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Detection of Geologically Recent Deformation Near the Northern Terminus of the New Madrid Seismic Zone, Using High-Resolution Seismic Reflection and Drill Hole Information@

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**ABSTRACT**

This investigation was carried out to determine the cause of a swarm of earthquakes that occurred in 1984 on the Ohio River near Olmsted, near the southern tip of Illinois. More than 150 earthquakes were recorded over a period of several weeks, the largest registered a magnitude of 3.6 and was felt in three states. The epicenters plot to an ellipse with the long axis running northeast, parallel to the river and centered at Lock & Dam 53.

Analysis of existing outcrop and borehole data, including logs of water wells, oil-test boreholes, and core drilling done by the U.S. indicated a zone of faults trending northeast toward the 1984 earthquake cluster. To investigate further, we conducted a series of high-resolution seismic reflection surveys on both sides of the Ohio River and drilled two continuously cored boreholes 76 and 150 m deep.

The new data indicate faulting is far more pervasive than previously suspected. Intricate zones of high-angle normal and reverse faults strike north-south to NNE-SSW and outline horsts and grabens. Several episodes of movement are evident, including either strike-slip or reversals in the direction of displacement. The largest offsets took place during the Cretaceous Period, evidently triggered by uplift of the Pascola Arch and subsequent foundering of the arch to form the Mississippi Embayment. These fault movements were accompanied by deep-seated igneous intrusion and hydrothermal activity that altered and silicified Paleozoic bedrock. As a consequence, bedrock of the Olmsted area has been weakened - along a trend directly in line with the northeast-trending Aprong@of the active New Madrid seismic zone. The 1984 earthquake swarm probably was triggered by right-lateral reactivation of one or more ancient N-S or NNE-SSW trending fracture zones in hydrothermally altered bedrock. This seismic activity is another event in the ongoing tectonic readjustment of the central Mississippi Valley.