BULLETIN OF THE EARTHQUAKE
RESEARCH INSTITUTE
Vol. 46 (1968), pp. 1127-1147

54. *Observation of Microtremors. XII.*
(*Case of the U. S. A.*)

By Teiji TANAKA, Kiyoshi KANAI*, Kaio OSADA,

Earthquake Research Institute

and

David J. LEEDS,

Department of Engineering,
University of California, Los Angeles**.

(Read July 26, 1960 and Jan. 24, 1961.—Received July 31, 1968.)

1. Introduction

Observation of microtremors at the sites of strong-motion seismograph and seismoscope stations in the western United States were carried out in 1960, in cooperation with many governmental and private organizations in the region.

The project was originated by C. M. Duke of the University of California, Los Angeles, and one of the authors. The objective was the study and application of microtremors for the following purposes:

1) Comparison between the spectrum of strong earthquake motions and the spectrum of microtremors.

2) Comparison between the dynamical characteristics of the ground derived from microtremors and those expected from measured properties and geometry of the ground (theoretical amplification spectrum).

3) Reasonable utilization of the strong-motion seismograms for aseismic design of structures, based on the concept that seismograms recorded at a given site could be applied to other sites with similar vibrational properties.

Some research concerning these problems has been conducted using part of the microtremors data from the present observations[1),2)]. However,

---

* Presently Professor of Nihon University.

** Presently associated with Dames & Moore, Los Angeles.

1) K. KANAI, "On the Spectrum of Strong Earthquake Motions," *Bull. Earthq. Res. Inst.*, **40** (1962), 71.

2) T. TANAKA, T. K. DUTTA and K. KANAI, "Study of Microtremor Amplitude Spectrum in Relation to Ground Amplification Character for Sites in Southern California," *Bull. Internat. Inst., Seism. Earthq. Engg.*, **3** (1966), 21.

because of the quantitative limitation of the strong earthquake records and site data[3] available at present, a great deal of the microtremors data has remained unused.

Similar observations were made recently at the strong-motion seismograph sites in Japan, and the results of frequency analysis have been reported[4], so that anyone interested in the site characteristics, can refer those data to his own study.

This report is, therefore, presented in the hope that it will serve as a valuable addition to other data obtained to date in providing information on the dynamic properties of the ground in the region[5],[6].

2. Observation and analysis of microtremors.

Field observations were made with two types of microtremometers[7] one a magnetic recording instrument by which the distribution of periods of microtremors can easily be computed through the analyzer, and the other a visible type used for monitoring the recording conditions.

A magnification between 5,000 and 300,000 times was adopted, depending on the amplitude level of the ground vibrations at each observation site. The overall response of the magnetic recording microtremometer is almost flat from 0.05 to 1 sec and falls off rather rapidly beyond the 1-sec period. Observations were made in the daytime, and a record was taken for about 3 minutes per component. At most sites, observations were made for two directions perpendicular to each other, but not simultaneously. This should be taken into account when comparing the results of analysis for both directions.

The period distribution of microtremors was obtained by a specially

3) C. M. DUKE and D. J. LEEDS, "Site Characteristics of Southern California Strong-Motion Earthquake Stations," *Report of Dept. Engg. Univ. Calif. L. A.*, 62-55, (1962).

R. B. MATTHIESEN, C. M. DUKE, D. J. LEEDS and J. C. FRASER, "Site Characteristics of Southern California Strong-Motion Earthquake Stations, Part Two," *ditto*, 64-15, (1964).

4) The Research Group for Earthquake Response to Subsoil and Structure, "The Results of Microtremors Observations at the Strong-motion Seismograph Sites in Japan, I-X," (1967-1968), (in Japanese).

5) D. S. CARDER and M. H. GILMORE, "Ground Vibrations," *Bull. Seism. Soc. Amer.*, **35** (1945), 13.

6) D. J. LEEDS, "Engineering Seismology in Southern California," *Special Publ. of the Los Angeles Section of the Assoc. of Engg. Geologists*, (1966), 35.

7) T. TANAKA, "Some Equipment Used in Microtremor Measurement," *Bull. Earthq. Res. Inst.*, **40** (1962), 533.

designed analyzer[8]. The method of obtaining the period distribution diagram of microtremors is as follows. First, each successive zero-crossing time interval of the waves is measured from the sample record for 2 minutes; twice the time interval thus obtained is considered as the period of a wave. Then, the number of waves of each period in the range from 0.02 to 2.5 sec is classified into one of the 20 ranges which has a nearly equal bandwidth in the logarithmic scale. Finally, taking the center period of each range on the abscissa and the total number of waves in that range on the ordinate, the diagram of period distributions is drawn.

In this process, recorded waves shorter than 0.1 sec are filtered out to avoid the influences of high frequency disturbances from artificial noise sources close to the observation point.

3. Site characteristics derived from microtremors.

Records of microtremors at more than 250 sites were obtained in five Western states of the U. S. A. during the period March- June 1960. Excluding the results for buildings, dams and other structures, those for the ground at 221 sites are presented in this report. The number of observation sites in each state is shown in Table 1; 82% of the total were in California.

Location of each observation site is illustrated in Figs. 1 through 7 and in Table 3, with an indication of the sites for strong-motion seismograph and seismoscope stations. Microtremors were observed at 50 strong-motion seismograph sites and 65 seismoscope sites. Some of the

Table 1. Distribution of microtremors observation sites.

State	No. of obs. sites
California	182
Washington	27
Nevada	6
Montana	5
Oregon	1

8) T. TANAKA, "Period Distribution Analyser for Irregular Motions," *Bull. Earthq. Res. Inst.*, **40** (1962), 861.

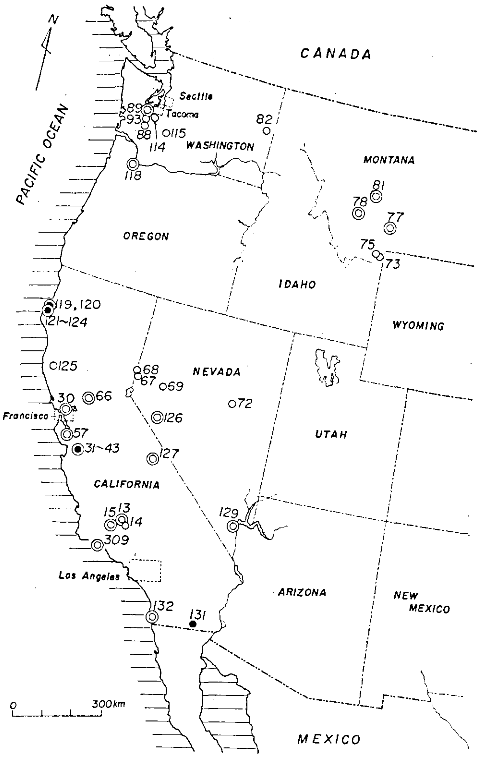

Fig. 1. Map showing locations of microtremors observation sites in the west coastal region of the U. S. A. (sites in Los Angeles, San Francisco, Oakland, Berkeley, Seattle and Tacoma area are shown in other figures.) ◎; Strong-motion seismograph site, ●; Seismoscope site.

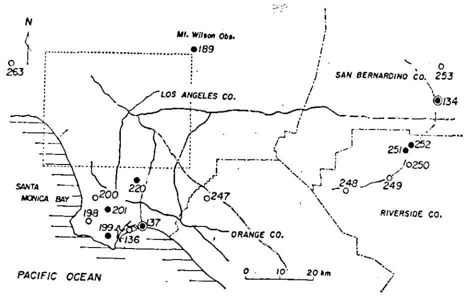

Fig. 2. Map showing locations of microtremors observation sites in the Los Angeles area. ◎; Strong-motion seismograph site. ●; Seismoscope site.

remaining sites were selected for a special purpose of the microtremors study, and the others were chosen to learn the general features of the subsoil conditions at the surrounding area of the seismic stations.

