Appendix A: Northern California Earthquake Data Center

Description

The Northern California Earthquake Data Center (NCEDC) is a long-term archive and data distribution system for seismic and earthquake-related data of northern California. The NCEDC is a jointly funded project of the UC Berkeley Seismographic Station and the United States Geological Survey.

The major networks contributing data to the NCEDC are:

- The UC Berkeley Digital Seismic Network (BDSN), which contributes continuous and event-triggered digital broadband seismograms, event-triggered digital strong motion seismograms, and earthquake hypocentral parameters and phase data.
- The USGS Northern California Seismic Network (NCSN), which contributes event-triggered digital short-period seismograms, earthquake hypocenters, phase parameters, and first motion data.
- The Bay Area Regional Deformation (BARD) network, which contributes continuous GPS data. The BARD network is a joint project of the UC Berkeley Seismographic Station, the USGS, and the Lawrence Livermore National Labs (LLNL).

Data Sets

The following data sets are available from the NCEDC.

- Continuous and event-triggered digital broadband seismograms from 1991 to the present.
- Event-triggered digital short-period seismograms from 1984 to the present.
- Event-triggered digital strong motion seismograms from 1991 to the present.
- Earthquake hypocenter catalog from 1910 to the present.
- Earthquake phase data from 1967 to the present.
- Earthquake first motion data from 1967 to the present.
- Continuous GPS data from 1993 to the present.

Data Access

The NCEDC is accessible via the Internet. The table below lists the hostname and IP address of the NCEDC as well as information required to access data on the NCEDC.

hostname:	**quake.geo.berkeley.edu**
IP address:	**128.32.146.106**
WWW homepage:	**http://quake.geo.berkeley.edu/**
Bulletin board account:	**bulletin**
Bulletin board password:	**board**
Anonymous ftp account:	**anonymous**
Anonymous ftp password:	*your email address*

Data may be accessed or retrieved from the NCEDC using several methods:

- World Wide Web (WWW) browsers, such as Mosaic.

  Many of the data sets are available via the WWW, including earthquake catalog, phase and first motion data, GPS data, and broadband and strong motion digital seismograms. The address of the WWW homepage for the NCEDC is provided in the table above. The WWW interface is the easiest access to the Data Center.

- Bulletin board account. The NCEDC maintains a public bulletin board account that provided terminal-based access to the NCEDC data. The bulletin board account information is provided in the table above.
- Anonymous ftp. Certain data sets, such as the GPS data and various documents describing the NCEDC are available via anonymous ftp. The anonymous ftp account information is provided in the above table.
- Research accounts. Researchers with legitimate scientific research needs can acquire a personal full-access account on the NCEDC. To request an account, either connect to the NCEDC via the WWW or bulletin board account, fill out the form requesting a RESEARCH account, and you will be contacted with the account information.

If you have questions or comments concerning the NCEDC, you may contact the Data Center manager at the following address.

Contact:	NCEDC Manager
Address:	UC Berkeley Seismographic Station
	475 McCone Hall
	Berkeley, CA 94720-4760
email:	adm@quake.geo.berkeley.edu
phone:	510-642-3977
fax:	510-643-5811

Appendix B: BDSN Broadband Station Instrumentation

Overview

During 1992 the Berkeley Digital Seismograph Network (BDSN) consisted of broadband instruments residing at nine locations: ARC, BKS, CMB, MHC, ORV, PKD1, SAO, STAN, and WDC. During this time interval, the instrumentation at three of the sites (CMB, MHC, and SAO) was upgraded. As of 12/31/94, the BDSN consists of twelve broadband stations with continuous telemetry to UC Berkeley for recording and analysis.

The representation of transfer functions for each BDSN data stream can be decomposed into an analog component and a digital component. The development of the transfer function given here closely parallels parts of Appendix C in Version 2.3 of the SEED Reference Manual (Feb. 1993; contributed by C. R. Hutt) and the reader is referred to this manual for more detailed information.

Three different dataloggers were in operation during 1992: a PC-based system, a DRS-based system and a Quanterra system. The first two have 16-bit integer resolution and the third has 24-bit integer resolution. Event detection algorithms are used with the DRS- and Quanterra systems. The event detections are used, in part, to initiate the telemetry of triggered data streams. All data are archived at the NCEDC and are available via Internet.

In this appendix, we provide station descriptions and transfer functions for the twelve BDSN stations in operation as of 12/31/94.

Generation of the Transfer Functions

The transfer function is constructed from up to 4 components: seismometer, analog filters, digitizer, and digital filters. In the sections which follow, the seismometer output is given in Volts per unit ground motion (meters/sec for all instruments except the FBA-23 force balance accelerometers which are in meters/sec^2). The analog filters (both simulated galvanometer and anti-aliasing) are Volts in and Volts out. The digitizers are Volts in and digital units (DU or counts) out. The digitizer sensitivity is nominally 3276.8 and 400,000 counts per volt for the 16 bit and 24 bit resolution systems, respectively. Digital FIR filters are only used in the Quanterra dataloggers. The following section and Appendix B provide the details of the analog pole-zero and digital FIR filter representation of the transfer functions. The resulting transfer function, G, at angular frequency ω which includes both analog,A_c, and digital, H_c, representations is

$$G(\omega) = A_c(\omega)H_c(\omega)$$

where the components are as described below. Note that $H_c(\omega) = 1.0$ if there is no digital component.

Analog Pole-Zero Representation

This representation is widely used to describe the frequency response of a seismometer system because it is easy to implement via computer codes. The polynomials representing the seismometer and associated filters are specified by their roots. The N roots of the numerator polynomial are the instrument zeroes (Z) and the M roots of the denominator polynomial are the instrument poles (P). Because the polynomials have real coefficients, the complex poles and zeroes occur in complex conjugate pairs. By convention, the real parts of the poles and zeroes are negative, which leads to the following functional form:

$$A(\omega) = S_d \ A_0 \ H_p(\omega)$$

where

- $A(\omega)$ is the overall response of the seismometer system in digital units per unit ground motion at angular frequency ω;
- S_d is the scaling factor which converts ground motion to digital units (representing the effective digitizer sensitivity in digital units per Volt); and

A_0 is the normalization factor at a specified reference frequency (representing seismometer sensitivity in Volts per unit ground motion). A_0 is chosen to be the inverse of $H_p(\omega)$ at the reference frequency:

$$H_p(\omega) = \frac{\prod_{n=0}^{N}(s - Z_n)}{\prod_{m=0}^{M}(s - P_m)}$$

and s is the complex angular frequency, $i\omega$.

Calibration Accuracy

The overall calibration accuracy of the force-feedback seismometer systems is better than 1 percent within the passband for all BDSN broadband seismometer systems. These seismometer systems are inherently as stable as their associated feedback electronics. As a test of the calibration stability, the absolute calibration of the NS component STS-1 seismometer at MHC was checked using a 3 microradian resolution tilt table four years after it was initially installed, and found to be within 0.8 percent of the values supplied by the manufacturer (Uhrhammer and Collins, 1990). The calibration accuracy of the Model H-5100 Sprengnether seismometers sited at BKS (until 09 May 1991) is not nearly as stable. The H-5100 seismometers operate inertially without feedback at a natural period of 100 seconds and require occasional recentering and adjustment of their natural period in order to maintain calibration. The natural period and centering was typically checked once a month and the natural period was only adjusted when it drifted more than about 10 percent from its nominal value of 100 seconds (Marvin Hilger, personal communication, July 1993).

The FIR filters employed by the Quanterra dataloggers contribute significantly to the overall calibration accuracy. Neglecting this component can lead to errors as large as five percent within the flat passband (DC to 0.8 of the Nyquist frequency). The greatest differences are in the upper half of the passband but differences of order 2 percent are present at low frequencies. Thus, the biggest source of calibration error is ignoring the effects of the FIR filters.

Data Telemetry and Storage Formats

Three different digital data acquisition and telemetry systems were used in the BDSN network during 1992: (1) a PC-based system, (2) a prototype DWWSSN DRS-based system and (3) a Quanterra system. The PC-based systems at BKS, MHC, and SAO were replaced with Quanterra systems in 1992, leaving PKD1 as the only station being acquired with 16-bit digitizers (the PC-based system was replaced at PKD1 in Feb 1993). The DRS-based system was used only at CMB and this was replaced with a Quanterra datalogger in 1992. At the end of 1992, Quanterra dataloggers were installed at ARC, BKS, CMB, MHC, ORV, SAO, STAN, and WDC. All the systems use continuous telemetry over leased telephone lines or microwave circuits. The telemetry rates are 9600, 2400 and 19200 bps for the PC, DRS & Quanterra based systems, respectively. All communication links are duplex.

PC-based system:

The data word for all data streams is a 16-bit signed integer with a range of +32767 to -32768 counts. The data are telemetered in 20 sample packets in a compressed format using first differences to reduce the average telemetry bandwidth requirement. The data are then uncompressed for storage. For a detailed description see "A PC-Based Broadband Digital Seismograph Network" (Bolt et al, 1988)

Digital Recording System (DRS)-based system:

The data word for all data streams is a 16-bit signed integer with a range of +32767 to -32768 counts. For a detailed description, see pages 187-190 of the Directory of World Digital Seismic Stations (Ganse and Hutt, 1982)

Quanterra system:

Two types of Quanterra dataloggers are employed in the BDSN network. The Q935 system is a 9 channel recording system. 6 of the 9 channels are high-resolution 24-bit digitizers; the remaining 3 channels are medium-resolution 20-bit digitizers. The Q680 system has 6 channels of high resolution digitizers and does not have the medium resolution channels. Both the Q680 and Q935 employ the same event detection and filtering algorithms. The data word is a 32-bit signed integer (2's complement format). Typical actual resolution is equivalent to 24 bits in a 1-10 Hz bandwidth. In thermally stable vaults, the dynamic range below 1 Hz approaches 25 bits. The 24-bit dynamic range is +8388607 to -8388608 counts. The data are telemetered and archived in a compressed format using the Steim 1 compression algorithm. This algorithm stores 1, 2 or 4 byte quantities as necessary to represent first differences. See Appendix B in Version 2.3 of the SEED Reference Manual (Feb 1993; contributed by C. R. Hutt) for a detailed description.

Event Detection Algorithms

Two types of event detection algorithms are used, one for the DRS-based system and one for the Quanterra systems. The PC-based systems are continuously telemetered and do not use event detection algorithms.

DRS-based system:

Events are detected on the BH channels on an absolute amplitude threshold basis. The threshold is switch selectable and its value is encoded into the data headers. Normally, the threshold was increased during the winter months in order to reduce the number of noise triggers.

Quanterra system:

The Murdock and Hutt event detector (Murdock and Hutt, 1983) is implemented as the event detector in the SHEAR software used in the Quanterra dataloggers. This detector operates only on vertical component data streams with sample rates of 1 sps or higher (HH, BH, LH, HL, BL & LL). The corresponding horizontal components are triggered by the vertical component detection. All detection messages are telemetered as part of the console log. The HH and HL data streams are telemetered only when a corresponding event is detected. The BL & LL data streams, when a corresponding event detection occurs, are stored locally on the Quanterra disk and are retrieved if required by dialing up the station.

There are 12 detector parameters listed in Chapter 4 of the Quanterra SHEAR Software Configuration Guide (Revision B, 1991). Five of the parameters have a significant effect on the performance of the detector. Suggested values for the parameters are given in a final report to IRIS (Murdock, 1990). The actual detector parameter values are listed in the AQCFG file installed on each Quanterra. The detector parameters used during the 1990-1991 period are the default values shipped by Quanterra in the SHEAR software distribution.

Explanation of Table Parameters

Stream Information:

Data Stream: Follows the SEED naming convention, where the three characters are the band code, the instrument code and the orientation code, respectively.

Band Code:
- H - High Broad Band
- B - Broad Band
- L - Long Period
- V - Very Long Period
- U - Ultra Long Period

Instrument Code:
- H - High Gain Seismometer (Broadband)
- L - Low Gain Seismometer (Accelerometer)

Orientation Code:
- Z, N & E - Traditional (vertical, north-south & east-west)
- 1, 2 & 3 - Orthogonal components but with non-traditional orientations

Sample Rate: Digital sample rate in samples per second.

T/C: Telemetry code.

T - Triggered data stream. Only telemetered when an event is detected at the remote station.

C - Continuously telemetered.

Dip: Component dip in degrees from horizontal. -90 is up.

Azi: Component azimuth in degrees clockwise from North.

A_0: Normalizing factor at reference frequency, fn.

fn: Reference frequency in Hz.

Sd: The scale factor at the normalizing frequency (fn). With the above definition for A_0, Sd is the product of the seismometer generator constant and the datalogger sensitivity. For all H instrument codes (i.e. broadband seismometers), Sd is in counts per meter/sec for all instruments except FBA-23 accelerometers, which have units of meters/sec^2. A negative number implies that the ground motion sensor produces an increasingly negative output voltage for an increasingly positive ground motion in the direction indicated by the dip and azimuth of the sensor's component orientation.

Pole/Zero Index: Identifies which pole/zero coefficients (from the accompanying table) are used.

FIR Filter Index: Identifies which set of FIR filter coefficients (given in Appendix C), if any, is used.

S. Date: Year and day of year of initial operation.

E. Date: Year and day of year of last operation.

Transfer Functions:

Index: Index corresponding to index indicated in stream information table above.

Data Stream: Band and instrument codes as given in the stream information table (presented for convenience).

Poles: Transfer function poles. Given as conjugate pole pairs and a single real pole if required. The poles are in units of angular frequency. Note that the STS-1's have 4 poles and the STS-2's have 5 poles which describe the seismometer response. Additional poles accompanying these instruments describe low-pass Butterworth anti-aliasing filters.

Zeroes: Transfer function zeroes. The power of s indicates the number of zeroes; where there are non-zero values they are given explicitly. A velocity transducer (such as used in the STS seismometers) has two zeroes and an accelerometer (such as the FBA-23) has no zeroes.

ARC – Arcata, California

Latitude: 40.877 Longitude: -124.075 Elevation: 60

Geology: Sandstone

Vault conditions: The instruments are sited on the ground floor of Founders Hall at Humboldt State University. The site was established in 1948 with the installation of Wood-Anderson torsion seismometers. The instruments are located on a concrete pier in a room at the northwest corner, which is isolated from the hallway via two doors. The seismometers are thermally insulated with 4" of polyurethane foam. An adjoining room contains the datalogger and supporting equipment.

