Solving the Midwest's biggest geologic mystery

March 11 2014, by Megan Fellman

Kayakers on Lake Superior in the Apostle Islands National Lakeshore, paddling along rocks deposited late in the evolution of the Midcontinent Rift. Credit: Seth Stein

(Phys.org) —Geologists from Northwestern University, the University of Illinois at Chicago, the University of Oklahoma and Purdue University have a new explanation for the Midwest's biggest geologic mystery: What caused the giant 2,000-mile-long rift that starts in Lake Superior and runs south to Oklahoma and Alabama?

Using new data from the North American Midcontinent Rift and

observations of rifting occurring today between Africa and Arabia, the scientists propose that the Midcontinent Rift formed when rocks now in South America rifted away from North America, forming a new ocean. As a result, rocks from the two sides match like pieces of a jigsaw puzzle.

The study was published March 5 in the journal *Geophysical Research Letters*.

A little more than a billion years ago, North America started to split, and 350,000 cubic miles of volcanic rock poured out. These rocks formed the valley that Lake Superior filled, and thick rock layers are exposed in the rift's northern reaches but are underground elsewhere. The rocks of the Midcontinent Rift can be traced for thousands of miles underground because they are dense and highly magnetized.

"Although the rift made the Midwest's best geology and scenery, we've never had a good explanation for what caused it," said the study's lead author, Carol A. Stein, professor of Earth and Environmental Sciences at the University of Illinois at Chicago. "The best we could do was to say that a plume of hot stuff came up under North America, for some unknown reason, and then stopped. That was never a satisfying explanation."

To solve the puzzle, the geologists looked at a similar geologic feature forming today, the East African Rift that is splitting up Africa, causing the huge rift valley and volcanoes like Mount Kilimanjaro.

"The rift system is splitting Africa and rifting Arabia away from it, forming new ocean basins in the Red Sea and Gulf of Aden," explained Seth Stein, the William Deering Professor of Geological Sciences at Northwestern's Weinberg College of Arts and Sciences. "We see the same thing at other times in the past—rifts form and break continents

apart. Once rifting succeeds in forming a new ocean, the leftover piece of rift shuts down. This seems to be how the Midcontinent Rift formed."

Detailed mapping of the underground Midcontinent Rift using gravity data from G. Randy Keller, professor of geophysics at the University of Oklahoma in Norman and director of the Oklahoma Geological Survey, shows that the rift extends much farther than had been previously thought.

"It's not just in the middle of the continent—it goes all the way to what was then the edge of the continent," Keller said.

After putting the lines of evidence together, Carol Stein said, "The whole story now makes sense. We used to think of the Midcontinent Rift as this weird feature that started and died in the middle of a continent. Now we realize it formed as part of the rifting that split rocks now in South America off from North America. So instead of being a mysterious special case, we realize it formed in a way that's familiar to geologists and what we see today and in the past. That's gratifying because scientists hate to invoke special cases."

The study is part of the National Science Foundation's EarthScope program, in which geologists from across the U.S. are studying how North America formed.

Seth Stein, one of EarthScope's organizers, said, "This is the kind of big advance we were hoping for. You can never predict breakthroughs, but when good people work together they often happen. It's great that we got one for the Midwest because sometimes people think that exciting geology only happens in places like California. We hope results like this will encourage young Midwesterners to study geology and make even further advances."

More information: Stein, C. A., S. Stein, M. Merino, G. Randy Keller, L. M. Flesch, and D. M. Jurdy (2014), "Was the Midcontinent Rift part of a successful seafloor-spreading episode?", *Geophys. Res. Lett.*, 41, DOI: 10.1002/2013GL059176.

Provided by Northwestern University