

Final Report

OPERATION OF THE MID-AMERICA INTEGRATED SEISMIC NETWORK – UKY

February 1, 2007 – January 31, 2010

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ABSTRACT

This project is part of the operation and maintenance of the MA-ANSS regional seismic networks accomplished through the network partners in the region. The partners are St. Louis University (SLU), the Center for Earthquake Research and Information (CERI) at the University of Memphis, the University of South Carolina (USC), and the University of Kentucky (UK). The UK components of MA-ANSS are:

1. To enhance operation and maintenance of the Kentucky Seismic and Strong-Motion Network;
2. To enhance data sharing with CERI, NEIC, and USGS NSMP in real-time and other methods;
3. To better provide earthquake information for all Kentuckians and other stakeholders.

KSSMN consists of 19 short-period stations and nine strong-motion stations, including two vertical strong-motion arrays. The short-period network includes 12 permanent and seven temporary one- and three-channel stations with L-4C and L-28 sensors. The analog signals from 12 permanent short-period stations (BHKY, FLKY, FMKY, HEKY, LLKY, LOKY, MOKY, PAKY, PKKY, ROKY, SMKY, and SOKY) are transmitted to the University of Kentucky campus in Lexington, Ky., through the Kentucky Emergency Warning System (KEWS) and digitized and recorded on a NetDAS 64-Channel system. The helicorder displays of 12 permanent short-period stations are generated by Earthworm and posted on www.uky.edu/KGS/geologichazards/quake3.htm. The waveforms from the 12 permanent stations are being delivered in real time to the CERI and IRIS data centers through the Earthworm mechanism. The strong-motion network of nine stations is in a remote area of the central and northern New Madrid Seismic Zone. The strong-motion stations are accessed through dial-up telephone lines once every week.

A significant change to KSSMN during this project period is the completion of the Central US Seismic Observatory (CUSSO), a vertical strong-motion and broadband array, near the center of the New Madrid Seismic Zone in Fulton County, Ky., through a partnership between UK, the U.S. Geological Survey (USGS), and the U.S. Department of Energy (DOE). CUSSO is equipped with a Kinematics 36-channel Dolomite recorder and the following sensors at different depths: strong-motion and broadband at the surface, strong-motion at 30 m (100 ft), strong-motion at 260 m (850 ft), strong-motion at 512 m (1,700 ft), and strong-motion and broadband at 595 m (1,930 ft). The installation of CUSSO was completed in early October 2009. The recorder and sensors at CUSSO were tested with a weight drop in late October 2009. CUSSO has been in operation in a trigger mode since late October 2009.

INTRODUCTION

UK operates and maintains the Kentucky Seismic and Strong-Motion Network (KSSMN). KSSMN was started with short-period stations in the 1980's right after the 1980 Sharpsburg earthquake, and expanded to include strong-motion stations in the 1990's. The main funding for KSSMN is from the Commonwealth of Kentucky. The main purposes of KSSMN are:

1. To monitor and provide information on earthquakes, mine blasts, and other activities in and around Kentucky;
2. To better understand the basic earthquake processes and seismotectonics in the state and surrounding areas;
3. To better understand and characterize seismic hazards, ground motion and site-effects in particular, in the central US;
4. To provide a real-time laboratory for education in seismology.

As part of the cooperative effort between SLU, CERI, SUSC, and UK in the operation and maintenance of the MA-ANSS regional seismic network, this project focuses on:

1. Enhancing the operation and maintenance of KSSMN;
2. Enhancing data sharing with CERI, NEIC, and USGS NSMP in real-time and other methods;
3. Better providing earthquake information for all Kentuckians and other stakeholders.

The report will cover UK's part of the cooperative effort between February 1, 2007, and January 31, 2010.

KSSMN

Currently, UK operates and maintains 19 short-period and nine strong-motion stations (Fig. 1 and Table 1). Between February 1, 2007, and January 31, 2010, there was no significant change in short-period stations. The analog signals from 12 permanent short-period stations (BHKY, FLKY, FMKY, HEKY, LLKY, LOKY, MOKY, PAKY, PKKY, ROKY, SMKY, and SOKY) were transmitted to the University of Kentucky campus in Lexington, Ky., through the Kentucky Emergency Warning System (KEWS) and digitized and recorded on a NetDAS 64- channel system. The waveforms from the 12 permanent stations were delivered in real time to CERI and IRIS data centers through the Earthworm mechanism. KEWS is being upgraded from analog to digital. This ongoing upgrade has affected some of the short-period stations. All short-period stations will also be upgraded to digital as soon as the KEWS upgrade is completed.

