

## Scans of the Caltech Archive

This directory contains images of seismograms formally stored by the Caltech in the Kresge Seismological Laboratory, Pasadena CA. The images are a subset of the approximately 1 million paper records accumulated from 1928 through the mid-1980's. The images were scanned in 2009-2011 by Google in collaboration with UC Santa Cruz as part of the Google Books project. Scans include fronts and backs of the paper records and are organized into directories that each corresponds to an individual box in which the records were originally stored at Kresge. The goal of this electronic library of seismograms is to allow users to simulate the experience of going to the paper archives and flipping through a box to find a record. The organization is imperfect and the search engine non-existent, but the original records are now as accessible to the world-wide user group as they once were to a small group of California seismologists.

As only a small part of the collection could be scanned, the images sent to Google were prioritized as follows:

- 1) The Special Collection was scanned in its entirety. The Special Collection contains records collected by Caltech seismologists for their study on significant historical events. These records are predominantly from the Pasadena long-period Press-Ewing seismometers, but the collection is extremely heterogeneous and includes copies of records from a number of historical sites. The Special Collection directories are labeled with brief names of important events or sites contained. Often the station information is written on the back of the record. The station information is either a station code or a pier number at Pasadena (see below).
- 2) The Southern California Seismic Network short-period records were scanned with highest priority going to the earliest records. Records that were deemed too brittle to run through the scan apparatus were skipped. These directories are labeled with the date range covered and the annotation "SCSN". Within each date range, the full suite of operating instruments is covered. Usually records appear in a directory chronologically with all of the stations in a row for each day and then the same suite of stations again the next day. The station codes and dates are usually stamped on the front of the record.

### *User information*

Each directory contains the full images numbered in the order they were removed from the box (hopefully the filing order). The directories also contain thumbnails of each image to enable faster browsing. The thumbnails have the same name as the original high-resolution file with the appendix ".thumb.jpg". Sometimes a box was split in two due to a scanner interruption. In these cases, the two directories have the appendix "a" and "b".

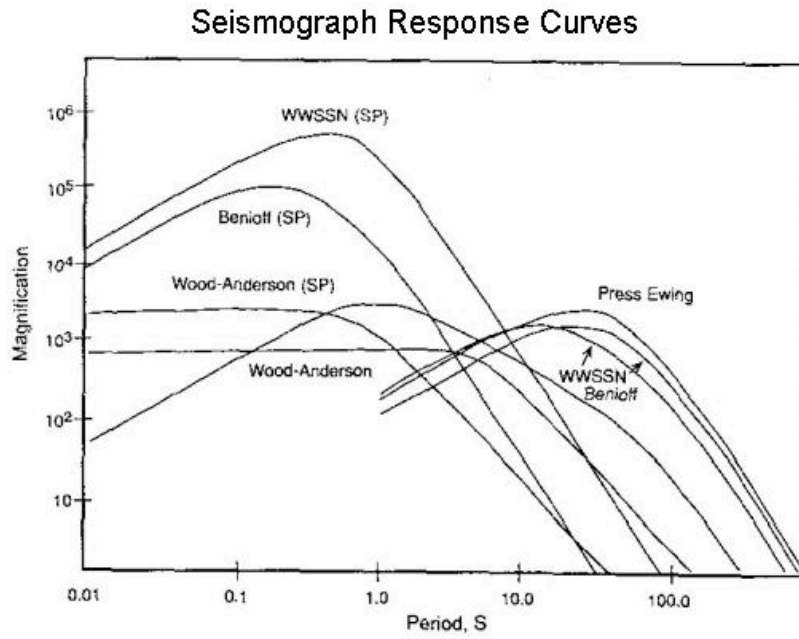
There is also a user-editable documentation tool at: <http://www.iris.edu/CaltechSeismoWiki/> This is meant to be a community document to help users identify events and instrumental issues. Please read the document upon starting your work and add to it as often as you can. The WIKI requires a user-account that is automatically generated if you fill in the form at: <http://www.iris.edu/CaltechSeismoWiki/Login.jsp?redirect=Main#>

## *Instrument Responses*

The two most common sensor types in the archive are Wood-Anderson short-periods seismometers in the SCSN and Press-Ewing seismometers in the special collections. Typical response curves are in Figure 1 and instrument constants in Table 1. Further information is available in the Appendix to Kanamori (1988).