The period-distribution diagrams of microtremors derived from the observed records are shown in Figs. 11 through 15. The shape of the diagram varies from site to site and it is not so simple as to be able to point out the predominant period at all the sites. Approximate values of the amplitudes of microtremors for all of the sites and of the predominant periods determined for some hundred sites are listed in Table 2.

Since the present observations in the U. S. A. were made mostly in a populated area similar to Japan, it may be possible to gain some information relating to the difference in ground conditions for each country from statistical comparison of the microtemors amplitudes. Fig. 8 shows the distribution of amplitudes for each country and points out that there is no significant difference between them. Similar comparison of the period characteristics is more difficult. However, it should be noted that all of the types of period-distribution curves which have been

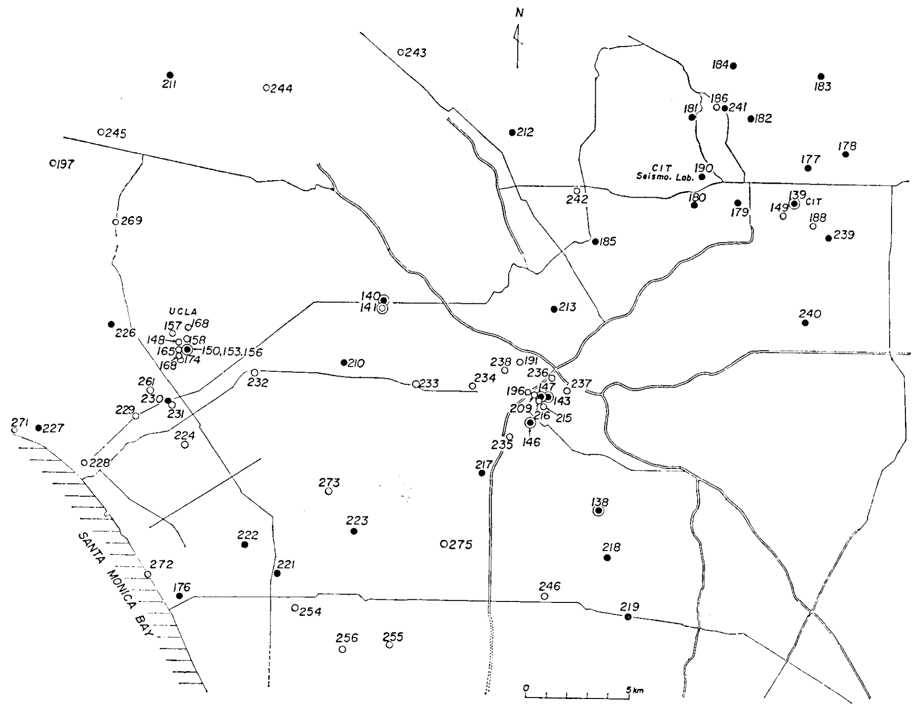

Fig. 3. Map showing locations of microtremors observation sites in the Los Angeles City area. ◎; Strong-motion seismograph site. ●; Seismoscope site.

experienced in Japan were also found in the observed region of the U. S. A.

A typical example showing the effect of local geology on the period characteristics of microtremors is presented in Fig. 9, which was obtained at a natural and a reclaimed island adjacent to each other in San Francisco Bay.

Fig. 10 shows the daily variations of microtremors amplitude and predominant period obtained from 24 hours observation at a site in Los Angeles on a calm day. The result is that the amplitude at night reduced to about a half of that in the daytime, while changes in period were smaller than those in amplitude.

General properties of microtremors obtained from the present observations and the previous investigations[9] on the basis of the derived data may be summarized as follows.

9) *loc. cit.*, 1) 2).

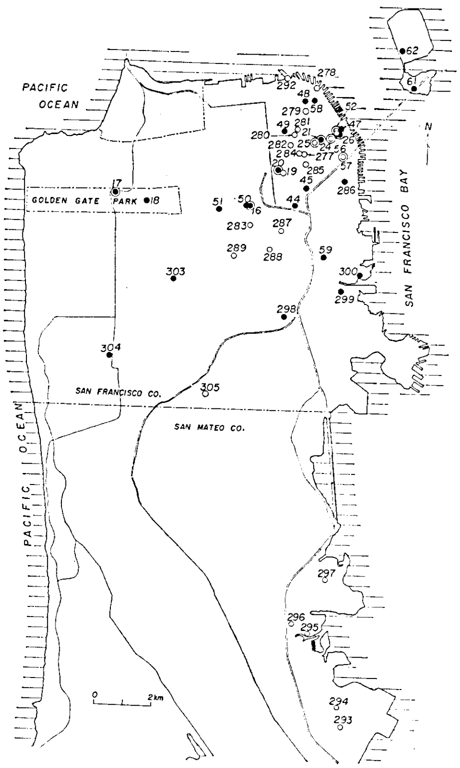

Fig. 4. Map showing locations of microtremors observation sites in the San Francisco City area. ◎; Strong-motion seismograph site. ●; Seismoscope site.

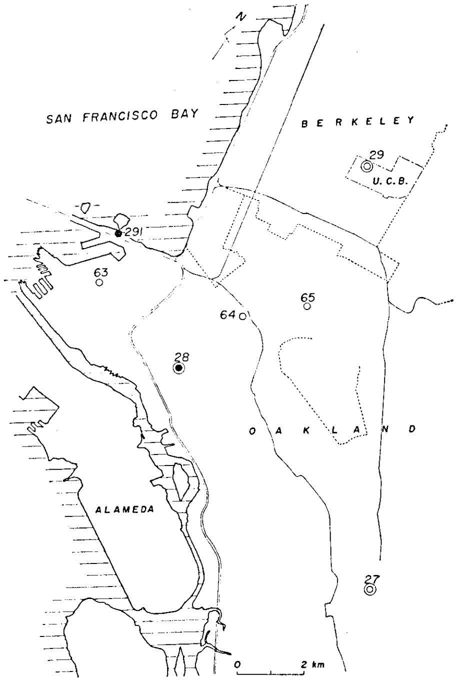

Fig. 5. Map showing locations of microtremors observation sites in the Oakland and Berkeley area. ◎; Strong-motion seismograph site. ●; Seismoscope site.

1) Variations of shape of the period distribution curve and of the predominant period of microtremors with time are much smaller than those in amplitude and are within the limits allowable for the application of microtremors to earthquake engineering.

2) Period distribution and spectrum of microtremors show definite shapes for a particular site, and bear a close resemblance to the spectrum developed from ground properties, that is, geometry and elastic constants of the subsoil layers.

3) Similarity in the shapes of the period-distribution curves of strong earthquake motions and microtremors for a given site is fairly good. Also, the predominant microtremors periods have good correlation

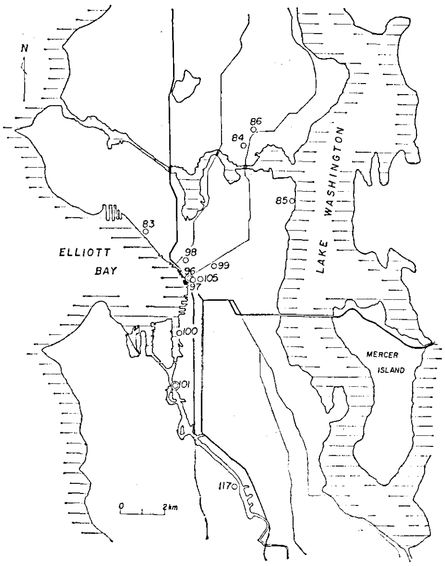

Fig. 6. Map showing locations of microtremors observation sites in the Seattle area. ◎; Strong-motion seismograph site. ●; Seismoscope site.

