Final Technical Report

Reducing Earthquake Loss in the Central U.S. Through the 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) ContinuousGPS data collected between 2000 and 2006 and set up two additional GPS stations. The GPS phase data was processed using GAMIT/GLOBK software, IGS orbits and SOPAC h-files.

Analysis of GAMA (GPS Array for Mid-America) Continuous GPS data from 2000 – 2004, suggested statistically significant motion between two of the sites straddling the Reelfoot fault scarp. These results were extensively debated with an alternate interpretation that the GPS measurements indicate no or insignificant motion between the GPS monuments. In an attempt to create more input to this debate and be able to tend to converge to a realistic estimate of the New Madrid deformation, we have installed two sites on either side of the reelfoot scarp and also analyzed the data of the gama network from 2004 to 2006 in addition to the data from 2000 to 2004 that was analysed and results published. Both the sites are fully operational since last six months and are logging data at 1 and 30 sec intervals. These two sites were installed in Lake County High School in Tiptonville, TN and New Markam, TN. The monuments are deep drilled braced GPS and are designed to create a highly rigid and immobile structure isolated from surface soil movement and cemented in place at depth. The monument consists of 5 legs (stainless steel pipes) placed into drilled holes, and welded together above the surface to create a “tripod” frame. Of the 5 legs, the center leg is vertical and the 4 other legs are installed at angles to brace the vertical leg.

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

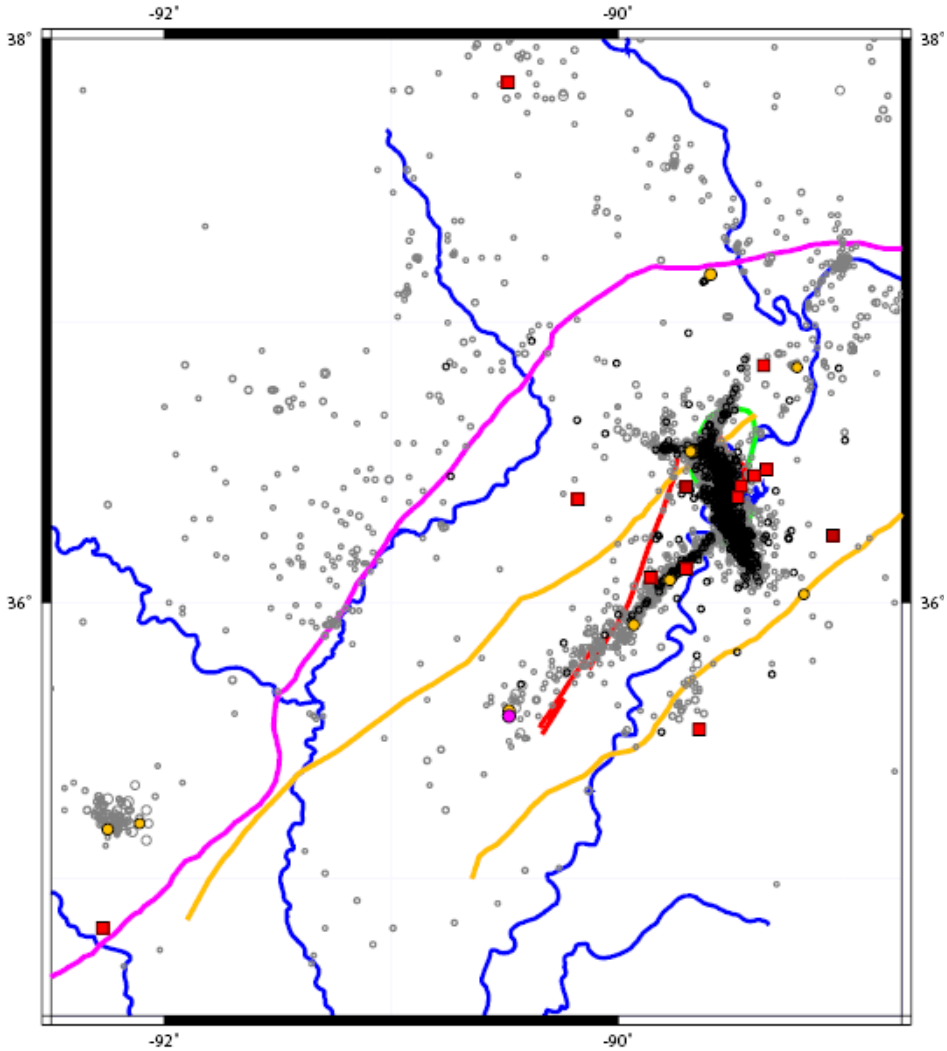

Figure 1- Map showing the locations of the 13 continuous GPS stations (Red squares) of the GAMA network.

the USGS/NEHRP (2 sites in 1997 and 2 sites in 2007), 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 first 11 sites use a 'strong' monument consisting of a ~20-m-long, 36-cm 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 radome is mounted on this mast. The sites outside the embayment are mounted directly in rock outcrop using a ~3m steel mast, the bottom ~2m of which is cemented into the rock. The two new sites installed have Trimble Zephyr geodetic antennas. All sites have been upgraded to Trimble NetRS receivers, and all but one is now on the internet. All sites collect data at 15 sec, 1 sec and 5Hz. All the 15 sec data are archived and distributed at the UNAVCO Facility archive. The receivers are programmed the same as PBO stations with continuous archiving of the 15 and 1 (at CERI) sec epoch data and

triggered downloading and archiving of the 1 and 5 Hz data together with PBO at the UNAVCO Facility.