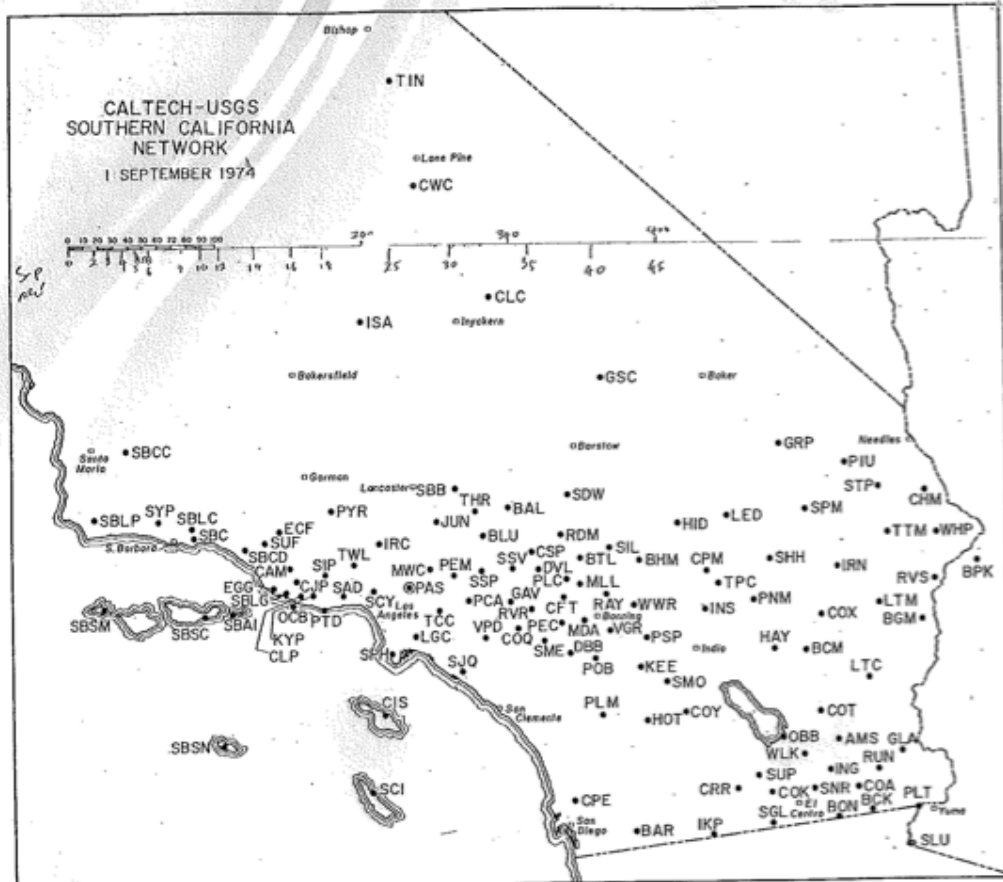
The short-period records are stamped with a station code. The SCSN stations eventually covered all of Southern California (Figure 2) and are documented in Appendix A of this document with the station names, abbreviations, coordinates, sensor types and basic operational notes.

Many of the records in the special collection are marked with handwritten pier numbers on the reverse rather than instruments. These numbers correspond to a specific location in the Pasadena instrument room and the corresponding sensor changes with time. The most common pier numbers are 34A, B and C corresponding to the three components of the Press-Ewing instruments. A map of the Kresge building with pier numbers and sensor annotations is in Figure 3.