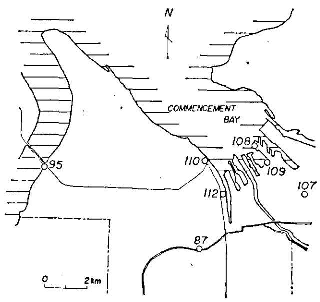

Fig. 7. Map showing locations of microtremors observation sites in the Tacoma area.

with the periods most often found in strong-motion seismograms at the same site.

Further studies concerning these problems will be made in the future when accumulation of the data of strong earthquake motions and site characteristics to be compared has increased.

The fact, found from the present observation of microtremors, that the ground in the U. S. A. varies greatly in dynamical behavior similar to that in Japan, emphasizes the need for quantitative consideration of the effects of local ground conditions in aseismic structural design.

4. Acknowledgments

The authors acknowledge with gratitude the cooperation of Prof. C. M. Duke, University of California, Los Angeles; Dr. W. K. Cloud, U. S. Coast and Geodetic Survey; Prof. D. E. Hudson, California Institute of Technology; Prof. R. W. Clough, University of California, Berkeley; and the late Prof. F. Neuman, University of Washington; in realizing the project. They are also grateful to personnel from the U. S. Coast

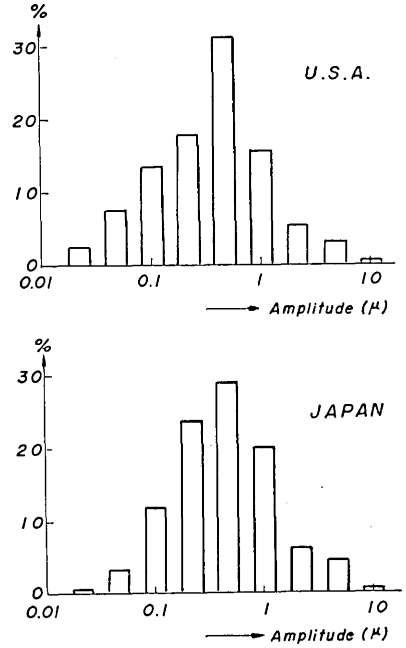

Fig. 8. Comparison of frequency distributions of amplitudes of microtremors obtained in the U. S. A. (168 sites) and Japan (800 sites).

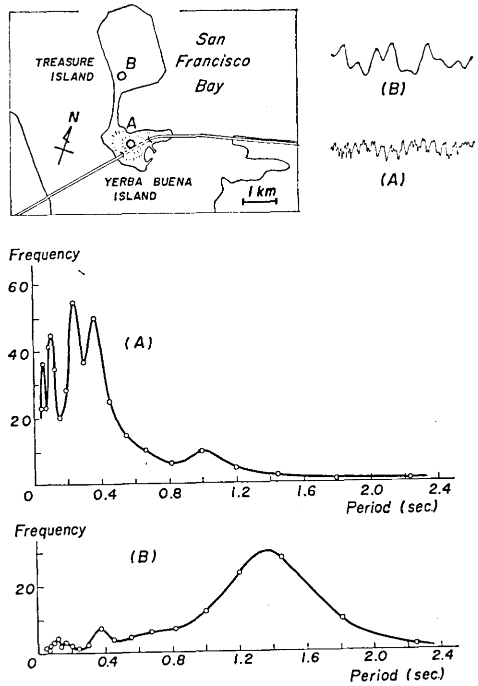

Fig. 9. Example of results of microtremors observations for different site conditions.

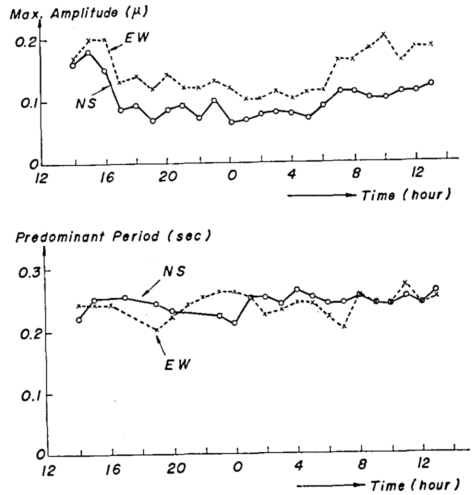

Fig. 10. Daily variations of amplitude and period of microtremors obtained from 24 hours observations in Los Angeles (Site No. 224).

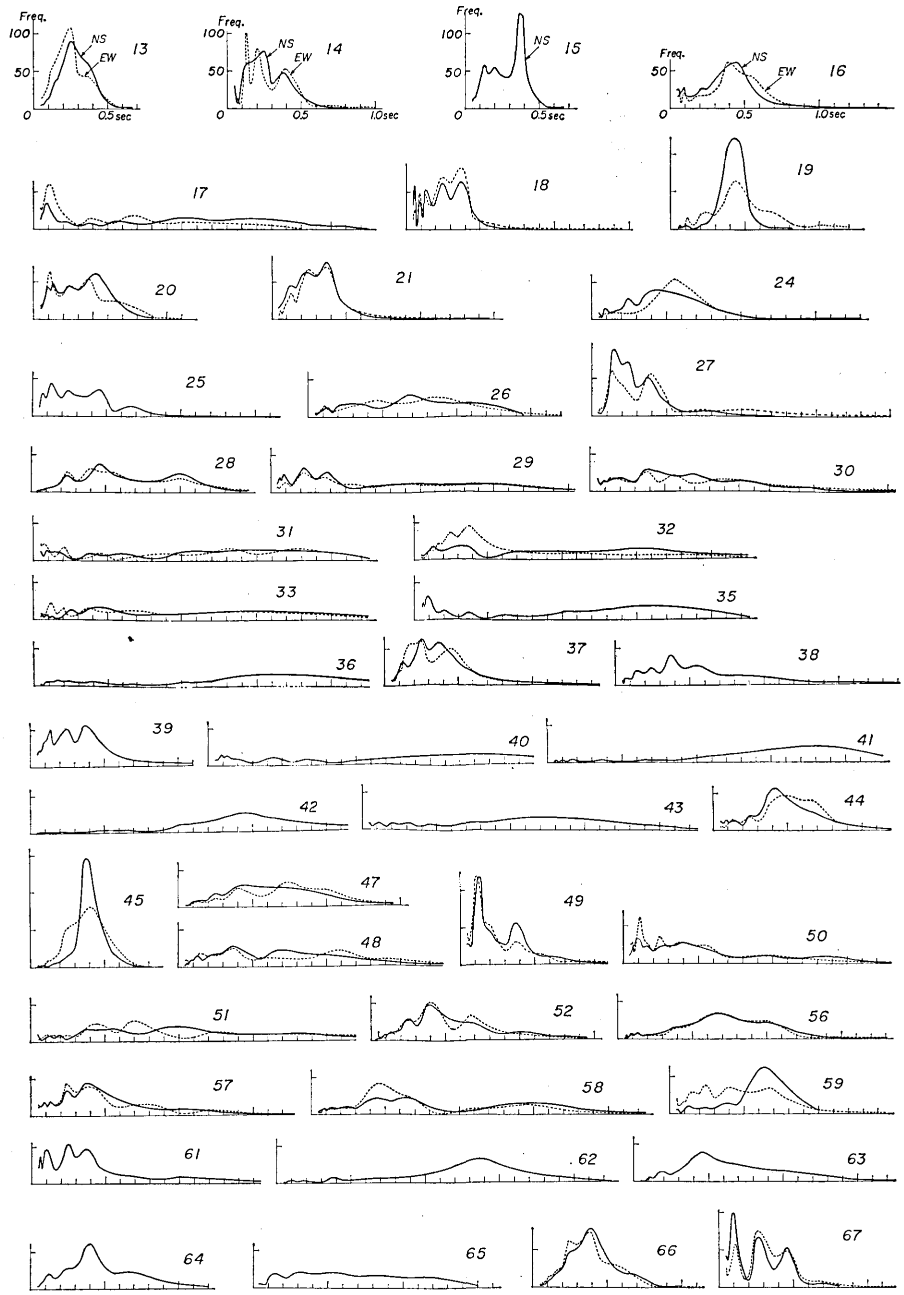

Fig. 11. Period-distribution curves of microtremors. (Site Nos. 13-67)

