CENTRAL WATER AND POWER RESEARCH STATION
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STRONG EARTHQUAKE GROUND MOTION DATA IN EQINFOS FOR INDIA: PART 1A

by

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PREFACE

An extensive, complete and uniform database of strong motion recordings is essential in earthquake hazard mitigation. Therefore, strong motion networks have been set up in various seismically active regions worldwide, as full scale in situ laboratories gathering experimental ground motion data. This data is used for empirical scaling of various parameters and functions of strong ground motion, such as Fourier spectra, response spectra, attenuation of duration, for source mechanism studies, and in many other studies on the nature and site specific characteristics of strong ground motion. For all these studies, the completeness and uniformity of the database is essential. At present, the most extensive uniformly processed strong motion database is available for California. Efforts have been made to gather such uniform data for other regions of the world where sufficient number of data has been recorded. Parallel studies of strong motion in different geographic regions will make it possible to separate the region specific from the intrinsic characteristics of the strong motion.

This report is one of the series of EQINFOS reports containing Volume II and III plots and cross-reference tables of uniformly processed data for a region. The first report of this type was published for the Western United States, up to 1986 (Lee and Trifunac, 1987). It was followed by a report for Yugoslavia (Jordanovski et al., 1987), and for Bulgaria (Nenov et al., 1990). This report contains 49 accelerograms recorded at Koyna Dam, in the Indian state of Maharashtra, between 1967 and 1982. The processing of these data was taken up at the Central Water and Power Research Station, Pune, India, with the help of the first of the editors during his visit to the Institute in November-December 1983, as an UNDP consultant.

The editors

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CHAPTER I
INTRODUCTION

On the basis of seismic activity, the Indian subcontinent can be divided into three zones, the Himalayan Zone, the Indian Peninsula, and the Indo-Gangetic Alluvial Plains intervening the two. The Himalayan Zone is one of the highly seismic areas in the world, and it has experienced several destructive earthquakes with magnitude greater than 8. The northern parts of the Indo-Gangetic Plains forming the foothills of the Himalayas are moderately seismic. The level of seismic activity in the Peninsula, except the Kachchh region, can be rated as below moderate to low, with very rare occurrence of earthquakes of magnitude 5.0 or above in its marginal areas only. The Kachchh region, however, has experienced a couple of earthquakes of magnitude above 7.0. Thus, more than fifty percent of the Indian territory is prone of earthquake damage. However, no systematic study was started on recording and processing of strong-motion data in India, till the late 1970's.

The first useful strong-motion data set in India was obtained from the Koyna Dam earthquakes. Koyna Dam (73° 45'E, 17° 23.85' N) is situated in the Peninsular India, which is generally regarded as one of the aseismic Pre-Cambrian land masses. However, after impounding of the Koyna reservoir during 1962 Monsoon, reports of experience of earth tremors began to be prevalent in the vicinity of the dam. In view of these local tremors, the Central Water and Power Research Station (CW&PRS), Pune, India, undertook detailed seismological investigations, under which two AR-240 accelerographs were also installed in the body of the dam in March, 1966. The first useful accelerogram was recorded by an instrument in the foundation gallery of the dam on 12 September, 1967, from an earthquake of magnitude 3.9 in the vicinity of the dam. The very next day a couple of additional accelerograms were recorded from an earthquake of magnitude 5.0 and its aftershocks. Then, on 10 December, 1967, the main Koyna earthquake ($M = 6.5$) occurred, which provided the most significant accelerogram in India till to date. Subsequently, the number of accelerograph stations were increased to thirteen. Details of these accelerograph stations are given in Table I.I and their locations in the body of the dam and outside the dam are shown in Figures I.1(a) and I.1(b), respectively.

Seeing the increase in seismic activity in the vicinity of the Koyna dam after impounding of the reservoir, authorities of several river-valley projects in India became interested in recording of strong-motion data in the dam structures. In 1968, a code (IS:4967-1968) was also brought out by the Indian Standards Institute (now Bureau of Standards) regarding the seismic instrumentation of river-valley projects. This code recommends installation of accelerographs at the base and at the top of a dam. It also suggests the installation of an accelerograph at mid height for dams with height more than 100 m. The Department of Irrigation, Govt. of Uttar Pradesh, India, provided funds to the Department of Earthquake Engineering, Roorkee University for the design and development of the strong-motion accelerograph known as RESA (Roorkee Earthquake School Accelerograph) accelerographs.

At present, a network of 40 RESA accelerographs is installed in the Himalayan Seismic Zone (Chandrasekaran, 1987), for which the funds were provided by the Department of Science and Technology (DST), Govt. of India. DST has also funded the

TABLE I.I
DETAILS OF ACCELEROGRAPH STATIONS IN THE BODY
AND IN THE REGION OF KOYNA DAM

Accelerograph Stations	Foundation Type	Accelerograph Type	Date of Installation
1. Koyna dam 1-A gallery, 644 m above M.S.L.	Concrete monolith founded on basalt	AR-240 RFT-250	3/29/66 9/24/71
2. Koyna dam shear zone gallery, Monolith No. 13, 595 m above M.S.L.	Dam	AR-240 RFT-250	3/29/66 9/24/71
3. Koyna dam inspection gallery, Monolith No. 17, 585 m above M.S.L.	Dam	RFT-250	1978
4. Koyna dam operation gallery, Monolith No. 17, 610 m above M.S.L.	Dam	RFT-250	1978
5. Koyna dam top, Monolith No. 17, 665 m above M.S.L.	Dam	RFT-250	9/24/71
6. 100 m downstream of the dam on right bank, 644 m above M.S.L.	Basalt	AR-240 RFT-250	9/10/68 9/24/71
7. Kirnos Observatory (on ground) about 300 m from the right bank near the dam site, 675 m above M.S.L.	Basalt	RFT-250	1978
8. Pophali power house 17 26.00N, 73 41.00E, and 168 m above M.S.L.	Basalt	RFT-250	9/17/71
9. Pophali interadit point, 17 26.00N, 73 41.00E, and 365 m above M.S.L.	Basalt	RFT-250	9/17/71
10. Alore observatory, 17 29.00N, 73 39.00E, and 85 m above M.S.L.	Basalt	RFT-250	10/27/71

11. Govalkot observatory, 17 32.50N, 73 29.43E, and 15 m above M.S.L.	Basalt	AR-240	6/27/72
12. Satara observatory, 17 40.87N, 74 00.00E, and 650 m above M.S.L.	Basalt	AR-240	1/27/72
13. Mahabaleshwar observatory, 17 55.36N, 73 39.55E, and 1430 m above M.S.L.	Thick hard lateritic soil underlain by basalt	RFT-240	6/27/72

AR-240 accelerograph:	Natural period	= 0.056 sec
	Damping ratio	= 0.60 of critical
	Recording speed	= 2 cm/sec
	Recording medium	= 12" photo paper
	Sensitivity	= 77 mm/g
RFT-250 accelerograph:	Natural period	= 0.051 sec
	Damping ratio	= 0.60 of critical
	Recording speed	= 1 cm/sec
	Recording medium	= 70 mm film
	Sensitivity	= 19 mm/g

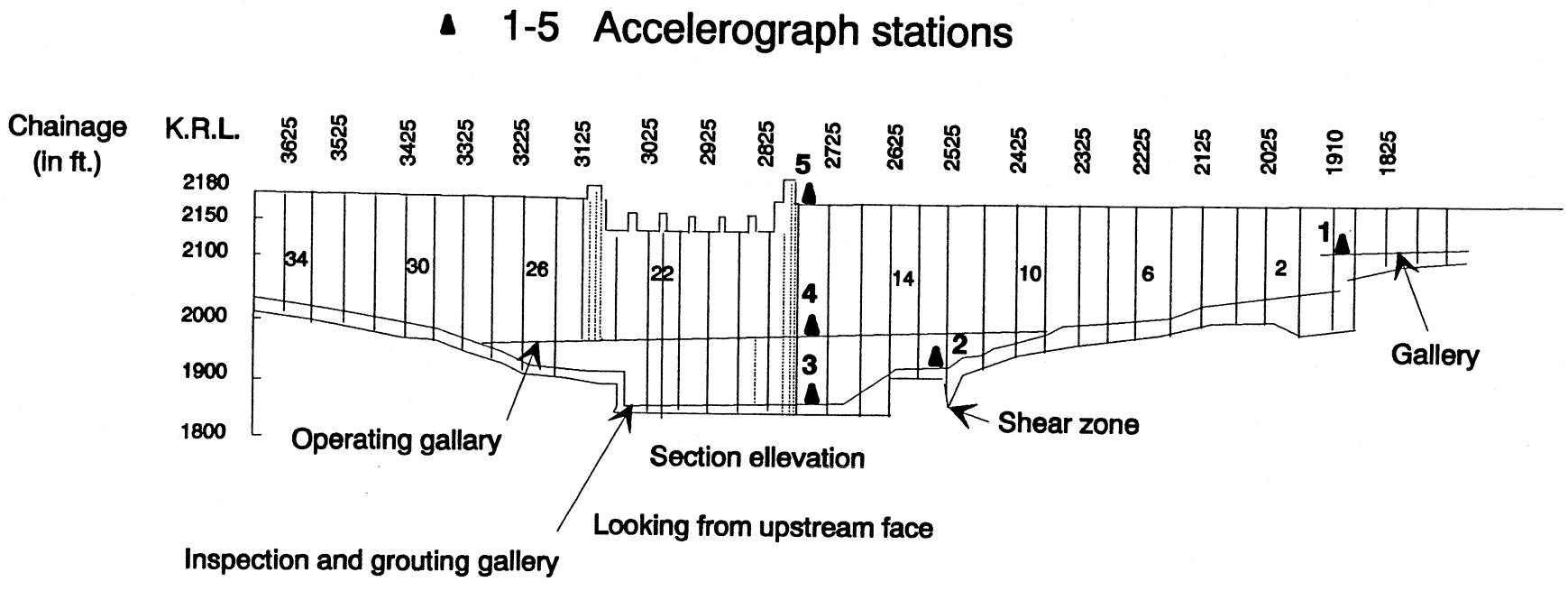

Fig. I.1a Location of accelerograph stations 1-5, listed in Table I.1.

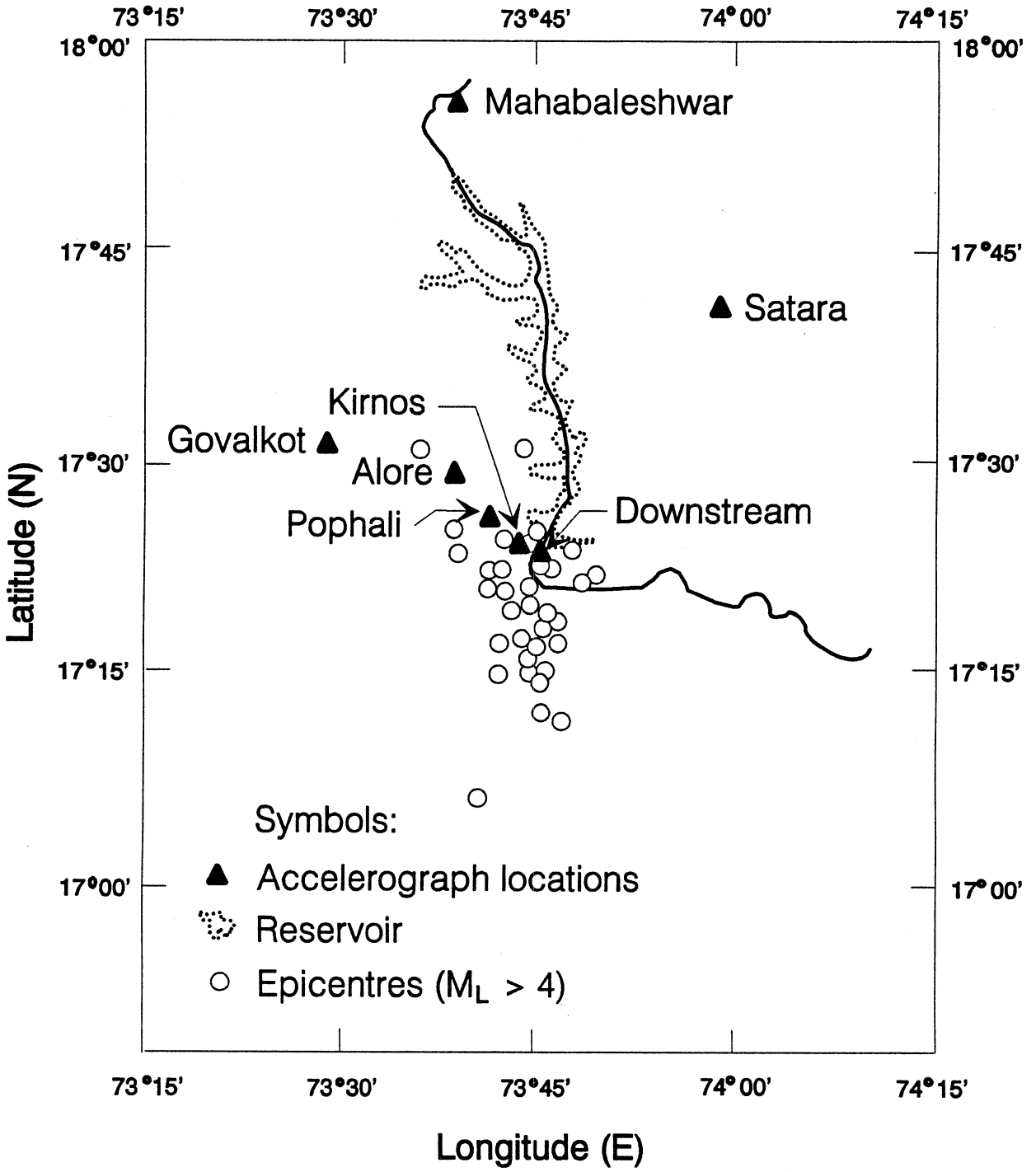

Fig. I.1b Location of accelerograph stations 6-13, listed in Table I.1.

deployment of an array of 45 SMA-1 accelerographs in the Shillong region of northeast India, where an earthquake of magnitude 8.7 occurred in 1897. This region is one of the six sites in the World, which were assigned the highest priority for immediate instrumentation by the International Workshop on Strong-Motion Instrument Array held at Honolulu, USA in May, 1978 (Iwan, 1978). The Shillong array, as well as the network of RESA accelerographs, are proposed to be densified in near future by the Department of Earthquake Engineering, Roorkee University with the help of grants from DST, India. Rookee University has also installed an array of 50 SMA-1 accelerographs in the Kangra region of Himachal Pradesh, India for which the funds were provided by the National Science Foundation, USA, under a collaborative program. Thus the Himalayan Zone is now better prepared to record the strong-motion data from future earthquakes. Since the installation of these instruments, no major earthquake has occurred under these arrays, and so, at present, the Koyna Dam accelerograms remain a significant strong-motion database in India.

Most of the Koyna Dam accelerograms have been recorded at different heights in the body of the dam, with a large number of them recorded only at the dam top from very small magnitude earthquakes. Those records are thus affected by the response of the dam. However, the accelerograms recorded in the foundation gallery may perhaps be approximated as ground acceleration records. After scrutinizing all the available data, a set of forty-nine significant records has been selected for processing and presentation in this report. Processing and analysis of the data recorded till May 1974 has been performed earlier also by Guha et al. (1970, 1974). But the results of their analysis do not meet all the current requirements of strong-motion data processing. Over the period of about past two decades, the methods of strong-motion accelerogram analysis have undergone several improvements, and at present the principles and the requirements of the analysis procedures are almost standardized (Trifunac and Lee, 1973; Lee and Trifunac, 1984, 1990). Though the digitizing facilities and the digital signal processing techniques adopted by different analysts may vary, the results of their analysis are comparable, with everybody following the same standard steps of processing.

In the previous analyses of the Koyna Dam accelerograms, instrument correction was not applied, due to which, the high frequency components of ground acceleration were not represented accurately. These accelerograms are recorded on hard rock sites at small epicentral distances, and thus, they are conspicuous in high frequency contents. Therefore, to get more accurate ground acceleration values for comparatively higher frequencies, it is essential to apply the correction for the dynamic response of the instrument (Trifunac, 1972). Further, in the previous analyses, the ground velocity and displacement were computed by fitting a least square parabolic line as the zero acceleration base-line (Schiff and Bogdanoff, 1967). Parabolic base-line is able to remove the base-line distortions of the periods of about twice the record length only, and thus the records of different lengths are treated differently. In reality, base-line distortions of various periods may be present in an accelerogram due to (i) some transverse play in the transport mechanism of the recording medium, (ii) the photographic developing process and aging of the record, and (iii) the inaccuracies in the digitization. To correct an accelerogram for all the base-line distortions, Trifunac (1971) presented a new method for base-line correction, which is based on the technique of digital filtering. By suitably

choosing the cut-off frequency for the digital filter to keep the signal to noise ratio above one, all the base-line distortions can be removed to obtain quite accurate values of the computed velocity and displacement (Trifunac and Lee, 1974).

This report presents the results on the processing of selected Koyna Dam accelerograms by correcting the accelerograms for the dynamic response of the instrument and applying the base-line correction as per the Trifunac's method (Trifunac, 1971). The present data satisfies the standards for inclusion in the EQUINFOS type data bank (Lee and Trifunac, 1982). Also, these accelerograms provide a unique data base in the sense that all the data are recorded very close to the epicenters, where the attenuation of strong motion is not known perfectly and where the destruction is the maximum.

CHAPTER II
DATA RECORDED AT KOYNA DAM BETWEEN 1967 AND 1982

II.1 The Data

The Volume 1A of the EQINFOS data base for India contains 49 uniformly processed records of 40 earthquakes ($3.2 \leq M \leq 6.5$), recorded at 6 locations in Koyna Dam, state of Maharashtra, India, at epicentral distances from about 1.5 km to about 21.5 km, in the period between 1967 and 1982.

Table II.I contains a list of the recorded earthquakes, in a chronological order. The columns from left to right contain the earthquake number, the date, the time (hour and minutes), the epicentral latitude and longitude (degrees, minutes and seconds), the depth of the focus (km), the magnitude, the epicentral MMI, and the earthquake name. Only for 29 of the earthquakes, the hypocentral coordinates are available. The magnitude has been determined for all the 40 contributing earthquakes. Reported intensity is not available for any of the earthquakes. The intensity in Table II.I is Modified Mercalli Intensity (MMI) estimated empirically (Lee and Trifunac, 1985) as

$$MMI = 1.5M - A - B\ln(\Delta) - C\Delta/100 - Ds, \tag{1}$$

where M is the magnitude, and s is the geological site condition at the epicenter ($s = 0$ for sites on alluvium, $s = 2$ for sites on basement rock, and $s = 1$ for sites which are not clearly either on alluvial or on rock). The estimates in Table II.I are for $s = 0$ (assumed). Δ is the hypocentral distance evaluated as

$$\Delta = (R^2 + H^2 + S^2)^{1/2} \tag{2}$$

where R is the epicentral distance (taken as 1 km for the estimates in Table II.I), and S is the size of the source. For magnitudes $M \geq 3$, S is related to the magnitude M by

$$S = -25.34 + 8.51M. \tag{3}$$

To each record, a unique pair of a Log.# and a Ref.# is assigned. The Log.# is made of six digits and two periods. The first two digits correspond to the year when the recording took place. The next three digits, in this report, are same as the number of the record in the database. The last digit is arbitrarily set to be 0. The Ref.# is assigned to the record at the time of processing, indicating the order of the processed record in the data base. The Ref.# uniquely corresponds to a couple of a station an earthquake. It is made up of two letters and three digits. The records in this report have Ref.#'s from KD001 to KD049.

Table II.II is another list of earthquakes, in chronological order, which also contains the Ref.#'s of the records of that earthquake. The columns from left to right in this table correspond to the earthquake number, year, time, name, magnitude, estimated epicentral MMI (same as in Table II.I), and the Ref.#'s of the corresponding records of

TABLE II.I
LIST OF CONTRIBUTING EARTHQUAKES

EQ#	DATE	TIME	LATITUDE	LONGTITUDE	DEPTH	MAG	MMI	EQ NAME
1	9/12/67	0841IST				3.9	5	KOYNA DAM EARTHQUAKE #01, INDIA
2	9/13/67	0623IST				5.8	7	KOYNA DAM EARTHQUAKE #02, INDIA
3	9/13/67	0648IST				4.5	6	KOYNA DAM EARTHQUAKE #03, INDIA
4	9/13/67	0821IST				3.2	5	KOYNA DAM EARTHQUAKE #04, INDIA
5	11/16/67	2016IST	17 26 54	73 51 06	5.0	3.5	5	KOYNA DAM EARTHQUAKE #05, INDIA
6	12/10/67	2251IST	17 30 30	73 43 48	12.0	6.5	8	KOYNA DAM EARTHQUAKE #06, INDIA
7	12/11/67	2049IST	17 17 54	73 53 30	8.0	3.8	5	KOYNA DAM EARTHQUAKE #07, INDIA
8	12/12/67	1549IST				3.6	5	KOYNA DAM EARTHQUAKE #08, INDIA
9	12/12/67	1820IST	17 16 54	73 41 42	13.0	4.7	6	KOYNA DAM EARTHQUAKE #09, INDIA
10	12/13/67	0509IST	17 17 48	73 46 54	15.0	4.6	6	KOYNA DAM EARTHQUAKE #10, INDIA
11	12/13/67	1936IST	17 29 12	73 46 36	23.0	3.8	4	KOYNA DAM EARTHQUAKE #11, INDIA
12	12/14/67	0916IST	17 18 24	73 46 54	13.0	4.1	5	KOYNA DAM EARTHQUAKE #12, INDIA
13	12/14/67	1506IST	17 22 18	73 45 00	5.0	4.1	5	KOYNA DAM EARTHQUAKE #13, INDIA
14	12/17/67	2253IST	17 18 18	73 45 18	3.0	3.7	5	KOYNA DAM EARTHQUAKE #14, INDIA
15	12/24/67	2349IST	17 21 00	73 42 36	20.0	5.0	6	KOYNA DAM EARTHQUAKE #15, INDIA
16	1/12/68	0437IST	17 23 12	73 45 00	4.0	4.1	5	KOYNA DAM EARTHQUAKE #16, INDIA
17	2/14/68	0916IST	17 19 54	73 42 12	16.0	3.6	4	KOYNA DAM EARTHQUAKE #17, INDIA
18	3/ 4/68	2136IST	17 21 54	73 46 06	10.0	4.2	5	KOYNA DAM EARTHQUAKE #18, INDIA
19	10/29/68	1000IST	17 21 00	73 43 30	7.0	5.2	6	KOYNA DAM EARTHQUAKE #19, INDIA
20	6/27/69	2005IST	17 24 12	73 44 24	3.0	3.9	5	KOYNA DAM EARTHQUAKE #20, INDIA
21	6/27/69	2005IST	17 24 12	73 44 24	3.0	4.7	6	KOYNA DAM EARTHQUAKE #21, INDIA
22	1/ 1/70	2230IST	17 19 63	73 42 48	11.0	4.3	5	KOYNA DAM EARTHQUAKE #22, INDIA
23	5/27/70	1245IST	17 28 48	73 48 42	3.0	4.4	6	KOYNA DAM EARTHQUAKE #23, INDIA
24	6/17/70	0648IST				3.6	5	KOYNA DAM EARTHQUAKE #24, INDIA
25	9/26/70	1636IST	17 22 00	73 39 06	13.0	4.4	5	KOYNA DAM EARTHQUAKE #25, INDIA
26	2/14/71	0130IST	17 21 42	73 49 36	3.0	4.2	5	KOYNA DAM EARTHQUAKE #26, INDIA
27	2/17/74	1406IST	17 15 00	73 45 24	19.0	4.7	5	KOYNA DAM EARTHQUAKE #27, INDIA
28	5/29/74	1826IST	17 29 24	73 46 36	11.0	3.5	4	KOYNA DAM EARTHQUAKE #28, INDIA
29	7/29/74	2317IST	17 19 24	73 44 42	24.0	4.3	5	KOYNA DAM EARTHQUAKE #29, INDIA
30	9/ 2/75	2317IST	17 21 48	73 41 24	7.0	4.0	5	KOYNA DAM EARTHQUAKE #30, INDIA
31	3/14/76	0516IST	17 14 18	73 43 42	5.0	3.9	5	KOYNA DAM EARTHQUAKE #31, INDIA
32	4/22/76	1046IST	17 21 24	73 41 00	13.0	3.8	4	KOYNA DAM EARTHQUAKE #32, INDIA
33	12/12/76	0052IST	17 22 42	73 44 00	13.0	3.9	5	KOYNA DAM EARTHQUAKE #33, INDIA
34	9/19/77	0003IST	17 16 30	73 45 00	19.0	4.0	4	KOYNA DAM EARTHQUAKE #34, INDIA
35	9/ 2/80	1639IST	17 14 18	73 44 36	6.0	4.3	5	KOYNA DAM EARTHQUAKE #35, INDIA
36	9/20/80	0728IST	17 12 24	73 45 36	8.0	4.7	6	KOYNA DAM EARTHQUAKE #36, INDIA
37	9/20/80	1045IST	17 15 00	73 42 00	8.0	4.9	6	KOYNA DAM EARTHQUAKE #37, INDIA
38	10/26/80	0132IST	17 15 12	73 44 18	13.0	3.7	4	KOYNA DAM EARTHQUAKE #38, INDIA
39	1/25/81	2030IST	17 18 00	73 43 48	7.0	3.7	5	KOYNA DAM EARTHQUAKE #39, INDIA
40	4/25/82	2304IST	17 14 24	73 42 12	13.0	4.3	5	KOYNA DAM EARTHQUAKE #40, INDIA

MMI is calculated from magnitude using Eq. (1) at distance 1 km from the epicenter, assuming s = 0.

TABLE II.II

CROSS-INDEX OF EARTHQUAKES AND RECORD DATA FILES

EQ#	YEAR	TIME	EQ NAME	MAG	MMI	DATA REPORT REF #
1	1967	0841IST	KOYNA DAM EARTHQUAKE #01	3.9	5	KD001
2	1967	0623IST	KOYNA DAM EARTHQUAKE #02	5.8	7	KD002
3	1967	0648IST	KOYNA DAM EARTHQUAKE #03	4.5	6	KD003
4	1967	0821IST	KOYNA DAM EARTHQUAKE #04	3.2	5	KD004
5	1967	2016IST	KOYNA DAM EARTHQUAKE #05	3.5	5	KD005
6	1967	2251IST	KOYNA DAM EARTHQUAKE #06	6.5	8	KD006
7	1967	2049IST	KOYNA DAM EARTHQUAKE #07	3.8	5	KD007
8	1967	1549IST	KOYNA DAM EARTHQUAKE #08	3.6	5	KD008
9	1967	1820IST	KOYNA DAM EARTHQUAKE #09	4.7	6	KD009
10	1967	0509IST	KOYNA DAM EARTHQUAKE #10	4.6	6	KD010
11	1967	1936IST	KOYNA DAM EARTHQUAKE #11	3.8	4	KD011
12	1967	0916IST	KOYNA DAM EARTHQUAKE #12	4.1	5	KD012
13	1967	1506IST	KOYNA DAM EARTHQUAKE #13	4.1	5	KD013
14	1967	2253IST	KOYNA DAM EARTHQUAKE #14	3.7	5	KD014
15	1967	2349IST	KOYNA DAM EARTHQUAKE #15	5.0	6	KD015 KD016
16	1968	0437IST	KOYNA DAM EARTHQUAKE #16	4.1	5	KD017 KD018
17	1968	0916IST	KOYNA DAM EARTHQUAKE #17	3.6	4	KD019
18	1968	2136IST	KOYNA DAM EARTHQUAKE #18	4.2	5	KD020 KD021
19	1968	1000IST	KOYNA DAM EARTHQUAKE #19	5.2	6	KD022-KD024
20	1969	2005IST	KOYNA DAM EARTHQUAKE #20	3.9	5	KD025
21	1969	2005IST	KOYNA DAM EARTHQUAKE #21	4.7	6	KD026
22	1970	2230IST	KOYNA DAM EARTHQUAKE #22	4.3	5	KD027
23	1970	1245IST	KOYNA DAM EARTHQUAKE #23	4.4	6	KD028
24	1970	0648IST	KOYNA DAM EARTHQUAKE #24	3.6	5	KD029-KD030
25	1970	1636IST	KOYNA DAM EARTHQUAKE #25	4.4	5	KD031
26	1971	0130IST	KOYNA DAM EARTHQUAKE #26	4.2	5	KD032
27	1974	1406IST	KOYNA DAM EARTHQUAKE #27	4.7	5	KD033
28	1974	1826IST	KOYNA DAM EARTHQUAKE #28	3.5	4	KD034
29	1974	2317IST	KOYNA DAM EARTHQUAKE #29	4.3	5	KD035
30	1975	2317IST	KOYNA DAM EARTHQUAKE #30	4.0	5	KD036
31	1976	0516IST	KOYNA DAM EARTHQUAKE #31	3.9	5	KD037
32	1976	1046IST	KOYNA DAM EARTHQUAKE #32	3.8	4	KD038
33	1976	0052IST	KOYNA DAM EARTHQUAKE #33	3.9	5	KD039
34	1977	0003IST	KOYNA DAM EARTHQUAKE #34	4.0	4	KD040
35	1980	1639IST	KOYNA DAM EARTHQUAKE #35	4.3	5	KD041 KD042
36	1980	0728IST	KOYNA DAM EARTHQUAKE #36	4.7	6	KD043
37	1980	1045IST	KOYNA DAM EARTHQUAKE #37	4.9	6	KD044 KD045
38	1980	0132IST	KOYNA DAM EARTHQUAKE #38	3.7	4	KD046
39	1981	2030IST	KOYNA DAM EARTHQUAKE #39	3.7	5	KD047
40	1982	2304IST	KOYNA DAM EARTHQUAKE #40	4.3	5	KD048 KD049

MMI is calculated from magnitude using Eq. (1) at distance 1 km from the epicenter, assuming s = 0.

TABLE II.III

GEOGRAPHICAL INDEX OF ACCELEROGRAPH SITES AND RECORD DATA FILES

CITY / ADDRESS	REF.#	LOG.#
KOYNA DAM, MAHARASHTRA, INDIA 17 23 51N, 73 45 0E		
KOYNA DAM SHEAR ZONE GALLERY	KD001	67.001.0
	KD002	67.002.0
	KD003	67.003.0
	KD004	67.004.0
	KD005	67.005.0
	KD009	67.009.0
	KD014	67.014.0
	KD015	67.015.0
	KD017	68.001.0
	KD019	68.003.0
	KD020	68.004.0
	KD023	68.007.0
	KD030	70.004.0
	KD049	82.002.0
KOYNA DAM 1A GALLERY	KD006	67.006.0
	KD007	67.007.0
	KD008	67.008.0
	KD010	67.010.0
	KD011	67.011.0
	KD012	67.012.0
	KD013	67.013.0
	KD016	67.016.0
	KD018	68.002.0
	KD021	68.005.0
	KD022	68.006.0
	KD025	69.001.0
	KD026	69.002.0
	KD027	70.001.0
	KD029	70.003.0
	KD031	70.005.0
	KD032	71.001.0
KOYNA DAM DOWNSTREAM OBS.	KD024	68.008.0
	KD028	70.002.0
	KD039	76.003.0
KOYNA DAM TOP (M17)	KD033	74.001.0
	KD034	74.002.0
	KD035	74.003.0
	KD036	75.001.0
	KD037	76.001.0
	KD038	76.002.0
	KD040	77.001.0
	KD046	80.006.0
	KD047	81.001.0
	KD048	82.001.0

KOYNA DAM KIRNOS OBS.	KD041 80.001.0
	KD043 80.003.0
	KD044 80.004.0
KOYNA DAM OPERATION GALLERY	KD042 80.002.0
	KD045 80.005.0

TABLE II.IV

CROSS-INDEX OF RECORD DATA FILES AND STATION ADDRESS

REF.#	LOG.#	ADDRESS
KD001	67.001.0	KOYNA DAM SHEAR ZONE GALLERY, MAHARASHTRA, INDIA
KD002	67.002.0	KOYNA DAM SHEAR ZONE GALLERY, MAHARASHTRA, INDIA
KD003	67.003.0	KOYNA DAM SHEAR ZONE GALLERY, MAHARASHTRA, INDIA
KD004	67.004.0	KOYNA DAM SHEAR ZONE GALLERY, MAHARASHTRA, INDIA
KD005	67.005.0	KOYNA DAM SHEAR ZONE GALLERY, MAHARASHTRA, INDIA
KD006	67.006.0	KOYNA DAM 1A GALLERY, MAHARASHTRA, INDIA
KD007	67.007.0	KOYNA DAM 1A GALLERY, MAHARASHTRA, INDIA
KD008	67.008.0	KOYNA DAM 1A GALLERY, MAHARASHTRA, INDIA
KD009	67.009.0	KOYNA DAM SHEAR ZONE GALLERY, MAHARASHTRA, INDIA
KD010	67.010.0	KOYNA DAM 1A GALLERY, MAHARASHTRA, INDIA
KD011	67.011.0	KOYNA DAM 1A GALLERY, MAHARASHTRA, INDIA
KD012	67.012.0	KOYNA DAM 1A GALLERY, MAHARASHTRA, INDIA
KD013	67.013.0	KOYNA DAM 1A GALLERY, MAHARASHTRA, INDIA
KD014	67.014.0	KOYNA DAM SHEAR ZONE GALLERY, MAHARASHTRA, INDIA
KD015	67.015.0	KOYNA DAM SHEAR ZONE GALLERY, MAHARASHTRA, INDIA
KD016	67.016.0	KOYNA DAM 1A GALLERY, MAHARASHTRA, INDIA
KD017	68.001.0	KOYNA DAM SHEAR ZONE GALLERY, MAHARASHTRA, INDIA
KD018	68.002.0	KOYNA DAM 1A GALLERY, MAHARASHTRA, INDIA
KD019	68.003.0	KOYNA DAM SHEAR ZONE GALLERY, MAHARASHTRA, INDIA
KD020	68.004.0	KOYNA DAM SHEAR ZONE GALLERY, MAHARASHTRA, INDIA
KD021	68.005.0	KOYNA DAM 1A GALLERY, MAHARASHTRA, INDIA
KD022	68.006.0	KOYNA DAM 1A GALLERY, MAHARASHTRA, INDIA
KD023	68.007.0	KOYNA DAM SHEAR ZONE GALLERY, MAHARASHTRA, INDIA
KD024	68.008.0	KOYNA DAM DOWNSTREAM OBS., MAHARASHTRA, INDIA
KD025	69.001.0	KOYNA DAM 1A GALLERY, MAHARASHTRA, INDIA
KD026	69.002.0	KOYNA DAM 1A GALLERY, MAHARASHTRA, INDIA
KD027	70.001.0	KOYNA DAM 1A GALLERY, MAHARASHTRA, INDIA
KD028	70.002.0	KOYNA DAM DOWNSTREAM OBS., MAHARASHTRA, INDIA
KD029	70.003.0	KOYNA DAM 1A GALLERY, MAHARASHTRA, INDIA
KD030	70.004.0	KOYNA DAM SHEAR ZONE GALLERY, MAHARASHTRA, INDIA
KD031	70.005.0	KOYNA DAM 1A GALLERY, MAHARASHTRA, INDIA
KD032	71.001.0	KOYNA DAM 1A GALLERY, MAHARASHTRA, INDIA
KD033	74.001.0	KOYNA DAM TOP (M17), MAHARASHTRA, INDIA
KD034	74.002.0	KOYNA DAM TOP (M17), MAHARASHTRA, INDIA
KD035	74.003.0	KOYNA DAM TOP (M17), MAHARASHTRA, INDIA
KD036	75.001.0	KOYNA DAM TOP (M17), MAHARASHTRA, INDIA
KD037	76.001.0	KOYNA DAM TOP (M17), MAHARASHTRA, INDIA
KD038	76.002.0	KOYNA DAM TOP (M17), MAHARASHTRA, INDIA
KD039	76.003.0	KOYNA DAM DOWNSTREAM OBS., MAHARASHTRA, INDIA
KD040	77.001.0	KOYNA DAM TOP (M17), MAHARASHTRA, INDIA
KD041	80.001.0	KOYNA DAM KIRNOS OBS., MAHARASHTRA, INDIA
KD042	80.002.0	KOYNA DAM OPERATION GALLERY, MAHARASHTRA, INDIA
KD043	80.003.0	KOYNA DAM KIRNOS OBS., MAHARASHTRA, INDIA
KD044	80.004.0	KOYNA DAM KIRNOS OBS., MAHARASHTRA, INDIA
KD045	80.005.0	KOYNA DAM OPERATION GALLERY, MAHARASHTRA, INDIA
KD046	80.006.0	KOYNA DAM TOP (M17), MAHARASHTRA, INDIA
KD047	81.001.0	KOYNA DAM TOP (M17), MAHARASHTRA, INDIA
KD048	82.001.0	KOYNA DAM TOP (M17), MAHARASHTRA, INDIA
KD049	82.002.0	KOYNA DAM SHEAR ZONE GALLERY, MAHARASHTRA, INDIA

