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DATA REPORT ON SEISMOLOGICAL FIELD INVESTIGATION OF THE 29 JUNE 1992 LITTLE SKULL MOUNTAIN EARTHQUAKE

Submitted by
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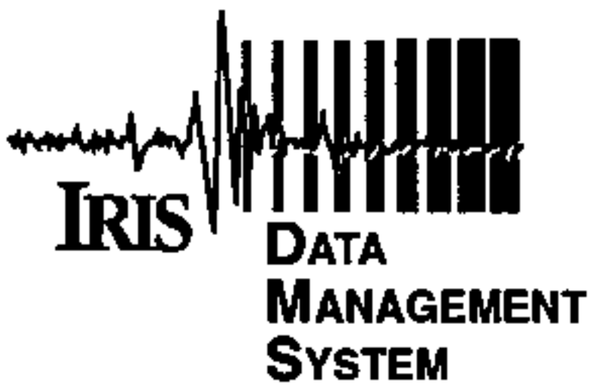
Seismological Laboratory

24 March 1994

PASSCAL Data Report 95-001



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ABSTRACT

This report describes data collected by researchers from the University of Nevada, Reno (UNR), during the June 29, 1992 Little Skull Mountain Aftershock Deployment. The UNR portion of this deployment consisted of a total of sixteen 3-component stations with a variety of sensors including broadband Guralp CMG4 seismometers, Guralp CMG5 strong motion accelerometers, and 2 Hz L22 and S-13 velocity sensors. The six L22 sensors used were provided by the IRIS PASSCAL instrument center at Lamont. This data report briefly describes the Little Skull Mountain mainshock, the field deployment, data format, and instrument responses. Data accompanying this report consist of digital waveform data recorded on Reftek instruments between julian day 184, 1992, and 006, 1993, EDA/PRS4 data collected between julian days 182 and 197, 1992, as well as cluster test data collected during February and March 1993.

CONTENTS

I-A. DESCRIPTION OF DEPLOYMENT AND OVERVIEW OF DATA REPORT

INTRODUCTION

The Little Skull Mountain earthquake occurred at 3:14 AM (PDT) on Sunday, June 29, 1992, about 20 km southeast of the potential high level nuclear waste repository at Yucca Mountain, Nevada. The magnitude was reported as 5.6, and the focal mechanism indicates normal faulting on a northeast trending structure. The Little Skull Mountain earthquake occurred less than 24 hours after a Ms 7.5 earthquake in Landers, California, and may have been triggered by this larger event.

FIELD DEPLOYMENT AND INSTRUMENT PARAMETERS

A number of portable instruments were installed in the region of Little Skull Mountain (LSM) beginning about one day after the mainshock by teams from the University of Nevada, Reno (UNR), the U. S. Geological Survey (USGS), and Lawrence Livermore National Laboratory (LLNL). This report discusses the data collected by the University of Nevada, Reno. Description of the field deployment by the USGS can be found in Meremonte et al. (1993). The first instruments deployed by UNR were three EDA/PRS4 portable digital recorders configured with S-13 1 Hz seismometers that were deployed late Sunday, June 29, 1992 (julian day 181). The first Reftek (Reference Technology, Inc. - manufacturer) portable recorders were deployed on Wednesday, July 2, 1992 (julian day 184). Station locations were determined using a handheld GPS system and verified using topographic maps. Errors in latitude and longitude are estimated to be no larger than 100 m. Sensors were oriented with a Brunton compass.

Reftek station information, including locations, dates of operation and instrument type, is provided in table format within this report. This information is also contained in the station logs included in this data release and the SEGY format binary data. Each Reftek Data Acquisition System (DAS) was equipped with an OMEGA clock that provided precise timing. Station logs provide information on timing for each station. The file TIME_PROBS describes timing problems experienced during the deployment.

All relevant information files are also listed in this report.

DATA DISTRIBUTION FORMAT

The Reftek waveform data provided with this data report are in binary SEGY format. EDA/PRS4 data are in binary PRS4 format and also in corresponding SAC format files (programs to convert from PRS4 binary format to SAC format as well as SEGY to SAC are included on 9-track tape). The user must refer to Table I-D below to determine station location, station name, and instrument type of the SEGY data.

All noise triggers have been deleted, and all remaining event triggers are included in this report. However, copies of the raw field tapes remain at UNR.

The file structure of the SEGY tapes is described in file 'desc.doc' in this report and on the tapes, and is briefly summarized here. For the Reftek data, the directories on the 9-track tapes

contain seismogram records for a range of julian days, and the range is reflected in the directory name (e.g., jd200.92-206.92.dir). Within such directories each Julian day and data stream has a separate directory, e.g., R200.01 for Julian day 200, data stream 1. The seismogram traces for all instruments are in these directories in files of the form: hh.mm.ss.0das.x, where hh.mm.ss are the trace start time, das is the Reftek DAS number, and x is the component (1-3 for data stream 1; 4-6 for data stream 2). Log and err files reside in the directory of the seismograms that they correspond to. The file reftapes.lst lists all the original Reftek data tapes, the julian day range they cover, and miscellaneous notes about them. EDA/PRS4 data are arranged by station and deployment tape number. These file names also contain the julian date of the recording. Drift corrections for the EDA are accounted for in the SAC files, and drifts for each deployment are listed in a table in this report. Raw data files collected on the EDA/PRS4's are also included and are not drift corrected. The directory SHELLS contains c-shell scripts used to manipulate the SEGY data.

Tapes included in this report:

Tape 1 - EDA Seismograms - PRS4 Binary and SAC format
Tape 2 - Reftek Files Julian Days 184-193, 1992
Tape 3 - Reftek Files Julian Days 194-200, 1992
Tape 4 - Reftek Files Julian Days 201-206, 1992
Tape 5 - Reftek Files Julian Days 207-222, 1992
Tape 6 - Reftek Files Julian Days 223-254, 1992
Tape 7 - Reftek Files Julian Days 225, 1992 to 006, 1993 and Cluster Tests 1 & 2
Tape 8 - Cluster test 3

Each 9-track tape includes three tar files. File 1 includes the actual data files for the above time periods and Unix shell scripts used for organizational purposes, whereas tar files 2 and 3 are duplicated on each tape. Tar file 2 includes all programs necessary for looking at PASSCAL format data, converting SEGY/PRS4 to SAC format. Tar file 3 includes all pickfiles generated from merging portable and network data as well as station location lists and the velocity model used in the relocation. In addition, the relocated hypocenters for the Little Skull Mountain sequence are also included in tar file 3; see technical report for description of the relocation procedure. Accessing particular tar files on a Unix format tar tape can be performed via no-rewind option in the tar command and/or the 'mt' Unix system command. See your Unix administrator for help if necessary.

INSTRUMENT RESPONSE

The original instrument response parameters provided by Guralp, the manufacturers, had some amplifications differing by a factor of two from the actual values as determined in the "cluster test" experiment described below. Guralp confirmed the corrected values in February, 1994, and only the corrected values are included in Table III-D.

In order to supplement and verify the factory calibrations of the seismometers, a "cluster test" was performed at the end of the experiment. This test consisted of

mounting most of the seismometers involved in the aftershock experiment, with about 0.25 m separation between seismometers, together on a single concrete pad of dimensions approximately 2×4 m. The seismometers were first connected to Reftek DAS's in such a way that the cluster test duplicated the setup of the last stations used in the experiment. The test was run in three stages, so that seismometers could be replaced and moved to other recording instruments if problems were noted, and so that station RXTN set up in the X tunnel could remain in place with a different set of seismometers at the beginning and end of the deployment. During the last stage of the cluster test, three EDA instruments hooked up to S-13 seismometers were included. After each segment of the cluster test, enough data from the seismometers were dumped onto disk so that at least one event that had recorded on most of the seismometers was available to examine for discrepancies between factory and field values. The data from the deployments reside in directories CLUSTER, CLUSTER2, and CLUSTER3 on 9-track tape provided with this report.

Tables with descriptions of notes from each deployment are included in Tables III.1, III.2, and III.3 in this report, and in a number of figures in this report. A final summary table in III.4 indexes the problems noted in the cluster test deployment to the station names and seismometer/DAS setups used in the deployment. Most of the seismometers and DAS's that were in the deployment were included in the cluster test, except as noted in Table III. An additional seismometer, a posthole CMG4, was also included in this test to see how it would perform for possible future use.

Sensitivity and response parameters for the Guralp instruments have recently been confirmed by the manufacturer and with help from the PASSCAL instrument group at Lamont.

All EDA/PRS4 instruments were configured with 1 Hz three-component Teledyne Geotech S-13 instruments with a manufacturer's reported coil constant of 629 V/m/sec for all components. We have confirmed the average value of $2.35 \pm 0.06\ 10^{-6}$ V/count for the EDA digitizer as used in the experiment. However, as seen in the figures in section III-C, when these values are used to compare the EDA/S13 records with the Reftek/Guralp records, the EDA/S13 amplitudes are a factor of two lower than the Reftek/Guralp amplitudes. This discrepancy is currently being examined. However, note that the timing and polarities, which have been the only data used in the report at this date, are not in question. Only the 3 stations YUC, BND, and DUN used EDA recorders until they were replaced by Refteks on July 14. Calibration pulses from the EDA/PRS4's are included in the data set, and three of the instruments were included in Cluster Test 3. The calibration pulses can be analyzed to determine a more exact instrument response function and are included with the EDA/PRS4 trace data. Calibration of the EDA/PRS4's is described in this report.

