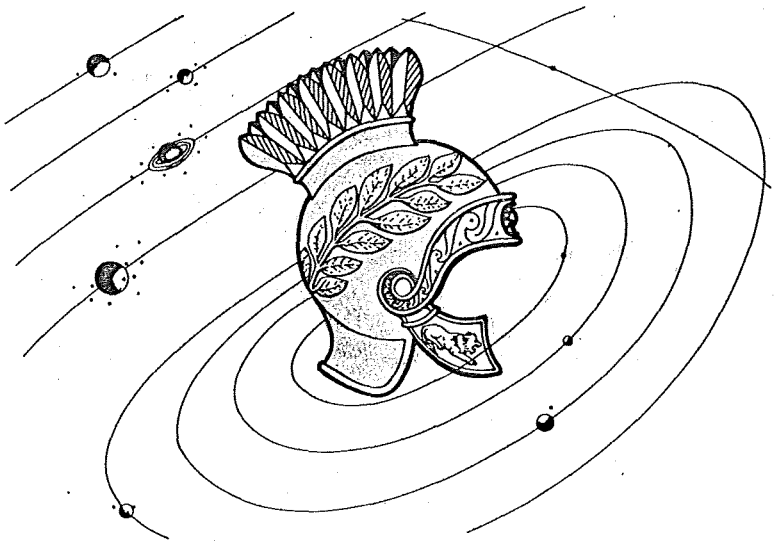
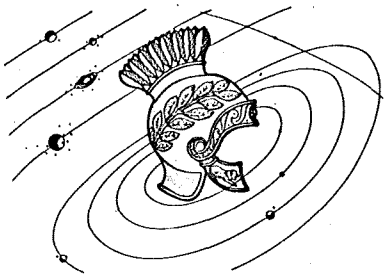


BIEBER, CALIFORNIA MICROEARTHQUAKE SURVEY

FOR

INTERCONTINENTAL ENERGY CORPORATION

SENTURION SCIENCES, INC.
TULSA, U.S.A.



SENTURION SCIENCES, INC.

6945 EAST 11TH STREET, TULSA, OKLAHOMA
P.O. BOX 15447, TULSA, OKLAHOMA 74115
PHONE (918) 836-6746

August 3, 1973

Mr. Warren Westphal
Intercontinental Energy Corporation
1560 Colorado State Bank Building
1600 Broadway
Denver, Colorado 80202

Dear Warren:

The Bieber data were extensively analyzed and hopefully the ideas presented and results found will eventually be meaningful to Intercontinental. The low frequency signals (wiggles) found are thought to be very significant and their origin definitely needs to be determined.

The Canby report took a back seat until these data were processed. We will have the target for Canby about Wednesday (August 8) and orders are to mail as soon as possible.

Talk with you soon.

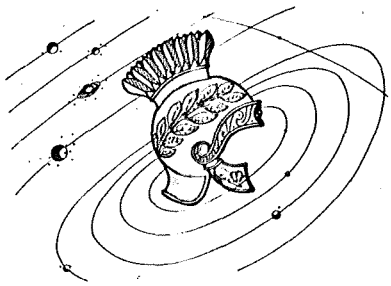
Sincerely,

SENTURION SCIENCES, INC.

John R. Bailey

JRB/sd

encl.



SENTURION SCIENCES, INC.

6945 EAST 11TH STREET, TULSA, OKLAHOMA
P.O. BOX 15447, TULSA, OKLAHOMA 74115
PHONE (918) 836-6746

IMAGINEERING for EXPLORATION, ENGINEERING and ENVIRONMENT

BIEBER, CALIFORNIA MICROEARTHQUAKE SURVEY

Table of Contents

BIEBER, CALIFORNIA MICROEARTHQUAKE SURVEY

Introduction

A network consisting of 6 stations was employed in the Hog Valley (California) 7 miles southeast of Bieber. The network was operational from June 18 to June 27, 1973. Location of the network is shown in Figure 1.

Epicenter azimuths are obtained from the apparent velocity vectors. These azimuths are opposite to the direction which the wave front sweeps across the array. Distances are obtained from the S-P arrival time difference, by assuming a Poisson's ratio equal to .25. No correction was done for elevation and weathering. Epicenters were located by utilizing the mean X and Y positions of the multiple solutions obtained from the most symmetrical configuration arrays within the network.

Results

Table I summarizes the seismicity during our interval of investigation near Bieber. The earthquakes are tabulated separately from the rather difficult to explain events termed "wiggles" because it is possible their (the wiggles') source is very different from the more ordinary earthquakes.

Wiggles, as herein described are low frequency (1-2 Hz) signals with ultra high apparent velocities (40-80 Kft/sec). Wiggles have been observed only contiguous with volcanic regions and specifically they have been recorded for Intercontinental at the Nivloc, Nevada and Baker, Oregon networks. The characteristics of wiggles are typically shown in Figure 2 and described below:

- They are low frequency (.5 Hz to 2 Hz) signals and this consistant characteristic may be due to either travel path or source spectrum. No other frequency is superimposed upon the signal which is in contrast to the teleseisms. The startling lack of energy beyond 4 Hz is shown in the spectral analyses of Figures 3, 4, 5 and 6. These data should be compared with the spectrum of a typical event as shown in Figure 7. This does not help resolve whether the origin is a low frequency generator or whether the signal has been subject to harsh earth filtering.

- The onsets are both impetus and emergent types.

- The more puzzling aspects of these signals is their apparent high velocity of between 40,000 ft/sec and 90,000 ft/sec. Obviously, these events have a high angle of emergence.

Table I

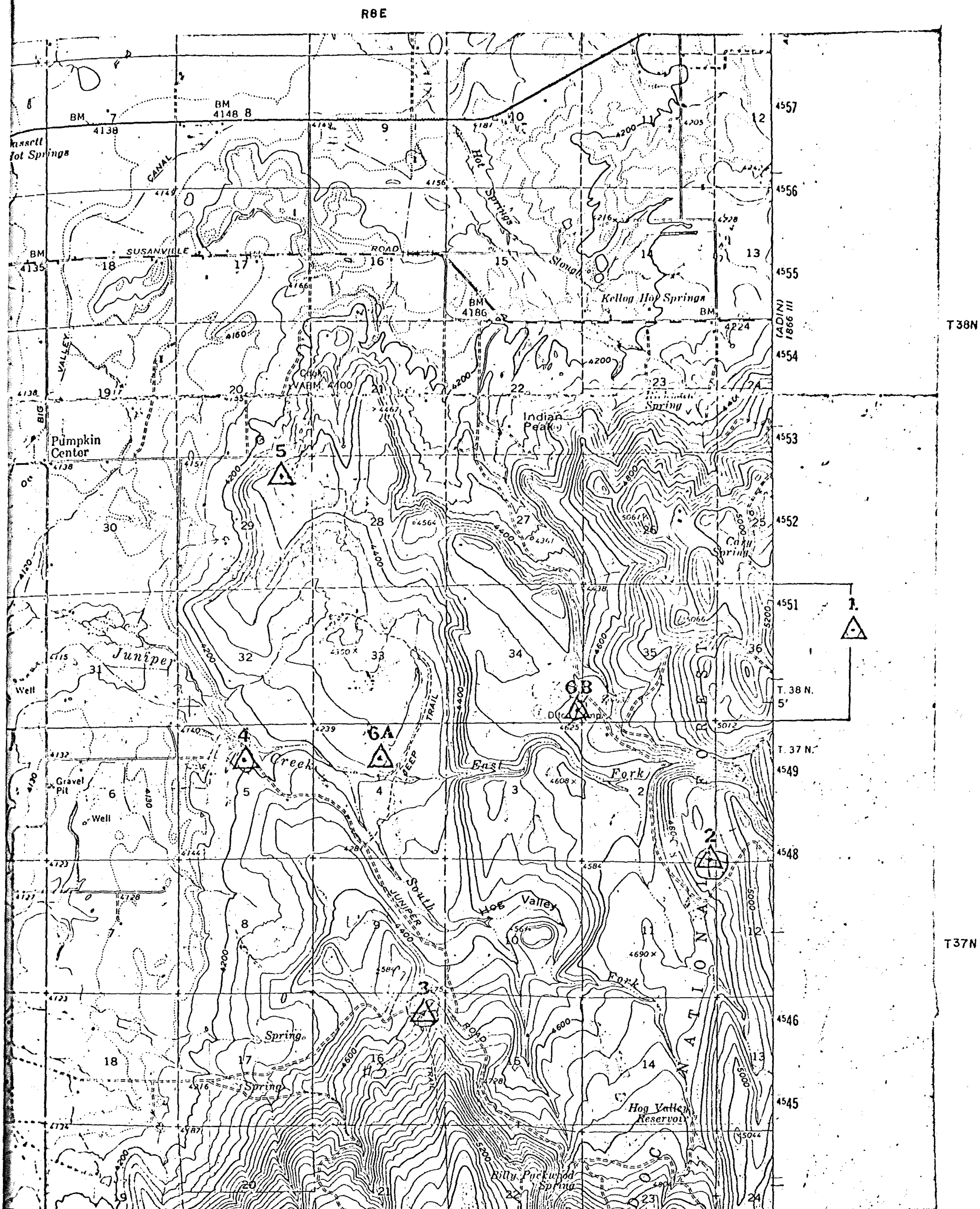
BIEBER EVENTS

Event	Date (June, '73)	Hour	Location		Frequency (cps)	Apparent Velocity (Kft/sec)
			Azimuth (degrees)	Distance		
1	19	16.01	70	50 miles	3.5	20
2	20	11.28	180	30	11	20
3	18	18.07	140	65	2.5	17
4	20	23.42	210	4.5	7	22
5	18	23.18	220	7	10	24
6	21	11.50	155	33	20	17
7	21	12.15	35	12	2.5	17
8	22	13.35	125	65	3.6	22
9	19	14.49	120	70	3.3	20
10	25	21.58	130	50	2.9	18
11	26	16.54	114	50	5	29
12	26	23.15	190	10	3.3	18
13	25	21.34	150	10	3.1	18
14	25	21.53	145	5	2.5	15
15	26	14.57	?	65	7	?
16	27	02.02	220	?	5.2	30

