650108

GEOPHYSICAL REPORT
BOREHOLE ELECTROMAGNETIC SURVEY

ON THE

WEST CLAIMS

CROFTON AREA

VICTORIA MINING DISTRICT, B.C.

NTS SHEETS 92B/13E

BY

DELTA GEOSCIENCE LTD.

MARCH 6, 1989.

G.A. HENDRICKSON, P.GEOPH.

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INTRODUCTION

This report is concerned with a borehole electromagnetic logging program using the Remi-Melis system developed by the Bureau de Recherches Geologiques et Minieres (B.R.G.M.) of France.

The main application of the Remi-Melis system is in mining exploration, where massive to semi-massive sulphide bodies (conductors) missed by drill holes can be detected up to 100m. from the hole.

Falconbridge Ltd., the operator of the West Claims, contracted Delta Geoscience Ltd. to log several holes during the period October 19 to December 3, 1988. Falconbridge Ltd has the West Claims under an option agreement. The work program had two objectives:

a) the detection of any conductive zones around the drill holes.

b) the continuing evaluation of the Remi-Melis system.

The Remi-Melis system is a hole to surface frequency EM method that aims at detecting conductive targets located around a drill hole. Basically, the system consists of transmitting an alternating current into a loop positioned on the surface of the ground and encircling the borehole, and in measuring the component of the magnetic field along the borehole axis.

Secondary currents induced by the primary field of the loop into any nearby conductive bodies will produce secondary magnetic fields which, in addition to the primary field, are measured by the down hole Remi probe. The in-phase and out of phase components of the total axial (borehole) field with respect to the primary field, are determined through a reference magnetic sensor located on the surface adjacent to the drill hole.

