STRONG-MOTION RECORDS
RECOVERED FROM
THE MAMMOTH LAKES, CALIFORNIA, EARTHQUAKE
OF
30 SEPTEMBER 1981

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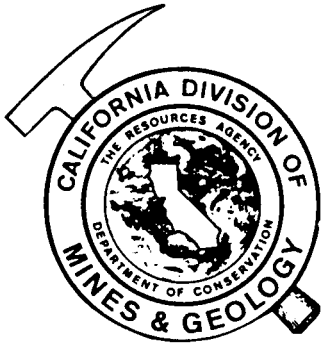
CALIFORNIA DIVISION OF MINES AND GEOLOGY
OFFICE OF STRONG MOTION STUDIES

REPORT 81-10.1



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N.A. Kaliakin

16 October 1981

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California Division of Mines and Geology

PRELIMINARY DATA

(Subject to Revision)

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ILLUSTRATIONS

INTRODUCTION

A moderate-magnitude earthquake [M_L=5.8, California Institute of Technology (CIT), Seismological Laboratory] occurred at 0453 Pacific Daylight Time (PDT) on 30 September 1981 approximately 10.5 km southeast of Mammoth Lakes, Mono County, California (figure 1). The earthquake epicenter is located by the California Division of Mines and Geology (CDMG) at 37.585°N and 118.886°W in the vicinity of Laurel Mountain at a focal depth of 6.2 km. Numerous aftershocks were generated after the main event. As of 1800 PDT on 1 October 1981, thirty-four M_L=3.0-3.9 and five M_L=4.0-4.9 aftershocks had occurred (Smith, 1981). The largest aftershock in this earthquake series occurred at 0606 PDT on 30 September and is located by CDMG to be at 37.642°N and 118.872°W (figure 1). Its magnitude is calculated by several agencies and varies from M_L=4.5 (Office of Emergency Services - Sacramento) to M_L=5.5 (CIT, National Earthquake Center - Golden). CDMG seismologists estimate the event at $M_L \sim 5.2$ based on magnitudes calculated by CIT, University of California, Berkeley, and University of Nevada, Reno.

The main shock of 30 September 1981 is in an area of the east-central Sierra Nevada that has experienced numerous moderate-magnitude events since occurrence of the 4 November 1978 Bishop earthquake (near Crowley Lake). This region was most active during the M_L>6.0 (CIT) Mammoth Lakes earthquakes of 25 and 27 May 1980 (see, McJunkin and Bedrossian, 1980; Sherburne, 1980; Turpen, 1980; Clark and Young, 1981; Cramer and Toppozada, 1981).

Damage from this recent episode of earthquake activity was minor. No structural damage was reported in Mammoth Lakes, the closest community to

