

**Quarterly Report to the Harry Reid Center
NSHE-DOE Cooperative Agreement
DE-FC28-04RW12232**

**Task ORD-FY04-006: Seismic Monitoring
Reporting Period: 10/01–12/31 2006**

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Progress:

- During the last quarter of calendar year 2006 (Oct. 1–Dec. 31, 2006; 1st Quarter FY07) the Nevada Seismological Laboratory has maintained a regional seismic network and of 34 real-time seismograph stations (weak and strong motion instruments) in the Yucca Mountain, NTS and Death Valley region. In addition, 6 six-channel seismograph stations (configured with velocity and strong motion sensors) are operated in the ESF area, including 3 in the tunnel and 3 at corresponding surface locations directly above the underground stations. Also in the site area, we operate nine accelerometers in 3 boreholes in the ESF pad area and a real-time multi-channel data acquisition system at borehole UZ-16. We also maintain the telemetry infrastructure, combined analog and digital, for real-time data management at UNR. All seismic waveform and event locations (automatic and analyst reviewed) are managed and archived in an Antelope data management system. Supplement 1 (below) summarizes the regional seismicity for the calendar year 2006 (Figure 1) including reviewed and non-reviewed preliminary earthquake locations and earthquakes that have occurred in close proximity to the Yucca Mountain site (Figure 2).
- Installation of seismic recording instrumentation and telemetry systems under the network upgrade task is continuing.
- Preliminary event location determination and review of event locations continued for FY06 earthquakes. Event sheet review forms, timing check forms, and polarity check forms were submitted according to IPR-001. Event reviews have been completed through August of 2006. Once events review sheets are complete, the FY06 earthquake catalog can be completed.
- The Software Activity Plan for was accepted to begin qualification of software components of the Antelope 4.8 seismic recording and analysis system.
- Software application db2hypo.pl was baselined. This application was required to develop and complete FY05 earthquake locations and magnitudes. The FY05 earthquake catalog

was compiled and technical reviews have been completed. QA review is process. The FY05 Seismicity Report is under development and will be completed in 2nd Quarter of FY07.

- Routine and instrument-replacement system checks were maintained.
- Antelope 4.8 operations for automatic earthquake locations and magnitudes have been implemented in a test mode in anticipation of the completion of software QA. Due to the nature of the real-time operations, and the necessity to maintain continuous data recording, Antelope 4.8 systems must be in place prior to sun setting Antelope 4.6 systems. This is a configuration testing activity and does not impact any Q tasks.

Network Upgrade Status/Network Maintenance:

We received delivery of 11 RT-130 dataloggers in the 4th Quarter of FY06. Backplane boards have been completed for the next round of 72A-08 datalogger replacements. Stations FRG and STO are experiencing communication problems due to interference between the IP and analog (200 MHz) bands; this will place STO and FRG as priority for upgrade. Current emphasis has been on completing the communications link between Skull Mountain and Angel Peak outside of Las Vegas. A pair of Harris IP radios were installed between Skull Mountain in Area 25 and Angel Peak, outside of Las Vegas, in November. The Harris radios are capable of a total of 8 T1 tributaries running at 1.5mbps each. Cisco 2811 DC routers with T1 cards were installed at Skull and Angel to implement IP over T1 functionality. A total of 3 T1links bonded together with Multilink PPP provides us with a single 4.5mpbs IP network connection between Skull and Angel. Testing indicated there is no detectable packet loss over this link. The Harris radios are fully manageable via telnet and thru a web browser interface. They also feature out of band management capability through a separate 64kbps side band, which enables configuration of the remote Harris radio if, for any reason, all of the T1 tributaries are down.

Significant effort was involved in configuring and signal conditioning for the Skull/Angel link. Currently we rely on the State microwave link from Skull Mountain to Las Vegas for communications to existing RT130 IP dataloggers in the Yucca Mountain area; the Skull/Angel link will provide a real-time redundant link. The link will be completed with a Canopy back-haul 30 Meg radio pair from Angel to UNLV. Reconnaissance for the installation of the Harris radio link was conducted on Shoshone Peak. This link will allow us to upgrade 72A08 stations in the northern NTS area that use the Shoshone com-link. We have implemented an electronic log for field activities.