Station Instrumentation:

VELOCITY CHANNELS

1 – Digital Seismograph System: Streckeisen STS-2 with Quanterra Q935 Datalogger

Date of Operation: 26 May 1992 to present

STS-2 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HHZ	80.00	T	-90.0	0.0	4.92464E+07	0.0200	6.23183E+08	1	1	1992.147	-
HHN	80.00	T	0.0	0.0	4.92464E+07	0.0200	6.02140E+08	1	1	1992.147	-
HHE	80.00	T	0.0	90.0	4.92464E+07	0.0200	6.28076E+08	1	1	1992.147	-
BHZ	20.00	C	-90.0	0.0	4.92464E+07	0.0200	6.23183E+08	1	2	1992.147	-
BHN	20.00	C	0.0	0.0	4.92464E+07	0.0200	6.02140E+08	1	2	1992.147	-
BHE	20.00	C	0.0	90.0	4.92464E+07	0.0200	6.28076E+08	1	2	1992.147	-
LHZ	1.00	C	-90.0	0.0	4.92464E+07	0.0200	6.23183E+08	1	3	1992.147	-
LHN	1.00	C	0.0	0.0	4.92464E+07	0.0200	6.02140E+08	1	3	1992.147	-
LHE	1.00	C	0.0	90.0	4.92464E+07	0.0200	6.28076E+08	1	3	1992.147	-
VHZ	0.10	C	-90.0	0.0	4.92464E+07	0.0200	2.49273E+09	1	4	1992.147	-
VHN	0.10	C	0.0	0.0	4.92464E+07	0.0200	2.40856E+09	1	4	1992.147	-
VHE	0.10	C	0.0	90.0	4.92464E+07	0.0200	2.51230E+09	1	4	1992.147	-
UHZ	0.01	C	-90.0	0.0	4.92464E+07	0.0200	2.49273E+09	1	5	1992.147	-
UHN	0.01	C	0.0	0.0	4.92464E+07	0.0200	2.40856E+09	1	5	1992.147	-
UHE	0.01	C	0.0	90.0	4.92464E+07	0.0200	2.51230E+09	1	5	1992.147	-

ACCELERATION CHANNELS

1 – Digital Seismograph System: Kinemetrics FBA-23 with Quanterra Q935 Datalogger

Date of Operation: 26 May 1992 to present

FBA-23 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HLZ	80.00	T	-90.0	0.0	2.75993E+05	0.0200	-5.38324E+04	2	1	1992.147	-
HLN	80.00	T	0.0	0.0	2.53879E+05	0.0200	-5.27571E+04	3	1	1992.147	-
HLE	80.00	T	0.0	90.0	2.66112E+05	0.0200	-4.99862E+04	4	1	1992.147	-
BLZ	20.00	T	-90.0	0.0	2.75993E+05	0.0200	-5.38324E+04	2	2	1992.147	-
BLN	20.00	T	0.0	0.0	2.53879E+05	0.0200	-5.27571E+04	3	2	1992.147	-
BLE	20.00	T	0.0	90.0	2.66112E+05	0.0200	-4.99862E+04	4	2	1992.147	-
LLZ	1.00	T	-90.0	0.0	2.75993E+05	0.0200	-5.38324E+04	2	3	1992.147	-
LLN	1.00	T	0.0	0.0	2.53879E+05	0.0200	-5.27571E+04	3	3	1992.147	-
LLE	1.00	T	0.0	90.0	2.66112E+05	0.0200	-4.99862E+04	4	3	1992.147	-

OPERATION NOTES

05/26/1992: A Streckeisen STS-2 and a Kinemetrics FBA-23 were installed with a Quanterra Q935 digitizer.

Table of Transfer Functions

Index	Data Stream	Poles	Zeroes
1	HH, BH, LH, VH, UH	-3.70240E-02 ± 3.70240E-02j -1.18630E+02 ± 4.23070E+02j -2.51330E+02	s^2=0
2	HLZ, BLZ, LLZ	-3.46730E+02 ± 3.94680E+02j	-
3	HLN, BLN, LLN	-3.22470E+02 ± 3.87160E+02j	-
4	HLE, BLE, LLE	-3.35310E+02 ± 3.92020E+02j	-

BKS – Berkeley (Byerly), California

Latitude: 37.877 Longitude: -122.235 Elevation: 276

Geology: Franciscan sandstone

Vault conditions: The instruments are sited in the Byerly Seismographic Vault in Strawberry Canyon. The vault is a 105 foot adit dug horizontally at a NW azimuth into the side of a hill. The piers are constructed of reinforced concrete in the rear of the vault and are not isolated from floor and walls. The vault is thermally stable and a ventilating/dehumidifying system is connected to all rooms. There are three interior doors leading to the room housing the seismometers. The seismometers are thermally insulated with 4" of polyurethane foam.

Station Instrumentation:

VELOCITY CHANNELS

1 – Digital Seismograph System: Streckeisen STS-1/UVBB with Quanterra Q935 Datalogger

Date of Operation: 03 December 1993 to present

STS-1/UVBB Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HHZ	80.00	T	-90.0	0.0	9.87140E+02	0.0200	9.47688E+08	3	1	1993.348	-
HHN	80.00	T	0.0	0.0	9.87140E+02	0.0200	1.04720E+09	3	1	1993.348	-
HHE	80.00	T	0.0	90.0	9.87140E+02	0.0200	1.05247E+09	3	1	1993.348	-
BHZ	20.00	C	-90.0	0.0	9.87140E+02	0.0200	9.47688E+08	3	2	1993.348	-
BHN	20.00	C	0.0	0.0	9.87140E+02	0.0200	1.04720E+09	3	2	1993.348	-
BHE	20.00	C	0.0	90.0	9.87140E+02	0.0200	1.05247E+09	3	2	1993.348	-
LHZ	1.00	C	-90.0	0.0	9.87140E+02	0.0200	9.47688E+08	3	3	1993.348	-
LHN	1.00	C	0.0	0.0	9.87140E+02	0.0200	1.04720E+09	3	3	1993.348	-
LHE	1.00	C	0.0	90.0	9.87140E+02	0.0200	1.05247E+09	3	3	1993.348	-
VHZ	0.10	C	-90.0	0.0	9.87140E+02	0.0200	3.79075E+09	3	4	1993.348	-
VHN	0.10	C	0.0	0.0	9.87140E+02	0.0200	4.18881E+09	3	4	1993.348	-
VHE	0.10	C	0.0	90.0	9.87140E+02	0.0200	4.20990E+09	3	4	1993.348	-
UHZ	0.01	C	-90.0	0.0	1.20159E+03	0.0033	3.79075E+09	3	5	1993.348	-
UHN	0.01	C	0.0	0.0	1.20159E+03	0.0033	4.18881E+09	3	5	1993.348	-
UHE	0.01	C	0.0	90.0	1.20159E+03	0.0033	4.20990E+09	3	5	1993.348	-
HHZ	80.00	T	-90.0	0.0	9.87140E+02	0.0200	1.00488E+09	3	1	1993.337	1993.347
HHN	80.00	T	0.0	0.0	9.87140E+02	0.0200	1.02201E+09	3	1	1993.337	1993.347
HHE	80.00	T	0.0	90.0	9.87140E+02	0.0200	1.04045E+09	3	1	1993.337	1993.347
BHZ	20.00	C	-90.0	0.0	9.87140E+02	0.0200	1.00488E+09	3	2	1993.337	1993.347
BHN	20.00	C	0.0	0.0	9.87140E+02	0.0200	1.02201E+09	3	2	1993.337	1993.347
BHE	20.00	C	0.0	90.0	9.87140E+02	0.0200	1.04045E+09	3	2	1993.337	1993.347
LHZ	1.00	C	-90.0	0.0	9.87140E+02	0.0200	1.00488E+09	3	3	1993.337	1993.347
LHN	1.00	C	0.0	0.0	9.87140E+02	0.0200	1.02201E+09	3	3	1993.337	1993.347
LHE	1.00	C	0.0	90.0	9.87140E+02	0.0200	1.04045E+09	3	3	1993.337	1993.347
VHZ	0.10	C	-90.0	0.0	9.87140E+02	0.0200	4.01953E+09	3	4	1993.337	1993.347
VHN	0.10	C	0.0	0.0	9.87140E+02	0.0200	4.08804E+09	3	4	1993.337	1993.347
VHE	0.10	C	0.0	90.0	9.87140E+02	0.0200	4.16178E+09	3	4	1993.337	1993.347
UHZ	0.01	C	-90.0	0.0	1.20159E+03	0.0033	4.01953E+09	3	5	1993.337	1993.347
UHN	0.01	C	0.0	0.0	1.20159E+03	0.0033	4.08804E+09	3	5	1993.337	1993.347
UHE	0.01	C	0.0	90.0	1.20159E+03	0.0033	4.16178E+09	3	5	1993.337	1993.347

2 – Digital Seismograph System: Streckeisen STS-1/UVBB with Quanterra Q680 Datalogger

Date of Operation: 10 May 1991 to 03 December 1993

STS-1/UVBB Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HHZ	80.00	T	-90.0	0.0	9.87140E+02	0.0200	9.46454E+08	3	1	1991.130	1993.337
HHN	80.00	T	0.0	0.0	9.87140E+02	0.0200	1.01881E+09	3	1	1991.130	1993.337
HHE	80.00	T	0.0	90.0	9.87140E+02	0.0200	1.03372E+09	3	1	1991.130	1993.337
BHZ	20.00	C	-90.0	0.0	9.87140E+02	0.0200	9.46454E+08	3	2	1991.130	1993.337
BHN	20.00	C	0.0	0.0	9.87140E+02	0.0200	1.01881E+09	3	2	1991.130	1993.337
BHE	20.00	C	0.0	90.0	9.87140E+02	0.0200	1.03372E+09	3	2	1991.130	1993.337
LHZ	1.00	C	-90.0	0.0	9.87140E+02	0.0200	9.46454E+08	3	3	1991.130	1993.337
LHN	1.00	C	0.0	0.0	9.87140E+02	0.0200	1.01881E+09	3	3	1991.130	1993.337
LHE	1.00	C	0.0	90.0	9.87140E+02	0.0200	1.03372E+09	3	3	1991.130	1993.337
VHZ	0.10	C	-90.0	0.0	9.87140E+02	0.0200	3.78581E+09	3	4	1991.130	1993.337
VHN	0.10	C	0.0	0.0	9.87140E+02	0.0200	4.07523E+09	3	4	1991.130	1993.337
VHE	0.10	C	0.0	90.0	9.87140E+02	0.0200	4.13487E+09	3	4	1991.130	1993.337
UHZ	0.01	C	-90.0	0.0	1.20159E+03	0.0033	3.78581E+09	3	5	1991.130	1993.337
UHN	0.01	C	0.0	0.0	1.20159E+03	0.0033	4.07523E+09	3	5	1991.130	1993.337
UHE	0.01	C	0.0	90.0	1.20159E+03	0.0033	4.13487E+09	3	5	1991.130	1993.337

3 – Digital Seismograph System: Sprengnether SPR/ULPV with PC-based Datalogger

Date of Operation: 28 January 1988 to 09 May 1991

SPR/ULPV Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
BH1	20.00	C	-90.0	0.0	9.60749E+14	0.0200	3.74342E+07	1	-	1988.028	1991.129
BH2	20.00	C	0.0	315.0	9.60749E+14	0.0200	3.85810E+07	1	-	1988.028	1991.129
BH3	20.00	C	0.0	45.0	9.60749E+14	0.0200	3.84434E+07	1	-	1988.028	1991.129
LH1	1.00	C	-90.0	0.0	5.91138E+13	0.0200	3.74342E+07	2	-	1988.028	1991.129
LH2	1.00	C	0.0	315.0	5.91138E+13	0.0200	3.85810E+07	2	-	1988.028	1991.129
LH3	1.00	C	0.0	45.0	5.91138E+13	0.0200	3.84434E+07	2	-	1988.028	1991.129

ACCELERATION CHANNELS

1 – Digital Seismograph System: Kinemetrics FBA-23 with Quanterra Q935 Datalogger

Date of Operation: 10 May 1991 to present

FBA-23 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HLZ	80.00	T	-90.0	0.0	2.47487E+05	0.0200	-5.40378E+04	4	1	1993.348	-
HLN	80.00	T	0.0	0.0	2.57584E+05	0.0200	-5.33029E+04	5	1	1993.348	-
HLE	80.00	T	0.0	90.0	2.52662E+05	0.0200	-5.21146E+04	6	1	1993.348	-
BLZ	20.00	T	-90.0	0.0	2.47487E+05	0.0200	-5.40378E+04	4	2	1993.348	-
BLN	20.00	T	0.0	0.0	2.57584E+05	0.0200	-5.33029E+04	5	2	1993.348	-
BLE	20.00	T	0.0	90.0	2.52662E+05	0.0200	-5.21146E+04	6	2	1993.348	-
LLZ	1.00	T	-90.0	0.0	2.47487E+05	0.0200	-5.40378E+04	4	3	1993.348	-
LLN	1.00	T	0.0	0.0	2.57584E+05	0.0200	-5.33029E+04	5	3	1993.348	-
LLE	1.00	T	0.0	90.0	2.52662E+05	0.0200	-5.21146E+04	6	3	1993.348	-
HLZ	80.00	T	-90.0	0.0	2.47487E+05	0.0200	-5.22072E+04	4	1	1993.337	1993.347
HLN	80.00	T	0.0	0.0	2.57584E+05	0.0200	-5.39329E+04	5	1	1993.337	1993.347
HLE	80.00	T	0.0	90.0	2.52662E+05	0.0200	-5.40685E+04	6	1	1993.337	1993.347
BLZ	20.00	T	-90.0	0.0	2.47487E+05	0.0200	-5.22072E+04	4	2	1993.337	1993.347
BLN	20.00	T	0.0	0.0	2.57584E+05	0.0200	-5.39329E+04	5	2	1993.337	1993.347
BLE	20.00	T	0.0	90.0	2.52662E+05	0.0200	-5.40685E+04	6	2	1993.337	1993.347
LLZ	1.00	T	-90.0	0.0	2.47487E+05	0.0200	-5.22072E+04	4	3	1993.337	1993.347
LLN	1.00	T	0.0	0.0	2.57584E+05	0.0200	-5.39329E+04	5	3	1993.337	1993.347
LLE	1.00	T	0.0	90.0	2.52662E+05	0.0200	-5.40685E+04	6	3	1993.337	1993.347

2 – Digital Seismograph System: Kinemetrics FBA-23 with Quanterra Q680 Datalogger

Date of Operation: 10 May 1991 to 03 December 1993

FBA-23 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HLZ	80.00	T	-90.0	0.0	2.47487E+05	0.0200	-5.28308E+04	4	1	1991.130	1993.337
HLN	80.00	T	0.0	0.0	2.57584E+05	0.0200	-5.30200E+04	5	1	1991.130	1993.337
HLE	80.00	T	0.0	90.0	2.52662E+05	0.0200	-5.37875E+04	6	1	1991.130	1993.337
BLZ	20.00	T	-90.0	0.0	2.47487E+05	0.0200	-5.28308E+04	4	2	1991.130	1993.337
BLN	20.00	T	0.0	0.0	2.57584E+05	0.0200	-5.30200E+04	5	2	1991.130	1993.337
BLE	20.00	T	0.0	90.0	2.52662E+05	0.0200	-5.37875E+04	6	2	1991.130	1993.337
LLZ	1.00	T	-90.0	0.0	2.47487E+05	0.0200	-5.28308E+04	4	3	1991.130	1993.337
LLN	1.00	T	0.0	0.0	2.57584E+05	0.0200	-5.30200E+04	5	3	1991.130	1993.337
LLE	1.00	T	0.0	90.0	2.52662E+05	0.0200	-5.37875E+04	6	3	1991.130	1993.337

OPERATION NOTES

12/14/1993: The Q935 datalogger was replaced to repair a faulty digitizer module. This change affected the digitizer sensitivity which is reflected in the Sd parameter.

12/03/1993: The Q680 datalogger was replaced with a Q935 unit. This change affected the digitizer sensitivity which is reflected in the Sd parameter.

05/09/1991: The PC-based 16-bit datalogger was replaced with a Q680 24-bit system. The Sprengnether ULPV seismometers were removed and replaced with a set of Streckeisen STS-1 instruments. A Kinemetrics FBA-23 accelerometer was installed.