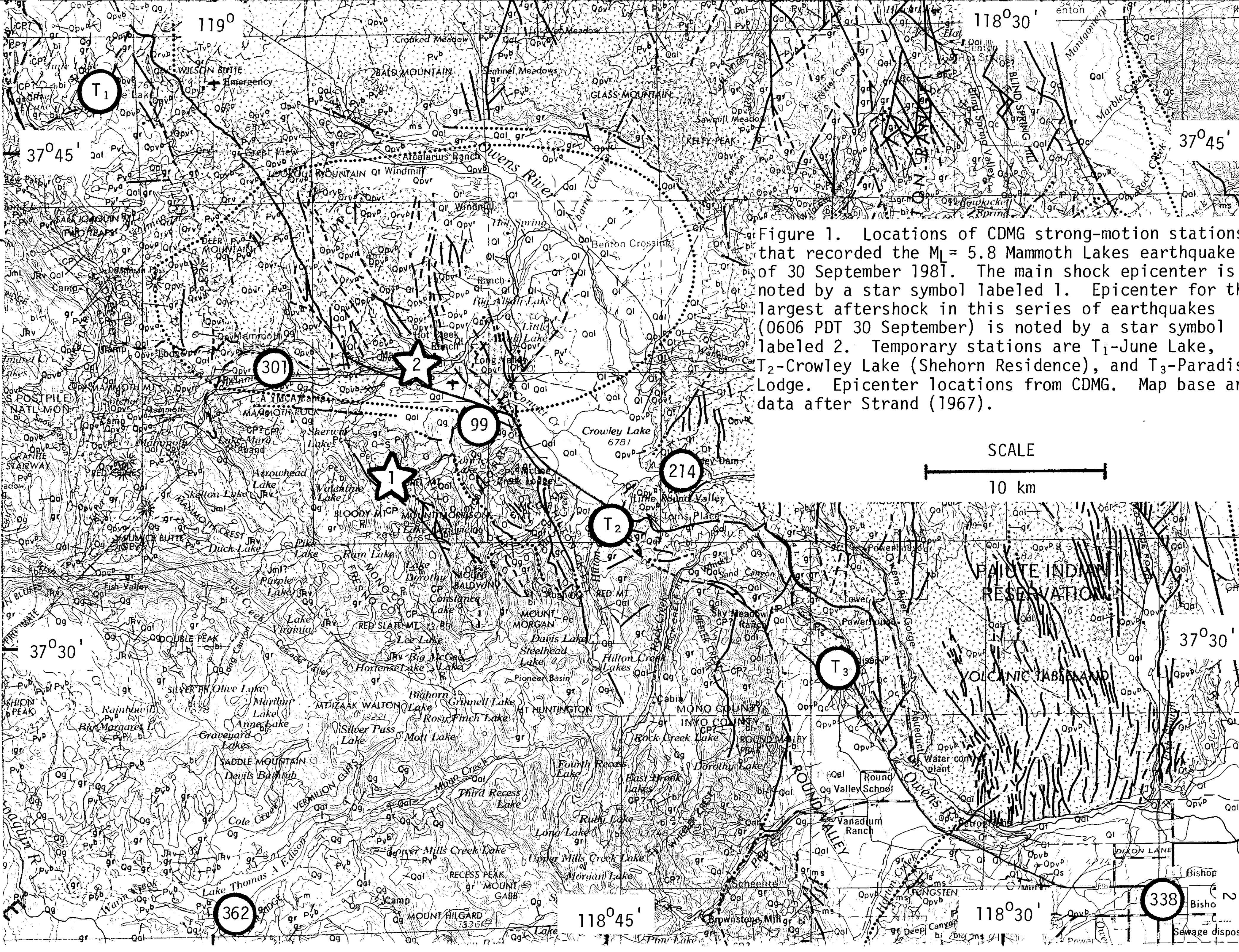


Figure 1. Locations of CDMG strong-motion stations that recorded the $M_L = 5.8$ Mammoth Lakes earthquake of 30 September 1981. The main shock epicenter is noted by a star symbol labeled 1. Epicenter for the largest aftershock in this series of earthquakes (0606 PDT 30 September) is noted by a star symbol labeled 2. Temporary stations are T_1-June Lake, T_2-Crowley Lake (Shehorn Residence), and T_3-Paradise Lodge. Epicenter locations from CDMG. Map base and data after Strand (1967).

the main event. The most notable damage was non-structural and occurred in the Hot Creek area approximately 10 km east of Mammoth Lakes. In this location, much of the shelf stock at the Mammoth Lakes School District bus barn was toppled onto parked buses in the structure and the building floor. At the adjacent State Fish Hatchery, many fish died from suffocation when filters of the holding tanks were clogged by high concentrations of silt that was added to tributaries from discharges of local springs; additionally, concrete channels at this facility were cracked in several places from seismic shaking. As a precautionary measure, the U.S. Forest Service (USFS) closed access to Hot Creek and Convict Canyon until earthquake activity subsided. The Hot Creek area was closed because of surges and unpredictable behavior in geothermal emissions; access into Convict Canyon was halted because of rock slide danger from steep canyon walls which are underlain by loose rock and slope debris. Numerous rock slides did in fact occur in mountainous regions of the earthquake area during the first few days after the main event.

GROUND EFFECTS

Post-earthquake field investigations, for the most part, were restricted to roads and pre-existing faults in the Long Valley caldera. Tectonically-induced ground rupture was identified and mapped in several places during these investigations by CDMG geologists and a USFS hydrologist. Numerous ground breaks were mapped along pre-existing faults in the Long Valley caldera. Maximum displacements measured were 2 cm to 4 cm of extensional opening and 1 cm to 2 cm of vertical down-to-the-east normal offset on an east facing pre-existing scarp. It should be noted that down-to-the-west offsets were also observed on west facing

pre-existing scarps. Most ground cracks were in exactly the same location as those mapped and flagged by Bryant and others (1980) after the May 25 and 27, 1980 Mammoth Lakes earthquakes; in some places flagging was still present and precisely located the 1980 crack zone. A short segment of extensional cracking (open ∿1 mm) on the Hilton Creek fault was mapped in compacted road base overlying glacial moraine deposits where McGee Canyon road crosses the fault (Bill Bryant, CDMG geologist, personal communication, 1981). A few sand boils, minor lurching, and slump cracks were also identified at various places throughout the region (Mark Clark, USFS hydrologist, personal communication, 1981).

STRONG-MOTION DATA

Instruments at eight CDMG Strong Motion Instrumentation Program (SMIP) Stations were triggered by the 30 September 1981 Mammoth Lakes main event (table 1). Four of these stations recorded ground accelerations greater than 0.05 g which is the minimum value used by CDMG for significant earthquake accelerations (CDMG, 1979; Porter and Real, 1979). The CDMG station at Convict Creek-Sierra Nevada Aquatic Research Lab was closest to the main event (6 km) and recorded the highest ground accelerations (table 2). This station recorded peak accelerations of 0.20 g vertically and 0.26 g and 0.21 g horizontally. The other three strong-motion stations with significant accelerations are Crowley Lake-Shehorn Residence, Mammoth Lakes-High School Gym, and Long Valley Dam. All CDMG stations with significant ground accelerations from this event are located at epicentral distances of 16 km or less. The most distant CDMG station triggered by the main event (49.5 km) was an office building instrumented with a central recording accelerograph system in Bishop,

TABLE 1

Alphabetical list of CDMG strong-motion accelograph stations that were triggered and recorded the 30 September 1981 Mammoth Lakes main event.