Table I

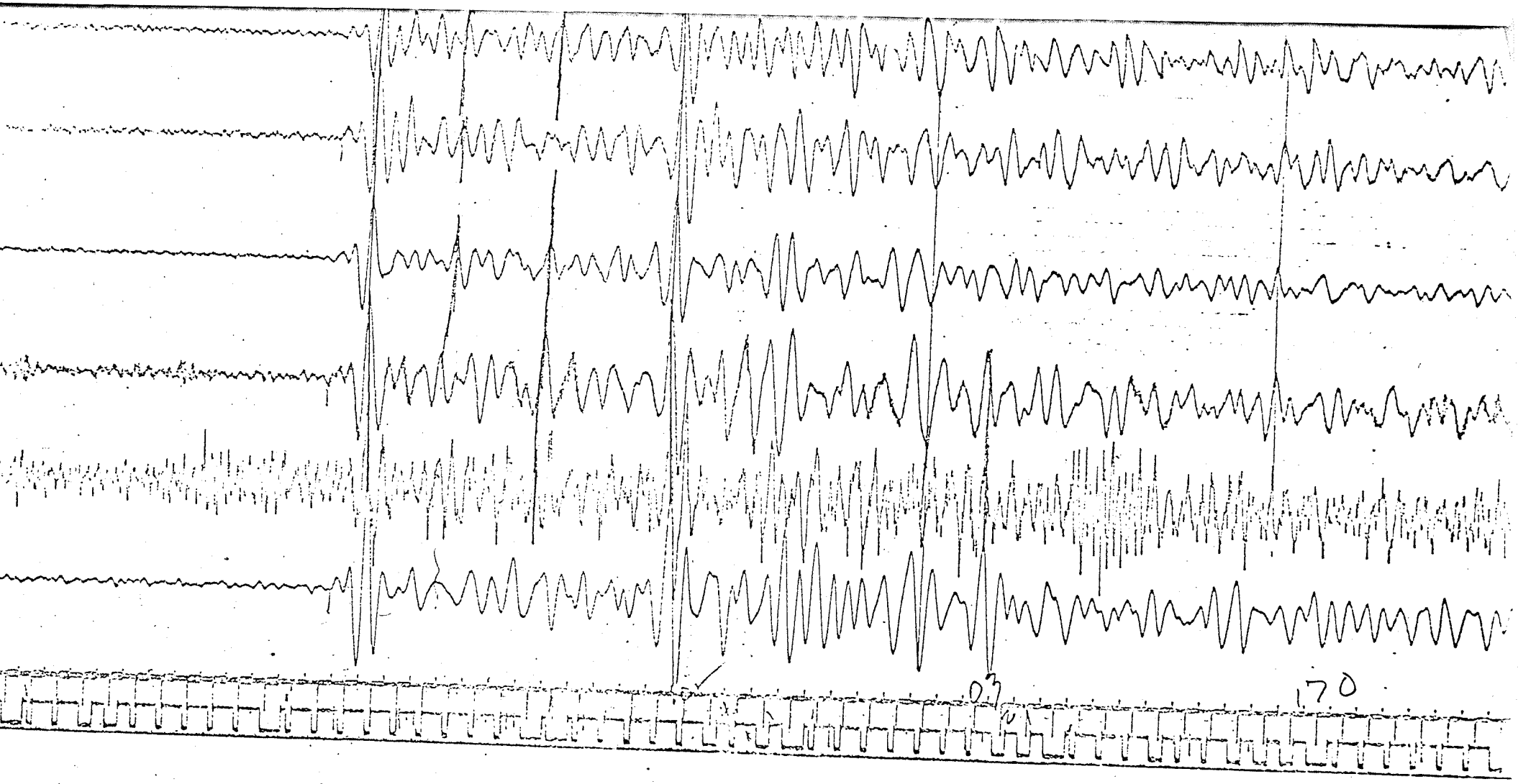
BIEBER WIGGLES

Event	Date (June, '73)	Hour	Location		Frequency (cps)	Apparent Velocity (Kft/sec)
			Azimuth (degrees)	Distance		
	21	12.02	250	17	1.9	45
	23	05.17	250	40	1.25	100
	22	04.25	220	10 ✓	2	55
	18	02.33	270	14	1.3	60
	22	07.20	265		1.9	65
	18	07.07	290	30	1.3	60
	22	04.57	300	35	1.5	80
	18	11.09	290	35	1.6	80
	18	09.48	150	25 (?)	1.1	45
	19	14.07	200	40	.8	50
	20	14.46	135	12	2	21
	18	08.47	300	35	1.7	55
	19	00.59	260	17	2.5	32
	18	03.05	270	40	2.2	45
	18	21.56	290	35	3.1	75
	18	06.48	260	35	1.25	90
	19	12.16	260	?	2.5	60
	26	22.40	145	?	1.1	25
	27	08.19	90	23	3.3	20
	27	18.30	80	24	3.5	18
	24	07.18	280	15	1.7	50
	26	23.04	250	35	1.2	80
	26	22.15	240	12 ✓	2.2	40
	26	03.20	270	50	1.6	80
	26	01.52	?	36		
	25	12.29	290	28	2	50
	27	19.16	160	?	2.2	20
	24	07.35	250	25	1	25
	25	11.50	250	18	1.7	18



BIEBER AREA
LASSEN COUNTY, CAL.
Figure 1.

△ SEISMOMETER LOCATION



Event #19

Figure 2.

Figure 3.

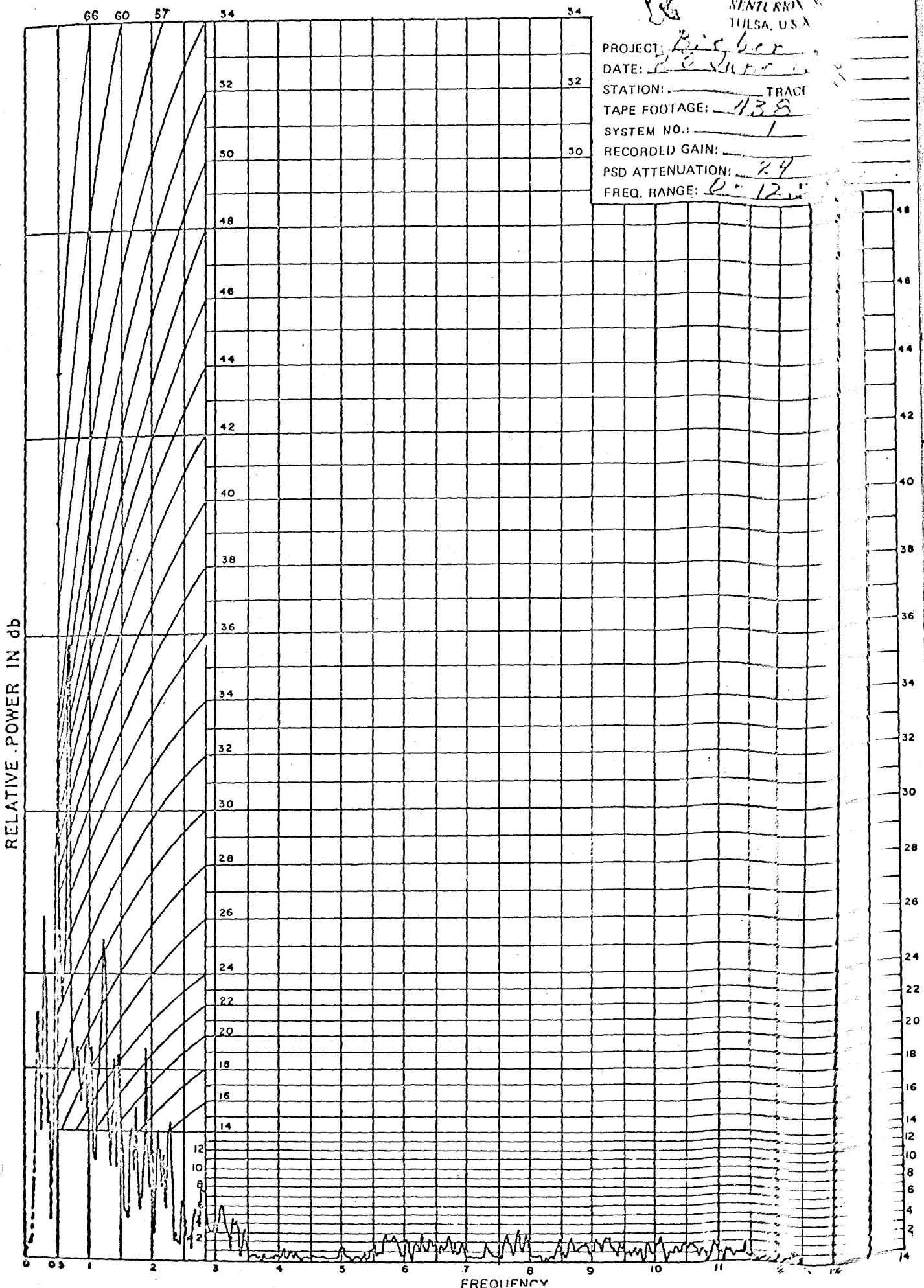

Miggle
PROJECT:
DATE:
STATION:
TRACE
TAPE FOOTAGE:
SYSTEM NO.:
RECORDED GAIN:
PSD ATTENUATION:
FREQ. RANGE:
RELATIVE POWER IN db
FREQUENCY
66 60 57
34
32
30
48
46
44
42
40
38
36
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0 .03 1 2 3 4 5 6 7 8 9 10 11 12

Figure 4.