TABLE III.V

CROSS-INDEX OF RECORD DATA FILES WITH COMPONENT DIRECTION & FILE #

REF.#	LOG.#	COMP	FILE#	COMP	FILE#	COMP	FILE#	REC.#
IIKD001	67.001.0	LONG	0001	VERT	0002	TRAN	0003	1
IIKD002	67.002.0	LONG	0004	VERT	0005	TRAN	0006	2
IIKD003	67.003.0	LONG	0007	VERT	0008	TRAN	0009	3
IIKD004	67.004.0	LONG	0010	VERT	0011	TRAN	0012	4
IIKD005	67.005.0	LONG	0013	VERT	0014	TRAN	0015	5
IIKD006	67.006.0	LONG	0016	VERT	0017	TRAN	0018	6
IIKD007	67.007.0	LONG	0019	VERT	0020	TRAN	0021	7
IIKD008	67.008.0	LONG	0022	VERT	0023	TRAN	0024	8
IIKD009	67.009.0	LONG	0025	VERT	0026	TRAN	0027	9
IIKD010	67.010.0	LONG	0028	VERT	0029	TRAN	0030	10
IIKD011	67.011.0	LONG	0031	VERT	0032	TRAN	0033	11
IIKD012	67.012.0	LONG	0034	VERT	0035	TRAN	0036	12
IIKD013	67.013.0	LONG	0037	VERT	0038	TRAN	0039	13
IIKD014	67.014.0	LONG	0040	VERT	0041	TRAN	0042	14
IIKD015	67.015.0	LONG	0043	VERT	0044	TRAN	0045	15
IIKD016	67.016.0	LONG	0046	VERT	0047	TRAN	0048	16
IIKD017	68.001.0	LONG	0049	VERT	0050	TRAN	0051	17
IIKD018	68.002.0	LONG	0052	VERT	0053	TRAN	0054	18
IIKD019	68.003.0	LONG	0055	VERT	0056	TRAN	0057	19
IIKD020	68.004.0	LONG	0058	VERT	0059	TRAN	0060	20
IIKD021	68.005.0	LONG	0061	VERT	0062	TRAN	0063	21
IIKD022	68.006.0	LONG	0064	VERT	0065	TRAN	0066	22
IIKD023	68.007.0	LONG	0067	VERT	0068	TRAN	0069	23
IIKD024	68.008.0	LONG	0070	VERT	0071	TRAN	0072	24
IIKD025	69.001.0	LONG	0073	VERT	0074	TRAN	0075	25
IIKD026	69.002.0	LONG	0076	VERT	0077	TRAN	0078	26
IIKD027	70.001.0	LONG	0079	VERT	0080	TRAN	0081	27
IIKD028	70.002.0	LONG	0082	VERT	0083	TRAN	0084	28
IIKD029	70.003.0	LONG	0085	VERT	0086	TRAN	0087	29
IIKD030	70.004.0	LONG	0088	VERT	0089	TRAN	0090	30
IIKD031	70.005.0	LONG	0091	VERT	0092	TRAN	0093	31
IIKD032	71.001.0	LONG	0094	VERT	0095	TRAN	0096	32
IIKD033	74.001.0	LONG	0097	VERT	0098	TRAN	0099	33
IIKD034	74.002.0	LONG	0100	VERT	0101	TRAN	0102	34
IIKD035	74.003.0	LONG	0103	VERT	0104	TRAN	0105	35
IIKD036	75.001.0	LONG	0106	VERT	0107	TRAN	0108	36
IIKD037	76.001.0	LONG	0109	VERT	0110	TRAN	0111	37
IIKD038	76.002.0	LONG	0112	VERT	0113	TRAN	0114	38
IIKD039	76.003.0	LONG	0115	VERT	0116	TRAN	0117	39
IIKD040	77.001.0	LONG	0118	VERT	0119	TRAN	0120	40
IIKD041	80.001.0	LONG	0121	VERT	0122	TRAN	0123	41
IIKD042	80.002.0	LONG	0124	VERT	0125	TRAN	0126	42
IIKD043	80.003.0	LONG	0127	VERT	0128	TRAN	0129	43
IIKD044	80.004.0	LONG	0130	VERT	0131	TRAN	0132	44
IIKD045	80.005.0	LONG	0133	VERT	0134	TRAN	0135	45
IIKD046	80.006.0	LONG	0136	VERT	0137	TRAN	0138	46
IIKD047	81.001.0	LONG	0139	VERT	0140	TRAN	0141	47
IIKD048	82.001.0	LONG	0142	VERT	0143	TRAN	0144	48
IIKD049	82.002.0	LONG	0145	VERT	0146	TRAN	0147	49

TABLE II.VI

CROSS-INDEX OF DATA RECORD FILES WITH
PEAK ACCELERATION, PA, PEAK VELOCITY, PV, PEAK DISPLACEMENT, PD, AND
LEFT, f1, AND RIGHT, f2, BAND PASS FREQUENCIES (HZ)

REF.# LOG.# COMP	PA	PV	PD	f1-f2
IIKD001 67.001.0				
LONG	48.939	.54	.02	2.000-25.0
VERT	17.341	.22	.01	1.600-25.0
TRAN	15.199	.23	.01	2.500-25.0
IIKD002 67.002.0				
LONG	160.830	2.88	.17	.800-25.0
VERT	60.989	2.36	.06	1.600-25.0
TRAN	67.200	1.99	.11	1.100-25.0
IIKD003 67.003.0				
LONG	22.424	.64	.04	1.000-25.0
VERT	39.989	.96	.04	2.500-25.0
TRAN	23.907	.64	.02	1.400-25.0
IIKD004 67.004.0				
LONG	13.650	.36	.02	1.250-25.0
VERT	14.019	.39	.03	1.000-25.0
TRAN	14.119	.62	.02	1.400-25.0
IIKD005 67.005.0				
LONG	33.345	.47	.01	2.000-25.0
VERT	14.469	.23	.01	2.500-25.0
TRAN	10.285	.12	.01	2.000-25.0
IIKD006 67.006.0				
LONG	480.266	19.66	1.34	.750-25.0
VERT	239.996	14.82	2.17	.600-25.0
TRAN	371.587	20.89	3.18	.400-25.0
IIKD007 67.007.0				
LONG	52.090	1.21	.03	2.000-25.0
VERT	68.808	2.68	.17	.750-25.0
TRAN	34.310	1.56	.08	.950-25.0
IIKD008 67.008.0				
LONG	24.182	1.13	.08	.500-25.0
VERT	26.719	.98	.05	1.250-25.0
TRAN	33.751	1.37	.07	1.100-25.0
IIKD009 67.009.0				
LONG	33.988	1.12	.05	1.000-25.0
VERT	23.204	.51	.03	1.250-25.0
TRAN	35.551	1.47	.16	.500-25.0
IIKD010 67.010.0				
LONG	42.674	1.42	.04	2.000-25.0
VERT	21.443	.43	.01	1.500-25.0
TRAN	18.009	.34	.02	1.400-25.0
IIKD011 67.011.0				
LONG	21.615	.41	.01	2.000-25.0
VERT	20.094	.42	.02	1.200-25.0
TRAN	21.222	.51	.01	1.800-25.0
IIKD012 67.012.0				
LONG	22.168	.46	.01	2.000-25.0
VERT	30.038	.44	.02	2.000-25.0
TRAN	22.763	.44	.02	1.500-25.0
IIKD013 67.013.0				
LONG	19.732	.61	.02	2.500-25.0
VERT	24.267	.49	.01	2.000-25.0
TRAN	14.660	.41	.01	2.000-21.5
IIKD014 67.014.0				
LONG	10.943	.44	.02	1.600-25.0
VERT	15.017	.67	.04	.900-25.0
TRAN	10.273	.29	.01	2.000-25.0
IIKD015 67.015.0				
LONG	48.000	.75	.03	2.000-25.0
VERT	38.451	1.12	.04	2.000-25.0
TRAN	25.683	.50	.01	1.500-25.0
IIKD016 67.016.0				
LONG	26.359	.49	.02	3.500-25.0
VERT	32.249	.77	.01	2.500-25.0
TRAN	35.180	.60	.01	2.000-25.0
IIKD017 68.001.0				
LONG	46.858	1.43	.07	1.400-25.0
VERT	42.261	.80	.05	2.000-25.0
TRAN	13.934	.28	.02	2.000-25.0
IIKD018 68.002.0				
LONG	51.373	1.50	.03	2.000-25.0
VERT	25.246	.33	.01	2.000-25.0
TRAN	12.315	.34	.02	2.000-25.0
IIKD019 68.003.0				
LONG	16.841	.26	.03	2.500-25.0
VERT	12.244	.19	.01	2.000-25.0
TRAN	10.851	.21	.01	3.000-25.0
IIKD020 68.004.0				
LONG	19.134	.32	.01	2.500-25.0
VERT	10.894	.62	.04	2.500-25.0
TRAN	9.909	.24	.00	3.000-25.0
IIKD021 68.005.0				
LONG	8.993	.18	.01	2.000-25.0
VERT	12.216	.27	.01	3.500-25.0
TRAN	8.426	.21	.01	1.200-25.0
IIKD022 68.006.0				
LONG	87.805	3.18	.19	.450-25.0
VERT	92.920	5.15	.35	.400-25.0
TRAN	46.231	1.18	.06	.800-25.0

IIKD023 68.007.0

LONG	112.990	2.54	.10	1.100-25.0
VERT	69.992	2.62	.18	.750-25.0
TRAN	47.035	2.38	.11	1.000-25.0

IIKD025 69.001.0

LONG	13.151	.35	.01	3.500-25.0
VERT	8.985	.99	.04	1.200-25.0
TRAN	9.672	.22	.01	2.000-25.0

IIKD027 70.001.0

LONG	8.532	.20	.01	2.000-25.0
VERT	9.436	.21	.02	1.250-25.0
TRAN	12.699	.27	.01	3.500-25.0

IIKD029 70.003.0

LONG	32.515	.73	.02	1.400-25.0
VERT	19.218	.34	.01	2.000-25.0
TRAN	29.721	.31	.02	1.600-25.0

IIKD031 70.005.0

LONG	40.625	1.98	.07	.750-25.0
VERT	19.365	.39	.01	2.000-25.0
TRAN	25.792	.81	.04	.950-25.0

IIKD033 74.001.0

LONG	21.008	.56	.02	2.000-25.0
VERT	8.515	.19	.01	2.000-25.0
TRAN	19.977	.33	.01	2.000-25.0

IIKD035 74.003.0

LONG	34.508	1.57	.05	1.100-25.0
VERT	10.404	.38	.02	2.000-25.0
TRAN	21.642	.97	.02	2.000-22.5

IIKD037 76.001.0

LONG	30.682	.66	.02	1.600-25.0
VERT	7.287	.16	.01	1.400-25.0
TRAN	24.516	.22	.01	2.000-25.0

IIKD039 76.003.0

LONG	7.274	.14	.00	2.500-25.0
VERT	10.603	.23	.01	2.000-25.0
TRAN	22.908	.28	.02	2.000-25.0

IIKD041 80.001.0

LONG	21.024	.45	.01	2.500-25.0
VERT	19.639	.39	.03	1.400-25.0
TRAN	17.752	.44	.02	1.400-25.0

IIKD043 80.003.0

LONG	17.873	.37	.02	2.000-25.0
VERT	32.474	.94	.04	1.400-25.0
TRAN	28.972	.96	.03	2.000-25.0

IIKD045 80.005.0

LONG	20.957	.89	.03	2.000-25.0
VERT	14.222	.69	.02	2.500-22.5
TRAN	21.508	.80	.05	1.250-25.0

IIKD047 81.001.0

LONG	98.638	.89	.04	1.400-25.0
VERT	17.789	.33	.02	1.400-25.0
TRAN	67.553	1.08	.07	1.000-25.0

IIKD049 82.002.0

LONG	9.180	.48	.04	1.100-25.0
VERT	9.057	.38	.03	1.000-25.0
TRAN	8.556	.75	.12	.750-25.0

IIKD024 68.008.0

LONG	75.462	2.52	.13	.800-25.0
VERT	67.198	2.98	.17	.700-25.0
TRAN	45.338	1.84	.15	.700-25.0

IIKD026 69.002.0

LONG	86.591	2.81	.11	1.500-25.0
VERT	40.554	1.80	.29	.400-25.0
TRAN	43.219	1.61	.06	1.250-25.0

IIKD028 70.002.0

LONG	53.743	.72	.02	3.000-25.0
VERT	18.330	.41	.00	2.500-25.0
TRAN	68.478	.99	.03	1.300-25.0

IIKD030 70.004.0

LONG	24.953	.27	.01	1.100-25.0
VERT	15.661	.27	.02	1.000-25.0
TRAN	26.194	.57	.02	2.000-25.0

IIKD032 71.001.0

LONG	21.478	.39	.02	2.000-25.0
VERT	15.496	.39	.01	3.000-25.0
TRAN	14.738	.46	.02	1.500-25.0

IIKD034 74.002.0

LONG	31.131	1.09	.04	1.400-25.0
VERT	11.726	.26	.01	2.000-25.0
TRAN	16.169	.34	.02	1.400-25.0

IIKD036 75.001.0

LONG	17.498	.58	.02	1.000-25.0
VERT	8.781	.28	.02	1.000-25.0
TRAN	15.904	.36	.01	3.000-25.0

IIKD038 76.002.0

LONG	47.915	1.58	.08	2.000-23.5
VERT	26.253	.61	.03	3.500-25.0
TRAN	31.413	.71	.03	1.600-25.0

IIKD040 77.001.0

LONG	28.383	.86	.06	1.100-25.0
VERT	13.762	.25	.01	2.000-25.0
TRAN	19.483	.72	.02	2.000-25.0

IIKD042 80.002.0

LONG	31.489	.69	.02	2.000-25.0
VERT	42.568	.86	.03	2.000-25.0
TRAN	19.760	.66	.03	2.000-25.0

IIKD044 80.004.0

LONG	11.366	.29	.02	2.500-25.0
VERT	12.368	.35	.03	1.000-25.0
TRAN	24.015	.59	.03	2.000-25.0

IIKD046 80.006.0

LONG	44.701	.80	.02	2.500-25.0
VERT	9.108	.21	.01	2.000-25.0
TRAN	11.505	.22	.01	2.000-25.0

IIKD048 82.001.0

LONG	28.708	1.01	.03	2.000-25.0
VERT	9.689	.35	.02	2.000-25.0
TRAN	11.987	.44	.01	1.800-25.0

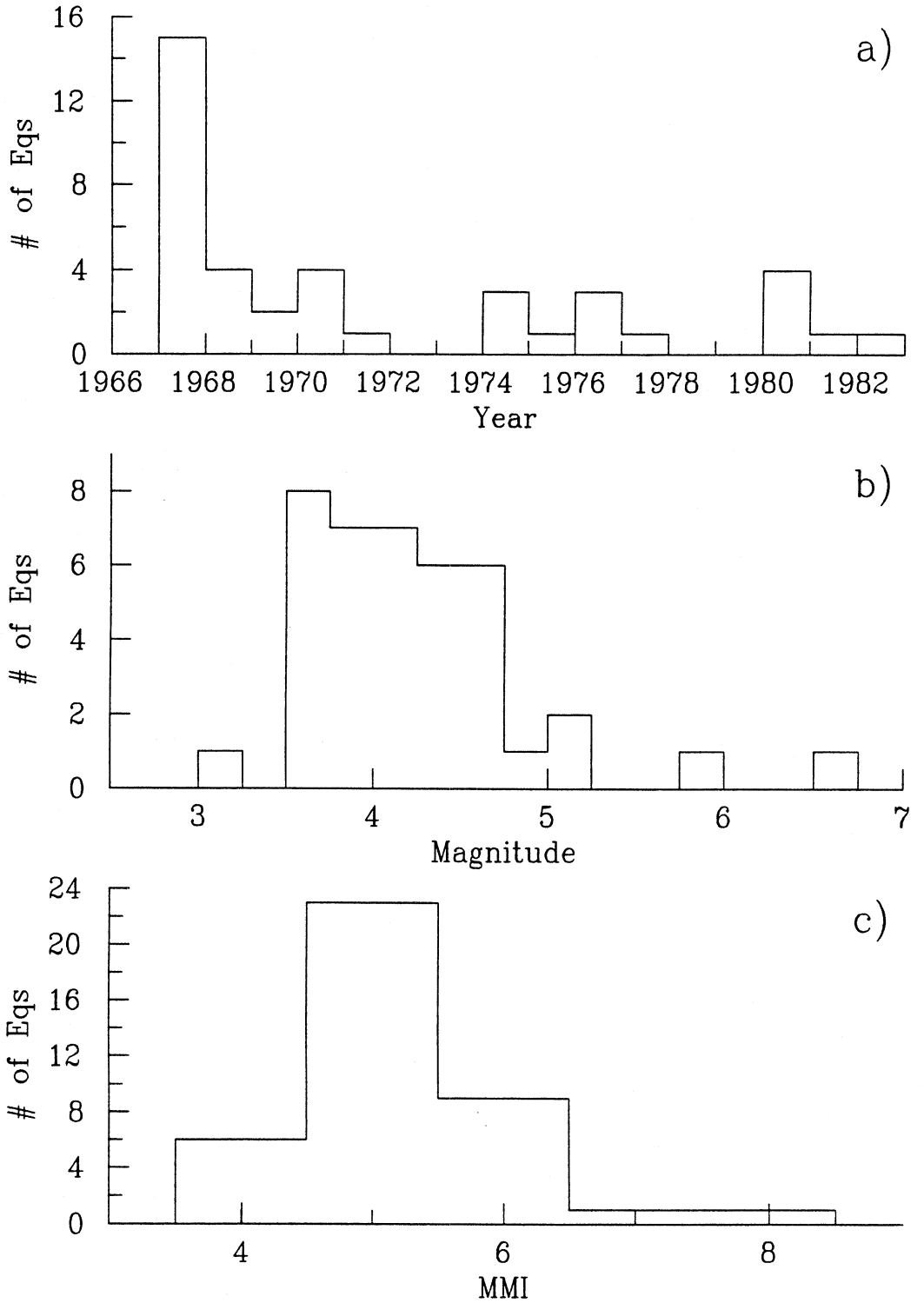

Fig. II.1 Distribution of the number of recorded earthquakes with: (a) time, (b) magnitude, and (c) Modified Mercalli intensity.

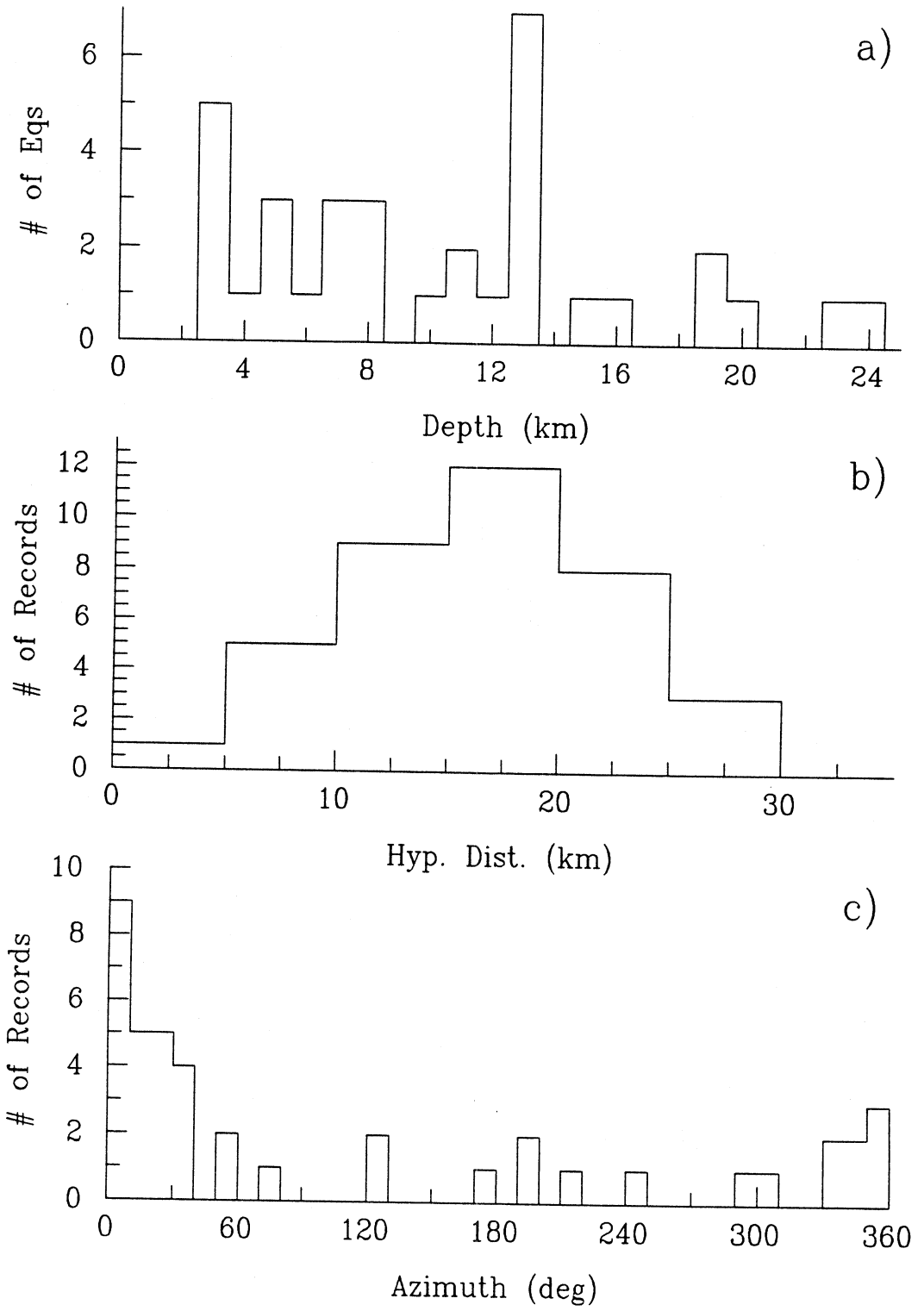

Fig. II.2 (a) Distribution of the number of recorded earthquakes with depth, (b) distribution of the number of records with hypocentral distance, and (c) distribution of the number of records with azimuth.

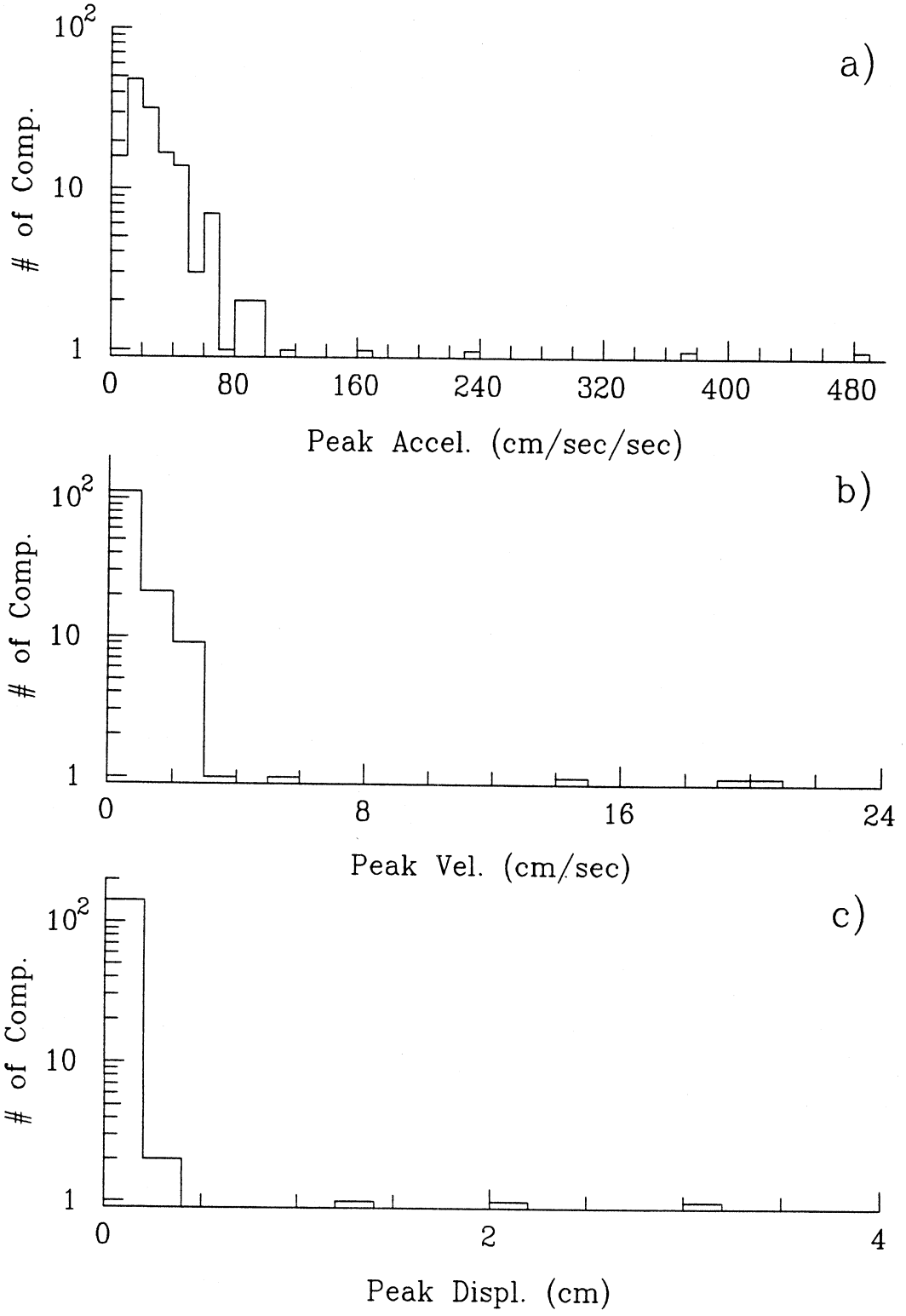

Fig. II.3 Distribution of the number of recorded components of motion with: (a) peak acceleration, (b) peak velocity, and (c) peak displacement.

the data base. This table also represents a list of records ordered in chronological order. Table II.III is a list of recording sites that contributed to this database, which in this case are 6 instruments at various locations in the dam. Table II.IV is a list of records by Ref.#. From left to right, the columns of this table correspond to the record Ref.#, the Log.#, and the location of the station.

Table II.V is a list of components for each record, ordered with respect to increasing Ref.#, and the file number where that components is stored. Table II.VI presents a list of all the recorded peak ground accelerations (cm/sec/sec), velocities (cm/sec) and displacements (cm). The Ref.#, the Log.# and the names of the components are given for each record. The records are ordered with increasing Ref.#. The component names are LONG, VERT or TRAN. The component orientation in degrees is not available for any of the stations.

For visualization of the distribution of data, histograms are presented of the distribution of recorded earthquakes versus time (Fig.II.1a), magnitude (Fig.II.1b), Modified Mercalli Intensity (Fig.II.1c), and depth (Fig.II.2a), the distribution of records versus hypocentral distance (Fig.II.2b) and azimuth (Fig.II.2c), and the distribution of recorded components versus peak ground acceleration (Fig.II.3a), velocity (Fig.II.3b) and displacement (Fig.II.3c).

Appendix A contains plots of corrected accelerations (Volume II), and of Fourier and response response spectra (Volume III) for all the records, arranged in chronological order (as in Tables II.I and II.II).

II.2 Processing of the Accelerograms

For processing of an accelerogram and to apply various corrections, it is necessary to digitize the analog record to get the data on a computer. For this purpose we have used a Hewlett Packard 9874A semi-automatic digitizer. Its digitizing table has an active area of 315 mm $\times$ 435 mm, and its maximum resolution is 25 μm. The record to be digitized is fixed on the digitizing table and a cursor with a cross-hair is manually set at different points on the record trace. The cursor has a switch, which when pressed, the X and Y coordinates of each point are stored in a disk file on the HP-1000 mini-computer.

The Koyna accelerograms are of two types; viz., the AR-240 accelerograph records on 12" photographic paper and the RFT-250 accelerograph records on 70 mm film. The AR-240 records have been digitized directly, and about five times enlarged photographs were prepared from 70 mm film records for their digitization. A length of about 21.5 sec of the AR-240 record and a length of about 17.0 sec of the five times enlarged 70 mm film record can be digitized in one position without moving the record. It is seen that, in general, the Koyna accelerograms are of short durations with very small strong-motion portions. All the selected accelerograms could therefore be digitized in one position only. For each of the records selected for the processing, we have digitized three acceleration traces corresponding to three components of ground motions, three fixed traces for the three acceleration components, and one-time mark trace. The digitization of the accelerograms is performed on an unequal time basis to ensure the best definition of the records by digitized points. To check the accuracy of digitization, a computer

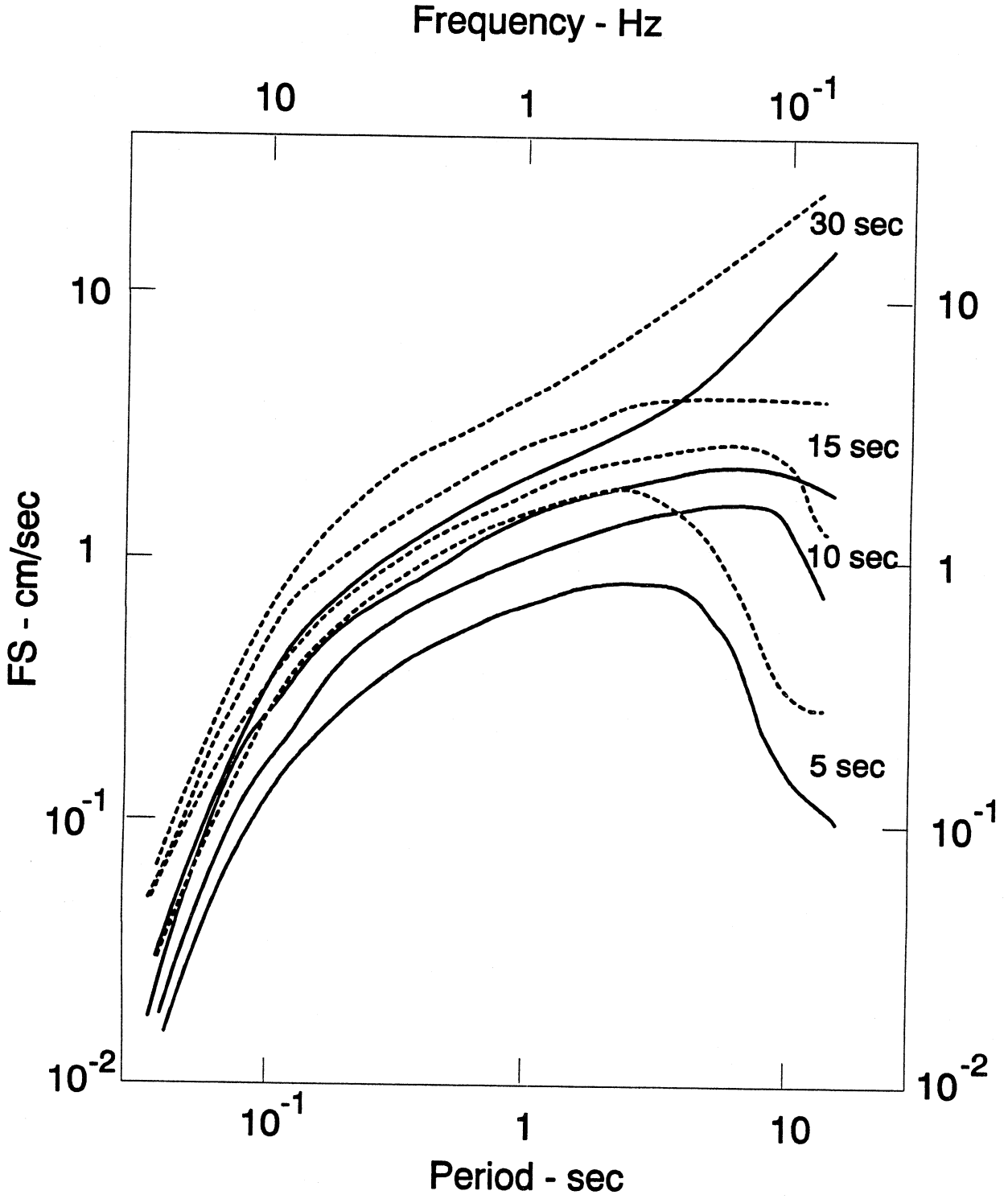

Fig. II.4a The mean and mean plus one standard deviation of smoothed noise Fourier spectra for the HP9874A digitizer used in processing of the presented data.

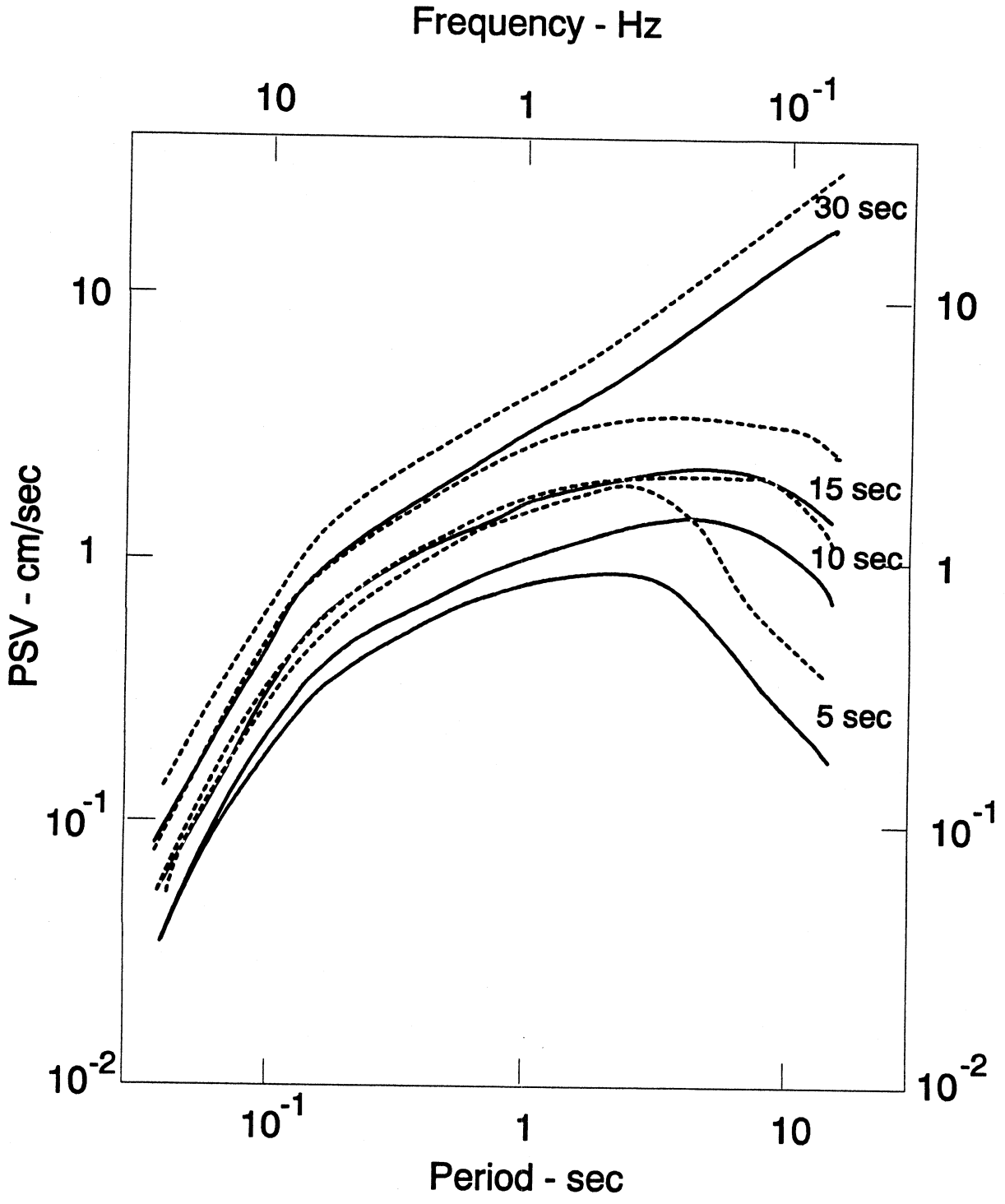

Fig. II.4b The mean and mean plus one standard deviation of smoothed noise PSV spectra for the HP9874A digitizer used in processing of the presented data.

plot of the digitized data was taken on the same scale as the original record, and it was superimposed on the original record to find out any errors in the digitization.

From the digitized time marks, average distance between two successive time marks is evaluated and this is used to scale the digitized X coordinates of all the traces to units of time in seconds. The fixed traces are smoothed and subtracted from the respective acceleration traces to remove any slight rotation of a record in placing it on the digitizing table. The zero axis of an acceleration trace is chosen as a line which makes the mean amplitude as zero, and the Y coordinates are then scaled to the units of acceleration in cm/sec/sec, by considering the photographic enlargement, if any, and the sensitivity of the instrument as specified by the manufacturer. This provides the basic raw digitized data for further processing.