A significant change to KSSMN during the project period is the completion of CUSSO, the vertical strong-motion and broadband array (Fig. 2) near the center of the New Madrid Seismic Zone in Fulton County, Ky. (Fig. 1), through a partnership between UK, USGS, and DOE. Supplemental funding was provided by USGS to purchase sensors and other equipment for CUSSO in 2009. CUSSO is equipped with a Kinometrics 36-channel Dolomite recorder and the following sensors at different depths: strong-motion and broadband at the surface, strong-motion at 30 m (100 ft), strong-motion at 259 m (850 ft), strong-motion at 518 m (1,700 ft), and strong-

motion and broadband at 585 m (1,920 ft) (Fig. 2). The installation of CUSSO was completed in early October 2009. The recorder and sensors at CUSSO were tested with a weight drop in late October 2009. The test revealed that the cables for the strong-motion sensors and tilt meters at the bottom (585 m) are shorted, which is probably caused by high water pressure. A new cable for the deephole (585 m) sensors and tilt meters with improved specifications has been ordered. The cable replacement is expected to be in the summer 2010. Currently, CUSSO is in operation in a trigger mode with these sensors: strong-motion at the surface, strong-motion at 30 m, strong-motion at 259 m, strong-motion at 518 m, and broadband at 585 m. Figure 3 shows the accelerations from an earthquake (M3.1) that occurred on December 18, 2009 near Tiptonville, Tenn. Figure 4 shows the velocity recordings from the same event.

DATA PROCESS AND SHARING

UK is maintaining real-time data sharing with the CERl and IRIS data centers through the Earthworm mechanism for the 12 permanent short-period stations (BHKY, FLKY, FMKY, HEKY, LLKY, LOKY, MOKY, PAKY, PKKY, ROKY, SMKY, and SOKY). The helicorder displays of the 12 short-period permanent seismic stations are generated by Earthworm and posted on www.uky.edu/KGS/geologic hazards/equake3.htm. The recordings from the short-period stations were processed routinely for differentiating earthquakes from mine blasts.

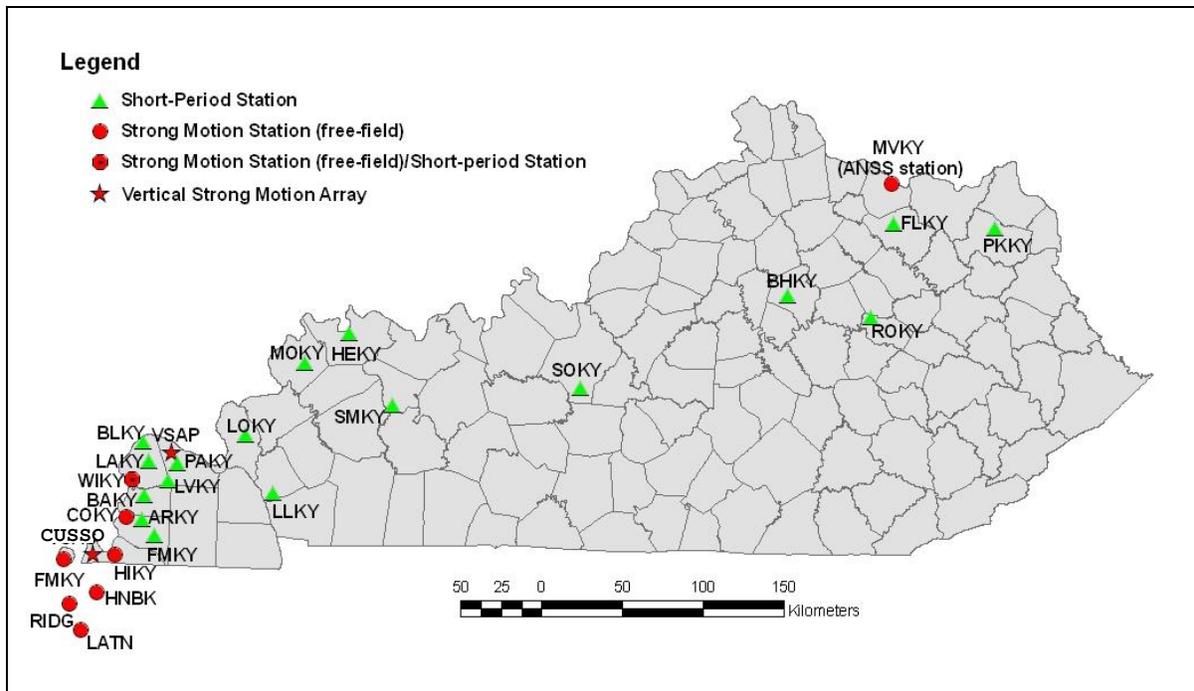


Figure 1. Kentucky Seismic and Strong-Motion Network.