No.	Station	Coordinates	Site Geology	Structure Type/Size	Instrument Location(s)
338	Bishop Office Bldg	37.370°N 118.396°W	alluvium >1000 m	2-story bldg	ground level 2nd, roof
99	Convict Creek UC Res Station	37.614°N 118.831°W	alluvium >200 m	1-story bldg	ground level
Temp	Crowley Lake Shehorn Res	37.561°N 118.743°W	alluvium ∿50 m	1-story bldg	ground level
Temp	June Lake Fire Station	37.783°N 119.075°W	granitic rock	2-story bldg	ground level
214	Long Valley Dam	37.588°N 118.705°W	rock (Bishop tuff)	earth dam	abutment crest,face,toe
301	Mammoth Lakes High School Gym	37.641°N 118.963°W	glacial debris ∿75 m	1-story bldg	ground level roof
Temp	Paradise Lodge	37.481°N 118.602°W	∿5 m alluvium over tuff	1-story bldg	ground level
362	Vermilion Dam	37.370°N 118.987°W	glacial debris ≥75 m	earth dam	abutment crest,face,toe

TABLE 2

Alphabetical listing of CDMG accelerograph stations that were triggered and recorded the 30 September 1981 M_L =5.8 Mammoth Lakes earthquake. Acceleration data are for ground motion at these stations. An asterisk (*) indicates that ground acceleration was less than significant (<0.05 g).

Station (Instrument; Serial No.)	Acceleration Data Azimuth[1]	Peak Acc.[2] (g)
Bishop	270	*
Office Bldg	Up	*
(CRA-1; #183)	360	*
Convict Creek	180	0.26
UC Res Station	Up	0.20
(SMA-1T; #2593)	90	0.21
Crowley Creek	90	0.11
Shehorn Residence	Up	0.09
(SMA-1T; #1811)	360	0.10
June Lake	360	*
Fire Station	Up	*
(SMA-1T; #2778)	270	*
Long Valley Dam	90	*
(CRA-1; #190)	Up	*
	360	0.07
Mammoth Lakes	254	0.12
High School Gym	Up	0.15
(CRA-1; #135)	344	0.16
Paradise Lodge	150	*
(SMA-1T; #1827)	Up	*
	60	*
Vermilion Dam	192	*
(CRA-1; #195)	Up	*
	282	(non operational)

1 Azimutal direction of ground acceleration for upward trace deflection on accelerogram (degrees clockwise from north).

2 Peak acceleration (g) is the decimal fraction of acceleration due to gravity where 1.0 g $\sim$9.8 m/sec^2.

California. Ground and structural accelerations at this station were all less than 0.05 g.

The largest aftershock in the earthquake series (0606 PDT - 30 September) triggered accelerographs at the Convict Creek, Crowley Lake-Shehorn Residence, Long Valley Dam, and Mammoth Lakes-High School Gym strong-motion stations. Two of these CDMG stations produced significant records for the event. As with the main event that occurred approximately one hour before, the instrument at the Convict Creek strong-motion station was closest to the aftershock epicenter (4.6 km) and recorded the highest ground accelerations. These accelerations are 0.10 g vertically and 0.22 g and 0.19 g horizontally. One ground motion channel at Mammoth Lakes-High School Gym produced an acceleration of 0.07 g; the other two ground motion channels at this station were less than 0.05 g (see, Earthquake Records section).

A M_L=3.8 (CIT) aftershock centered in the vicinity of the mouth of Convict Canyon occurred at approximately 1821 PDT on 2 October 1981. The only CDMG instruments triggered by the earthquake were at the Convict Creek station and a temporary installation sited near Convict Lake to monitor aftershock activity (figure 1). Peak accelerations at the Convict Creek station from the event were 0.09 g and 0.06 g horizontally with the vertical movement less than 0.05 g (see, Earthquake Records section). At the Convict Lake instrument, located approximately 4 km to the west, accelerations recorded were all less than 0.05 g.

REFERENCES CITED

Bryant, W A., Taylor, G.C., Hart, E.W., Kahle, J.E., Bedrossian, T.L., and McJunkin, R.D., 1980, Preliminary map of surface rupture associated with the Mammoth Lakes, California earthquakes, May 25 and 27, 1980; California Division of Mines and Geology Open-File Report 80-12 SAC, 19 p., map scale 1:62,500.

California Division of Mines and Geology, 1979, Feasibility study report, data processing needs of the California Strong Motion Instrumentation Program: California Division of Mines and Geology in-house report (unpublished).

Clark, M.M., and Yount, J.C., 1981, Surface faulting along the Hilton Creek fault associated with the Mammoth Lakes, California earthquakes of May 1981 (abstract): Seismological Society of America Earthquake Notes, v. 51, no. 1, p. 45-46.

Cramer, C.H., and Toppozada, T.R., 1981, The 1980 Mammoth Lakes, California earthquake sequence: evidence for a complex rupture zone (abstract): Seismological Society of America Earthquake Notes, v. 52, no. 1, p. 45.

McJunkin, R.D., and Bedrossian, T.L., 1980, Mammoth Lakes earthquakes May 25-27, 1980, Mono County, California : California Geology, v. 33, no. 9, p. 194-201.

Porter, L.D., and Real, C.R., 1979, Data load estimation techniques for strong-motion networks, *in* Earthquake Engineering Research Institute Proceedings of the 2nd U.S. National Conference on Earthquake Engineering: Earthquake Engineering Research Institute, p. 213-222.

Sherburne, R.W., editor, 1980, Mammoth Lakes, California earthquakes of May 1980: California Division of Mines and Geology Special Report 150, 141 p.

Smith, K., 1981, Mammoth aftershocks continue, *in* Wellman, R., publisher: Sierra Daily News, v. 1, no. 96, p. 1.

Strand, R.G., 1967, Geologic Map of California, Mariposa Sheet: California Division of Mines and Geology, scale 1:250,000.