To find the amplitude and frequency range in which the digitized accelerograms provide accurate representation of the ground motion, it is necessary to know the noise characteristics of the overall digitization process. The amplitudes of this noise depend mostly on the resolution of the digitizing equipment and on the quality of the record trace. The mean and mean plus one standard deviation of smoothed noise Fourier and PSV spectra for the HP9874A digitizer, used in the processing of the presented data, are shown in Figure II.4ab. These are evaluated by digitizing a thin straight line as zero acceleration record (Trifunac, 1976). The results of the present processing are computed with variable frequency bands to maintain the signal to noise ratio greater than one.

The raw digitized and scaled accelerograms have been processed to apply the corrections for the instrument frequency response and the baseline distortions, and were integrated to get the velocity and displacement data. The Fourier and the Response spectra of the corrected accelerograms have been computed using and approach based on the exact analytical solution of the Duhamel integral for successive linear segments of the accelerograms (Nigam and Jennings, 1968). For applying the instrument correction, the natural frequency, f_N, and the damping ratio, ς, of each accelerograph transducer are determined from the calibration tests. However, for some of the cases, where the calibration signals were not available, we have used the nominal values of f_N and ς, as given in the specifications. The baseline adjustments are performed by using the method of Trifunac (1971).

With some minor modifications, the computer programs used for the present analysis are the same as in Trifunac and Lee (1973). The later improvements in the data processing are only related to using better digitizing facilities (Trifunac and Lee, 1979) and more accurate and efficient digital signal processing techniques (Lee and Trifunac, 1984; Lee, 1984). The method of analysis has changed little from that of Trifunac and Lee (1973). Thus the presented data are uniform (Trifunac and Lee, 1978) with the results of all the EQINFOS past and future analyses.

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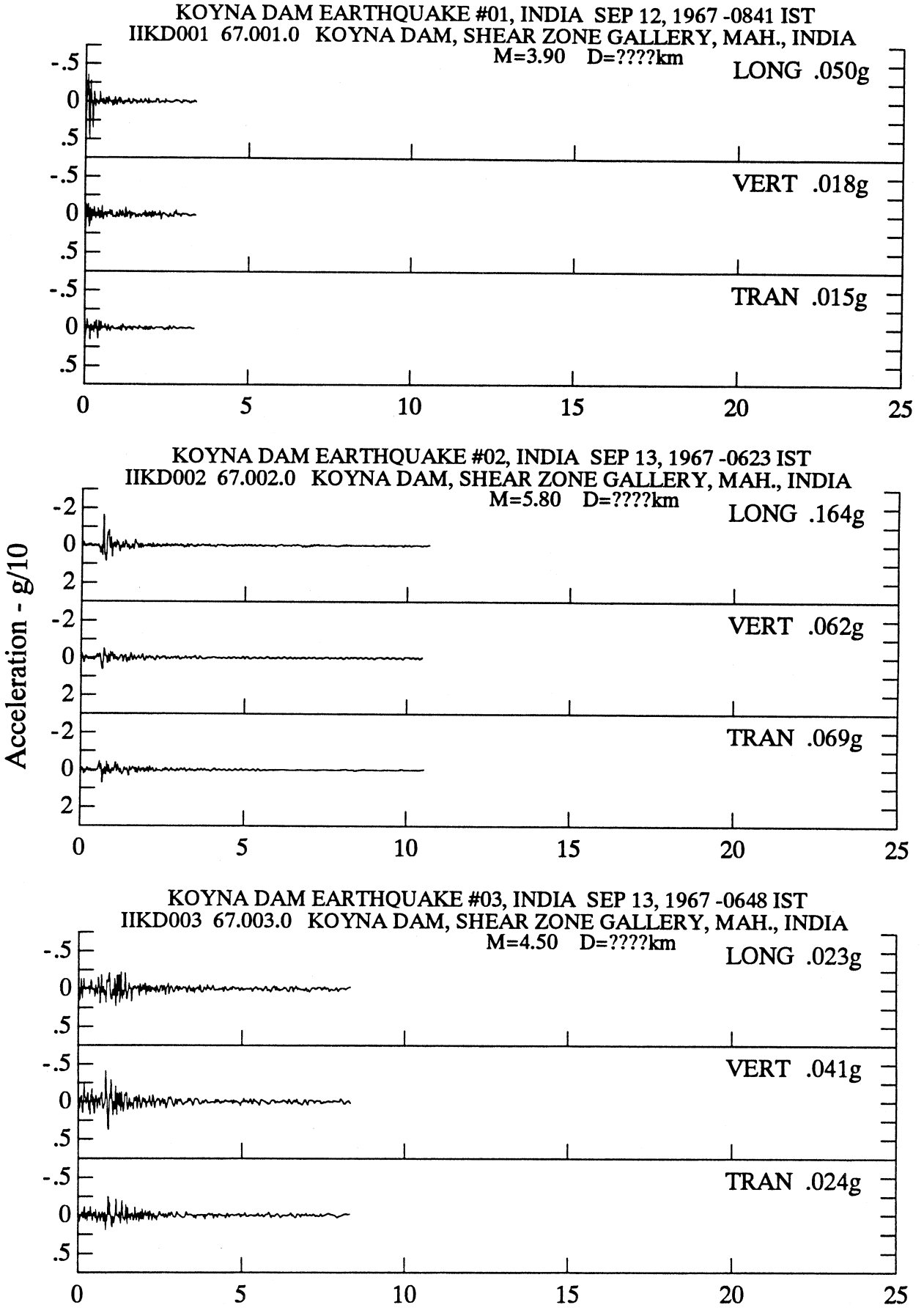
APPENDIX A

This appendix contains plots of corrected accelerations (Volume II), and of Fourier and response spectra (Volume III) for all the records, arranged in chronological order (as in Tables II.I and II.II).

Each of the Volume II plots presents acceleration (as a fraction of G/10, G is the acceleration due to gravity) plotted versus time in [sec]. The text above each plot contains information about the earthquake name, date, time and magnitude (M), the station location and the epicentral distance (D) in [km]. Also, for each recorded component of motion, the orientation and the absolute value of the peak ground acceleration (as a fraction of G) are shown.

Each of the Volume III plots contains Fourier (the dashed line) and response spectra (the solid lines) for five values of the damping ratio (0, 2, 5, 10 and 20% of critical), for a recorded component of motion. On the x-axis is the period in [sec], and on the y-axis are the PSV spectral amplitudes in [in/sec]. On the axes at 45° and 135°, the displacement spectral amplitudes (SD) in [in] and the pseudo acceleration spectral amplitudes, expressed as a fraction of G, can be read.


KOYNA DAM EARTHQUAKE #01, INDIA SEP 12, 1967 -0841 IST
IIKD001 67.001.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA
M=3.90 D=????km
LONG .050g
VERT .018g
TRAN .015g
KOYNA DAM EARTHQUAKE #02, INDIA SEP 13, 1967 -0623 IST
IIKD002 67.002.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA
M=5.80 D=????km
LONG .164g
VERT .062g
TRAN .069g
KOYNA DAM EARTHQUAKE #03, INDIA SEP 13, 1967 -0648 IST
IIKD003 67.003.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA
M=4.50 D=????km
LONG .023g
VERT .041g
TRAN .024g
Acceleration - g/10
Time - seconds

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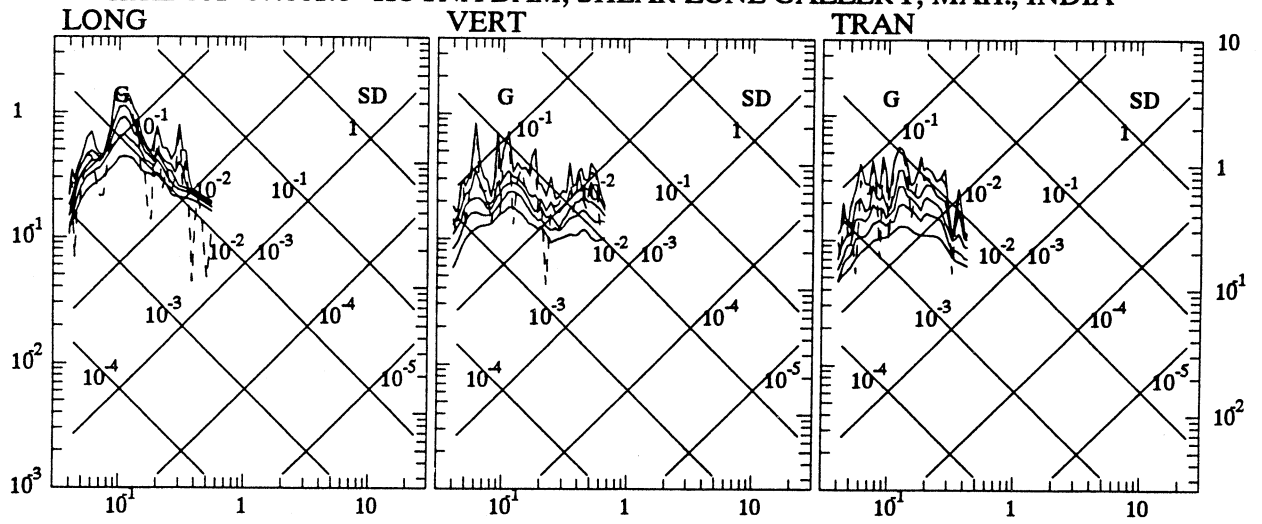
IIIKD001 67.001.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA



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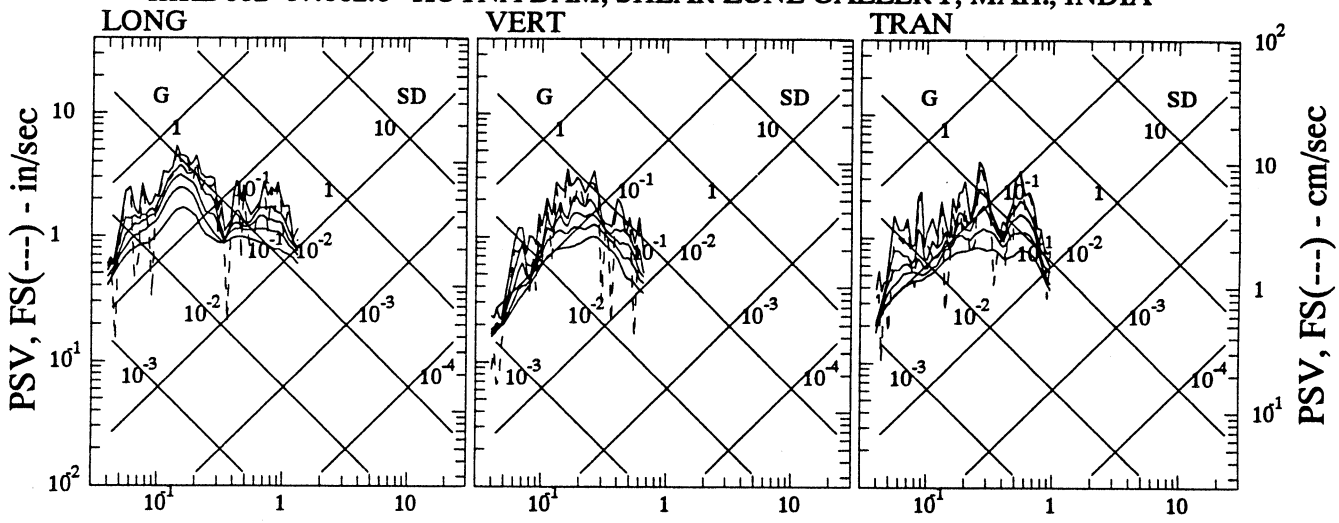
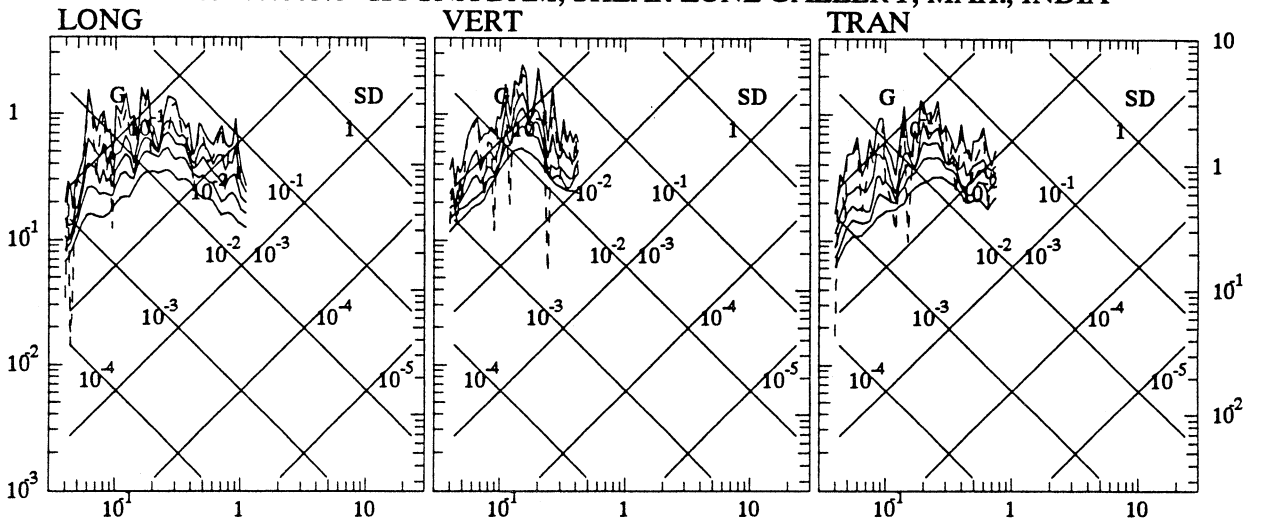
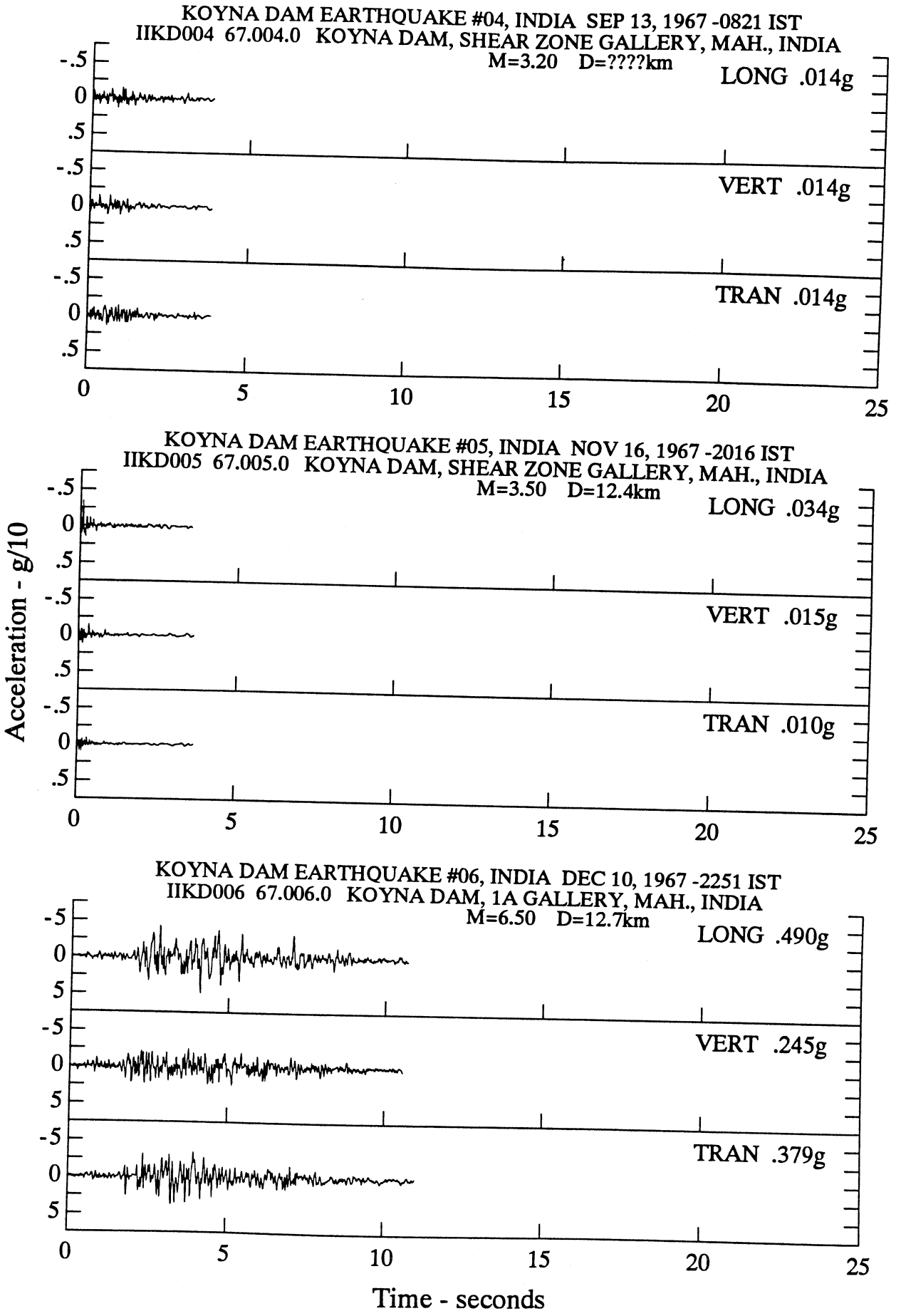
IIIKD002 67.002.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA



KOYNA DAM EARTHQUAKE #03, INDIA SEP 13, 1967 -0648 IST
IIIKD003 67.003.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA



Period - sec


KOYNA DAM EARTHQUAKE #04, INDIA SEP 13, 1967 -0821 IST
IIKD004 67.004.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA
M=3.20 D=????km
LONG .014g
VERT .014g
TRAN .014g
KOYNA DAM EARTHQUAKE #05, INDIA NOV 16, 1967 -2016 IST
IIKD005 67.005.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA
M=3.50 D=12.4km
LONG .034g
VERT .015g
TRAN .010g
KOYNA DAM EARTHQUAKE #06, INDIA DEC 10, 1967 -2251 IST
IIKD006 67.006.0 KOYNA DAM, 1A GALLERY, MAH., INDIA
M=6.50 D=12.7km
LONG .490g
VERT .245g
TRAN .379g
Acceleration - g/10
Time - seconds

KOYNA DAM EARTHQUAKE #04, INDIA SEP 13, 1967 -0821 IST
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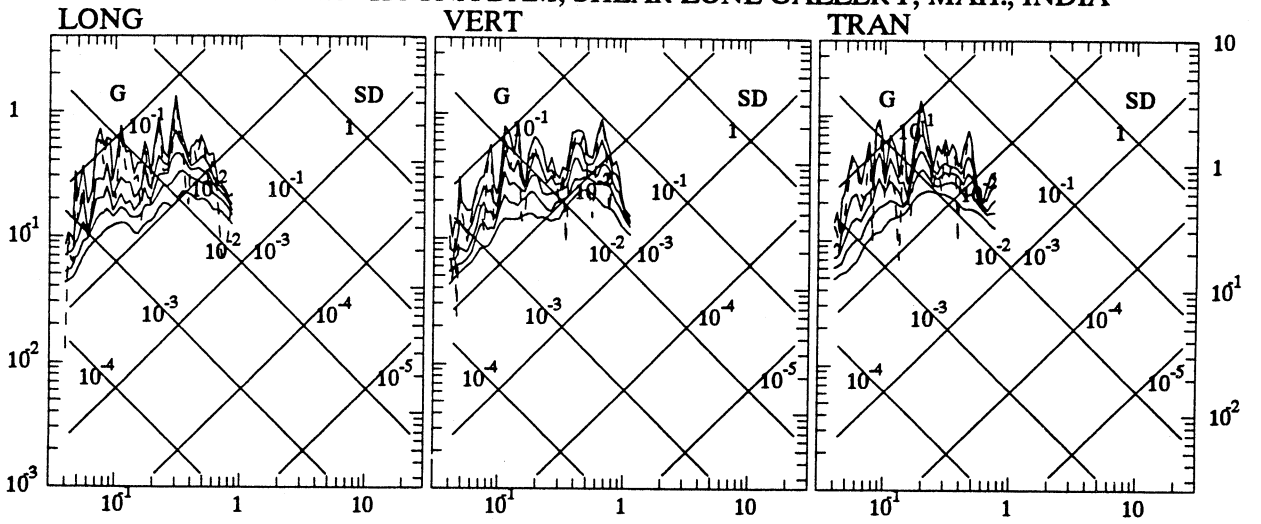

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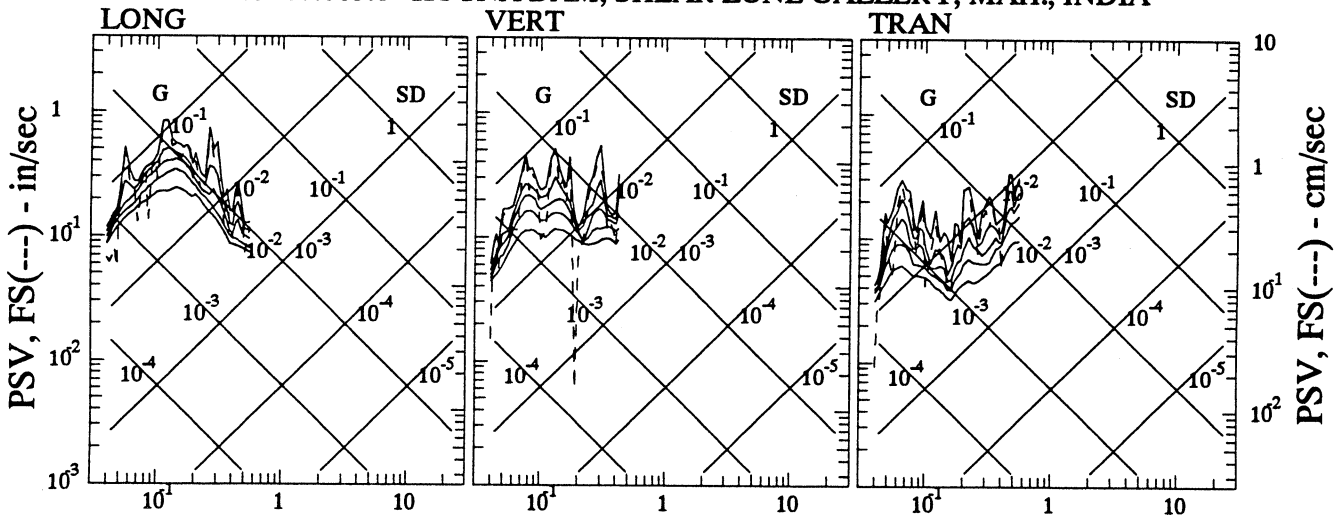
IIIKD005 67.005.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA



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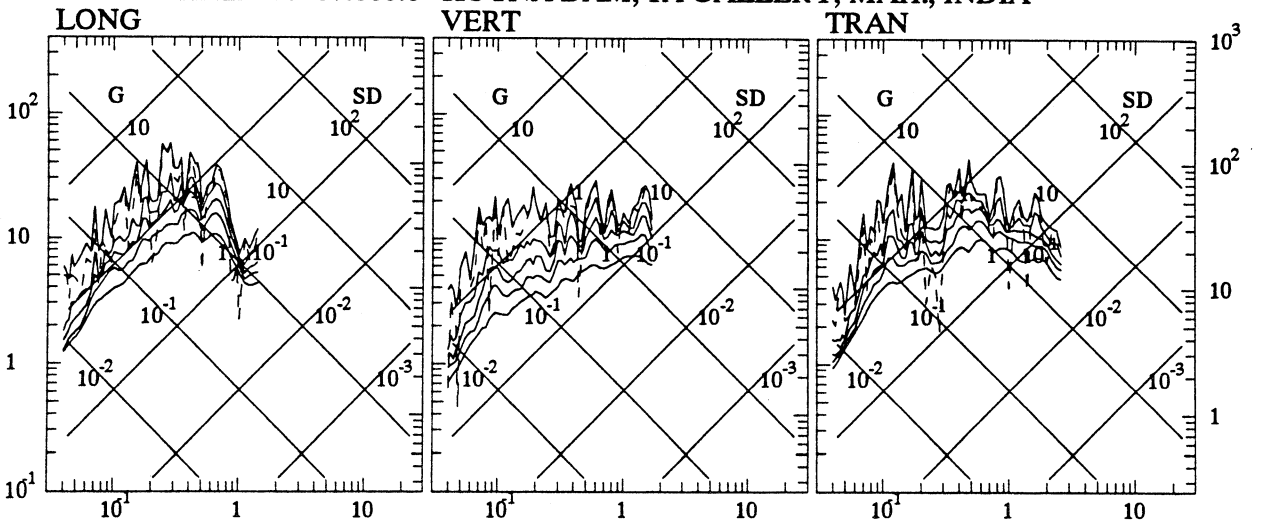
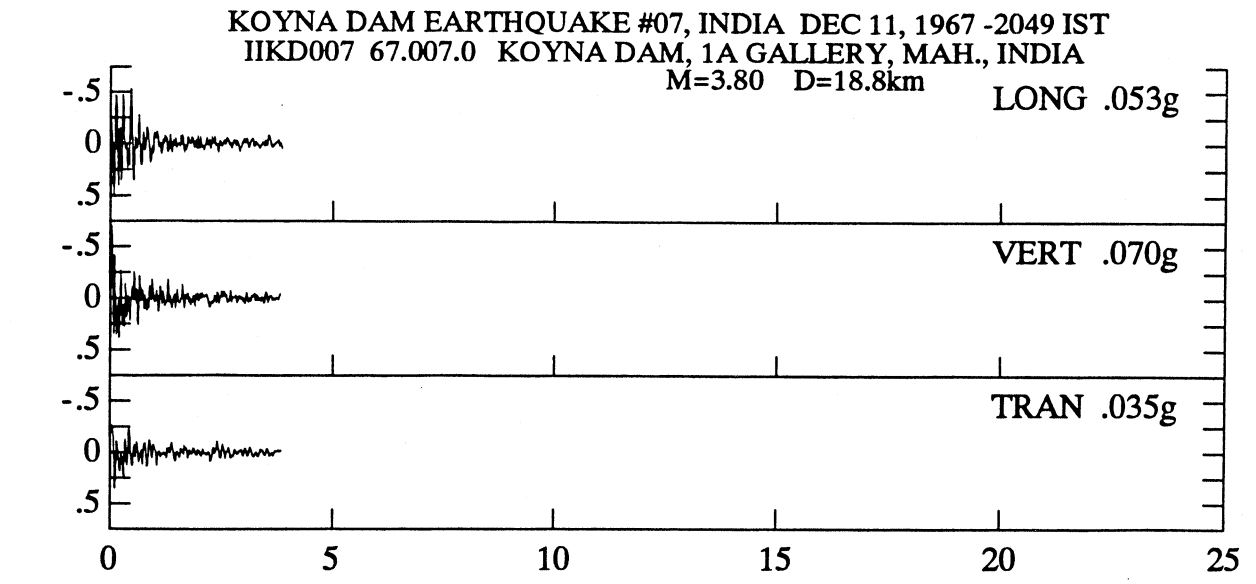
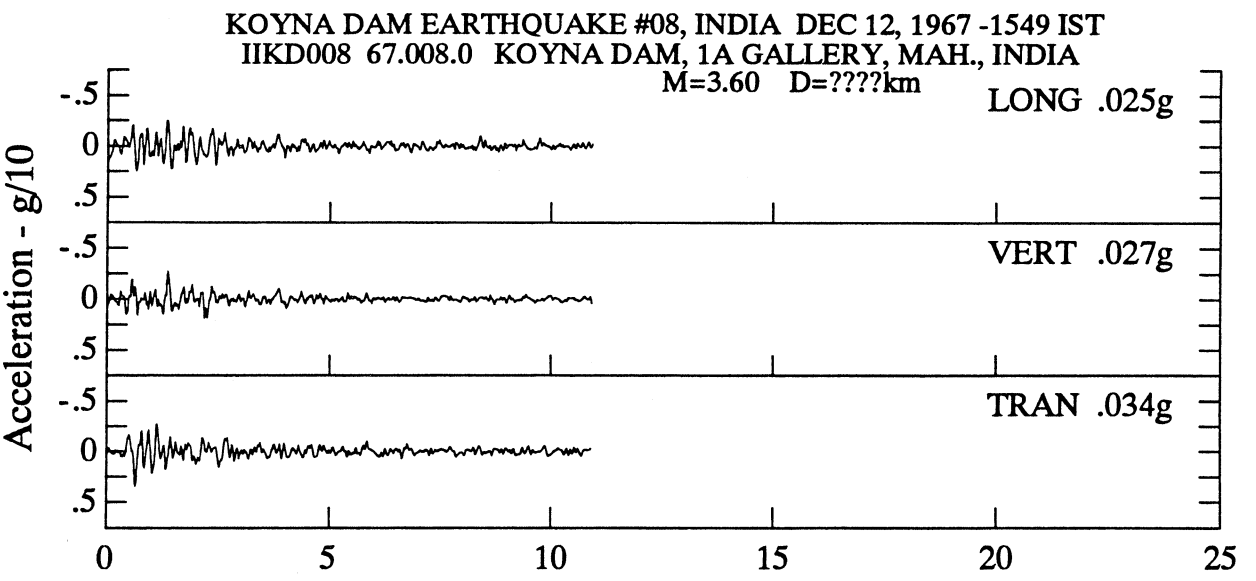
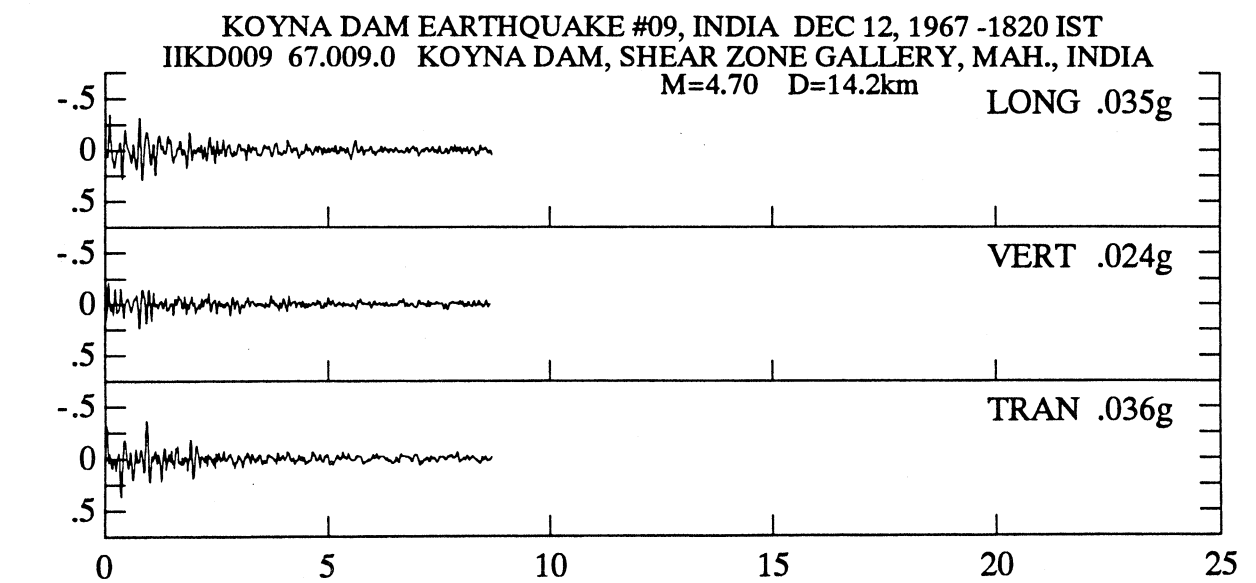
IIIKD006 67.006.0 KOYNA DAM, 1A GALLERY, MAH., INDIA



Period - sec


KOYNA DAM EARTHQUAKE #07, INDIA DEC 11, 1967 -2049 IST
IIKD007 67.007.0 KOYNA DAM, 1A GALLERY, MAH., INDIA
M=3.80 D=18.8km
LONG .053g
VERT .070g
TRAN .035g
-.5
0
.5
0
5
10
15
20
25


KOYNA DAM EARTHQUAKE #08, INDIA DEC 12, 1967 -1549 IST
IIKD008 67.008.0 KOYNA DAM, 1A GALLERY, MAH., INDIA
M=3.60 D=????km
LONG .025g
VERT .027g
TRAN .034g
Acceleration - g/10
-.5
0
.5
0
5
10
15
20
25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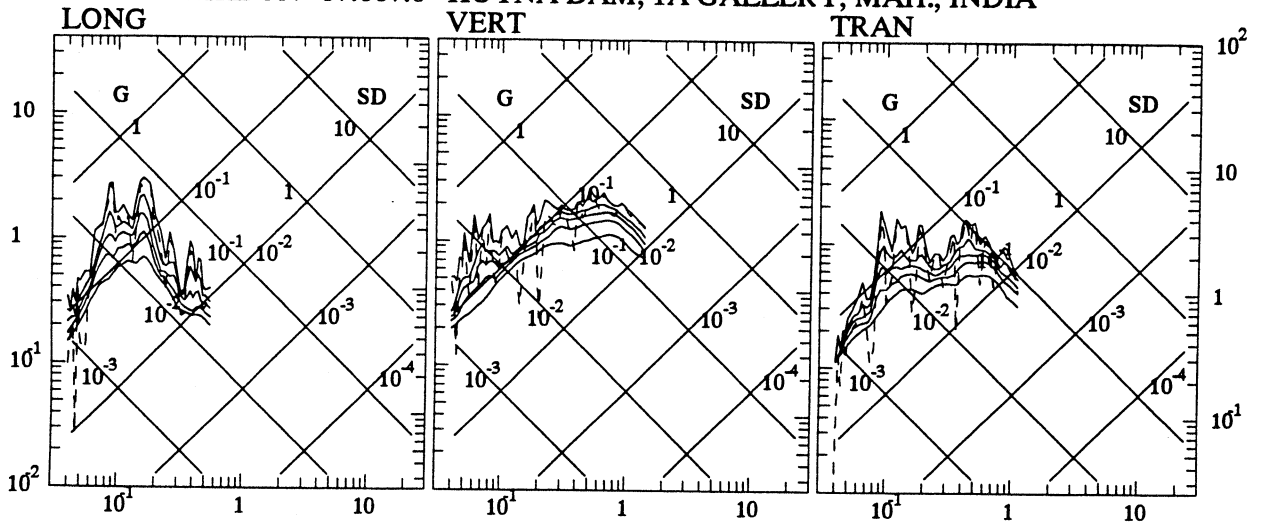
IIKD009 67.009.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA
M=4.70 D=14.2km
LONG .035g
VERT .024g
TRAN .036g
-.5
0
.5
0
5
10
15
20
25
Time - seconds

KOYNA DAM EARTHQUAKE #07, INDIA DEC 11, 1967 -2049 IST
IIIKD007 67.007.0 KOYNA DAM, 1A GALLERY, MAH., INDIA



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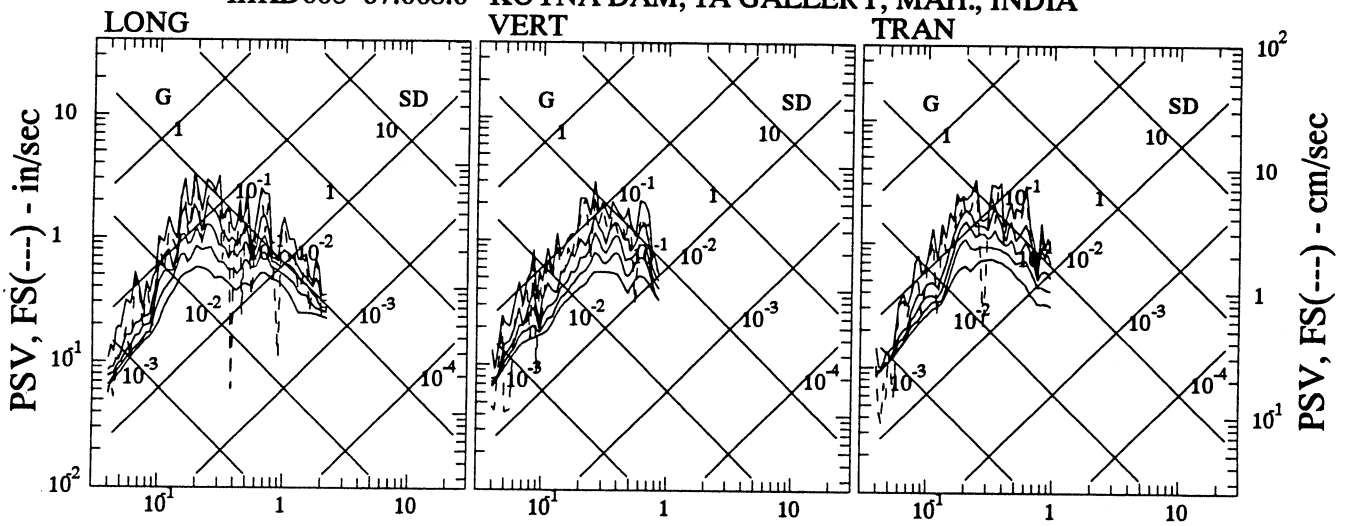