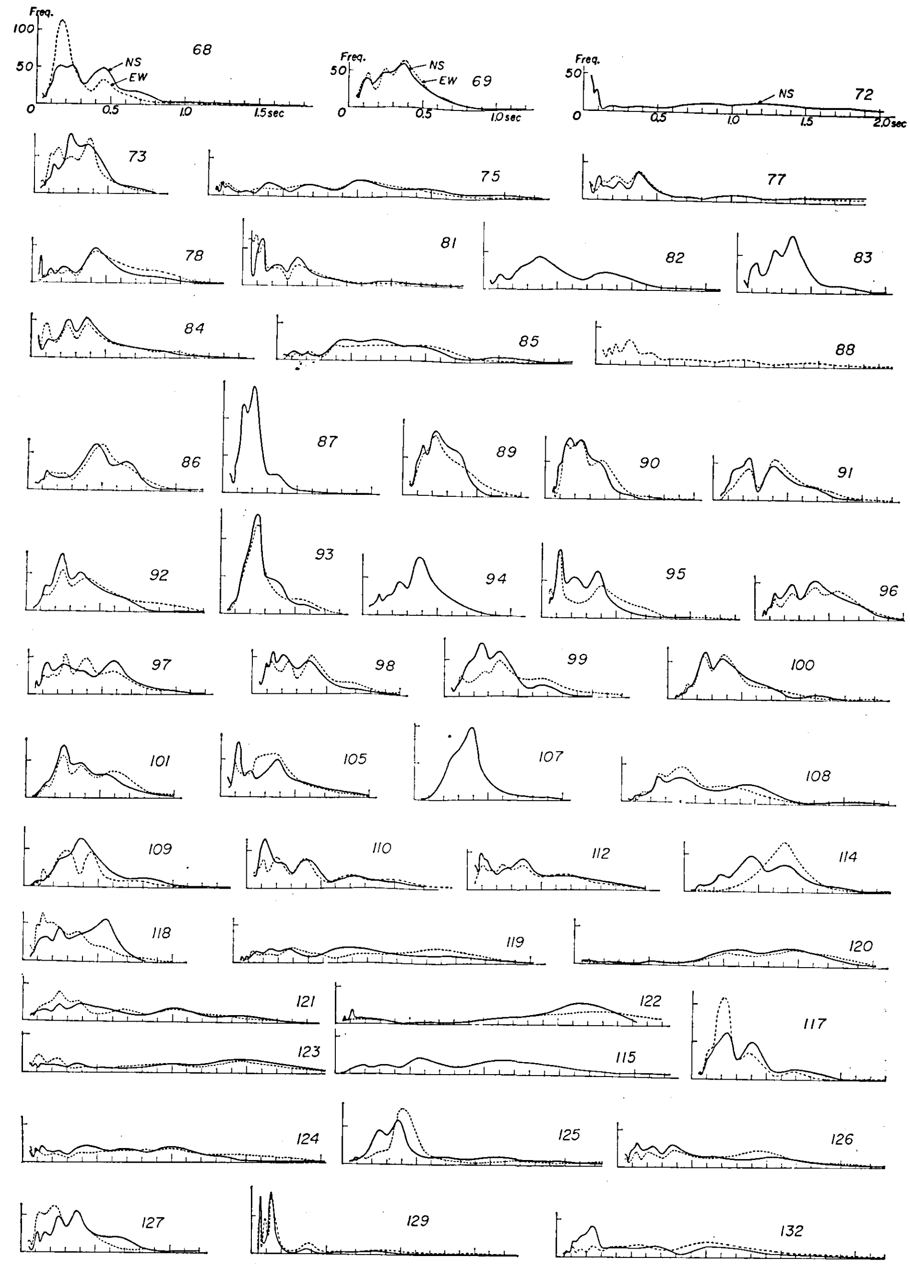

Fig. 12. Period-distribution curves of microtremors. (Site Nos. 68–132)

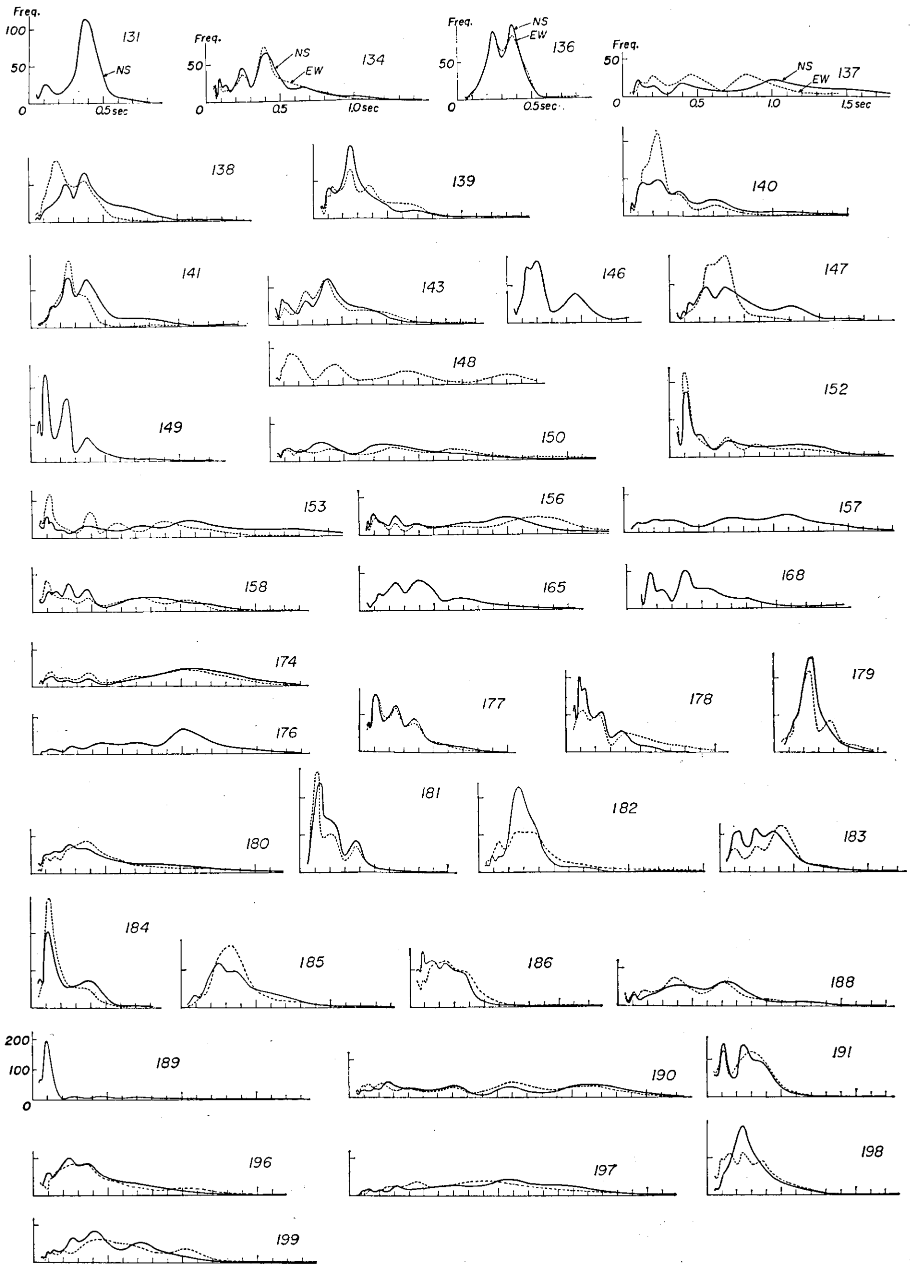

Fig. 13. Period-distribution curves of microtremors. (Site Nos. 131–199)