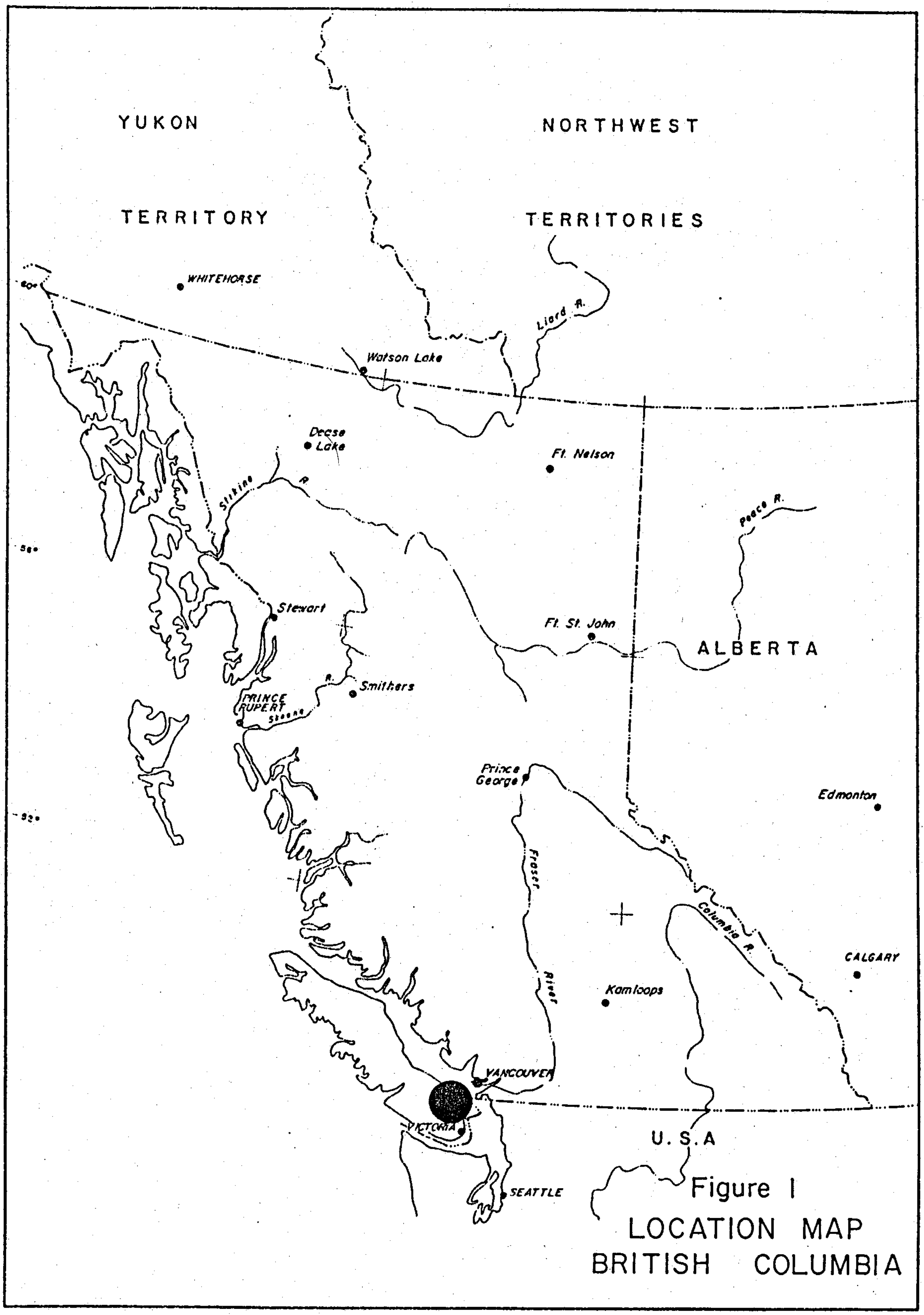
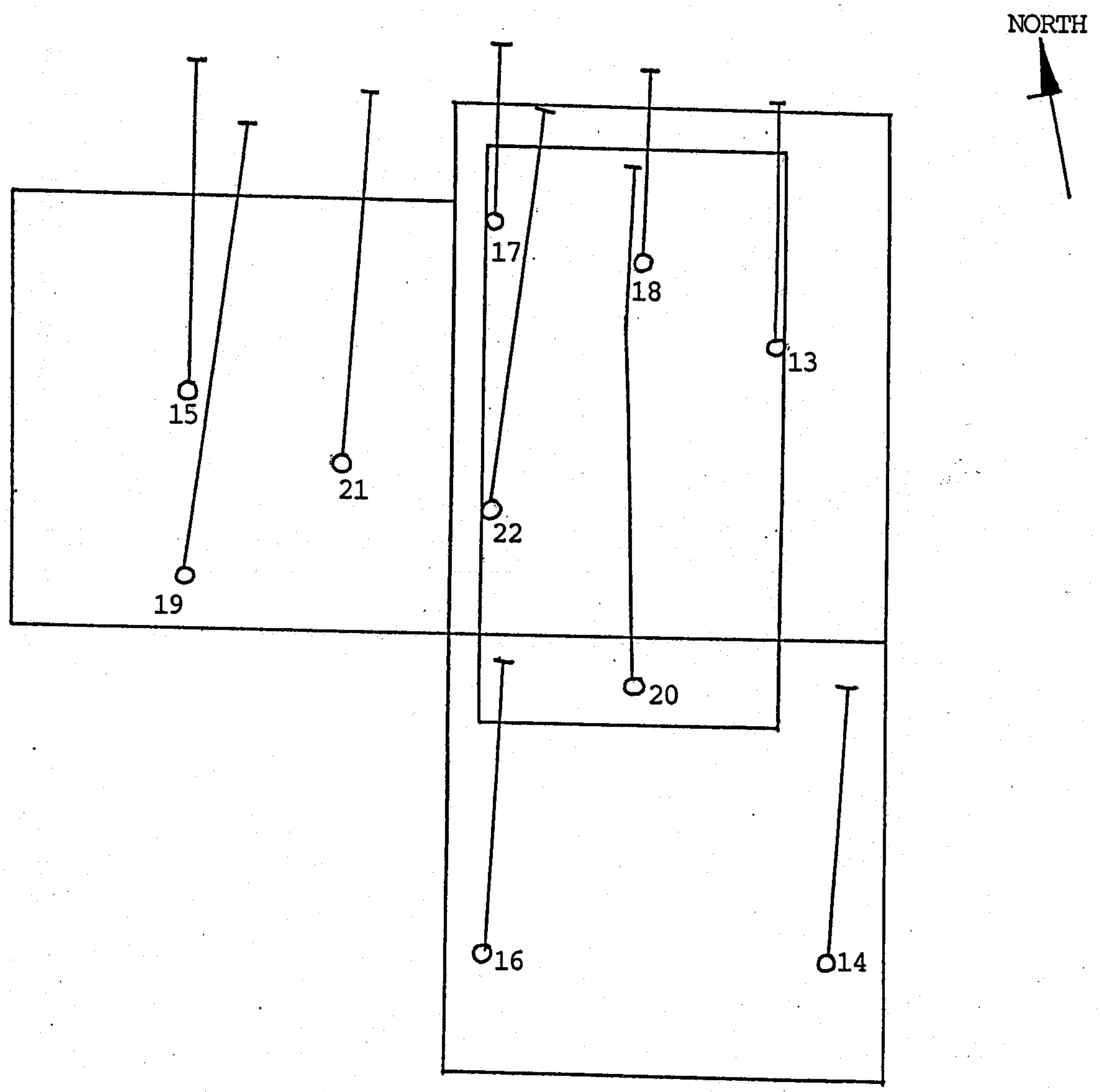