Turpen, C.D, 1980, Strong-motion records from the Mammoth Lakes earthquakes of May 1980: California Division of Mines and Geology Preliminary Report 27, 42 p.

Bishop Office Building
CRA-1 (#183)

All traces <0.05 g

1)

2)

3)

4)

5)

6)

7)

8)

9)

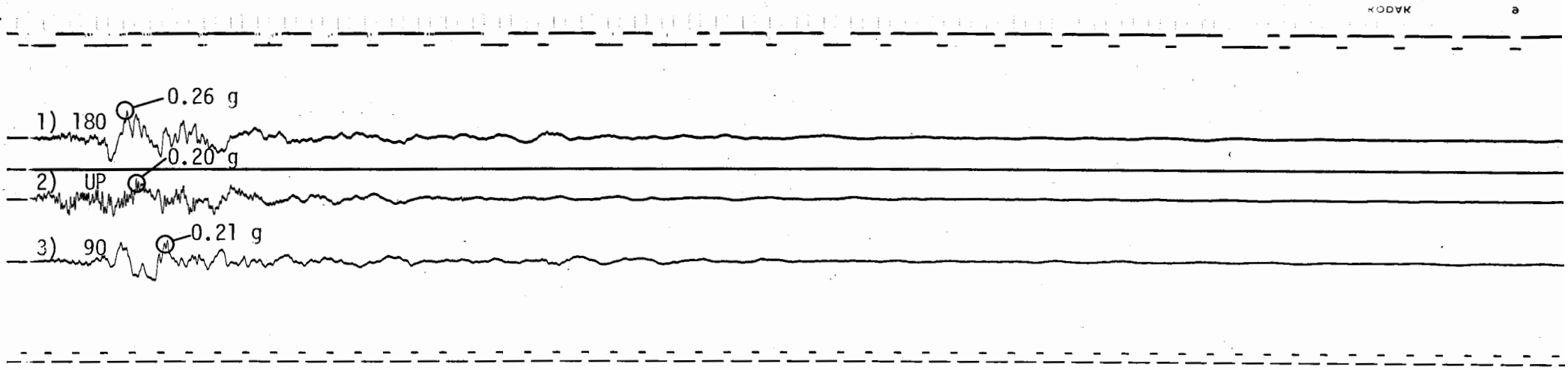
10)

11)

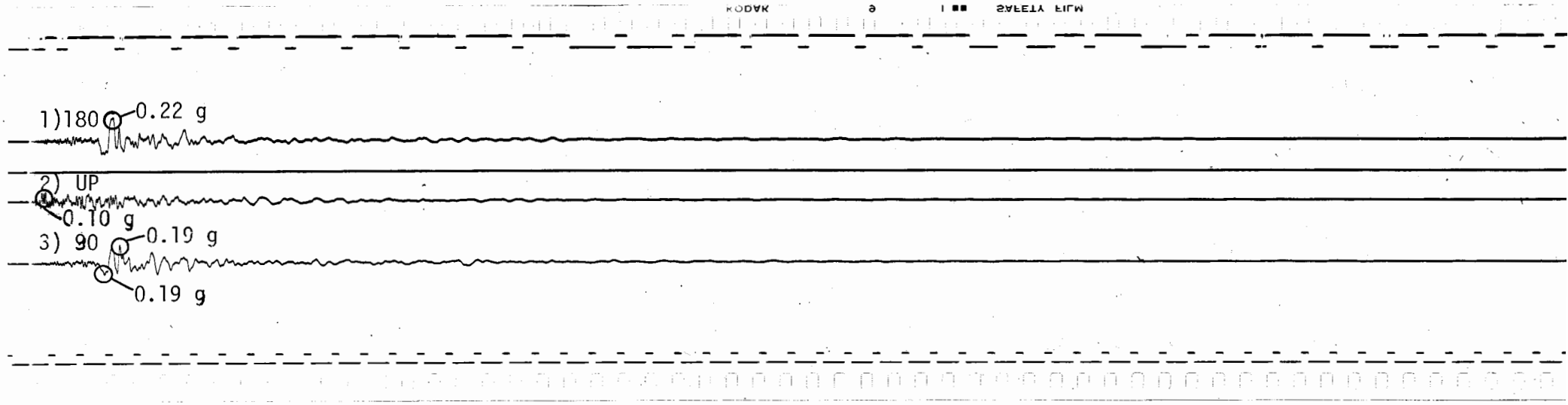
12)

13)

Convict Creek-UC Research Station
SMA-1T (#2593)

