Southern Appalachian Cooperative Seismic Network
Center for Earthquake Research and Information
The University of Memphis

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SUMMARY

This is the annual project summary for USGS Award 1434-HQ-98-AG-01932: " *Collaborative Research: The University of Memphis, The University of North Carolina at Chapel Hill, and Virginia Tech: The Southern Appalachian Cooperative Seismic Network.*" This agreement covers the CERI component of the SACSN to perform network operations, and routine data processing, archiving, and dissemination for the purpose of seismic hazards evaluation and scientific studies in the Southern Appalachian Seismic Zone. This report includes a review of station operations, technical challenges, data processing modifications, and a brief explanation of near-future directions.

Due to severe communications limitations only events of interest are downloaded and immediately analyzed; other, smaller events must be retrieved manually. The largest event recorded occurred on June 17, 1998 (near Oakridge, TN) with a duration magnitude of 3.6. Waveforms generated by the September 25, 1998 Pymatuning earthquake are are available as images on the WWW. These data were also made available to researchers shortly after the earthquake.

ABSTRACT

CERI operated 6 stations in the Southern Appalachian Seismic Zone during the period covered by this

report. Data were retrieved and immediately analyzed only for earthquakes of particular interests (e.g. 6/17 Oakridge event). We have been hampered by unreliable communications and by an antiquated acquisition system, both of which should be mitigated in FY99. Data are available in various levels of completeness depending on the mechanism employed by the user (e.g. ftp, finger, www). We expect to significantly enhance our monitoring efficiency and capability by converting to (*earthworm*). The broadband deployment has been delayed due to various technical problems with the sensors and digitizers from the manufacturer.

Station Operations

The CERI component of the SACSN operated 6 permanent seismic stations in FY 1998. They are located in the eastern Tennessee portion of the Southern Appalachian Seismic Zone (SASZ), are all 3-component. The sensors are 1 Hz S-13 geophones attached to the gain-ranged PandaII electronics. Telemetry concerns require geographically dividing this network into two subnetworks (the southern subnet is operational, the northern subnet is planned), each with its own autonomous central processing facility (referred to as remote nodes) where triggered data files are recorded digitally. The currently operating node began operation in December, 1997 and is located on top of Star Mountain near Etowah, TN. Data are relayed to the Athens/McMinn county emergency managment office where we have installed a pc that is connected to CERI via ISDN telephone. Interfacing the telephone switching system in eastern, TN with the system in western TN (two different long-distance carriers) has been problematic and has hampered timely data analysis. We suspect this may be due to our methods of bridging data packets rather than routing them. We are currently investigating solutions.

In July, 1997 CERI returned the 15 CMG40T digitizing units to Guralp Systems for upgrade. Of these, 4 will be deployed in the SASZ. These units were returned to CERI in April, 1998. The upgraded systems require considerably more power than the original design and has required doubling the solar panel and battery outputs as well as construction of new power regulators. Because the original design used a single gps receiver for timing and the upgrade requires on-site timing, gps receivers were purchased and an interface to the sensors was developed. Each instrument had to be rewired to correct a factory error. Each instrument required specialized cleaning to prevent the mass from "sticking." Additional bugs continue to be resolved on an instrument by instrument basis (e.g. inexplicable wildly varying signal levels on one channel after operating normally for days, and corruption of the data channels by the timing signal). We are investigating sites for these instruments and will begin seek permissions in early 1999.

Routine Data Analysis

There is a significant backlog in routine analysis of remote node data. Connection to the remote nodes is gained via ISDN telephone so daily triggered data are not downloaded to CERI thus minimizing long-distance charges. Rather, these data are stored remotely and archived to 8 mm magnetic tape which is manually retrieved approximately every 2 to 3 months. This situation is less than desirable but required unless funding for an alternate communications system can be acquired. Problems with numerous false triggers, the sheer number of data channels, and other duties has hampered efforts of CERI's seismic analyst in reviewing the node data. We have recently hired a part-time analyst who's sole duties will be reviewing these data tapes and we expect to be caught up within a few months. Appropriate hardware and software has been installed to create a work-station exclusively for tape review. We have also created a "front end" to the location program, *hypoellipse*, and linked this to the picking program, *xpick*, to enhance the efficiency of the analysts.