01/28/1988: A set of Sprengnether ULPV seismometers were installed with a PC-based 16-bit datalogger.

Table of Transfer Functions

Index	Data Stream	Poles	Zeroes
1	BH	-4.39820E-02 $\pm$ 4.48710E-02j	s^2=0
		-4.91450E+00 $\pm$ 3.10290E+01j	
		-1.42630E+01 $\pm$ 2.79920E+01j	
		-2.22140E+01 $\pm$ 2.22140E+01j	
		-2.79920E+01 $\pm$ 1.42630E+01j	
		-3.10290E+01 $\pm$ 4.91450E+00j	
2	LH	-4.39820E-02 $\pm$ 4.48710E-02j	s^2=0
		-1.62620E-01 $\pm$ 6.06910E-01j	
		-4.44290E-01 $\pm$ 4.44290E-01j	
		-6.06910E-01 $\pm$ 1.62620E-01j	
		-4.91450E+00 $\pm$ 3.10290E+01j	
		-1.42630E+01 $\pm$ 2.79920E+01j	
		-2.22140E+01 $\pm$ 2.22140E+01j	
		-2.79920E+01 $\pm$ 1.42630E+01j	
		-3.10290E+01 $\pm$ 4.91450E+00j	
3	HH, BH, LH, VH, UH	-1.23410E-02 $\pm$ 1.23410E-02j	s^2=0
		-1.95880E+01 $\pm$ 2.45620E+01j	
4	HLZ, BLZ, LLZ	-3.23360E+02 $\pm$ 3.78050E+02j	-
5	HLN, BLN, LLN	-3.29890E+02 $\pm$ 3.85690E+02j	-
6	HLE, BLE, LLE	-3.21700E+02 $\pm$ 3.86230E+02j	-

CMB – Columbia College, California

Latitude: 38.035 Longitude: -120.385 Elevation: 719

Geology: Paleozoic marine limestone

Vault conditions: The vault is a buried fiberglass cylinder, eight feet in diameter and six feet deep. It has a flat top at grade level with a hatch for entry. The floor is concrete poured directly on rock. The datalogger and supporting equipment are located in an air conditioned trailer located about 70 feet from the vault and connected via underground conduits. The seismometers are thermally insulated with 4" of polyurethane foam and the top of the vault is covered with bark for additional insulation.

Station Instrumentation:

VELOCITY CHANNELS

1 – Digital Seismograph System: Streckeisen STS-1/VBB with Quanterra Q935 Datalogger

Date of Operation: 24 June 1992 to present

STS-1/VBB Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HHZ	80.00	T	-90.0	0.0	3.94857E+03	0.0200	9.09259E+08	4	1	1992.176	-
HHN	80.00	T	0.0	0.0	3.94857E+03	0.0200	9.43992E+08	4	1	1992.176	-
HHE	80.00	T	0.0	90.0	3.94857E+03	0.0200	1.01500E+09	4	1	1992.176	-
BHZ	20.00	C	-90.0	0.0	3.94857E+03	0.0200	9.09259E+08	4	2	1992.176	-
BHN	20.00	C	0.0	0.0	3.94857E+03	0.0200	9.43992E+08	4	2	1992.176	-
BHE	20.00	C	0.0	90.0	3.94857E+03	0.0200	1.01500E+09	4	2	1992.176	-
LHZ	1.00	C	-90.0	0.0	3.94857E+03	0.0200	9.09259E+08	4	3	1992.176	-
LHN	1.00	C	0.0	0.0	3.94857E+03	0.0200	9.43992E+08	4	3	1992.176	-
LHE	1.00	C	0.0	90.0	3.94857E+03	0.0200	1.01500E+09	4	3	1992.176	-
VHZ	0.10	C	-90.0	0.0	3.94857E+03	0.0200	3.63704E+09	4	4	1992.176	-
VHN	0.10	C	0.0	0.0	3.94857E+03	0.0200	3.77597E+09	4	4	1992.176	-
VHE	0.10	C	0.0	90.0	3.94857E+03	0.0200	4.06000E+09	4	4	1992.176	-
UHZ	0.01	C	-90.0	0.0	4.80637E+03	0.0033	3.63704E+09	4	5	1992.176	-
UHN	0.01	C	0.0	0.0	4.80637E+03	0.0033	3.77597E+09	4	5	1992.176	-
UHE	0.01	C	0.0	90.0	4.80637E+03	0.0033	4.06000E+09	4	5	1992.176	-

2 – Digital Seismograph System: Guralp CMG-3/EBB with DRS Datalogger

Date of Operation: 17 March 1989 to 17 June 1992

CMG-3/EBB Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
BHZ	10.00	T	-90.0	0.0	4.15278E+17	0.0250	3.89938E+07	1	-	1989.076	1992.169
BHN	10.00	T	0.0	0.0	4.39253E+17	0.0250	3.45386E+07	2	-	1989.076	1992.169
BHE	10.00	T	0.0	90.0	3.55741E+17	0.0250	3.43776E+07	3	-	1989.076	1992.169
LHZ	1.00	C	-90.0	0.0	4.15278E+07	0.0250	1.55973E+08	1	-	1989.076	1992.169
LHN	1.00	C	0.0	0.0	4.39253E+07	0.0250	1.38152E+08	2	-	1989.076	1992.169
LHE	1.00	C	0.0	90.0	3.55741E+07	0.0250	1.37508E+08	3	-	1989.076	1992.169

ACCELERATION CHANNELS

1 – Digital Seismograph System: Kinemetrics FBA-23 with Quanterra Q935 Datalogger

Date of Operation: 24 June 1992 to present

FBA-23 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HLZ	80.00	T	-90.0	0.0	2.71885E+05	0.0200	-5.38509E+04	5	1	1992.176	-
HLN	80.00	T	0.0	0.0	2.51453E+05	0.0200	-5.36889E+04	6	1	1992.176	-
HLE	80.00	T	0.0	90.0	2.69198E+05	0.0200	-5.06333E+04	7	1	1992.176	-
BLZ	20.00	T	-90.0	0.0	2.71885E+05	0.0200	-5.38509E+04	5	2	1992.176	-
BLN	20.00	T	0.0	0.0	2.51453E+05	0.0200	-5.36889E+04	6	2	1992.176	-
BLE	20.00	T	0.0	90.0	2.69198E+05	0.0200	-5.06333E+04	7	2	1992.176	-
LLZ	1.00	T	-90.0	0.0	2.71885E+05	0.0200	-5.38509E+04	5	3	1992.176	-
LLN	1.00	T	0.0	0.0	2.51453E+05	0.0200	-5.36889E+04	6	3	1992.176	-
LLE	1.00	T	0.0	90.0	2.69198E+05	0.0200	-5.06333E+04	7	3	1992.176	-

OPERATION NOTES

06/24/1992: A Streckeisen STS-1 and a Kinemetrics FBA-23 were installed with a Quanterra Q935 datalogger, replacing the Guralp CMG-3 and DRS system. This upgrade was partially funded by IRIS and data from this site are contributed to the IRIS Data Management Center.

03/17/1989: A set of CMG-3 seismometers with a DRS recording system were installed at this site. This station formed part of the DWWSSN and data from this site were contributed to the Global Seismic Network.

Table of Transfer Functions

Index	Data Stream	Poles	Zeroes
1	BHZ, LHZ	-1.23410E-02 $\pm$ 1.23410E-02j	s^2=0
		-4.76490E+01 $\pm$ 5.87060E+01j	
		-7.94230E+01	
		-2.45730E+00 $\pm$ 1.55150E+01j	
		-7.13130E+00 $\pm$ 1.39960E+01j	
		-1.11070E+01 $\pm$ 1.11070E+01j	
		-1.39960E+01 $\pm$ 7.13130E+00j	
		-1.55150E+01 $\pm$ 2.45730E+00j	
2	BHN, LHN	-1.23410E-02 $\pm$ 1.23410E-02j	s^2=0
		-4.27390E+01 $\pm$ 5.37470E+01j	
		-1.01850E+02	
		-2.45730E+00 $\pm$ 1.55150E+01j	
		-7.13130E+00 $\pm$ 1.39960E+01j	
		-1.11070E+01 $\pm$ 1.11070E+01j	
		-1.39960E+01 $\pm$ 7.13130E+00j	
		-1.55150E+01 $\pm$ 2.45730E+00j	
3	BHE, LHE	-1.23410E-02 $\pm$ 1.23410E-02j	s^2=0
		-3.14680E+01 $\pm$ 4.81710E+01j	
		-1.17490E+02	
		-2.45730E+00 $\pm$ 1.55150E+01j	
		-7.13130E+00 $\pm$ 1.39960E+01j	
		-1.11070E+01 $\pm$ 1.11070E+01j	
		-1.39960E+01 $\pm$ 7.13130E+00j	
		-1.55150E+01 $\pm$ 2.45730E+00j	
4	HH, BH, LH, VH, UH	-1.23410E-02 $\pm$ 1.23410E-02j	s^2=0
		-3.91760E+01 $\pm$ 4.91230E+01j	
5	HLZ, BLZ, LLZ	-3.28500E+02 $\pm$ 4.04940E+02j	-
6	HLN, BLN, LLN	-3.15910E+02 $\pm$ 3.89420E+02j	-
7	HLE, BLE, LLE	-3.47620E+02 $\pm$ 3.85170E+02j	-

HOPS – Hopland Field Station, California

Latitude: 38.994 Longitude: -123.072 Elevation: 299

Geology: Sandstone, vertically fractured

Vault conditions: The instruments are located in a steel and concrete vault benched into a hillside with 2 meters of soil overburden. The vault is oriented north/south to minimize the effects of solar heating. The concrete pier is covered with 4" of insulation on the sides and 8" of insulation on the top. The datalogger and supporting equipment are in an adjacent room.

Station Instrumentation:

VELOCITY CHANNELS

1 – Digital Seismograph System: Streckeisen STS-1/VBB with Quanterra Q935 Datalogger

Date of Operation: 20 October 1994 to present

STS-1 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HHZ	80.00	T	-90.0	0.0	3.94857E+03	0.0200	1.00476E+09	1	1	1994.293	-
HHN	80.00	T	0.0	0.0	3.94857E+03	0.0200	9.81270E+08	1	1	1994.293	-
HHE	80.00	T	0.0	90.0	3.94857E+03	0.0200	9.84536E+08	1	1	1994.293	-
BHZ	20.00	C	-90.0	0.0	3.94857E+03	0.0200	1.00476E+09	1	2	1994.293	-
BHN	20.00	C	0.0	0.0	3.94857E+03	0.0200	9.81270E+08	1	2	1994.293	-
BHE	20.00	C	0.0	90.0	3.94857E+03	0.0200	9.84536E+08	1	2	1994.293	-
LHZ	1.00	C	-90.0	0.0	3.94857E+03	0.0200	1.00476E+09	1	3	1994.293	-
LHN	1.00	C	0.0	0.0	3.94857E+03	0.0200	9.81270E+08	1	3	1994.293	-
LHE	1.00	C	0.0	90.0	3.94857E+03	0.0200	9.84536E+08	1	3	1994.293	-
VHZ	0.10	C	-90.0	0.0	3.94857E+03	0.0200	4.01904E+09	1	4	1994.293	-
VHN	0.10	C	0.0	0.0	3.94857E+03	0.0200	3.92508E+09	1	4	1994.293	-
VHE	0.10	C	0.0	90.0	3.94857E+03	0.0200	3.93814E+09	1	4	1994.293	-
UHZ	0.01	C	-90.0	0.0	4.80637E+03	0.0033	4.01904E+09	1	5	1994.293	-
UHN	0.01	C	0.0	0.0	4.80637E+03	0.0033	3.92508E+09	1	5	1994.293	-
UHE	0.01	C	0.0	90.0	4.80637E+03	0.0033	3.93814E+09	1	5	1994.293	-

ACCELERATION CHANNELS

1 – Digital Seismograph System: Kinemetrics FBA-23 with Quanterra Q935 Datalogger

Date of Operation: 20 October 1994 to present

FBA-23 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HLZ	80.00	T	-90.0	0.0	1.06315E+05	0.0200	-9.99968E+04	2	1	1994.293	-
HLN	80.00	T	0.0	0.0	1.01828E+05	0.0200	-1.10037E+05	3	1	1994.293	-
HLE	80.00	T	0.0	90.0	1.10519E+05	0.0200	-9.86060E+04	4	1	1994.293	-
BLZ	20.00	T	-90.0	0.0	1.06315E+05	0.0200	-9.99968E+04	2	2	1994.293	-
BLN	20.00	T	0.0	0.0	1.01828E+05	0.0200	-1.10037E+05	3	2	1994.293	-
BLE	20.00	T	0.0	90.0	1.10519E+05	0.0200	-9.86060E+04	4	2	1994.293	-
LLZ	1.00	T	-90.0	0.0	1.06315E+05	0.0200	-9.99968E+04	2	3	1994.293	-
LLN	1.00	T	0.0	0.0	1.01828E+05	0.0200	-1.10037E+05	3	3	1994.293	-
LLE	1.00	T	0.0	90.0	1.10519E+05	0.0200	-9.86060E+04	4	3	1994.293	-

OPERATION NOTES

10/20/1994: A Streckeisen STS-1 and a Kinemetrics FBA-23 were installed with a Quanterra Q935 digitizer.

Table of Transfer Functions

Index	Data Stream	Poles	Zeroes
1	HH, BH, LH, VH, UH	-1.23410E-02 $\pm$ 1.23410E-02j	s^2=0
		-3.91760E+01 $\pm$ 4.91230E+01j	
2	HLZ, BLZ, LLZ	-2.08680E+02 $\pm$ 2.50540E+02j	-
3	HLN, BLN, LLN	-2.01040E+02 $\pm$ 2.47820E+02j	-
4	HLE, BLE, LLE	-2.12760E+02 $\pm$ 2.55440E+02j	-

JRSC – Jasper Ridge, Stanford, California

Latitude: 37.404 Longitude: -122.238 Elevation: 103

Geology: Franciscan Greenstone, with some quartz

Vault conditions: The vault is located in an east/west adit, 20' in length, constructed for the development of Searsville Dam (circa 1900). The instruments are located in an aluminum pressure tank on a concrete pier. Approximately 4 meters of overburden cover the adit. The datalogger and accessory equipment are located in front of the adit.