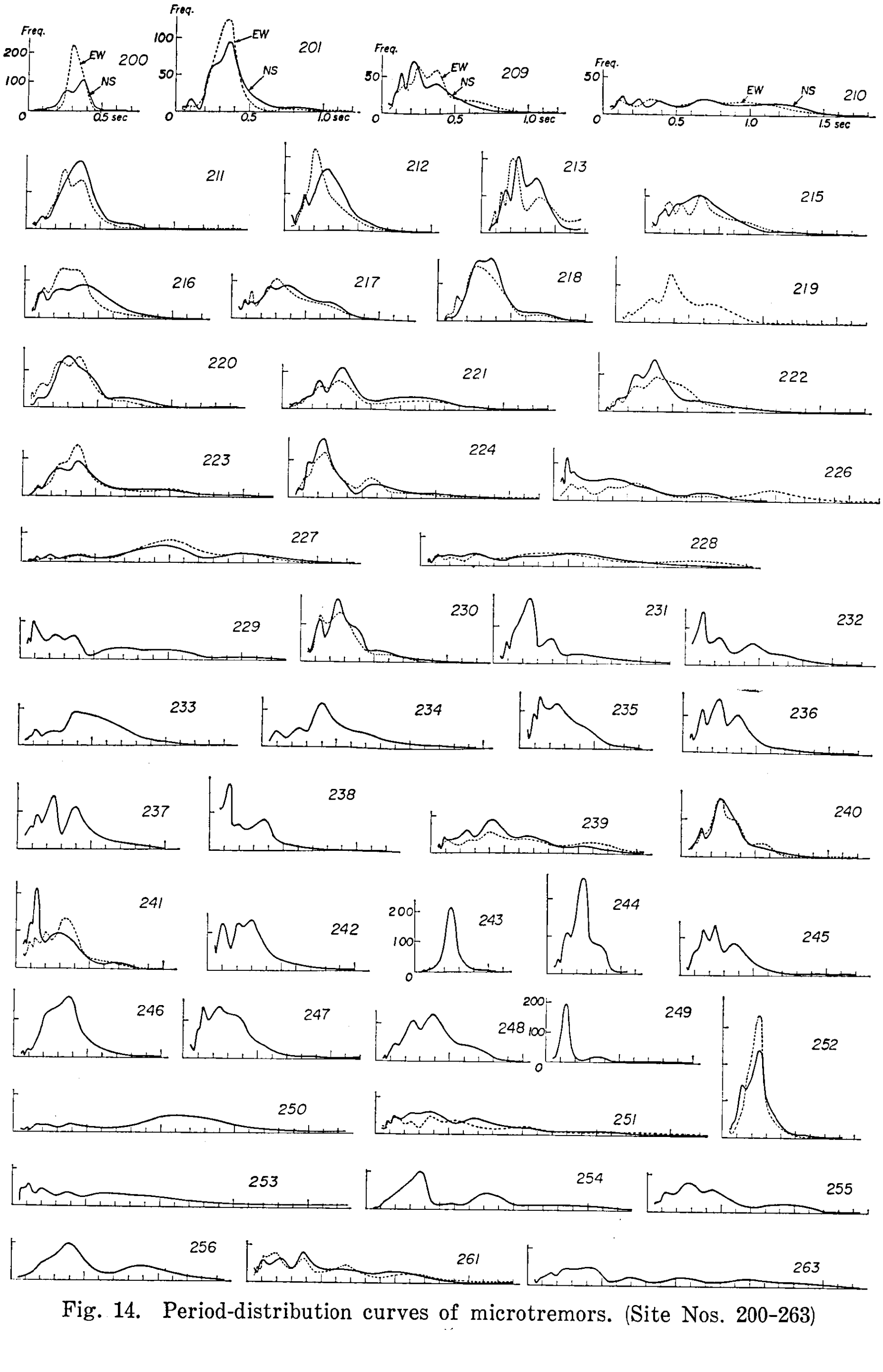

Fig. 14. Period-distribution curves of microtremors. (Site Nos. 200-263)

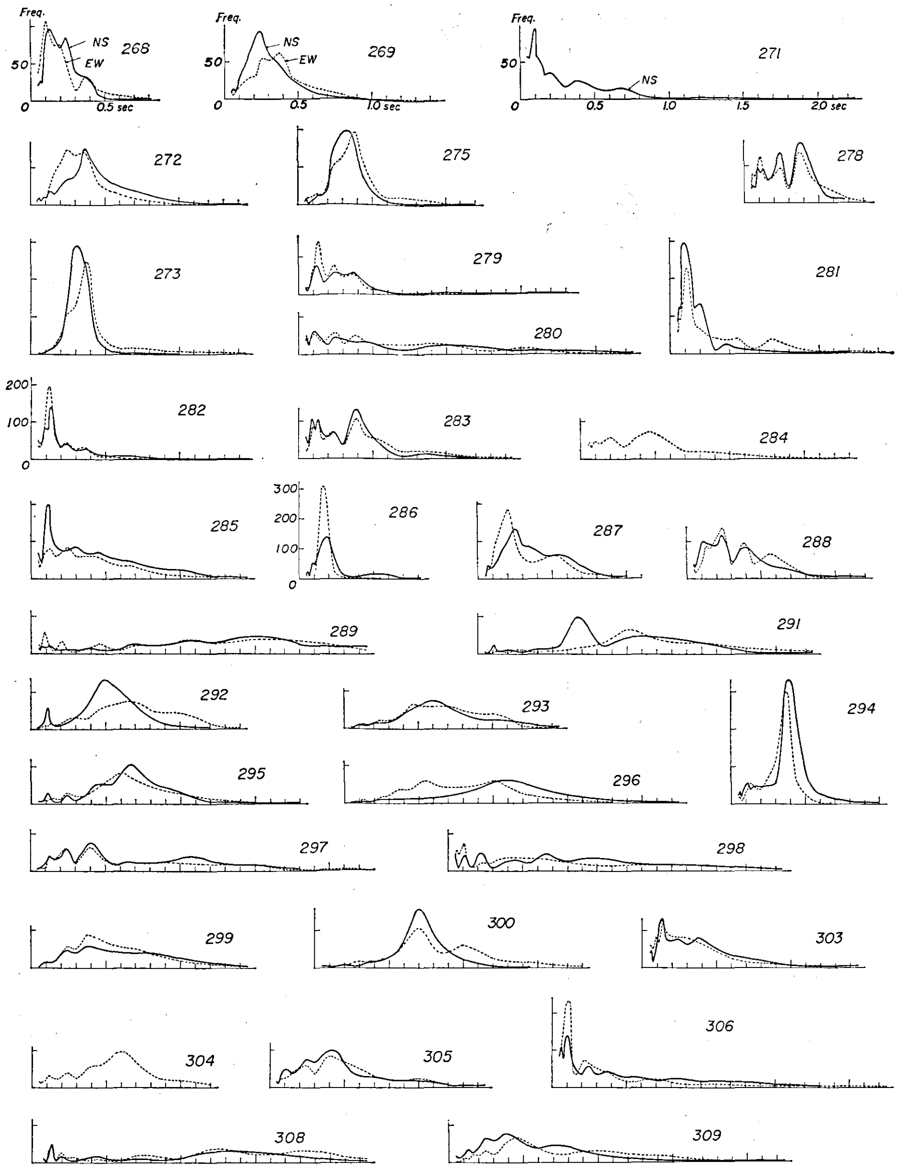

Fig. 15. Period-distribution curves of microtremors. (Site Nos. 268-309)

Table 2. Predominant period and amplitude of microtremors for sites in the U. S. A.