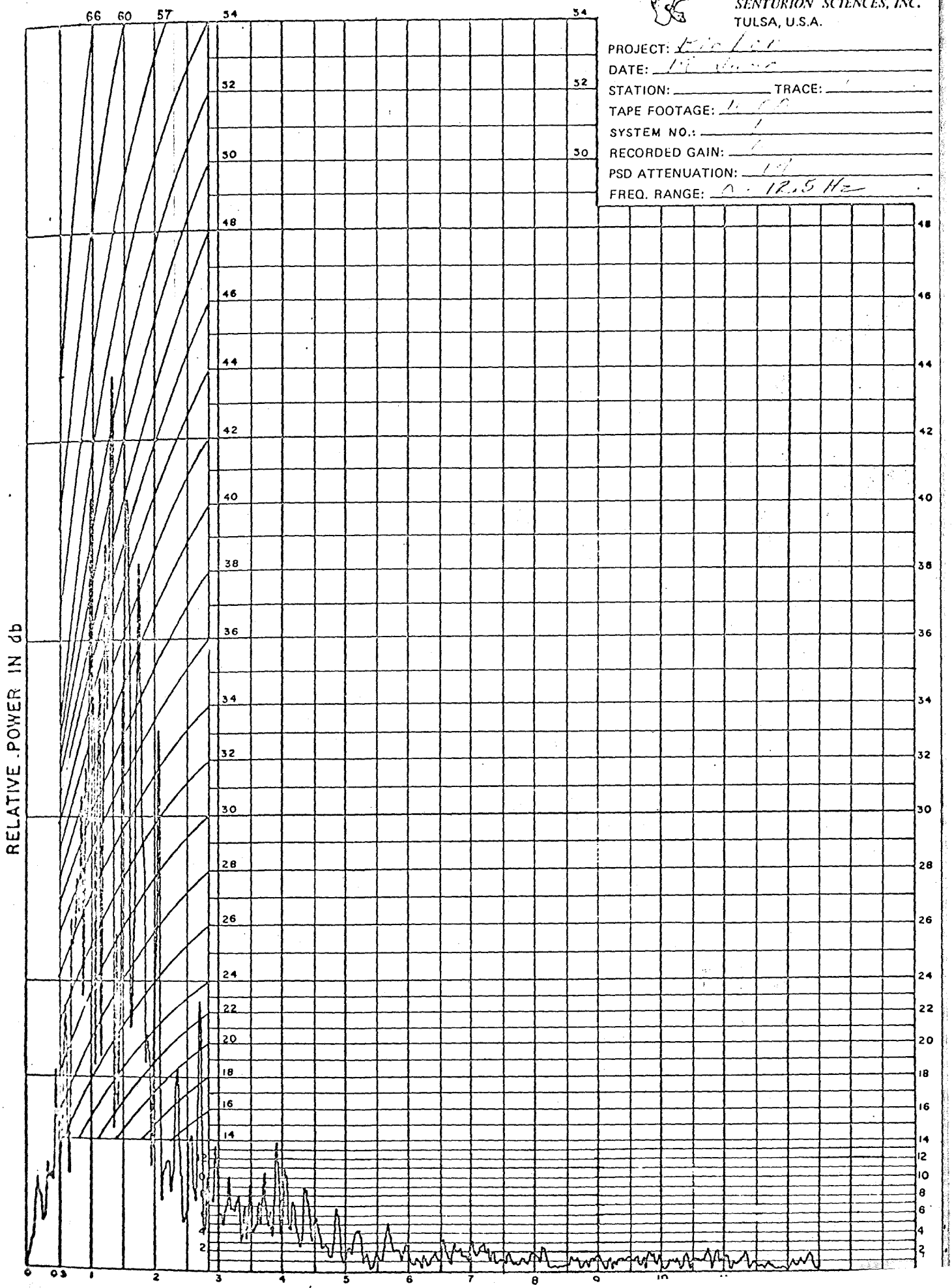

Wiggle #19.
SENTURION SCIENCES, INC.
TULSA, U.S.A.
PROJECT:
DATE:
STATION:
TRACE:
TAPE FOOTAGE:
SYSTEM NO.:
RECORDED GAIN:
PSD ATTENUATION:
FREQ. RANGE: 0 - 12.5 Hz
RELATIVE POWER IN db
66 60 57
54
52
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0 .03 1 2 3 4 5 6 7 8 9 10

Figure 5.

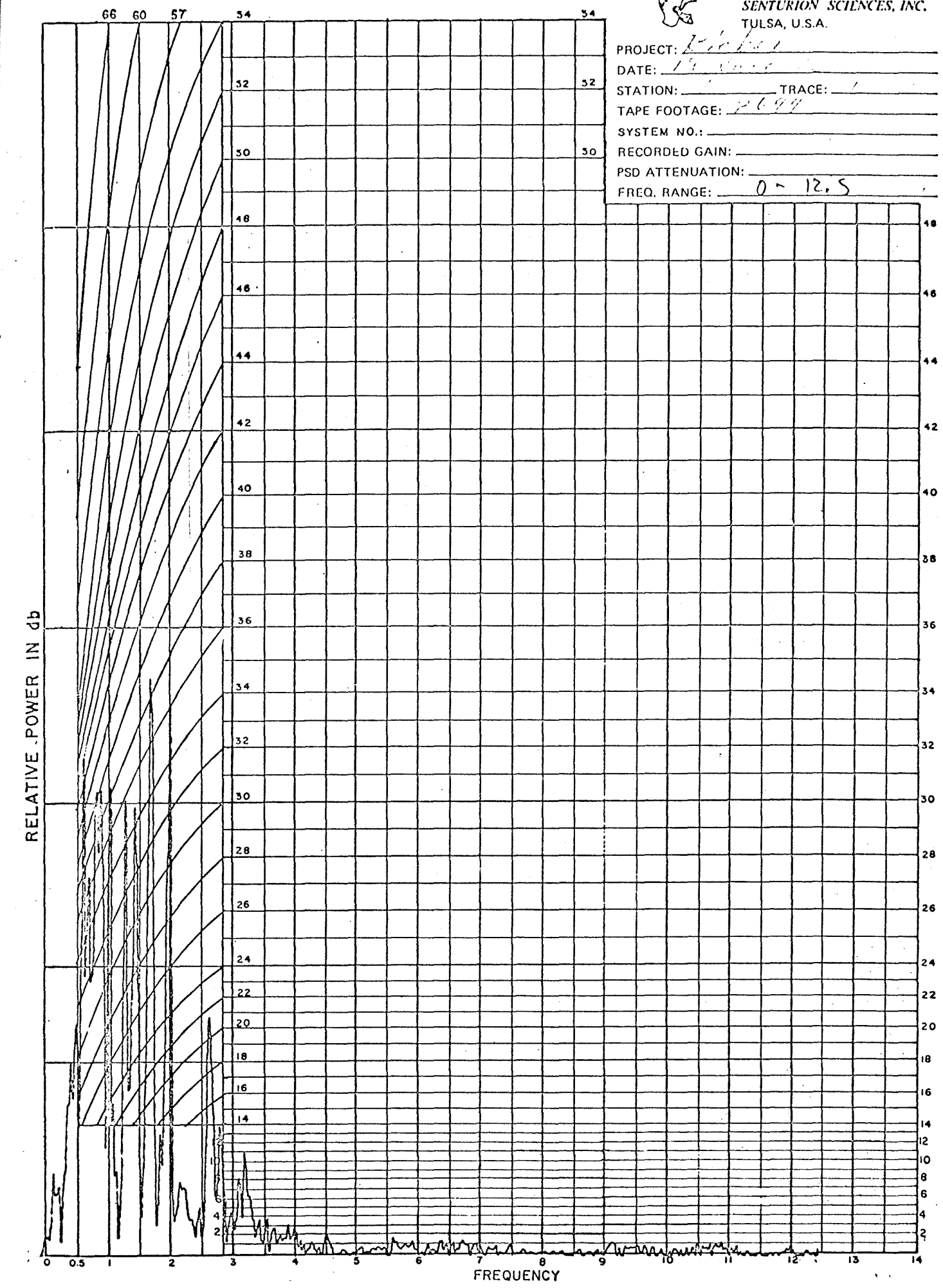

Wiggle #21.
SENTURION SCIENCES, INC.
TULSA, U.S.A.
PROJECT:
DATE:
STATION:
TRACE:
TAPE FOOTAGE:
SYSTEM NO.:
RECORDED GAIN:
PSD ATTENUATION:
FREQ. RANGE: 0 - 12.5
66 60 57
RELATIVE POWER IN db
FREQUENCY

Figure 6.

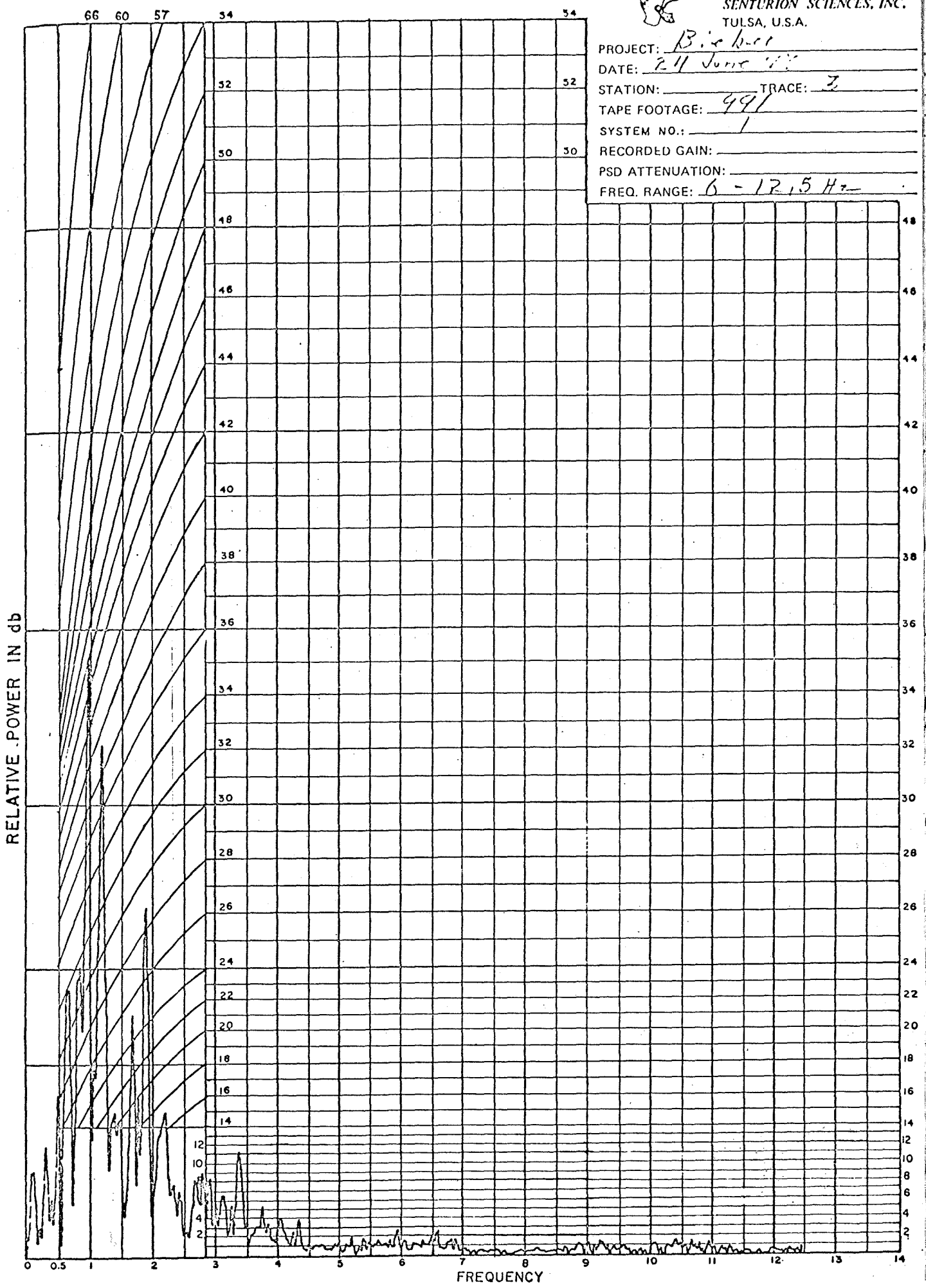
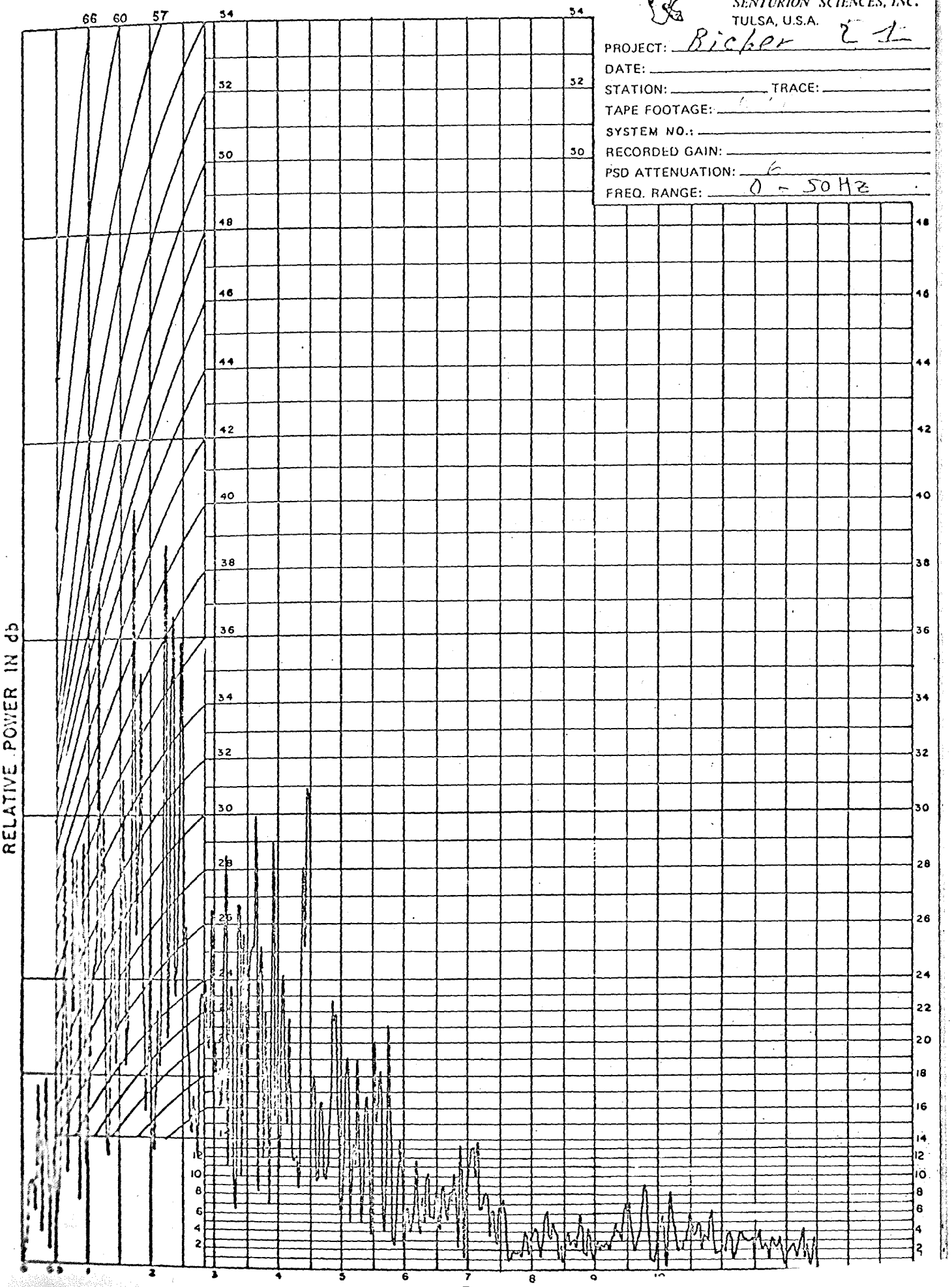