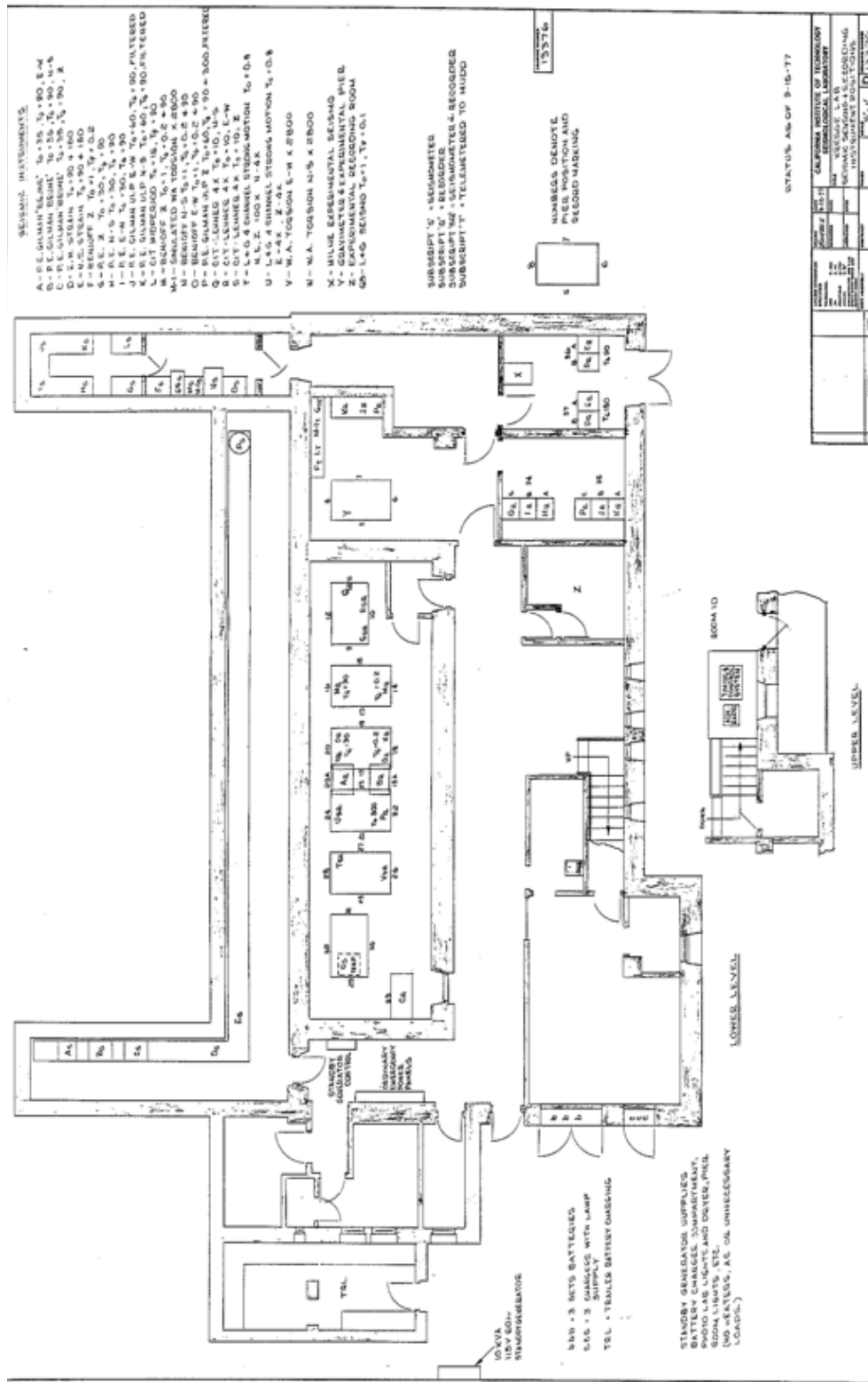
**Figure 1.** Approximate response curves of historical seismograms (Courtesy H. Kanamori).

Seismographic stations of the southern California network, operated jointly by Caltech and the U. S. Geological Survey. Seismic signals from most of these stations are telemetered to Pasadena on leased telephone lines or by radio. A few such stations are operated co-operatively with other groups such as the California Department of Water Resources and the University of California at San Diego.