No.	Period (sec)	Amplitude (microns)
13	0.25	0.55
14	—	0.15
15	0.37	0.21
16	0.40	0.13
17	0.10	0.17
18	0.37	0.16
19	0.43	0.77
20	0.42	0.43
21	0.30	0.65
24	0.55	0.65
25	—	0.15
26	—	2.3
27	—	0.10
28	—	0.31
29	—	0.03
30	—	0.18
31	—	0.13
32	—	0.20
33	—	0.26
35	—	0.22
36	—	0.22
37	—	0.38
38	—	0.21
39	0.38	0.24
40	—	0.58
41	—	0.50
42	1.5	0.58
43	—	0.22
44	0.42	1.2
45	0.40	3.3
47	—	1.5
48	—	0.13
49	—	0.16
50	—	0.20
51	—	0.09
52	0.40	1.4
56	0.65	2.5
57	0.40	0.44
58	—	0.10
59	0.64	0.28
61	—	0.10
62	1.4	1.6
63	0.45	0.67
64	0.40	0.33
65	—	0.18
66	0.38	0.64
67	—	0.09
68	0.45	0.07
69	0.38	0.14
72	—	0.30
73	—	0.07
75	—	0.32
77	0.38	0.30
78	0.42	0.02
81	0.37	0.02
82	0.38	2.1
83	0.37	0.42
84	0.37	0.15
85	—	0.16
86	0.50	0.54
87	0.20	0.50
88	—	0.03
89	0.22	1.1
90	0.23	1.1
91	—	0.28
92	0.25	0.40
93	0.25	1.8
94	0.38	0.16
95	0.40	0.16
96	0.40	0.37
97	—	0.26
98	0.40	0.22
99	0.38	0.23
100	0.37	5.0
101	—	3.7
105	0.38	0.29
107	0.38	1.4
108	—	1.5
109	0.38	2.1
110	—	0.12
112	—	0.11
114	0.70	0.52
115	—	0.03
117	—	0.15
118	—	0.53
119	—	1.3
120	—	1.2
121	—	0.45
122	—	0.30
123	—	0.32
124	—	0.27
125	0.40	0.12
126	—	0.11
127	0.38	0.22
129	0.13	0.32
131	0.38	0.73
132	—	0.91
134	0.40	0.18
136	0.30	3.9
137	—	1.1
138	—	1.1
139	0.25	0.14
140	0.24	0.45
141	0.25	0.45
143	0.40	0.21
146	—	0.29
147	0.37	0.32
148	—	0.63
149	—	1.7
150	—	0.36
152	—	0.26
153	—	0.41
156	—	0.38
157	—	0.31
158	—	0.44
165	0.40	0.15
168	0.40	0.21
174	1.1	0.55
176	1.0	0.72
177	—	0.09
178	—	0.10
179	0.24	0.14
180	—	0.05
181	0.12	0.03
182	0.27	0.06
183	—	0.07
184	0.12	0.05
185	0.32	0.23
186	—	0.06
188	—	0.12
189	0.10	0.03
190	—	0.06
191	0.30	0.37
196	—	0.37
197	—	0.06
198	0.25	0.63
199	—	0.28
200	0.30	2.8
201	0.37	0.78
209	—	0.15
210	—	0.33
211	0.35	0.18
212	0.25	0.12
213	—	0.14
215	—	0.12
216	—	0.14
217	—	0.12
218	0.30	0.47
219	—	0.41
220	0.30	0.60

(to be continued)

Table 2.

(continued)

No.	Period (sec)	Amplitude (microns)
221	0.40	0.32
222	0.38	0.41
223	0.38	0.35
224	0.24	0.37
226	—	0.05
227	—	0.63
228	—	0.44
229	—	0.34
230	0.25	0.49
231	0.25	0.41
232	—	0.15
233	—	0.79
234	0.40	0.22
235	0.25	0.36
236	—	0.70
237	—	1.2
238	—	0.32
239	—	0.31
240	0.27	0.33
241	0.32	0.07
242	—	0.23
243	0.24	1.3
244	0.24	0.82
245	—	0.39
246	0.35	0.61
247	—	0.82
248	0.38	1.1
249	0.13	0.90
250	1.1	0.45
251	—	0.08
252	0.24	0.13
253	—	0.05
254	—	0.31
255	—	0.25
256	0.40	0.28
261	—	0.24
263	—	0.07
268	0.20	0.08
269	—	0.07
271	—	0.11
272	0.37	1.2
273	0.35	0.58
275	0.35	0.44
278	0.40	0.37
279	—	0.07
280	—	0.10
281	0.10	1.4
282	0.13	0.20
283	0.40	0·07
284	0.45	0.10
285	—	0.15
286	0.17	0.10
287	0.22	0.24
288	—	0.08
289	—	0.09
291	—	1.4
292	0.50	0.59
293	0.60	0.29
294	0.40	1.2
295	0.65	0.45
296	—	0.95
297	—	0.06
298	—	0.06
299	—	2.1
300	0.70	1.8
303	—	0.07
304	0.60	0.48
305	0.40	0.11
306	0.10	0.03
308	—	0.06
309	—	0.18

Table 3. Locations of microtremors observation sites in the U.S.A. A ; Strong-motion seismograph site, S ; Seismoscope site.

No.	Site	City, Town	State	Remarks
13	Harvey Auditorium (Basement)	Bakersfield	Calif.	A
14	Arvin High School (Conc. Apron Front)	Arvin	〃	
15	Lincoln School (Tunnel)	Taft	〃	A
16	New Mint Bldg. (1st Floor)	San Francisco	〃	A, S
17	Golden Gate Park, Drake's Tower	〃	〃	A (Old), S
18	Academy of Science (Basement)	〃	〃	S
19	Civic Center Library (Basement)	〃	〃	
20	State Bldg. (Basement)	〃	〃	A, S
21	Alexander Bldg. (Basement)	〃	〃	A, S
24	Shell Bldg. (Basement)	〃	〃	A
25	450 Sutter Bldg. (Basement)	〃	〃	A
26	Southern Pacific Bldg. (Basement)	〃	〃	A, S
27	Chabot Observatory (Basement)	Oakland	〃	A
28	Oakland City Hall (Basement)	〃	〃	A, S
29	Univ. of Calif. Haviland Hall (Basement)	Berkeley	〃	A
30	Contra Costa Jr. College (Basement)	San Pablo	〃	A
31	Westavoc Quarry—11 miles south of Hollister	Hollister	〃	S
32	Almaden Winery	〃	〃	S
33	San Justo School—4 miles west of Hollister	〃	〃	
35	Portland Cement Quarry	〃	〃	
36	2 miles—WSW (Road) of Hollister	〃	〃	
37	Hollister City Library (Basement)	〃	〃	A, S
38	1/2 mile West of Library (Road)	〃	〃	
39	1/2 mile South of Library (Road)	〃	〃	
40	$2\frac{1}{4}$ miles East of Library (Road)	〃	〃	
41	$4\frac{1}{2}$ miles East of Hollister (Road)	〃	〃	
42	$5\frac{1}{2}$ miles East of Hollister (Road)	〃	〃	
43	St. Francis Retreat (Road)	〃	〃	
44	Burgermeister Brewery Bldg. (Basement)	San Francisco	〃	S
45	Engine Company #6 (Basement)	〃	〃	S
47	Santa Marina Bldg. (Basement)	〃	〃	S
48	Engine Company #28 (Basement)	〃	〃	S
49	Engine Company #41 (Basement)	〃	〃	S
50	San Francisco Funeral Service (Basement)	〃	〃	S
51	Randall Jr. Museum (Basement)	〃	〃	S
52	Bethlehem Pacific Bldg. (Basement)	〃	〃	A
56	Bechtel Bldg. (Basement)	〃	〃	
57	Bank of America Bldg. (Basement)	San Jose	〃	A
58	Coit Tower (1st Floor)	San Francisco	〃	S
59	Potrero Hts. (1st Floor)	〃	〃	S
61	Yerba Buena Island (Summit)	〃	〃	S
62	Treasure Island (Road)	〃	〃	S
63	Army Base, Warehouse #5 (Conc. Floor)	Oakland	〃	
64	School of Blind (1st Floor)	〃	〃	
65	College of Arts and Crafts (Road)	〃	〃	
66	Post Office (Basement)	Sacramento	〃	A
67	Univ. of Nevada, Sch. of Mines Bldg. (B.)	Reno	Nevada	
68	Univ. of Nevada, McKay Science Bldg. (B.)	〃	〃	
69	Fallon City Hall (Basement)	Fallon	〃	
72	Ruby Hill Mine	Eureka	〃	