Table 1. Station List of the Kentucky Seismic and Strong-Motion Network.

Name	Latitude	Longitude	Elevation (m)	Type	Type_Generic	Telemetry	Open	Network
COKY	36.763	-89.108	134	HN3	sm	du	19901000	KY
HIKY	36.551	-89.183	122	HN3	sm	du	19890800	KY
HNBK	36.333	-89.296	140	HN3	sm	du	19910000	KY
LATN	36.168	-89.375	99	HN3	sm	du	19910000	KY
RIDG	36.264	-89.481	87	HN3	sm	du	19910000	KY
VSAB	36.514	-89.532	98	HN3	sm	du	19920900	KY
CUSSO	36.552	-89.330	94	BL6, HN15	bb, sm	du	20040400	KY
ARKY	36.748	-88.997	88	EH3	sp	sa	20030100	KY
BAKY	36.887	-88.994	80	EH1	sp	sa	20030100	KY
BHKY	38.035	-84.505	284	EH1	sp	cm	19901106	KY
BLKY	37.184	-89.015	90	EH1	sp	sa	20030100	KY
FLKY	38.426	-83.751	280	EH1	sp	cm	19890000	KY
FMKY	36.664	-88.909	52	EH1	sp	cm	19890800	KY
LAKY	37.079	-88.969	88	EH1	sp	sa	20030100	KY
LLKY	36.922	-88.097	177	EH1	sp	cm	19890800	KY
LOKY	37.237	-88.295	230	EH1	sp	cm	19910700	KY
LVKY	36.970	-88.829	92	EH3	sp	sa	20040816	KY
MOKY	37.647	-87.901	204	EH1	sp	cm	19890800	KY
PAKY	37.068	-88.772	98	EH1	sp	cm	19901000	KY
PKKY	38.383	-83.034	336	EH1	sp	cm	19901000	KY
ROKY	37.909	-83.926	433	EH1	sp	cm	19890900	KY
SMKY	37.423	-87.276	158	EH1	sp	cm	19900500	KY
SOKY	37.526	-85.965	304	EH1	sp	cm	19890600	KY
HEKY	37.815	-87.592	94	EH3, HN3	sp	ci	20050800	KY
VSAP	37.131	-88.813	113	EH3, HN6	sp, sm	du	19901100	KY
WIKY	36.974	-89.084	116	EH3, HN3	sp, sm	du	19890800	KY

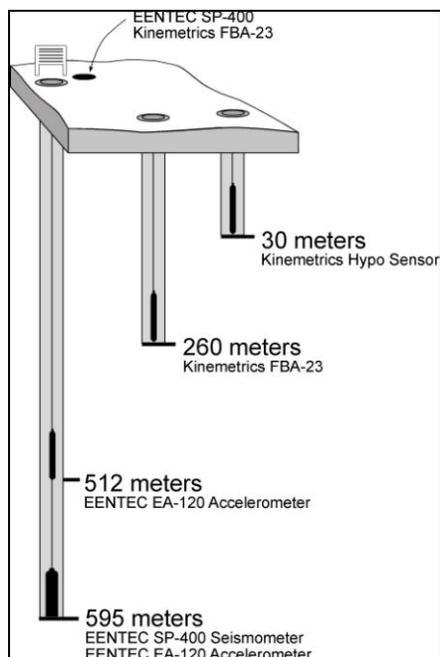


Figure 2. Instrumentation at the Central U.S. Seismic Observatory.