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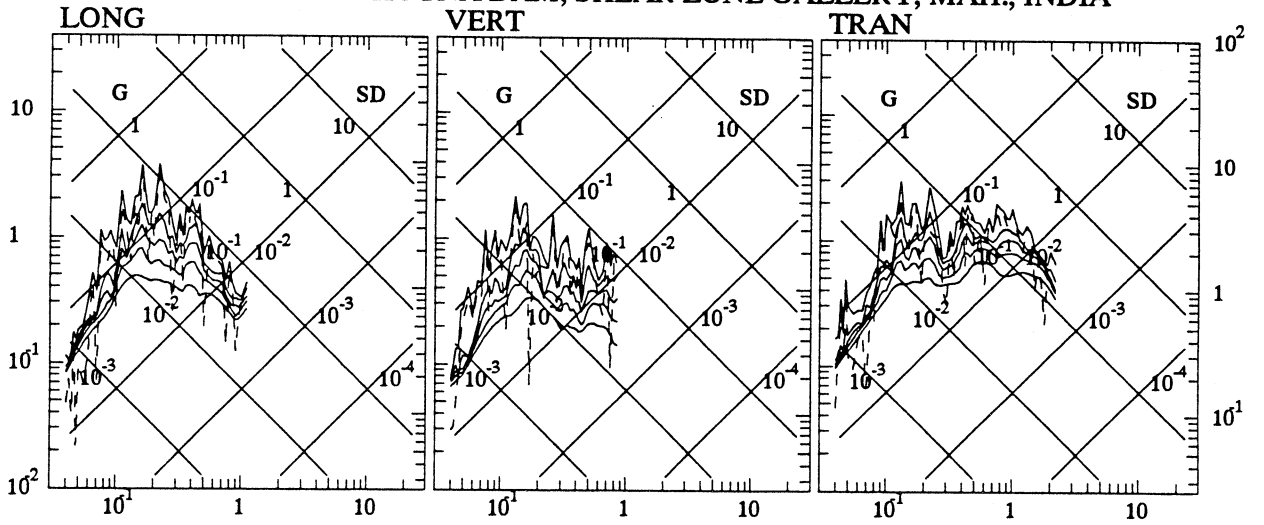

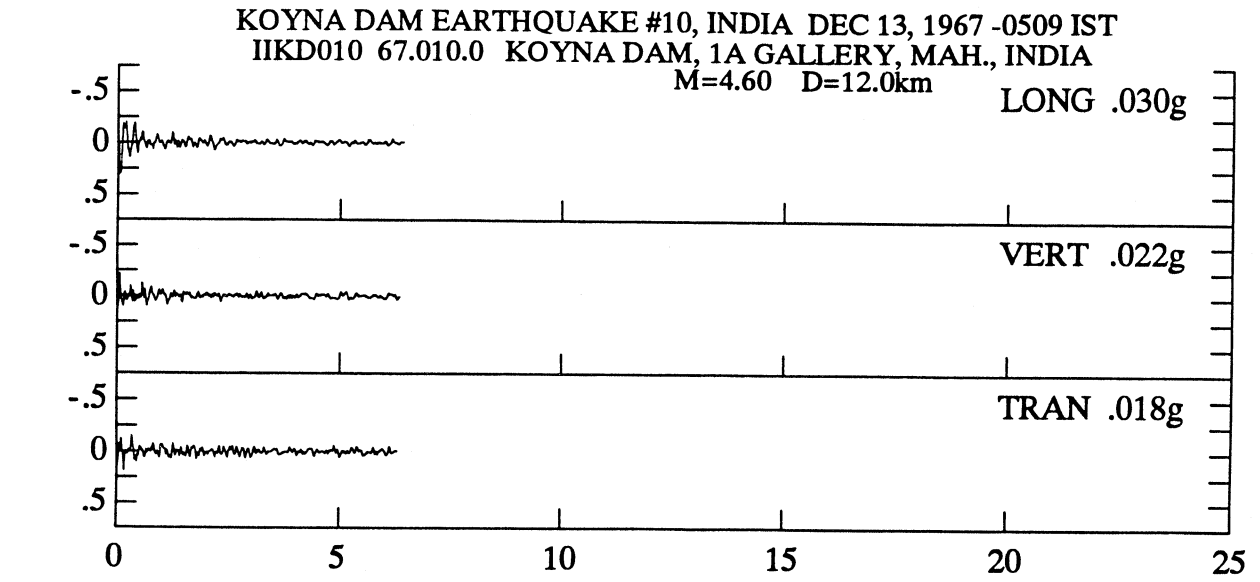
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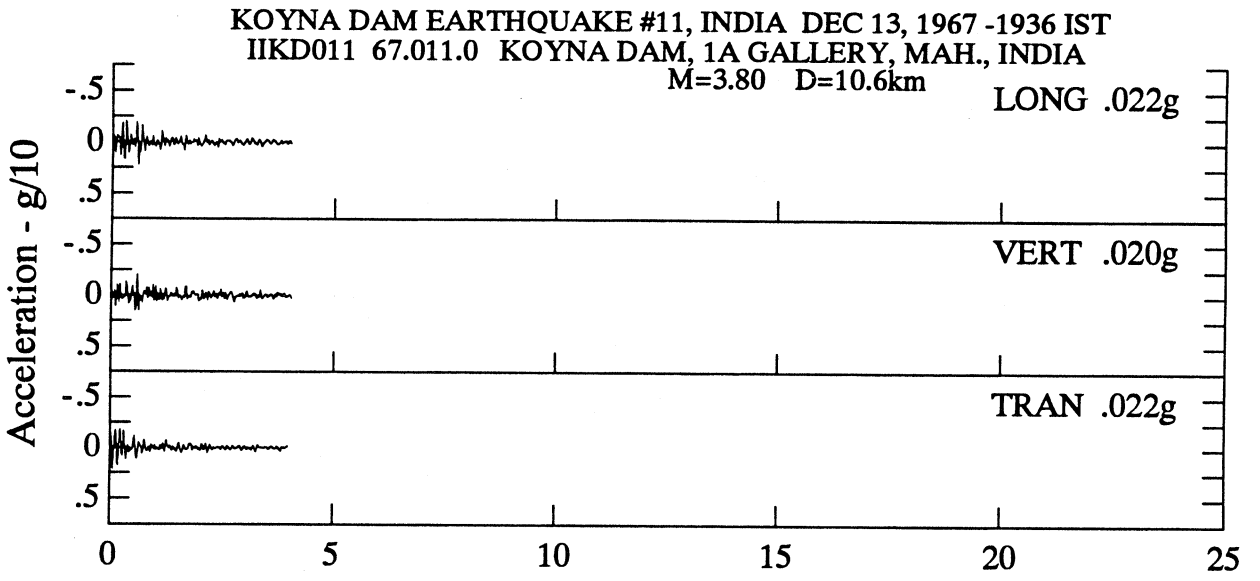
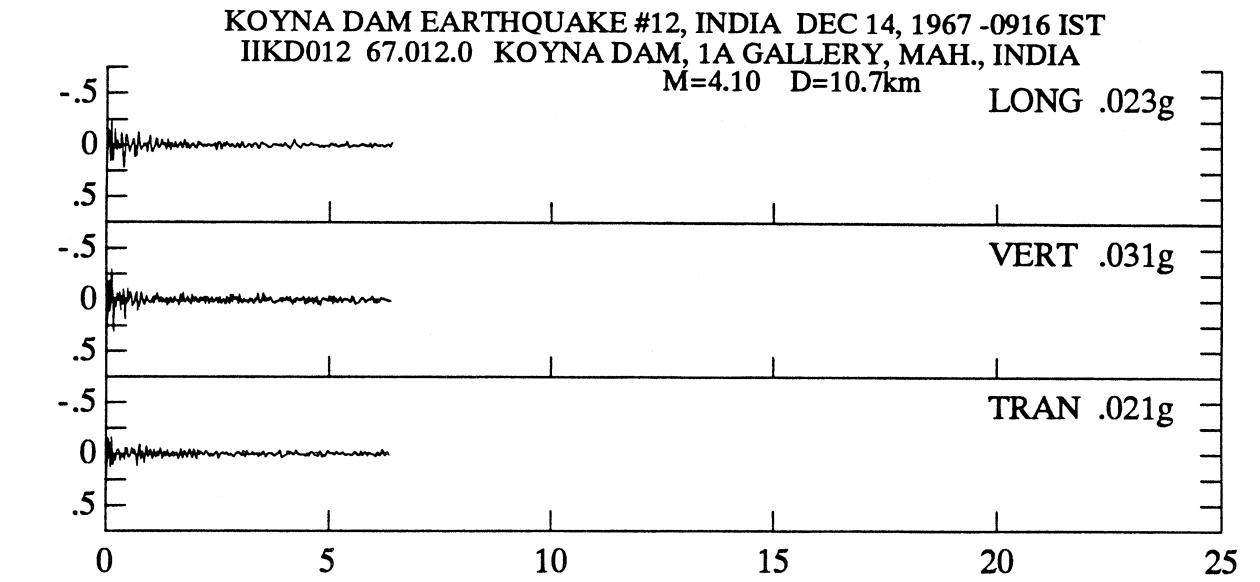
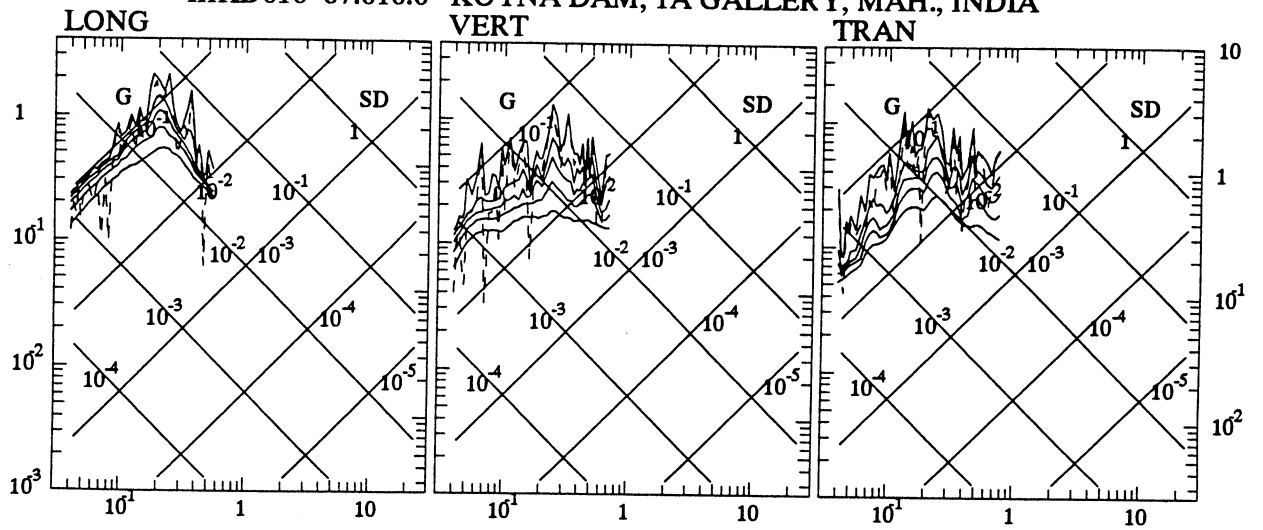
IIKD010 67.010.0 KOYNA DAM, 1A GALLERY, MAH., INDIA
M=4.60 D=12.0km
LONG .030g
VERT .022g
TRAN .018g
-.5
0
.5
0
5
10
15
20
25


KOYNA DAM EARTHQUAKE #11, INDIA DEC 13, 1967 -1936 IST
IIKD011 67.011.0 KOYNA DAM, 1A GALLERY, MAH., INDIA
M=3.80 D=10.6km
LONG .022g
VERT .020g
TRAN .022g
Acceleration - g/10
-.5
0
.5
0
5
10
15
20
25


KOYNA DAM EARTHQUAKE #12, INDIA DEC 14, 1967 -0916 IST
IIKD012 67.012.0 KOYNA DAM, 1A GALLERY, MAH., INDIA
M=4.10 D=10.7km
LONG .023g
VERT .031g
TRAN .021g
-.5
0
.5
0
5
10
15
20
25
Time - seconds

KOYNA DAM EARTHQUAKE #10, INDIA DEC 13, 1967 -0509 IST
IIIKD010 67.010.0 KOYNA DAM, 1A GALLERY, MAH., INDIA



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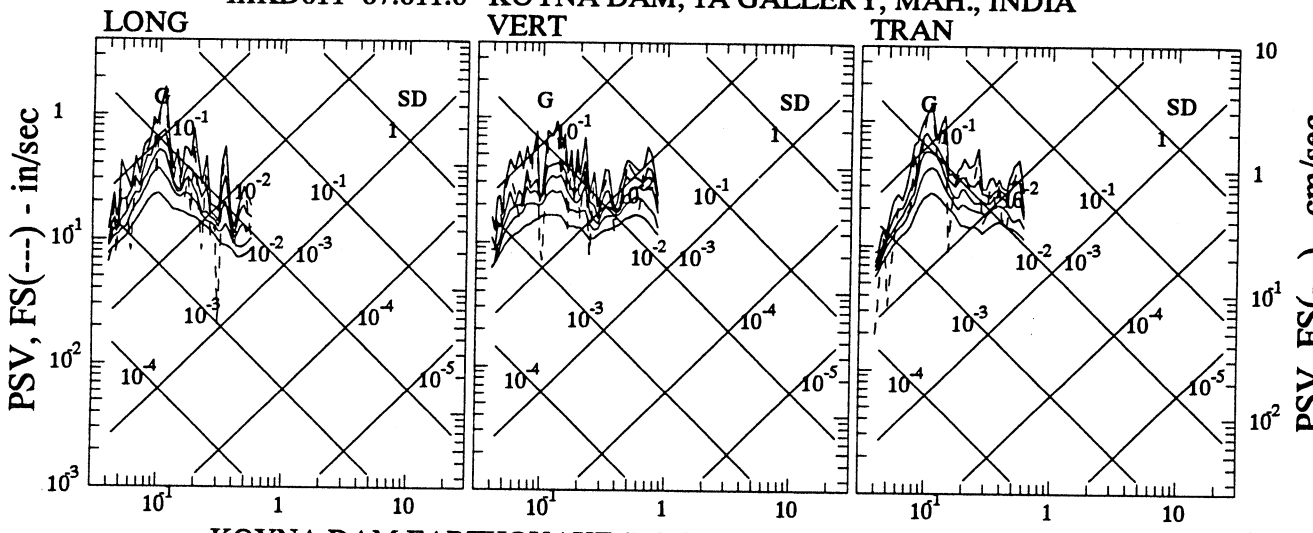

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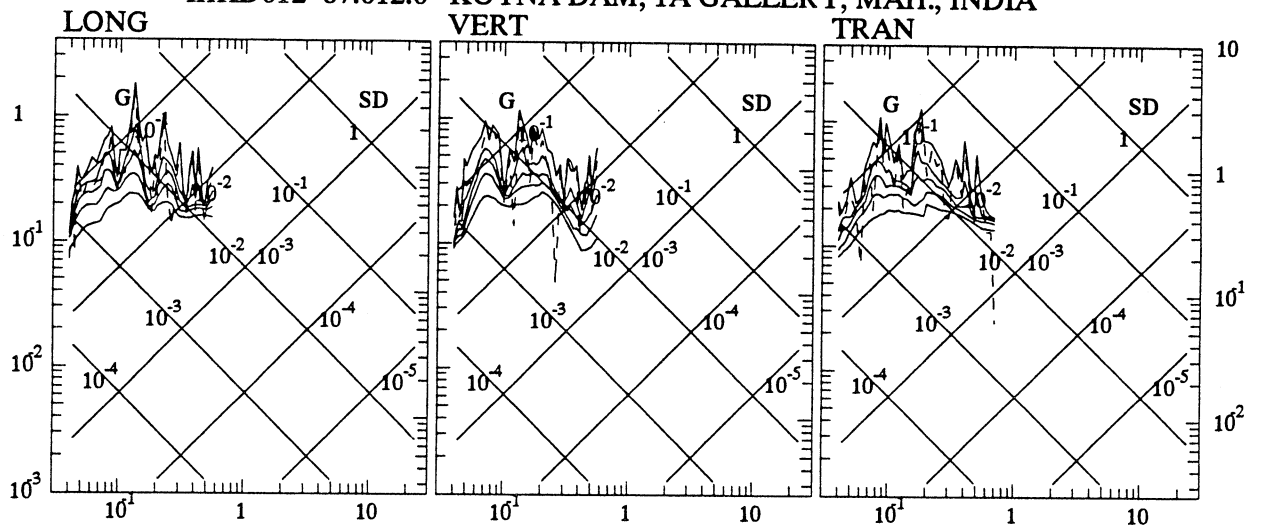

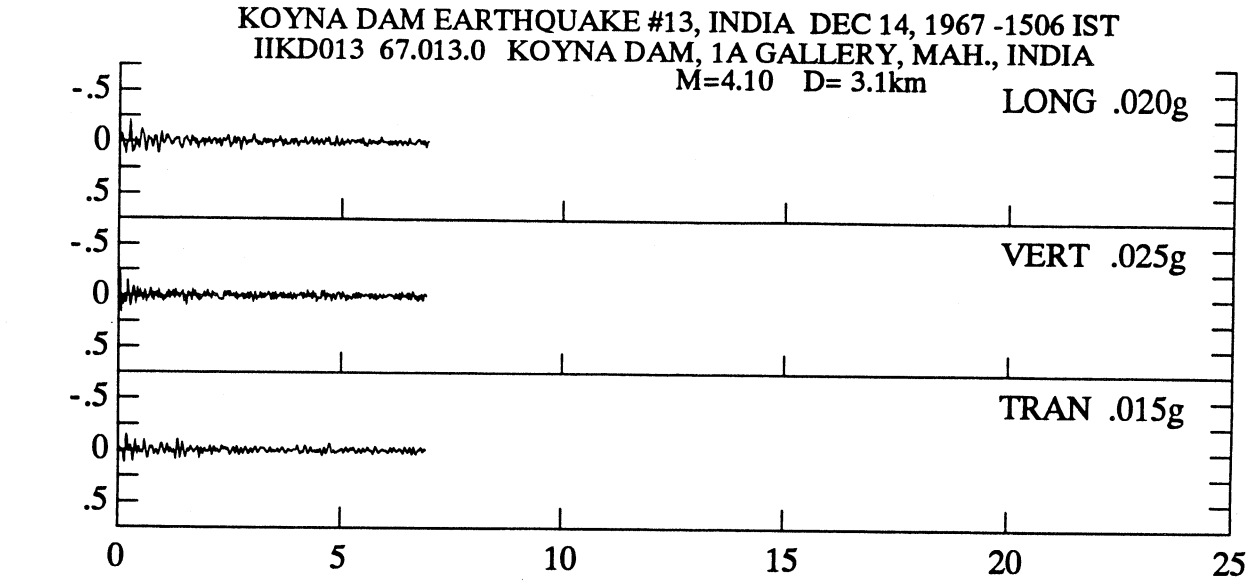
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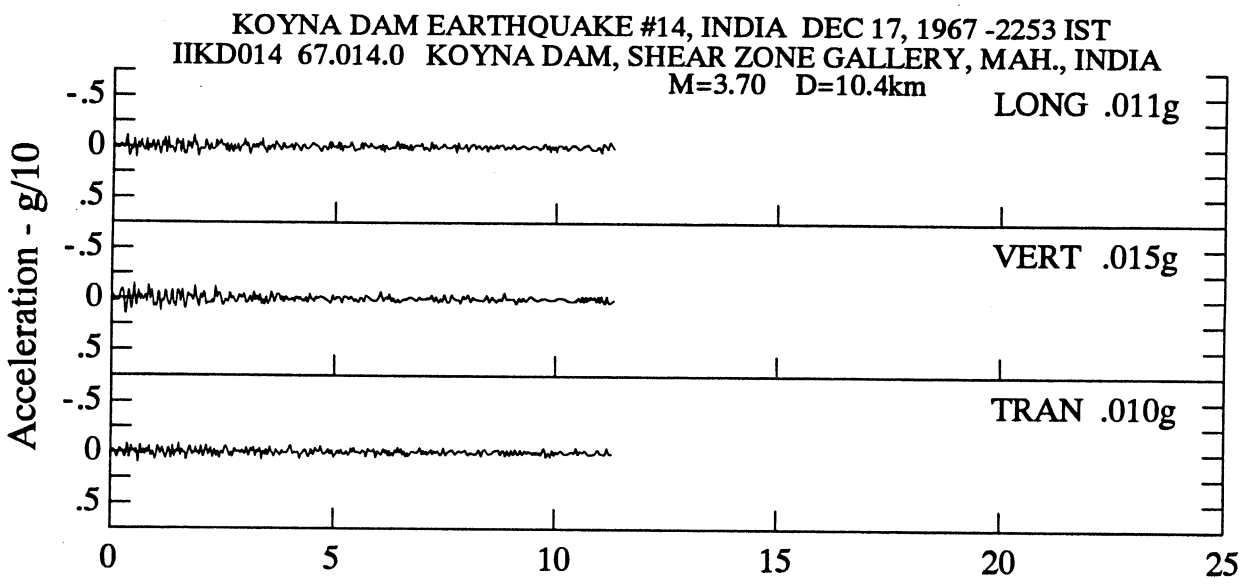
IIKD013 67.013.0 KOYNA DAM, 1A GALLERY, MAH., INDIA
M=4.10 D= 3.1km
LONG .020g
VERT .025g
TRAN .015g
-.5
0
.5
0
5
10
15
20
25


KOYNA DAM EARTHQUAKE #14, INDIA DEC 17, 1967 -2253 IST
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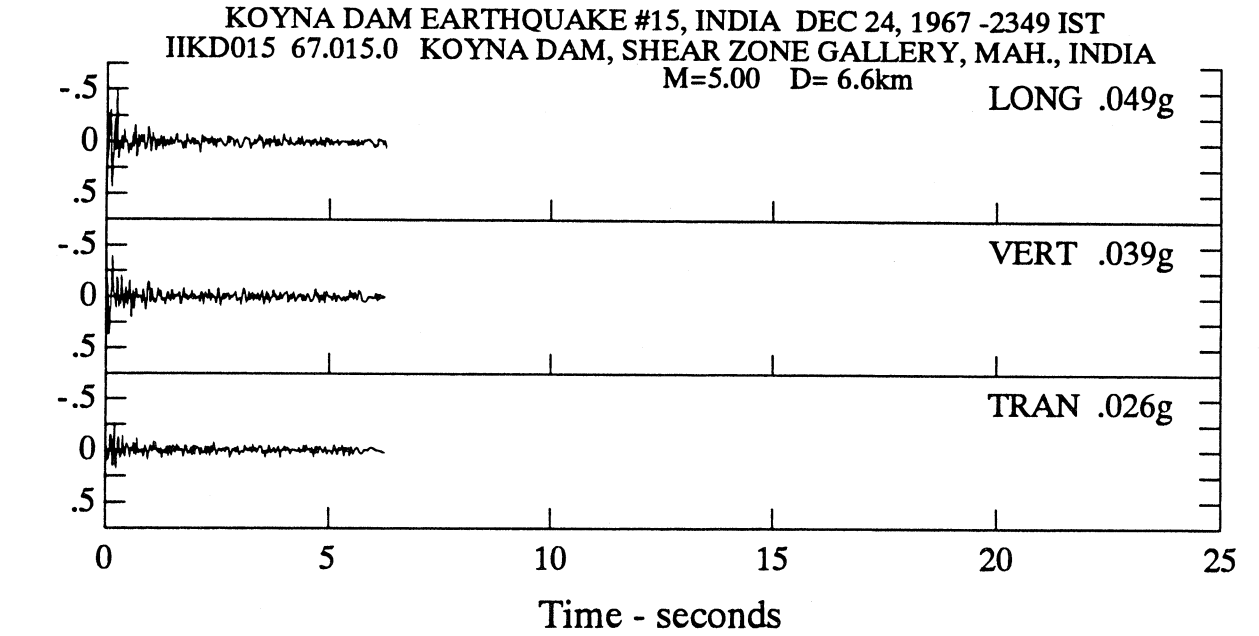
M=3.70 D=10.4km
LONG .011g
VERT .015g
TRAN .010g
Acceleration - g/10
-.5
0
.5
0
5
10
15
20
25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IIKD015 67.015.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA
M=5.00 D= 6.6km
LONG .049g
VERT .039g
TRAN .026g
-.5
0
.5
0
5
10
15
20
25
Time - seconds

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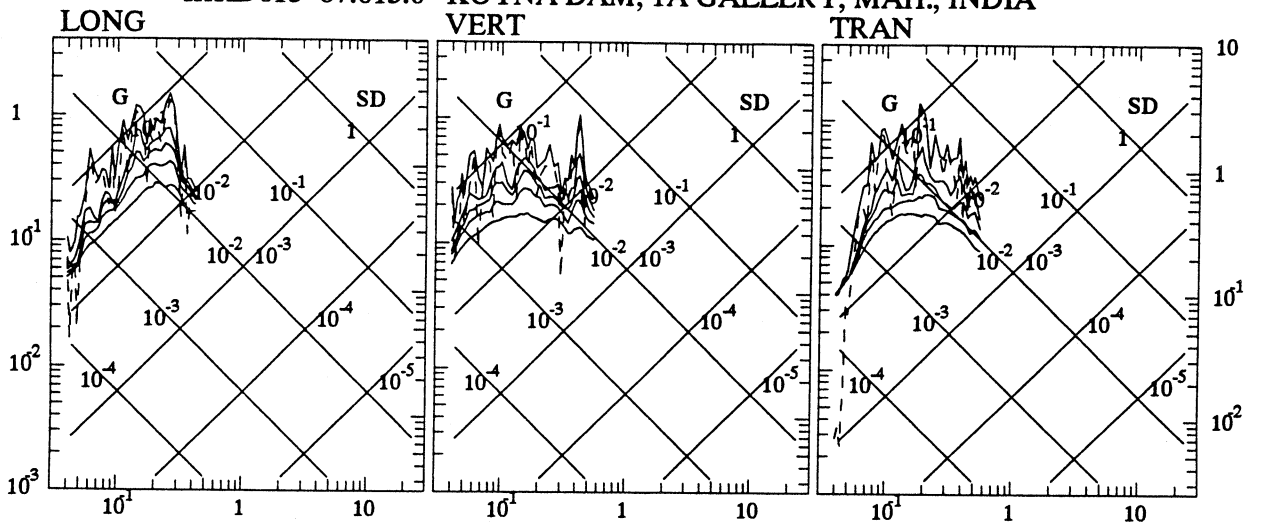

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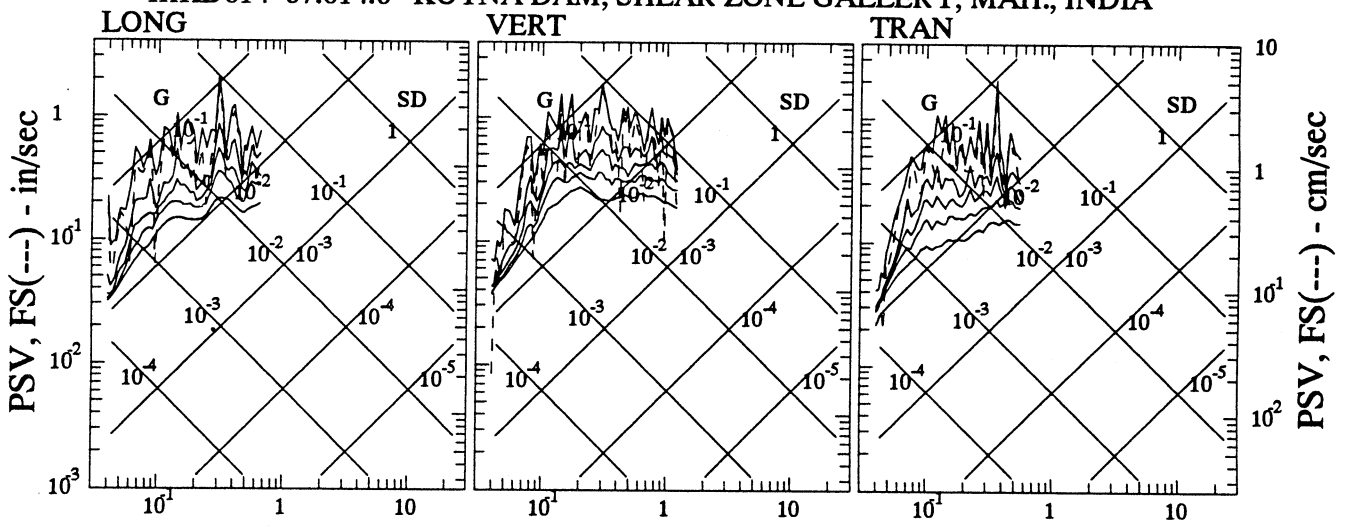
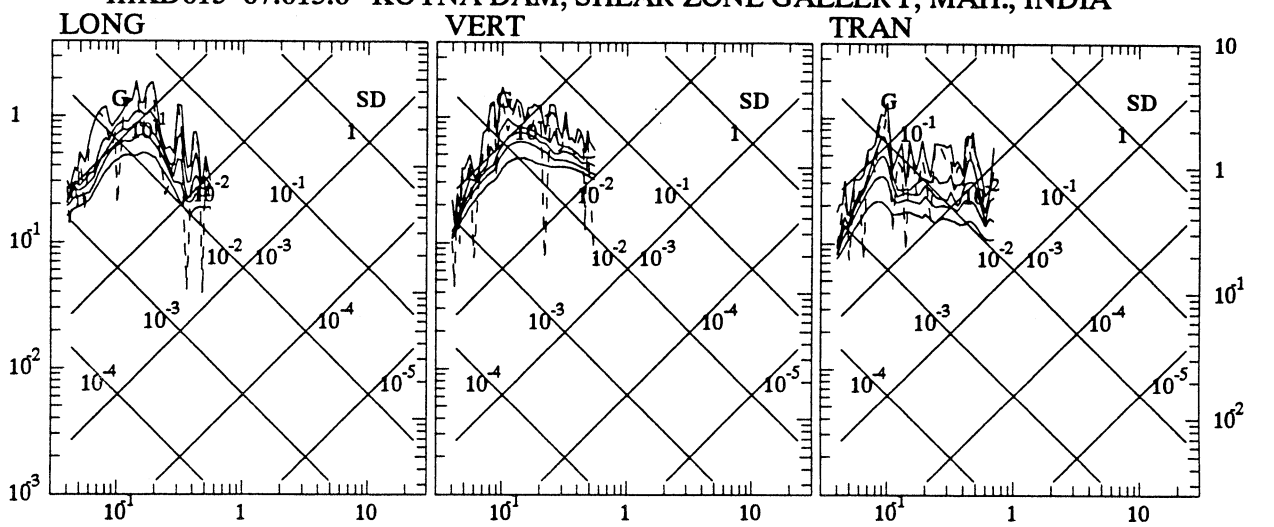
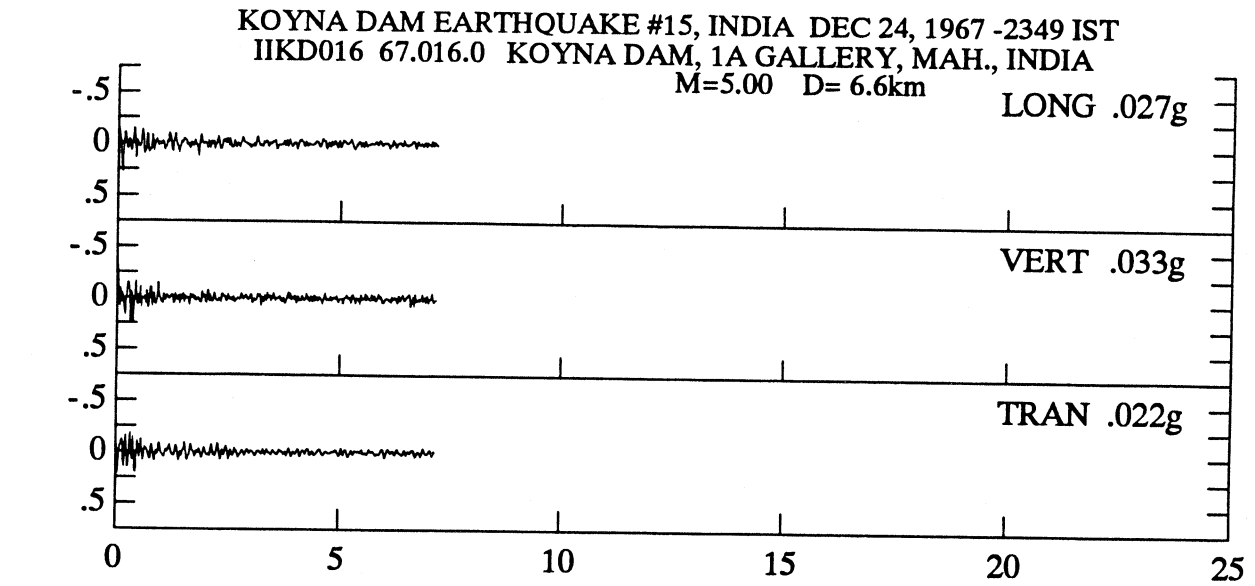
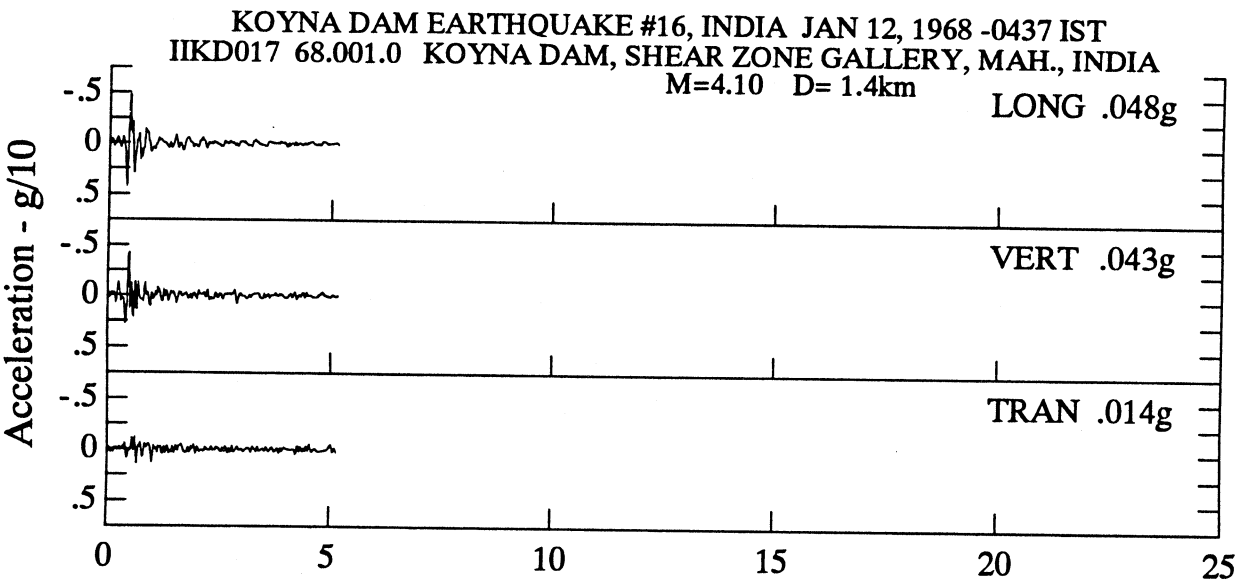


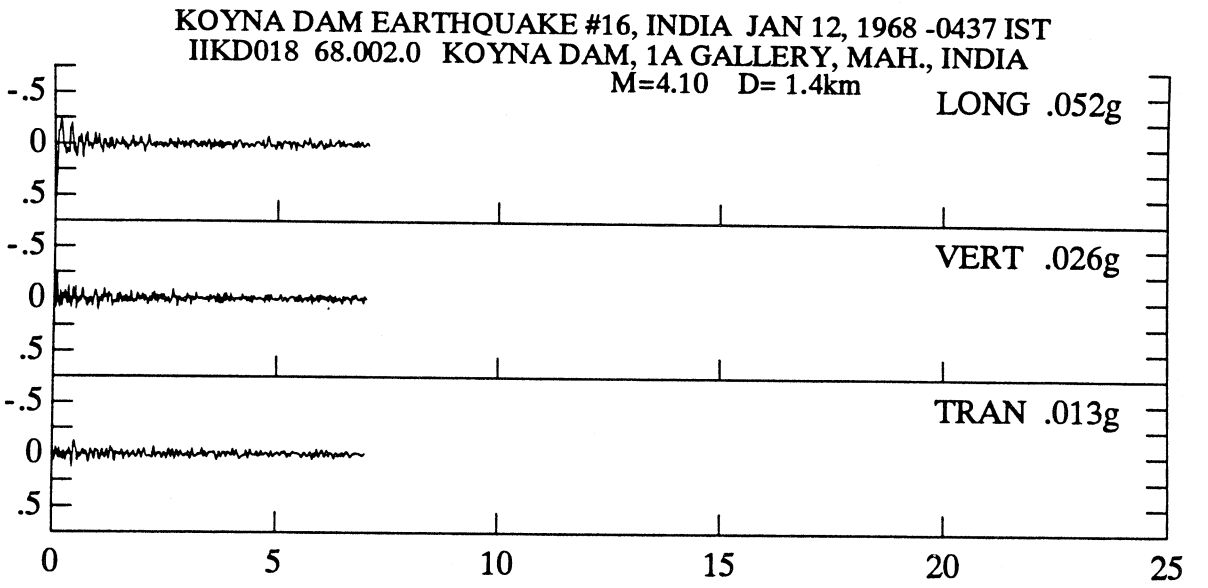
KOYNA DAM EARTHQUAKE #15, INDIA DEC 24, 1967 -2349 IST
IIIKD015 67.015.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA



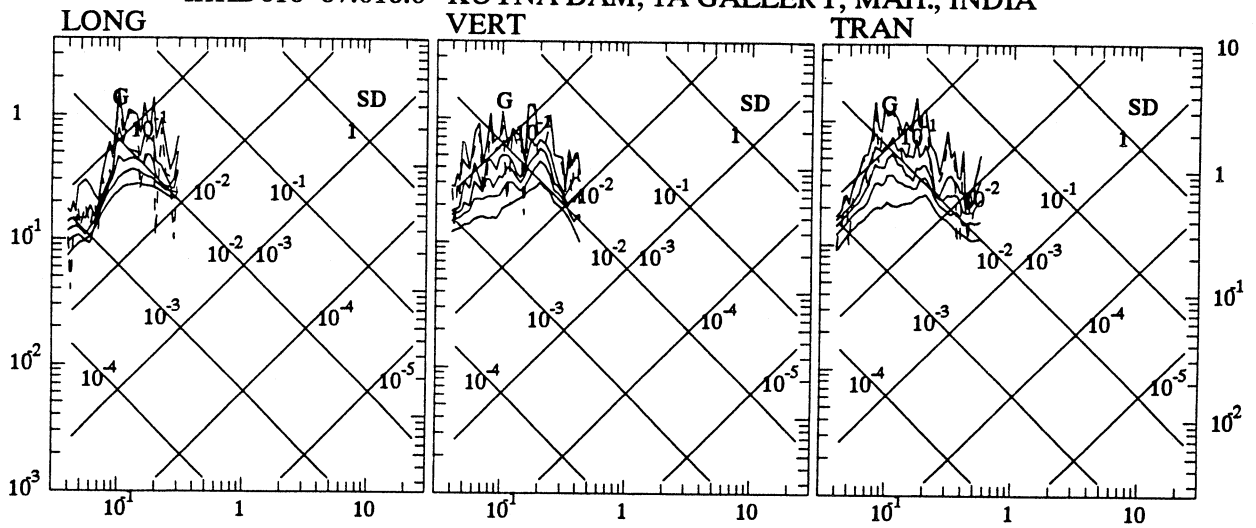
Period - sec


KOYNA DAM EARTHQUAKE #15, INDIA DEC 24, 1967 -2349 IST
IIKD016 67.016.0 KOYNA DAM, 1A GALLERY, MAH., INDIA
M=5.00 D= 6.6km
LONG .027g
VERT .033g
TRAN .022g
-.5
0
.5
0
5
10
15
20
25

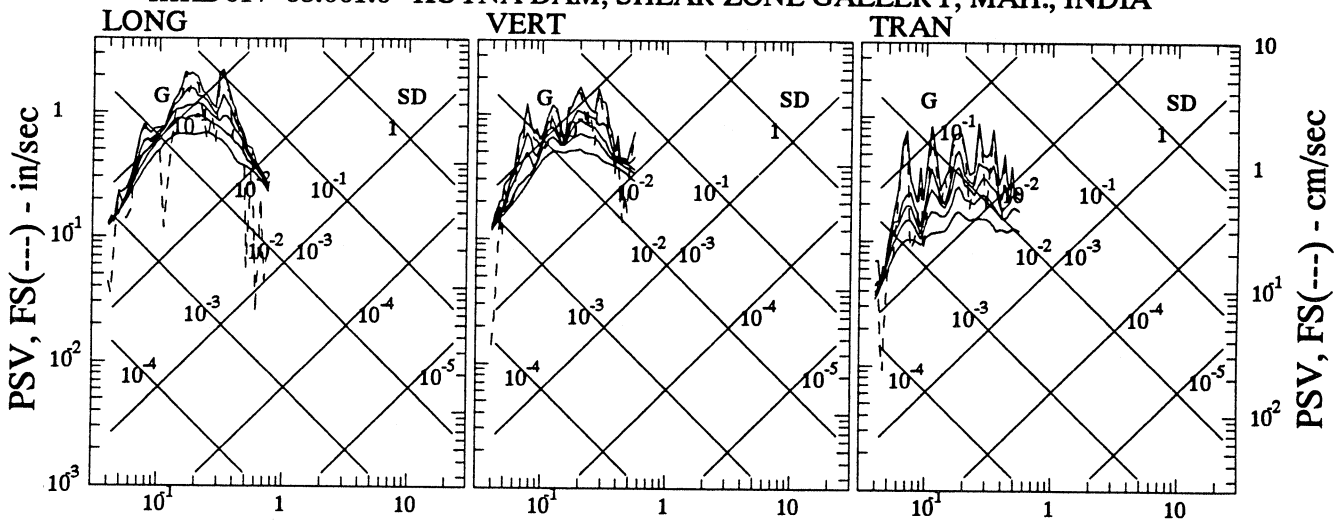

KOYNA DAM EARTHQUAKE #16, INDIA JAN 12, 1968 -0437 IST
IIKD017 68.001.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA
M=4.10 D= 1.4km
LONG .048g
VERT .043g
TRAN .014g
Acceleration - g/10
-.5
0
.5
0
5
10
15
20
25


KOYNA DAM EARTHQUAKE #16, INDIA JAN 12, 1968 -0437 IST
IIKD018 68.002.0 KOYNA DAM, 1A GALLERY, MAH., INDIA
M=4.10 D= 1.4km
LONG .052g
VERT .026g
TRAN .013g
-.5
0
.5
0
5
10
15
20
25
Time - seconds

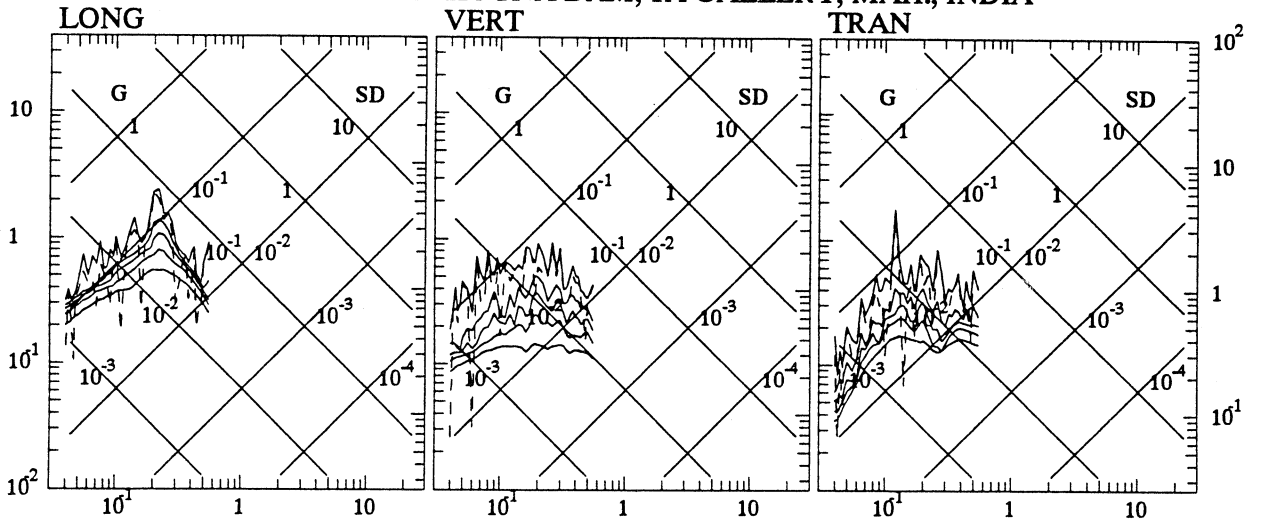
KOYNA DAM EARTHQUAKE #15, INDIA DEC 24, 1967 -2349 IST
IIIKD016 67.016.0 KOYNA DAM, 1A GALLERY, MAH., INDIA



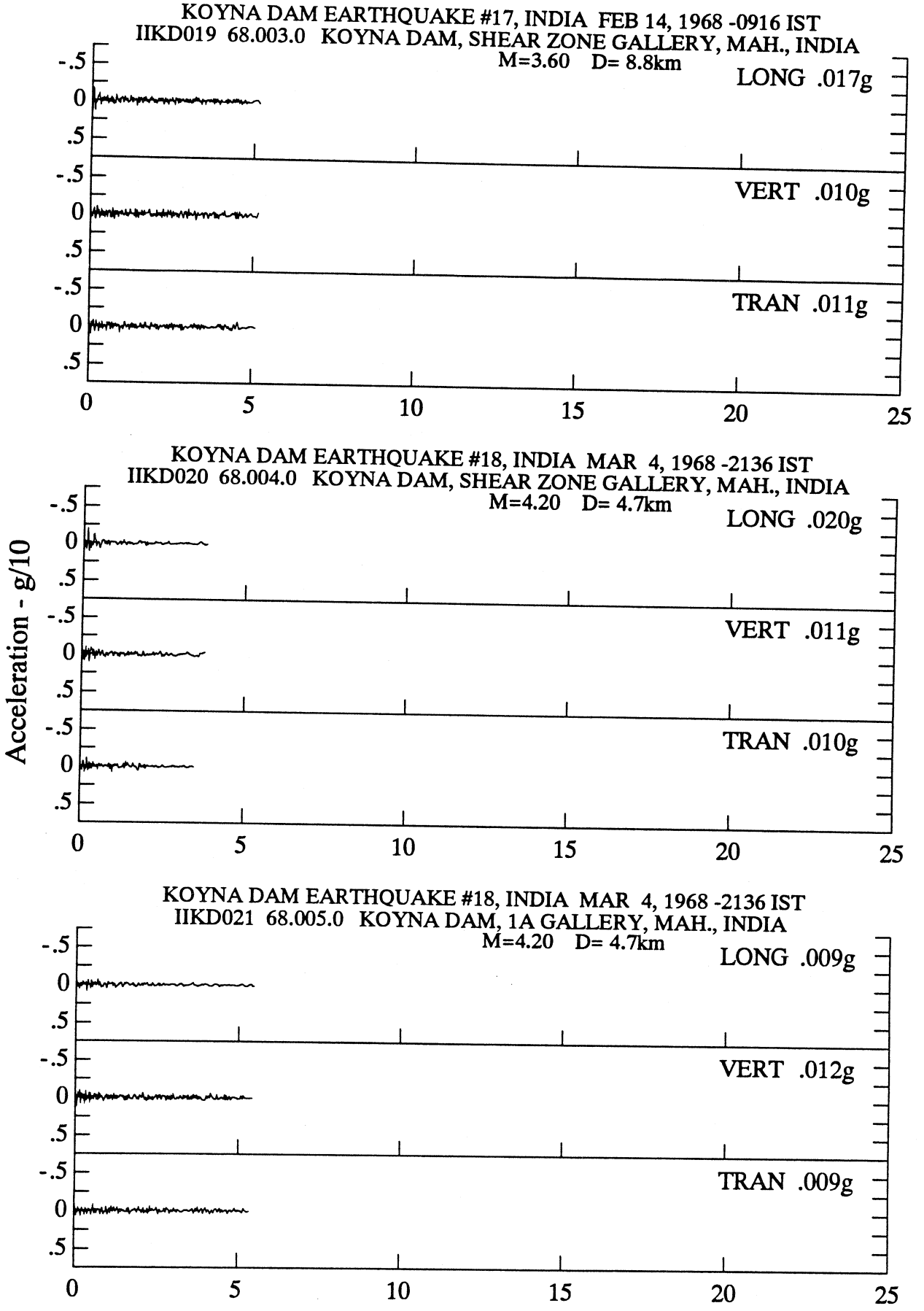
KOYNA DAM EARTHQUAKE #16, INDIA JAN 12, 1968 -0437 IST
IIIKD017 68.001.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA



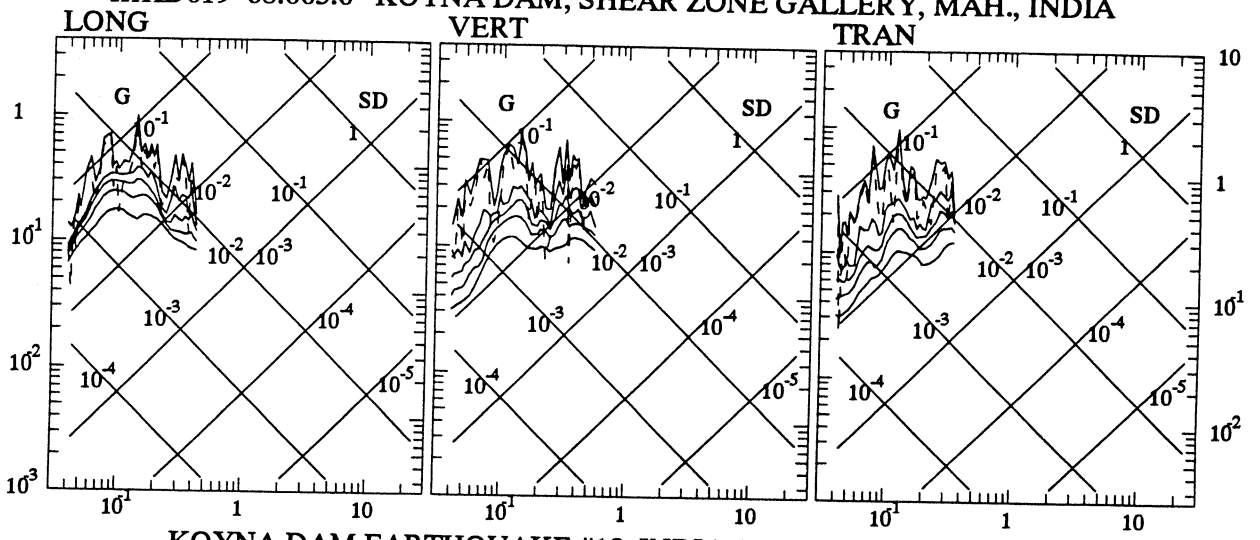
KOYNA DAM EARTHQUAKE #16, INDIA JAN 12, 1968 -0437 IST
IIIKD018 68.002.0 KOYNA DAM, 1A GALLERY, MAH., INDIA



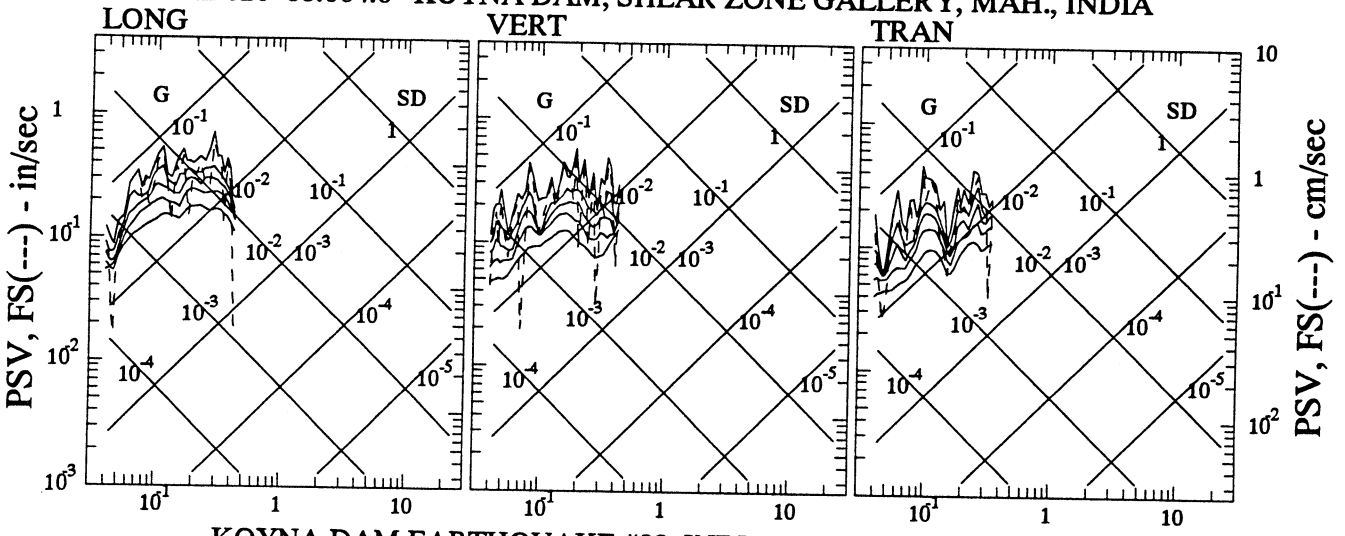
Period - sec


KOYNA DAM EARTHQUAKE #17, INDIA FEB 14, 1968 -0916 IST
IIKD019 68.003.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA
M=3.60 D= 8.8km
LONG .017g
VERT .010g
TRAN .011g
KOYNA DAM EARTHQUAKE #18, INDIA MAR 4, 1968 -2136 IST
IIKD020 68.004.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA
M=4.20 D= 4.7km
LONG .020g
VERT .011g
TRAN .010g
KOYNA DAM EARTHQUAKE #18, INDIA MAR 4, 1968 -2136 IST
IIKD021 68.005.0 KOYNA DAM, 1A GALLERY, MAH., INDIA
M=4.20 D= 4.7km
LONG .009g
VERT .012g
TRAN .009g
-.5
0
.5
0
5
10
15
20
25
Acceleration - g/10
Time - seconds

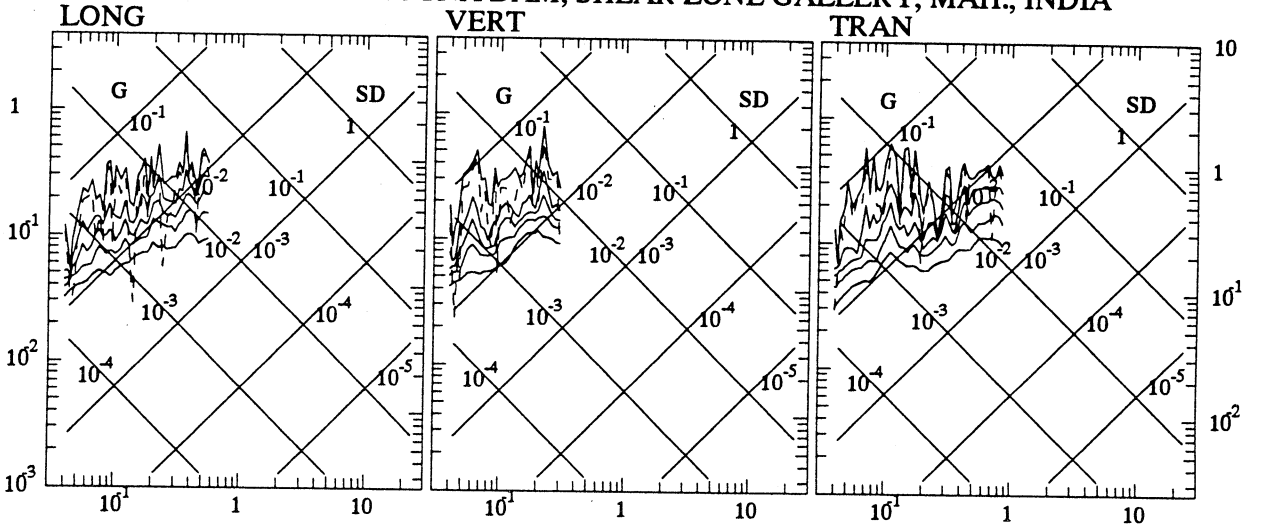
KOYNA DAM EARTHQUAKE #17, INDIA FEB 14, 1968 -0916 IST
IIIKD019 68.003.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA



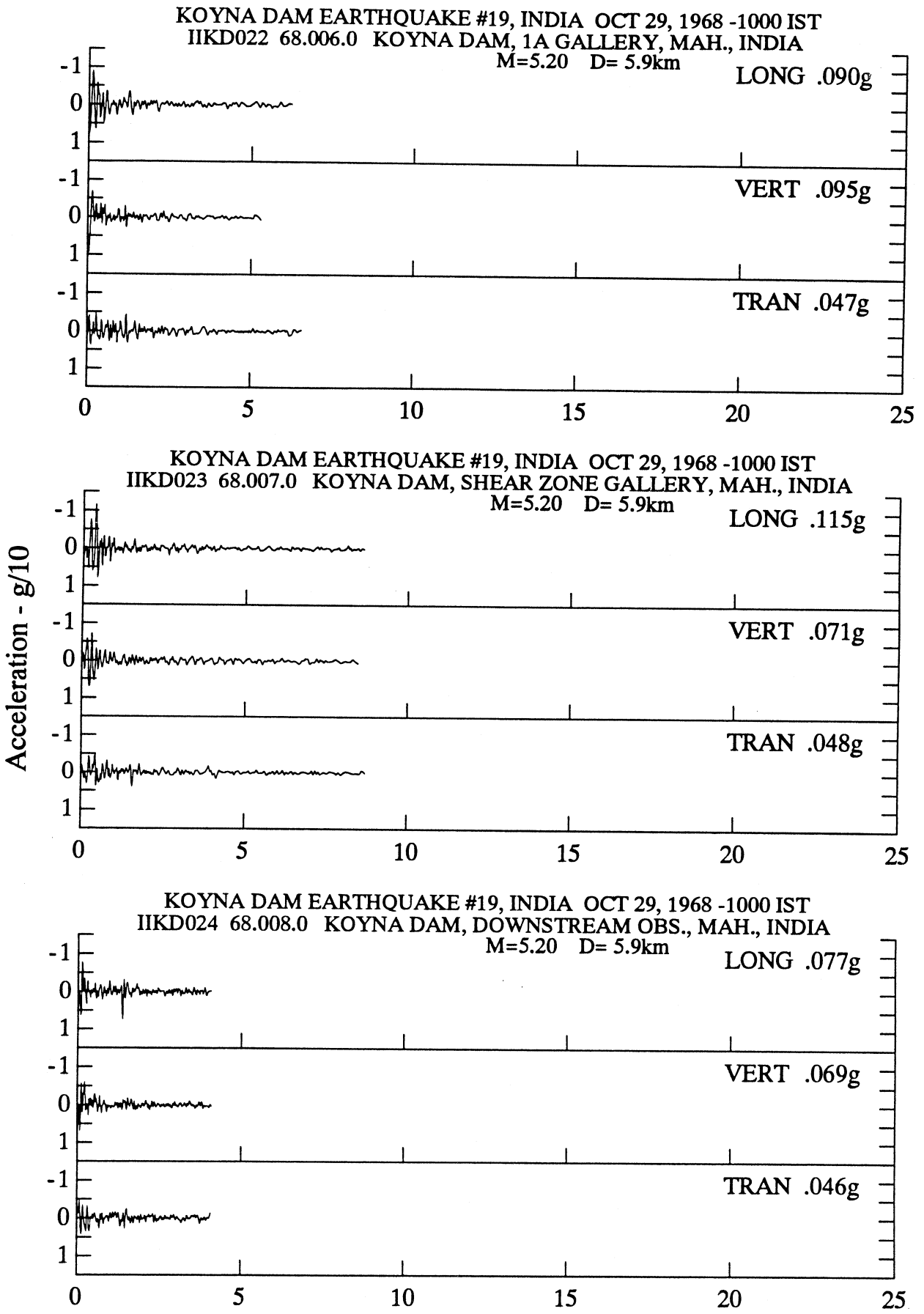
KOYNA DAM EARTHQUAKE #18, INDIA MAR 4, 1968 -2136 IST
IIIKD020 68.004.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA



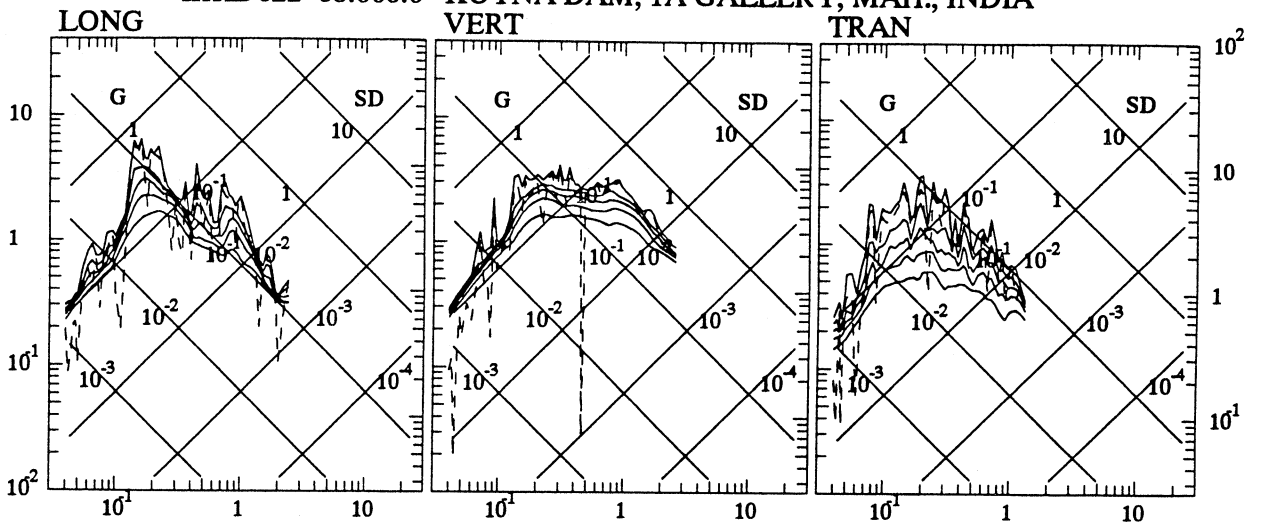
KOYNA DAM EARTHQUAKE #02, INDIA SEP 13, 1967 -0623 IST
IIIKD021 68.005.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA



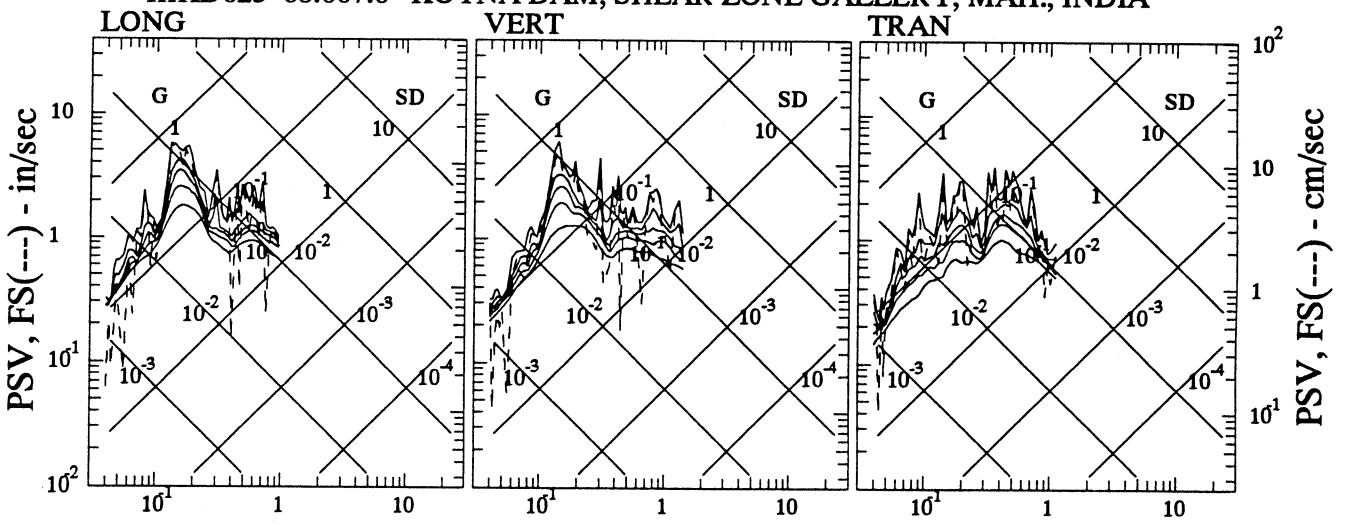
Period - sec


KOYNA DAM EARTHQUAKE #19, INDIA OCT 29, 1968 -1000 IST
IIKD022 68.006.0 KOYNA DAM, 1A GALLERY, MAH., INDIA
M=5.20 D= 5.9km
LONG .090g
VERT .095g
TRAN .047g
KOYNA DAM EARTHQUAKE #19, INDIA OCT 29, 1968 -1000 IST
IIKD023 68.007.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA
M=5.20 D= 5.9km
LONG .115g
VERT .071g
TRAN .048g
KOYNA DAM EARTHQUAKE #19, INDIA OCT 29, 1968 -1000 IST
IIKD024 68.008.0 KOYNA DAM, DOWNSTREAM OBS., MAH., INDIA
M=5.20 D= 5.9km
LONG .077g
VERT .069g
TRAN .046g
-1
0
1
0
5
10
15
20
25
Acceleration - g/10
Time - seconds

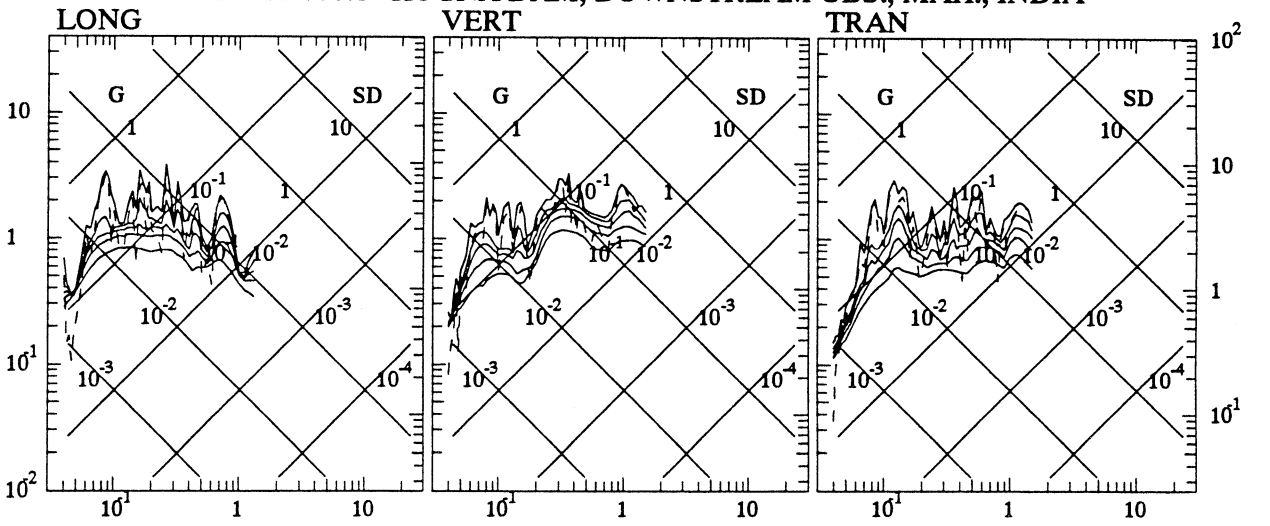
KOYNA DAM EARTHQUAKE #19, INDIA OCT 29, 1968 -1000 IST
IIIKD022 68.006.0 KOYNA DAM, 1A GALLERY, MAH., INDIA



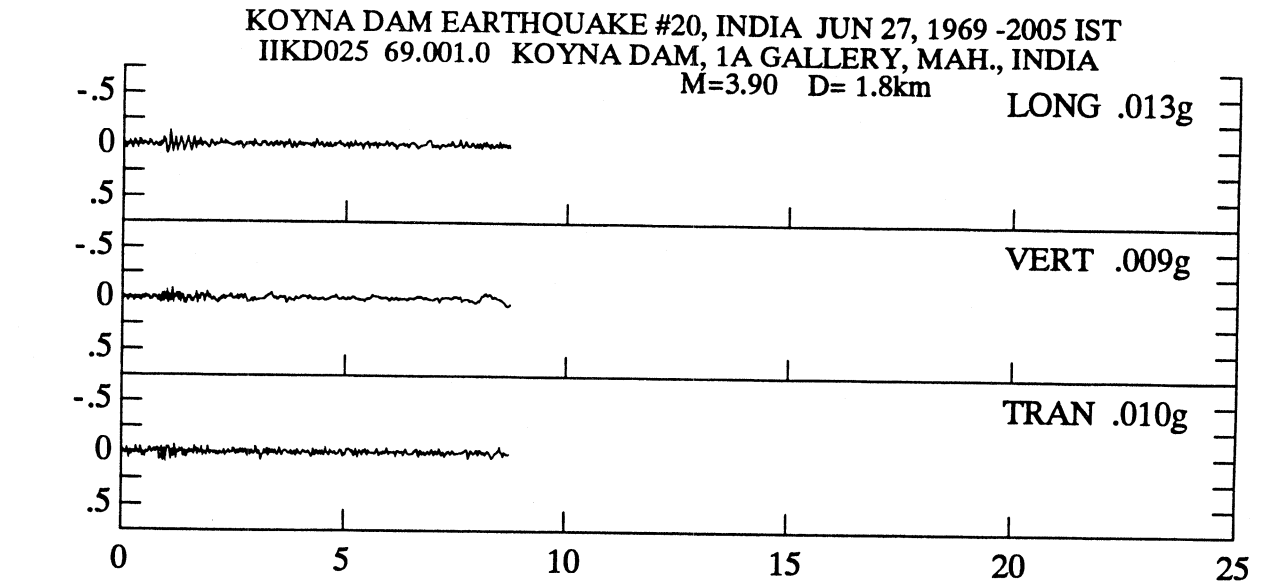
KOYNA DAM EARTHQUAKE #19, INDIA OCT 29, 1968 -1000 IST
IIIKD023 68.007.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA

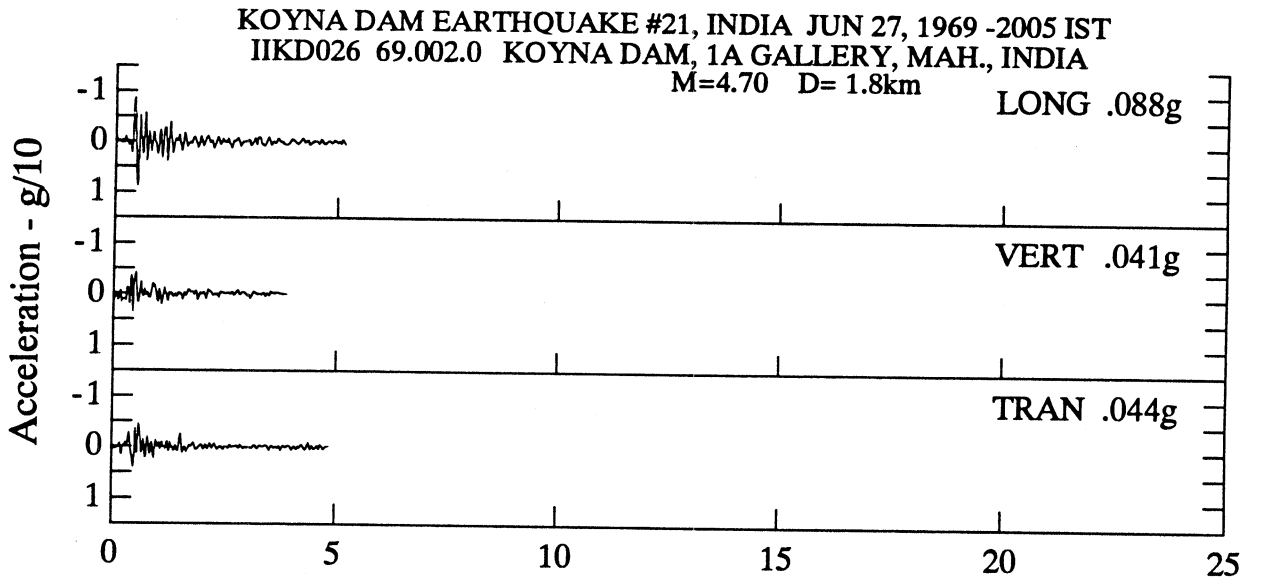


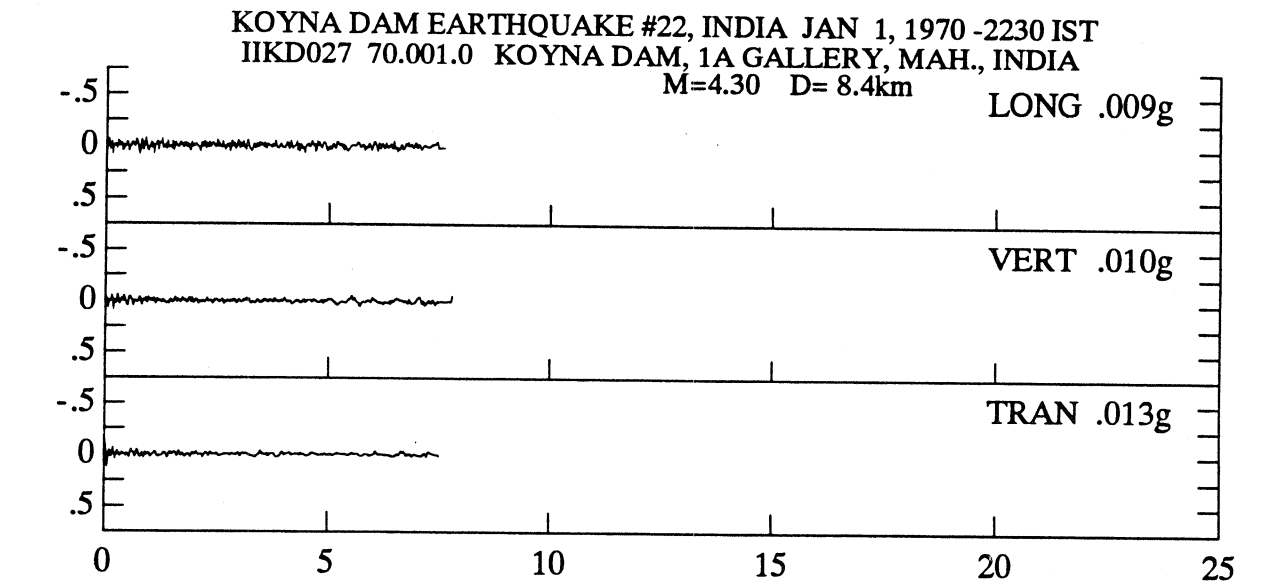
KOYNA DAM EARTHQUAKE #19, INDIA OCT 29, 1968 -1000 IST
IIIKD024 68.008.0 KOYNA DAM, DOWNSTREAM OBS., MAH., INDIA