Station Maintenance:

1. Sensor free-period adjustments at TIM (included replacement of vertical sensor) and FRG.
2. GPS receiver replacement at station LWLS (Lathrop Wells).
3. Verify GPS coordinates at STH.
4. YFT site visit to reestablish data communications.
5. Troubleshoot power failure at Echo Peak analog relay building.
6. Upgrade and replacement of Reftek Rev F Amplifier boards and datalogger replacement at ESF stations NI5, AL5, and SME. These stations were installed with early amplifier

boards and have been upgraded to establish identical configuration for ESF and corresponding surface systems.

7. WCT (Wildcat Canyon) battery replacement.
8. Troubleshoot/repair power failure at Shoshone Peak/Sober Peak.
9. Yucca Node/A-15, field testing of 900MHz Canopy radios for use in the SGBDSN upgrade. These are true IP radios and allow for remote configuration and diagnostics.
10. ESF pad, RF-13/15/16/DCS, swap of marginally reliable 2.4 MHz 80211b radios for communications to ESF pad borehole accelerometers. No improvement in communications in replacement of 80211b systems; apparently getting interference in the 80211 protocol on the pad. 900MHz radios are more reliable and robust. Special site visit prior to holiday close of ESF to reestablish borehole communications.
11. Yearly site visit was conducted at free-field strong motion station FOCS; the remaining station operated under IPR-004. Data download and station maintenance.

Software Qualification Activities:

We completed and obtained approval for the Antelope Real-Time System Data Acquisition and Processing v.4.8 Software Activity Plan. This plan includes qualification of six inter-linked software elements; three for data acquisition itself (Q3302ORB, RT2ORB, and REF2ORB), one for timing arrivals of seismic recordings (DBPICK), one for earthquake location (DBLOC2), and one for estimation of local magnitude (DBML). The plan provides for submission of Control Point 1 documentation for review early next quarter.

Borehole UZ-16 Data Collection and Analysis:

System checks were performed at UZ-16 finalizing the QA status of the UZ-16 borehole initiative; application eq2orb, that communicates with the real-time data collections systems at UNR is QA, and system check pulse analysis software CALIB (modified to accept weight drop system check techniques) is QA. System checks were completed on all recorded channels including surface instruments and documented; a weight drop was also conducted at the borehole to compare surface-to-depth borehole P-wave velocities with earthquake P-wave velocities. Event data at UZ-16 has been subset by visual inspection of the continuous records, in conjunction with backwall RT130 recordings, and archived in and Antelope database. Communications is maintained through the Skull IP link; relay through Fran Ridge and to the DCS on the ESF pad. Communications has been reliable.

A poster presentation was prepared for the Fall American Geophysical Union Meeting, in San Francisco in December.

Leiph Preston, Smith, K. D., American Geophysical Union Fall Meeting, "Seismic Wave Amplification, Attenuation, and Scattering at the UZ-16 Borehole, Yucca Mountain, Nevada", American Geophysical Union, San Francisco.

Summary of Presentation Results:

The UZ-16 borehole array at Yucca Mountain, Nevada provides an opportunity to investigate near surface effects on seismic waveforms as a function of depth. The downhole 3-component geophone array consists of 96 depth levels from about 30 m to 500 m depth below the surface, of which we are continuously recording 18

approximately equally spaced levels. The borehole array was augmented with three 3-component surface instruments in May 2006 allowing for full waveform recording from 500 m depth, to include 3 surface locations. We have initiated several investigations of the seismic data including spectral ratios and spectral variation as a function of depth. Nearly 150 events, both local and regional sources, have been extracted from the continuous data surface geophones were installed. Based on log averaged spectral amplitude from a subset of these 150 events, most amplification (from about 3 Hz to 15 Hz) appears to occur within the top 60 m of the borehole with the surface geophones exhibiting the largest amplifications at all frequencies, as expected. Q values determined from the spectral ratios average near 30 with values <10 within the top 50 m. P-velocities of 3.5 km/s at the bottom of the hole drop to ~2.3 km/s near the top; S-velocities, although poorly constrained, are near 2 km/s at the bottom of the hole and drop to just over 1 km/s within the top 50 m.