Data at all the eleven sites in GAMA were processed using GAMIT/GLOBK software using IGS orbits and SOPAC h-files for period from 2000 to 2006. The time series for RLAP, PTGV, NWCC and MCTY are shown in Figure 3a, 3b, 3c and 3d. These time series do not shown any significant signs of increase in reliability of deformation signal. We however do not conclude anything since we have encountered problems in the time series due to the usage of h-files from SOPAC and orbits from IGS. There are cosmetic jumps in the vertical and sometimes in the horizontal. Eric Kendrick of Ohio State University has calculated a set of Orbits and h-files to circumvent this problem and we are in the process of using his orbits and h-files to process the GPS data.

Fig 2: The Deep drill based monument at the newly constructed site at New Markum.

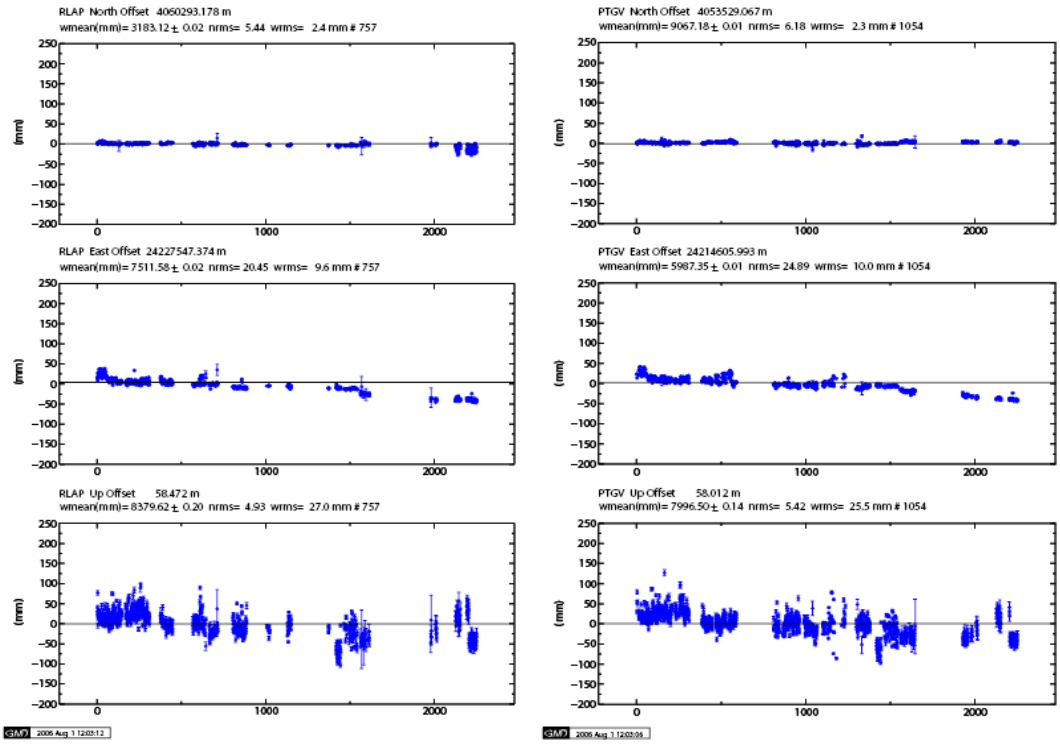

Fig 3(a) and 3(b): Time series of RLAP and PTGV. Note the cosmetic jumps in the vertical. X-Axis is days since 1/1/2000

