Midcontinent heat may explain great quakes

While most North Americans think of California as "The Earthquake State," three of the largest tremors in U.S. history struck the nation's heartland near New Madrid, Mo., during the winter of 1811-1812. Why such massive jolts should rock the continent's otherwise stable center has long puzzled geologists. This week, two researchers proposed that excess heat under the New Madrid region may explain its seismic unrest, which is expected to continue in the future.

At a meeting of the American Geophysical Union in Baltimore, Lanbo Liu and Mark D. Zoback of Stanford University suggested that heat in the mantle underneath the New Madrid area has weakened this portion of the North American plate, making it more susceptible to earthquakes.

"On the basis of our calculations, the strength of the New Madrid seismic zone is much, much less than in the surrounding region," Liu says.

Most earthquakes occur along the edges of the dozen large tectonic plates that cover Earth's surface like a cracked egg shell. When two plates crash together as in the Himalayas, or when they grind past each other as in California, their margins absorb the brunt of impact, leaving the stronger interior land undeformed.

In U.S. history, large jolts have rattled only two sites within the stable eastern half of the North American plate: the New Madrid area and Charleston, S.C., which although on the coast lies several thousand kilometers from the plate boundary in the mid-Atlantic. The three New Madrid quakes had estimated strengths of magnitude 8.0 or greater; an 1886 Charleston quake had an estimated strength of 7.8. For every one-point increase in magnitude, the power of an earthquake increases 30-fold.

Geologists traditionally seek to explain such intraplate earthquakes by focusing on weaknesses within the crust. By this thinking, previous tectonic injury in a particular location would fracture the upper crust there, predisposing the plate to break again in the same spot. New Madrid, for instance, sits atop a scar formed 600 million years ago after a great rent started, but failed, to rip the North American plate in two.

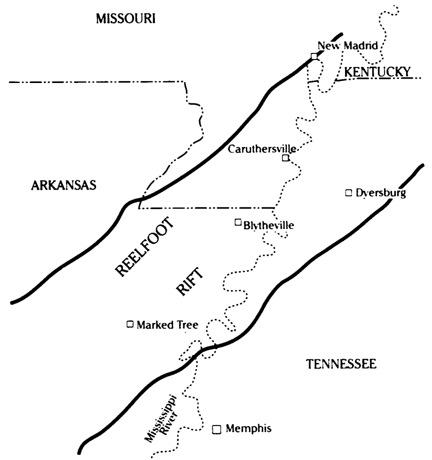
Liu and Zoback took a different approach by considering the upper mantle, which forms the underside of the plate. In most of eastern North America, the upper mantle is relatively cool and stiff; it provides a strong layer that keeps the plate from breaking under the tectonic force pushing North America away from Europe. But in the New Madrid area, they suggest, the mantle is too hot and malleable. Without the support of a strong mantle, the crust in this region cannot stand up to the force, so it breaks and causes earthquakes.

According to Liu and Zoback, several lines of evidence suggest the mantle underneath New Madrid is warmer than surrounding areas. Heat coming out of the crust averages 58 milliwatts per square meter near New Madrid; heat flow values in other areas of the eastern United States average 20 percent lower.

Seismic waves passing through the lower crust underneath New Madrid move slower than elsewhere, providing another indication that the upper mantle has excess heat, Liu says.

Lastly, he cites evidence that molten rock rose up into the crust underneath the New Madrid region 40 million years ago, relatively recent by geologic standards. Heat from that volcanic episode would have lingered in the mantle even until today, he says.

The new theory would explain measurements reported last year by Liu and others, showing that the New Madrid region is being squeezed at an extremely high rate. While the plate tectonic forces push on the entire eastern United States, New Madrid compresses more than others because the lower part of the plate can't support the force, Zoback says.



New Madrid, Mo., was hit by huge quakes in the past. Small jolts continue in a seismic zone running from Marked Tree, Ark., past New Madrid. Solid lines show borders of this ancient rift.

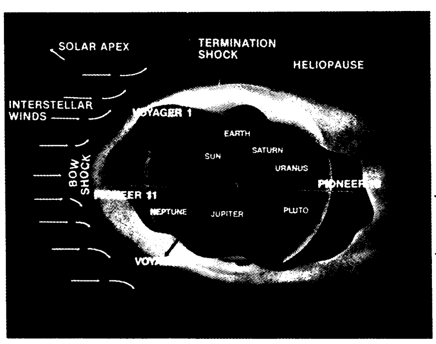
– R. Monastersky

Mysterious radio bursts hint at heliopause

Hurtling through space a few billion kilometers beyond Neptune and Pluto, two aging spacecraft have recorded intense bursts of radio waves that may originate from the very edge of the solar system. If verified by further analysis, the bursts will provide a new way to gauge the size of the solar system, as well as reveal the structure of the heliopause – the proposed boundary between the solar system and interstellar space.

The radio emissions, detected by Voyagers 1 and 2, peaked in intensity in December. Their discovery marks a new era of exploration for the nearly 16-year-old probes, best known for their close-up portraits of Jupiter, Saturn, Uranus, and Neptune. Voyager 1 is now 52 astronomical units (AU) from the sun (one AU equals about 149.6 million kilometers), while Voyager 2 lags behind at 40 AU.

Since July 1992, the craft have recorded radio emissions from an unknown source whose total power exceeds 10 trillion watts. These bursts have about two to 30 times the intensity of an equally puzzling group of bursts detected by the Voyagers in 1983 and 1984, says Donald A. Gurnett of the University of Iowa in Iowa City, and may represent the most powerful radio source in the solar system. However, the bursts are too low in frequency to penetrate the solar system's sea of charged particles to reach Earth.



NASA/Jet Propulsion Lab.

Drawing shows location of spacecraft now probing the outer solar system.

Gurnett, William S. Kurth of the University of Iowa, and their colleagues reported the findings in Baltimore this week at an American Geophysical Union meeting. They trace the radio emissions to events that began in May 1991. A series of large solar flares erupted then, accompanied by an explosive release of gas into the solar wind, the stream of charged particles emanating from the sun.

Three months after this explosive release, the two Voyagers and the Pioneer 10 craft recorded a sudden drop in the intensity of cosmic rays – high-energy particles from outside the solar system. One explanation for the falloff is that the enhanced solar wind deflected the cosmic rays. The time lag between the flare activity and the cosmic-ray decline suggests that the solar wind traveled at a speed of 600 to 800 kilometers per second, compared to the 400 km/sec speed of the average solar wind, John A. Lockwood of the University of New Hampshire in Durham and William R. Webber of New Mexico State University in Las Cruces calculate in the May 1 Journal of Geophysical Research.

Eventually, Gurnett suggests, the bulk-