Wiggle #27
SENTURION SCIENCES, INC.
TULSA, U.S.A.
PROJECT: Bi hart
DATE: 24 June
STATION:
TRACE: 3
TAPE FOOTAGE: 491
SYSTEM NO.: 1
RECORDED GAIN:
PSD ATTENUATION:
FREQ. RANGE: 6 - 12.5 Hz
66 60 57
RELATIVE POWER IN db
FREQUENCY

Figure 7.

Event #5.

SENTURION SCIENCES, INC.
TULSA, U.S.A.

PROJECT: Bicher 2-1
DATE:
STATION: TRACE:
TAPE FOOTAGE:
SYSTEM NO.:
RECORDED GAIN:
PSD ATTENUATION: 6
FREQ. RANGE: 0 - 50 Hz



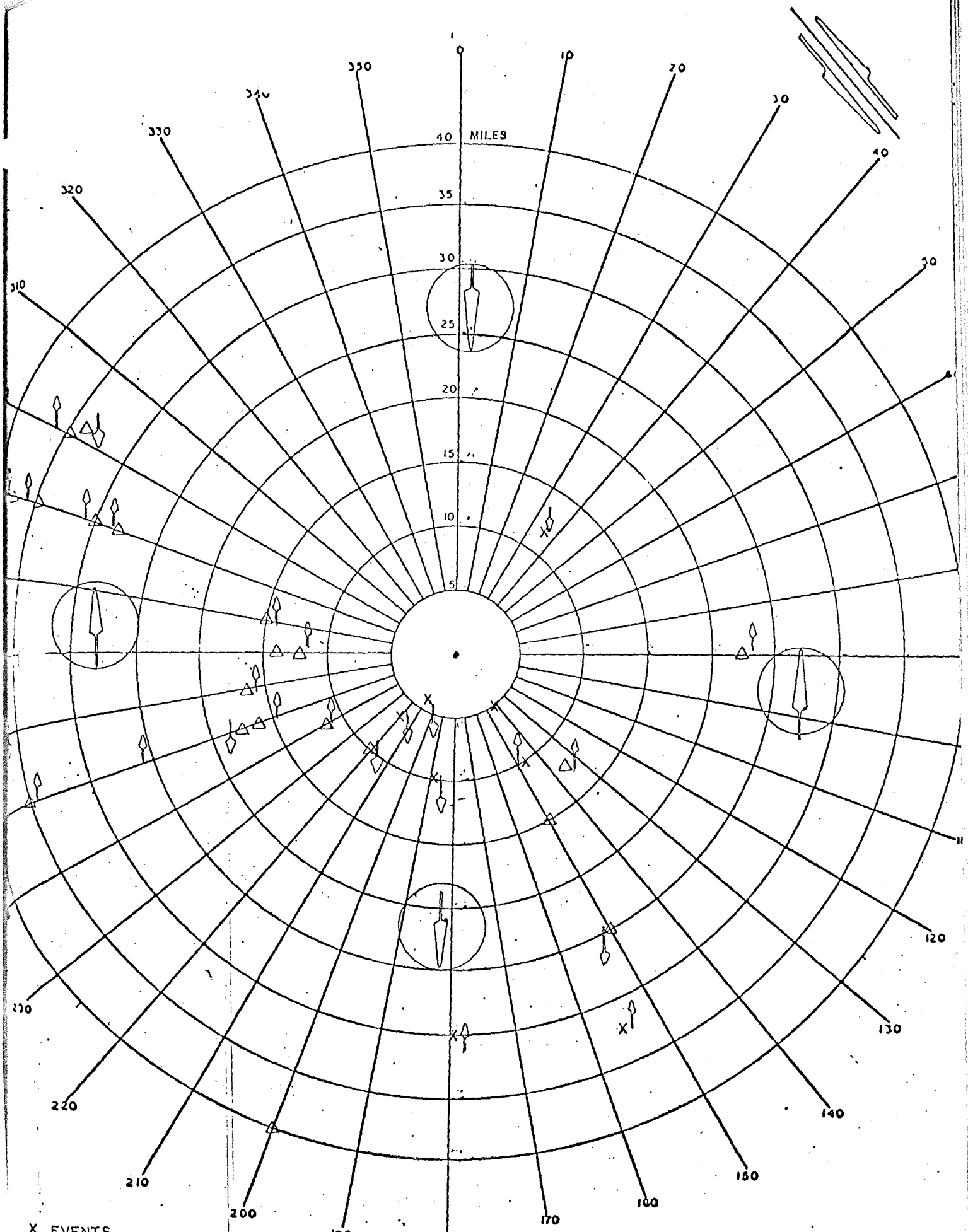
- The signals on all six stations have very similar envelopes and signature. In fact, the signals have successive event appearances, but again if these differing phases or successive events are real, then why do they have equal intervals to all stations? For instance, for event 21 (azimuth 270 degrees) the phase separation is 11.3, 11.4, 11.4, 11.4, 11.4 and 11.4 seconds. Whether these apparent phase arrivals represent differing successive events or actual phases within a given signal this sameness in separation is difficult to explain. Should these represent S-P intervals the foci would be 34 vector miles distant, yet the maximum interval between stations of the network is 3 miles and the expected 9% change in S-P interval does not materialize. Pursuing this signal variation as a shear wave arrival we conclude the depth of the event must be seven times the radius of the array to reduce to 1% the difference in S-P times. If the angle of emergence is 60 degrees or larger it is very likely that the S wave is not noticeable on the vertical seismometer.

- The events are not detectable at distances as great as 25 miles from the network. For instance, at the Baker network the Blue Mountain Observatory did not detect wiggle events. During the Bieber survey Senturion was operating another network 150 miles away and we did not see any signals within 30 seconds of any of the Bieber wiggles.

The wiggles and some of the events were investigated with respect to resolving fault motion, i.e., left or right lateral movement defined according to which quadrant the event originated in. The arrows associated with each event's epicenter in Figure 8 define first motion (up is dialational, down is compressional). The large arrows of each quadrant reflect theoretical first motions for NW-SE left lateral fault and/or NE-SW right lateral fault with respect to the Bieber network (Richter 1958 and Gutenberg 1941). At Bieber the NW-SE left lateral faulting appears to be in conformance with topographic fabric. Should these events be caused by phenomena other than faulting or shear failure, then the previous analyses is not valid.

The epicenters are located via apparent velocity vectors, vector intersections with and without S-P input. Nonetheless, the model used to locate the events was not the model postulated in Figure 9, and therefore if the postulated model is a close approximation, the events will be closer to the network yet the NW-SE trend would persist. This suggests that the seismicity could trend NW-SE through Rickett's Hill in Section 4, Township 37 North, Range 7 East (Lassen County, California).

Figure 9 illustrates a simple and realistic model that could cause the apparent velocities of the Bieber wiggles. These wiggles correlate with prospective geothermal (volcanic) areas only; therefore their origin needs to be resolved for proper evaluation with respect to geothermal development. We strongly suggest moving a network progressively toward the apparent source of the wiggles.



Comparison of the actual pattern of first motion with theoretical pattern caused by right lateral faulting occurring at points located in each quadrant.