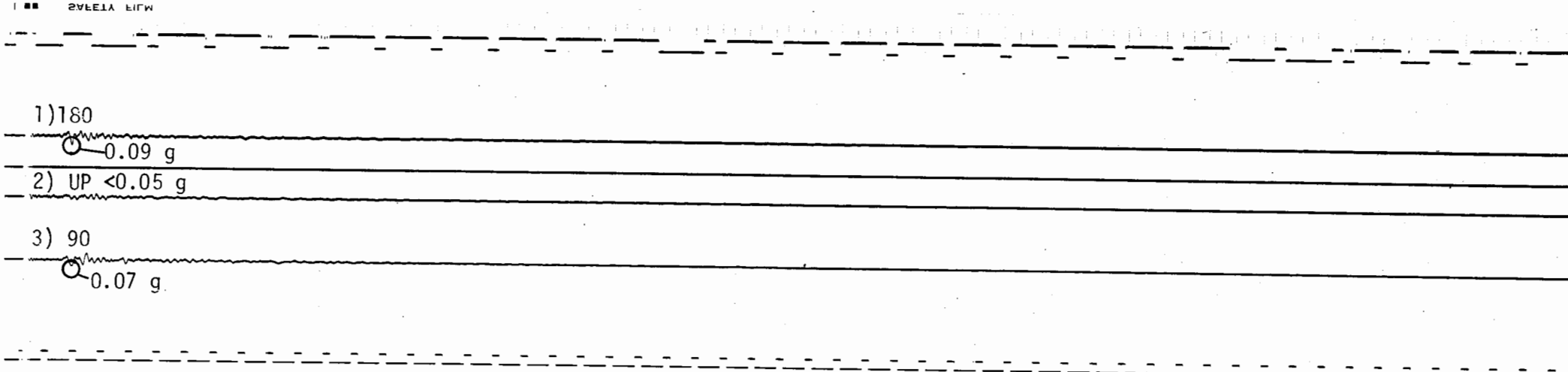


Convict Creek-UC Research Station AFTERSHOCK-0606 PDT, 30 September
SMA-1T (#2593)

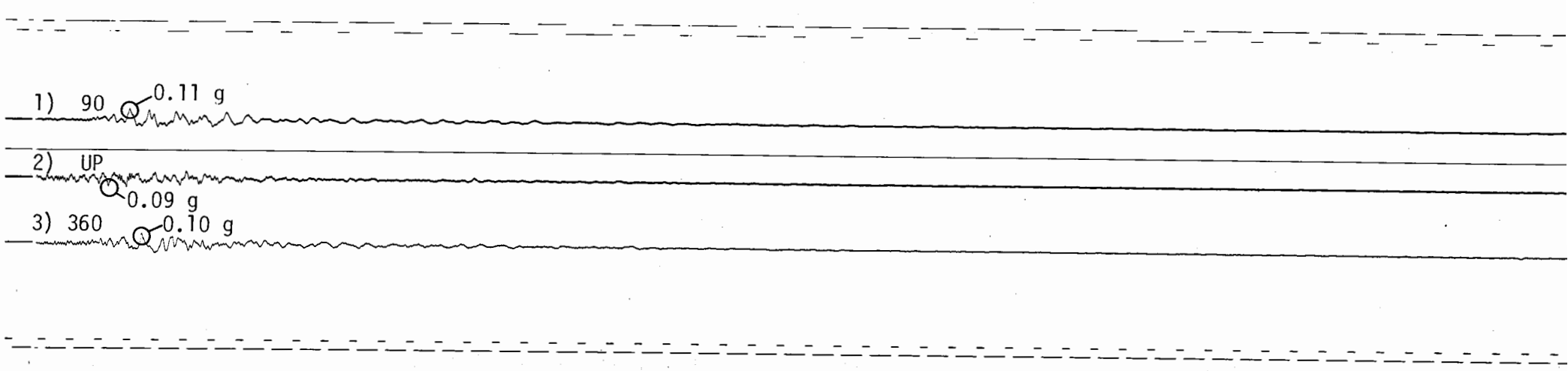


Convict Creek-UC research Station
SMA-1T (#2593)

AFTERSHOCK-1820 PDT, 2 October



Crowley Lake-Shehorn Residence
SMA-1T (#1811)



June Lake-Fire Station CDMG-Temp
SMA-1T (#2778)