Data Archive

We have begun a project to collect all hypocenter data from 1974 to present and archive it in a CSS3.0 relational database. This is necessary to provide reproducible results as much of the older data was stored on an aging computer system. To date, we have migrated the hypocenter and arrival data from the VAX to the networks SUN Ultra30. We will next convert these files to the new standard and glean all hypocenters that are reproducible from the available data. Then, they will be suitable for automatic inclusion in the relational database. Waveforms for these events are currently stored on 9 track tapes in an obsolete format and should be migrated to modern storage media. Without additional funding and resources for this migration, these waveform data will be lost.

For current data, waveforms are archived in ah_xdr format and hypocenter and arrival information are archived in *Hypoellipse* archive phase file format. Perl programs have been obtained from the University of Alaska, Fairbanks to convert these files to a CSS3.0 flat-file database. A successful test has been performed. We will likely abandon this method, however, in favor of an Oracle database with direct updates from the automated, rapid event processing system (*earthworm*).

Data Availability

A weekly summary of regional and worldwide earthquakes is faxed to approximately 100 recipients in the government and the private sector. While long-distance telephone charges for these faxes was not contained within the budget, the popularity of these reports has precluded other, less costly communications (e.g. internet). Data are also available via a finger utility and via the world wide web. For brevity the finger utility only includes data from the current year. The searchable web based catalog includes events from 1974 through the present. Psuedo helicorder images of select channels are also online on the webserver and updated every ten minutes. We have also instituted a weekly automatic transfer of the CERI catalog to the CNSS composite catalog in Berkeley. Currently only data from 1997 to present have been submitted to the composite catalog. Event data are available via anonymous on a case-by-case basis.

Data Acquisition Modifications

It was decided in 1994 that the best data acquisition system would be *eqacquire* because of its operation on a UNIX variant and success at Saint Louis University. At the time, earthworm did not perform one of the primary roles of regional networks: waveform archiving. Recent developments in earthworm have corrected this shortcoming and allows us to replace *eqacquire*. In addition to operating on modern hardware, y2k compliance, and partial platform independence, earthworm now performs basic waveform archiving as well has a host of additional functions beyond the scope of this report. Hardware and software have been acquired, and a prototype earthworm system has been in operation since August, 1998. The parameter configuration was considerably modified to reflect the geology and seismicity of the central U.S. We have also developed a new earthworm module (*trig2disk*) to enable the system to store waveforms in ah_xdr or sac, for subsequent review, analysis, and archive. We have also developed a backplane for the AMUX64T that eliminates the severe crosstalk problem with this hardware, reduces noise by a factor of 3, provides on-board guide channel, a bnc timing connector, and allows use of 8-pin ribbon cables (as opposed to error-prone individual wiring). Note that the majority of the AMUX64T problems result in using the board for sensitive, single-ended acquistion: a task it was not designed to do. We have also developed new hardware to produce a gain channel for the isis instrumentation system and thus allow automated deconvolution of the instrument response. We are cooperating with Ditigal

Technology Associates and the University of Alaska, Fairbanks in the development of a new earthworm module (*gcf2ew*) that will enable seamless integration of the Guralp CMG40T data into the system.

In addition to the central processing node at CERI, we will be converting two of the remote nodes to earthworm in Spring, 1999.

Near-Future Directions

On October 26, 1998 we will visit UNC Chapel Hill to install an earthworm system similar to that running at the CNMSN CERI node in Memphis. We will then upgrade the Athens node to earthworm to facilitate automated near-real-time communications between Athens and Chapel Hill.

Beginning January, 1999, we will be installing what is refered to as the "earthworm PhaseII". This is an extension that provides automated, near-real-time updates to an *Oracle* RDBMS. It also provides, routine analysis and review functionality, web based catalog searches, and archiving mechanisms. It also allows the potential for mirrored databases and combined with the core v3.3 earthworm modules and current work being performed for the Tsunami Warning Project, presents exciting possibilities for linking regional networks into a near-real-time National Seismic System.