Station Instrumentation:

VELOCITY CHANNELS

1 – Digital Seismograph System: Streckeisen STS-2 with Quanterra Q680 Datalogger

Date of Operation: 01 July 1994 to present

STS-2 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HHZ	80.00	T	-90.0	0.0	4.92464E+07	0.0200	6.02526E+08	1	1	1994.182	-
HHN	80.00	T	0.0	0.0	4.92464E+07	0.0200	5.78876E+08	1	1	1994.182	-
HHE	80.00	T	0.0	90.0	4.92464E+07	0.0200	6.21744E+08	1	1	1994.182	-
BHZ	20.00	C	-90.0	0.0	4.92464E+07	0.0200	6.02526E+08	1	2	1994.182	-
BHN	20.00	C	0.0	0.0	4.92464E+07	0.0200	5.78876E+08	1	2	1994.182	-
BHE	20.00	C	0.0	90.0	4.92464E+07	0.0200	6.21744E+08	1	2	1994.182	-
LHZ	1.00	C	-90.0	0.0	4.92464E+07	0.0200	6.02526E+08	1	3	1994.182	-
LHN	1.00	C	0.0	0.0	4.92464E+07	0.0200	5.78876E+08	1	3	1994.182	-
LHE	1.00	C	0.0	90.0	4.92464E+07	0.0200	6.21744E+08	1	3	1994.182	-
VHZ	0.10	C	-90.0	0.0	4.92464E+07	0.0200	2.41010E+09	1	4	1994.182	-
VHN	0.10	C	0.0	0.0	4.92464E+07	0.0200	2.31550E+09	1	4	1994.182	-
VHE	0.10	C	0.0	90.0	4.92464E+07	0.0200	2.48698E+09	1	4	1994.182	-
UHZ	0.01	C	-90.0	0.0	4.92464E+07	0.0200	2.41010E+09	1	5	1994.182	-
UHN	0.01	C	0.0	0.0	4.92464E+07	0.0200	2.31550E+09	1	5	1994.182	-
UHE	0.01	C	0.0	90.0	4.92464E+07	0.0200	2.48698E+09	1	5	1994.182	-

ACCELERATION CHANNELS

1 – Digital Seismograph System: Kinemetrics FBA-23 with Quanterra Q680 Datalogger

Date of Operation: 1 July 1994 to present

FBA-23 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HLZ	80.00	T	-90.0	0.0	3.97962E+05	0.0200	2.09018E+05	2	1	1994.182	-
HLN	80.00	T	0.0	0.0	3.87773E+05	0.0200	2.10348E+05	3	1	1994.182	-
HLE	80.00	T	0.0	90.0	4.04432E+05	0.0200	2.10265E+05	4	1	1994.182	-
BLZ	20.00	T	-90.0	0.0	3.97962E+05	0.0200	2.09018E+05	2	2	1994.182	-
BLN	20.00	T	0.0	0.0	3.87773E+05	0.0200	2.10348E+05	3	2	1994.182	-
BLE	20.00	T	0.0	90.0	4.04432E+05	0.0200	2.10265E+05	4	2	1994.182	-
LLZ	1.00	T	-90.0	0.0	3.97962E+05	0.0200	2.09018E+05	2	3	1994.182	-
LLN	1.00	T	0.0	0.0	3.87773E+05	0.0200	2.10348E+05	3	3	1994.182	-
LLE	1.00	T	0.0	90.0	4.04432E+05	0.0200	2.10265E+05	4	3	1994.182	-

OPERATION NOTES

07/01/1994: A Streckeisen STS-2 and a Kinemetrics FBA-23 were installed with a Quanterra Q680 digitizer. This site is the replacement installation for the STAN location and is operated cooperatively with Stanford University.

Table of Transfer Functions

Index	Data Stream	Poles	Zeroes
1	HH, BH, LH, VH, UH	-3.70240E-02 $\pm$ 3.70240E-02j	s^2=0
		-1.18630E+02 $\pm$ 4.23070E+02j	
		-2.51330E+02	
2	HLZ, BLZ, LLZ	-4.03740E+02 $\pm$ 4.84720E+02j	-
3	HLN, BLN, LLN	-4.10990E+02 $\pm$ 4.67820E+02j	-
4	HLE, BLE, LLE	-4.07010E+02 $\pm$ 4.88650E+02j	-

MHC – Mt. Hamilton, California

Latitude: 37.342 Longitude: -121.642 Elevation: 1282

Geology: Franciscan formation (greenstone)

Vault conditions: The vault is located in a room in the east wing of the Lick Observatory on top of Mt. Hamilton. The piers are reinforced concrete which are isolated from the building. The seismometer room is isolated from the hallway via two doors and the datalogger and supporting equipment are in an adjacent room. The seismometers are thermally insulated with 4" of polyurethane foam.

Station Instrumentation:

VELOCITY CHANNELS

1 – Digital Seismograph System: Streckeisen STS-1/VBB with Quanterra Q935 Datalogger

Date of Operation: 02 February 1993 to present

STS-1/VBB Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HHZ	80.00	T	-90.0	0.0	3.94857E+03	0.0200	1.05869E+09	4	1	1993.033	-
HHN	80.00	T	0.0	0.0	3.94857E+03	0.0200	9.41926E+08	4	1	1993.033	-
HHE	80.00	T	0.0	90.0	3.94857E+03	0.0200	9.40878E+08	4	1	1993.033	-
BHZ	20.00	C	-90.0	0.0	3.94857E+03	0.0200	1.05869E+09	4	2	1993.033	-
BHN	20.00	C	0.0	0.0	3.94857E+03	0.0200	9.41926E+08	4	2	1993.033	-
BHE	20.00	C	0.0	90.0	3.94857E+03	0.0200	9.40878E+08	4	2	1993.033	-
LHZ	1.00	C	-90.0	0.0	3.94857E+03	0.0200	1.05869E+09	4	3	1993.033	-
LHN	1.00	C	0.0	0.0	3.94857E+03	0.0200	9.41926E+08	4	3	1993.033	-
LHE	1.00	C	0.0	90.0	3.94857E+03	0.0200	9.40878E+08	4	3	1993.033	-
VHZ	0.10	C	-90.0	0.0	3.94857E+03	0.0200	4.23477E+09	4	4	1993.033	-
VHN	0.10	C	0.0	0.0	3.94857E+03	0.0200	3.76770E+09	4	4	1993.033	-
VHE	0.10	C	0.0	90.0	3.94857E+03	0.0200	3.76351E+09	4	4	1993.033	-
UHZ	0.01	C	-90.0	0.0	4.80637E+03	0.0033	4.23477E+09	4	5	1993.033	-
UHN	0.01	C	0.0	0.0	4.80637E+03	0.0033	3.76770E+09	4	5	1993.033	-
UHE	0.01	C	0.0	90.0	4.80637E+03	0.0033	3.76351E+09	4	5	1993.033	-

2 – Digital Seismograph System: Streckeisen STS-1/UVBB with Quanterra Q935 Datalogger

Date of Operation: 29 April 1992 to 02 February 1993

STS-1/UVBB Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HHZ	80.00	T	-90.0	0.0	9.87140E+02	0.0200	9.63606E+08	3	1	1992.296	1993.033
HHN	80.00	T	0.0	0.0	9.87140E+02	0.0200	9.26627E+08	3	1	1992.296	1993.033
HHE	80.00	T	0.0	90.0	9.87140E+02	0.0200	9.44148E+08	3	1	1992.296	1993.033
BHZ	20.00	C	-90.0	0.0	9.87140E+02	0.0200	9.63606E+08	3	2	1992.296	1993.033
BHN	20.00	C	0.0	0.0	9.87140E+02	0.0200	9.26627E+08	3	2	1992.296	1993.033
BHE	20.00	C	0.0	90.0	9.87140E+02	0.0200	9.44148E+08	3	2	1992.296	1993.033
LHZ	1.00	C	-90.0	0.0	9.87140E+02	0.0200	9.63606E+08	3	3	1992.296	1993.033
LHN	1.00	C	0.0	0.0	9.87140E+02	0.0200	9.26627E+08	3	3	1992.296	1993.033
LHE	1.00	C	0.0	90.0	9.87140E+02	0.0200	9.44148E+08	3	3	1992.296	1993.033
VHZ	0.10	C	-90.0	0.0	9.87140E+02	0.0200	3.85442E+09	3	4	1992.296	1993.033
VHN	0.10	C	0.0	0.0	9.87140E+02	0.0200	3.70651E+09	3	4	1992.296	1993.033
VHE	0.10	C	0.0	90.0	9.87140E+02	0.0200	3.77659E+09	3	4	1992.296	1993.033
UHZ	0.01	C	-90.0	0.0	1.20159E+03	0.0033	3.85442E+09	3	5	1992.296	1993.033
UHN	0.01	C	0.0	0.0	1.20159E+03	0.0033	3.70651E+09	3	5	1992.296	1993.033
UHE	0.01	C	0.0	90.0	1.20159E+03	0.0033	3.77659E+09	3	5	1992.296	1993.033
HHZ	80.00	T	-90.0	0.0	9.87140E+02	0.0200	9.63606E+08	3	1	1992.127	1992.296
HHN	80.00	T	0.0	0.0	9.87140E+02	0.0200	-9.26627E+08	3	1	1992.127	1992.296
HHE	80.00	T	0.0	90.0	9.87140E+02	0.0200	9.44148E+08	3	1	1992.127	1992.296
BHZ	20.00	C	-90.0	0.0	9.87140E+02	0.0200	9.63606E+08	3	2	1992.127	1992.296
BHN	20.00	C	0.0	0.0	9.87140E+02	0.0200	-9.26627E+08	3	2	1992.127	1992.296
BHE	20.00	C	0.0	90.0	9.87140E+02	0.0200	9.44148E+08	3	2	1992.127	1992.296
LHZ	1.00	C	-90.0	0.0	9.87140E+02	0.0200	9.63606E+08	3	3	1992.127	1992.296
LHN	1.00	C	0.0	0.0	9.87140E+02	0.0200	-9.26627E+08	3	3	1992.127	1992.296
LHE	1.00	C	0.0	90.0	9.87140E+02	0.0200	9.44148E+08	3	3	1992.127	1992.296
VHZ	0.10	C	-90.0	0.0	9.87140E+02	0.0200	3.85442E+09	3	4	1992.127	1992.296
VHN	0.10	C	0.0	0.0	9.87140E+02	0.0200	-3.70651E+09	3	4	1992.127	1992.296
VHE	0.10	C	0.0	90.0	9.87140E+02	0.0200	3.77659E+09	3	4	1992.127	1992.296
UHZ	0.01	C	-90.0	0.0	1.20159E+03	0.0033	3.85442E+09	3	5	1992.127	1992.296
UHN	0.01	C	0.0	0.0	1.20159E+03	0.0033	-3.70651E+09	3	5	1992.127	1992.296
UHE	0.01	C	0.0	90.0	1.20159E+03	0.0033	3.77659E+09	3	5	1992.127	1992.296
HHZ	80.00	T	-90.0	0.0	9.87140E+02	0.0200	4.81803E+09	3	1	1992.120	1992.126
HHN	80.00	T	0.0	0.0	9.87140E+02	0.0200	-4.63313E+09	3	1	1992.120	1992.126
HHE	80.00	T	0.0	90.0	9.87140E+02	0.0200	4.72074E+09	3	1	1992.120	1992.126
BHZ	20.00	C	-90.0	0.0	9.87140E+02	0.0200	4.81803E+09	3	2	1992.120	1992.126
BHN	20.00	C	0.0	0.0	9.87140E+02	0.0200	-4.63313E+09	3	2	1992.120	1992.126
BHE	20.00	C	0.0	90.0	9.87140E+02	0.0200	4.72074E+09	3	2	1992.120	1992.126
LHZ	1.00	C	-90.0	0.0	9.87140E+02	0.0200	4.81803E+09	3	3	1992.120	1992.126
LHN	1.00	C	0.0	0.0	9.87140E+02	0.0200	-4.63313E+09	3	3	1992.120	1992.126
LHE	1.00	C	0.0	90.0	9.87140E+02	0.0200	4.72074E+09	3	3	1992.120	1992.126
VHZ	0.10	C	-90.0	0.0	9.87140E+02	0.0200	1.92721E+10	3	4	1992.120	1992.126
VHN	0.10	C	0.0	0.0	9.87140E+02	0.0200	-1.85325E+10	3	4	1992.120	1992.126
VHE	0.10	C	0.0	90.0	9.87140E+02	0.0200	1.88830E+10	3	4	1992.120	1992.126
UHZ	0.01	C	-90.0	0.0	1.20159E+03	0.0033	1.92721E+10	3	5	1992.120	1992.126
UHN	0.01	C	0.0	0.0	1.20159E+03	0.0033	-1.85325E+10	3	5	1992.120	1992.126
UHE	0.01	C	0.0	90.0	1.20159E+03	0.0033	1.88830E+10	3	5	1992.120	1992.126

3 – Digital Seismograph System: Streckeisen STS-1/UVBB with PC-based Datalogger

Date of Operation: 27 October 1987 to 28 April 1992

STS-1/UVBB Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
BHZ	20.00	C	-90.0	0.0	2.41278E+16	0.0200	3.71917E+07	1	-	1987.300	1992.119
BHN	20.00	C	0.0	0.0	2.41278E+16	0.0200	3.67165E+07	1	-	1987.300	1992.119
BHE	20.00	C	0.0	90.0	2.41278E+16	0.0200	3.78470E+07	1	-	1987.300	1992.119
LHZ	1.00	C	-90.0	0.0	1.48456E+15	0.0200	3.71917E+07	2	-	1987.300	1992.119
LHN	1.00	C	0.0	0.0	1.48456E+15	0.0200	3.67165E+07	2	-	1987.300	1992.119
LHE	1.00	C	0.0	90.0	1.48456E+15	0.0200	3.78470E+07	2	-	1987.300	1992.119

ACCELERATION CHANNELS

1 – Digital Seismograph System: Kinemetrics FBA-23 with Quanterra Q935 Datalogger

Date of Operation: 29 April 1992 to present

FBA-23 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HLZ	80.00	T	-90.0	0.0	2.47487E+05	0.0200	-5.21647E+04	5	1	1992.120	-
HLN	80.00	T	0.0	0.0	2.68754E+05	0.0200	-5.42944E+04	6	1	1992.120	-
HLE	80.00	T	0.0	90.0	2.62223E+05	0.0200	-5.30437E+04	7	1	1992.120	-
BLZ	20.00	T	-90.0	0.0	2.47487E+05	0.0200	-5.21647E+04	5	2	1992.120	-
BLN	20.00	T	0.0	0.0	2.68754E+05	0.0200	-5.42944E+04	6	2	1992.120	-
BLE	20.00	T	0.0	90.0	2.62223E+05	0.0200	-5.30437E+04	7	2	1992.120	-
LLZ	1.00	C	-90.0	0.0	2.47487E+05	0.0200	-5.21647E+04	5	3	1992.120	-
LLN	1.00	C	0.0	0.0	2.68754E+05	0.0200	-5.42944E+04	6	3	1992.120	-
LLE	1.00	C	0.0	90.0	2.62223E+05	0.0200	-5.30437E+04	7	3	1992.120	-

OPERATION NOTES

02/02/1993: The Streckeisen STS-1/UVBB seismometers were replaced with a set of STS-1/VBB. The VBB instruments have a 10 Hz high-frequency corner while the UVBB have a 5 Hz corner.

10/22/1992: The polarity of the NS channel of the STS-1 seismometer was corrected. From 04/29/92-10/22/92, the polarity of this channel was reversed and the sign of the Sd coefficient reflects this reversal.

05/05/1992: The line-driver gain on the STS-1 was changed, modifying the Sd parameter.

04/29/1992: The 16-bit PC-based datalogging system was replaced with the 24-bit Quanterra Q935 system.

10/27/1987: The Streckeisen STS-1/UVBB seismometers were installed with a PC-based datalogging system.