INSTRUMENT POLARITIES AND CHANNEL CONVENTIONS

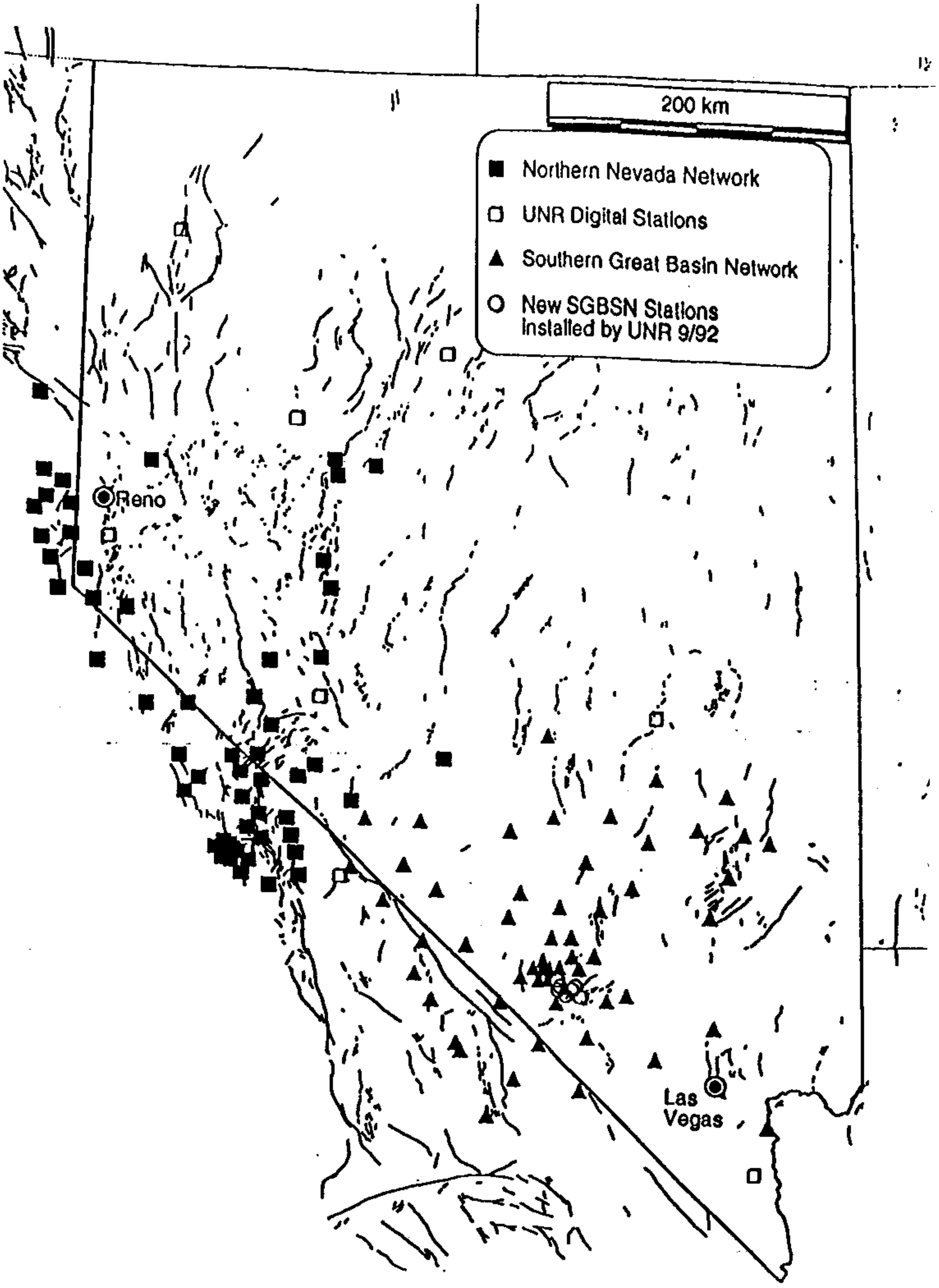
Channel 1 on all instruments had larger P waves than the other channels, and is thus almost surely the vertical component, as per the usual convention. The L22 channel 1 had opposite polarity from all the other instruments. The L22s and CMG4-posthole had identical waveforms on channels 2 and 3, which corresponded to channels 3 and 2 on the surface CMG4s and

CMG5s. Our engineer confirmed that the cables for the EDA's, the surface CMG-4's and CMG-5's were wired with the UNR convention or CH1=positive up, CH2=positive east and CH3=positive N. The Lamont documentation also confirms these results, which leads to the following table for positive voltage or counts:

Instrument	Channel 1	Channel 2	Channel 3
L22	Down	North	East
CMG4-posthole	Up	North	East
CMG5	Up	East	North
EDA	Up	East	North
CMG4 Surface	Up	East	North

I-B. MAP OF PERMANENT SEISMOGRAPH STATIONS.

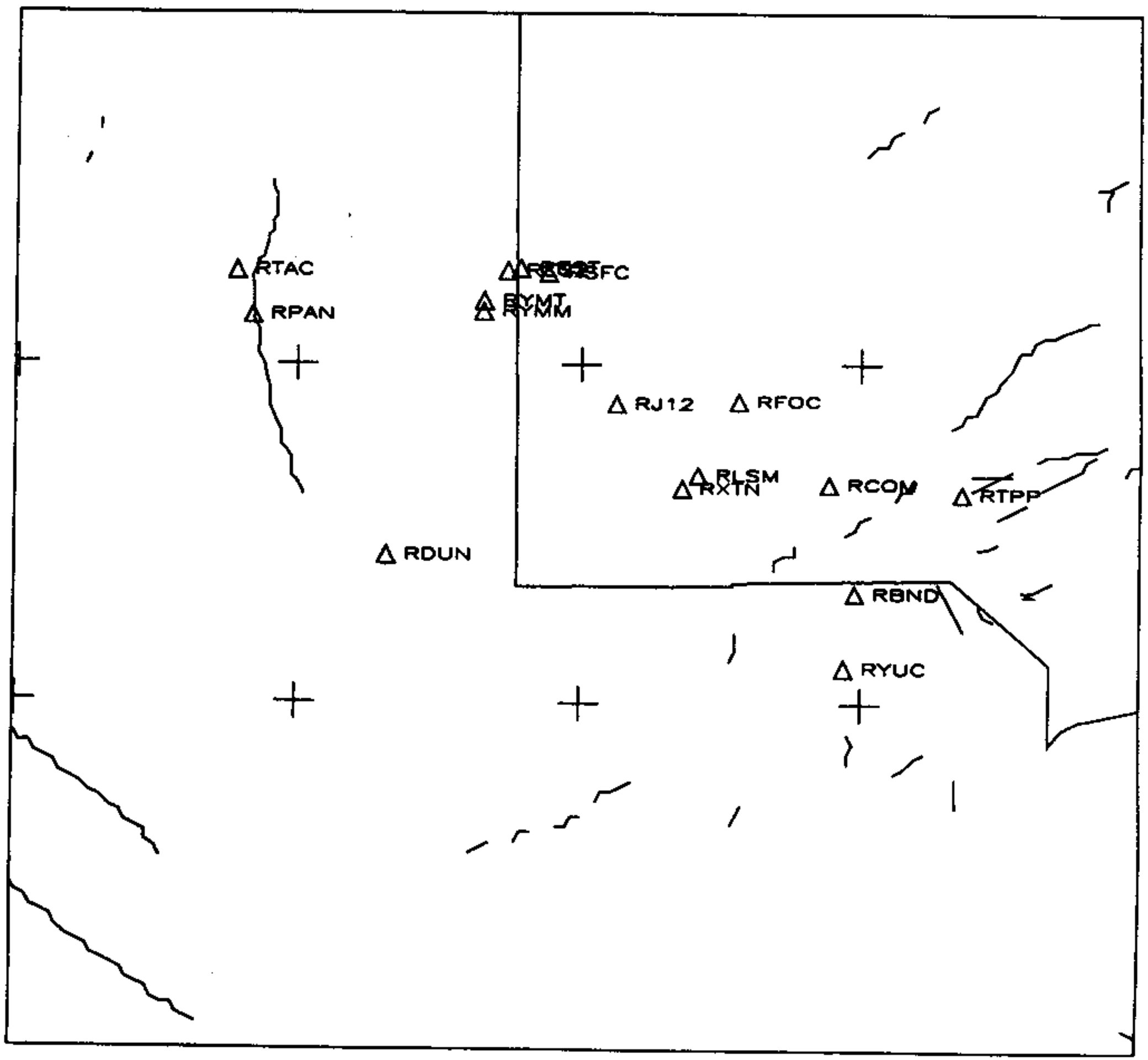
Southern Great Basin Seismic Network and Western Great Basin Seismic Network (aka Northern Nevada Network).


200 km
Northern Nevada Network
UNR Digital Stations
Southern Great Basin Network
New SGBSN Stations
Installed by UNR 9/92
Reno
Las
Vegas

I-C. MAP OF PORTABLE SEISMIC INSTRUMENTS.

Deployed by the University of Nevada, Reno, in Little Skull Mountain aftershock study.

Portable Stations — NTS Boundary Marked



PROJECTION: LAMBERT. CENTER: 36.50 −116.30 0.0
WINDOW CORNERS 36.4000 −116.8000 37.0000 −116.0000

I-D. LISTING OF PORTABLE STATIONS: INFORMATION AND PARAMETERS

1. UNR Little Skull Mountain Aftershock deployment - Station parameters.

stn		lat	lon	elev(m)	DAS	instrument	dates in operation
RXTN	X Tunnel	36.7261	116.3275	1054	428	CMG5 #5034	7/16/92 - 3/3/93
					435	CMG5 #5031	3/3/93 - 5/26/93
RYMM	Yucca Mtn Middle	36.8310	116.4688	1529	406	L22 #459	7/29/92 -
						L22 #511	- 1/6/93
RYMT	Yucca Mtn Top	36.8371	116.4683	1549	427	CMG5 #5029	7/5/92 - 1/5/93
RYUC	Specter Range	36.6206	116.2117	847	434	L22 #475	7/11/92 - 1/5/93
REST	Electrical Storage Trailer	36.8557	116.4430	1250	428	CMG5 #5034	7/4/92 -7/13/92
					424		7/13/92 -7/16/92
RES2	Electrical Storage Trailer	36.8543	116.4520	1293	432	CMG5 #5028	7/18/92 -11/21/92
RFOC	Field Oper. Ctr.	36.7779	116.2868	1006	413	CMG4 #4046 ch456	7/2/92 - 7/3/92
						L22 #490 ch123	7/2/92 - 7/3/92
						CMG4 #4046 ch1-6	7/3/92 - 10/27/92
						CMG4 #4046 ch123	10/27/92 - 12/10/92
						CMG5 #5035 ch456	10/27/92 - 12/10/92
					424	CMG5 #5035 ch1-6	9/29/92 - 10/27/92
RTAC	Tarantula Canyon	36.8539	116.6442	1500	425	L22 #490	7/4/92 - 7/11/92
						L22 #459	7/11/92 - 7/13/92
					406	L22 #459	7/13/92 - 7/29/92
RTPP		36.7229	116.1288	1132	431	L22 #502	7/13/92 - 1/5/93
RCOM	Skull Mtn	36.7285	116.2223	1136	430	CMG4 #4044	7/13/92 - 7/16/92