Kappa Project:

We completed high-level software qualification for macro suite kappaAH in early December. This clears the way to complete the analysis, which we will do in the first quarter of 2007. Non-Yucca Mountain elements of the kappa report are progressing.

Remote Access Communications:

Mobile device applications are being implemented for efficient, effective and secure access to real-time network status, network diagnostics, ShakeMap (USGS implementation of automatic ground motions maps following significant earthquakes), real-time event information, and general remote access to seismic network control systems. We envision, these applications developed under PHP and Perl scripting languages for mobile internet devices will eliminate the need a number of local-remote coordination activities and allow direct access by field technicians and network operators to real-time data management systems, communications network status, diagnostics and control functions. We anticipate these systems will minimize required site visits. Under these initial systems, field technicians can debug some communications issues and datalogger communications functions remotely without coordination with the seismic network data center in Reno.

We are currently adapting the system check process to a remote Internet device application to allow field technicians to complete and confirm system checks results. This effort will make possible: 1) instrument-replacement system checks directly from the field; 2) be the basis for generalized automatic routine system checks and automated preliminary in-house compliance checks. Field technicians can complete instrument maintenance activities, through remote system response, with assurances that instrumentation performs according to expectations without additional field visits.

Death Valley Seismic Stations:

Permit renewal will be due for seismograph stations located in the Death Valley Park by the end of calendar year 2007. A meeting was held with Death Valley, DOE and UNR representatives at Death Valley administrative offices in Furnace Creek in November to ensure we are on track for the renewal process. The permit will require review by Death Valley Park to ensure that

earthquake monitoring activities are consistent with the Park's research mission prior to potential final approval. There will be additional reporting requirements to the Park with respect to research and finding of monitoring activities; required for Park related activities.

Death Valley Earthquake (felt event):

A Magnitude 3.17 earthquake occurred approximately 6 km southeast of Furnace Creek Ranch on November 30, 2006 (Origin Time 12:21 GMT; Latitude: 36.4019; Longitude; -116.9088; Depth: 12.8 km). The earthquake was felt at Furnace Creek; there were no reported incidents or damage.

Problems:

Telemetry was lost to stations that require the Shoshone Peak link during New Year's weekend. These include stations that require the Echo Peak relay. This was resolved at the Shoshone, and Sober com-sites. Communications problems have come up on the ESF on the 80211b com-link for the ESF pad borehole accelerometer in late December. Replacement of the existing radio at the data receive site on the pad did not resolve the issue; we have replaced a couple of the pad com-links with 900 MHz IP radios. No significant events were missed during any of these outages; network coverage remained sufficient to resolve regional event locations.

An internal change inadvertently caused the event excerpts for some FY2005 events to be saved in ground motion units instead of digital counts, which qualified program MLCALC expects. Excerpts were redone from the raw recordings. This did not impact any submitted data.

A deficiency report was submitted on a software issue related to final qualification of the FY03 earthquake catalog. All catalog technical reviews had been completed. The Antelope version application that was applied to a portion of the analysis, identification of phase arrivals, predated the QA'd baseline version; and therefore, all FY03 catalog analysis has been deemed, non-Q. This issue will further delay QA of both the final FY03 and FY04 seismicity reports which use and/or reference the FY03 catalog. FY03 and FY04 seismicity reports have technical reviews. This will require a data qualification exercise for the FY03 under QAP3.7. Currently a review of a revision of QAP3.7 is underway pursuant to Revision 17 of the QARD, in effect in May 2006 that may impact the data qualification exercise.

Status of Funds:

Under-runs in FY06 funding due to delays in hiring staff positions and under-runs in other network operations contracts have been applied to support staff through the quarter. We are requesting support through the University of Nevada system to cover costs prior to receipt of supplemental FY07 DOE funds. Yearly funding delays have required us to delay equipment purchases under the five-year network upgrade task. We expect the same for FY07.

