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EARTH'S EARLY EVOLUTION

When did terra firma firm up? And what happened to it once it did?

These are among the great unanswered questions in earth science. Prevailing wisdom holds that the bulk of Earth's continental crust didn't form until at least 2.5 billion years after Earth's birth. And like scum floating on the surface of a bubbling broth, this early crust was too buoyant to founder into Earth's interior, melt and be recycled into the raw material for new crust. According to this view, most, if not all, of the continental crust ever formed is still present on the surface in one form or another, as it has never been recycled in the mantle.

Now, however, new research suggests otherwise. According to Samuel Bowring of the Massachusetts Institute of Technology and Todd Housh of the University of Texas, most continental crust formed shortly after Earth itself, within its first 500 million years. Moreover, the scientists say this early crust, as well as much of the continental crust formed afterward, has been continually recycled to become the land we walk upon today.

Few fragments of very old crust (older than 3.0 billion years) have been found. Thus many geologists believed that the young Earth had little or no crust at all early on. But Bowring thought a lot of old rock is probably still around but just hasn't been found. To check his hunch, Bowring and Housh analyzed isotopes of samarium and neodymium in rocks from northwestern Canada that date back 4 billion years.

The geochemical record from these rocks suggested the mantle has been altered by the addition of continental rock since Earth's early history. Also, the isotopic composition of the rock indicated that it formed when molten material from the mantle, modified by past additions of continental crust, rose up toward the surface and mixed with pre-existing continental rock. (Bowring points out that this process occurs today when crust plunges beneath a continent at a subduction zone: Molten rock from the mantle arrives at the base of the overlying continental crust and mixes with it.) According to Bowring, the Canadian

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rocks are survivors that record this mixing. The rest of the crust present back then has since been plowed back into the mantle.

Bowring suspects a mechanism similar to modern-day plate tectonics dragged ancient crust down into the mantle. He acknowledges this challenges the view of many that plate tectonics did not operate early in Earth's history. "But," he says, "the burden of proof is on them."

PHOTO (COLOR): The locations of the world's oldest rocks are shown in dark colors. Hew work on 4-billion-year-old rocks from Canada (star) is helping revise ideas about the early days of our planet.

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By Roslyn M. Dupre

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