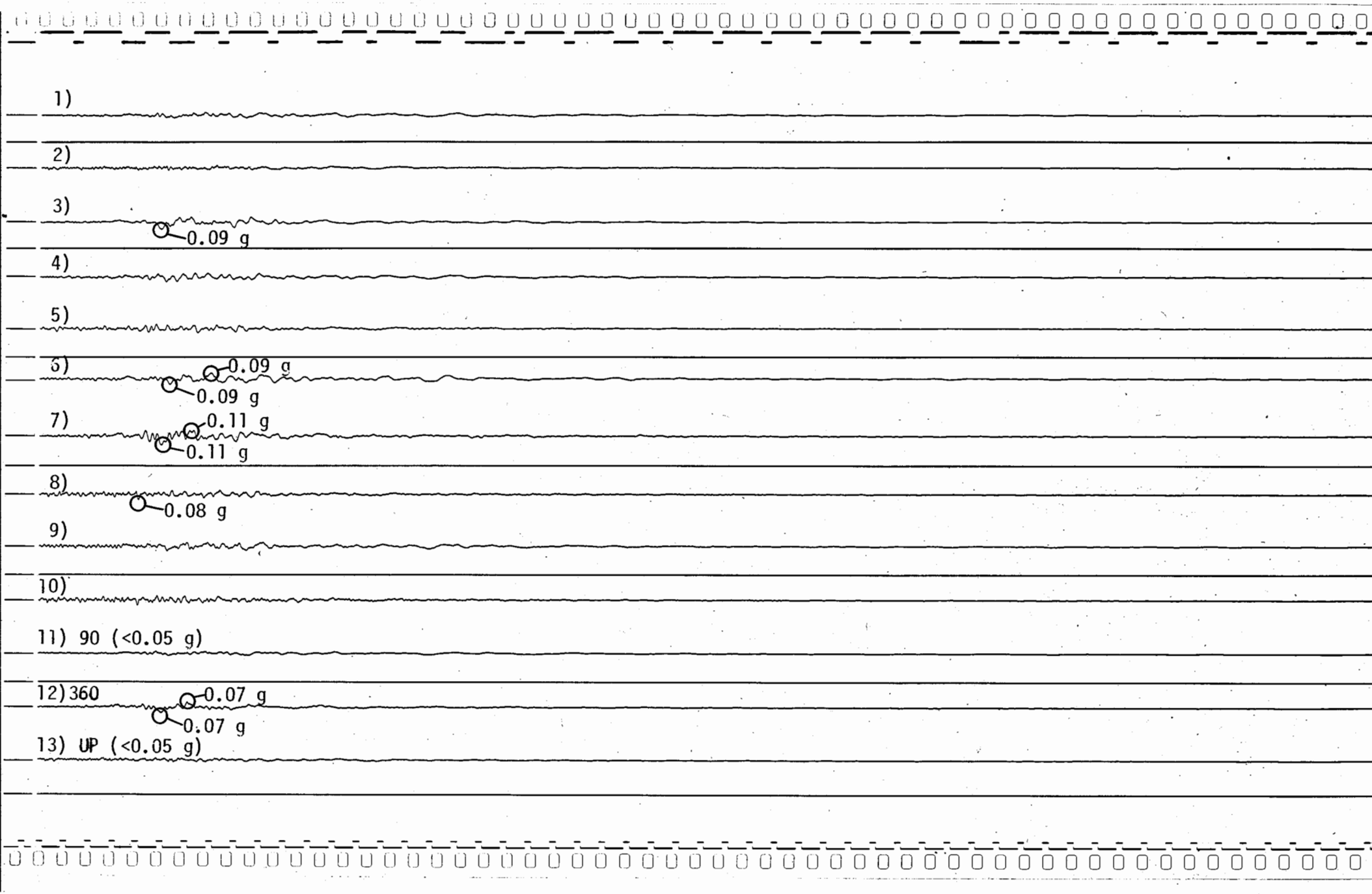
All traces < 0.05 g

1) 360

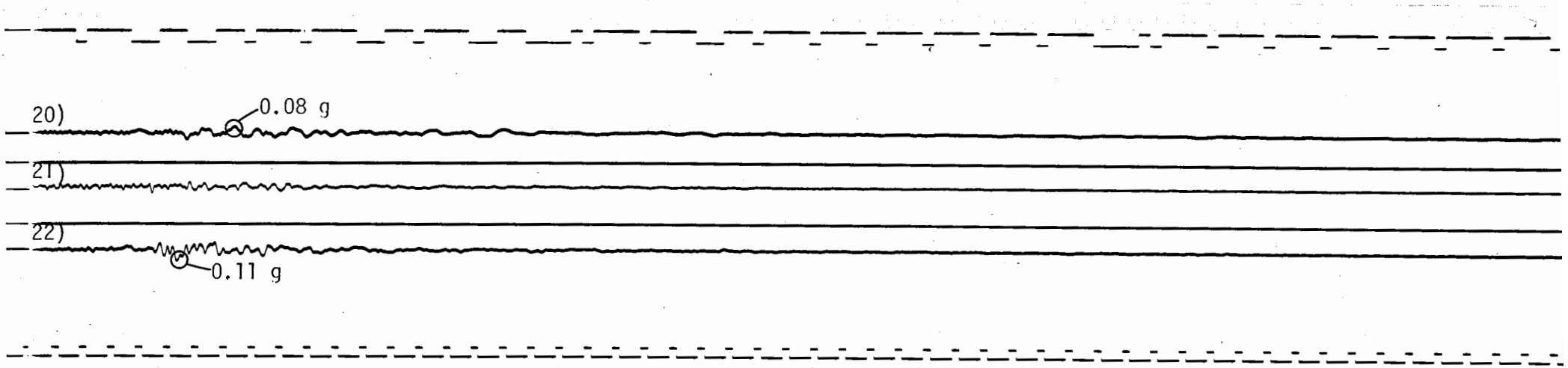
2) UP

3) 270

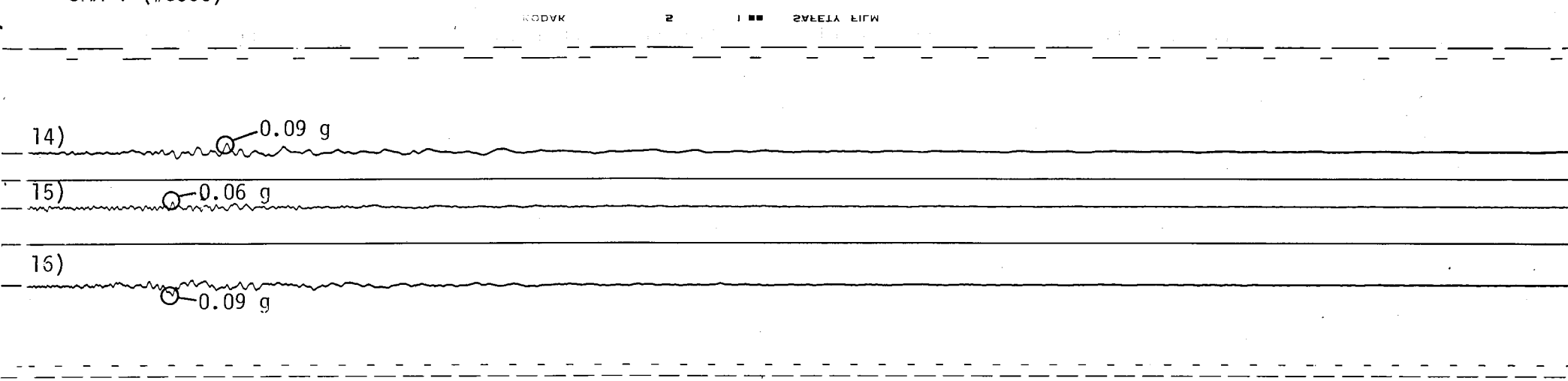
Long Valley Dam
CRA-1T (#190)