						CMG4 #4045	7/16/92 - 11/4/92
RLSM	Little Skull Mtn	36.7339	116.3161	1215	426	CMG5 #5002	7/4/92 - 7/7/92
						CMG5 #5030	7/7/92 - 1/6/93
RLS2	new LSM stn				427	CMG5 #5029	3/5/93 - 5/6/93
RDUN	off-site, Crater	36.6865	116.5363	824	429	L22 #508	7/15/92 - 1/4/93
RBND	Boundary	36.6646	116.2041	1157	433	L22 #511	7/10/92 -
						L22 #459	- 11/20/92
RSFC	Surface Facility	36.8531	116.4237	1092	432	CMG5 #5032	7/3/92 - 7/5/92
					432	CMG5 #5031	7/5/92 - 7/16/92
					435	CMG5 #5031	7/16/92 - 11/19/92
RJ12	near well J12	36.7764	116.3747	1050	406	CMG4 #4045	7/2/92 - 7/2/92
					406	L22 #453 not oriented	7/2/92 - 7/3/92
					406	CMG4 # 4044	7/3/92 - 7/6/92
					435	CMG4 # 4044	7/6/92 -7/13/92
RPAN	Panama Mine	36.8286	116.6326	1250	429	L22 #489	7/4/92 - 7/13/92
						L22 #508	7/13/92- 7/15/92

2. UNR Little Skull Mountain Aftershock deployment - Station Parameters and Performance

AUGUST 9, 1992

stn	DAS	instrument	Trig. Ratio	Gain Ch123	Gain Ch456	#events bit	#events out of 26	mag. range	comments
L22's:									
RYMM	406	L22 #459	3	1	-	32	3	2.3+	3 data streams (DS) defined - doesn't make sense - only one DS used mag 2.3 barely above noise -gain too low

RYUC	434	L22 #475-2	3	1	-	32	3	2.3+	mag 2.3 barely above noise
RTAC	406 425	L22 #490							
RTPP	431	L22 #502	3	32	8192* * ch456 not used	32	34		1.1+ high gains definitely improve performance many events, not too many noise trigs nothing clipped (even m 3.65) m 2.3 well recorded - well above noise 6 channels and 2 data streams defined but only 3 ch and 1 DS used (L22's are cabled such that only 3 channels can be used at one time)
RDUN	429	L22 #508	3	-	8	32	0	X	3 data streams defined - doesn't make sense - only one DS used
RBND	433	L22#459	3	1	-	32	3	2.3+	mag 2.3 barely above noise need higher gain
---									
CMG5's:									
RXTN	428	CMG5 #?	3	1	not set	32	13	1.5?	needs higher gain ch456 not defined so gain unknown ch456 unusable
RYMT	427	CMG5#T-5029	5	1	8	32	disk filled		
RES2	432	CMG5#T-5028	3	1	8	32	disk filled		
RLSM	426	CMG5#T-5030	3	1	8	32	18	1.1+	excellent performance almost all triggers are events lo gain ch's bad drift
RSFC	435	CMG5#T-5031	3	1	8	32			no data on Aug 9 (did tape fill up?)

CMG4's:

RFOC	413	CMG4#T-4046	2.6	1	8	16	6	1.8?	DS1 clipped on m3.65 event, DS2 on scale only 2 noise triggers (on both DS1&2)
RCOM	430	CMG4#T-4045	3	1	8	32			no data on Aug 9 (did tape fill up?)

Trigger ratios changed sometime in mid-August

NOVEMBER 1992 - JANUARY 1993

stn	DAS	instrument	Trig. Ratio	Gain Ch123	Gain Ch456	bit	#events 18/18/34	mag. range	comments

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L22's:

RYMM	406	L22 #459	3	1	-	16	Jan1 X Nov1 1 3.23+ Nov3		gains too low
RYUC	434	L22 #475-2	3	1	-	16	Jan1 1 2.76+ Nov1 1 3.23+ Nov3		gains too low
RTAC	406 425	L22 #490							
RTPP	431	L22 #502	5	1		16	Jan1 1 2.76+ Nov1 1 3.23+ Nov3		gains too low
RDUN	429	L22 #508	3	-	1	16	Jan1 1 2.76+		barely recorded

							Nov1 0	gains too low
							Nov3 0	ch 5 bad (OK in August)
RBND	433	L22 #459	5	1	-	16	Jan1 X	
							Nov1 1 3.23+	gains too low
							Nov3 0	

CMG5's:

RXTN	428	CMG5 #?	5	1	-	16	Jan1 1 2.76+	hi-gain only. should set up
							Nov1 4 1.8+	lo-gain on next site visit.
							Nov3	gain too low
RYMT	427	CMG5#T-5029	5	1	8	16	Jan1 1	
							Nov1 1 3.23+	gain too low
							Nov3	
RES2	432	CMG5#T-5028	5	1	8	16	Jan1 X	
							Nov1 2 2.37+	gain too low
							Nov3 0	
RLSM	426	CMG5#T-5030	5	1	8	16	Jan1 2 0.88+	lo gain more sensitive than hi
							Nov1 X	
							Nov3 8 0.74+	
RSFC	435	CMG5#T-5031	5	1	8	16	Jan1 X	bad drift on ch 2, 5
							Nov1 1 3.23+	much construction-related noise
RFOC	413	CMG5#T-5035	3		1	16	Jan1 X	
							Nov1 1 3.23+	
							Nov3 0	

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CMG4's:

RFOC  413   CMG4#T-4046  3     1          16    Jan1 X
                                               Nov1 2 2.37+     DS1 clipped on M 3.23 event
                                               Nov3 0

RCOM  430   CMG4#T-4045  5     1     8    16    Jan1 X
                                               Nov1 X
                                               Nov3 1 2.07+

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Nominal Instrument sensitivities
(consult calibration and test sheets for more info on individual instruments)

L22      velocity:                 88 V/m/s

CMG4*    velocity:      lo-gain 546 V/m/s       hi-gain 54600 V/m/s


CMG5     acceleration: lo-gain .522 V/m/s**2    hi-gain   5.2 V/m/s**2

Instrument responses:
L22      2 Hz free period
CMG4   0.1 - 50 Hz
CMG5   frequency band dc to 80 Hz

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II. WAVEFORM DATA FROM REFTEKS

II-A. SUMMARY DESCRIPTION

Directories contain seismogram records for a range of julian days, and the range is reflected in their name (e.g., jd200.92-206.92.dir).

Within such directories each julian day and data stream has a separate directory, e.g., R200.01 for julian day 200, data stream 1. The seismogram traces for all instruments are in these directories in files of the form: hh.mm.ss.0das.?, where hh.mm.ss are the trace start time, das is the DAS number, and ? is the component (1-3 for data stream 1; 4-6 for data stream 2).

The file reftapes.lst lists all the Reftek data tapes, the julian day range they cover, and miscellaneous notes on them.

The directory SHELLS contains miscellaneous c-shell scripts useful for manipulating the data and file structures.

In addition, the main directory contains the following file types:

*.0das.log, *.0das.err - (* is either tape number or the julian day the tape was collected from the field. Tape numbers are a site abbreviation followed by a zero-padded digit, e.g. rymt008.) The log and error files for the Reftek seismometers are output by the program ref2segy. A copy of each log file (and error file, if one exists) in which at least some events are in the julian day range of the directory is included.

*.jday1.yr1_jday2.yr2.? - these are "mark" files, lists (subdirectory and filename) of non-noise events. They thus list the events contained in these directories. A copy of each mark file relevant to the directory's julian day range is included.

* is either the DAS number or the tape name for individual mark files; the name "allmark" is for merged and sorted mark files. These thus list all non-noise events for the given julian day range.

? is one of the characters 1, 2, 3, 4, or R. 1 is locatable local events; 2 is regional events; 3 is teleseisms; 4 is unpickable or unknown events; R ("rest") is files containing all of types 2, 3, or 4.

Certain directories also contain readme (0readme, README) files with specific notes.

II-B. PROCEDURE FOR ARCHIVING AND EDITING EVENTS OFF REFTEK TAPES

(1) Use PASSCAL program ref2segy to dump Reftek tapes from a given time period (i.e., julian day range) into a directory. Directories are typically named with the julian day range included, e.g. "jd207.92_212.92.dir". ref2segy will automatically create subdirectories in the current directory of the form Rjday.0s, where jday is the julian day (always 3 digits) and s is the data stream number (1 or 2). Files in these subdirectories each contain a single trace and their names have the form: hh.mm.ss.0das.?, where hh, mm, ss are the hour, minute, second, respectively, of the event trigger time; das is the 3-digit DAS number of the instrument; and ? is the single digit extension for the Cartesian component to which the trace corresponds (1, 2, or 3 for data stream 1; 4, 5, or 6 for data stream 2). Note that the year of the trigger is not used in any of the file structure naming, although it is present in the file header itself.

(2) Use program pql2 to scan and "mark" all events on the tapes. pql2 is a version of the PASSCAL program pql that includes a "mark" option. Filenames (i.e., traces) selected with the mouse can be written into files having the names "mark.?", where ? is a single-digit file extension 0-9. Current conventions for the digit are:

1 = local event
2 = regional event
3 = teleseismic event
4 = unknown/unpickable event.

Noise triggers are not marked.

These "mark" files can then used as inputs to shell scripts. Currently, the scripts keep all filenames appearing in any of the mark lists. Filenames not appearing at all are assumed to be noise traces and deleted.

(3) Run the script namedas.sh to rename the "mark" files. namedas uses the DAS number of the instrument to locate its corresponding .log file; then it extracts the beginning and ending julian days from the .log file; finally it uses this information to construct a new name of the form:

DAS#.jday1.yr1_jday2.yr2.?

where DAS# is the DAS #; jday1, yr1 are the beginning julian day and year; jday2, yr2 are the ending day and year; and ? is the digit extension of the mark file name (1-4). (For some older mark files, all events corresponding to event types 2 through 4 are included in a single file with extension "R", for "rest".)

(4) A tar tape archive (1/4 inch cassete tape) is made of the entire directory.

(5) Noise triggers are then removed by running the shells. Do this as follows:

(a) merge all the mark files with the shell sortmark.sh. This generates sorted, merged mark files of the form: allmark.day1.yr1_day2.yr2.?, where again jday1, yr1 are the beginning julian day and year; jday2, yr2 are the ending day and year; and ? is the digit extension of the mark file name (1-4, or R).

sortmark.sh determines the julian day range to use in the name by examining the range of Rjday.0s subdirectories.

The allmark files, since they are sorted, are also convenient for visual scanning to determine if a particular event with known time was detected, and if so by what instruments.