(to be continued)

Table 3.

(continued)

No.	Site	City, Town	State	Remarks
73	Ranger's Residence	Yellow Stone	Montana	
75	Hebgen Dam, West abutment (on rock)	〃	〃	
77	Montana State College, Engg. Bldg. (B.)	Bozeman	〃	A
78	Montana School of Mines (Basement)	Butte	〃	A
81	Federal Bldg. (Basement)	Helena	〃	A (Old)
82	U. S. Post Office (Basement)	Spokane	Wash.	
83	Office of Dames & Moore	Seattle	〃	
84	University of Washington (Basement)	〃	〃	
85	43 and Blaine (Sidewalk)	〃	〃	
86	Carnation Milk Plant, Parking Lot	〃	〃	
87	"M" Street Bridge (Road)	Tacoma	〃	
88	Teleseismic Station (Door step)	Tumwater	〃	
89	State Highway Test Laboratory	Olympia	〃	A
90	50′ West of Franklin St. (Sidewalk)	〃	〃	
91	State Library Bldg. (Sidewalk)	〃	〃	
92	J. C. Penney Bldg. (1st Floor)	〃	〃	
93	Hyak Lumber Co., Parking Lot	〃	〃	
94	Epicenter of 1949 Earthquake	Steilacoom	〃	
95	Narrows Bridge, East Approach	Tacoma	〃	
96	Federal Office Bldg. (Basement)	Seattle	〃	A
97	Norton Bldg. (Footing)	〃	〃	
98	Parking Garage, 3rd and Pine (Basement)	〃	〃	
99	Swedish Hospital (Basement)	〃	〃	
100	Proposed site for pier #28	〃	〃	
101	Boeing MPC Plant, Parking Lot	〃	〃	A (Old)
105	Proposed City Office Bldg., Parking Lot	〃	〃	
107	Stauffer Chemical Co. (Garage)	〃	〃	
108	Port of Tacoma, Bulk Wheat Storage Bldg.	〃	〃	
109	Proposed Bulk Storage Facility	〃	〃	
110	Stadium Bowl, Stadium High School	〃	〃	
112	Weyerhaeuser Bldg. (Doorway)	Tacoma	〃	
114	Andover Industrial Park	Tukwila	〃	
115	Teleseismic Station (Rock Outcrop)	Longmire	〃	
117	Boeing South Park, Parking Lot	Seattle	〃	
118	State Office Bldg. (Basement)	Portland	Oregon	A
119	Post Office Bldg. (Basement)	Eureka	Calif.	A, S
120	Valley Flower Creamery (1st Floor)	Port Kenyon	〃	S
121	City Hall and Fire Station (1st Floor)	Ferndale	〃	A, S
122	Bunker Hill Ranch, South of Ferndale	Ferndale Area	〃	
123	Leo Christie Ranch, South of Ferndale	〃	〃	
124	C. A. A. Bldg., Top of Bear River Ridge	〃	〃	S
125	Latitude Observatory of USCGS (Basement)	Ukiah	〃	
126	Naval Ammunition Depot, Admin. Bldg. (B.)	Hawthorne	Nevada	A
127	L. A. City Dept. of Water and Power (Garage)	Bishop	Calif.	A
129	Hoover Dam, Switchyard Oilhouse (Basement)	Boulder City	Nevada	A
131	El Centro High School (Road)	El Centro	Calif.	S
132	Light and Power Co. Service Bldg. (1st Fl.)	San Diego	〃	A
134	San Bernardino Post Office (Basement)	San Bernardino	〃	A, S
136	Intersection of T. I. FWY at Seaside Ave.	Long Beach	〃	
137	Municipal Utilities Bldg. (Basement)	〃	〃	A, S

(to be continued)

Table 3.

(continued)

No.	Site	City, Town	State	Remarks
138	Central Mfg. District Terminal Bldg. (B.)	Vernon	Calif.	A, S
139	CIT Faculty Club Bldg. (Front Door)	Pasadena	〃	A, S
140	Hollywood Storage Bldg., P. E. Lot	Los Angeles	〃	A, S
141	Hollywood Storage Bldg., (Basement)	〃	〃	A
143	Subway Terminal Bldg. (Basement)	〃	〃	A, S
146	Occidental Life Bldg. (Basement)	〃	〃	A, S
147	Edison Bldg. (Basement)	〃	〃	A, S
148	UCLA Engineering Bldg. II, Room 5252	〃	〃	
149	CIT Engineering Bldg. (Basement)	Pasadena	〃	
150	UCLA Engineering Bldg. IB (1st Floor)	Los Angeles	〃	A, S
152	UCLA Faculty Center, Parking Lot	〃	〃	
153	UCLA Engg. Bldg. IA, 40′ NW of Bldg.	〃	〃	
156	UCLA SW Corner of Grade School	〃	〃	
157	143 Groverton Place (Road)	〃	〃	
158	UCLA Mechanics Bldg., Parking Lot	〃	〃	
165	UCLA Franz Hall addition (Basement)	〃	〃	
168	UCLA Western Data Processing Center	〃	〃	
174	UCLA Medical Center (Basement)	〃	〃	
176	Playa Del Rey School (Basement)	〃	〃	S
177	Residence of Mr. J. M. Norquist (Garage)	Pasadena	〃	S
178	Hale Elementary School (Basement)	〃	〃	S
179	Garfield Elementary School (Basement)	〃	〃	S
180	San Raphael Elementary School (Basement)	〃	〃	S
181	Residence of Mr. N. Motta (Hobby Shop)	〃	〃	S
182	Washington Jr. High School (1st Floor)	〃	〃	S
183	Residence of Dr. Frank Press (Garage)	〃	〃	S
184	Residence of Mr. R. Gilman (Garage)	〃	〃	S
185	Residence of Mr. E. Frackelton (Garage)	Los Angeles	〃	S
186	Residence of Dr. C. F. Richter (Garage)	Pasadena	〃	
188	Huntington Library (Basement)	San Marino	〃	
189	Mt. Wilson Observatory Teleseismic Station	Mt. Wilson	〃	S
190	CIT Seismological Laboratory (Bault)	Pasadena	〃	S
191	1619 Beverly Blvd., Parking Lot	Los Angeles	〃	
196	Signal Oil Bldg. (Basement)	〃	〃	
197	Encino Dam (Spot 8), West Side	Encino	〃	
198	Palos Verdes School Dist., Admin. Center	Rolling Hills	〃	
199	San Pedro High School (Basement)	San Pedro	〃	S
200	New Torrance City Hall (Basement)	Torrance	〃	
201	Narbonne High School (1st Floor)	Los Angeles	〃	S
209	Tishman Bldg. (Basement)	〃	〃	
210	Hancock Park, Service Bldg.	〃	〃	S
211	Van Nuys High School (Basement)	Van Nuys	〃	S
212	Hoover High School (Basement)	Glendale	〃	S
213	Elysian Heights El. School (1st Floor)	Los Angeles	〃	S
215	California Bank (4th Basement)	〃	〃	
216	Parking Square (Lowest Level)	〃	〃	
217	Museum of Science and Industry (Basement)	〃	〃	S
218	City Hall (Basement)	Huntington Park	〃	S
219	Southgate High School, Main Bldg. (B.)	Southgate	〃	S
220	Compton School Administration Bldg. (B.)	Compton	〃	S