Figure I
LOCATION MAP
BRITISH COLUMBIA

Fig. #2.



WEST PROJECT

LOOP LOCATION MAP

SCALE 1:5000

DELTA GEOSCIENCE LTD.

PERSONNEL

Scott Cosman - Geophysicist/Crew Chief
Tim Tokarsky - Geophysicist
Grant Hendrickson - Senior Geophysicist/Supervisor

EQUIPMENT

1 - BRGM Melis Receiver: two channel frequency EM receiver (frequency range 0.12 hz to 8000 hz). connected to the downhole and surface sensors.
1 - TX1000 BRGM Transmitter: frequency EM transmitter, 0.11 hz to 7500 hz, powered by a 220 volt, 60 hz, 3.5 kva Honda Motor Generator.
1 - Surface Loop: 1200m. electric wire with a total resistance of 8 ohms.
1 - Remi borehole probe: downhole CMS magnetic sensor, frequency range is 2 hz to 8 hz, with a sensitivity of 50 mV/γ.
1 - Godek Winch Downhole System, with a 4 conductor armoured shield cable (610m).
1 - Sheave wheel assembly for depth in hole measurement, attaches to hole collar.
2 - King VHF Radios.
1 - 4x4 Toyota Truck.
1 - Toshiba T1200 Field Computer
1 - H.P. Quietjet Printer.

DATA PRESENTATION

Data is presented as EM profiles of the borehole. Four profiles of each hole are presented, as follows:

a) in-phase/reference.
b) out of phase/reference.
c) amplitude/reference.
NOTE: AMPLITUDE = $\left[\left(\frac{I.P}{R}\right)^2 + \left(\frac{Q}{R}\right)^2\right]^{1/2}$
d) phase angle.
NOTE: Phase Angle = ARCTAN (Q/I.P) is in degrees.

Scales are presented on the profiles as the normalized electromagnetic response, versus depth in meters.

In addition, drill hole location maps are provided showing the location of the surface loops and the boreholes.

SURVEY PROCEDURE

Surface loops generally 300m by 300m, but occasionally 200m by 400m, were laid out to encompass adjacent drill holes. The spatial distribution of drill holes required four separate loop setups. All drill holes and their horizontal projection lie within their respective loops. The enclosed location map illustrates the location of drill holes relative to their transmitting loops.

The reference sensor was set up approximately 10m. from each drill hole. This reference was fixed for the duration of the logging of that hole.

Holes were logged from the bottom to the top, in increments of 5 to 10 meters, depending on the detail desired. At each depth increment, four frequencies were transmitting in sequence: 90hz, 700hz, 1798hz and 3623hz. At each frequency the Melis receiver measured the in-phase (I.P) and out of phase (Q) components of the borehole axial field in amps/meter and the amplitude of the reference R also in amps/meter.

Note: That a full choice of frequencies from .1hz to 7500hz, with 10 frequencies per decade is available to the operator. This full frequency capability allows the geophysicist to design the survey to suit the range of conductivities expected for the mineralization and host rock, an important consideration in conductive terrains.