(b) Use the shell script days.sh or daysj.sh to delete all records not explicitly appearing in the allmark* files (i.e., all noise triggers). Use days.sh if the subdirectories containing the event files are very large; daysj.sh may be used (and is faster) if the subdirectories are modest-sized.

Both days.sh and daysj.sh ultimately call the shell noisej.sh to actually scan the subdirectories and delete files not appearing in the allmark lists. The only difference is that days.sh uses the script hours.sh as an intermediate, to scan only one hour at a time. This takes longer but avoids overflow on very large data sets.

NOTE: both days.sh and daysj.sh were updated on 6/30/93 to determine the julian days to treat by examining the R*.0? subdirectories in the current directory. Hence they now DO NOT need to be edited to specifically list the julian days before each use. They now will work within all directories without modification.

noisej.sh, which does the actual comparison, only compares the filestems up to the component extension; i.e., the final "1, 2, 3" or "4, 5, 6" representing the Cartesian component to which the trace belongs. Thus, if any component is present in the mark lists, all components will be preserved. For example, if the filespec R206.01/00.33.24.0431.1 is present in any one of the allmark.* files, noisej.sh only uses the stem R206.01/00.33.24.0431. for comparison, and all files having this same stem will be preserved.

days.sh can take several hours or even most of a day to run on large directories containing many files, so plan accordingly.

All shells must be run in the directory in which the julian day directories (i.e., all the directories with names of the form Rjday.0s, where jday is the julian day and s is the data stream number) are stored. All mark files must also exist in this directory.

At the conclusion of days.sh or daysj.sh, only the "real" triggers are left; all noise is deleted.

(6) Now make a tar archive tape of the directory and mark it "events only".

(7) At this point movall.sh may optionally be used to move the entire edited directory to permanent disk storage, typically onto the optical drive.

II-C. List and description of C-shells for manipulating Reftek data

A plus sign (+) denotes those not routinely needed for downloading, editing, and archiving events from Reftek tapes; an asterisk (*) denotes shells or awk programs that are called by other shells, and hence not generally executed directly:

+arrange.sh - rearranges a seismo data directory organized by site into one organized by julian day; i.e., from subdirectories named by site, each containing julian day directories for that site (e.g., RBND/R200.01, etc.), to one containing only julian day directories, each of which contains records for that day from all sites.
Arguments: none.

+clobdir.sh - delete only empty Reftek julian day directories (i.e., directories with names of form Rjday.0n, where jday is the 3-digit julian day and n is the data stream number.)
Arguments: none

+cnvtrig.sh - converts old edited "trigger" files, made fall 1992, into new "mark" format. This is probably no longer needed, but kept just in case. Files are assumed to have extension .s?e, where ? is 1 or 2 for the data stream. These files contain all the seismogram records to keep, in a somewhat different format from the mark files; they're the events as extracted from the .log files by the Unix utility grep. Files with extension .s?p are also looked for; these contain the subset of events (identified only by event number) that correspond to locatable events ("1" extension in the new convention.) Mark files of the form: mark.filestem.? are output; a "1" extension is all locatable events; the "R" ("rest") are all other events (marked with .2, .3, or .4 in the new convention).
Arguments: filestem of files to process (generally tape number; e.g., rbnd007).

days.sh - The main high-level routine for deleting noise triggers off the disk. It calls hours.sh (which in turn calls noisej.sh) with a range of julian days to treat.
NOTE: days.sh now determines the range of julian days to use automatically by extracting the Jday from all the R*.0? subdirectories in the current directory (updated 6/30/93). Hence, this shell NO LONGER must be edited ad-hoc each time to explicitly put the proper julian days in the outer foreach list.
Arguments: none

daysj.sh - version of days.sh that calls noisej.sh directly, rather than thru hours.sh. It can be used when the number of triggers for a whole julian day is small enough that the shell won't overflow.
NOTE: daysj.sh also now determines the range of julian days to use automatically by extracting the Jday from all the R*.0? subdirectories in the current directory (updated 6/30/93). Hence, this shell NO LONGER must be edited ad-hoc each time to explicitly put the proper julian days in the outer foreach list.

Arguments: none

*hours.sh - Calls noisej.sh for each hour individually, 0-23, for a given julian day. This avoids overflowing the shell on very large data sets, where the number of triggers even in a single day is more than the C-shell can handle. hours.sh is generally called by days.sh rather than used directly.
Argument: julian day to treat.

movall.sh - moves an entire seismo directory, with its subdirectories assumed to be of form Rjday.0?, all at once. Typically used to move a directory between disks, such as to the optical drive.
Argument: directory to move.

markupd.sh - used to update the mark files when files have been renamed and have had their time header changed by timechng.sh. markupd.sh uses the awk program markupd.{DAS}.awk (where {DAS} = DAS number of instrument) which is generated by timechng.sh. This contains lines with the old and new filenames in the format of an awk pattern-match program.
Arguments: DAS number (including leading zero if one exists) and specification of mark files to change (wildcards are OK; more than one mark file can be updated).

namedas.sh - renames mark.? files output by the modified pql (i.e., lists of filenames of records to keep) according to the DAS number and the period of time the mark file covers. Format is as follows:
das.jday1.yr1_jday2.yr1.?,
where das is the DAS number; jday1, jday2 are the beginning and ending julian days, respectively; yr1, yr2 are the years of the julian days; and ? is the single character numeric extension (generally 1, 2, 3, or 4) of the mark file. Typically a mark file covers a single Reftek data tape. namedas.sh extracts the times covered automatically from the corresponding .log file (which is output by ref2segy) for the data tape, using the awk program times.awk. The log file must exist in the same directory as the mark files, and must have the format xxx.0das#.log, where das# is the DAS number. The proper log file is identified automatically from the DAS number. Modified 5/93 to use new format log files, generated by latest version of ref2segy.
Argument: DAS number.

+namemark.sh - Similar to namedas but obsolete with new directory structures. namemark renames a mark.? file according to the name of the directory it's in, which is assumed to be the site name; e.g., RBDN.jday1.yr1_jday2.yr1.?, where jday1, etc., are as with namedas. Again, the julian day range is extracted from the .log file using times.awk, but the .log file used is assumed to be the only .log file in the current directory.
Argument: none

+namemrk2.sh - temporary version of namemark for renaming the new mark files generated from the "trigger" files by cnvtrig.sh. The .log files are assumed to be in /wave/motion/scratch/yucca/LOGS.

Argument: none

+noise.sh - deletes all files in a directory structure that don't appear in any of the (note carefully) _renamed_ mark files. This shell does NOT recognize the "mark.?" filenames output by the new pql; they must be renamed first. The shell must be run from the level above the julian day directories; i.e., the current directory must contain directories of the form Rjday.0?, each of which contains seismogram files. It requires the .awk programs nextdir.awk and nextstem.awk.

This is the early version and is generally unusable for large data sets, as the shell's internal variables overflow. Instead, use days.sh (described above) in conjunction with hours.sh and noisej.sh.

Argument: none

*noisej.sh - this is the working version of noise.sh. It deletes all the records not appearing in the mark files for a single julian day only (and optionally only a single hour in a single julian day). This is to avoid overflow of the shell's internal variable lists for directories containing large numbers of records (as when hundreds of noise triggers exist). Both data streams are handled automatically. It also requires the .awk programs nextdir.awk and nextstem.awk, and generates the temporary files edirs.awk and templist in the current directory. Last (note carefully!) it REQUIRES that ALL the markfiles with a particular extension (i.e., all files of form *.*.*.?, where ? is 1, 2, 3, 4, or R) to have been merged, via the shell sortmark.sh, into a master list allmark.*.*.?

Argument: julian day (required), hour (0-23 inclusive; optional)

+ref2sac.sh - old shell for converting Reftek records downloaded by ref2segy to SAC format and copying them off to either a "locatable" or an "archive" directory. It used the edited trigger files (*.s?e) and associated lists of pickable events to determine which files to convert and where to copy them to. Files not appearing in the trigger files (i.e, noise) are neither copied nor converted. This version is now obsolete; it uses the old edited "trigger" files and assumes a site-based directory structure, and thus would need to be extensively revised.

sortmark.sh - merges and sorts all the renamed mark files (assumed to have names of the form *.*.*.?) into a single sorted file allmark.jday1.92_jday2.92.?, where the julian day range is determined from the range of the Rjday.0? subdirectories.

Arguments: none.

timechng.sh - this shell changes the start times of both a seismogram trace file itself and of the trigger time by adding a constant "offset" time to both. It calls segyhdr to get the current times and uses segymod to insert the new times. It also renames the file with the new time, and creates a new julian day subdirectory for it if necessary. The

shell keeps track of the filename changes in an output file markup.{DAS}.awk (where {DAS} is the instrument DAS number). This file is in the format of an awk program that will substitute all occurrences of the old name with the new name, and can be used by the shell markupd.sh to change the filenames in the mark files.

The subshell timeoff.sh does the direct manipulations on each individual file. The shell also needs the Fortran program newtime.f, which adds a time and an offset, both expressed in years, days, hours, minutes, seconds, and milliseconds, and outputs the result as a string of space-separated integers with explicit leading zeros.

Arguments: filespec time_offset

Filespec MUST contain an explicit julian day subdirectory specification and MUST be enclosed in single quotes. It may contain wildcard characters so that various combinations of data stream, julian day, DAS number, etc. can be specified.

Time_offset is in the format: year day hour minute second millisecond, all space-separated. If low-order values are zero they may be omitted; zero values before a non-zero value, however, must be explicitly specified.

Examples:

csh timechng.sh 'R*/*' 0 30 4 6

add a time offset of 30 days, 4 hours, and 6 minutes to all files

csh timechng.sh 'R*.01/*.0427.?' 1

add a time offset of 1 year exactly to all data stream 1 files for DAS #427.

*timeoff.sh - this changes the start and trigger times for a specific file, and renames it with the new time, creating a new subdirectory if necessary. It is called as a subroutine by timechng.sh. It is NOT generally called directly.

Arguments: filename markupname.awk offset

where filename is a single seismogram filename (no wildcards!) with explicit leading julian day directory, markupname.awk is the filename into which the correspondence between the old and new filenames is logged (in the format of an awk program), and offset is the time offset, in the same format as timechng.sh.

+ttimes.sh - uses times.akw to find the beginning and ending julian days in a Reftek logfile or trigger file.

NOTE: has been modified to work with the .log files generated by the new ref2segy. Will not work on old (PASSCAL v. 1.3 or earlier) logfiles!