Table of Transfer Functions

Index	Data Stream	Poles	Zeroes
1	BH	-1.23410E-02 $\pm$ 1.23410E-02j	s^3=0
		-1.95880E+01 $\pm$ 2.45620E+01j	
		-4.91450E+00 $\pm$ 3.10290E+01j	
		-1.42630E+01 $\pm$ 2.79920E+01j	
		-2.22140E+01 $\pm$ 2.22140E+01j	
		-2.79920E+01 $\pm$ 1.42630E+01j	
		-3.10290E+01 $\pm$ 4.91450E+00j	
2	LH	-1.23410E-02 $\pm$ 1.23410E-02j	s^3=0
		-1.95880E+01 $\pm$ 2.45620E+01j	
		-1.62620E-01 $\pm$ 6.06910E-01j	
		-4.44290E-01 $\pm$ 4.44290E-01j	
		-6.06910E-01 $\pm$ 1.62620E-01j	
		-4.91450E+00 $\pm$ 3.10290E+01j	
		-1.42630E+01 $\pm$ 2.79920E+01j	
		-2.22140E+01 $\pm$ 2.22140E+01j	
		-2.79920E+01 $\pm$ 1.42630E+01j	
		-3.10290E+01 $\pm$ 4.91450E+00j	
3	HH, BH, LH, VH, UH	-1.23410E-02 $\pm$ 1.23410E-02j	s^2=0
		-1.95880E+01 $\pm$ 2.45620E+01j	
4	HH, BH, LH, VH, UH	-1.23410E-02 $\pm$ 1.23410E-02j	s^2=0
		-3.91760E+01 $\pm$ 4.91230E+01j	
5	HLZ, BLZ, LLZ	-3.23360E+02 $\pm$ 3.78050E+02j	-
6	HLN, BLN, LLN	-3.36970E+02 $\pm$ 3.93960E+02j	-
7	HLE, BLE, LLE	-3.27730E+02 $\pm$ 3.93470E+02j	-

MIN – Mineral, California

Latitude: 40.345 Longitude: -124.605 Elevation: 1495

Geology: Volcanic

Vault conditions: The instruments are sited in a wooden frame building constructed as a WPA project (circa 1935) for the installation of Wood-Anderson torsion seismometers. The hillside building is partially underground and unheated. The concrete pier is located in the same room as the datalogger and supporting equipment. The seismometers are thermally insulated with 4" of polyurethane foam.

Station Instrumentation:

VELOCITY CHANNELS

1 – Digital Seismograph System: Streckeisen STS-1/VBB with Quanterra Q935 Datalogger

Date of Operation: 19 March 1993 to present

STS-1 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HHZ	80.00	T	-90.0	0.0	9.87140E+02	0.0200	1.07380E+09	1	1	1993.144	-
HHN	80.00	T	0.0	0.0	9.87140E+02	0.0200	9.66629E+08	1	1	1993.144	-
HHE	80.00	T	0.0	90.0	9.87140E+02	0.0200	9.85589E+08	1	1	1993.144	-
BHZ	20.00	C	-90.0	0.0	9.87140E+02	0.0200	1.07380E+09	1	2	1993.144	-
BHN	20.00	C	0.0	0.0	9.87140E+02	0.0200	9.66629E+08	1	2	1993.144	-
BHE	20.00	C	0.0	90.0	9.87140E+02	0.0200	9.85589E+08	1	2	1993.144	-
LHZ	1.00	C	-90.0	0.0	9.87140E+02	0.0200	1.07380E+09	1	3	1993.144	-
LHN	1.00	C	0.0	0.0	9.87140E+02	0.0200	9.66629E+08	1	3	1993.144	-
LHE	1.00	C	0.0	90.0	9.87140E+02	0.0200	9.85589E+08	1	3	1993.144	-
VHZ	0.10	C	-90.0	0.0	9.87140E+02	0.0200	4.29518E+09	1	4	1993.144	-
VHN	0.10	C	0.0	0.0	9.87140E+02	0.0200	3.86652E+09	1	4	1993.144	-
VHE	0.10	C	0.0	90.0	9.87140E+02	0.0200	3.94236E+09	1	4	1993.144	-
UHZ	0.01	C	-90.0	0.0	1.20159E+03	0.0033	4.29518E+09	1	5	1993.144	-
UHN	0.01	C	0.0	0.0	1.20159E+03	0.0033	3.86652E+09	1	5	1993.144	-
UHE	0.01	C	0.0	90.0	1.20159E+03	0.0033	3.94236E+09	1	5	1993.144	-
HHZ	80.00	T	-90.0	0.0	9.87140E+02	0.0200	1.04316E+09	1	1	1993.078	1993.144
HHN	80.00	T	0.0	0.0	9.87140E+02	0.0200	9.66629E+08	1	1	1993.078	1993.144
HHE	80.00	T	0.0	90.0	9.87140E+02	0.0200	9.85589E+08	1	1	1993.078	1993.144
BHZ	20.00	C	-90.0	0.0	9.87140E+02	0.0200	1.04316E+09	1	2	1993.078	1993.144
BHN	20.00	C	0.0	0.0	9.87140E+02	0.0200	9.66629E+08	1	2	1993.078	1993.144
BHE	20.00	C	0.0	90.0	9.87140E+02	0.0200	9.85589E+08	1	2	1993.078	1993.144
LHZ	1.00	C	-90.0	0.0	9.87140E+02	0.0200	1.04316E+09	1	3	1993.078	1993.144
LHN	1.00	C	0.0	0.0	9.87140E+02	0.0200	9.66629E+08	1	3	1993.078	1993.144
LHE	1.00	C	0.0	90.0	9.87140E+02	0.0200	9.85589E+08	1	3	1993.078	1993.144
VHZ	0.10	C	-90.0	0.0	9.87140E+02	0.0200	4.17266E+09	1	4	1993.078	1993.144
VHN	0.10	C	0.0	0.0	9.87140E+02	0.0200	3.86652E+09	1	4	1993.078	1993.144
VHE	0.10	C	0.0	90.0	9.87140E+02	0.0200	3.94236E+09	1	4	1993.078	1993.144
UHZ	0.01	C	-90.0	0.0	1.20159E+03	0.0033	4.17266E+09	1	5	1993.078	1993.144
UHN	0.01	C	0.0	0.0	1.20159E+03	0.0033	3.86652E+09	1	5	1993.078	1993.144
UHE	0.01	C	0.0	90.0	1.20159E+03	0.0033	3.94236E+09	1	5	1993.078	1993.144

ACCELERATION CHANNELS

1 – Digital Seismograph System: Kinemetrics FBA-23 with Quanterra Q935 Datalogger

Date of Operation: 19 March 1993 to present

FBA-23 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HLZ	80.00	T	-90.0	0.0	1.06205E+05	0.0200	-5.03790E+04	2	1	1993.078	-
HLN	80.00	T	0.0	0.0	1.05112E+05	0.0200	-5.47043E+04	3	1	1993.078	-
HLE	80.00	T	0.0	90.0	1.03504E+05	0.0200	-5.35901E+04	4	1	1993.078	-
BLZ	20.00	T	-90.0	0.0	1.06205E+05	0.0200	-5.03790E+04	2	2	1993.078	-
BLN	20.00	T	0.0	0.0	1.05112E+05	0.0200	-5.47043E+04	3	2	1993.078	-
BLE	20.00	T	0.0	90.0	1.03504E+05	0.0200	-5.35901E+04	4	2	1993.078	-
LLZ	1.00	C	-90.0	0.0	1.06205E+05	0.0200	-5.03790E+04	2	3	1993.078	-
LLN	1.00	C	0.0	0.0	1.05112E+05	0.0200	-5.47043E+04	3	3	1993.078	-
LLE	1.00	C	0.0	90.0	1.03504E+05	0.0200	-5.35901E+04	4	3	1993.078	-

OPERATION NOTES

05/24/1993: The vertical component of STS-1 seismometers was replaced, modifying the Sd parameter.

03/19/1993: A Streckeisen STS-1 and a Kinemetrics FBA-23 were installed with a Quanterra Q935 digitizer.

Table of Transfer Functions

Index	Data Stream	Poles	Zeroes
1	HH, BH, LH, VH, UH	-1.23410E-02 $\pm$ 1.23410E-02j	s^2=0
		-1.95880E+01 $\pm$ 2.45620E+01j	
2	HLZ, BLZ, LLZ	-2.08570E+02 $\pm$ 2.50410E+02j	-
3	HLN, BLN, LLN	-2.07490E+02 $\pm$ 2.49110E+02j	-
4	HLE, BLE, LLE	-2.02680E+02 $\pm$ 2.49850E+02j	-

ORV – Oroville, California

Latitude: 39.556 Longitude: -121.500 Elevation: 360

Geology: Basalt

Vault conditions: The site is located in a concrete vault, oriented north/south, and excavated into a hilltop. Approximately 1 meter of backfilled soil covers the top of the vault. The datalogger is located in an adjacent building (90' away) connected by conduits. The seismometers are thermally insulated with 4" of polyurethane foam. The accelerometer is co-located with the datalogger.

Station Instrumentation:

VELOCITY CHANNELS

1 – Digital Seismograph System: Streckeisen STS-1/VBB with Quanterra Q935 Datalogger

Date of Operation: 29 July 1992 to present

STS-1 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HHZ	80.00	T	-90.0	0.0	3.94857E+03	0.0200	8.99661E+08	1	1	1992.211	-
HHN	80.00	T	0.0	0.0	3.94857E+03	0.0200	9.25320E+08	1	1	1992.211	-
HHE	80.00	T	0.0	90.0	3.94857E+03	0.0200	9.12859E+08	1	1	1992.211	-
BHZ	20.00	C	-90.0	0.0	3.94857E+03	0.0200	8.99661E+08	1	2	1992.211	-
BHN	20.00	C	0.0	0.0	3.94857E+03	0.0200	9.25320E+08	1	2	1992.211	-
BHE	20.00	C	0.0	90.0	3.94857E+03	0.0200	9.12859E+08	1	2	1992.211	-
LHZ	1.00	C	-90.0	0.0	3.94857E+03	0.0200	8.99661E+08	1	3	1992.211	-
LHN	1.00	C	0.0	0.0	3.94857E+03	0.0200	9.25320E+08	1	3	1992.211	-
LHE	1.00	C	0.0	90.0	3.94857E+03	0.0200	9.12859E+08	1	3	1992.211	-
VHZ	0.10	C	-90.0	0.0	3.94857E+03	0.0200	3.59864E+09	1	4	1992.211	-
VHN	0.10	C	0.0	0.0	3.94857E+03	0.0200	3.70128E+09	1	4	1992.211	-
VHE	0.10	C	0.0	90.0	3.94857E+03	0.0200	3.65144E+09	1	4	1992.211	-
UHZ	0.01	C	-90.0	0.0	4.80637E+03	0.0033	3.59864E+09	1	5	1992.211	-
UHN	0.01	C	0.0	0.0	4.80637E+03	0.0033	3.70128E+09	1	5	1992.211	-
UHE	0.01	C	0.0	90.0	4.80637E+03	0.0033	3.65144E+09	1	5	1992.211	-

ACCELERATION CHANNELS

1 – Digital Seismograph System: Kinemetrics FBA-23 with Quanterra Q935 Datalogger

Date of Operation: 29 July 1992 to present

FBA-23 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HLZ	80.00	T	-90.0	0.0	1.06758E+05	0.0200	-5.25216E+04	2	1	1993.161	-
HLN	80.00	T	0.0	0.0	1.03081E+05	0.0200	-5.42692E+04	3	1	1993.161	-
HLE	80.00	T	0.0	90.0	1.09589E+05	0.0200	-5.29930E+04	4	1	1993.161	-
BLZ	20.00	T	-90.0	0.0	1.06758E+05	0.0200	-5.25216E+04	2	2	1993.161	-
BLN	20.00	T	0.0	0.0	1.03081E+05	0.0200	-5.42692E+04	3	2	1993.161	-
BLE	20.00	T	0.0	90.0	1.09589E+05	0.0200	-5.29930E+04	4	2	1993.161	-
LLZ	1.00	T	-90.0	0.0	1.06758E+05	0.0200	-5.25216E+04	2	3	1993.161	-
LLN	1.00	T	0.0	0.0	1.03081E+05	0.0200	-5.42692E+04	3	3	1993.161	-
LLE	1.00	T	0.0	90.0	1.09589E+05	0.0200	-5.29930E+04	4	3	1993.161	-
HLZ	80.00	T	-90.0	0.0	1.06758E+05	0.0200	-5.25216E+04	2	1	1992.211	1993.161
HLN	80.00	T	0.0	320.0	1.03081E+05	0.0200	-5.42692E+04	3	1	1992.211	1993.161
HLE	80.00	T	0.0	50.0	1.09589E+05	0.0200	-5.29930E+04	4	1	1992.211	1993.161
BLZ	20.00	T	-90.0	0.0	1.06758E+05	0.0200	-5.25216E+04	2	2	1992.211	1993.161
BLN	20.00	T	0.0	320.0	1.03081E+05	0.0200	-5.42692E+04	3	2	1992.211	1993.161
BLE	20.00	T	0.0	50.0	1.09589E+05	0.0200	-5.29930E+04	4	2	1992.211	1993.161
LLZ	1.00	T	-90.0	0.0	1.06758E+05	0.0200	-5.25216E+04	2	3	1992.211	1993.161
LLN	1.00	T	0.0	320.0	1.03081E+05	0.0200	-5.42692E+04	3	3	1992.211	1993.161
LLE	1.00	T	0.0	50.0	1.09589E+05	0.0200	-5.29930E+04	4	3	1992.211	1993.161

OPERATION NOTES

06/10/1993: The FBA-23 package was reoriented so that the NS component was correctly aligned. From 07/29/92-06/10/93 the NS component was oriented N40W, as reflected in the azimuth parameter.

07/29/1992: A Streckeisen STS-1 and a Kinemetrics FBA-23 were installed with a Quanterra Q935 digitizer.

Table of Transfer Functions

Index	Data Stream	Poles	Zeroes
1	HH, BH, LH, VH, UH	-1.23410E-02 $\pm$ 1.23410E-02j	s^2=0
		-3.91760E+01 $\pm$ 4.91230E+01j	
2	HLZ, BLZ, LLZ	-2.12380E+02 $\pm$ 2.48300E+02j	-
3	HLN, BLN, LLN	-2.05480E+02 $\pm$ 2.46700E+02j	-
4	HLE, BLE, LLE	-2.11870E+02 $\pm$ 2.54360E+02j	-

PKD1 – Parkfield, California

Latitude: 35.889 Longitude: -120.425 Elevation: 466

Geology: Quaternary non-marine deposits

Vault conditions: The pier is a 4 inch concrete slab poured directly on the clay-rich soils. The STS-2 is housed in a thermal isolation container which sits on the slab. The datalogger and support equipment are sited in an air conditioned room of an adjacent house. This is a temporary site until the permanent PKD vault is constructed.