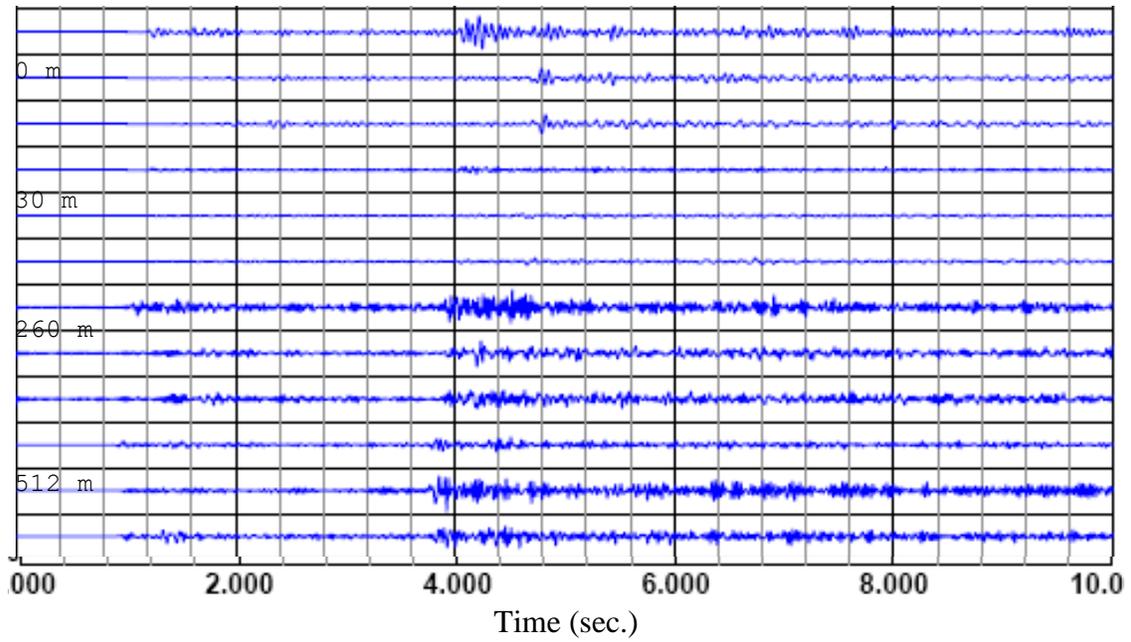


Figure 3. Acceleration recordings from the December 18, 2010, earthquake (M3.1) at CUSSO.

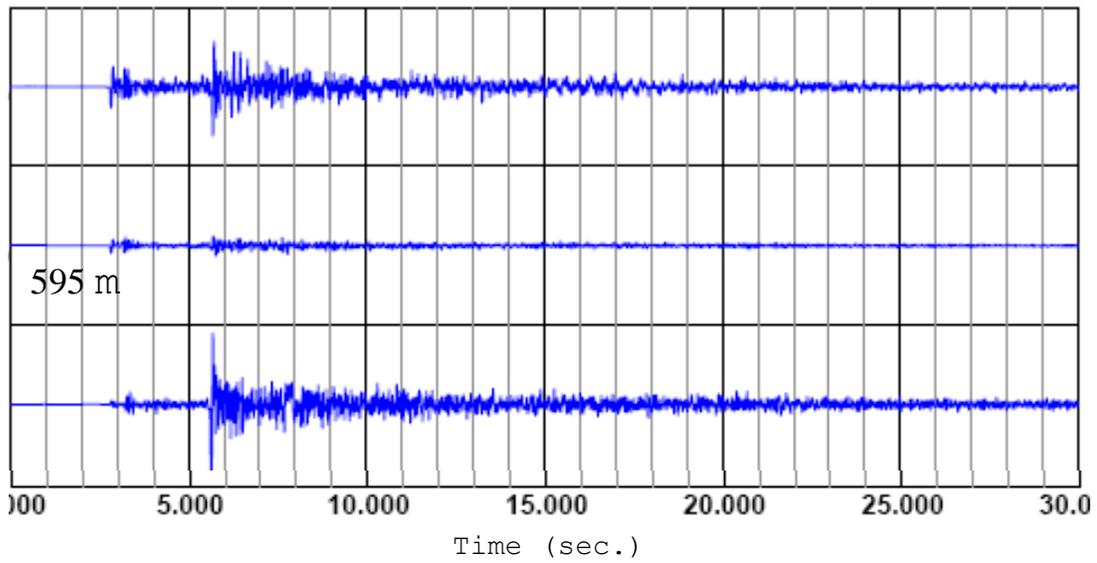


Figure 4. Velocity recordings (in bedrock) of the December 18, 2010, earthquake (M3.1) at CUSSO.

The recordings from the strong-motion stations are either accessed through dial-up phone lines or on-site download. The strong-motion data are processed and used by graduate students for their research projects and theses. During the project period, three graduate students were supported to collect, process, and use the strong-motion data. A thesis utilizing the strong-motion data was successfully defended in 2008 (McIntyre, 2008). The strong-motion data from the April 18, 2008, southern Illinois earthquake is being analyzed by a graduate student for a master's thesis. The data acquired by KSSMN were presented at conferences and workshops (McIntyre, 2007, 2009; Wang and Woolery, 2008; Wang and others, 2009). The data acquired by KSSMN were also distributed to the interested scientists and engineers for their uses ((Shumway, 2008).

EARTHQUAKE INFORMATION DISSEMINATION

KSSMN provides timely information on earthquakes for all Kentuckians and others who are interested. The hilocoder displays of KSSMN at www.uky.edu/KGS/geologichazards/quake3.htm have become one of the most popular Web sites at UK. Posters on earthquakes with magnitude greater than 3.0 in and around Kentucky and large earthquakes in the US and the rest of the world are produced and posted at www.uky.edu/KGS/geologichazards/index.htm. Our Web site has been updated continually to provide better information and services. Links to the national and regional networks and earthquake information centers have also been maintained.

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