Plans and Notes:

Continue upgrade with installation of next 11 RT130 dataloggers and telemetry systems. Install Harris IP radios at Shoshone Peak. Complete FY05 seismicity report and FY06 earthquake

catalog and draft of FY06 seismicity report during next quarter. Complete Antelope 4.8 software qualification activities. Maintain the YM area seismic network.

Supplement 1: Seismicity: January 1, 2006 through December 31, 2006. There are 1275 events within 65 km of Yucca Mountain in the preliminary earthquake catalog for calendar year 2006. Locations and magnitudes are subject to change following final review and processing.

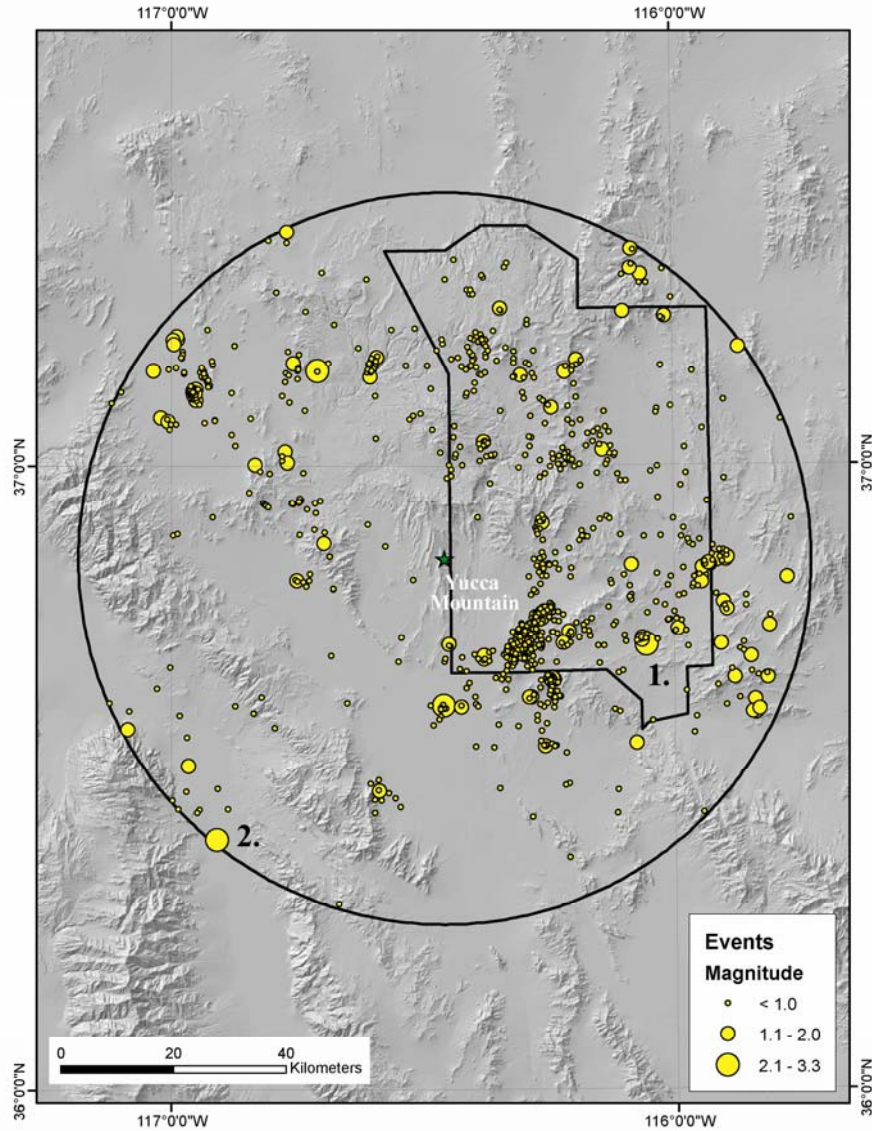


Figure 1. Preliminary earthquake locations for calendar year 2006; circle is 65 km radius from station RPY in the repository area.

