

Annual Project Summary: 2003 Shakemap for Memphis

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Program Element: Central/Eastern United States

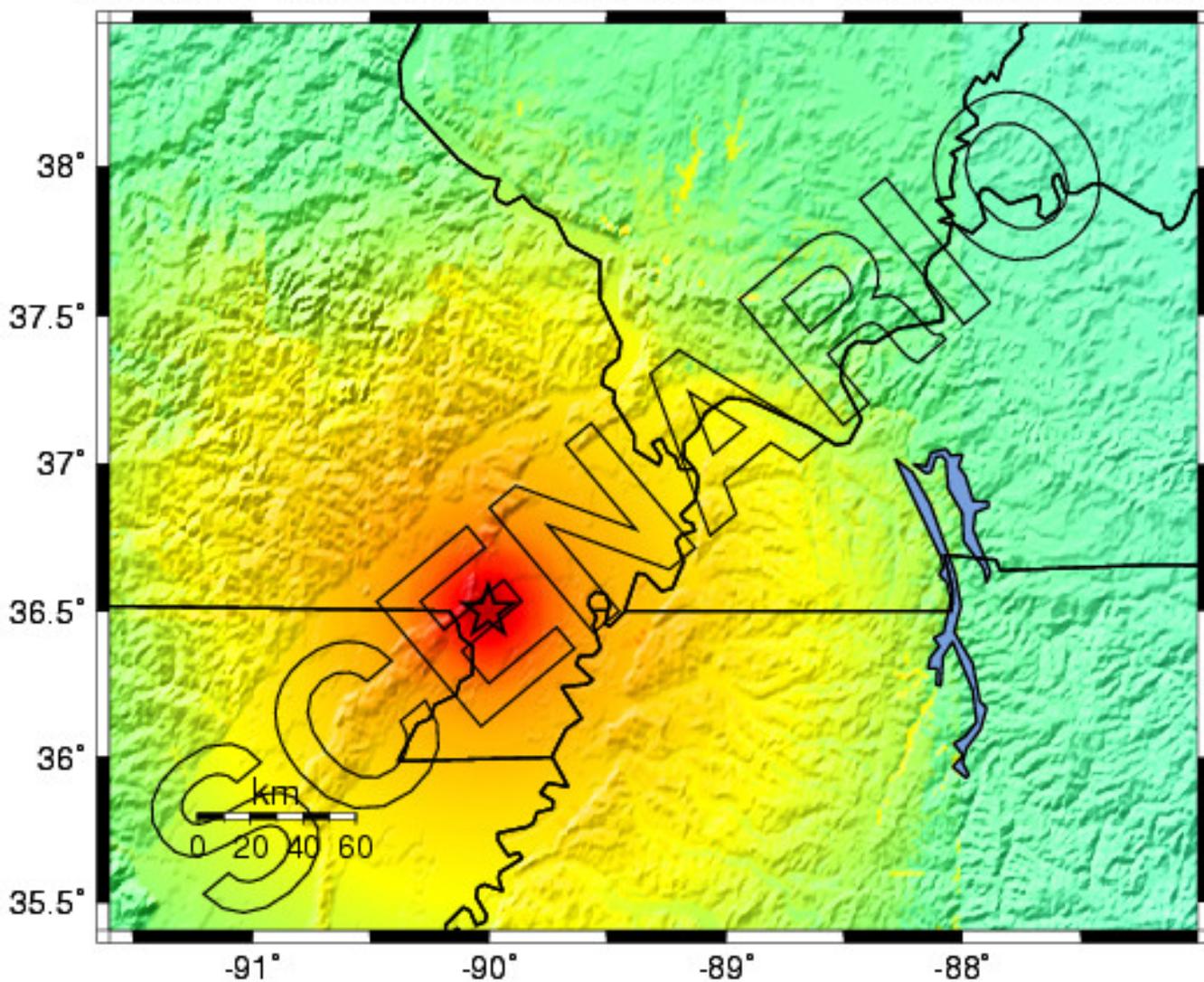
Key Words: Strong ground motion, Earthquake effects, Real-time earthquake information, Earthquake scenarios

November 25, 2003

-- Earthquake Planning Scenario --

Rapid Instrumental Intensity Map for 1 Scenario

Scenario Date: Thu Oct 12, 2000 11:51:19 AM CDT M 8.0 N36.50 W90.00 Depth: 20.0km



PLANNING SCENARIO ONLY -- PROCESSED: Mon Oct 20, 2003 01:22:18 PM CDT

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC. (%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL. (cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Investigations Undertaken

The goal of this project is to produce Shakemap (e.g. Wald et al. 1999) for the Memphis Metropolitan area and, if time and resources permit, for the upper Mississippi Embayment. Maps will be produced in both automated and scenario mode.

