single bridge, reports an environmental engineer at the University of Central Florida.

Yousef A. Yousef, who spoke at the annual meeting of the Transportation Research Board held in Washington, D.C., last week, summarized his research at various sites in central Florida. He found high concentrations of heavy metals not only in bridge runoff, but also in bottom sediments, plants and benthic animals beneath bridges with plastic scupper drains. Total lead concentrations were as high as 1,558 μg/l in runoff water and 75 μg/l overall in the lake. These values exceed the 50 μg/l maximum surface water concentration recommended by the U.S. Environmental Protection Agency and Florida Dept. of Environmental Regulation for the protection of human health.

Particles of heavy metals, coming from oil drippings, tires, highway paint, auto exhaust and other sources, are swept to the side of bridges and washed through drains in a rain storm. Mostly remaining in particulate form, the metals sink to the bottom before they can be dispersed. Lack of dispersion allows pollutants to build up in sediments in the vicinity of the bridge. Yousef found sediment concentrations of heavy metals to be twice as high under bridges with scupper drains as under those without them and concentrations of lead to be three times as high. Although sample sizes were very small, the concentrations found in algae, submerged plants, worms, snails and other organisms showed similar trends.

While the full biological impact of bridge runoff is not yet known, levels found in the biota so far are a bad sign. All of the metals tested, which become more concentrated as they move up the food chain, are poisonous to humans and other animals in high concentrations. Lead may have long-term detrimental impacts even at very low levels (SN: 3/8/80, p. 154). Yousef told SCIENCE NEWS that although "these [impacts] have not been quantified," fewer individuals and species of animals were found under a bridge with scupper drains compared to one on the same lake without them.

Yousef plans a three-year study, funded by the federal and Florida departments of transportation, of alternative bridge designs. Most promising is directing bridge runoff to adjacent floodplains, already being done on some bridges. —*L. Tangley*