Period - sec



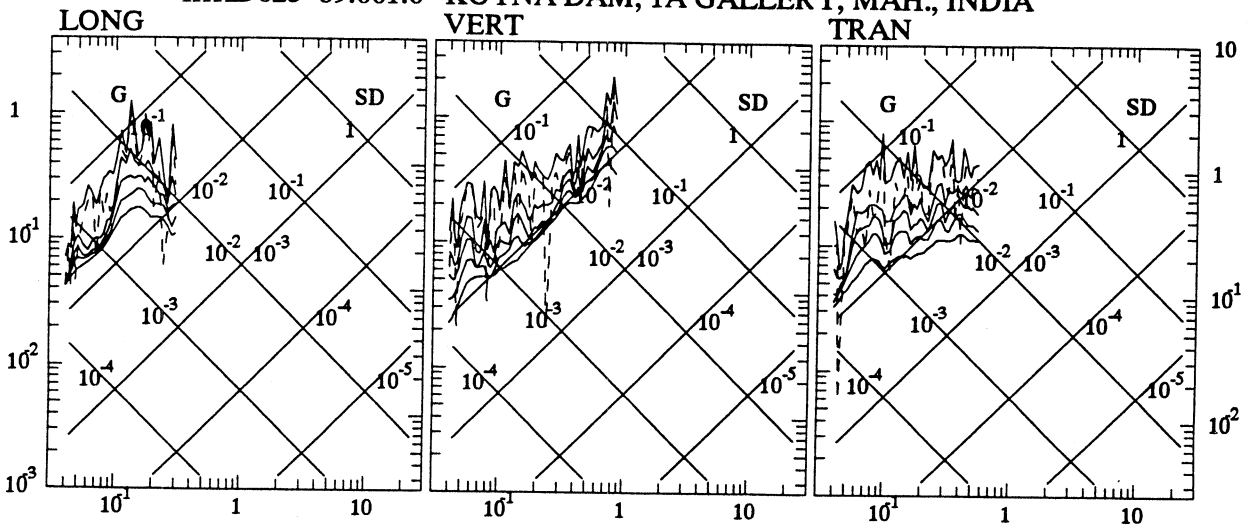




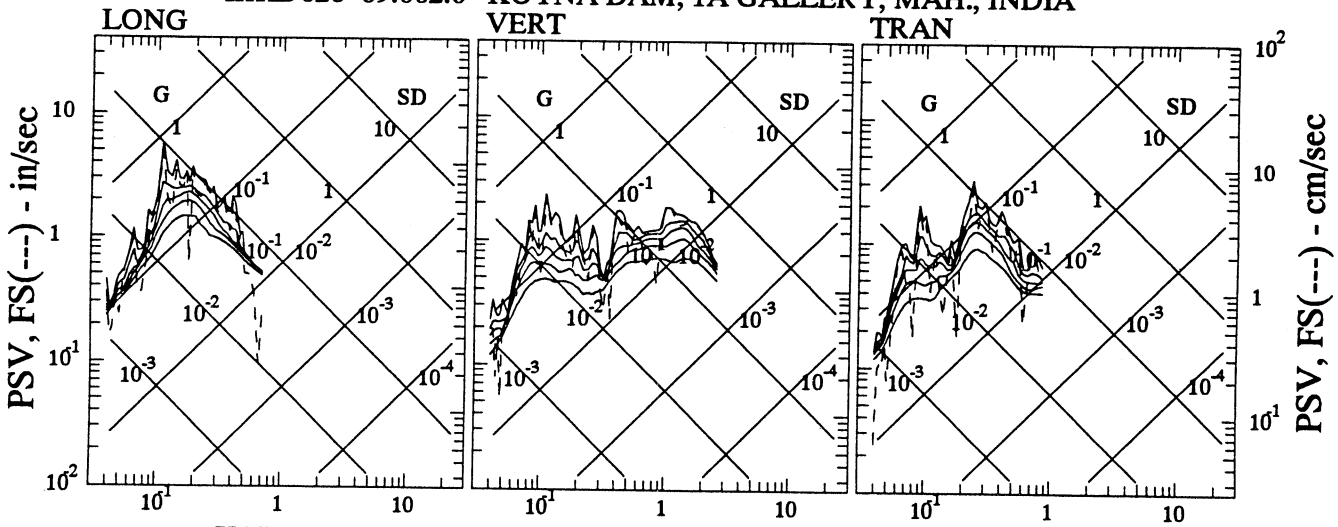
Acceleration - g/10

Time - seconds

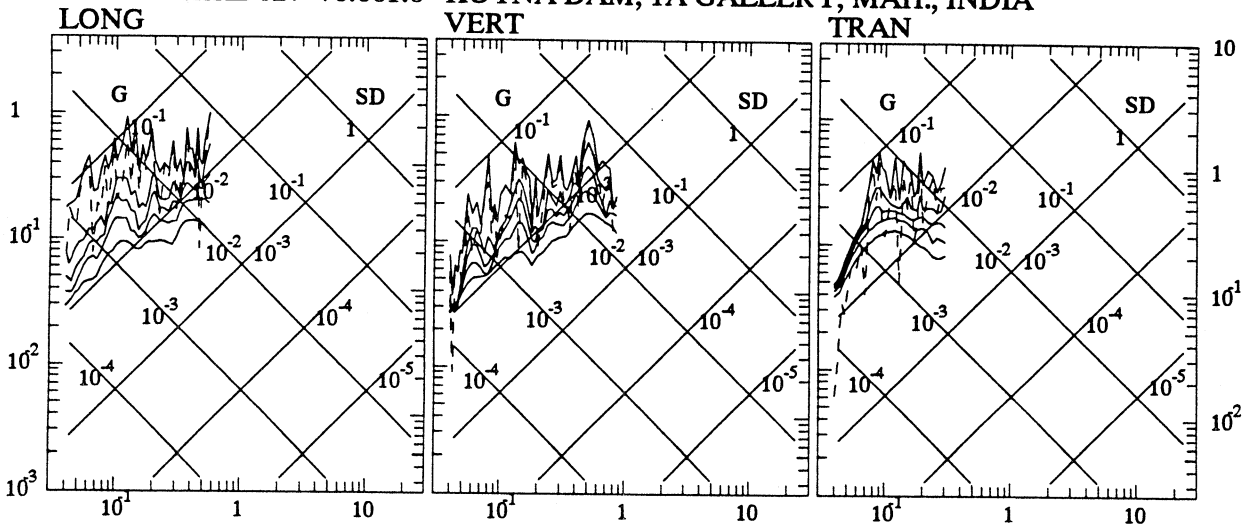
KOYNA DAM EARTHQUAKE #20, INDIA JUN 27, 1969 -2005 IST
IIIKD025 69.001.0 KOYNA DAM, 1A GALLERY, MAH., INDIA



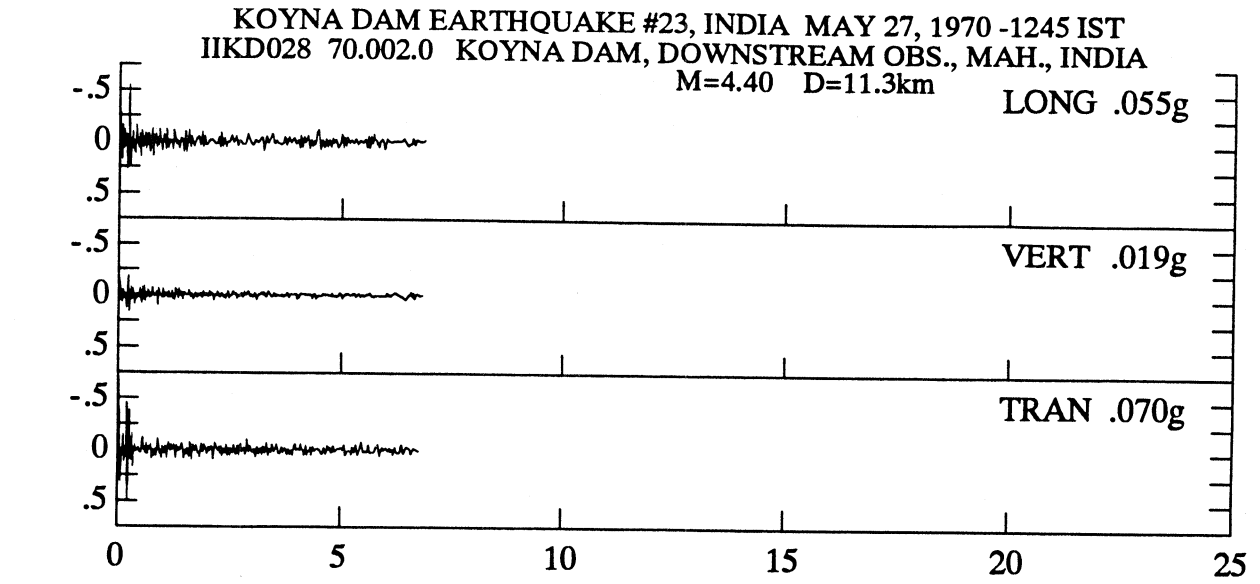
KOYNA DAM EARTHQUAKE #21, INDIA JUN 27, 1969 -2005 IST
IIIKD026 69.002.0 KOYNA DAM, 1A GALLERY, MAH., INDIA

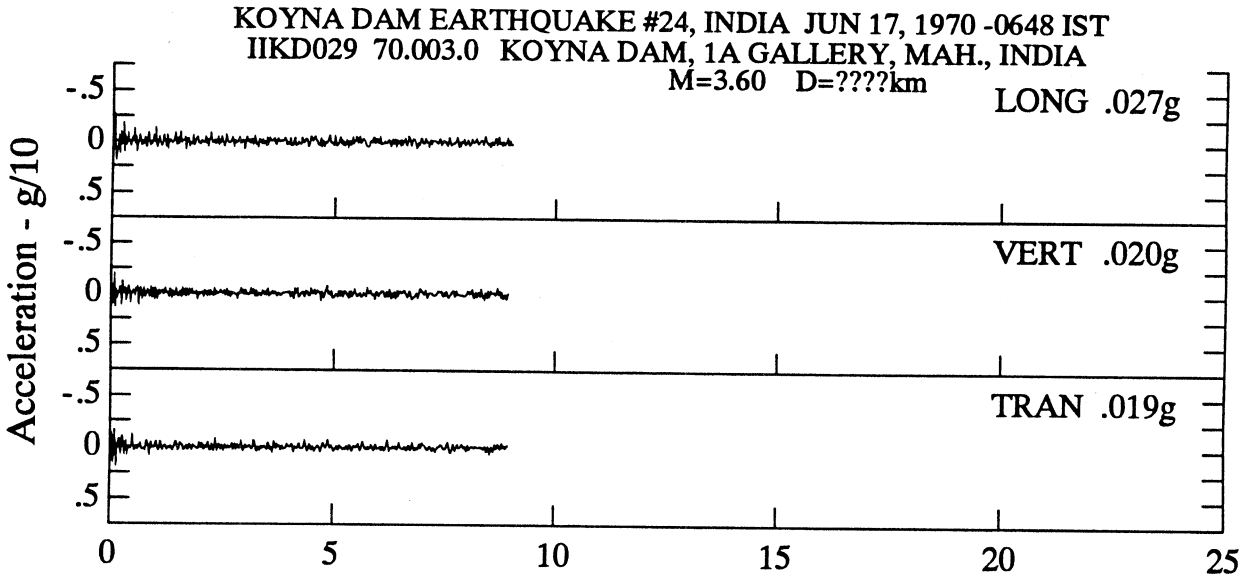


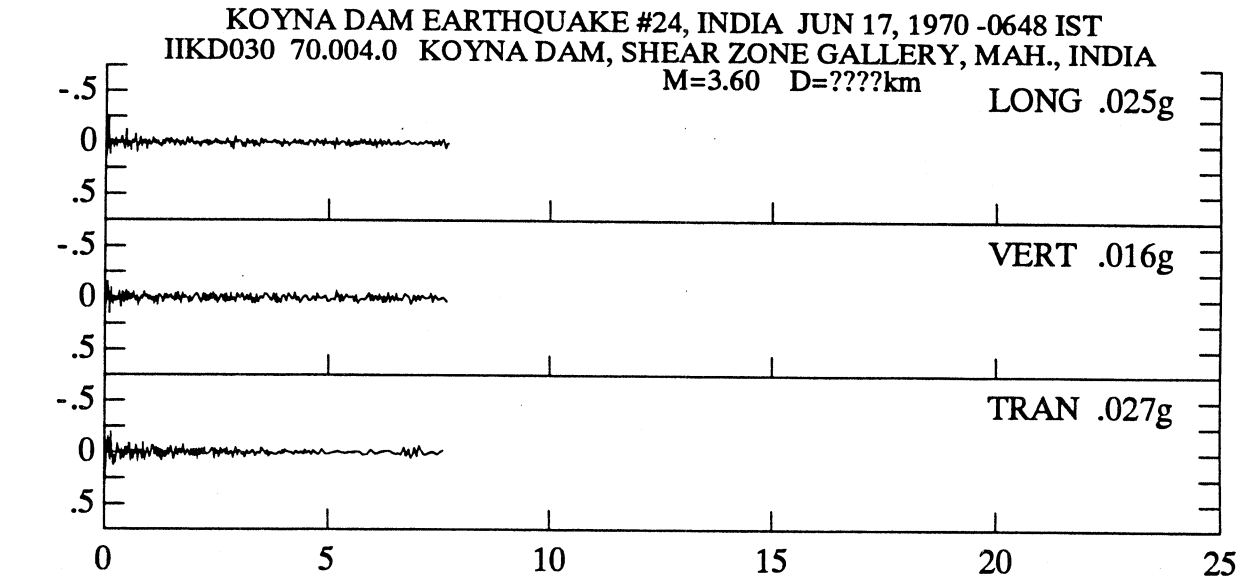
KOYNA DAM EARTHQUAKE #22, INDIA JAN 1, 1970 -2230 IST
IIIKD027 70.001.0 KOYNA DAM, 1A GALLERY, MAH., INDIA



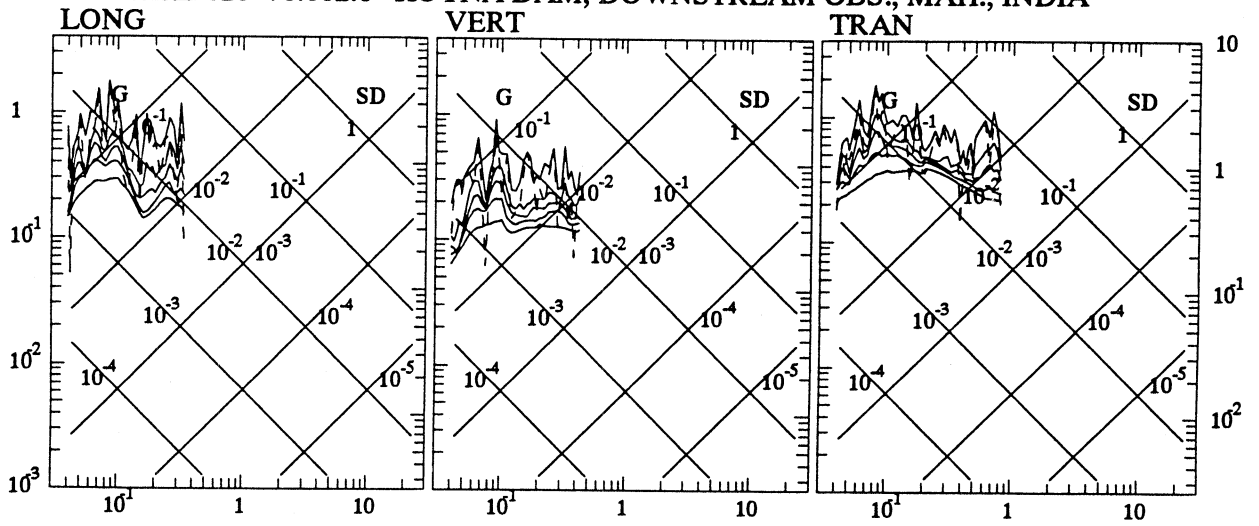
Period - sec


KOYNA DAM EARTHQUAKE #23, INDIA MAY 27, 1970 -1245 IST
IIKD028 70.002.0 KOYNA DAM, DOWNSTREAM OBS., MAH., INDIA
M=4.40 D=11.3km
LONG .055g
VERT .019g
TRAN .070g
-.5
0
.5
0
5
10
15
20
25

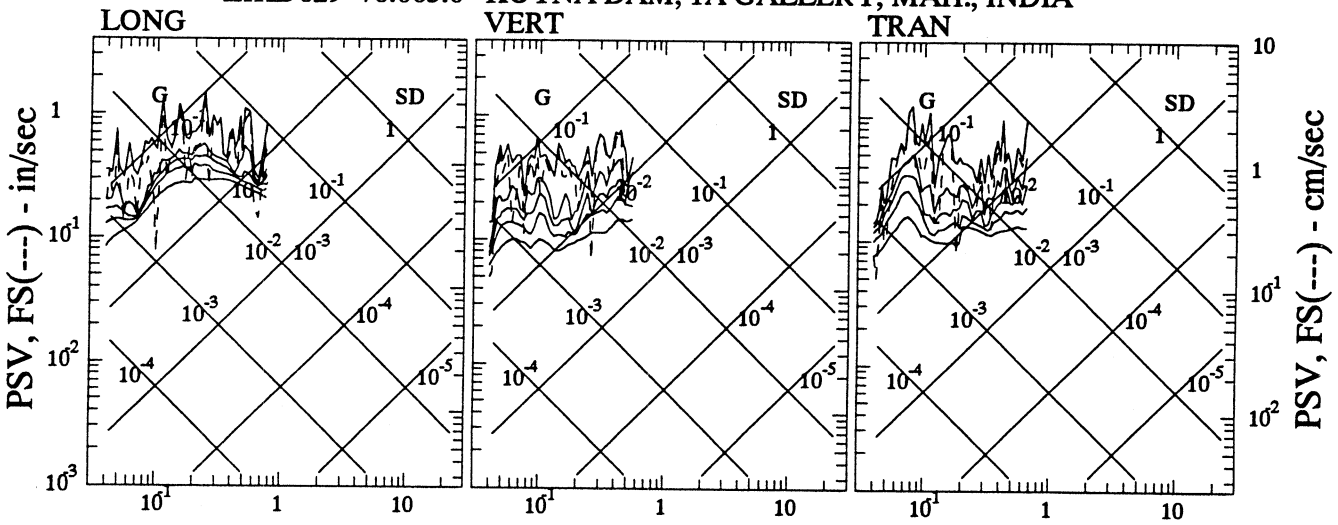

KOYNA DAM EARTHQUAKE #24, INDIA JUN 17, 1970 -0648 IST
IIKD029 70.003.0 KOYNA DAM, 1A GALLERY, MAH., INDIA
M=3.60 D=????km
LONG .027g
VERT .020g
TRAN .019g
Acceleration - g/10
-.5
0
.5
0
5
10
15
20
25


KOYNA DAM EARTHQUAKE #24, INDIA JUN 17, 1970 -0648 IST
IIKD030 70.004.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA
M=3.60 D=????km
LONG .025g
VERT .016g
TRAN .027g
-.5
0
.5
0
5
10
15
20
25
Time - seconds

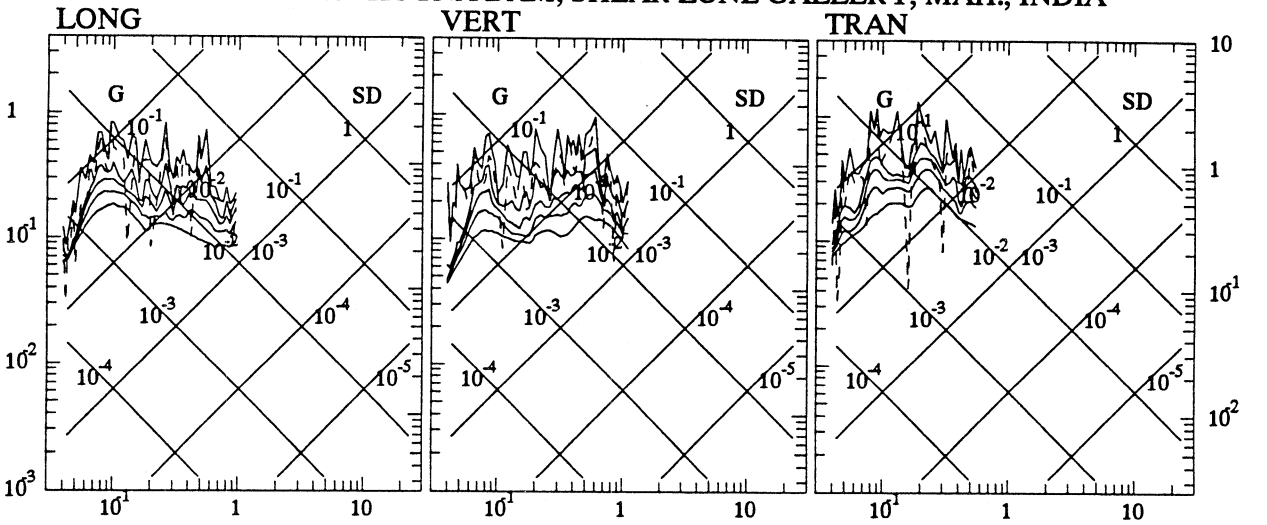
KOYNA DAM EARTHQUAKE #23, INDIA MAY 27, 1970 -1245 IST
IIIKD028 70.002.0 KOYNA DAM, DOWNSTREAM OBS., MAH., INDIA



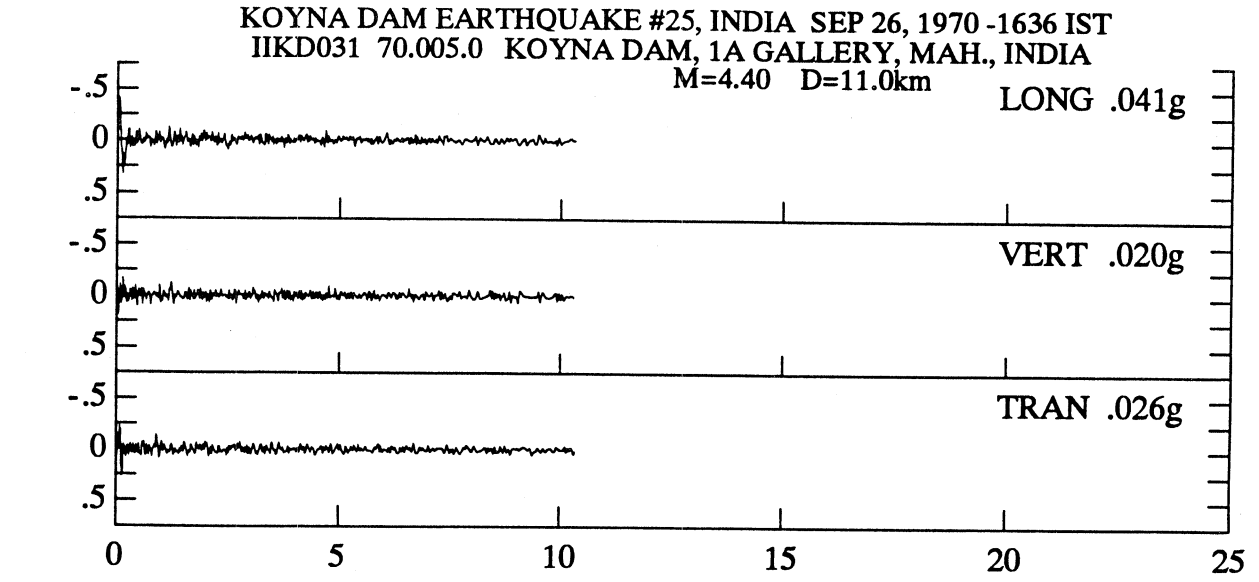
KOYNA DAM EARTHQUAKE #24, INDIA JUN 17, 1970 -0648 IST
IIIKD029 70.003.0 KOYNA DAM, 1A GALLERY, MAH., INDIA

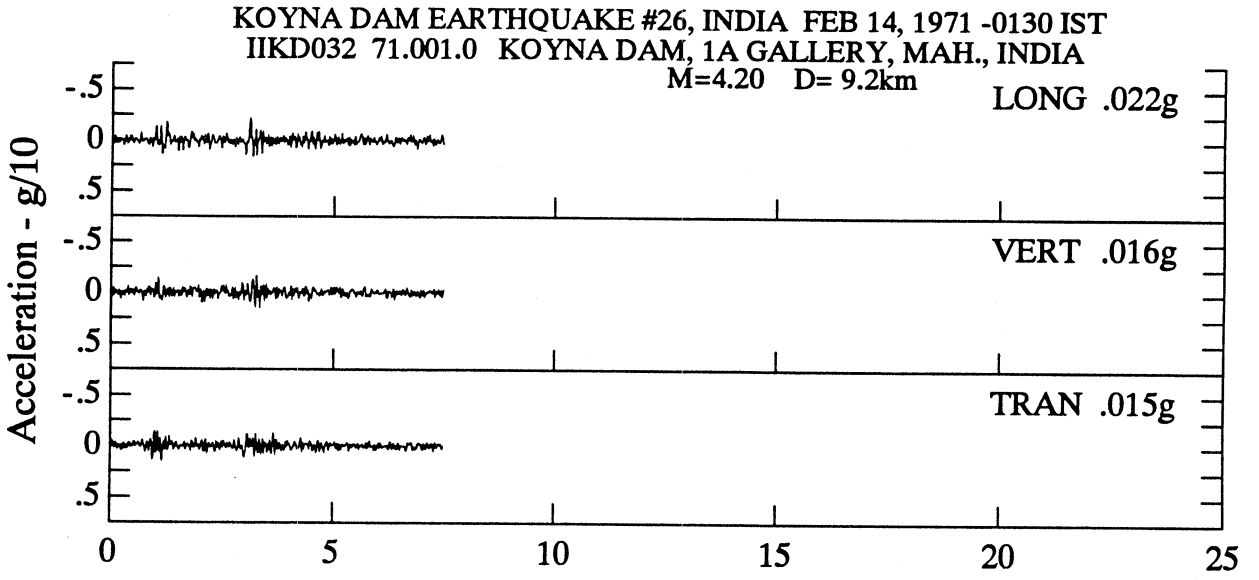


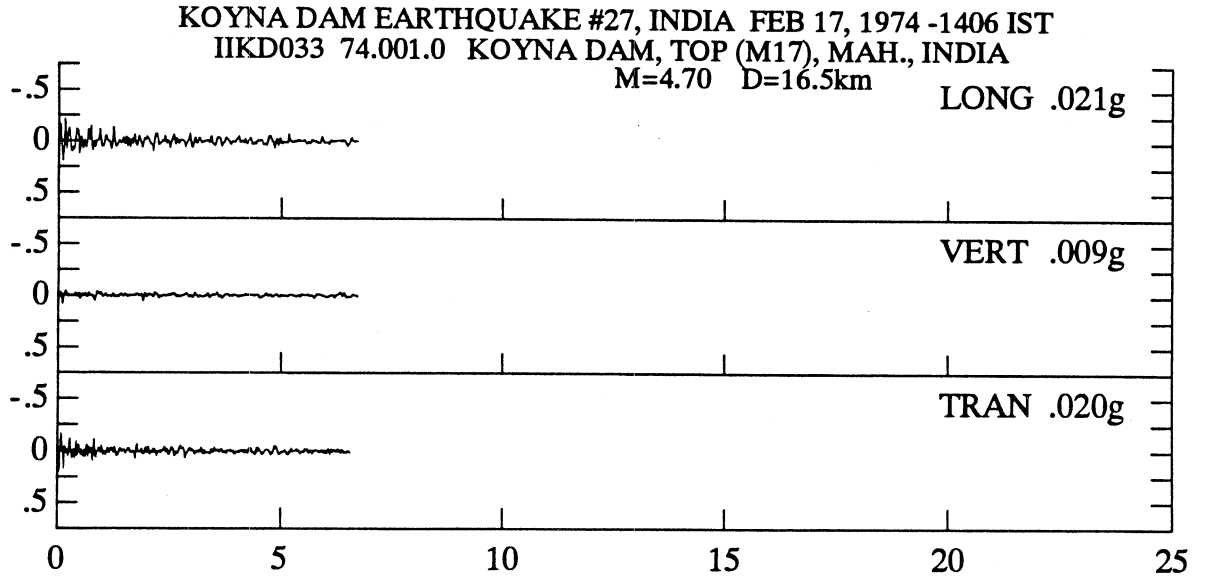
KOYNA DAM EARTHQUAKE #24, INDIA JUN 17, 1970 -0648 IST
IIIKD030 70.004.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA



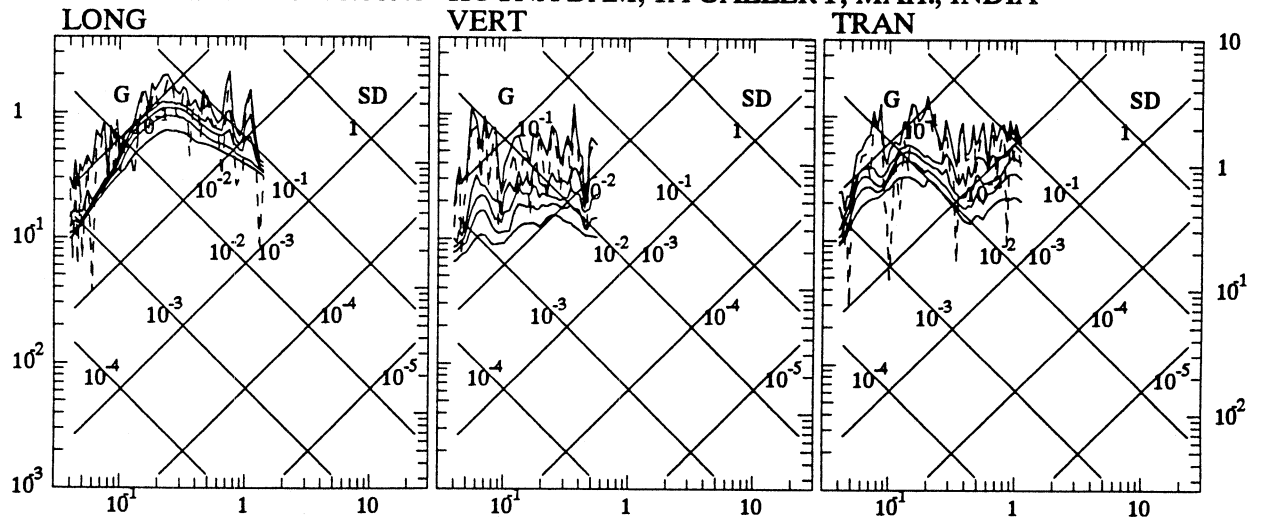
Period - sec


KOYNA DAM EARTHQUAKE #25, INDIA SEP 26, 1970 -1636 IST
IIKD031 70.005.0 KOYNA DAM, 1A GALLERY, MAH., INDIA
M=4.40 D=11.0km
LONG .041g
VERT .020g
TRAN .026g
-.5
0
.5
0
5
10
15
20
25

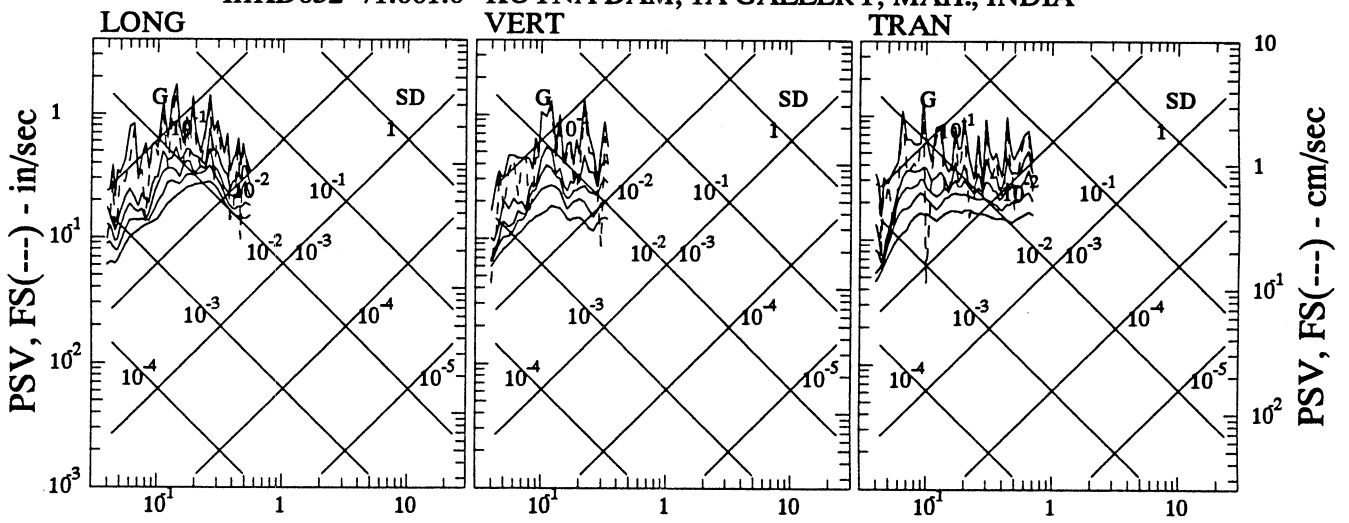

KOYNA DAM EARTHQUAKE #26, INDIA FEB 14, 1971 -0130 IST
IIKD032 71.001.0 KOYNA DAM, 1A GALLERY, MAH., INDIA
M=4.20 D= 9.2km
LONG .022g
VERT .016g
TRAN .015g
Acceleration - g/10
-.5
0
.5
0
5
10
15
20
25


KOYNA DAM EARTHQUAKE #27, INDIA FEB 17, 1974 -1406 IST
IIKD033 74.001.0 KOYNA DAM, TOP (M17), MAH., INDIA
M=4.70 D=16.5km
LONG .021g
VERT .009g
TRAN .020g
-.5
0
.5
0
5
10
15
20
25
Time - seconds