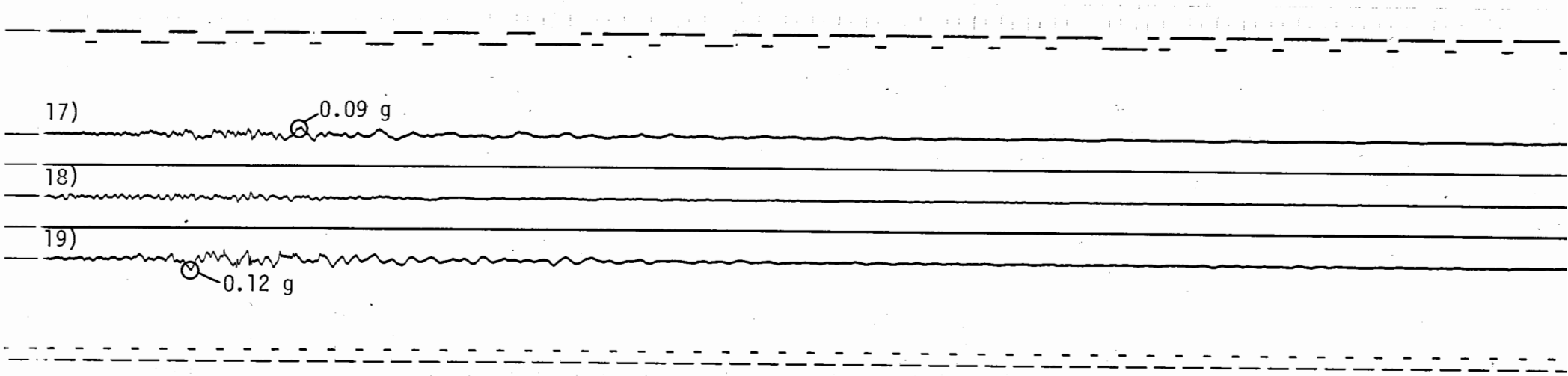
Long Valley Dam-Center Crest
S1A-1 (#3504)



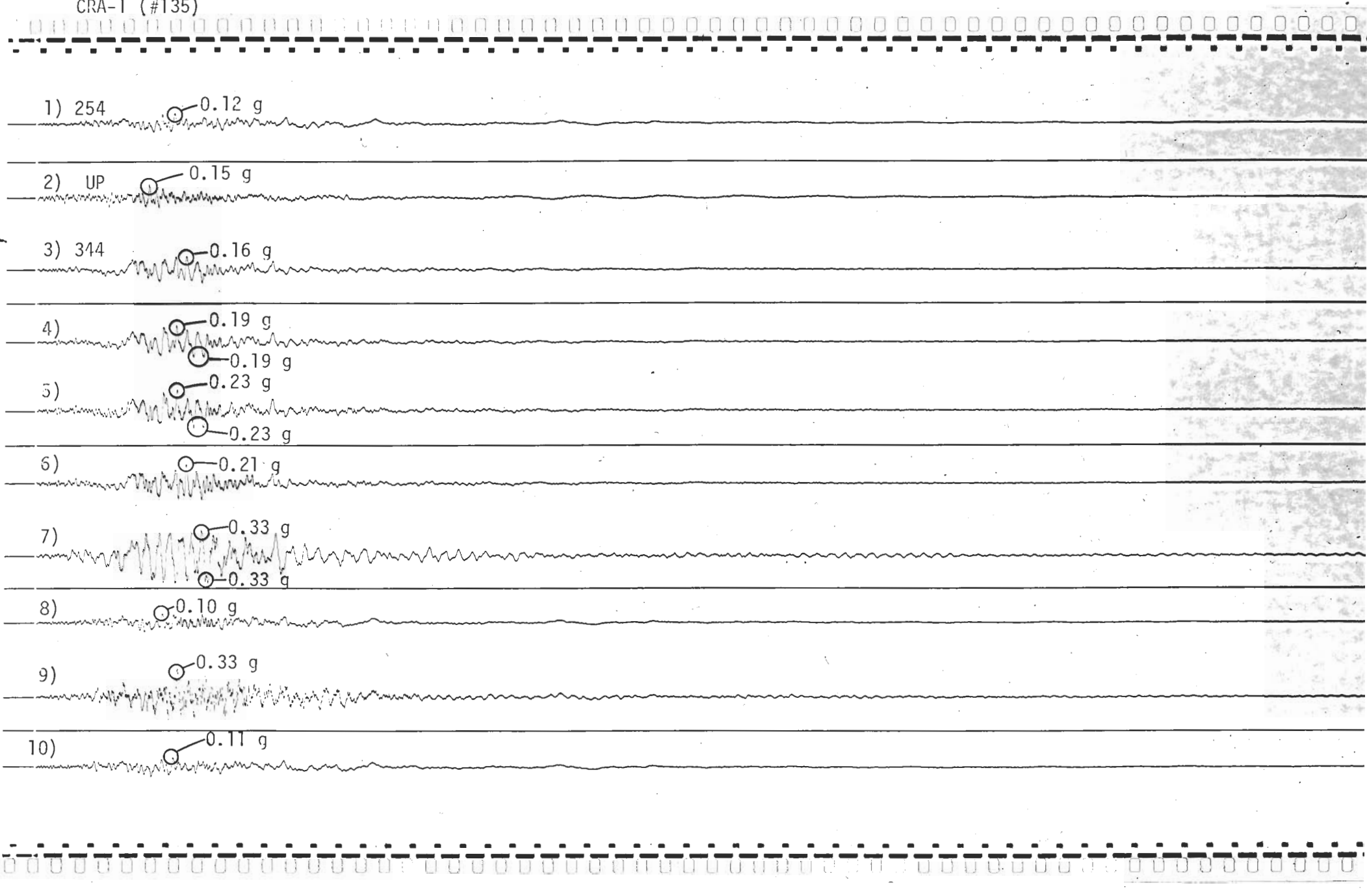
Long Valley Dam-Right Crest
SMA-1 (#3506)