Table 1. Evt. #'s labeled in Figure 1.

Evt#	Lat	Lon	Depth	M	Date	Time (GMT)
1.	36.7135	-116.0556	5.64	3.29	4/17/2006	20:14:51.09
2.	36.4019	-116.9088	12.83	3.17	11/30/2006	20:12:57.50

Depth: in kilometers

M: Local Magnitude

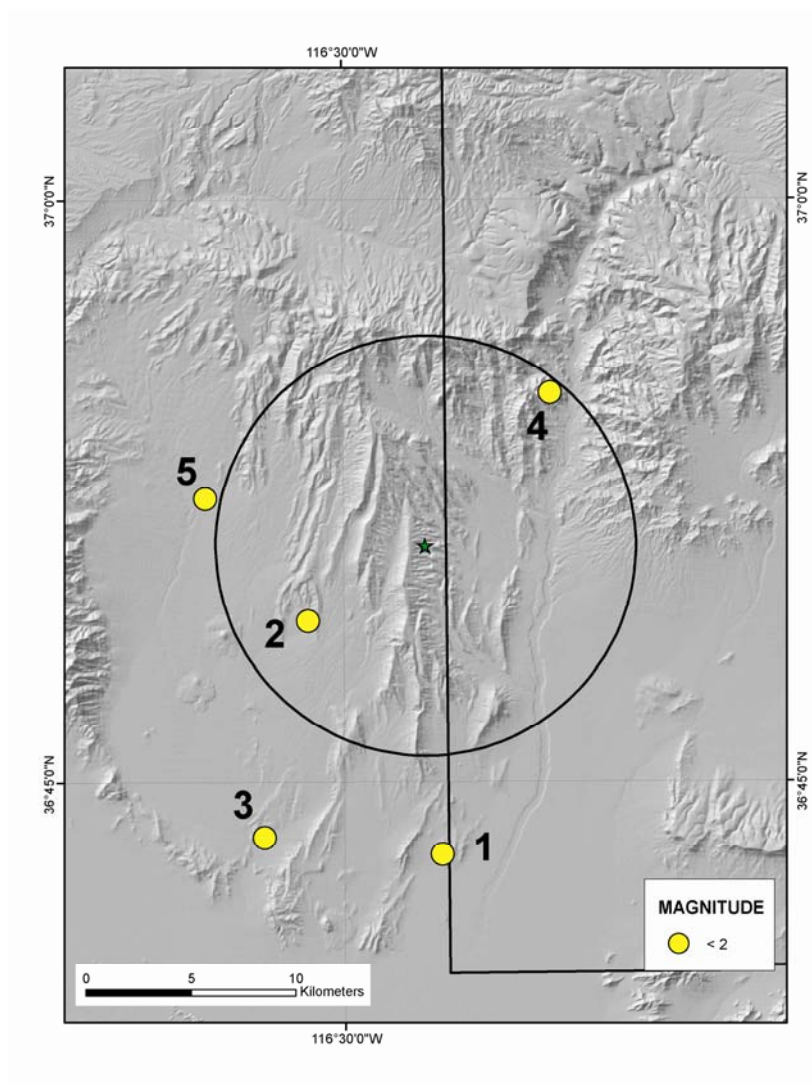


Figure 2. Preliminary earthquake locations and magnitudes, calendar year 2006. Circle represents 10 km from station RPY in the repository area.

Table 2. Earthquakes in Figure 2 (Evt. #'s labeled in Figure 2)

Evt#	Lat	Lon	Depth	M	Date	Time (GMT)
1	36.7140	-116.4483	9.15	1.69	3/07/2006	7:36:23.670
2	36.8179	-116.5188	6.86	-0.08	3/09/2006	11:50:08.362
3	36.7248	-116.5419	7.17	-0.35	6/05/2006	3:18:55.333
4	36.9177	-116.3893	9.67	-0.57	7/20/2006	15:50:59.679
5	36.8715	-116.5744	3.45	0.74	11/18/2006	8:03:27.510

Depth: in kilometers

M: Local Magnitude