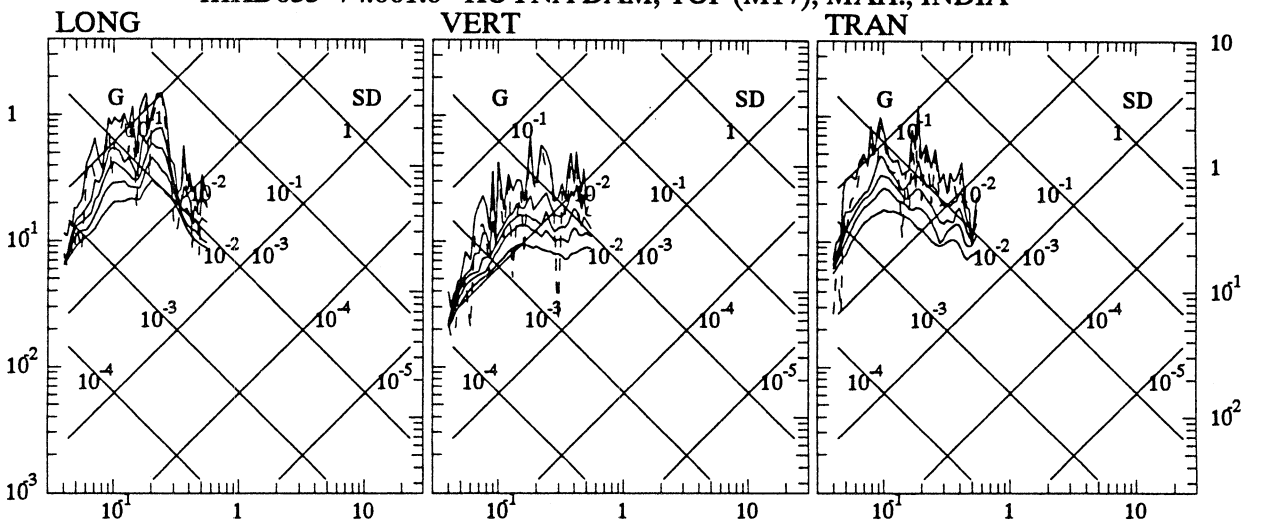
KOYNA DAM EARTHQUAKE #25, INDIA SEP 26, 1970 -1636 IST
IIIKD031 70.005.0 KOYNA DAM, 1A GALLERY, MAH., INDIA



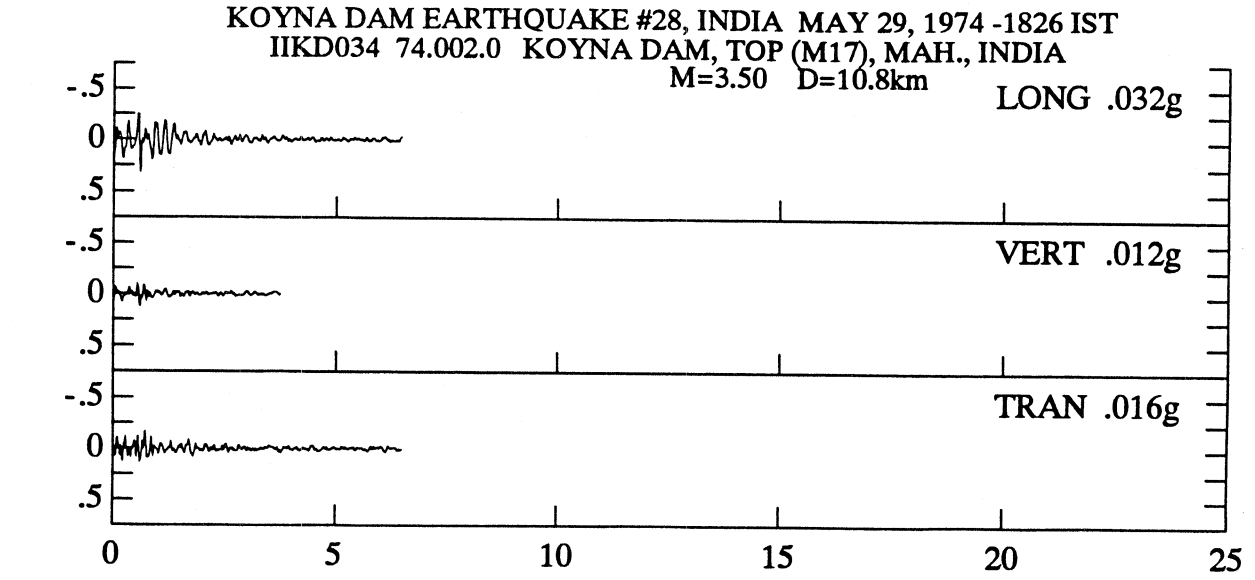
KOYNA DAM EARTHQUAKE #26, INDIA FEB 14, 1971 -0130 IST
IIIKD032 71.001.0 KOYNA DAM, 1A GALLERY, MAH., INDIA

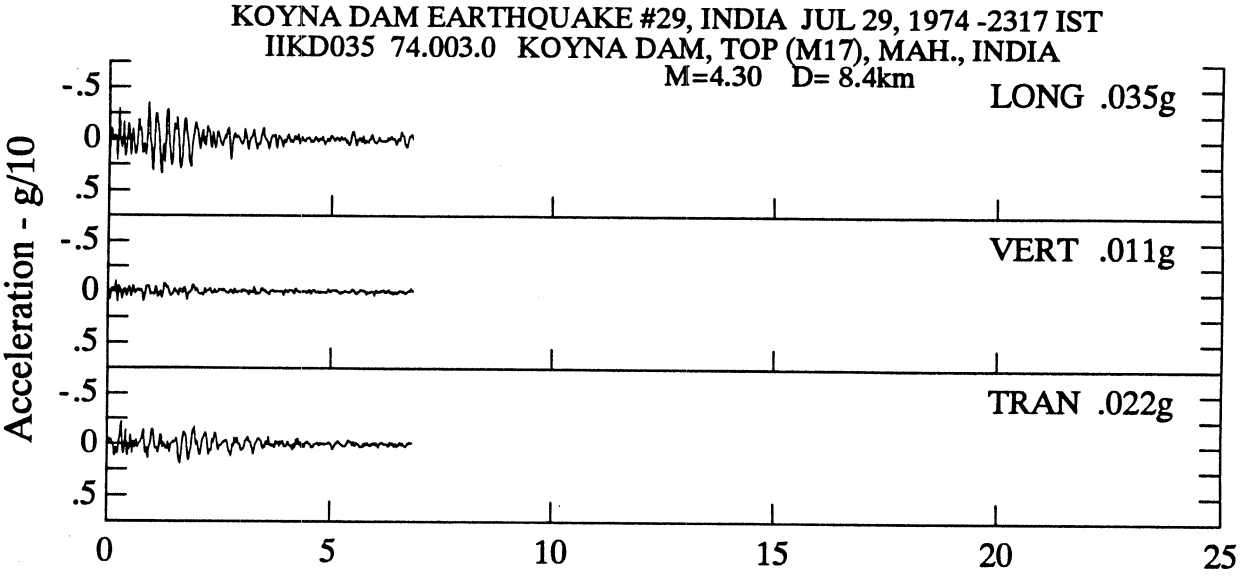


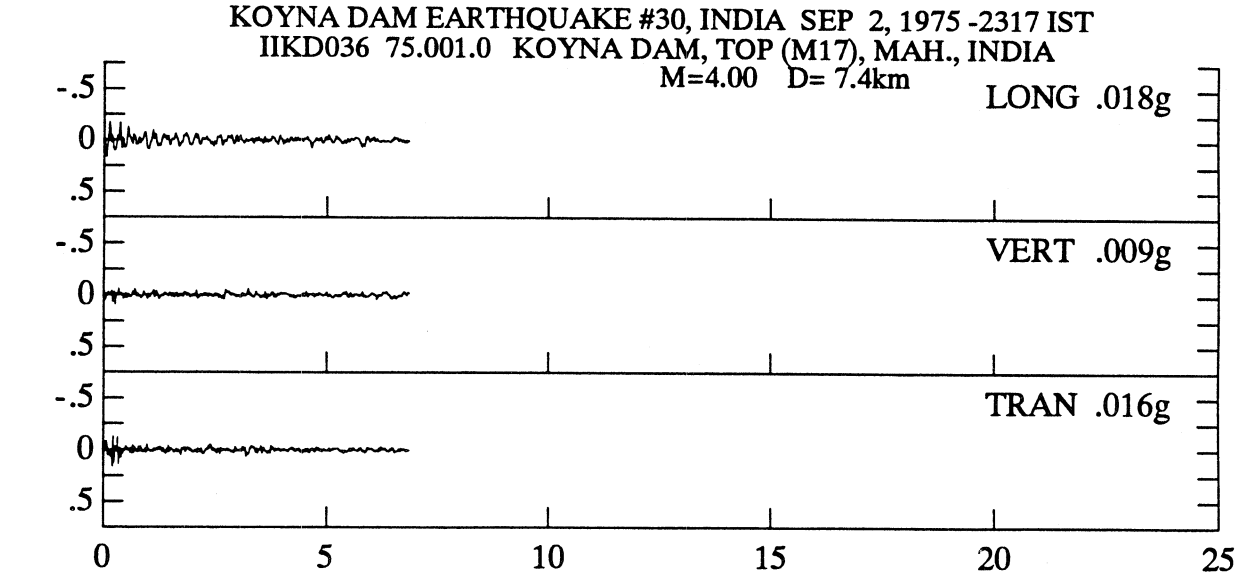
KOYNA DAM EARTHQUAKE #27, INDIA FEB 17, 1974 -1406 IST
IIIKD033 74.001.0 KOYNA DAM, TOP (M17), MAH., INDIA



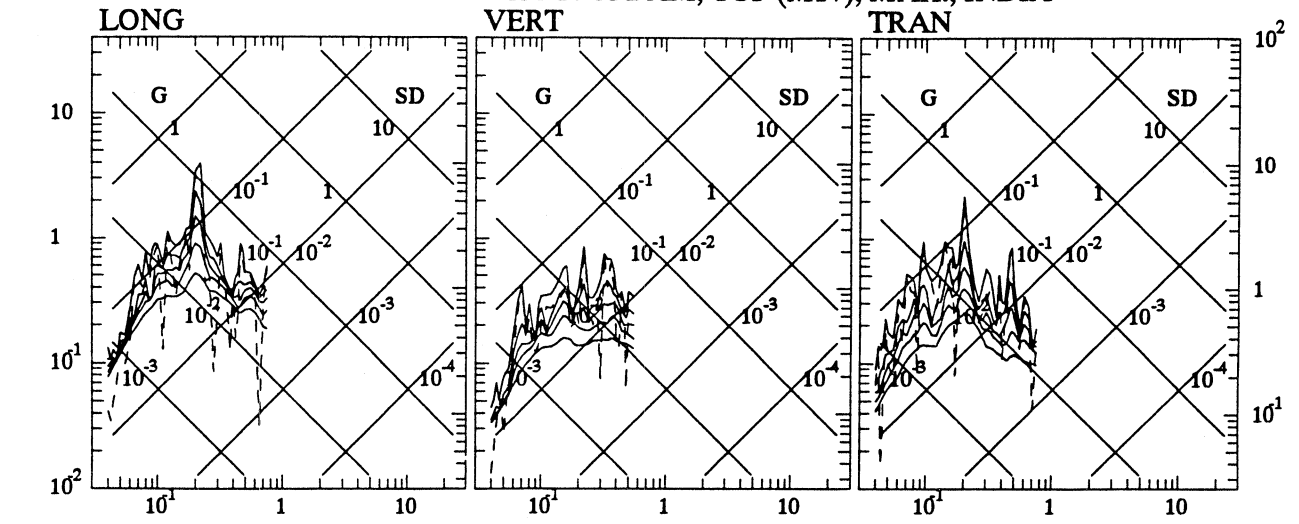
Period - sec


KOYNA DAM EARTHQUAKE #28, INDIA MAY 29, 1974 -1826 IST
IIKD034 74.002.0 KOYNA DAM, TOP (M17), MAH., INDIA
M=3.50 D=10.8km
LONG .032g
VERT .012g
TRAN .016g
-.5
0
.5
0
5
10
15
20
25

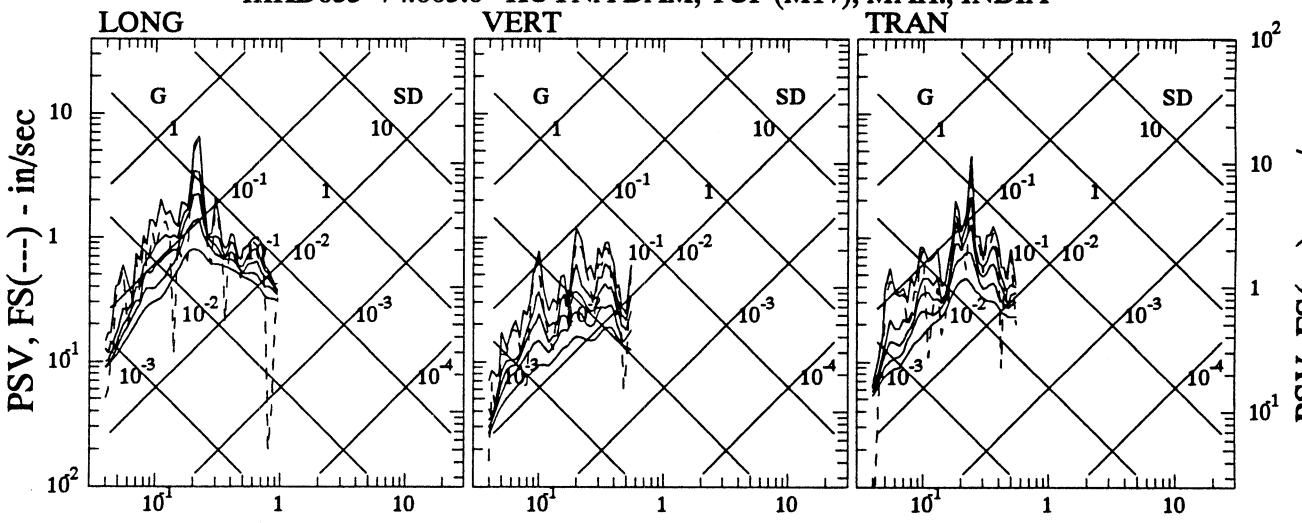

KOYNA DAM EARTHQUAKE #29, INDIA JUL 29, 1974 -2317 IST
IIKD035 74.003.0 KOYNA DAM, TOP (M17), MAH., INDIA
M=4.30 D= 8.4km
LONG .035g
VERT .011g
TRAN .022g
Acceleration - g/10
-.5
0
.5
0
5
10
15
20
25


KOYNA DAM EARTHQUAKE #30, INDIA SEP 2, 1975 -2317 IST
IIKD036 75.001.0 KOYNA DAM, TOP (M17), MAH., INDIA
M=4.00 D= 7.4km
LONG .018g
VERT .009g
TRAN .016g
-.5
0
.5
0
5
10
15
20
25
Time - seconds

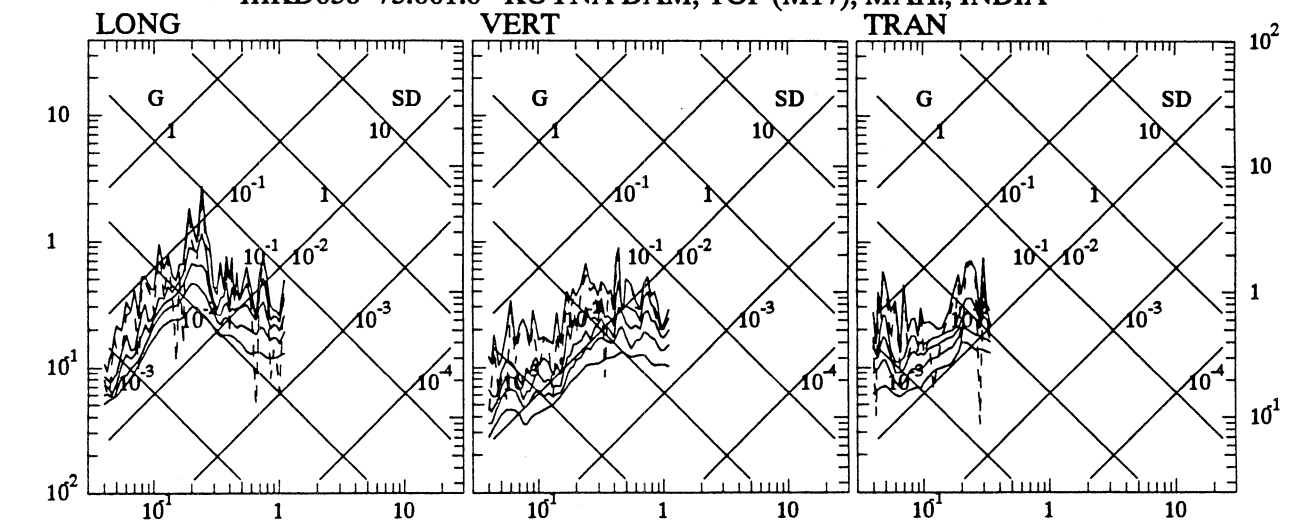
KOYNA DAM EARTHQUAKE #28, INDIA MAY 29, 1974 -1826 IST
IIIKD034 74.002.0 KOYNA DAM, TOP (M17), MAH., INDIA

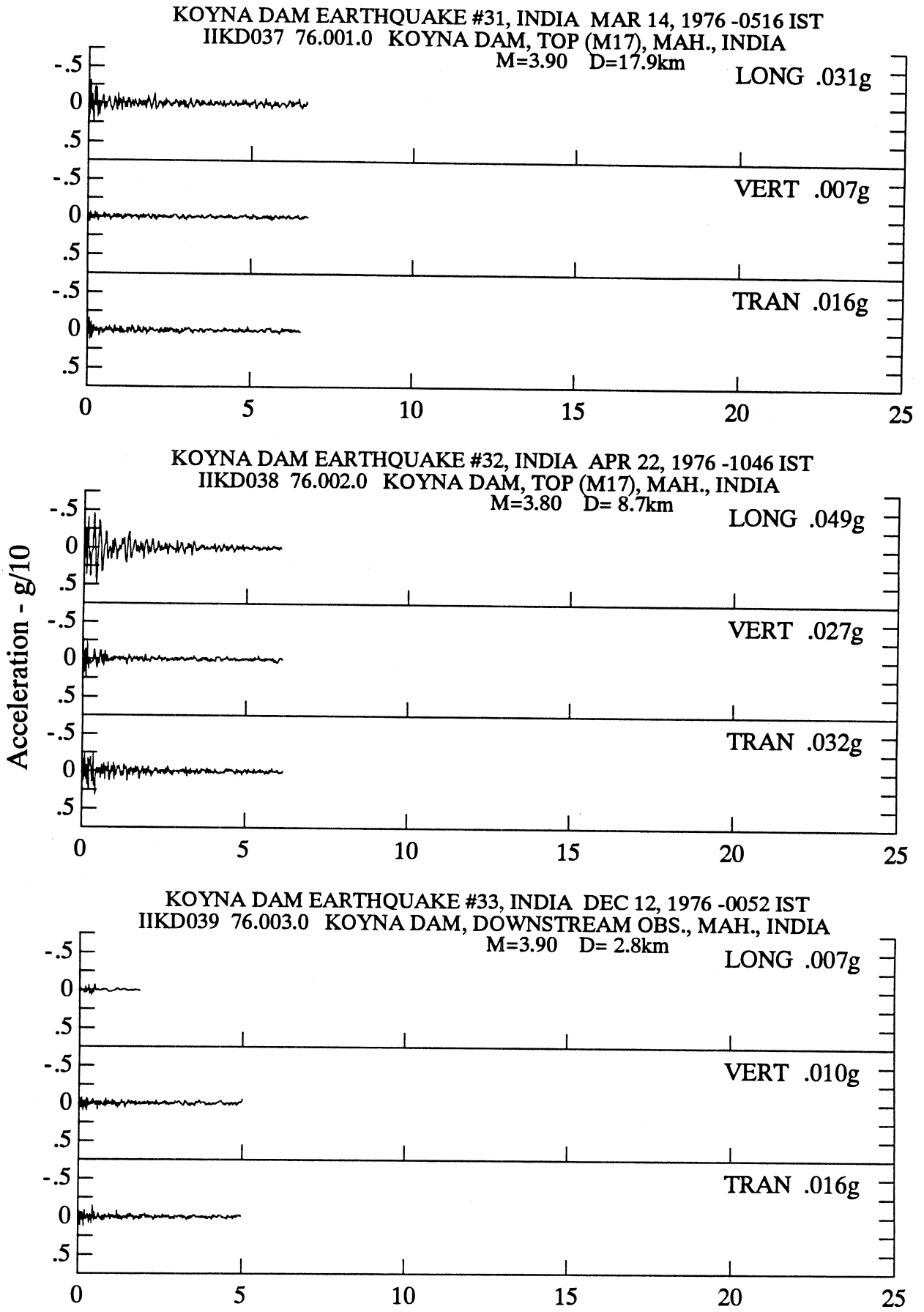


KOYNA DAM EARTHQUAKE #29, INDIA JUL 29, 1974 -2317 IST
IIIKD035 74.003.0 KOYNA DAM, TOP (M17), MAH., INDIA

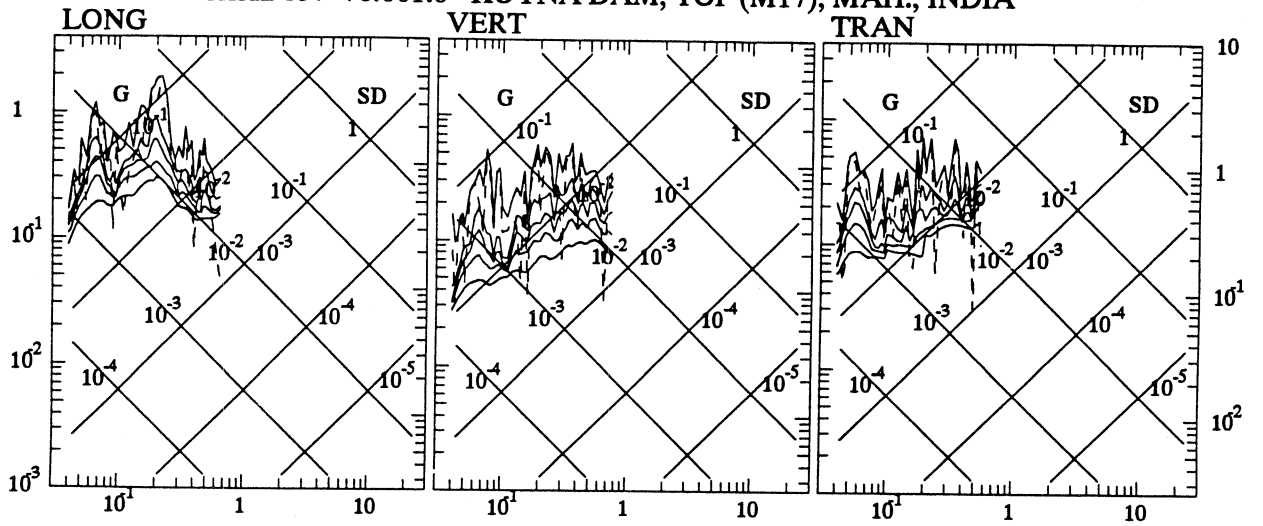


KOYNA DAM EARTHQUAKE #30, INDIA SEP 2, 1975 -2317 IST
IIIKD036 75.001.0 KOYNA DAM, TOP (M17), MAH., INDIA

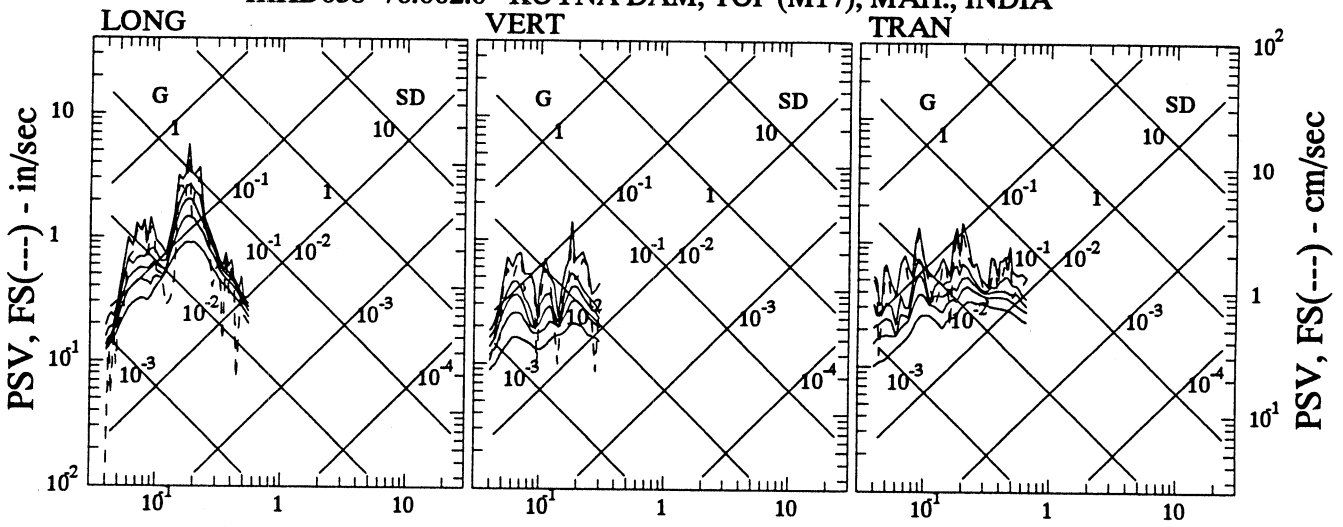



KOYNA DAM EARTHQUAKE #31, INDIA MAR 14, 1976 -0516 IST
IIKD037 76.001.0 KOYNA DAM, TOP (M17), MAH., INDIA
M=3.90 D=17.9km
LONG .031g
VERT .007g
TRAN .016g
KOYNA DAM EARTHQUAKE #32, INDIA APR 22, 1976 -1046 IST
IIKD038 76.002.0 KOYNA DAM, TOP (M17), MAH., INDIA
M=3.80 D= 8.7km
LONG .049g
VERT .027g
TRAN .032g
KOYNA DAM EARTHQUAKE #33, INDIA DEC 12, 1976 -0052 IST
IIKD039 76.003.0 KOYNA DAM, DOWNSTREAM OBS., MAH., INDIA
M=3.90 D= 2.8km
LONG .007g
VERT .010g
TRAN .016g
-.5
0
.5
0
5
10
15
20
25
Acceleration - g/10
Time - seconds

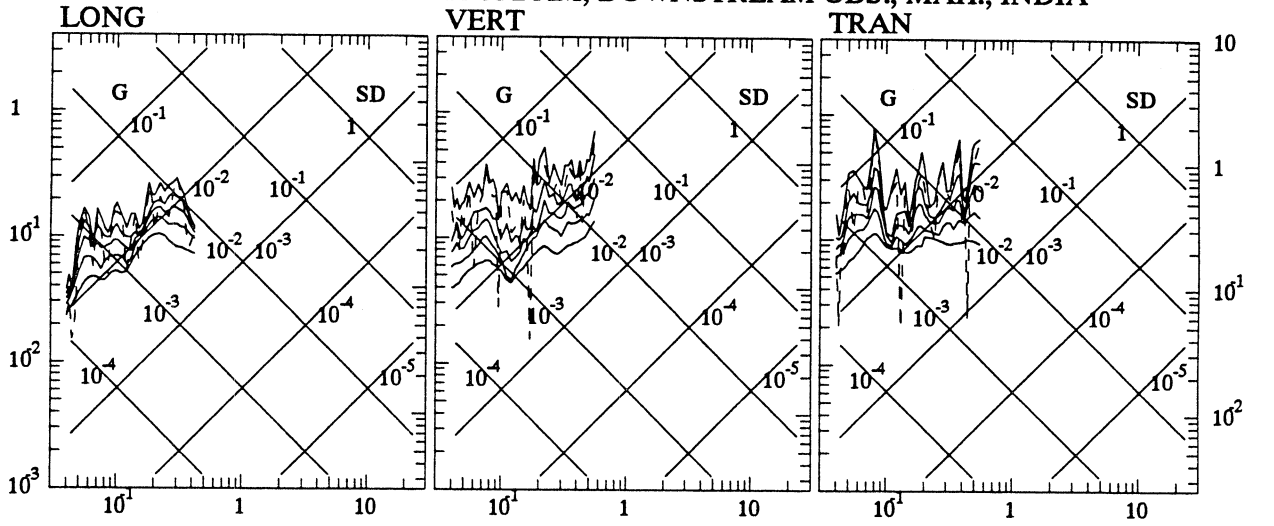
KOYNA DAM EARTHQUAKE #31, INDIA MAR 14, 1976 -0516 IST
IIIKD037 76.001.0 KOYNA DAM, TOP (M17), MAH., INDIA



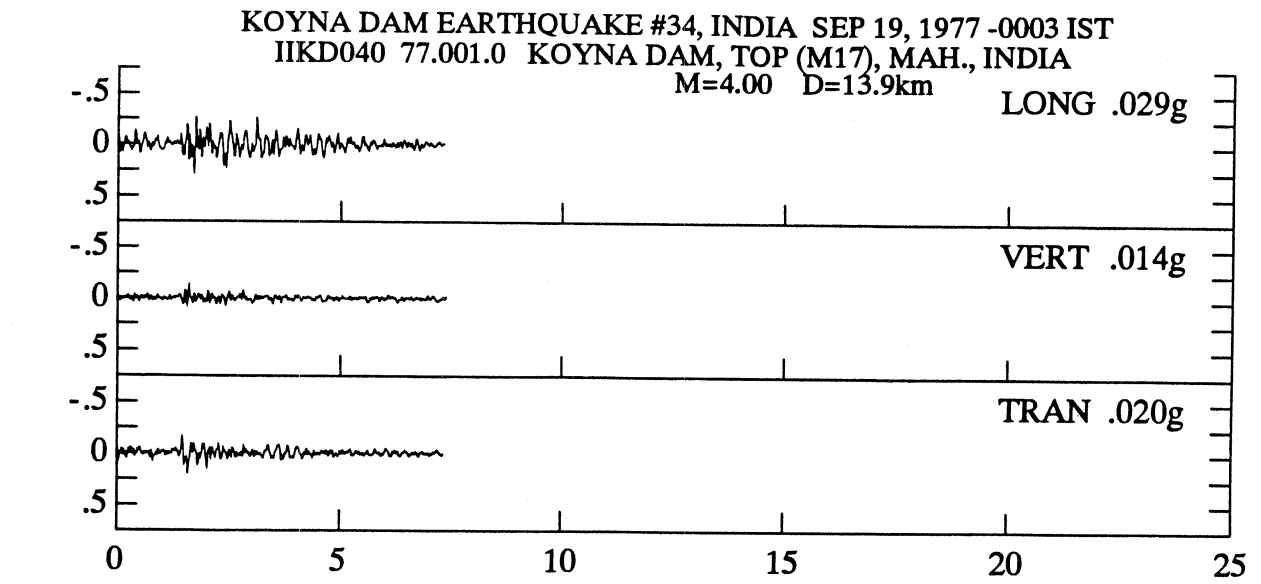
KOYNA DAM EARTHQUAKE #32, INDIA APR 22, 1976 -1046 IST
IIIKD038 76.002.0 KOYNA DAM, TOP (M17), MAH., INDIA

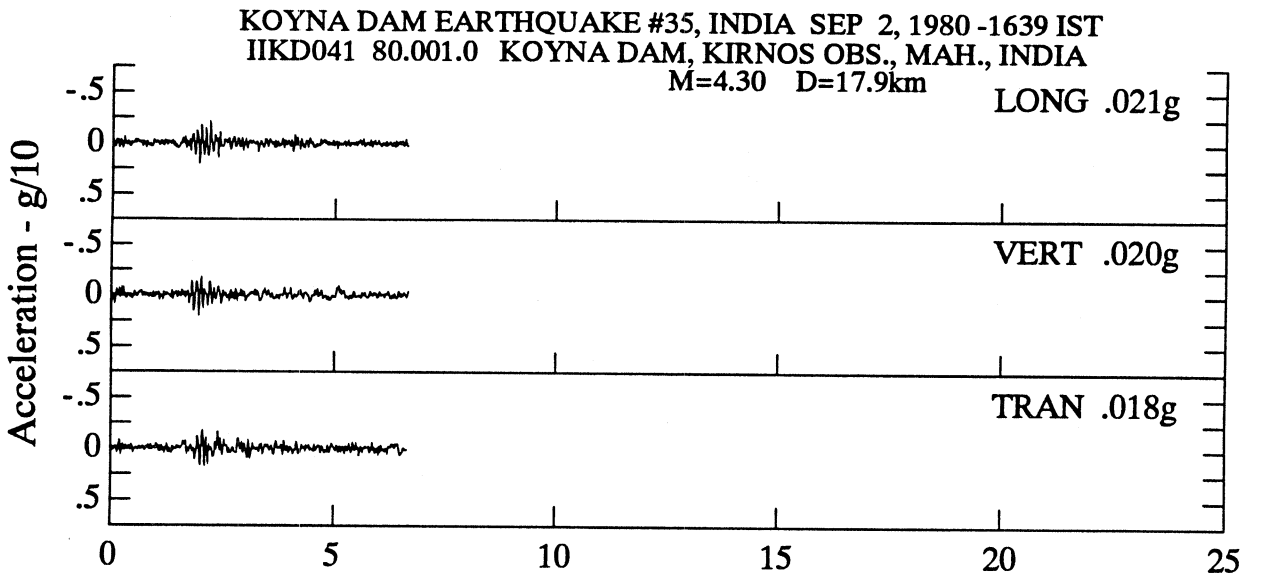


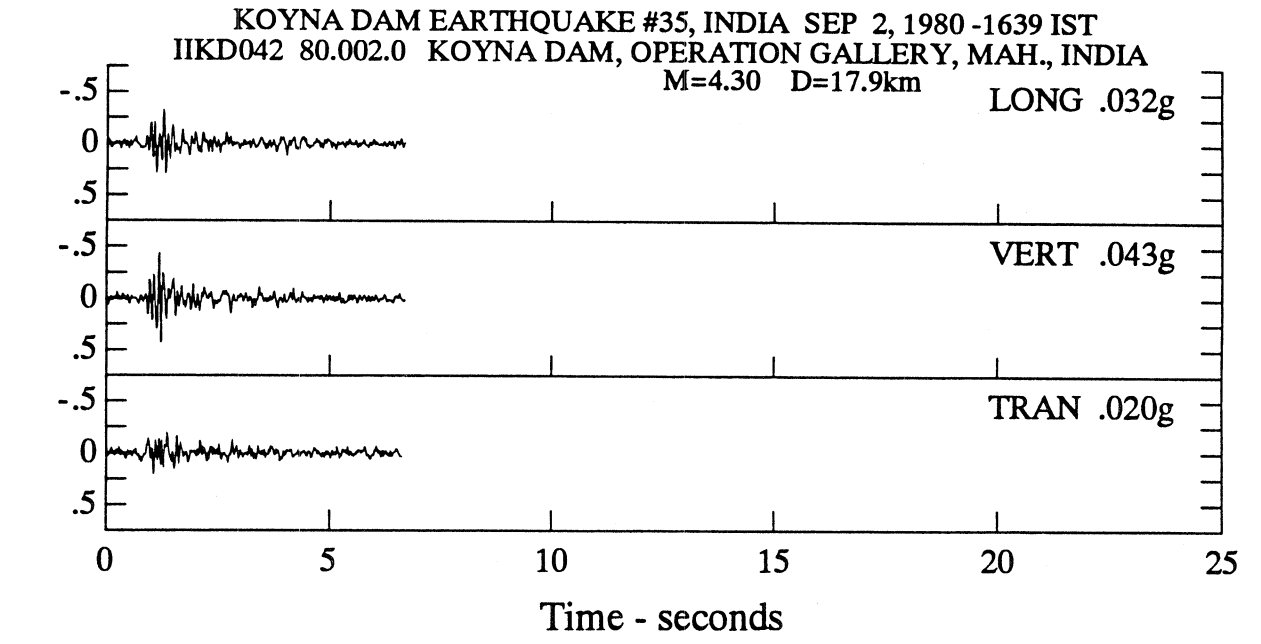
KOYNA DAM EARTHQUAKE #33, INDIA DEC 12, 1976 -0052 IST
IIIKD039 76.003.0 KOYNA DAM, DOWNSTREAM OBS., MAH., INDIA