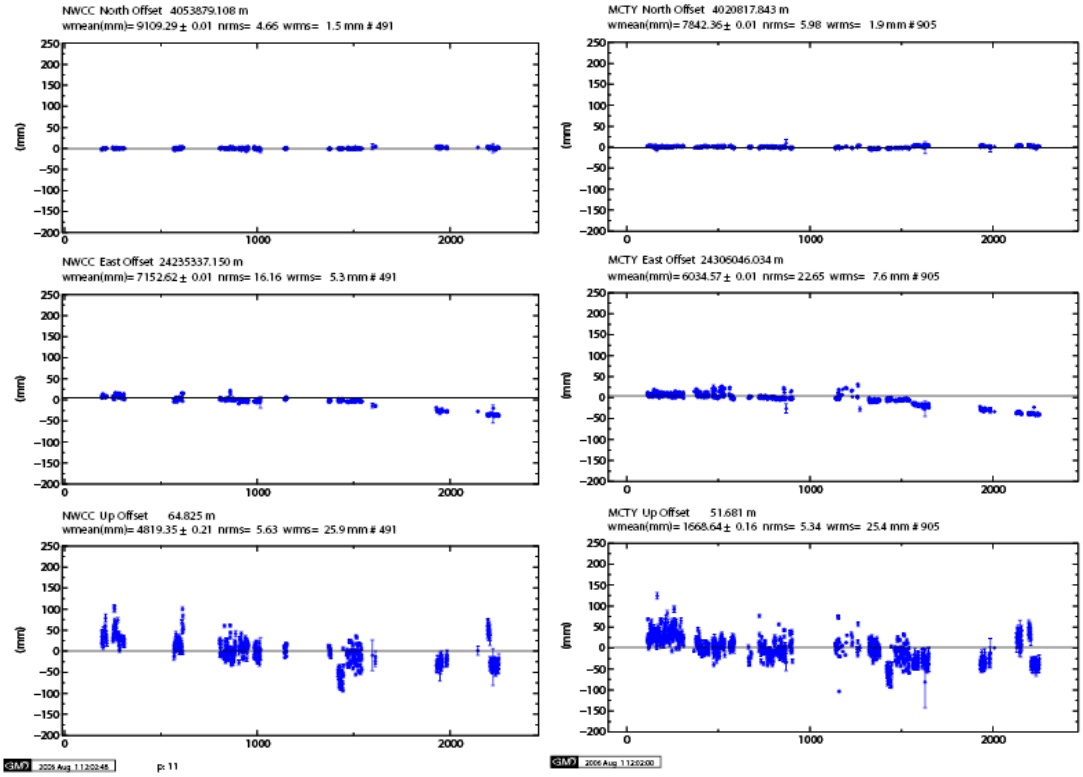

Fig 3(c) and 3(d): Time series of NWCC and MCTY. Vertical jumps are visible here too.

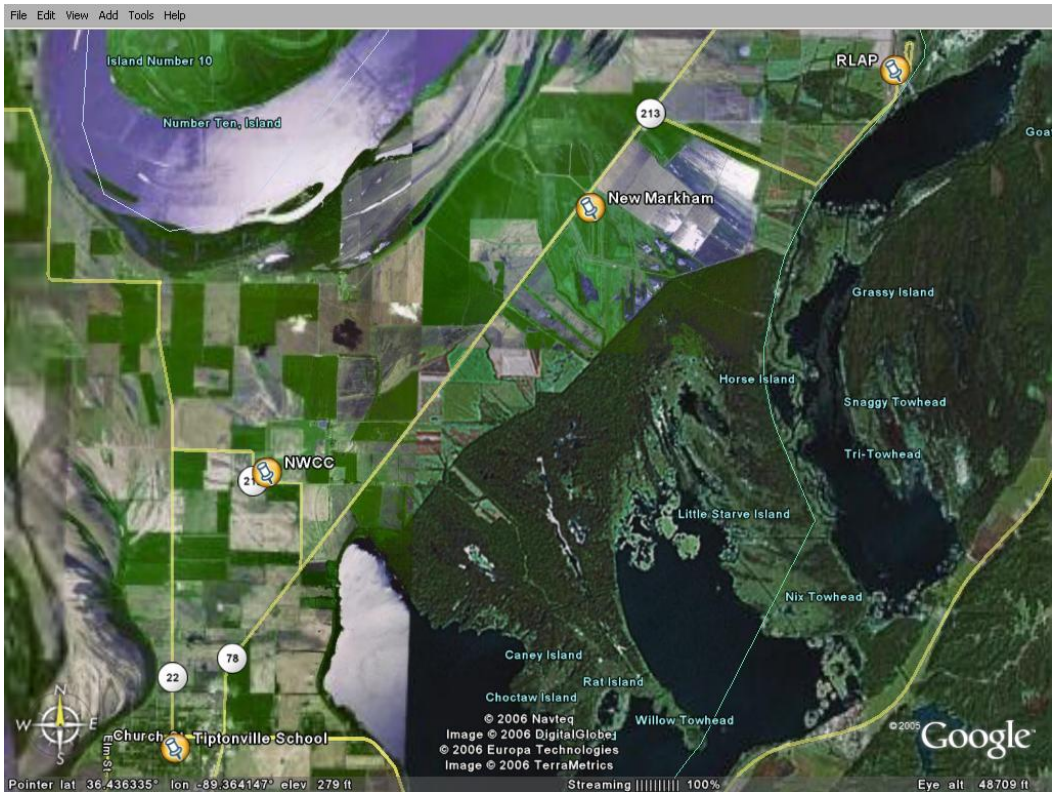

Figure 4: A map showing the four sites on either side of the reelfoot scarp.