Figure 8

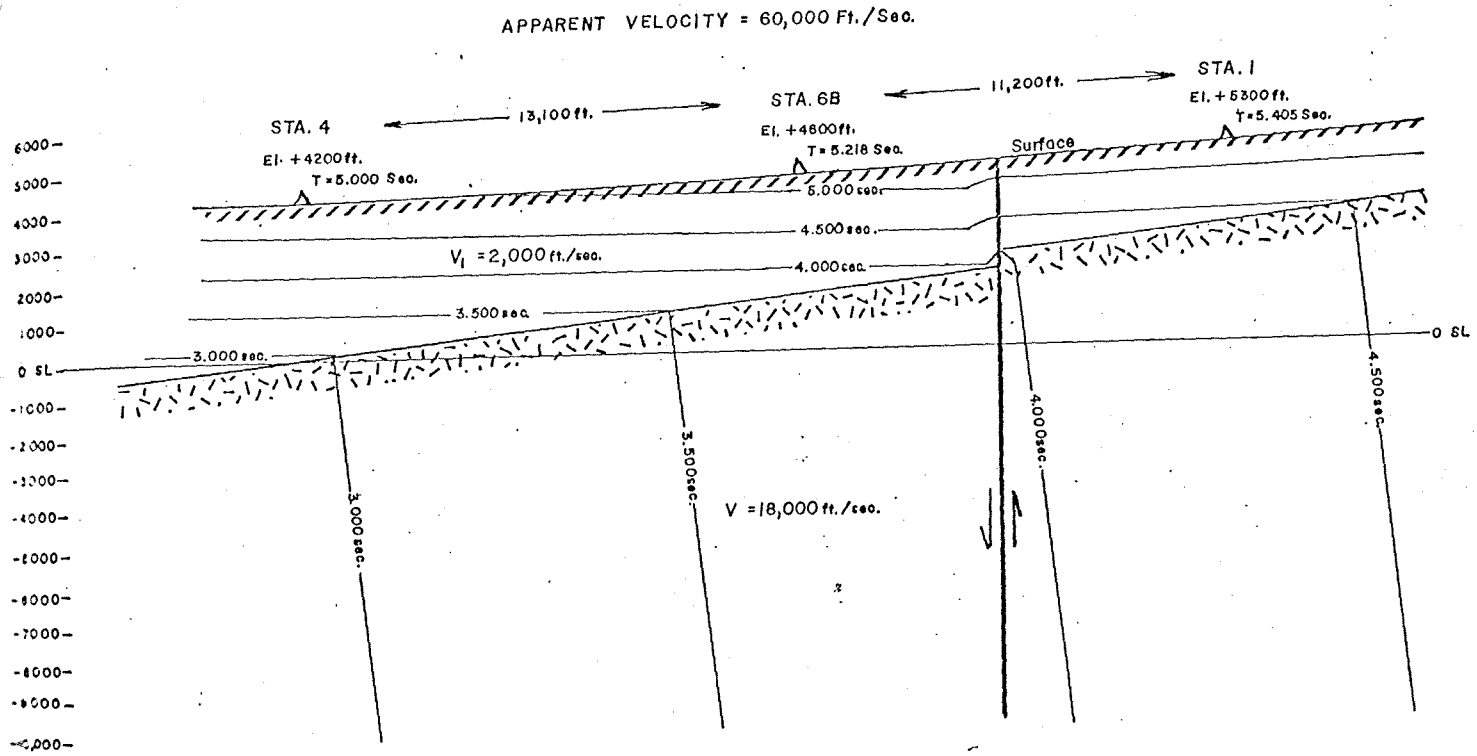

APPARENT VELOCITY = 60,000 Ft./Sec.
STA. 4
El. +4200ft.
T=5.000 Sec.
13,100ft.
STA. 6B
El. +4600ft.
T=5.218 Sec.
11,200ft.
STA. 1
El. +5300ft.
T=5.405 Sec.
Surface
5.000 sec.
4.500 sec.
4.000 sec.
3.500 sec.
3.000 sec.
V_1 = 2,000 ft./sec.
V = 18,000 ft./sec.
6000
5000
4000
3000
2000
1000
0 SL
-1000
-2000
-3000
-4000
-5000
-6000
-7000
-8000
-9000
-10,000

Figure 9.

Groundnoise

The groundnoise was inspected at each of the Bieber network stations and station #5 in Section 29, Township 38 North, Range 8 East had four times the groundnoise (Figures 10 through 15) of any other station.

Recommendations

Resolving the origin of the Bieber wiggles should be foremost in any continuing geothermal exploration program. The optimum method for confirmation of wiggle origin is to arrange a three station array between John's Valley and Pit River on the Bieber quadrangle and another three station array reoccupying stations 3, 4 and 6B of the Bieber network. This type of study for 7 to 10 days would confirm whether the proximity of the seismicity trends through the Thompson Reservoir vicinity. Should this verify the area of the wiggles then a refraction profile would edit the postulated model and simultaneously fix the velocity section for accurate positioning of events.

The groundnoise increase about station #5 likewise should be geologically investigated.

Figure 10.

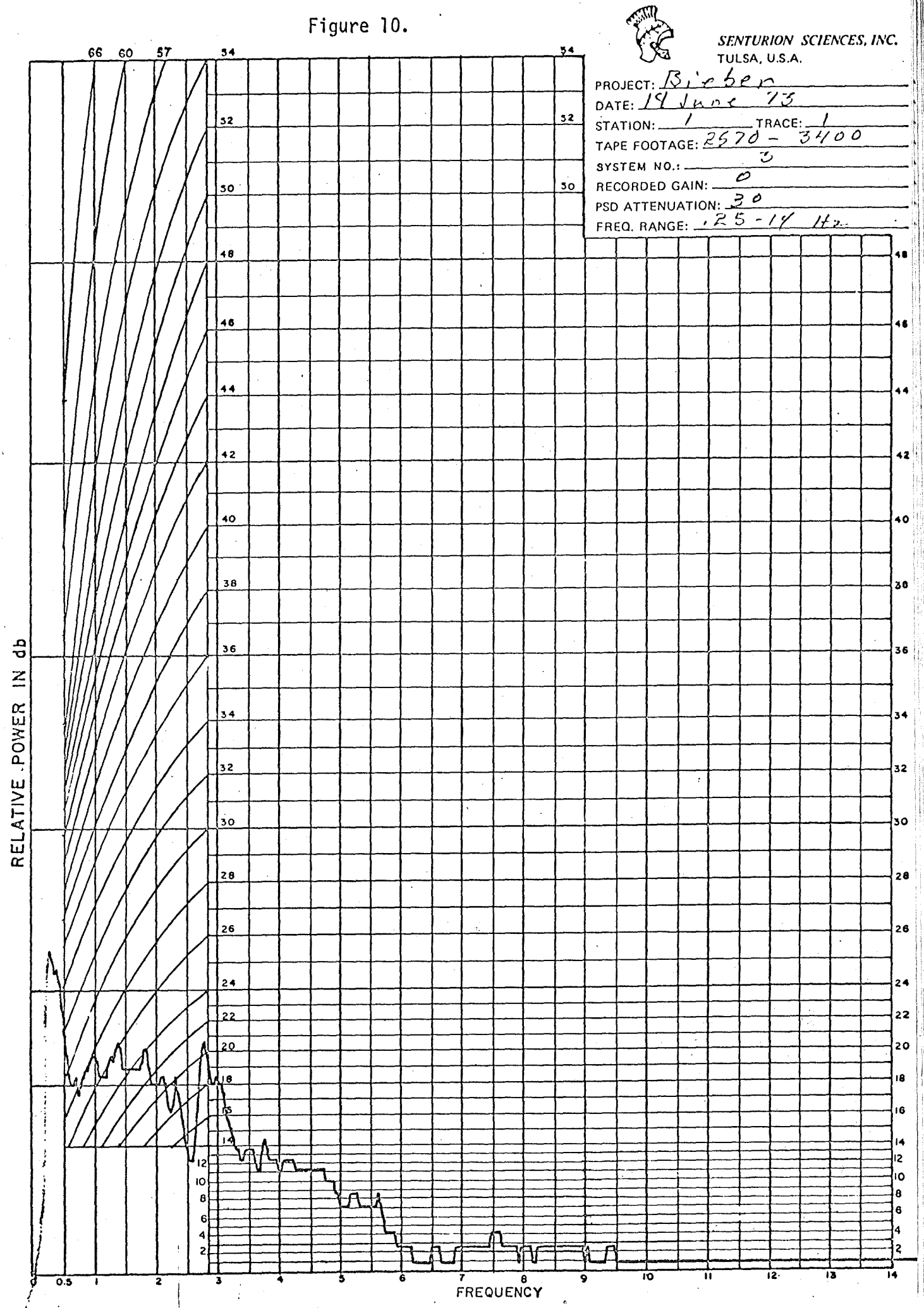

SENTURION SCIENCES, INC.
TULSA, U.S.A.
PROJECT: Bieber
DATE: 19 June 73
STATION: 1 TRACE: 1
TAPE FOOTAGE: 2570 - 3400
SYSTEM NO.: 3
RECORDED GAIN: 0
PSD ATTENUATION: 30
FREQ. RANGE: .25 - 14 Hz.
66 60 57
RELATIVE POWER IN db
FREQUENCY
0 0.5 1 2 3 4 5 6 7 8 9 10 11 12 13 14
54 52 50 48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 8 6 4 2

Figure 11.