Station Instrumentation:

VELOCITY CHANNELS

1 – Digital Seismograph System: Streckeisen STS-2 with Quanterra Q935 Datalogger

Date of Operation: 11 February 1993 to present

STS-2 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HHZ	80.00	T	-90.0	0.0	4.92464E+07	0.0200	5.96990E+08	3	1	1993.224	-
HHN	80.00	T	0.0	0.0	4.92464E+07	0.0200	6.41438E+08	3	1	1993.224	-
HHE	80.00	T	0.0	90.0	4.92464E+07	0.0200	6.39295E+08	3	1	1993.224	-
BHZ	20.00	C	-90.0	0.0	4.92464E+07	0.0200	5.96990E+08	3	2	1993.224	-
BHN	20.00	C	0.0	0.0	4.92464E+07	0.0200	6.41438E+08	3	2	1993.224	-
BHE	20.00	C	0.0	90.0	4.92464E+07	0.0200	6.39295E+08	3	2	1993.224	-
LHZ	1.00	C	-90.0	0.0	4.92464E+07	0.0200	5.96990E+08	3	3	1993.224	-
LHN	1.00	C	0.0	0.0	4.92464E+07	0.0200	6.41438E+08	3	3	1993.224	-
LHE	1.00	C	0.0	90.0	4.92464E+07	0.0200	6.39295E+08	3	3	1993.224	-
VHZ	0.10	C	-90.0	0.0	4.92464E+07	0.0200	2.38796E+09	3	4	1993.224	-
VHN	0.10	C	0.0	0.0	4.92464E+07	0.0200	2.56575E+09	3	4	1993.224	-
VHE	0.10	C	0.0	90.0	4.92464E+07	0.0200	2.55718E+09	3	4	1993.224	-
UHZ	0.01	C	-90.0	0.0	4.92464E+07	0.0200	2.38796E+09	3	5	1993.224	-
UHN	0.01	C	0.0	0.0	4.92464E+07	0.0200	2.56575E+09	3	5	1993.224	-
UHE	0.01	C	0.0	90.0	4.92464E+07	0.0200	2.55718E+09	3	5	1993.224	-
HHZ	80.00	T	-90.0	0.0	4.92464E+07	0.0200	5.97785E+08	3	1	1993.043	1993.224
HHN	80.00	T	0.0	0.0	4.92464E+07	0.0200	6.50167E+08	3	1	1993.043	1993.224
HHE	80.00	T	0.0	90.0	4.92464E+07	0.0200	6.42798E+08	3	1	1993.043	1993.224
BHZ	20.00	C	-90.0	0.0	4.92464E+07	0.0200	5.97785E+08	3	2	1993.043	1993.224
BHN	20.00	C	0.0	0.0	4.92464E+07	0.0200	6.50167E+08	3	2	1993.043	1993.224
BHE	20.00	C	0.0	90.0	4.92464E+07	0.0200	6.42798E+08	3	2	1993.043	1993.224
LHZ	1.00	C	-90.0	0.0	4.92464E+07	0.0200	5.97785E+08	3	3	1993.043	1993.224
LHN	1.00	C	0.0	0.0	4.92464E+07	0.0200	6.50167E+08	3	3	1993.043	1993.224
LHE	1.00	C	0.0	90.0	4.92464E+07	0.0200	6.42798E+08	3	3	1993.043	1993.224
VHZ	0.10	C	-90.0	0.0	4.92464E+07	0.0200	2.39114E+09	3	4	1993.043	1993.224
VHN	0.10	C	0.0	0.0	4.92464E+07	0.0200	2.60067E+09	3	4	1993.043	1993.224
VHE	0.10	C	0.0	90.0	4.92464E+07	0.0200	2.57119E+09	3	4	1993.043	1993.224
UHZ	0.01	C	-90.0	0.0	4.92464E+07	0.0200	2.39114E+09	3	5	1993.043	1993.224
UHN	0.01	C	0.0	0.0	4.92464E+07	0.0200	2.60067E+09	3	5	1993.043	1993.224
UHE	0.01	C	0.0	90.0	4.92464E+07	0.0200	2.57119E+09	3	5	1993.043	1993.224

2 – Digital Seismograph System: Streckeisen STS-2 with PC-based Datalogger

Date of Operation: 22 October 1991 to 11 February 1993

STS-2 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
BHZ	20.00	C	-90.0	0.0	4.61183E+22	0.0200	7.86432E+06	1	-	1992.071	1993.042
BHN	20.00	C	0.0	0.0	4.61183E+22	0.0200	7.86432E+06	1	-	1992.071	1993.042
BHE	20.00	C	0.0	90.0	4.61183E+22	0.0200	7.86432E+06	1	-	1992.071	1993.042
LHZ	1.00	C	-90.0	0.0	2.83761E+21	0.0200	7.86432E+06	2	-	1992.071	1993.042
LHN	1.00	C	0.0	0.0	2.83761E+21	0.0200	7.86432E+06	2	-	1992.071	1993.042
LHE	1.00	C	0.0	90.0	2.83761E+21	0.0200	7.86432E+06	2	-	1992.071	1993.042
BHZ	20.00	C	-90.0	0.0	4.61183E+22	0.0200	4.91520E+06	1	-	1991.311	1992.071
BHN	20.00	C	0.0	0.0	4.61183E+22	0.0200	4.91520E+06	1	-	1991.311	1992.071
BHE	20.00	C	0.0	90.0	4.61183E+22	0.0200	4.91520E+06	1	-	1991.311	1992.071
LHZ	1.00	C	-90.0	0.0	2.83761E+21	0.0200	4.91520E+06	2	-	1991.311	1992.071
LHN	1.00	C	0.0	0.0	2.83761E+21	0.0200	4.91520E+06	2	-	1991.311	1992.071
LHE	1.00	C	0.0	90.0	2.83761E+21	0.0200	4.91520E+06	2	-	1991.311	1992.071
BHZ	20.00	C	-90.0	0.0	4.61183E+22	0.0200	2.45760E+07	1	-	1991.295	1991.311
BHN	20.00	C	0.0	0.0	4.61183E+22	0.0200	2.45760E+07	1	-	1991.295	1991.311
BHE	20.00	C	0.0	90.0	4.61183E+22	0.0200	2.45760E+07	1	-	1991.295	1991.311
LHZ	1.00	C	-90.0	0.0	2.83761E+21	0.0200	2.45760E+07	2	-	1991.295	1991.311
LHN	1.00	C	0.0	0.0	2.83761E+21	0.0200	2.45760E+07	2	-	1991.295	1991.311
LHE	1.00	C	0.0	90.0	2.83761E+21	0.0200	2.45760E+07	2	-	1991.295	1991.311

ACCELERATION CHANNELS

1 – Digital Seismograph System: Kinemetrics FBA-23 with Quanterra Q935 Datalogger

Date of Operation: 12 February 1993 to present

FBA-23 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HLZ	80.00	T	-90.0	0.0	1.04250E+05	0.0200	-5.42857E+04	4	1	1993.224	-
HLN	80.00	T	0.0	0.0	1.05112E+05	0.0200	-5.47701E+04	5	1	1993.224	-
HLE	80.00	T	0.0	90.0	1.02661E+05	0.0200	-5.37991E+04	6	1	1993.224	-
BLZ	20.00	T	-90.0	0.0	1.04250E+05	0.0200	-5.42857E+04	4	2	1993.224	-
BLN	20.00	T	0.0	0.0	1.05112E+05	0.0200	-5.47701E+04	5	2	1993.224	-
BLE	20.00	T	0.0	90.0	1.02661E+05	0.0200	-5.37991E+04	6	2	1993.224	-
LLZ	1.00	T	-90.0	0.0	1.04250E+05	0.0200	-5.42857E+04	4	3	1993.224	-
LLN	1.00	T	0.0	0.0	1.05112E+05	0.0200	-5.47701E+04	5	3	1993.224	-
LLE	1.00	T	0.0	90.0	1.02661E+05	0.0200	-5.37991E+04	6	3	1993.224	-
HLZ	80.00	T	-90.0	0.0	1.04250E+05	0.0200	-5.42985E+04	4	1	1993.043	1993.224
HLN	80.00	T	0.0	0.0	1.05112E+05	0.0200	-5.35171E+04	5	1	1993.043	1993.224
HLE	80.00	T	0.0	90.0	1.02661E+05	0.0200	-5.21146E+04	6	1	1993.043	1993.224
BLZ	20.00	T	-90.0	0.0	1.04250E+05	0.0200	-5.42985E+04	4	2	1993.043	1993.224
BLN	20.00	T	0.0	0.0	1.05112E+05	0.0200	-5.35171E+04	5	2	1993.043	1993.224
BLE	20.00	T	0.0	90.0	1.02661E+05	0.0200	-5.21146E+04	6	2	1993.043	1993.224
LLZ	1.00	T	-90.0	0.0	1.04250E+05	0.0200	-5.42985E+04	4	3	1993.043	1993.224
LLN	1.00	T	0.0	0.0	1.05112E+05	0.0200	-5.35171E+04	5	3	1993.043	1993.224
LLE	1.00	T	0.0	90.0	1.02661E+05	0.0200	-5.21146E+04	6	3	1993.043	1993.224

OPERATION NOTES

08/12/1993: The Q935 unit was replaced, modifying the Sd parameter.

02/11/1993: The PC-based 16-bit datalogger was replaced with a Quanterra Q935 24-bit unit.

03/11/1992: The gain was changed on the STS-2, modifying the Sd parameter.

11/07/1991: The gain was changed on the STS-2, modifying the Sd parameter.

10/22/1991: The Streckeisen STS-2 and Kinemetrics FBA-23 were installed with a 16-bit PC-based datalogger.

Table of Transfer Functions

Index	Data Stream	Poles	Zeroes
1	BH	-3.70240E-02 ± 3.70240E-02j	s^2=0
		-1.18630E+02 ± 4.23070E+02j	
		-2.51330E+02	
		-4.91450E+00 ± 3.10290E+01j	
		-1.42630E+01 ± 2.79920E+01j	
		-2.22140E+01 ± 2.22140E+01j	
		-2.79920E+01 ± 1.42630E+01j	
		-3.10290E+01 ± 4.91450E+00j	
2	LH	-3.70240E-02 ± 3.70240E-02j	s^2=0
		-1.18630E+02 ± 4.23070E+02j	
		-2.51330E+02	
		-1.62620E-01 ± 6.06910E-01j	
		-4.44290E-01 ± 4.44290E-01j	
		-6.06910E-01 ± 1.62620E-01j	
		-4.91450E+00 ± 3.10290E+01j	
		-1.42630E+01 ± 2.79920E+01j	
		-2.22140E+01 ± 2.22140E+01j	
		-2.79920E+01 ± 1.42630E+01j	
		-3.10290E+01 ± 4.91450E+00j	
3	HH, BH, LH, VH, UH	-3.70240E-02 ± 3.70240E-02j	s^2=0
		-1.18630E+02 ± 4.23070E+02j	
		-2.51330E+02	
4	HLZ, BLZ, LLZ	-2.09870E+02 ± 2.45370E+02j	-
5	HLN, BLN, LLN	-2.07490E+02 ± 2.49110E+02j	-
6	HLE, BLE, LLE	-2.05060E+02 ± 2.46190E+02j	-

SAO – San Andreas Geophysical Observatory, California

Latitude: 36.765   Longitude: -121.445   Elevation: 350

Geology: Granite

Vault conditions: The vault is a buried steel culvert liner with a set of three isolation doors leading to the interior. The pier is poured concrete. The datalogger and supporting equipment are located in an air conditioned structure approximately 50' away and connected via underground conduits. The seismometers are thermally insulated with 4" of polyurethane foam.

Station Instrumentation:

VELOCITY CHANNELS

1 – Digital Seismograph System: Streckeisen STS-1/UVBB with Quanterra Q935 Datalogger

Date of Operation: 10 June 1992 to present

STS-1/UVBB Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HHZ	80.00	T	-90.0	0.0	9.87140E+02	0.0200	1.02415E+09	5	1	1993.097	-
HHN	80.00	T	0.0	0.0	9.87140E+02	0.0200	9.88722E+08	5	1	1993.097	-
HHE	80.00	T	0.0	90.0	9.87140E+02	0.0200	9.71075E+08	5	1	1993.097	-
BHZ	20.00	C	-90.0	0.0	9.87140E+02	0.0200	1.02415E+09	5	2	1993.097	-
BHN	20.00	C	0.0	0.0	9.87140E+02	0.0200	9.88722E+08	5	2	1993.097	-
BHE	20.00	C	0.0	90.0	9.87140E+02	0.0200	9.71075E+08	5	2	1993.097	-
LHZ	1.00	C	-90.0	0.0	9.87140E+02	0.0200	1.02415E+09	5	3	1993.097	-
LHN	1.00	C	0.0	0.0	9.87140E+02	0.0200	9.88722E+08	5	3	1993.097	-
LHE	1.00	C	0.0	90.0	9.87140E+02	0.0200	9.71075E+08	5	3	1993.097	-
VHZ	0.10	C	-90.0	0.0	9.87140E+02	0.0200	4.09662E+09	5	4	1993.097	-
VHN	0.10	C	0.0	0.0	9.87140E+02	0.0200	3.95489E+09	5	4	1993.097	-
VHE	0.10	C	0.0	90.0	9.87140E+02	0.0200	3.88430E+09	5	4	1993.097	-
UHZ	0.01	C	-90.0	0.0	1.20159E+03	0.0033	4.09662E+09	5	5	1993.097	-
UHN	0.01	C	0.0	0.0	1.20159E+03	0.0033	3.95489E+09	5	5	1993.097	-
UHE	0.01	C	0.0	90.0	1.20159E+03	0.0033	3.88430E+09	5	5	1993.097	-
HHZ	80.00	T	-90.0	0.0	9.87140E+02	0.0200	1.01895E+09	5	1	1992.162	1993.097
HHN	80.00	T	0.0	0.0	9.87140E+02	0.0200	9.93318E+08	5	1	1992.162	1993.097
HHE	80.00	T	0.0	90.0	9.87140E+02	0.0200	9.70375E+08	5	1	1992.162	1993.097
BHZ	20.00	C	-90.0	0.0	9.87140E+02	0.0200	1.01895E+09	5	2	1992.162	1993.097
BHN	20.00	C	0.0	0.0	9.87140E+02	0.0200	9.93318E+08	5	2	1992.162	1993.097
BHE	20.00	C	0.0	90.0	9.87140E+02	0.0200	9.70375E+08	5	2	1992.162	1993.097
LHZ	1.00	C	-90.0	0.0	9.87140E+02	0.0200	1.01895E+09	5	3	1992.162	1993.097
LHN	1.00	C	0.0	0.0	9.87140E+02	0.0200	9.93318E+08	5	3	1992.162	1993.097
LHE	1.00	C	0.0	90.0	9.87140E+02	0.0200	9.70375E+08	5	3	1992.162	1993.097
VHZ	0.10	C	-90.0	0.0	9.87140E+02	0.0200	4.07581E+09	5	4	1992.162	1993.097
VHN	0.10	C	0.0	0.0	9.87140E+02	0.0200	3.97327E+09	5	4	1992.162	1993.097
VHE	0.10	C	0.0	90.0	9.87140E+02	0.0200	3.88150E+09	5	4	1992.162	1993.097
UHZ	0.01	C	-90.0	0.0	1.20159E+03	0.0033	4.07581E+09	5	5	1992.162	1993.097
UHN	0.01	C	0.0	0.0	1.20159E+03	0.0033	3.97327E+09	5	5	1992.162	1993.097
UHE	0.01	C	0.0	90.0	1.20159E+03	0.0033	3.88150E+09	5	5	1992.162	1993.097

2 – Digital Seismograph System: Streckeisen STS-1/UVBB with PC-based Datalogger
Date of Operation: 23 May 1991 to 10 June 1992