- |                        |                     |                           |                      |                      |
|------------------------|---------------------|---------------------------|----------------------|----------------------|
| AMS Amos               | CPE Camp Elliot     | KYP Key Point             | RDM Round Min        | SLU San Luis         |
| BAL Baldy Mesa         | CPM Copper Min      | LED Lead Min              | RUN Ruthven          | SME Santa Rosa Mine  |
| BAR Barrett            | CRR Carrizo         | LGK Lakewood Golf Course  | RVS Riverside        | SNR Santa Rosa Mine  |
| BCK Brock's Farm       | CWP Cedar Springs   | LTM Little Maria Mts      | RVS Riverside Mts    | SNR Schallner Rich   |
| BCM Big Chuckwalla Mts | CWC Cottonwood      | LTC Little Chuckwalla Mts | SAD Gaddie Pk        | SPH San Pedro Hill   |
| BGM Big Maria Mts      | DBS Double Butte    | MDA Mt Davis              | SBAI Anacapa Is      | SPM Ship Mts         |
| BHM Bighorn Mts        | DVL Devil Canyon    | MLL Mill Creek            | SBS Saddleback Butte | SSP Sunset Pk        |
| BLU Blue Ridge         | ECF Echo Falls      | MWC Mt Wilson             | SBC Santa Barbara    | SSV San Sevaine      |
| BON Bonds Corner       | EGG Egg Rich        | OCB Obaldian Butte        | SBCC Colson Canyon   | STP Stapleholder Mts |
| BPK Black Pk           | GAV Glen Avon       | OCB Ocean Bottom          | SBCC Castles Dam     | SUF Suffer Ridge     |
| BTL Butler Pk          | GLA Glamis          | PAS Pasadena              | SBLC La Cumbre Pk    | SUP Superstition Mts |
| CAM Camarillo Hills    | GBP Granite Pass    | PCA Pomona                | SBLG Laguna Pk       | SYP Santa Ynez Pk    |
| CHM Chemehuavi Mts     | GBC Goldstone       | PEC Petris                | SBLP Lempop          | TCC Turnbull Canyon  |
| CIS Catalina Island    | HAY Hayfield        | PEM Pine Min              | SBSC Santa Cruz Is   | TIN Tinajas          |
| CJP Cajojo Pk          | HID Hidalgo Min     | PIU Pileto Mts            | SBRN San Nicolas Is  | TPO Twinnyline Palms |
| CLC China Lake         | HOT Hot Springs Min | PLC Plunge Cr             | SCY Stone Canyon Res | TTM Turtle Mts       |
| CLP Clarks Pk          | IKP Inkepah         | PLM Palomar               | SDW Sidewinder Mine  | TWL Twin Lakes       |
| COA Coschella          | ING Ingram Rich     | PLT Pilot Knob            | SGL Signal Mtn       | VGR Vista Lakes      |
| COK Cook Rich          | INS Inspiration     | PNM Pinto Mts             | SHI Sheephole Mts    | VPD Villa Park Dam   |
| COQ Corona Quarry      | IRC Iron Canyon     | POB Polly Butte           | SIL Silver Pk        | WPP Whipple Mts      |
| COT Chocolate Mts      | IRN Iron Mts        | PSF Palm Springs          | SJP Sini Pk          | WLK West Lake        |
| COX Coxcomb Mts        | ISA Isabella        | PTD Point Dume            | SJQ San Joaquin Res  | WWR Whitewater       |
| COY Coyote Min         | JUN Juniper Hills   | PYR Pyramid               |                      |                      |
|                        | KEE Keen Station    | RAY Raywood Flat          |                      |                      |

Figure 2. Map of the SCSN station configuration in 1974.