At the end of each day, the Melis receiver transferred the data to the Toshiba 1200, where the data was edited, normalized and plotted. This final step could easily be done on site if results were urgently needed.

DISCUSSION OF THE DATA

In-hole responses are indicated by positive deflections on the out-of-phase and phase profiles. If the conductor is strong enough, these deflections will be accompanied by negative deflections on the in-phase and amplitude profiles.

Off-hole responses are indicated by negative deflections on the out-of-phase and phase profiles. If the conductor is strong enough, these deflections will be accompanied by positive deflections on the in-phase and amplitude profiles.

The accompanying diagram illustrates the in-hole and off-hole phase angle response for a moderate conductor. The three degree phase response for a conductor off-hole 60 metres, although modest, is still 30 times the resolution of the REMI system.

The Melis receiver continuously monitors the electromagnetic noise in the hole and gives the operator two measurements of this noise: (a) standard deviation in %, and (b) quality factor in %. The quality coefficient depends on the noise observed at frequencies close to the analysis frequency; the standard deviation parameters depend on the noise observed at the frequency of the signal itself.

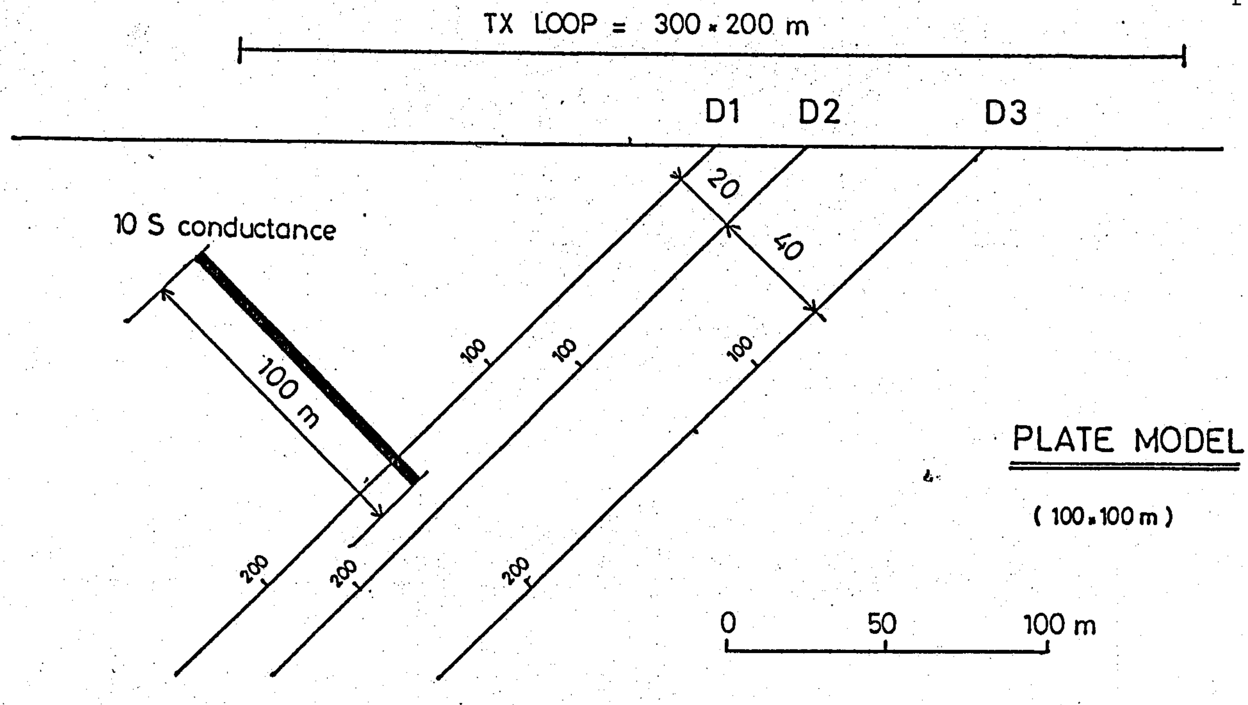
During the course of this survey, we were able to keep the standard deviation below 5% and the quality factor over 97% by continuously monitoring the noise at each frequency. Sometimes a longer stack was required to reduce the noise level. Resolution of the phase angle response is generally excellent (.1 degree).