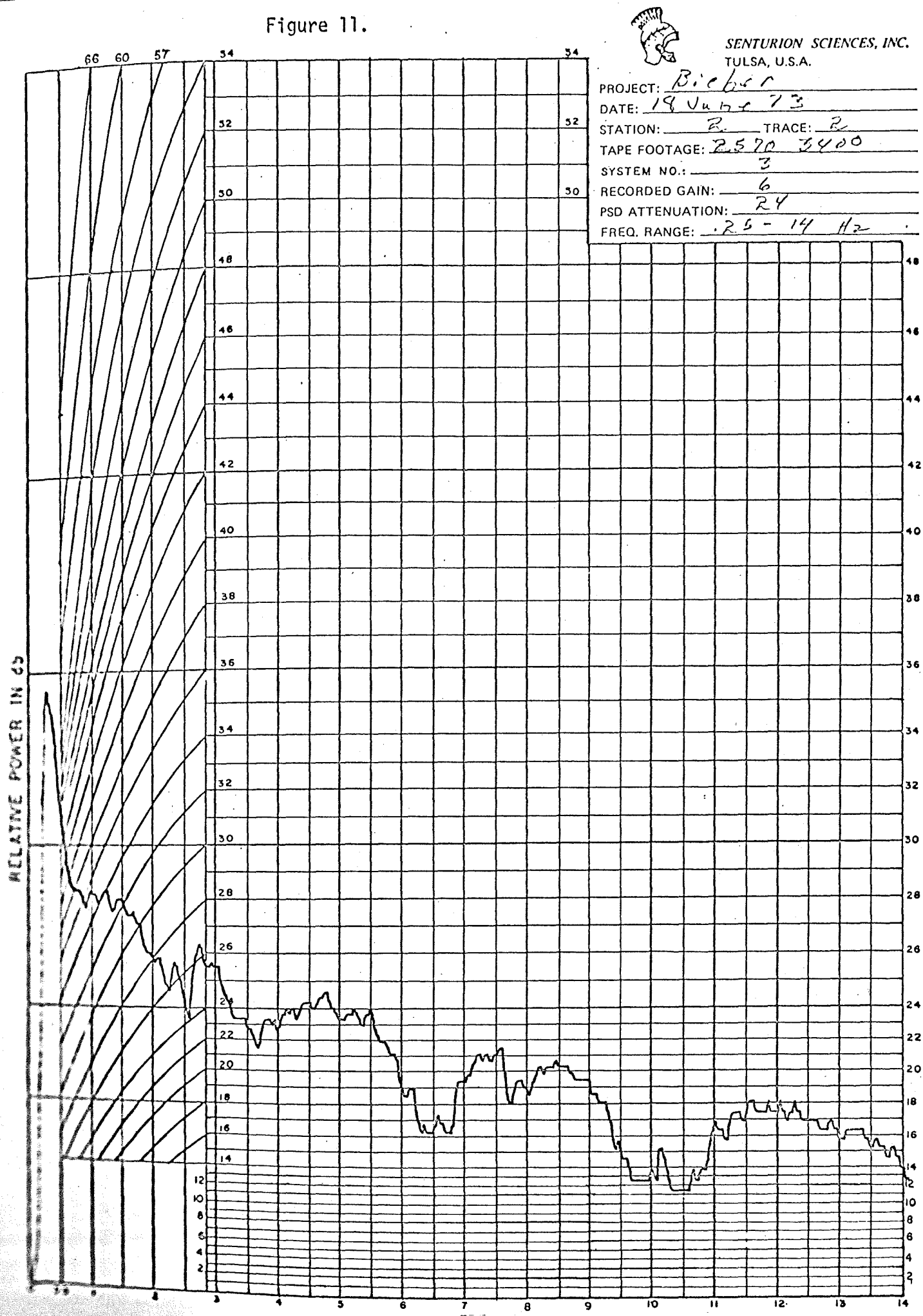

SENTURION SCIENCES, INC.
TULSA, U.S.A.
PROJECT: Bicber
DATE: 18 June 73
STATION: 2 TRACE: 2
TAPE FOOTAGE: 2570 3400
SYSTEM NO.: 3
RECORDED GAIN: 6
PSD ATTENUATION: 24
FREQ. RANGE: .25 - 14 Hz
RELATIVE POWER IN dB
66 60 57
34 32 30 48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 8 6 4 2
1 2 3 4 5 6 7 8 9 10 11 12 13 14

Figure 12.

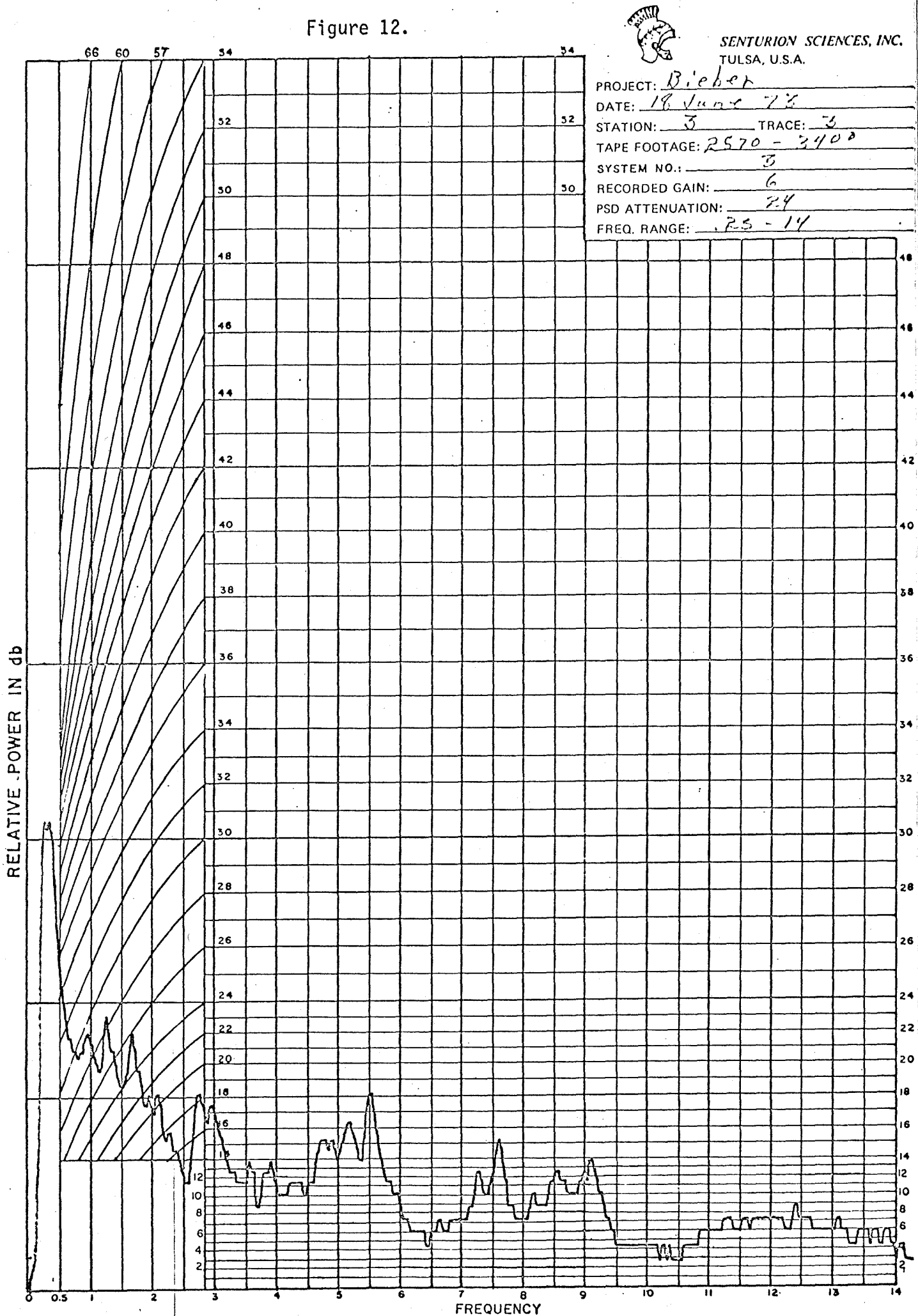

SENTURION SCIENCES, INC.
TULSA, U.S.A.
PROJECT: Bieber
DATE: 18 June 75
STATION: 3 TRACE: 3
TAPE FOOTAGE: 2570 - 3400
SYSTEM NO.: 3
RECORDED GAIN: 6
PSD ATTENUATION: 24
FREQ. RANGE: .25 - 14
RELATIVE POWER IN db
FREQUENCY
66 60 57
0 0.5 1 2 3 4 5 6 7 8 9 10 11 12 13 14
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54

Figure 13.

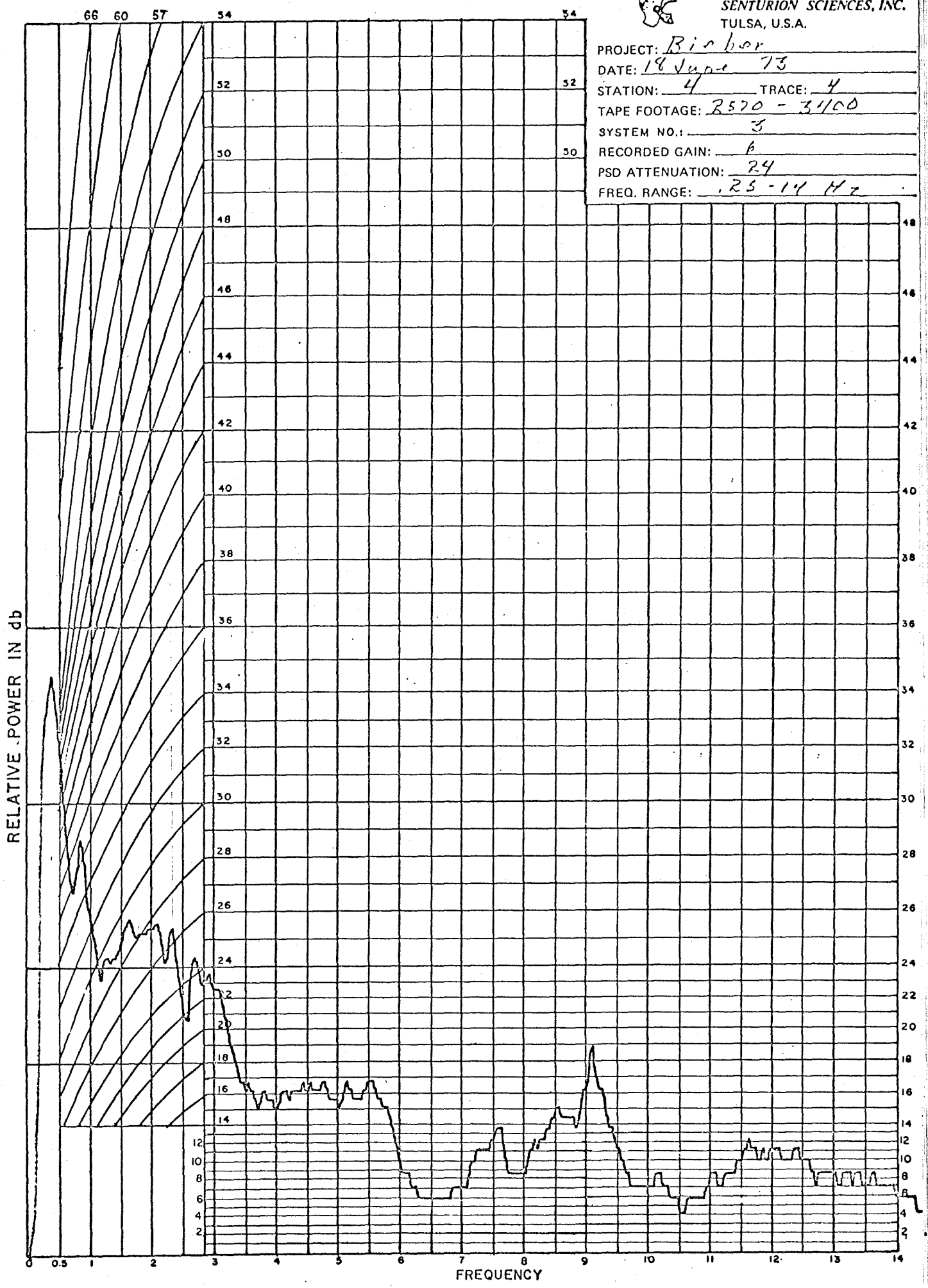

SENTURION SCIENCES, INC.
TULSA, U.S.A.
PROJECT: Bisbee
DATE: 18 June 73
STATION: 4 TRACE: 4
TAPE FOOTAGE: 2570 - 3400
SYSTEM NO.: 3
RECORDED GAIN: 6
PSD ATTENUATION: 24
FREQ. RANGE: .25 - 14 Hz
RELATIVE POWER IN db
FREQUENCY
66 60 57
0 0.5 1 2 3 4 5 6 7 8 9 10 11 12 13 14
54 52 50 48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 8 6 4 2

Figure 14.

