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Progress on digitization and recovery of historical U.S. nuclear test seismic data

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INTRODUCTION AND MAIN RESULTS

We have been working to digitize, recover, and calibrate waveforms of U.S. underground nuclear tests recorded by the Leo Brady Seismic Network on analog magnetic tapes from the 1960s to 1980s.

We publicly released the first calibrated waveforms from 20 events in late 2023. We are now working on recovering 27 more events.

Herein we describe this work and lessons learned during the process.

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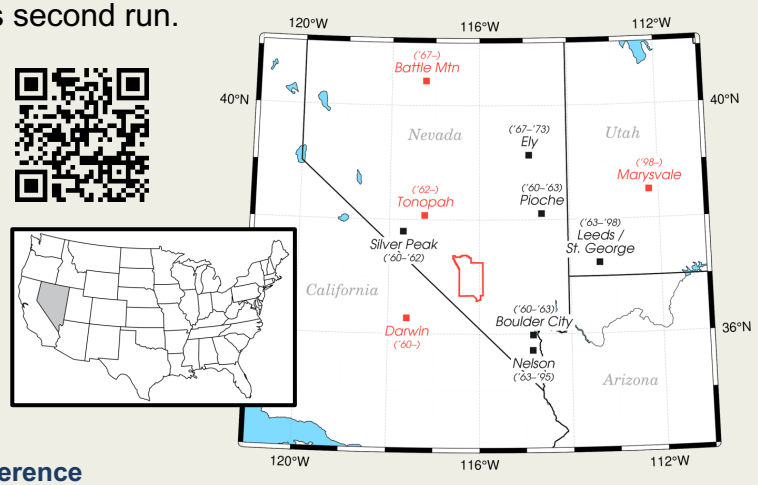
Introduction

The Leo Brady Seismic Network (LBSN) was established in 1960 to monitor U.S. underground nuclear tests (UGTs). Though later recordings were digital, until the mid-1980s, data from this network were frequency-modulated (FM), multiplexed, and recorded as analog "audio" on magnetic tapes. Those tapes have been in storage for decades and contain the only remaining copy of these irreplaceable data.

We have been methodically digitizing these tapes, and have developed a method to recover and calibrate the waveform data. In late 2023, we publicly released the first set of 20 events on EarthScope. We are currently working on another set and noting lessons learned on this second run.

Download 2023 dataset



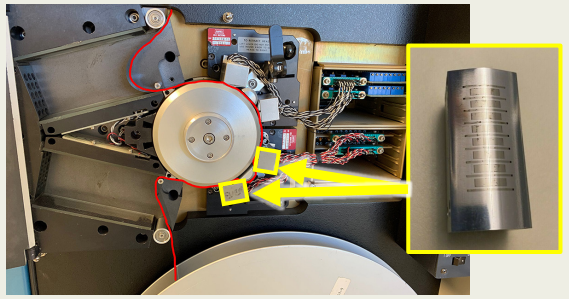
Lessons Learned

The most time-consuming part of the process is creating model files to filter, demodulate, and demux the signals. Each event requires over 1,000 processing steps, and when the seismometer configuration changes, it requires a new model. We have built a repository of relatively easily transferable models, significantly reducing this burden.

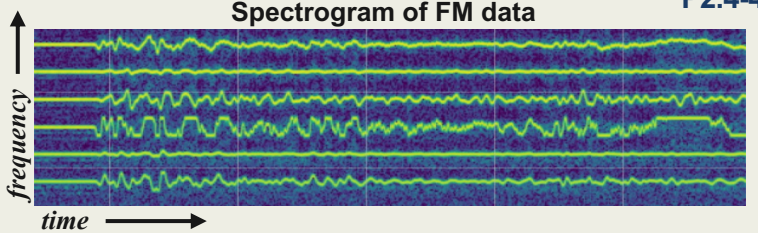
Each tape is physically almost 1 mile long. Combined with startup/shutdown overhead, digitizing at native speed (7.5 in/sec) can take half a day. We have had initial success digitizing at 4x speed, but we are examining the risk to data quality and equipment wear.

The end-to-end digitization, recovery, and calibration process is complex and requires specialized knowledge, not only making onboarding a slow, but also retaining the skill challenging. It is important to maintain a steady cadence so as not to forget steps and make mistakes.

Example FM tape



Routing of tape through the reader



Current Work

We are prioritizing digitizing, recovering, and calibrating events with publicly released yields (NNSA/NFO, 2015). We have tapes for 77 more of such events. Of these, we have digitized 27 and are now focused on extracting and calibrating the waveforms. These collection of events is diverse in seismic magnitude, with yields ranging from 370 t (TEMPLAR) to 870 kt (GREELEY).

1962-02-15 HARD HAT
1964-02-20 KLICKITAT
1966-03-24 TEMPLAR
1966-04-14 DURYEA
1966-04-23 FENTON
1966-05-05 CYCLAMEN
1966-05-06 CHARTREUSE
1966-05-27 DISCUS THROWER
1966-06-02 PILEDRIVER
1966-06-25 VULCAN
1966-06-30 HALFBEAK
1966-07-28 SAXON
1966-09-12 DERRINGER
1966-11-05 SIMMS
1966-12-20 GREELEY
1967-05-20 COMMODORE
1967-05-23 SCOTCH
1967-06-22 SWITCH
1967-12-10 GASBUGGY
1968-03-12 BUGGY
1968-09-17 STODDARD
1969-11-13 SCUTTLE
1970-02-05 LABIS
1970-05-26 FLASK
1970-12-18 BANEBERRY
1980-09-25 RIOLA
1982-01-28 JORNADA

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Reference

National Nuclear Security Administration, Nevada Field Office (2015). United States Nuclear Tests: July 1945 through September 1992. DOE/NV–209-REV 16. https://nnss.gov/publication-library/