(to be continued)

Table 3.

(continued)

No.	Site	City, Town	State	Remarks
221	Residence of Mr. D. J. Leeds (Garage)	Westchester	Calif.	S
222	Playa Del Ray El. School (1st Floor)	Los Angeles	〃	S
223	Windsor Hills El. School (1st Floor)	〃	〃	S
224	Residence of Mr. A. Zane (1st Floor)	〃	〃	
226	Residence of Mr. C. M. Duke (Garage)	〃	〃	S
227	Residence of Mr. G. Tauxe (Garage)	Santa Monica	〃	S
228	Santa Monica Public Library (Alley)	〃	〃	
229	Santa Monica Blvd. at Centinella, Park. Lot	〃	〃	
230	West Los Angeles Public Library (Basement)	Los Angeles	〃	S
231	Residence of Dr. K. Kanai (Garage)	〃	〃	
232	438 Roxbury, (Sidewalk)	Beverly Hills	〃	
233	906 Bronson at 9th St. (Curb)	Los Angeles	〃	
234	San Marino at Menlo (Sidewalk)	〃	〃	
235	20th St. at Flower, Parking Lot	〃	〃	
236	Site for L. A. Dept. of Water and Power	〃	〃	
237	Site for Customs House and Fed. Bldg.	〃	〃	
238	407 S. Alvarado, Parking Lot	〃	〃	
239	San Marino City Hall (Basement)	San Marino	〃	S
240	Residence of Mrs. Violet Taylor (Garage)	Los Angeles	〃	S
241	John Muir High School (Boiler Slab)	Pasadena	〃	S
242	604 S. Wing St. (Sidewalk)	Glendale	〃	
243	Lutheran Church (Sidewalk)	Burbank	〃	
244	Van Owen Park (Road)	Van Nuys	〃	
245	Encino Little League Baseball Park	Encino	〃	
246	84th Place at Zamora Ave. (Sidewalk)	South Gate	〃	
247	Knott's Berry Farm, Parking Lot	Buena Park	〃	
248	Grand Ave. S. 600 W. 7th St. (Sidewalk)	Corona	〃	
249	500′ West of R. R. Station (Road)	Arlington	〃	
250	California School of Deaf	Riverside	〃	
251	Teleseismic Station (Seismo. Lab.)	〃	〃	
252	Lincoln Elementary School (Basement)	〃	〃	S
253	Panorama Maintenance Sta. (On Granite)	San Bernardino	〃	
254	Airport Jr. High School, Parking Lot	Westchester	〃	
255	Morningside High School, Parking Lot	Inglewood	〃	
256	Lennox Blvd. at Condon (Sidewalk)	Lennox	〃	
261	Barrington Plaza, Center of Bldg. C	Los Angeles	〃	
263	20529 Tiara, Woodland Hills	〃	〃	
268	Residence of A. Komm, 9416 Varna (Garage)	Pacoima	〃	
269	Mulholland Overpass, West Abutment	Los Angeles	〃	
271	Will Rogers Beach State Park	Santa Monica	〃	
272	Venice Oil Field, 49th St. and Speedway	Venice	〃	
273	Baldwin Hills Dam, East Abutment		〃	
275	Harvard Playground, 62nd St. at Denker	Los Angeles	〃	
278	Embarcadero at Montogomery	San Francisco	〃	
279	Columbus at Green (Sidewalk)	〃	〃	
280	Nob Hill, Taylor St. Opp. Park	〃	〃	
281	Truett off Mason (Sidewalk)	〃	〃	
282	Jones at Sutter	〃	〃	
283	Mission Dolores (Curb)	〃	〃	
284	Downtown Center Garage (Ground Level)	〃	〃	

(to be continued)

Table 3.

(continued)

No.	Site	City, Town	State	Remarks
285	Jessie St. at 5th, Parking Lot	San Francisco	Calif.	
286	Southern Pacific Dept	〃	〃	S
287	Folsom St. between 16th and 17th Sts.	〃	〃	
288	21st St. at Mission	〃	〃	
289	22nd St. at Noe St.	〃	〃	
291	Bay Bridge Toll Plaza, Parking Lot	Oakland	〃	
292	Fisherman's Wharf, Parking Lot	San Francisco	〃	
293	Airport, 350′ S. W. Main Terminal Bldg.	〃	〃	
294	Airport, United Airlines, Engine Test Bldg.	〃	〃	
295	Harbor Rd. at Littlefield Ave.	〃	〃	
296	N. End of Wattis Way (Haas Way)	〃	〃	
297	Eccles and Sperry Avenues	〃	〃	
298	Paul Revere El. Sch., Tompkins at Banks St.	〃	〃	S
299	Rankin at Evans St. (Curb)	〃	〃	S
300	Islais Creek, East end of Marin St.	〃	〃	S
303	Laguna Honda Home, Service Yard	〃	〃	S
304	San Francisco State College	〃	〃	S
305	Res. of Mr. B. J. Morrill. Poinsettia	San Mateo	〃	
306	City Recreation Center (Basement)	San Luis Obispo	〃	A
308	Cachuma Dam, Gate House	Cachuma	〃	A
309	Court House (Basement)	Santa Barbara	〃	A

and Geodetic Survey; the University of California, Los Angeles; and Dames & Moore, Consultants in Applied Earth Sciences; for their helpful assistance in the observation of microtremors.

Thanks are due to Mr. T. Suzuki and Miss S. Yoshizawa for their valuable help in analyzing the microtremors records and in preparing this report.

Research grants were received from the National Science Foundation, and the University of California, Los Angeles. The authors wish to express gratitude to these organizations as well as to others not specifically identified.

---

54. 常時微動の観測結果 第12報 (アメリカ合衆国の場合)

地震研究所 田中貞二
金井　清
長田甲斐男

カリフォルニア大学 D. J. LEEDS

アメリカ合衆国西部の強震計設置場所およびその周辺地域の 250 ケ所以上で常時微動の観測を行なった.

観測記録の周期頻度解析の結果から推定される地盤の振動性状は，場所によるちがいが大きく，少なくともこの地域における構造物にたいしては，地盤特性を考慮に入れた耐震設計を行なう必要を示すものであった．また，常時微動の振巾分布，あるいは周期，振巾の日変化の模様などは，日本での観測結果と同様な傾向をもつことがわかった.

なお，この観測の主な目的である強震計記録と同一場所の常時微動との比較結果は，その 1 部をすでに報告したが，強震計資料ならびに地盤資料の蓄積をまって，さらに詳しい検討を行なう予定である.