Arguments: extension of files to search (.log or .trig)

*nextdir.awk - nawk program to get the next unique directory in a mark list (which consists of lines with directories prefixed to file names; thus the same directory name is commonly repeated at the beginning of each line). Used by noise, noisej, etc.

*nextstem.awk - nawk program to get the next unique filestem for a seismogram file in a list (either a directory list or mark file list). Seismogram files come as triplet, with extensions 1,2,3 (or 4,5,6) for the individual cartesian coordinates. This routine strips off the extension, as either all three seismogram files are kept or deleted; there's no point in separately checking each one. Used by noise, noisej, etc.

*parsdir.awk - get the name of the immediately overlying directory (e.g., RBND if current path is /yucca/s0/DATA/RBND). Used by cnvtrig.

*times.awk - extract the beginning and ending events (line containing EV:) from a Reftek .log file. Used by several shells (times, namedas, namemark, etc.).

II-D. MASTER LIST OF REFTEK DATA TAPES

	pulled from field	# trigs	DAS #	julian days	remarks
FOC001	184 jjp	23	413	184	spiky atop signals; 1st RFOC tape
FOC002	185 jjp	46	413	184-185	still v. spiky; 2nd RFOC tape
NLSM001	193 jjp	119	426	192-193	actually 1st RLSM
R5086001	189 jjp?	12	425	186-188	all noise, deleted
R5102001	189 jjp?	104	429	186-188	
RBND001	196 jjp	103	433	193-196	entered gain=1 for ch 4,5,6; jday 193-195
RBND002	212 jjp	284	433	196-212	entered gain=1 for jday 197
RBND003	227 jjp	455	433	212-227	
RBND004	256 jjp	264	433	227-256	
RBND005	305 jjp	347	433	257-305	
RBND006	6/93 kds	184	433	305-325	
RCLC001	184 kds	27	426	184	all spiky noise, deleted
RCOM001	198 kds	2872	430	196-198	ch 2,3 all noise; ch 1 has wavy baseline note on tape: "N-S alignment was backwards"
RCOM002	202? bwh	2904	430	198-202	marked as pulled on 201; entered gain=1 for ch 6, jday 198 entered gain=8 on 2nd (chk) dnload 2/8/93
RCOM003	210 jjp	2288	430	202-205	
RCOM004	226 jjp	2288	430	210-212	
RCOM005	254 kds	4494	430	226-245	event #'s repeat; 1-1798; 1-28; 1-1; 1-2665
RCOM006	307 jjp	1130	430	255-307	
RCOM007	6/93 kds	165	430	307-309	
RDUN001	212 jjp	64	429	197-208	entered g=1 for ch 4,5,6; jday 197; all noise, deleted
RDUN002	227 jjp	870	429	212-227	entered g=1 for ch 1,2,3; jday 212
RDUN003	256 jjp	340	429	227-256	
RDUN004	306 jjp	1112	429	257-306	
RDUN005	6/93 kds	236	429	306-004	

RES2001	206 jjp	1143	432	202-206	
RES2002	229 jjp	181	432	224-228	
RES2003	212 jjp	4351	432	206-208	
RES2004	223 jjp	2391	432	212-214	"4540 on tape"
RES2005	308 jjp	2598	432	259-308	also marked as pulled 304
RES2006	5/93 kds	722	432	304-326	"station dead when serviced"
REST001	189 jjp	1855	428	186-188	1st log incorrect, trunc. @ 127
REST002		111	428	188-195	2 copies of tape; entered sample rate=100 & gain=1 for ch 1,2,3
REST003	198 jjp	433	424	195-198	where is tape #002?
RFOC001	189 jjp	93	413	185-187	spiky
RFOC002	197 jjp	291	413	189-197	spiky
RFOC003	206 jjp	302	413	197-206	spiky locally
RFOC004	210 jjp	43	413	206-207	ch 1 noisier, spiky
RFOC005	226 jjp	475	413	210-226	
RFOC006	255 jjp	208	413	229-252	
RFOC007	301 jjp		413	88/004?-92/296	CMG4 test
RFOC008	301 jjp		424	274-296	CMG5 test
RFOC009	6/93 kds		413	302-345	
RJ12001	186 jjp	16	406	185	ch 2 glitched, v. noisy
RJ12002	188 jjp	556	406	186-188	"unidentified block no. error 32156, code 9C"; varying baseline
RJ12003	194 jjp	2862	435	188-193	
RJ12004	195 jjp	395	435	194-195	ch 1 & 3 events baseline clipped - pick ch 2 only
RLSM001	197 jjp	330	426	193-197	
RLSM002	203 lg	725	426	198-203	also scanned by slg, 9/12 says pulled 202
RLSM003	209 jjp	1230	426	203-209	
RLSM004	228 kds	2614	426	209-228	
RLSM005	253 kds	2976	426	228-253	
RLSM006	307 kds	163	426	253-307	

RLSM007	6/93 kds	1053	426	307-006	
RPAN001	194 jjp	231	429	188-194	ch 1 glitched all the way thru
RPAN002	197 bwh	73	429	195-197	entered gain=1 for ch 4,5,6, jday 195
RSFC001	189 jjp	292	432	186-189	
RSFC002	206 jjp	811	435	202-206	lots of baseline glitches, many deleted
RSFC003	212 jjp	4351	435	206-208	
RSFC004	228 jjp	118	435	224-228	
RSFC005	226?jjp	596	435	212-213	"uniden. block #32810, code 9A"; all noise, deleted
RSFC006	254?jjp	630	435	228-237	also Jdays 252-254? says pulled "524"
RSFC007	305 jjp	2142	435	255-305	
RSFC008	324?wn	1007	435	305-324	pulled Nov 92 by Wally Nicks
RTAC001	211 jjp	12	406	195-197	entered gain=1, ch 4,5,6; jday=195; repeated 3 times on tape!
RTPP001	210 jjp	1643	431	195-210	
RTPP002	226 jjp	1657	431	210-226	
RTPP003	253 jjp	356	431	226-253	on 11/6
RTPP004	302 jjp	157	431	254-302	
RTPP005	6/93 kds	165	431	302-005	
RTST001	197 jjp	10	428	197	"check battery charge" - all noise, deleted
RXTN001	205 jjp	4	428	198	
RXTN002	228 kds	2157	428	209-228	
RXTN003	209 jjp	429	428	205-209	
RXTN004	254 kds	161	428	228-254	records repeated on tape. DS 2 all noise
RXTN005	303 jjp	161	428	255-303	
RXTN006	6/93 kds	212	428	304-006	
RYMM001	jjp 228	135	406	211-226	
RYMM002	slg checked; this is dupe of RSFC005; evidently real RYMM002 was lost (accidentally overwritten?). "unid. blk #32810 code 9A"; much more than 7 events!				

RYMM003	jjp 305	55	406	257-271	
RYMM004	6/93 kds	103	406	305-337	
RYMT001	189 jjp	2034	427	187-189	
RYMT002	199 jjp	385	427	189-199	duplicate of all tape records at end
RYMT003	206 jjp	558	427	200-206	
RYMT004	228 jjp	75	427	223-228	
RYMT005	212 jjp	4348	427	206-208	
RYMT006	223 jjp	1864	427	212-213	"1864 vs. 3391" events noted (?)
RYMT007	254?jjp	1481	427	229-254	entered gain=1 for ch 1-6, sample rate=100 for DS 1&2 also set up short file w/DAS 430 w/6 events @ 2670, go with RCOM3 written as "pulled 524"
RYMT008	303 jjp	103	427	234-282	
RYMT009	6/93 kds	1722	427	305-005	
RYUC001	196 jjp	116	434	193-196	entered gain=1 for ch 4,5,6; jday 193-194
RYUC002	212 jjp	311	434	196-212	entered gain=1 for ch 4,5,6; jday 197
RYUC003	227 jjp	134	434	212-227	
RYUC004	256 jjp	73	434	227-245	more than 73 events but repeated @ end
RYUC005	305 jjp	17	434	257-258	
RYUC006	6/93 kds	146	434	305-005	

Explanation of headings:

"Pulled from field" - julian day this tape was retrieved, & initials of person retrieving.

"trigs" - number of triggers (also called events) on the tape.

"julian days" - julian days the tape covers

"remarks" - remarks, including known problems with tape. This includes problems encountered while reading the tape in, and any notes made on the tape itself.

Dramatis Personae:

afs - Anne F. Sheehan
bwh - William W. Honjas
jjp - John J. Perry
kds - Kenneth D. Smith
lg - Lee Grassechi
phil - Phil Rogers (undergrad assistant)
sf - Suzy Feng
slg - Stephen L. Gillett
wn - Walter Nicks

II-E. SUMMARY OF TIMING PROBLEMS WITH REFTEK DATA

This summarizes timing problems with Reftek stations used in the UNRSL portable deployment to record aftershocks of the June 29, 1992 Little Skull Mountain earthquake.

From July 1992 through mid-September 1992, all stations were fast by 2 seconds because the Reftek DAS software was hardwired for 15 leap seconds when in fact there were 17 leap seconds. The DAS software version used was version 2.41. To correct, subtract 2 sec from all picked times. Pickfiles included on tape have been corrected for any timing irregularities.

On September 9 and 10, 1992, the Reftek DAS's were upgraded to version 2.47 of the DAS software (involves replacing 2 eproms) and the omega boards were upgraded from PCB 1008 to PCB 1009. In version 2.47 of the DAS software the leap seconds must be entered by hand under station/xck setup. Unfortunately, the leap seconds were not entered and other major timing errors were also made (time must be set under "time" menu on hand terminal, as with v. 2.41). A summary of the timing errors for this time period (mid-Sept 92 to late Oct/early Nov 92) are listed below. We have used the reference time provided by two nuclear tests on NTS in September of 1992 to make time corrections. Corrections have been made to the hour for data on included tapes. Some timing errors may persist but are recoverable. All REFTEK data is synchronized (OMEGA synchronization) relative to a one second mark.

Tape		Julian days	Min	Sec	
RBND	005	257 - 305		-7	
RCOM	006	255 - 307	+1	-17	
RDUN	004	257 - 306		-7	
RES2	005	259 - 308	-3	+3	
RFOC	007	255 - 273		-7	(corrected jday 274 = 9/30/92)
RLSM	006	253 - 307		+3	
RSFC	007	255 - 305	+3	+13	
RTPP	004	254 - 302		-7	
RXTN	005	255 - 303	+1	-17	
RYMM	003	257 - 271		+3	
RYMM	004	305 - 337		0	
RYMT	008	254 - 302	+30	0	
RYUC	005	257 - 258		-7	

In late October/early November 1992 the stations were serviced and close attention was paid to the timing (including the leap seconds) and the major timing problems as listed above were eliminated (except for RYMM, as noted).