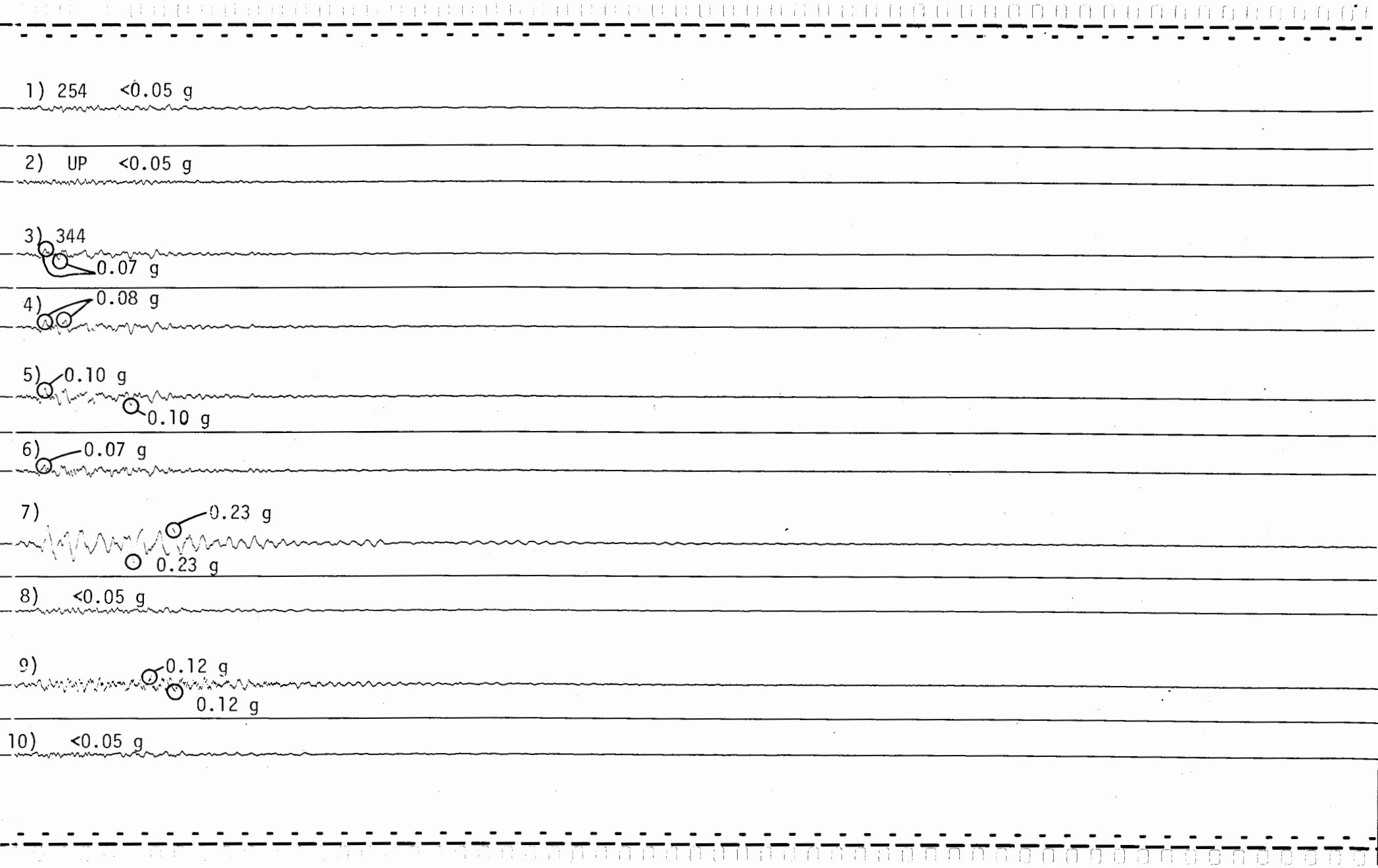
Long Valley Dam-Left Abutment
SMA-1 (#3484)



Mammoth Lakes-High School Gym
CRA-1 (#135)



Mammoth Lakes-High School Gym AFTERSHOCK-0606 PDT, 30 September
CRA-1 (#135)



Paradise Lodge CDMG-Temp
SMA-1T (#1827)

All traces <0.05 g

1) 150

2) UP

3) 60

Vermilion Dam CDMG #362
CRA-1T (#195)