STS-1/UVBB Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
BHZ	20.00	C	-90.0	0.0	2.41278E+16	0.0200	3.94199E+07	3	-	1991.143	1992.162
BHN	20.00	C	0.0	0.0	2.41278E+16	0.0200	4.00753E+07	3	-	1991.143	1992.162
BHE	20.00	C	0.0	90.0	2.41278E+16	0.0200	3.72572E+07	3	-	1991.143	1992.162
LHZ	1.00	C	-90.0	0.0	1.48456E+15	0.0200	3.94199E+07	4	-	1991.143	1992.162
LHN	1.00	C	0.0	0.0	1.48456E+15	0.0200	4.00753E+07	4	-	1991.143	1992.162
LHE	1.00	C	0.0	90.0	1.48456E+15	0.0200	3.72572E+07	4	-	1991.143	1992.162

3 – Digital Seismograph System: Streckeisen STS-1/BRB with PC-based Datalogger
Date of Operation: 28 January 1988 to 23 May 1991

STS-1/BRB Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
BHZ	20.00	C	-90.0	0.0	2.76751E+16	0.0667	3.94199E+07	1	-	1988.028	1991.143
BHN	20.00	C	0.0	0.0	2.76751E+16	0.0667	4.00753E+07	1	-	1988.028	1991.143
BHE	20.00	C	0.0	90.0	2.76751E+16	0.0667	3.72572E+07	1	-	1988.028	1991.143
LHZ	1.00	C	-90.0	0.0	1.70937E+15	0.0667	3.94199E+07	2	-	1988.028	1991.143
LHN	1.00	C	0.0	0.0	1.70937E+15	0.0667	4.00753E+07	2	-	1988.028	1991.143
LHE	1.00	C	0.0	90.0	1.70937E+15	0.0667	3.72572E+07	2	-	1988.028	1991.143

ACCELERATION CHANNELS

1 – Digital Seismograph System: Kinemetrics FBA-23 with Quanterra Q935 Datalogger
Date of Operation: 10 June 1992 to present

FBA-23 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HLZ	80.00	T	-90.0	0.0	2.75993E+05	0.0200	-5.50155E+04	6	1	1993.097	-
HLN	80.00	T	0.0	0.0	2.56340E+05	0.0200	-5.40463E+04	7	1	1993.097	-
HLE	80.00	T	0.0	90.0	2.66112E+05	0.0200	-5.51776E+04	8	1	1993.097	-
BLZ	20.00	T	-90.0	0.0	2.75993E+05	0.0200	-5.50155E+04	6	2	1993.097	-
BLN	20.00	T	0.0	0.0	2.56340E+05	0.0200	-5.40463E+04	7	2	1993.097	-
BLE	20.00	T	0.0	90.0	2.66112E+05	0.0200	-5.51776E+04	8	2	1993.097	-
LLZ	1.00	T	-90.0	0.0	2.75993E+05	0.0200	-5.50155E+04	6	3	1993.097	-
LLN	1.00	T	0.0	0.0	2.56340E+05	0.0200	-5.40463E+04	7	3	1993.097	-
LLE	1.00	T	0.0	90.0	2.66112E+05	0.0200	-5.51776E+04	8	3	1993.097	-
HLZ	80.00	T	-90.0	0.0	2.75993E+05	0.0200	-5.31595E+04	6	1	1992.162	1993.097
HLN	80.00	T	0.0	0.0	2.56340E+05	0.0200	-5.38615E+04	7	1	1992.162	1993.097
HLE	80.00	T	0.0	90.0	2.66112E+05	0.0200	-5.23964E+04	8	1	1992.162	1993.097
BLZ	20.00	T	-90.0	0.0	2.75993E+05	0.0200	-5.31595E+04	6	2	1992.162	1993.097
BLN	20.00	T	0.0	0.0	2.56340E+05	0.0200	-5.38615E+04	7	2	1992.162	1993.097
BLE	20.00	T	0.0	90.0	2.66112E+05	0.0200	-5.23964E+04	8	2	1992.162	1993.097
LLZ	1.00	T	-90.0	0.0	2.75993E+05	0.0200	-5.31595E+04	6	3	1992.162	1993.097
LLN	1.00	T	0.0	0.0	2.56340E+05	0.0200	-5.38615E+04	7	3	1992.162	1993.097
LLE	1.00	T	0.0	90.0	2.66112E+05	0.0200	-5.23964E+04	8	3	1992.162	1993.097

OPERATION NOTES

04/07/1993: The Q935 unit was replaced, modifying the Sd parameter.

06/10/1992: The 16-bit PC-based digitizer was replaced with a Quanterra Q935. A Kinemetrics FBA-23 was added.

05/23/1991: The STS-1 was upgraded from the BRB response to the VBB response.

01/28/1988: An STS-1 with a PC-based datalogger was installed.

Table of Transfer Functions

Index	Data Stream	Poles	Zeroes
1	BH	-2.22140E-01 ± 2.22150E-01j	s^3=0
		-1.95880E+01 ± 2.45620E+01j	
		-4.91450E+00 ± 3.10290E+01j	
		-1.42630E+01 ± 2.79920E+01j	
		-2.22140E+01 ± 2.22140E+01j	
		-2.79920E+01 ± 1.42630E+01j	
		-3.10290E+01 ± 4.91450E+00j	
2	LH	-2.22140E-01 ± 2.22150E-01j	s^3=0
		-1.95880E+01 ± 2.45620E+01j	
		-1.62620E-01 ± 6.06910E-01j	
		-4.44290E-01 ± 4.44290E-01j	
		-6.06910E-01 ± 1.62620E-01j	
		-4.91450E+00 ± 3.10290E+01j	
		-1.42630E+01 ± 2.79920E+01j	
		-2.22140E+01 ± 2.22140E+01j	
		-2.79920E+01 ± 1.42630E+01j	
		-3.10290E+01 ± 4.91450E+00j	
3	BH	-1.23410E-02 ± 1.23410E-02j	s^3=0
		-1.95880E+01 ± 2.45620E+01j	
		-4.91450E+00 ± 3.10290E+01j	
		-1.42630E+01 ± 2.79920E+01j	
		-2.22140E+01 ± 2.22140E+01j	
		-2.79920E+01 ± 1.42630E+01j	
		-3.10290E+01 ± 4.91450E+00j	
4	LH	-1.23410E-02 ± 1.23410E-02j	s^3=0
		-1.95880E+01 ± 2.45620E+01j	
		-1.62620E-01 ± 6.06910E-01j	
		-4.44290E-01 ± 4.44290E-01j	
		-6.06910E-01 ± 1.62620E-01j	
		-4.91450E+00 ± 3.10290E+01j	
		-1.42630E+01 ± 2.79920E+01j	
		-2.22140E+01 ± 2.22140E+01j	
		-2.79920E+01 ± 1.42630E+01j	
		-3.10290E+01 ± 4.91450E+00j	
5	HH, BH, LH, VH, UH	-1.23410E-02 ± 1.23410E-02j	s^2=0
		-1.95880E+01 ± 2.45620E+01j	
6	HLZ, BLZ, LLZ	-3.46730E+02 ± 3.94680E+02j	-
7	HLN, BLN, LLN	-3.29100E+02 ± 3.84750E+02j	-
8	HLE, BLE, LLE	-3.24990E+02 ± 4.00620E+02j	-

STAN – Stanford University, California

Latitude: 37.404 Longitude: -122.174 Elevation: 158

Geology: Miocene volcanics

Vault conditions: The instruments are sited at the northeast corner of a single story wood frame building located on a ridge. The pier is the poured concrete floor and all the support equipment is located adjacent to the seismometers. This site was closed in July, 1994 due to the high noise levels and the instrumentation was relocated to JRSC.

Station Instrumentation:

VELOCITY CHANNELS

1 – Digital Seismograph System: Streckeisen STS-2 with Quanterra Q680 Datalogger

Date of Operation: 01 April 1991 to 30 June 1994

STS-2 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HHZ	80.00	T	-90.0	0.0	4.92464E+07	0.0200	6.02526E+08	1	1	1991.091	1994.181
HHN	80.00	T	0.0	0.0	4.92464E+07	0.0200	5.78876E+08	1	1	1991.091	1994.181
HHE	80.00	T	0.0	90.0	4.92464E+07	0.0200	6.21744E+08	1	1	1991.091	1994.181
BHZ	20.00	C	-90.0	0.0	4.92464E+07	0.0200	6.02526E+08	1	2	1991.091	1994.181
BHN	20.00	C	0.0	0.0	4.92464E+07	0.0200	5.78876E+08	1	2	1991.091	1994.181
BHE	20.00	C	0.0	90.0	4.92464E+07	0.0200	6.21744E+08	1	2	1991.091	1994.181
LHZ	1.00	C	-90.0	0.0	4.92464E+07	0.0200	6.02526E+08	1	3	1991.091	1994.181
LHN	1.00	C	0.0	0.0	4.92464E+07	0.0200	5.78876E+08	1	3	1991.091	1994.181
LHE	1.00	C	0.0	90.0	4.92464E+07	0.0200	6.21744E+08	1	3	1991.091	1994.181
VHZ	0.10	C	-90.0	0.0	4.92464E+07	0.0200	2.41010E+09	1	4	1991.091	1994.181
VHN	0.10	C	0.0	0.0	4.92464E+07	0.0200	2.31550E+09	1	4	1991.091	1994.181
VHE	0.10	C	0.0	90.0	4.92464E+07	0.0200	2.48698E+09	1	4	1991.091	1994.181
UHZ	0.01	C	-90.0	0.0	4.92464E+07	0.0200	2.41010E+09	1	5	1991.091	1994.181
UHN	0.01	C	0.0	0.0	4.92464E+07	0.0200	2.31550E+09	1	5	1991.091	1994.181
UHE	0.01	C	0.0	90.0	4.92464E+07	0.0200	2.48698E+09	1	5	1991.091	1994.181

ACCELERATION CHANNELS

2 – Digital Seismograph System: Kinematics FBA-23 with Quanterra Q680 Datalogger

Date of Operation: 01 April 1991 to 30 June 1994

FBA-23 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HLZ	80.00	T	-90.0	0.0	3.97962E+05	0.0200	2.09018E+05	2	1	1992.155	1994.181
HLN	80.00	T	0.0	0.0	3.87773E+05	0.0200	2.10348E+05	3	1	1992.155	1994.181
HLE	80.00	T	0.0	90.0	4.04432E+05	0.0200	2.10265E+05	4	1	1992.155	1994.181
BLZ	20.00	T	-90.0	0.0	3.97962E+05	0.0200	2.09018E+05	2	2	1992.155	1994.181
BLN	20.00	T	0.0	0.0	3.87773E+05	0.0200	2.10348E+05	3	2	1992.155	1994.181
BLE	20.00	T	0.0	90.0	4.04432E+05	0.0200	2.10265E+05	4	2	1992.155	1994.181
LLZ	1.00	T	-90.0	0.0	3.97962E+05	0.0200	2.09018E+05	2	3	1992.155	1994.181
LLN	1.00	T	0.0	0.0	3.87773E+05	0.0200	2.10348E+05	3	3	1992.155	1994.181
LLE	1.00	T	0.0	90.0	4.04432E+05	0.0200	2.10265E+05	4	3	1992.155	1994.181
HLZ	80.00	T	-90.0	0.0	3.97962E+05	0.0200	2.10602E+05	2	1	1991.120	1992.155
HLN	80.00	T	0.0	0.0	3.87773E+05	0.0200	2.09435E+05	3	1	1991.120	1992.155
HLE	80.00	T	0.0	90.0	4.04432E+05	0.0200	2.09593E+05	4	1	1991.120	1992.155
BLZ	20.00	T	-90.0	0.0	3.97962E+05	0.0200	2.10602E+05	2	2	1991.120	1992.155
BLN	20.00	T	0.0	0.0	3.87773E+05	0.0200	2.09435E+05	3	2	1991.120	1992.155
BLE	20.00	T	0.0	90.0	4.04432E+05	0.0200	2.09593E+05	4	2	1991.120	1992.155
LLZ	1.00	T	-90.0	0.0	3.97962E+05	0.0200	2.10602E+05	2	3	1991.120	1992.155
LLN	1.00	T	0.0	0.0	3.87773E+05	0.0200	2.09435E+05	3	3	1991.120	1992.155
LLE	1.00	T	0.0	90.0	4.04432E+05	0.0200	2.09593E+05	4	3	1991.120	1992.155
HLZ	80.00	T	-90.0	0.0	3.97962E+05	0.0200	2.01855E+05	2	1	1991.091	1991.119
HLN	80.00	T	0.0	0.0	3.87773E+05	0.0200	2.06667E+05	3	1	1991.091	1991.119
HLE	80.00	T	0.0	90.0	4.04432E+05	0.0200	2.11348E+05	4	1	1991.091	1991.119
BLZ	20.00	T	-90.0	0.0	3.97962E+05	0.0200	2.01855E+05	2	2	1991.091	1991.119
BLN	20.00	T	0.0	0.0	3.87773E+05	0.0200	2.06667E+05	3	2	1991.091	1991.119
BLE	20.00	T	0.0	90.0	4.04432E+05	0.0200	2.11348E+05	4	2	1991.091	1991.119
LLZ	1.00	T	-90.0	0.0	3.97962E+05	0.0200	2.01855E+05	2	3	1991.091	1991.119
LLN	1.00	T	0.0	0.0	3.87773E+05	0.0200	2.06667E+05	3	3	1991.091	1991.119
LLE	1.00	T	0.0	90.0	4.04432E+05	0.0200	2.11348E+05	4	3	1991.091	1991.119

OPERATION NOTES

06/30/1994: The station was closed and the equipment relocated at JRSC.

04/24/1992: The FBA-23 was rewired.

04/29/1991: The digitizer module for the FBA-23 was replaced.

04/01/1991: A Streckeisen STS-2 and a Kinematics FBA-23 were installed with a Quanterra Q680 digitizer. This site is operated cooperatively with Stanford University.

Table of Transfer Functions

Index	Data Stream	Poles	Zeroes
1	HH, BH, LH, VH, UH	-3.70240E-02 ± 3.70240E-02j -1.18630E+02 ± 4.23070E+02j -2.51330E+02	s^2=0
2	HLZ, BLZ, LLZ	-4.03740E+02 ± 4.84720E+02j	-
3	HLN, BLN, LLN	-4.10990E+02 ± 4.67820E+02j	-
4	HLE, BLE, LLE	-4.07010E+02 ± 4.88650E+02j	-

WDC – WHISKEYTOWN DAM, CALIFORNIA

Latitude: 40.580 Longitude: -122.540 Elevation: 300

Geology: Pre-Devonian metavolcanics

Vault conditions: The sensors are located in approximately 150' into a tunnel and encased in a steel tank which is located on a poured concrete pad. Approximately 25 meters of overburden cover the tunnel. The datalogger and supporting equipment is located in an external building and connected via conduits.