**Figure 3. Kresge laboratory instrumentation map.** Use this map to connect pier numbers to sensor types.

*Typical Seismograph Constants*

<b>Seismograph</b>	<b>Ts (sec)</b>	<b>hs</b>	<b>Tg (sec)</b>	<b>hg</b>	<b><math>\sigma^2</math></b>	<b>V<sup>(1)</sup></b>
<b>Wood-Anderson (standard)</b>	0.8	0.8	NA	NA	NA	2800 <sup>(2)</sup>
<b>Press-Ewing</b>	30	1	90	1	0.1	2300 <sup>(3)</sup>
<b>Benioff (SP)</b>	1.0	1	0.2	1	0.1	100,000 <sup>(3)</sup>
<b>Benioff (LP)</b>	1.0	1	90	1	0.1	3000 <sup>(3)</sup>
<b>WWSSN (SP)</b>	1.0	1	0.7	1	0.1	50,000 <sup>(4)</sup>
<b>WWSSN (LP1)</b>	15	1	100	1	0.1	1500 <sup>(5)</sup>
<b>WWSSN (LP2)</b>	30	1.75	100	1	0.1	1500 <sup>(5)</sup>

**Table 1.** Summary of the constants for typical seismographs often used. Here, Ts, hs, Tg, hg,  $\sigma^2$ , and V are the pendulum period, damping constant of the pendulum, galvanometer period, damping constant of the galvanometer, coupling factor, and the magnification. The values listed are nominal values frequently used. However, the actual values may differ considerably from these.

Notes:

- (1) V varies for different stations.
- (2) Sometimes 2080 is used.
- (3) The magnification at the peak of the response.
- (4) The magnification at the period of 1 s.
- (5) The magnification at the period of the pendulum.

For the computation of the Wood-Anderson response, see Richter (1958). For others, see Hagiwara (1958).

*References*

Hagiwara, T., A note of the theory of the electromagnetic seismograph. *Bulletin of the Earthquake Research Institute*. 36, 139-164, 1958.

Kanamori, H. Importance of Historical Seismograms for Geophysical Research in *Historical Seismograms and Earthquakes of the World*, eds., Lee, Meyers, and Shimazaki, Academic Press, 1988.

Richter, C.F. *Elementary Seismology*, W.H. Freeman and Company, 1958.

## Appendix A

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### STATIONS

BARRETT (BAR): 32° 40.8' N, 116° 40.3' W; h = 510 m; Z SP; N,E,Z,LP; R WA; Z SM (not standard); Operated since 1-17-52, with cooperation of City of Diego, Water Department.

BIG BEAR (BB): 34° 14.3' N, 116° 54.8' W; h = 2060 m.

CHINA LAKE (CLC): 35° 49.0' N, 117° 35.8' W; h = 766 m; Z SP; Operated since 7-8-49, with cooperation of U. S. Naval Ordnance Test Station

COTTONWOOD (CWC): 36° 26.3' N, 118° 04.7' W; h = 1620 m; Z SP; N,E, WA; N,E,Z SM; Operated since 10-13-65, with cooperation of Los Angeles Department of Water and Power.

DALTON (D): 34° 10.2' N, 117° 48.6' W; h = 523 m.

EL CENTRO (ECC): 32° 47.9' N, 115° 32.9' W; h = -15 m; N,E,Z SM; Operated since 11-21-52, with cooperation of Imperial Irrigation District

FORT TEJON (FTC): 34° 52.4' N, 118° 53.6' W; h = 990 m; Z SP; Operated since 11-21-52, with cooperation of California Division of Beaches and Parks.

GLAMIS (GLA): 33° 03.1' N, 114° 49.6' W; h = 627 m; Z SP (telemetered to Pasadena); Operated since 12-20-66.

GOLDSTONE (GSC): 35° 18.1' N, 116° 48.3' W; h = 990 m; WSSS equipment, plus Z SP (telemetered to Pasadena since 10-12-66); Operated since 11-7-61, with cooperation of Jet Propulsion Laboratory.

HAIWEE (HAI): 36° 08.2' N, 117° 56.8' W; h = 1150 m; Z SP; N,E WA; N,E,Z SM; Operated from 9-11-29 to 10-27-65, with cooperation of Los Angeles Department of Water and Power; station supplanted by Cottonwood in 1965, because of dam construction at Haiwee.