Timing performance and clock drift can be further assessed using the PASSCAL clock performance display program "clockview" for openwindows. 'clockview' displays clock performance data extracted from PASSCAL Reftek logfiles. Specifically, it plots external phase error, internal clock time jerks, DSP time resets, and external clock lock

status. clockview has a screendump function and a pick function for echoing ASCII values of data points. It displays only one logfile at a time.

The PASSCAL program 'segyshift' can be used to correct for small time shifts (milliseconds to seconds).

The PASSCAL program 'segymod' can be used to modify header values of SEGY files and can be used to correct for the larger time offsets (hours, days, and years). A shell timechng.sh (which uses a subshell timeoff.sh and a small Fortran program newtime.f) has been written which uses 'segyhdr' and 'segymod' to automatically correct an entire directory structure for a timing problem. The correction is entered as an offset in the form: years, days, hours, minutes, seconds, and milliseconds. The filenames are also renamed automatically with the new times, but the correspondence between old and new filenames is logged in the file markup.{das#}.awk. Refer to this file if the original (i.e., as downloaded) filename is needed, for example if the event needs to be found in the Reftek .log file. (This file is written out as an awk program to make updating the mark files easier; use markupd.sh to update the mark files.)

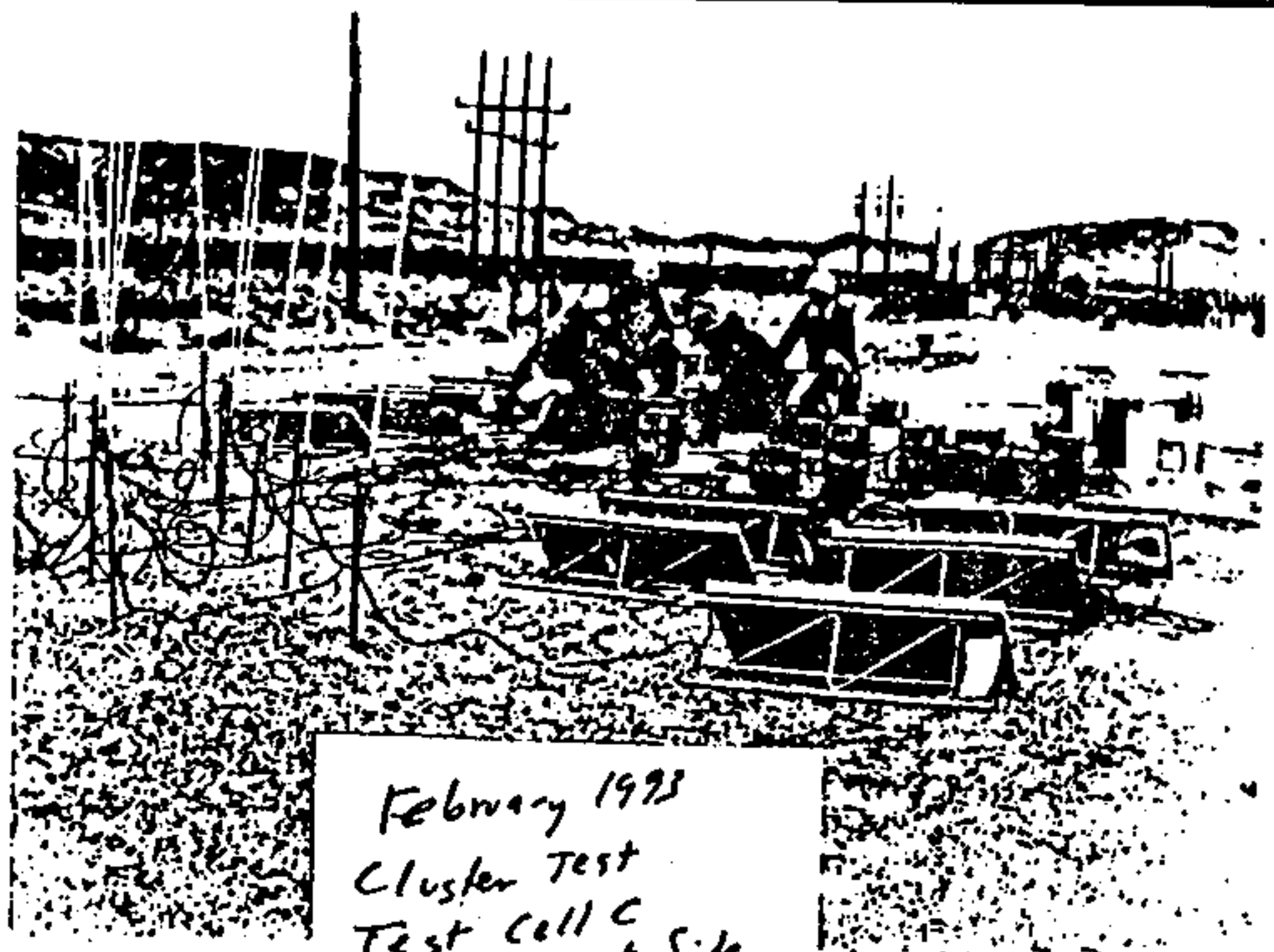
See the shell documentation (section II-C) for detailed information on using timechng.sh.

To determine whether this directory has had the timing corrections applied already, see if it contains any "markup.{das#}.awk" files. If not, it has not been corrected. In addition, if the mark files have been corrected, they will exist in two versions: an original version, and a corrected version with ".new" affixed.

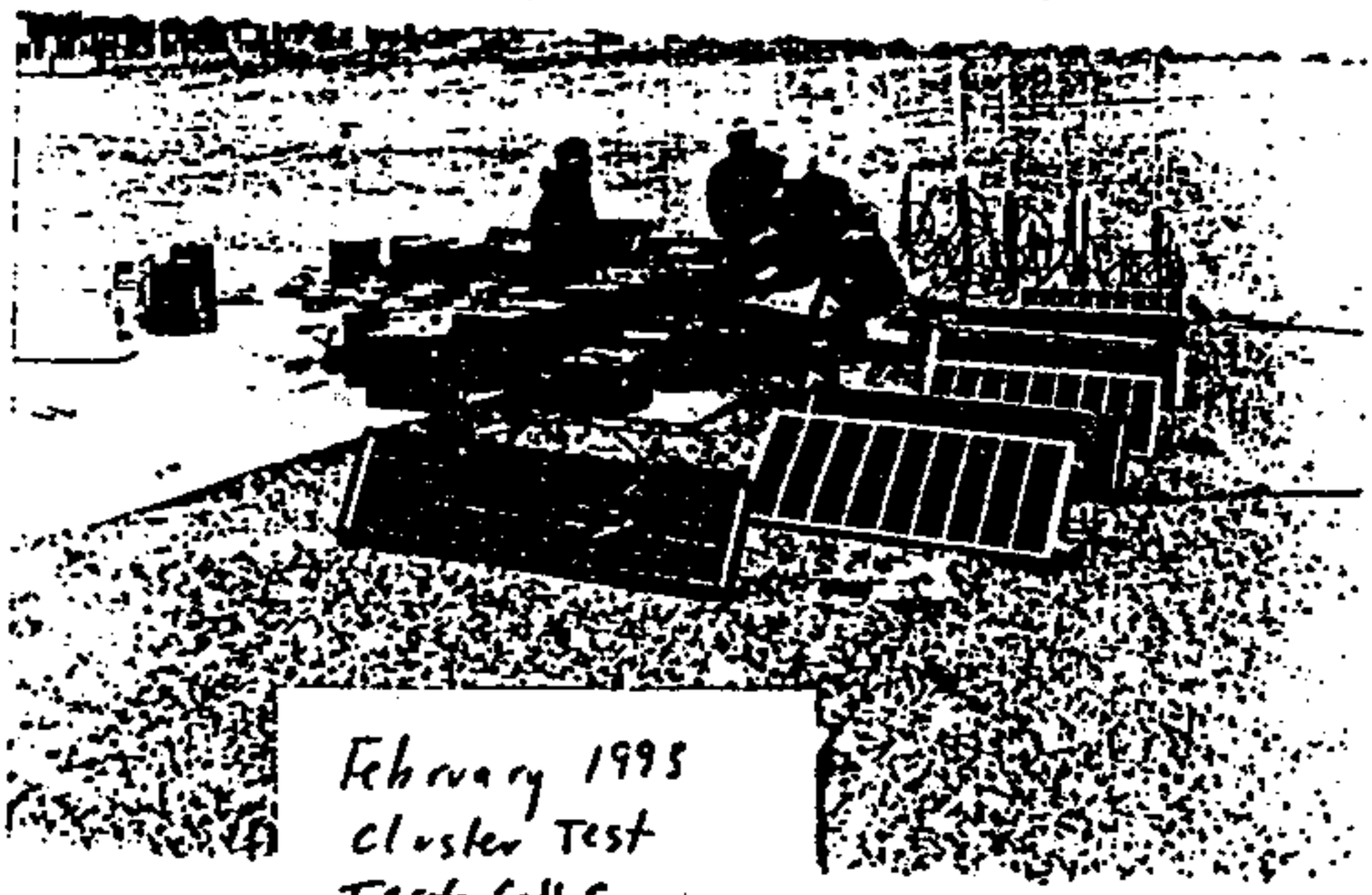
III. INSTRUMENTS/CLUSTER TEST

III-A. PHOTOGRAPHS OF CLUSTER TEST DEPLOYMENT.