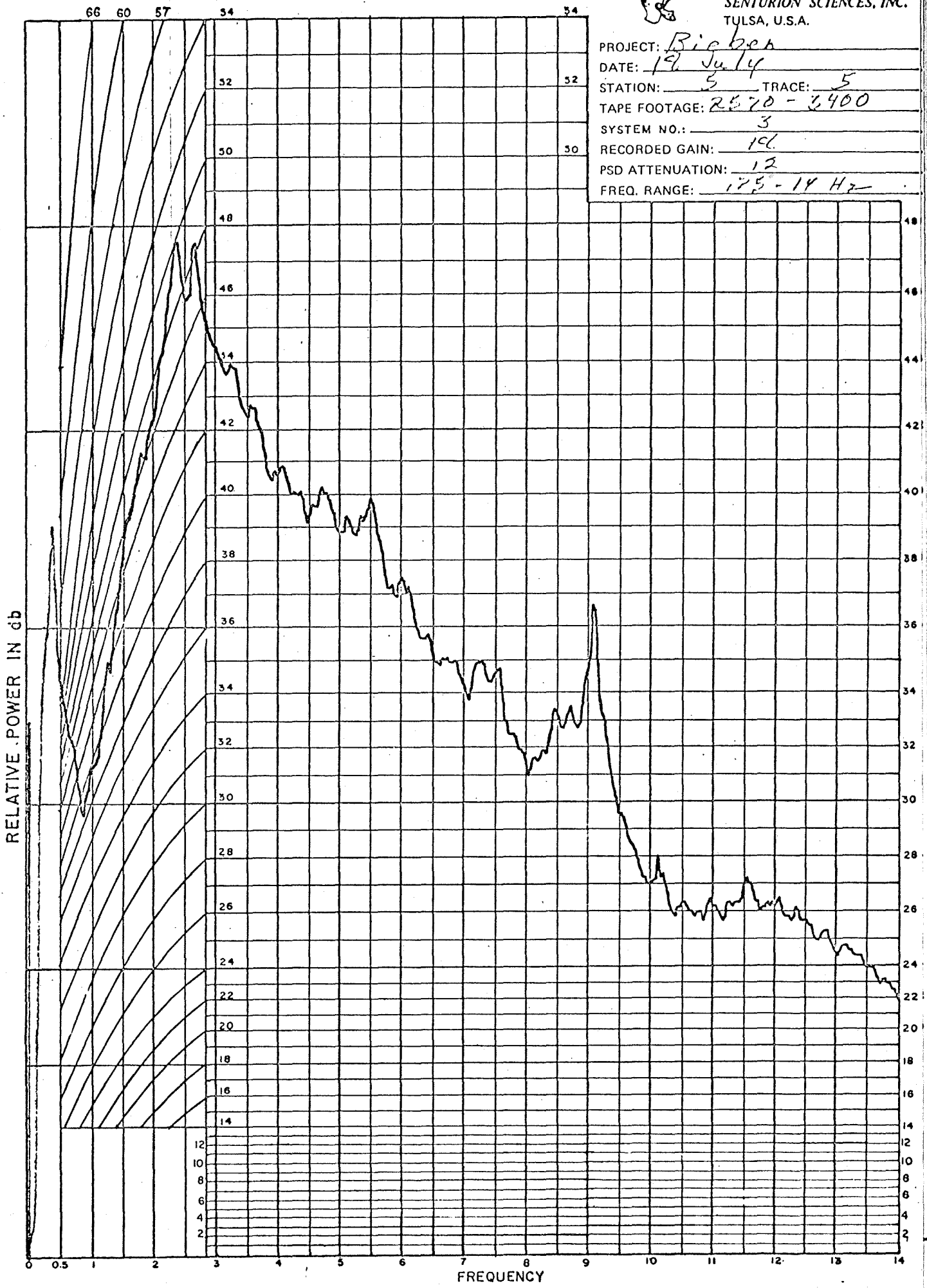
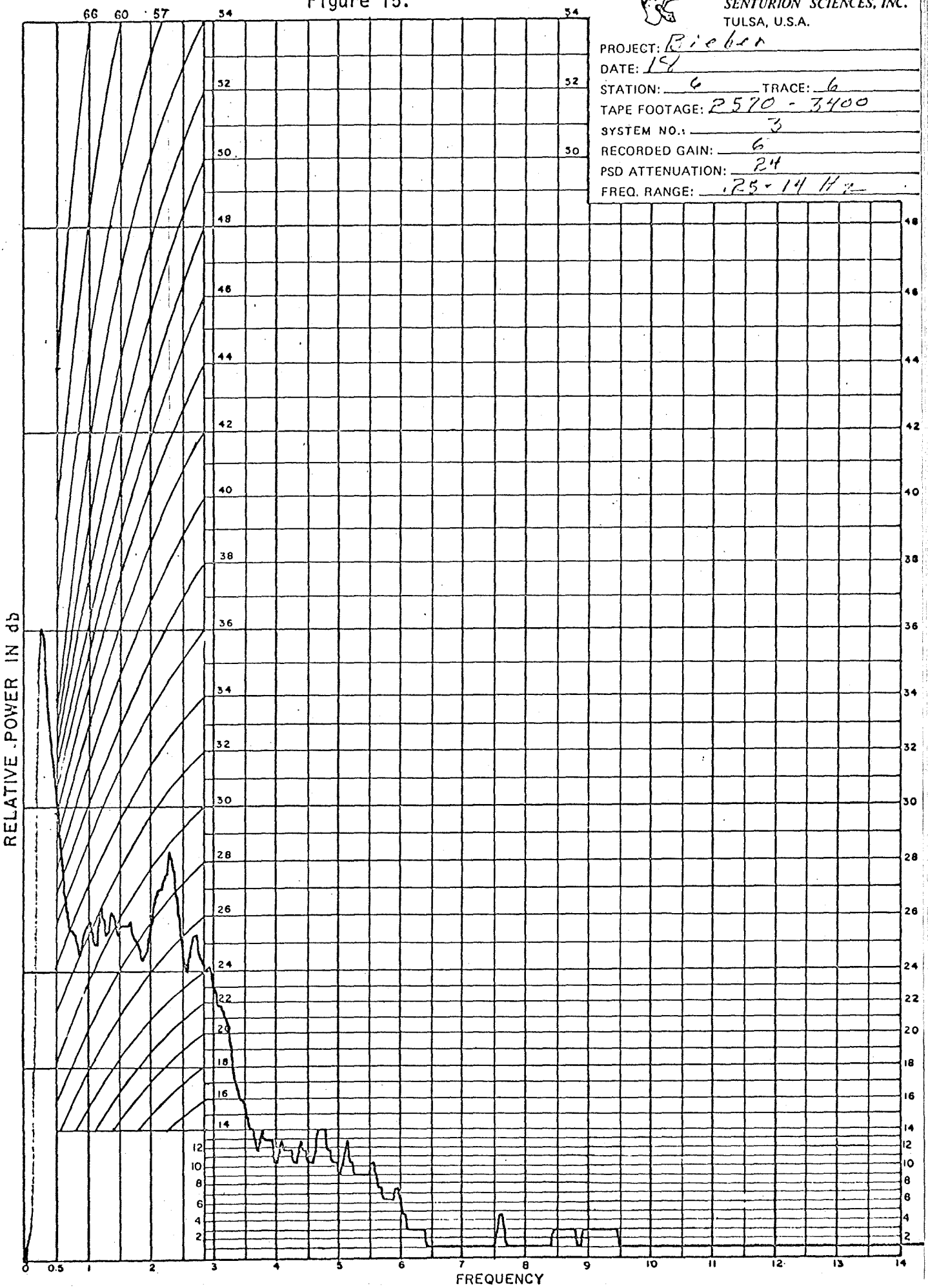

SENTURION SCIENCES, INC.
TULSA, U.S.A.
PROJECT: Bicbes
DATE: 19 Jul 4
STATION: 5 TRACE: 5
TAPE FOOTAGE: 2570 - 3400
SYSTEM NO.: 3
RECORDED GAIN: 16
PSD ATTENUATION: 12
FREQ. RANGE: .25 - 14 Hz
RELATIVE POWER IN db
FREQUENCY
66 60 57 54 52 50 48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 8 6 4 2
0 0.5 1 2 3 4 5 6 7 8 9 10 11 12 13 14

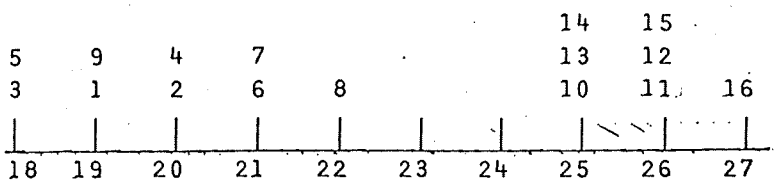
Figure 15.


SENTURION SCIENCES, INC.
TULSA, U.S.A.
PROJECT: Bieber
DATE: 15
STATION: 6 TRACE: 6
TAPE FOOTAGE: 2570 - 3400
SYSTEM NO.: 3
RECORDED GAIN: 6
PSD ATTENUATION: 24
FREQ. RANGE: .125 - 14 Hz
66 60 57
RELATIVE POWER IN db
FREQUENCY
0 0.5 1 2 3 4 5 6 7 8 9 10 11 12 13 14
54 52 50 48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 8 6 4 2