We decided to reverse the order in which we attempt to implement Shakemap. We will implement for the upper Mississippi Embayment and then attempt a higher resolution map for the Memphis/Shelby County Metropolitan area. Available data and formats as well as the geographic extent of the larger area more closely mimic those used in the original implementation of Shakemap for Trinet. Thus it is less complex to implement the Embayment maps first in order to focus on learning the software intricacies, then deviate from the "standard" (e.g. incorporate USGS Memphis Hazard Mapping amplification curves, operate on a smaller, higher resolution geographic scale, etc).

Necessary steps to implement shakemap include:

- hardware installation
- software installation
- incorporate surface geology
- incorporate station site response
- incorporate regional attenuation relations

Results

Hardware. A Sun SunFire 280R has been installed in the ANSS-MA (Advanced National Seismic System, Mid-America region) Regional Processing Center (RPC). In addition to shakemap, this system will serve as backup to the primary RPC automated processing server. It is connected via private ethernet to other RPC systems (e.g. webserver, data imports, real-time dbms, etc).

Software. Shakemap and ancilliary software are installed and tested on the server. Earthworm is installed but still needs to be configured to feed shakemap automated earthquake and groundmotion information.

Surface geology. The CUSEC State Geologists dataset was interpolated, reformatted, and imported into shakemap. Insufficient data were available for longitudes west of -92 and latitudes south of 35 so we are working on gathering available information from appropriate state geological surveys.

Station site response. Significant efforts outside this contract were made to determine VS30 for ANSS-MA stations using several different methods (e.g. cpt, seismic reflection survey, etc). We have obtained these results and will incorporate them into shakemap.

Attenuation relations. After we are comfortable with the version of shakemap we are running (2.4), we will upgrade to 3.0. The newer version will allow us to use multiple weighted equations and we will incorporate those used by the USGS Hazard Map (Frankel, et al., 2002).

MMI relations. It is likely that relations between PGA and MMI developed by Wald et al. (1999) are not appropriate for the Mid-America region. Results from Kaka and Atkinson (2004) indicate there are significant differences. We will perform offline tests for select events for which there are both *did you feel it* maps and observed pga values available.

Real-time DBMS. We have instantiated an earthworm database under Oracle and have populated it with station information. While this effort was performed under other contracts for other purposes, it is also a necessary step to incorporate measured groundmotions into Shakemap.

Memphis Metro. After successfully implementing shakemap for the upper Mississippi, we will repeat the process for the Memphis/Shelby County metropolitan area. This will require incorporating information from the USGS Memphis Hazard Mapping project and adjusting shakemap for the smaller area.

Non-Technical Summary

This project will produce rapid generation of maps depicting ground motion known as Shakemaps. Our initial focus is on the upper Mississippi embayment area of southwest MO, northeast AR, and northwest TN. After successful generation of these maps we will focus on the Memphis metropolitan area. Requisite datasets and software were assembled and implemented, and developmental offline maps were created. Work remains on linking with real-time systems in operation in Memphis and on addressing remaining scientific and technical issues primarily related to differences in earth structure and wave propagation in the eastern U.S. relative to the western U.S.

References

- Frankel, A. D., M. D. Petersen, C. S. Mueller, K. M. Haller, R. L. Wheeler, E. V. Leyendecker, R. L. Wesson, S. C. Harmsen, C. H. Cramer, D. M. Perkins, and K. S. Rukstales (2002). Documentation for the 2002 update of the national seismic hazard maps, *U. S. Geological Survey Open-File Report 02-420*.
- Kaka, S. I., and G. M. Atkinson (2004). Relationship between Peak Ground Velocity and Modified Mercalli Intensity in Eastern North America, *Bull. Seism. Soc. Am.*, in press.
- Wald, D. J., V. Quitoriano, T. H. Heaton, H. Kanamori, C. W. Scrivner, and C. B. Worden (1999). Trinet "Shakemaps": Rapid Generation of Instrumental Ground Motion and Intensity Maps for Earthquakes in Southern California, *Earthquake Spectra*, **15 no 3**, 537-556.
- Wald, D. J., V. Quitoriano, T. H. Heaton, and H. Kanamori (1999). Relationships between Peak Ground Acceleration, Peak Ground Velocity and Modified Mercalli Intensity in California, *Earthquake Spectra*, **15**, 557-564.