Final Technical Report

Reducing earthquake losses in the Central US through incorporation of strain rate data from GPS in hazard estimation.

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This grant supported analysis of the GAMA (GPS Array for Mid-America) Continuous GPS data collected between 2000 and 2004 by a Post-Doctoral associtae. The GPS phase data was processed using GAMIT/GLOBK software, IGS orbits and SOPAC h-files. The GPS results, shown in Figure 1, suggested statistically significant motion between two of the sites straddling the Reelfoot fault scarp (Smalley et al., 2005a). These results were extensively debated with an alternate interpretation that the GPS measurements indicate no or insignificant motion between the GPS monuments (Calais et al, 2005) and a rebuttal (Smalley et al., 2005b).

Continuous Global Positioning System measurements were started by the Center for Earthquake Research and Information at the University of Memphis in 1997. By 2000 a network of 11 GPS sites (GAMA) that both surround and straddle active faults within the New Madrid seismic zone had been installed. The GAMA continuous GPS array was built and operated with support from the USGS/NEHRP (first 2 sites in 1997), the MAEC (Mid-America Earthquake Center) and the University of Memphis/Center for Earthquake Research and Information (CERI)/State of Tennessee (the remaining sites). The sites located in the Mississippi embayment, a large southward facing U shaped basin of unconsolidated sediments associated with the Mississippi River that covers the region of the New Madrid seismic zone, use a ‘strong’ monument consisting of a ~20-m-long, 36-cm flange and web H-beam driven vertically into the ground with a ~1-m mast permanently mounted on the top of the H-beam. To prevent very shallow surface effects, such as frost heaving, from affecting the position of the monument, the top ~1m of the H-

beam is decoupled from the shallow soil with a PVC pipe. A choke-ring antenna with a radome is mounted on this mast. The sites outside the Mississippi embayment (outside the area shown in Figure 1) are mounted directly in rock outcrop using a ~3m steel mast, the bottom ~2m of which is cemented into the rock. All data are archived and distributed at the UNAVCO Facility archive.

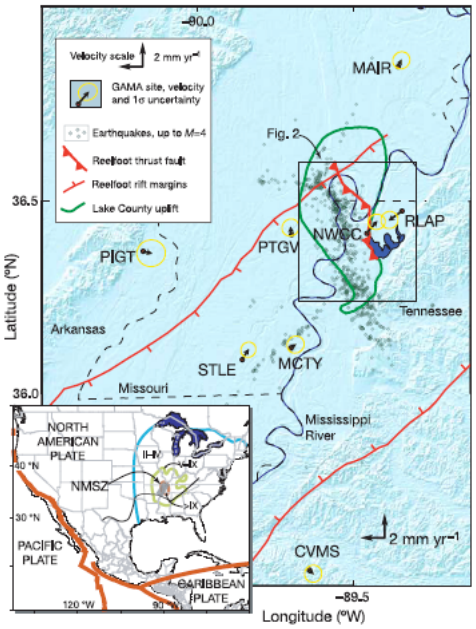

Figure 1 | Velocities and associated uncertainties of GAMA sites in the New Madrid seismic zone (NMSZ). Regional setting of the NMSZ (inset), where plate boundaries (red lines), are clearly remote. The significance of the 1811–1812 and similar earthquakes over the past 10,000 years is shown by reference to contours of intense ground-shaking, quantified by the modified Mercalli intensity scale (Roman numerals). The thick grey line under the region of highest shaking intensity is Reelfoot rift, a failed arm of the Precambrian rifted margin of North America, which is largely coincident with the interior extent of the Paleozoic Appalachian–Ouachita mountain belt (thin black line).

Papers published as a result of this support:

Smalley, R., M.A. Ellis, J. Paul, and R.B. VanArdsale, Space geodetic evidence for rapid strain rates in the New Madrid seismic zone of central USA, Nature, 453, 23, doi:10.1038/nature03642, 1088-1090,2005a.

Smalley, R., M.A. Ellis, J. Paul, and R.B. VanArdsale, Reply to Calais et. al., doi: 10.1038/nature04429/, E10,2005b.

Additional references:

Calais, E., G. Mattioli, C. DeMets, J.-M. Nocquet, S. Stein, A. Newman, and P. Rydelek, Tectonic strain in plate interiors?, Nature, 438, doi:10.1038/nature04428, 2005.