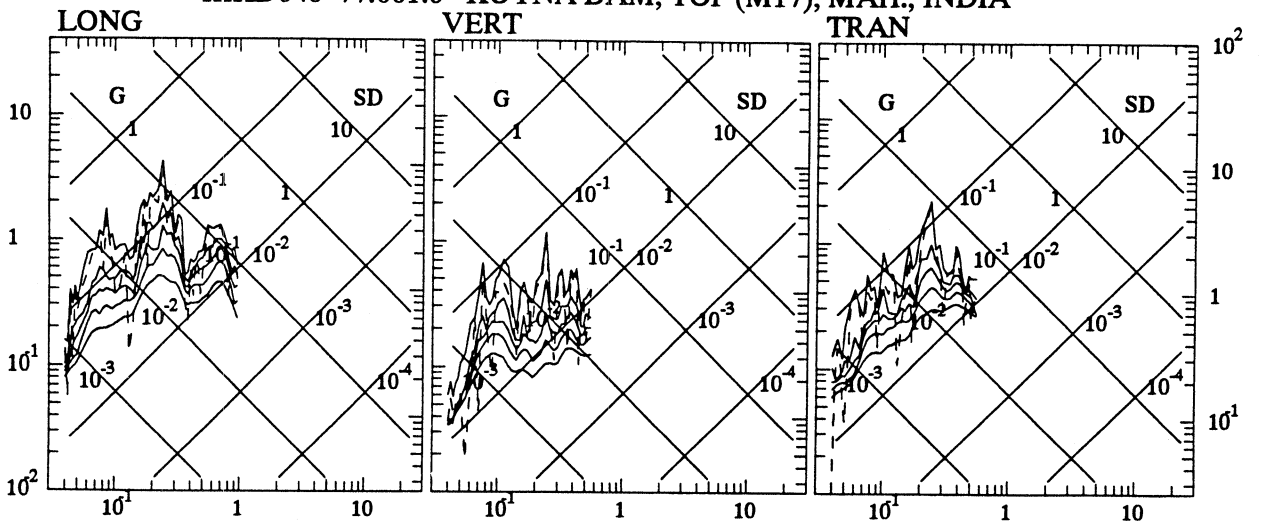
Period - sec


KOYNA DAM EARTHQUAKE #34, INDIA SEP 19, 1977 -0003 IST
IIKD040 77.001.0 KOYNA DAM, TOP (M17), MAH., INDIA
M=4.00 D=13.9km
LONG .029g
VERT .014g
TRAN .020g
-.5
0
.5
0
5
10
15
20
25

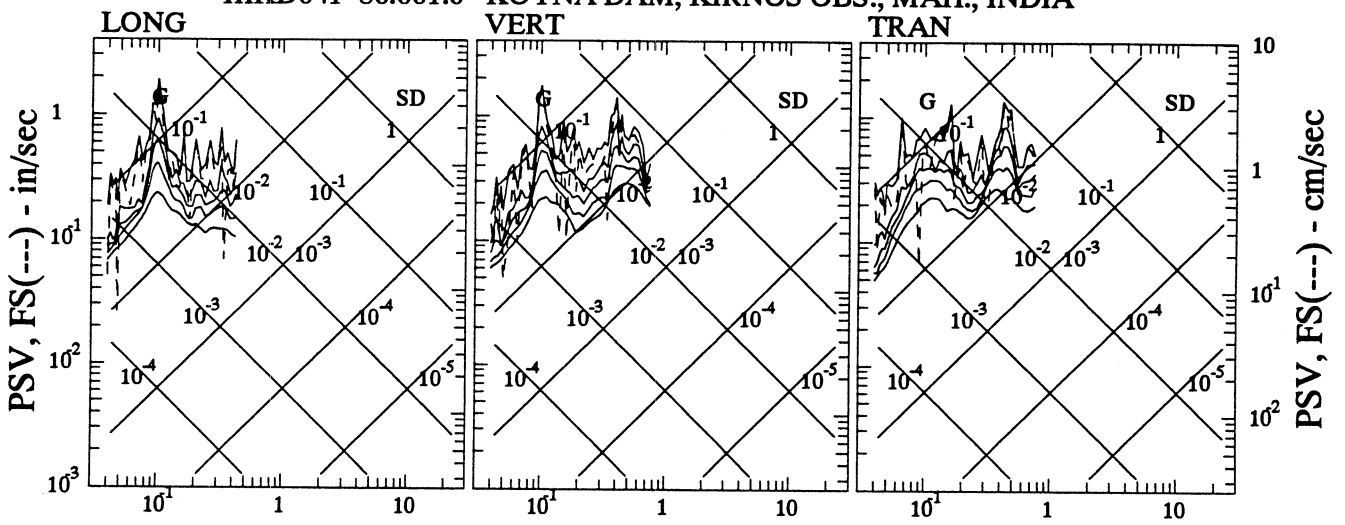

KOYNA DAM EARTHQUAKE #35, INDIA SEP 2, 1980 -1639 IST
IIKD041 80.001.0 KOYNA DAM, KIRNOS OBS., MAH., INDIA
M=4.30 D=17.9km
LONG .021g
VERT .020g
TRAN .018g
Acceleration - g/10
-.5
0
.5
0
5
10
15
20
25


KOYNA DAM EARTHQUAKE #35, INDIA SEP 2, 1980 -1639 IST
IIKD042 80.002.0 KOYNA DAM, OPERATION GALLERY, MAH., INDIA
M=4.30 D=17.9km
LONG .032g
VERT .043g
TRAN .020g
-.5
0
.5
0
5
10
15
20
25
Time - seconds

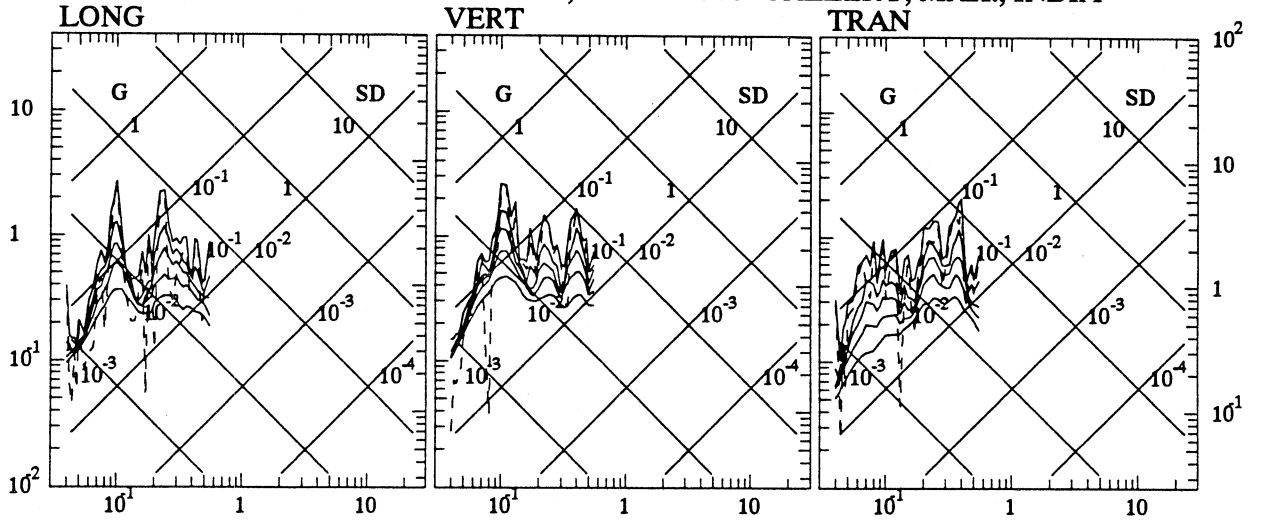
KOYNA DAM EARTHQUAKE #34, INDIA SEP 19, 1977 -0003 IST
IIIKD040 77.001.0 KOYNA DAM, TOP (M17), MAH., INDIA



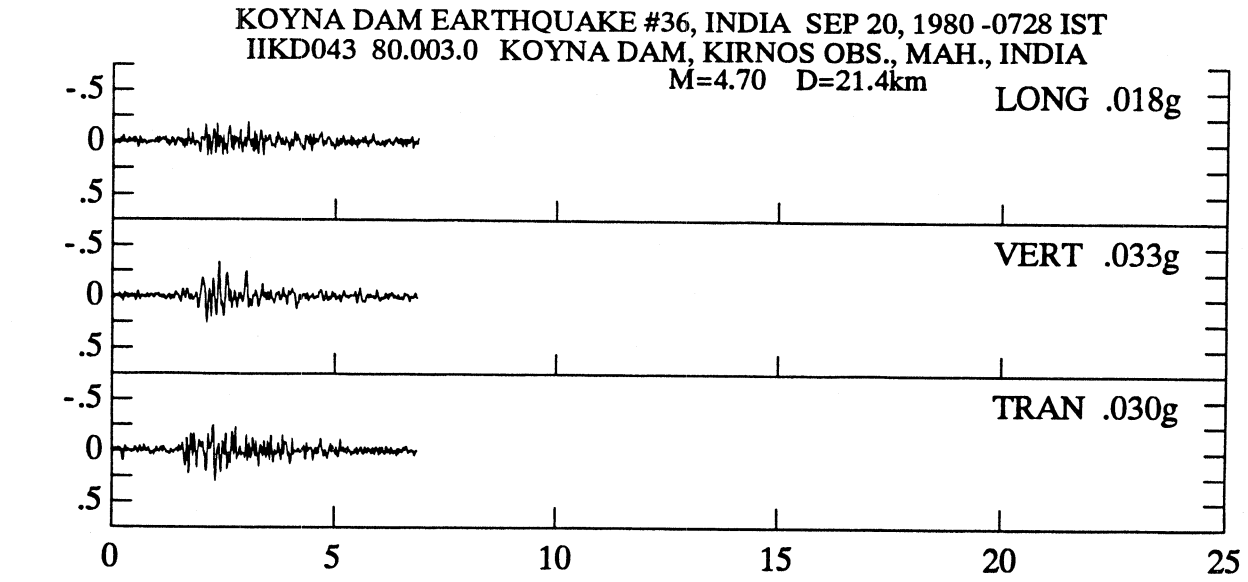
KOYNA DAM EARTHQUAKE #35, INDIA SEP 2, 1980 -1639 IST
IIIKD041 80.001.0 KOYNA DAM, KIRNOS OBS., MAH., INDIA

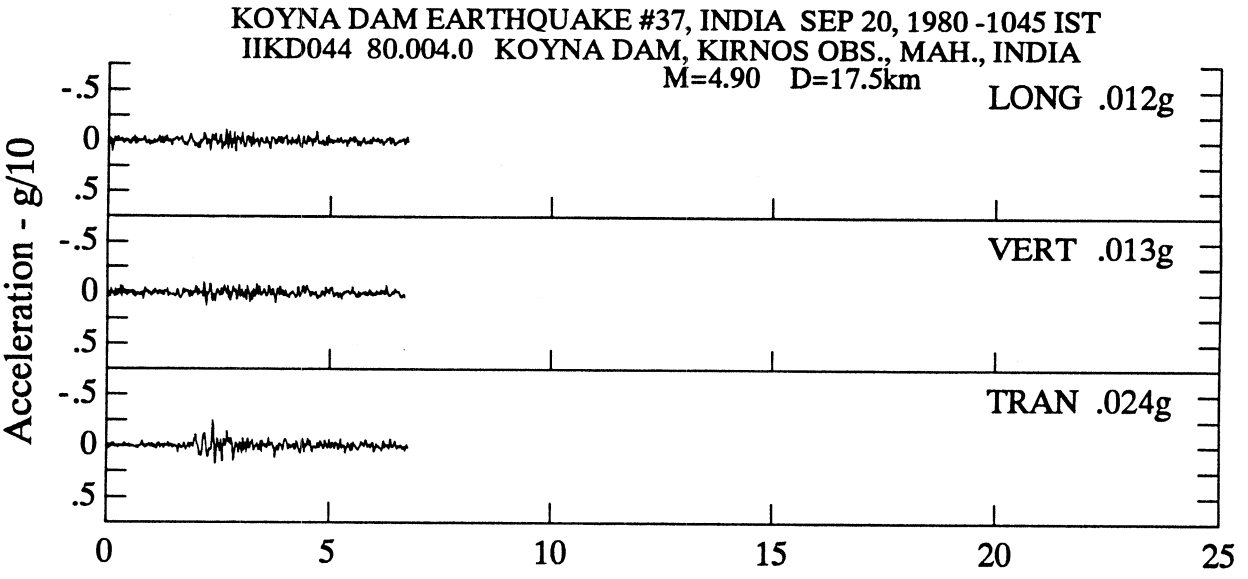


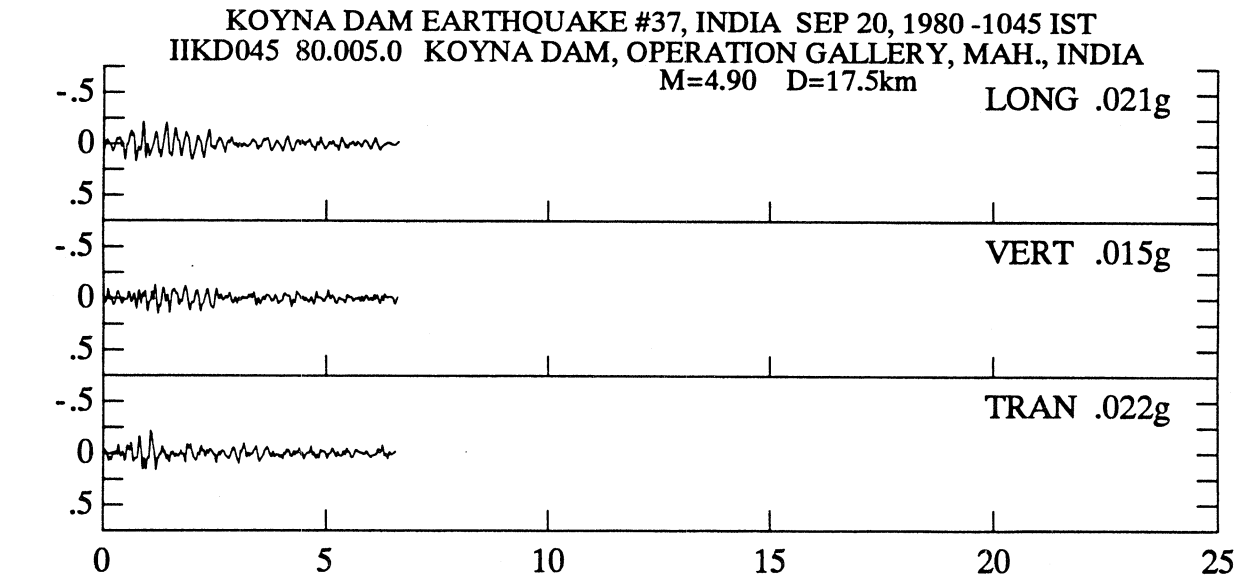
KOYNA DAM EARTHQUAKE #35, INDIA SEP 2, 1980 -1639 IST
IIIKD042 80.002.0 KOYNA DAM, OPERATION GALLERY, MAH., INDIA



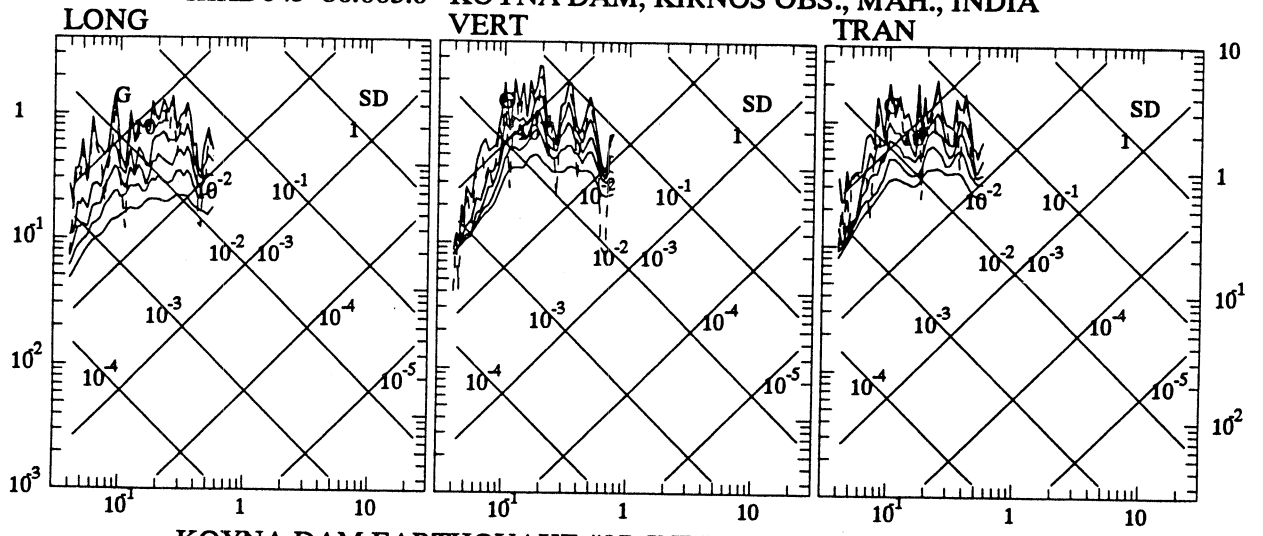
Period - sec


KOYNA DAM EARTHQUAKE #36, INDIA SEP 20, 1980 -0728 IST
IIKD043 80.003.0 KOYNA DAM, KIRNOS OBS., MAH., INDIA
M=4.70 D=21.4km
LONG .018g
VERT .033g
TRAN .030g
-.5
0
.5
0
5
10
15
20
25

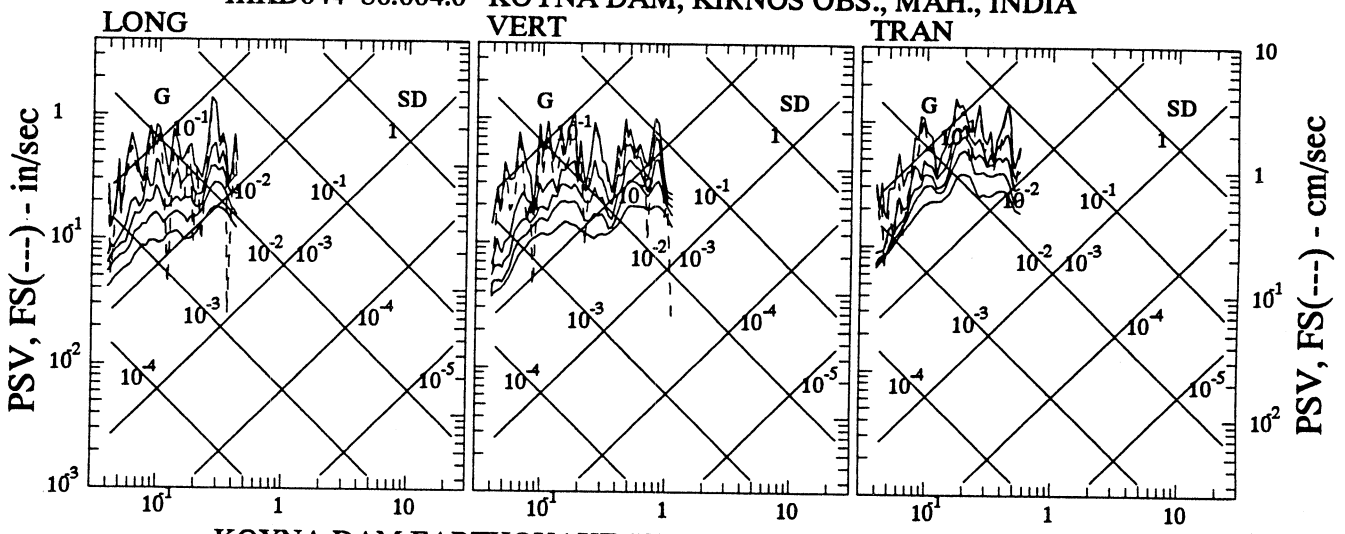

KOYNA DAM EARTHQUAKE #37, INDIA SEP 20, 1980 -1045 IST
IIKD044 80.004.0 KOYNA DAM, KIRNOS OBS., MAH., INDIA
M=4.90 D=17.5km
LONG .012g
VERT .013g
TRAN .024g
Acceleration - g/10
-.5
0
.5
0
5
10
15
20
25


KOYNA DAM EARTHQUAKE #37, INDIA SEP 20, 1980 -1045 IST
IIKD045 80.005.0 KOYNA DAM, OPERATION GALLERY, MAH., INDIA
M=4.90 D=17.5km
LONG .021g
VERT .015g
TRAN .022g
-.5
0
.5
0
5
10
15
20
25
Time - seconds

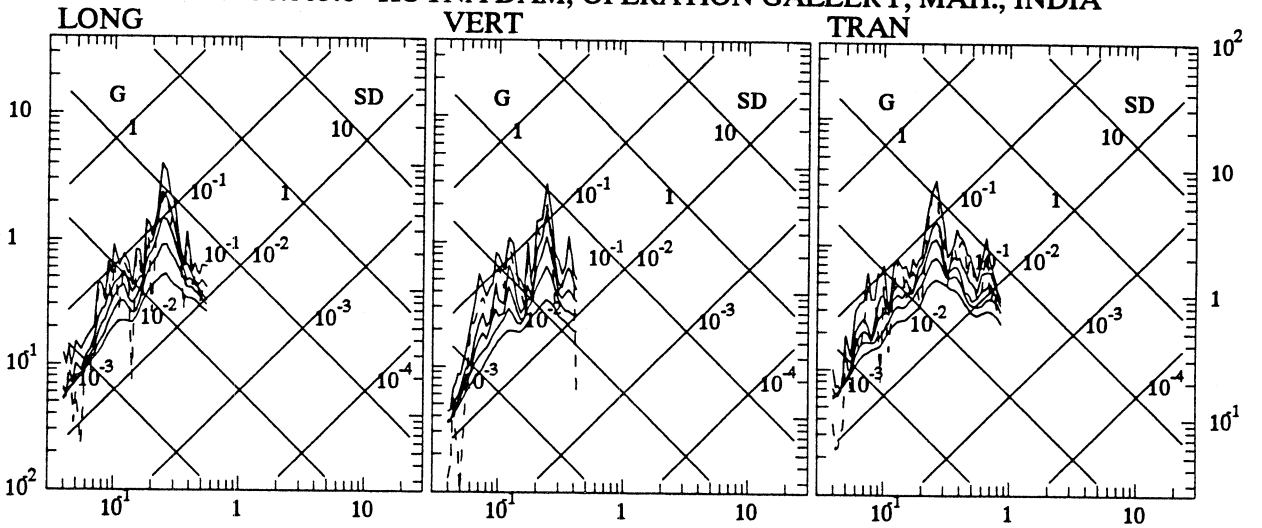
KOYNA DAM EARTHQUAKE #36, INDIA SEP 20, 1980 -0728 IST
IIIKD043 80.003.0 KOYNA DAM, KIRNOS OBS., MAH., INDIA



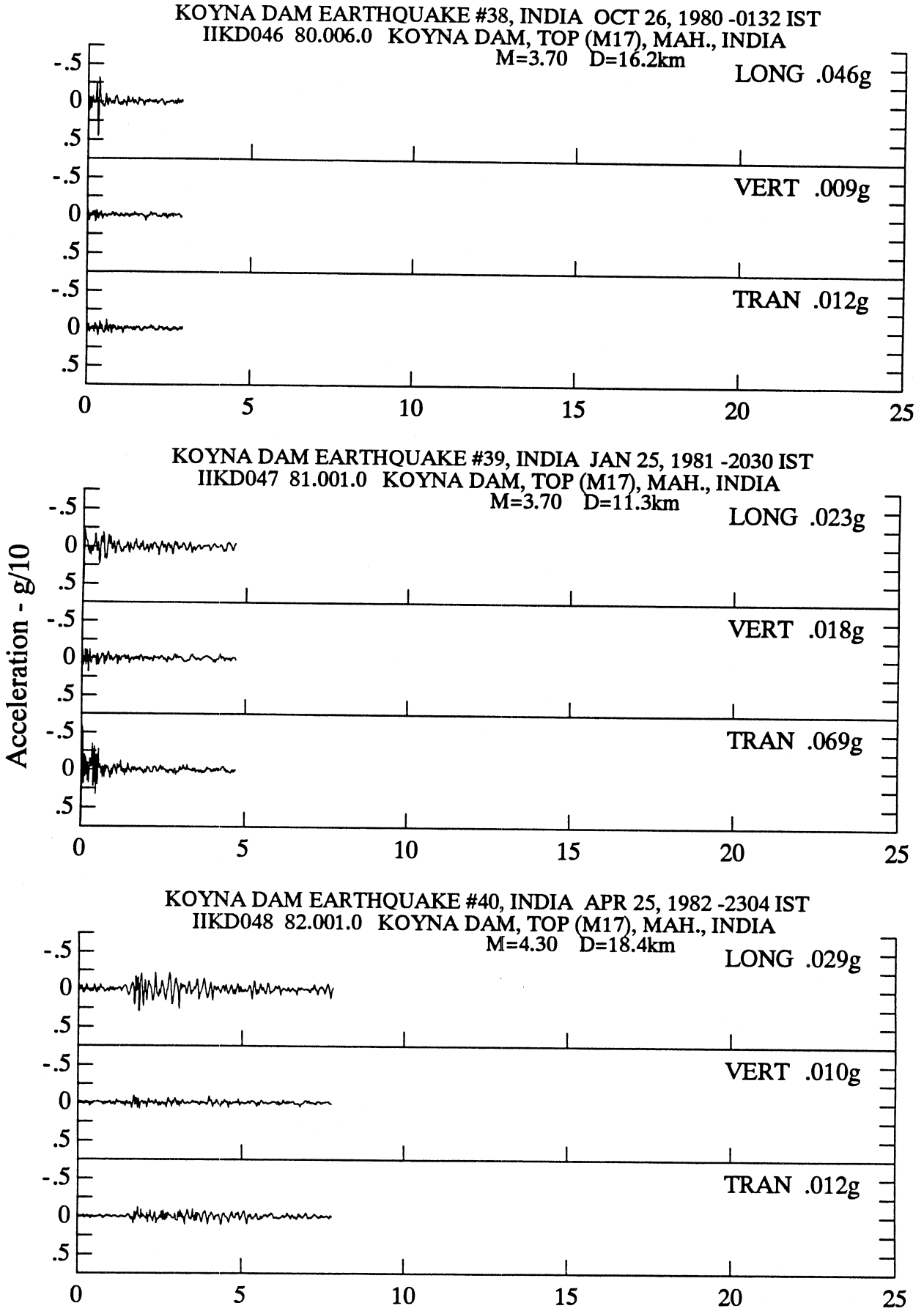
KOYNA DAM EARTHQUAKE #37, INDIA SEP 20, 1980 -1045 IST
IIIKD044 80.004.0 KOYNA DAM, KIRNOS OBS., MAH., INDIA



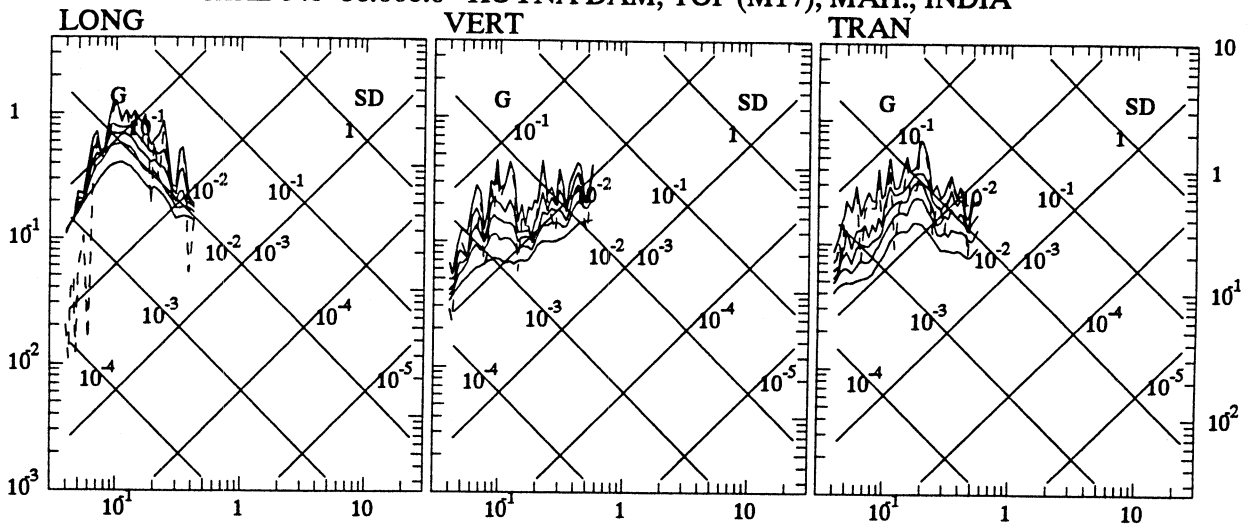
KOYNA DAM EARTHQUAKE #37, INDIA SEP 20, 1980 -1045 IST
IIIKD045 80.005.0 KOYNA DAM, OPERATION GALLERY, MAH., INDIA



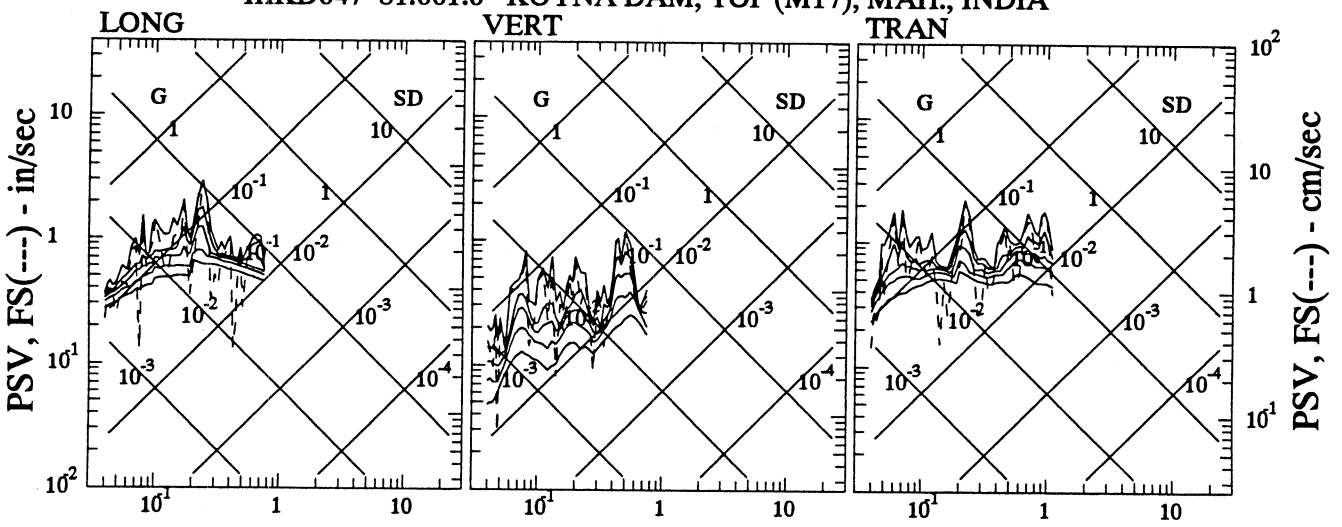
Period - sec


KOYNA DAM EARTHQUAKE #38, INDIA OCT 26, 1980 -0132 IST
IIKD046 80.006.0 KOYNA DAM, TOP (M17), MAH., INDIA
M=3.70 D=16.2km
LONG .046g
VERT .009g
TRAN .012g
KOYNA DAM EARTHQUAKE #39, INDIA JAN 25, 1981 -2030 IST
IIKD047 81.001.0 KOYNA DAM, TOP (M17), MAH., INDIA
M=3.70 D=11.3km
LONG .023g
VERT .018g
TRAN .069g
KOYNA DAM EARTHQUAKE #40, INDIA APR 25, 1982 -2304 IST
IIKD048 82.001.0 KOYNA DAM, TOP (M17), MAH., INDIA
M=4.30 D=18.4km
LONG .029g
VERT .010g
TRAN .012g
-.5
0
.5
0
5
10
15
20
25
Acceleration - g/10
Time - seconds

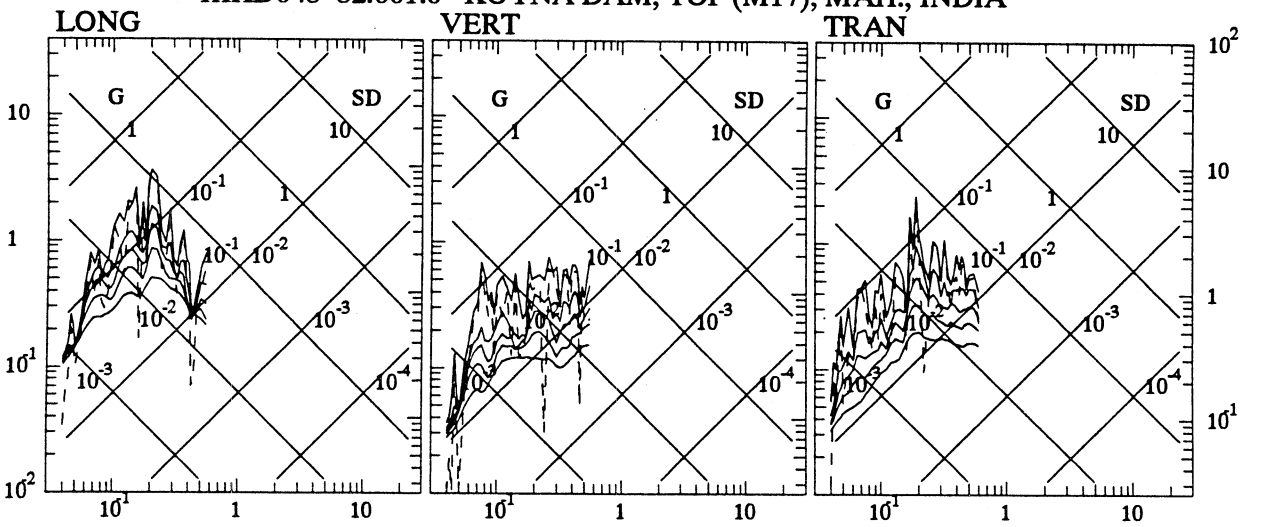
KOYNA DAM EARTHQUAKE #38, INDIA OCT 26, 1980 -0132 IST
IIIKD046 80.006.0 KOYNA DAM, TOP (M17), MAH., INDIA



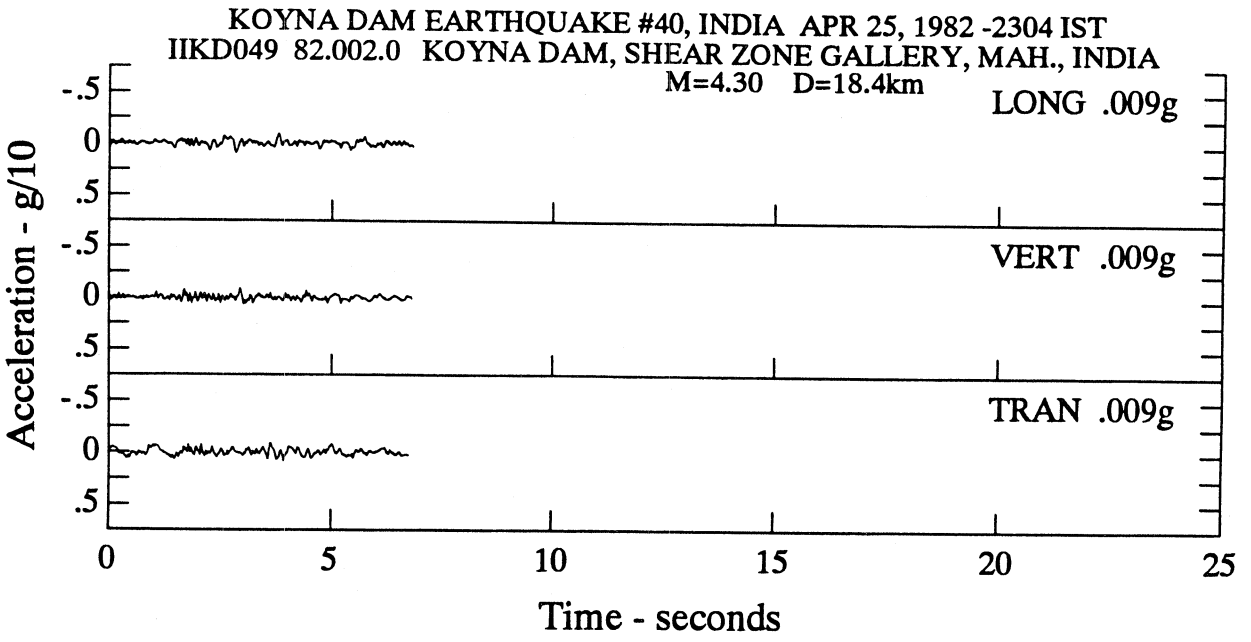
KOYNA DAM EARTHQUAKE #39, INDIA JAN 25, 1981 -2030 IST
IIIKD047 81.001.0 KOYNA DAM, TOP (M17), MAH., INDIA



KOYNA DAM EARTHQUAKE #40, INDIA APR 25, 1982 -2304 IST
IIIKD048 82.001.0 KOYNA DAM, TOP (M17), MAH., INDIA



Period - sec


KOYNA DAM EARTHQUAKE #40, INDIA APR 25, 1982 -2304 IST
IIKD049 82.002.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA
M=4.30 D=18.4km
LONG .009g
VERT .009g
TRAN .009g
Acceleration - g/10
-.5
0
.5
0
5
10
15
20
25
Time - seconds

KOYNA DAM EARTHQUAKE #40, INDIA APR 25, 1982 -2304 IST
IIIKD049 82.002.0 KOYNA DAM, SHEAR ZONE GALLERY, MAH., INDIA