Station Instrumentation:

VELOCITY CHANNELS

1 – Digital Seismograph System: Streckeisen STS-2 with Quanterra Q935 Datalogger

Date of Operation: 14 July 1992 to present

STS-2 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HHZ	80.00	T	-90.0	0.0	4.92464E+07	0.0200	5.94342E+08	1	1	1992.196	-
HHN	80.00	T	0.0	0.0	4.92464E+07	0.0200	6.25618E+08	1	1	1992.196	-
HHE	80.00	T	0.0	90.0	4.92464E+07	0.0200	5.85010E+08	1	1	1992.196	-
BHZ	20.00	C	-90.0	0.0	4.92464E+07	0.0200	5.94342E+08	1	2	1992.196	-
BHN	20.00	C	0.0	0.0	4.92464E+07	0.0200	6.25618E+08	1	2	1992.196	-
BHE	20.00	C	0.0	90.0	4.92464E+07	0.0200	5.85010E+08	1	2	1992.196	-
LHZ	1.00	C	-90.0	0.0	4.92464E+07	0.0200	5.94342E+08	1	3	1992.196	-
LHN	1.00	C	0.0	0.0	4.92464E+07	0.0200	6.25618E+08	1	3	1992.196	-
LHE	1.00	C	0.0	90.0	4.92464E+07	0.0200	5.85010E+08	1	3	1992.196	-
VHZ	0.10	C	-90.0	0.0	4.92464E+07	0.0200	2.37737E+09	1	4	1992.196	-
VHN	0.10	C	0.0	0.0	4.92464E+07	0.0200	2.50247E+09	1	4	1992.196	-
VHE	0.10	C	0.0	90.0	4.92464E+07	0.0200	2.34004E+09	1	4	1992.196	-
UHZ	0.01	C	-90.0	0.0	4.92464E+07	0.0200	2.37737E+09	1	5	1992.196	-
UHN	0.01	C	0.0	0.0	4.92464E+07	0.0200	2.50247E+09	1	5	1992.196	-
UHE	0.01	C	0.0	90.0	4.92464E+07	0.0200	2.34004E+09	1	5	1992.196	-

ACCELERATION CHANNELS

1 – Digital Seismograph System: Kinemetrics FBA-23 with Quanterra Q935 Datalogger

Date of Operation: 14 July 1992 to present

FBA-23 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HLZ	80.00	T	-90.0	0.0	1.02661E+05	0.0200	-5.11885E+04	2	1	1992.196	-
HLN	80.00	T	0.0	0.0	1.09243E+05	0.0200	-5.37278E+04	3	1	1992.196	-
HLE	80.00	T	0.0	90.0	1.05547E+05	0.0200	-5.27154E+04	4	1	1992.196	-
BLZ	20.00	T	-90.0	0.0	1.02661E+05	0.0200	-5.11885E+04	2	2	1992.196	-
BLN	20.00	T	0.0	0.0	1.09243E+05	0.0200	-5.37278E+04	3	2	1992.196	-
BLE	20.00	T	0.0	90.0	1.05547E+05	0.0200	-5.27154E+04	4	2	1992.196	-
LLZ	1.00	T	-90.0	0.0	1.02661E+05	0.0200	-5.11885E+04	2	3	1992.196	-
LLN	1.00	T	0.0	0.0	1.09243E+05	0.0200	-5.37278E+04	3	3	1992.196	-
LLE	1.00	T	0.0	90.0	1.05547E+05	0.0200	-5.27154E+04	4	3	1992.196	-

OPERATION NOTES

07/14/92: A Streckeisen STS-2 and a Kinemetrics FBA-23 were installed with a Quanterra Q935 digitizer.

Table of Transfer Functions

Index	Data Stream	Poles	Zeroes
1	HH, BH, LH, VH, UH	-3.70240E-02 $\pm$ 3.70240E-02j -1.18630E+02 $\pm$ 4.23070E+02j -2.51330E+02	s^2=0
2	HLZ, BLZ, LLZ	-2.05060E+02 $\pm$ 2.46190E+02j	-
3	HLN, BLN, LLN	-2.11530E+02 $\pm$ 2.53960E+02j	-
4	HLE, BLE, LLE	-2.04670E+02 $\pm$ 2.52300E+02j	-

YBH – Yreka Blue Horn, California

Latitude: 41.732 Longitude: -122.711 Elevation: 1100

Geology: Mesozoic greenstone

Vault conditions: The sensors are located in an abandoned mining adit, approximately 115' from the entrance, on a poured concrete pier. Approximately 75 meters of overburden cover the adit. The seismometers are thermally insulated with 2" of polyurethane foam. The datalogger and supporting equipment are located approximately 50' from the entrance to the adit.

Station Instrumentation:

VELOCITY CHANNELS

1 – Digital Seismograph System: Streckeisen STS-1/VBB with Quanterra Q935 Datalogger

Date of Operation: 24 July 1993 to present

STS-1 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HHZ	80.00	T	-90.0	0.0	9.87140E+02	0.0200	9.61356E+08	1	1	1993.205	-
HHN	80.00	T	0.0	0.0	9.87140E+02	0.0200	9.10068E+08	1	1	1993.205	-
HHE	80.00	T	0.0	90.0	9.87140E+02	0.0200	9.85737E+08	1	1	1993.205	-
BHZ	20.00	C	-90.0	0.0	9.87140E+02	0.0200	9.61356E+08	1	2	1993.205	-
BHN	20.00	C	0.0	0.0	9.87140E+02	0.0200	9.10068E+08	1	2	1993.205	-
BHE	20.00	C	0.0	90.0	9.87140E+02	0.0200	9.85737E+08	1	2	1993.205	-
LHZ	1.00	C	-90.0	0.0	9.87140E+02	0.0200	9.61356E+08	1	3	1993.205	-
LHN	1.00	C	0.0	0.0	9.87140E+02	0.0200	9.10068E+08	1	3	1993.205	-
LHE	1.00	C	0.0	90.0	9.87140E+02	0.0200	9.85737E+08	1	3	1993.205	-
VHZ	0.10	C	-90.0	0.0	9.87140E+02	0.0200	3.84543E+09	1	4	1993.205	-
VHN	0.10	C	0.0	0.0	9.87140E+02	0.0200	3.64027E+09	1	4	1993.205	-
VHE	0.10	C	0.0	90.0	9.87140E+02	0.0200	3.94295E+09	1	4	1993.205	-
UHZ	0.01	C	-90.0	0.0	1.20159E+03	0.0033	3.84543E+09	1	5	1993.205	-
UHN	0.01	C	0.0	0.0	1.20159E+03	0.0033	3.64027E+09	1	5	1993.205	-
UHE	0.01	C	0.0	90.0	1.20159E+03	0.0033	3.94295E+09	1	5	1993.205	-

ACCELERATION CHANNELS

1 – Digital Seismograph System: Kinemetrics FBA-23 with Quanterra Q935 Datalogger

Date of Operation: 24 July 1993 to present

FBA-23 Stream Information

Data Stream	Samp. Rate	T/C	dip	azi.	A_0	fn	Sd	P/Z Index	FIR Index	S. Date	E. Date
HLZ	80.00	T	-90.0	0.0	1.01828E+05	0.0200	-5.29899E+04	2	1	1993.205	-
HLN	80.00	T	0.0	0.0	1.06315E+05	0.0200	-5.40345E+04	3	1	1993.205	-
HLE	80.00	T	0.0	90.0	1.06315E+05	0.0200	-5.21880E+04	4	1	1993.205	-
BLZ	20.00	T	-90.0	0.0	1.01828E+05	0.0200	-5.29899E+04	2	2	1993.205	-
BLN	20.00	T	0.0	0.0	1.06315E+05	0.0200	-5.40345E+04	3	2	1993.205	-
BLE	20.00	T	0.0	90.0	1.06315E+05	0.0200	-5.21880E+04	4	2	1993.205	-
LLZ	1.00	C	-90.0	0.0	1.01828E+05	0.0200	-5.29899E+04	2	3	1993.205	-
LLN	1.00	C	0.0	0.0	1.06315E+05	0.0200	-5.40345E+04	3	3	1993.205	-
LLE	1.00	C	0.0	90.0	1.06315E+05	0.0200	-5.21880E+04	4	3	1993.205	-

OPERATION NOTES

07/24/1993: A Streckeisen STS-1 and a Kinemetrics FBA-23 were installed with a Quanterra Q935 digitizer.

Table of Transfer Functions

Index	Data Stream	Poles	Zeroes
1	HH, BH, LH, VH, UH	-3.70240E-02 $\pm$ 3.70240E-02j	s^2=0
		-1.18630E+02 $\pm$ 4.23070E+02j	
		-2.51330E+02	
2	HLZ, BLZ, LLZ	-1.23410E-02 $\pm$ 1.23410E-02j	s^2=0
		-1.95880E+01 $\pm$ 2.45620E+01j	
3	HLN, BLN, LLN	-2.04230E+02 $\pm$ 2.45190E+02j	-
4	HLE, BLE, LLE	-2.08680E+02 $\pm$ 2.50540E+02j	-

Appendix C: Composite FIR Filters

Overview

Finite impulse response (FIR) filters are used in the Quanterra Q680 and Q935 dataloggers. Although frequently ignored in computation of the instrument transfer function, the FIR filters have three characteristics which users should be aware of when processing the data. First, the FIR filters are designed to have a phase response which is independent of frequency. Second, they have amplitude ripple up to 4.5 percent within the passband. Third, the FIR filters are inherently non-causal. The non-causal nature of the FIR filters is readily apparent when high amplitude impulsive arrivals with energy near the FIR filter cutoff frequency are observed. We sometimes observe small precursors on the BH data streams which are not observed on the corresponding HH data streams for local earthquakes which generate large impulsive onsets. For example, local earthquakes which occur within 10 km of the BDSN station BKS invariably exhibit a non-causal arrival approximately 0.75 seconds prior to the P-wave onset on the BHZ data stream. The non-causal arrival is not readily apparent on the corresponding HHZ data stream.

Table 15 lists the FIR filter coefficients and the associated FIR filter delay times.

Digital FIR Filter Representation

This representation is used to describe the response of the finite impulse response anti-aliasing filters used in the Quanterra dataloggers. In this type of filter, the input time series (X_k) is convolved with a finite set of FIR coefficients (Z_n) to produce the output time series (Y_k):

$$Y_k = \sum_{n=0}^{N} (Z_n \; X_{k-n})$$

The transfer function for this filter is:

$$H_c(\omega) = \sum_{n=0}^{N} (Z_n \; z^{-n})$$

and the z-transform variable is:

$$z^{-n} = \exp(s \; dt)$$

where:

$$s = \text{the complex angular frequency}$$
$$dt = \text{the sample interval}$$

The coefficients Z_n are scaled so that $|H_c(z_s)| = 1.0$ where:

$$z_s = \exp(s_0 dt)$$

and s_0 is the complex angular frequency at which H_c is normalized. The FIR filter introduces a constant time delay into the time series which is accounted for in the Quanterra datalogger by altering the data time stamp. The appropriate time delay for each sample rate is given at the beginning of the following table. It should be noted that the filter parameters given in the table represent a composite filter which is equivalent to the chain of filters actually used in the Quanterra datalogger. In actuality, the Quanterra datalogger uses a sequence of 2, 3, 5, 6 & 7 successive FIR filters for the HH, BH, LH, VH & UH data streams, respectively.

Table 15: FIR Z-transform Coefficients

FIR INDEX	1	2	3	4	5
Group Delay (s)	1.04784E-01	1.24852E+00	1.48235E+01	1.35323E+02	1.34033E+03
Coefficients					
Z_0	1.75909E-03	-3.77791E-08	-3.38182E-08	3.14670E-06	3.86891E-06
Z_1	-9.26464E-03	-4.14883E-07	-8.44821E-06	-9.89321E-04	-1.36862E-03
Z_2	-1.17430E-02	9.44545E-06	-3.93826E-04	-2.33512E-03	-1.78652E-03
Z_3	2.63016E-02	3.37062E-05	-2.62119E-03	4.43089E-03	4.60660E-03
Z_4	-4.35231E-02	-2.42950E-05	2.57011E-03	-5.31705E-03	-7.00712E-03
Z_5	4.70488E-02	1.96052E-05	-6.21561E-04	2.06772E-03	5.81592E-03
Z_6	-1.72983E-02	1.54448E-06	-4.94670E-03	7.19694E-03	1.96574E-03
Z_7	-8.85877E-02	-2.15060E-05	1.33517E-02	-2.15325E-02	-1.71348E-02
Z_8	7.03875E-01	2.70553E-05	-2.09085E-02	3.58866E-02	3.63787E-02
Z_9	5.19951E-01	-1.67690E-05	2.14021E-02	-4.11620E-02	-5.14506E-02
Z_{10}	-1.58614E-01	5.12417E-03	-7.84606E-03	2.54544E-02	4.95721E-02
Z_{11}	4.53908E-02	1.77980E-03	-2.50736E-02	2.60634E-02	-1.26147E-02
Z_{12}	7.88644E-03	-4.33221E-03	7.96226E-02	-1.45914E-01	-1.01434E-01
Z_{13}	-2.67686E-02	7.43031E-03	-1.57069E-01	5.86650E-01	6.82379E-01
Z_{14}	2.43884E-02	-1.03934E-02	3.26484E-01	6.36767E-01	5.33221E-01
Z_{15}	-1.78914E-02	1.18328E-02	7.77895E-01	-1.26276E-01	-1.60141E-01
Z_{16}	-4.18644E-03	-1.05588E-02	3.76307E-02	7.36901E-03	4.29653E-02
Z_{17}	1.27532E-03	6.85903E-03	-8.19610E-02	3.77348E-02	1.31343E-02
Z_{18}	-	1.16337E-02	7.86199E-02	-4.68157E-02	-3.47086E-02
Z_{19}	-	-2.60449E-02	-5.41700E-02	3.66094E-02	3.42708E-02
Z_{20}	-	4.64855E-02	2.58734E-02	-1.96383E-02	-2.27822E-02
Z_{21}	-	-7.01584E-02	-3.66140E-03	4.70248E-03	9.38084E-03
Z_{22}	-	9.52216E-02	-8.37552E-03	3.94606E-03	2.40281E-04
Z_{23}	-	-1.27508E-01	1.10511E-02	-6.21812E-03	-4.33770E-03
Z_{24}	-	1.43697E-01	-8.04977E-03	4.57321E-03	4.19003E-03
Z_{25}	-	8.77830E-01	3.51806E-03	-2.08871E-03	-2.52318E-03
Z_{26}	-	8.81929E-02	-2.83619E-04	-1.16629E-03	-8.41169E-04
Z_{27}	-	-1.05915E-01	-1.99059E-03	-1.62086E-06	5.55116E-06
Z_{28}	-	8.73118E-02	-3.37218E-05	1.86478E-12	-
Z_{29}	-	-6.89965E-02	-3.69758E-06	-	-
Z_{30}	-	4.89921E-02	-8.39488E-09	-	-
Z_{31}	-	-3.02058E-02	-	-	-
Z_{32}	-	1.64037E-02	-	-	-
Z_{33}	-	2.73398E-03	-	-	-
Z_{34}	-	-7.89916E-03	-	-	-
Z_{35}	-	1.03642E-02	-	-	-
Z_{36}	-	-9.90279E-03	-	-	-
Z_{37}	-	7.60717E-03	-	-	-
Z_{38}	-	-4.88150E-03	-	-	-
Z_{39}	-	2.55726E-03	-	-	-
Z_{40}	-	4.75123E-03	-	-	-
Z_{41}	-	-8.74407E-05	-	-	-
Z_{42}	-	3.54503E-05	-	-	-
Z_{43}	-	-3.24492E-05	-	-	-
Z_{44}	-	9.07871E-06	-	-	-
Z_{45}	-	1.39588E-05	-	-	-
Z_{46}	-	-2.04426E-05	-	-	-
Z_{47}	-	3.44201E-05	-	-	-
Z_{48}	-	7.74323E-06	-	-	-
Z_{49}	-	-3.92528E-07	-	-	-
Z_{50}	-	-2.91436E-08	-	-	-

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