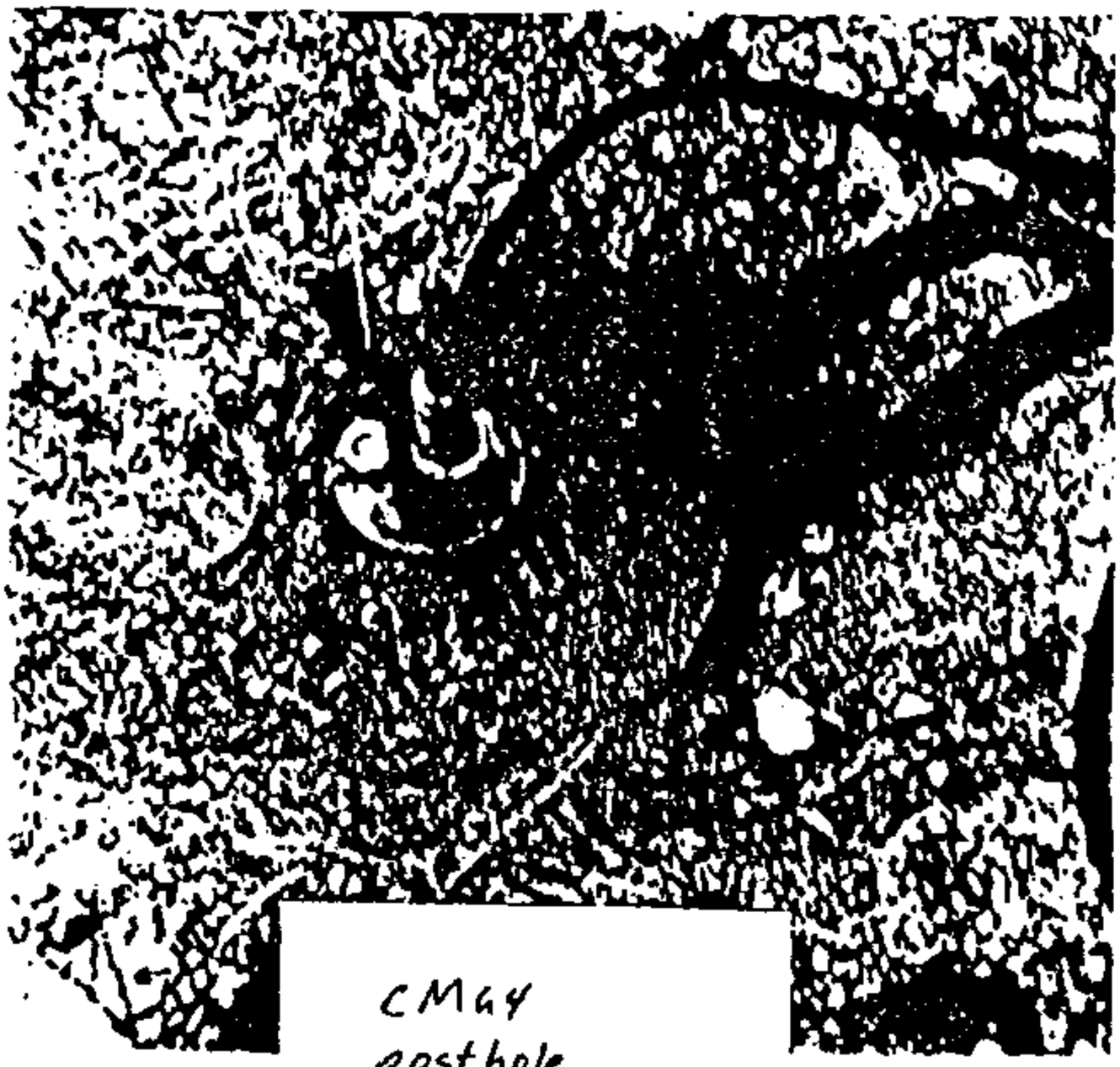
February 1993 at Test Cell C of the Nevada Test Site.



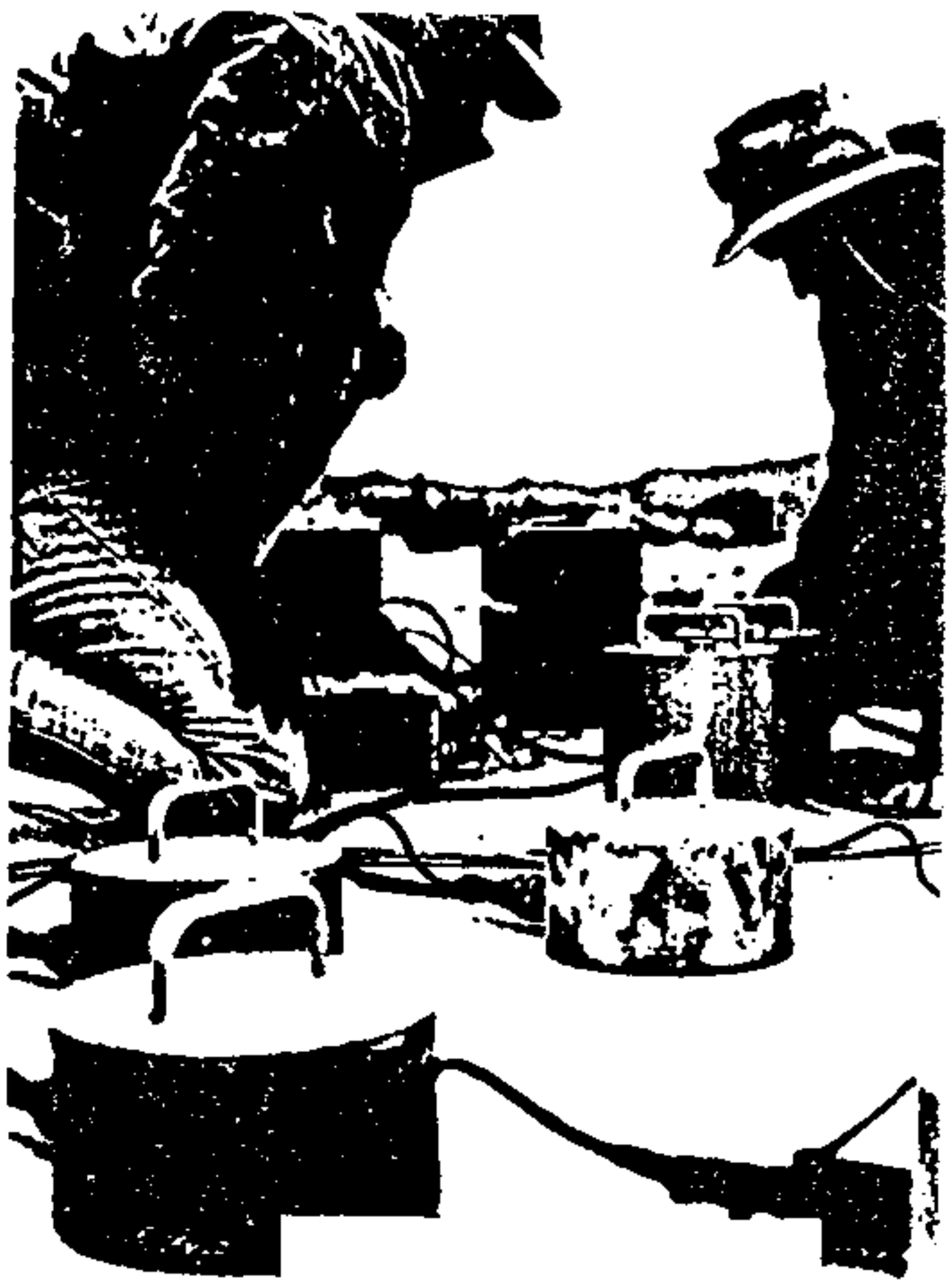
February 1993
Cluster Test
Test Cell C
Nevada Test Site
Sheehan, Smith,
Savage, Brune



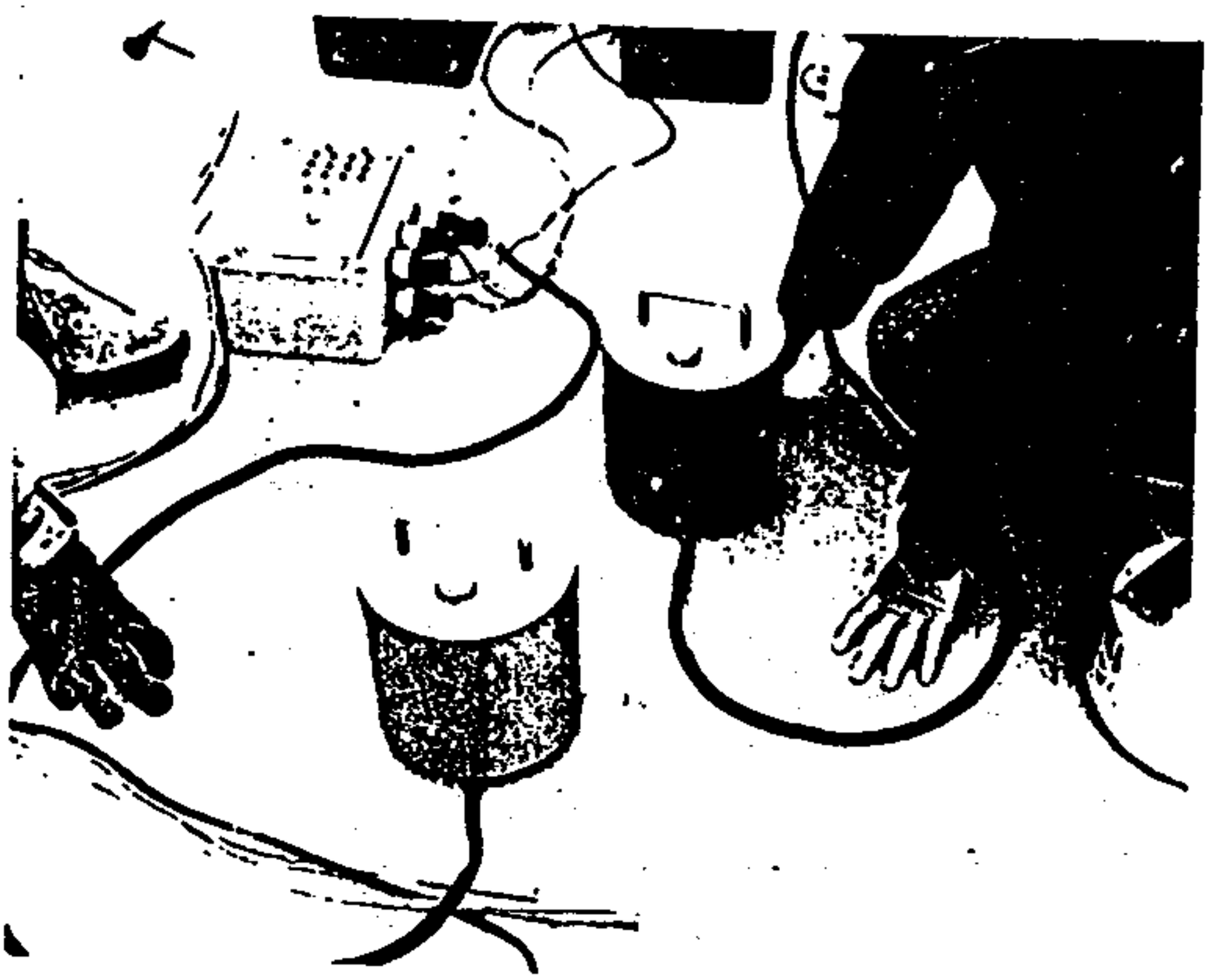
February 1995
Cluster Test
Test Cell C
Nevada Test Site
Savage, Smith, Sheehan