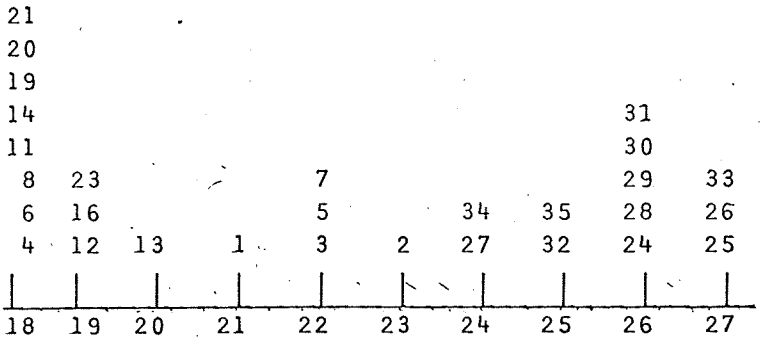
ADDENDUM

BIEBER

Seismicity vs. Day



Ordinary Events

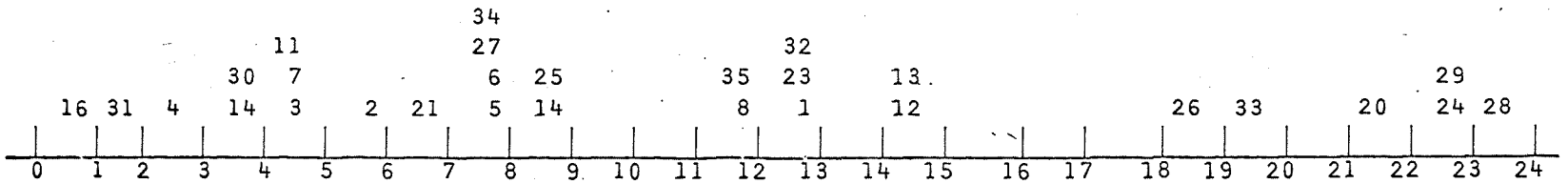


Wiggles

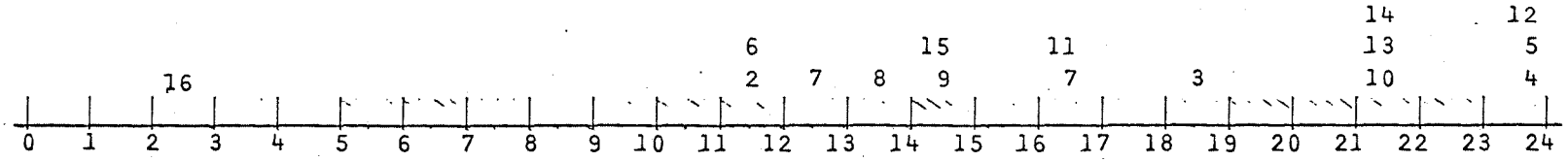
Total # 45.
Daily Average: 4.5
Wiggles: 2.9
Ordinary Events: 1.6

BIEBER

Seismicity vs. Time of Day



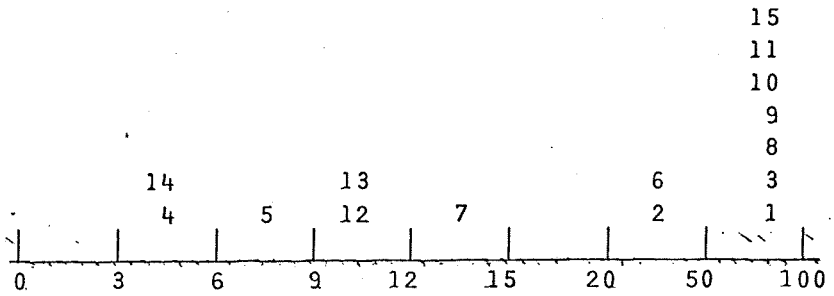
Wiggles



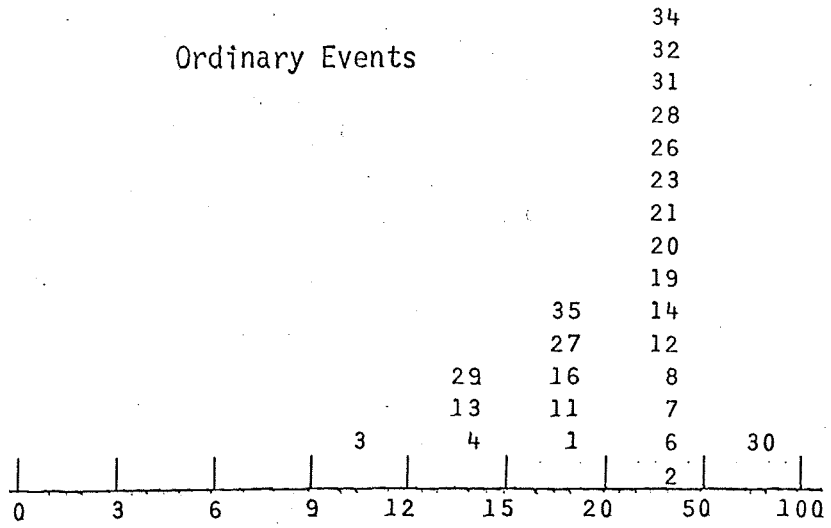
Ordinary Events

BIEBER

Seismicity vs. Distance



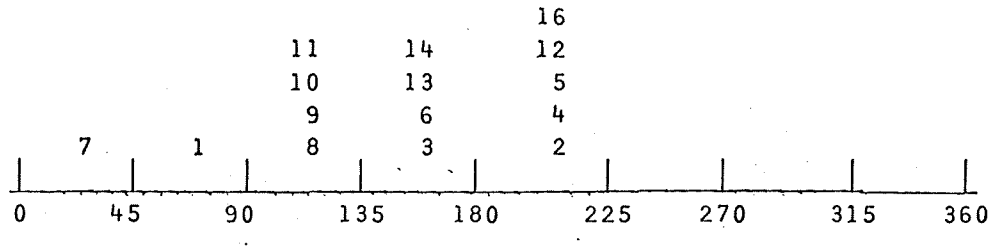
Ordinary Events



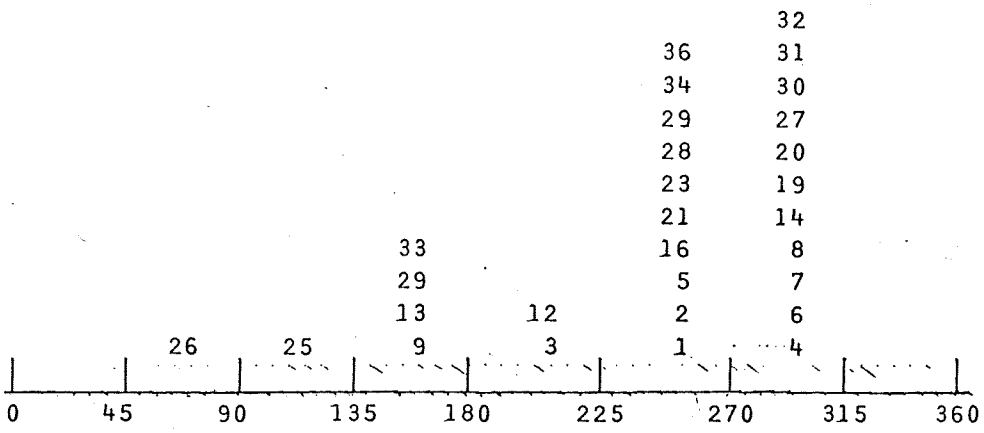
Wiggles

BIEBER

Seismicity vs. Angle



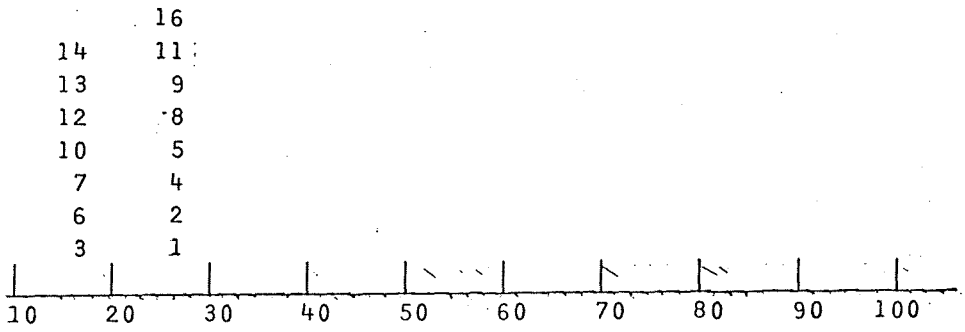
Ordinary Events



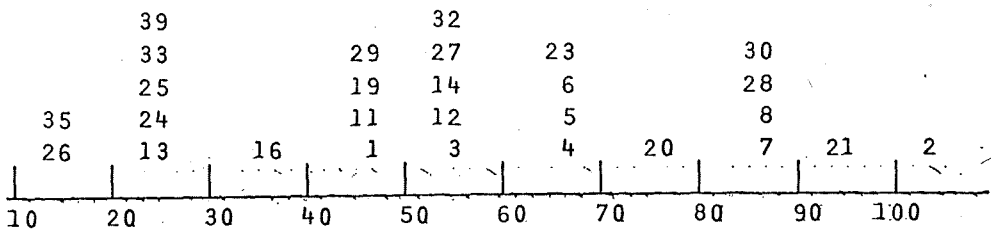
Wiggles

BIEBER

Apparent Velocity



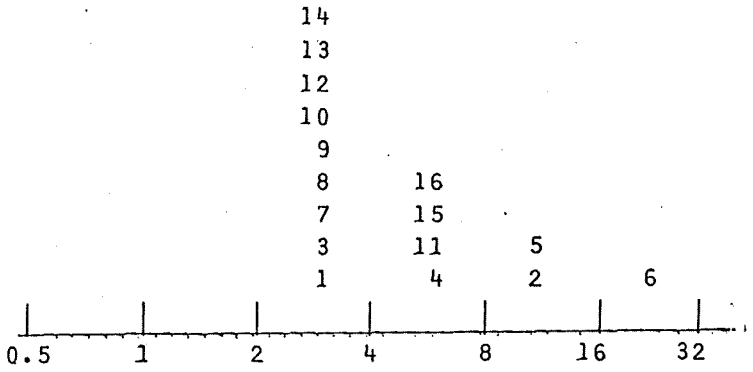
Ordinary Events
(kft/sec)



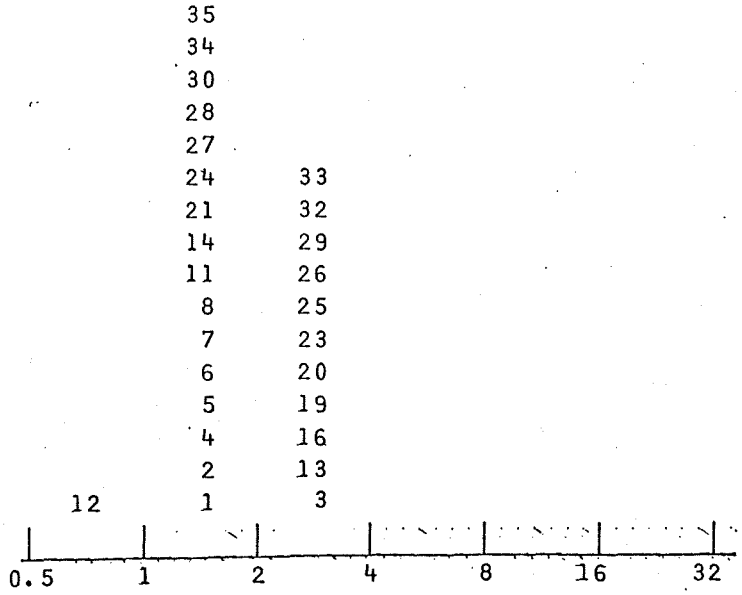
Wiggles
(kft/sec)

BIEBER

Seismicity vs. Frequency



Ordinary Events
(cps)



Wiggles
(cps)