HAYFIELD (HAY): 33° 42.4' N, 115° 38.2' W; h = 439 m; Z SP; Z LP; Operated since 6-20-56, with cooperation of Metropolitan Water District of Southern California.

ISABELLA (ISA): 35° 39.8' N, 118° 28.4' W; h = 835 m; Z SP, plus 2 strain extensometers and 3 ultra-long-period pendulums. SP Z telemetered to Pasadena since 4-5-67.

KING RANCH (KRC): 35° 19.7' N, 119° 44.7' W; h = 670 m; Z SP; Operated from 10-16-52 to 12-3-65; discontinued because of abandonment of ranch by tenants.

LA JOLLA (LJ): 32° 51.8' N, 117° 15.2' W; h = 8 m.

STATIONS CONTINUE

MOUNT WILSON (MWC): 34° 13.4' N, 118° 03.5' W; h = 1730 m; Z SP;  
Operated since 4-23-28.

PALOMAR (PLM): 33° 21.2' N, 116° 51.7' W; h = 1692 m; Z SP (telemetered  
to Pasadena since 12-22-66); Operated since 9-7-39.

PASADENA (PAS): 34° 08.9' N, 118° 10.3' W; h = 295 m; N,E,Z SP; N,E,Z LP;  
N,E WA; N,E,Z SM; plus strain, Press-Ewing, and experimental instruments;  
Operated since 3-17-27.

RIVERSIDE (RVR): 33° 59.6' N, 117° 22.5' W; h = 260 m; Z SP; N,E,Z LP;  
N,E WA; N,E,Z SM; Operated since 10-19-26, with cooperation of City of

SAN CLEMENTE ISLAND (SCI): 33° 58.8' N, 118° 32.8' W; h = 219 m; Z SP;  
(telemetered to Pasadena); Operated since 7-27-67.

SAN NICOLAS (SNC): 33° 14.9' N, 119° 31.4' W; h = 275 m; Z SP; Z LP;  
E WA; Operated since 7-24-57, with cooperation of U.S. Navy; Discon-  
tinued 1-24-68 in deference to more favorable conditions on San Clemente  
Island.

SANTA BARBARA (SBC): 34° 26.5' N, 119° 42.8' W; h = 90 m; Z SP (telemetered  
to Pasadena since 6-1-66); N,E WA; N,E,Z SM; Operated since 5-10-27,  
with cooperation of Santa Barbara Museum of Natural History.

SANTA YNEZ PEAK (SYP): 34° 31.6' N, 119° 58.7' W; h = 1305 m; SP Z, tele-  
metered to Pasadena since 6-7-67, moved from former location at SBC  
to reduce background noise; other instruments still operating at SBC.  
A new station.

SAWMILL (SWM): 34° 43.1' N, 118° 34.9' W; h = 1220 m; Z SP (high magnifi-  
cation, high frequency, for micro-earthquake monitoring); N,E WA; E SM;  
Operated since 3-7-66, with cooperation of Sawmill Mountain Ranch  
(Mr. Bruce Tyler).

TINEMAHA (TIN): 37° 03.3' N, 118° 13.7' W; h = 1195 m; Z SP; N,E,Z LP;  
N,E WA; Operated since 9-4-29, with cooperation of Los Angeles  
Department of Water and Power.

WOODY (WDY): 35° 42.0' N, 118° 50.6' W; h = 15 m; Z SP; E WA; Operated  
since 8-5-52, with cooperation of Kern County Forestry and Fire  
Department.

Abbreviations used in describing equipment:

N North-south component  
E East-west component  
Z Vertical component

SP Short-period Benioff characteristics ( $T_0 = 1$  sec;  $T_g = 0.2$  sec)  
LP Long-period Benioff characteristics ( $T_0 = 1$  sec;  $T_g = 90$  sec)  
WA Wood-Anderson torsion characteristics ( $T_0 = 0.8$  sec;  $V = 2800$ )  
SM Strong-motion characteristics ( $T_0 = 0.8$  sec;  $V = 4$  to  $125$ )