CMG4
posthole
seismometer



LZZ seismometer
(Foreground)
CMG4 seismometers
(Background)



CMG4 surface
seismometers

Feb 1993
Cluster test
Test Cell "C"
Nevada Test Site

III-B. INSTRUMENT PERFORMANCE/TRIGGER PARAMETER PERFORMANCE

1. UNR Little Skull Mountain Aftershock deployment - Cluster Test Parameters and Performance

FEBRUARY 1993

stn	DAS	instrument	Gain Ch123	Gain Ch456	days recorded	comments
L22's:						
1	433	L22 #511			034-038	ok
		DS2 tele				
		L22 #496				ok
2	434	#475	32	-	034-042	
3	406	#459	32	-	034-042	Amplification of Ch1 bad
4	429	#508	32	-	034-042	junk! 1 sec period spikes
5	431	#502	32	-	034-042	too many triggers
CMG4's:						
6	413	#4046	1	-	034-037	short term average too short - triggers on spikes
7	430	#4045	-	1	035-041	lots of noise and drop-outs but big events look good ch 5 bad drift
CMG5's:						
6	413	#5035	-	8	034-037	
8	426	#5030	1	8	035-042	
9	432	#5028	1	8	035-042	ch 1 amplification bad; ch 5 noisy
10	427	#5029	1	8	035-042	
11	435	#5031	1	8	035-042	
borehole CMG4:						
12	424	#4058				not written to tape; see Cluster 2 table

2. UNR Little Skull Mountain Aftershock deployment - Cluster Test Parameters and Performance

FEBRUARY -MARCH 1993

stn	DAS	instrument	Gain Ch123	Gain Ch456	days recorded	comments
L22's:						
1	423	L22 #511	32	-	043-047?	waveforms good
	DS2	teleseism (511)	32		043-047?	not good triggers
	DS3	L22 #496	-	32	043-047?	waveforms good
2	434	#475	32	-	043-062	waveforms good
	teleseism		32	-	043-062	not good triggers
3	406	#459	32	-	043-062	ch 1 amplification bad
	teleseism		32	-	043-062	not good events
4	429	#508	32	-	043-	ch 1, 5 amplification bad; removed DAS for repair
	teleseism				043-	not good events
5	431	#502	32	-	043-062	waveforms OK, but long-period drift on ch1 sets off triggers
	teleseism				043-062	not good events
CMG4's:						
6	413	#4046	1	-	043-044	waveforms OK ch 1-6, but stopped too soon.
7	426	#4045	1	8	043-044	bad: long-period noise on ch 1-2 causes it to hit both stops
	DS2			8	043-044	long-period drift on ch 5; probably seismometer
	DS3	teleseismic	1		043-044	
CMG5's:						
6	413	#5035	-	8	043-044	waveforms OK. seis.
8	430	#5030	1	8	043-062	waveforms OK chs 1-3.
	DS2 -lo			8	043-062	long-period noise on chs 4-5, but event OK
	DS3-teleseismic		1		043-062	

9	432 #5028	1	8	043-061	Ch 1 gain seems low
	DS2-lo			043-061	Ch 5 drift problem
	DS3-teleseismic	1		043-061	
10	427 #5029	1	8	043-061	waves OK.
	DS2-lo			043-061	waveforms OK.
	DS3-teleseismic	1		043-061	
11	435 #5031	1	8	048-058	OK last time, lost first few
	DS2-lo		8	048-058	days data this time so couldn't
	DS3-teleseismic	1		048-058	compare
borehole CMG4:					
12	424 #4058	1	8	043-061	waveforms OK
	DS2-lo		8	043-061	Only configured for CH 1-3
	DS3-teleseismic	1		043-061	

3. UNR Little Skull Mountain Aftershock Deployment - Cluster Test Parameters and Performance
(Most comments from examining event on Day 066 13:21 and Day 063 22:54)

MARCH 1993

stn	DAS	instrument	Gain Ch123	Gain Ch456	days recorded	comments
L22's:						
1	423	L22 #511	32	-	062-067?	waveforms good
	DS2	teleseism (511)	32		062-067?	not good triggers
	DS3	L22 #496	-	32	062-067?	waveforms good
2	434	#475	32	-	062-062?	playback time jump no data
3	406	#459	--	32	062-065	too many noise triggers but event day 063 22.54 looks good all chs 4-6 too many noise triggers --no good events
4	not used-removed to be fixed					
5	431	#502	32	-	063-067	waveforms OK,
		#508	--	32	063-067	Waveforms good
CMG4's:						
6	413	#4046 DS1	1	-	063-076	waveforms look good--clipped on big event
6.5	430	#4045	1	8	063-076	long-period noise ch 2 and 5 caused to hit stops --must be seismometer 4045 (event on 066.13.21 clipped ch 3 and partially clipped 1)
		DS2		8		long-period drift on ch 5 but still recorded events unclipped
		DS3 teleseismic	1			ch 2 had long-period noise causing it to hit stops

CMG5's:						
6	413	#5028 DS2			063-076	waveforms look good ch 4-6 Note: same DAS as #4046
7	426	#5030	1	-	063-070	Channel 1 looks almost identical to Ch 2 and different from all other seismometer channels
				8	063-070	Channels all look good and like other seismometer same-channels
7.5	428	#5034	1	8	063-076	all channels look good
9	432	#5035	1	8	063-065	Waveforms look good, but long-period harmonic noise
		DS2-lo		8	063-065	Ch 5 has irregular noise, but earthquakes look good
borehole CMG4:						
12	424	#4058	1	8	063-068	waveforms OK
		DS2-lo		8	063-068	bad chs on DAS or seis.? (seismometer channels not hooked up)
		DS3-teleseismic	1			good waveforms on big event
EDA's:						
36	1418(1-z), 1416(2-E), 1409(3-N)				062-070	waveforms OK polarities and channels like CMG4 regular
39	1415(1-z), 1419(2-E), 1406(3-N)				062-070	waveforms OK polarities and channels like CMG4 regular
56	1417(1-z), 1405(2-E), 1414(3-N)				062-070	waveforms OK except Channel 3 bad-high-freq. and low amp polarities and channels like CMG4 regular All waveforms in cluster test appear to be a factor of two too low compared to the other records.

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4. Problems Revealed by Cluster Test by Instrument Type and Former Name

Column Orientation gives the direction for each channel indicated by positive voltage; Chs 4,5,6 are same as 1,2,3 respectively, for same seismometer type (e.g., CMG5 or L22 or CMG4)

Stn	DAS	Seism.		Orientation	Problems in Cluster Test
RXTN	428	CMG5 #5034		ch1=up;ch2=east;ch3=north	No Problems
"	435	CMG5 #5031		ch1=up;ch2=east;ch3=north	No Problems
RYMM	406	L22 #459		ch1=down;ch2=north;ch3=east	DAS ch1 amp too low; others OK
	"	L22 #511		ch1=down;ch2=north;ch3=east	Seismometer OK but DAS ch1 bad in cluster
RYMT	427	CMG5 #5029		ch1=up;ch2=east;ch3=north	No Problems
RYUC	434	L22 #475		ch1=down;ch2=north;ch3=east	No Problems
REST	428	CMG5 #5034		ch1=up;ch2=east;ch3=north	No Problems
"	424	"		"	No Problems
RES2	432	CMG5 #5028		ch1=up;ch2=east;ch3=north	ch1 amp too low; others OK
RFOC	413	CMG4 #4046	ch456	ch4=up; ch5=east; ch6=north	No Problems
"	"	L22 # 490	ch123	ch1=down;ch2=north;ch3=east	seismometer not in cluster test
"	"	CMG4 #4046	ch1-6	ch1=up;ch2=east;ch3=north	No Problems
"	"	CMG4 #4046	ch123	ch1=up;ch2=east;ch3=north	No Problems
"	"	CMG5 #5035	ch456	ch1=up;ch2=east;ch3=north	No Problems
"	424	CMG5 #5035	ch1-6	ch1=up;ch2=east;ch3=north	No Problems
RTAC	425	L22 #490		ch1=down;ch2=north;ch3=east	Not in Cluster Test
RTPP	431	L22 #502		ch1=down;ch2=north;ch3=east	No Problems
RCOM	430	CMG4 #4044		ch1=up;ch2=east;ch3=north	seismometer not in cluster test
"	"	CMG4 #4045		ch1=up;ch2=east;ch3=north	Seismometer ch 2 & 5 bad drift
RLSM	426	CMG5 #5002		ch1=up;ch2=east;ch3=north	DAS good Seismometer not in cluster test
"	"	CMG5 #5030		ch1=up;ch2=east;ch3=north	No Problems

RLS2	427	CMG5 #5029	ch1=up;ch2=east;ch3=north	No Problems
RDUN	429	L22 #508	ch1=down;ch2=north;ch3=east	ch 1 bad--DAS
RBND	433	L22 #511	ch1=down;ch2=north;ch3=east	No Problems
	"	L22 #459	ch1=down;ch2=north;ch3=east	No Problems
RSFC	432	CMG5 #5032	ch1=up;ch2=east;ch3=north	Seismometer not in cluster test: DAS OK
"	"	CMG5 #5031	ch1=up;ch2=east;ch3=north	No Problems
"	435	CMG5 #5031	ch1=up;ch2=east;ch3=north	No Problems
RJ12	406	CMG4 #4045	ch1=up;ch2=east;ch3=north	Problem with DAS 406 ch 1 in cluster test seismometer bad drift on ch 2 &5
"	406	L22 #453	ch1=down;ch2=north;ch3=east	DAS problem ch1 in cluster seismometer not in cluster test-not oriented
"	406	CMG4 #4044	ch1=up;ch2=east;ch3=north	DAS problem ch1; Seismometer not in cluster test
	435	CMG4 #4044	ch1=up;ch2=east;ch3=north	DAS good Seismometer not in cluster test
RPAN	429	L22 #489	ch1=down;ch2=north;ch3=east	DAS ch 1 bad Seismometer not in cluster test
"	"	L22 #508	ch1=down;ch2=north;ch3=east	DAS ch 1 bad, Seismometer OK