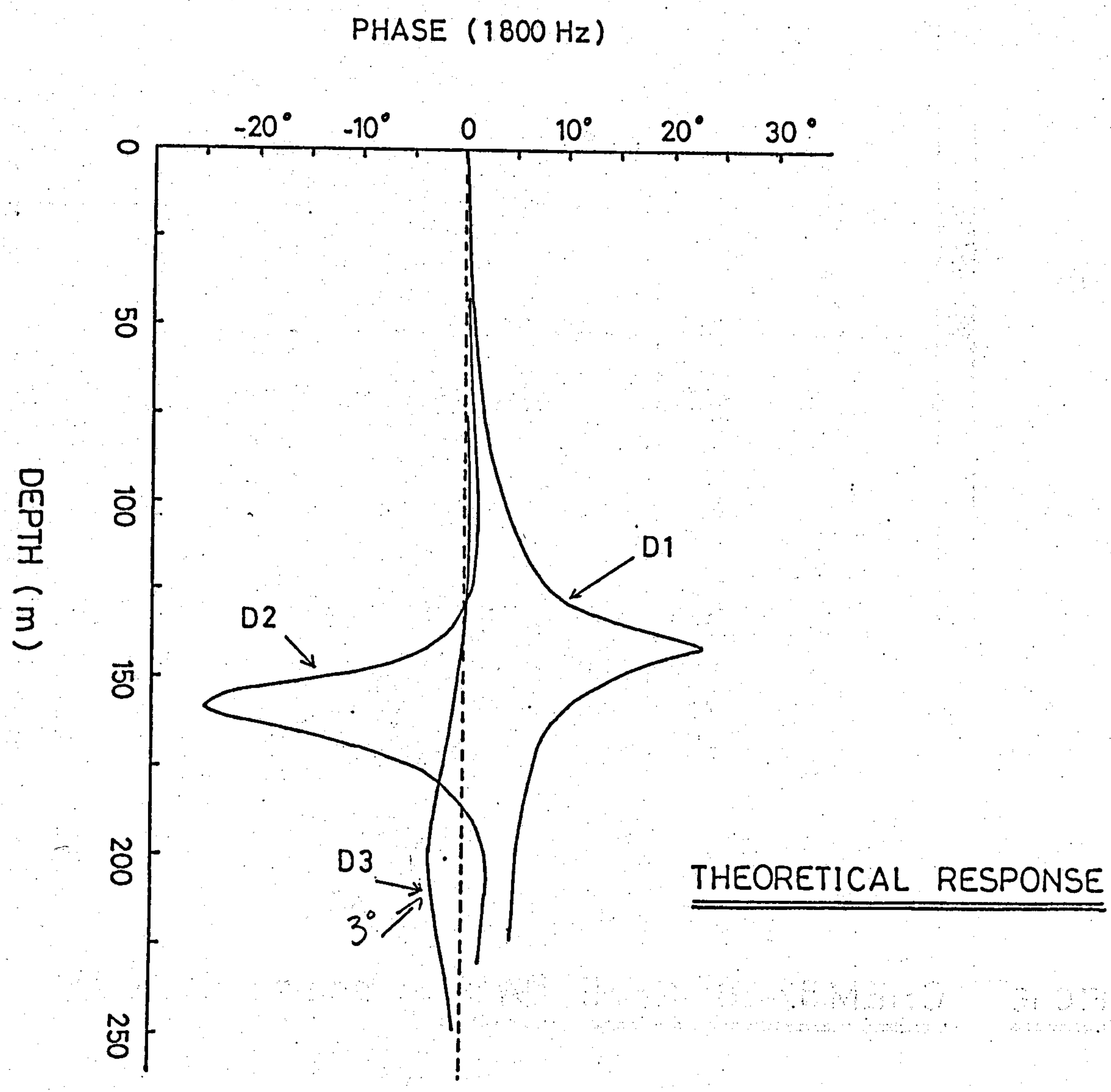
The narrow, in-hole and off-hole conductors detected by this survey may be due to sulphide mineralization and/or thin graphitic horizons possibly fault zones.

The correlation of in-hole responses to the geologic logs to date, suggests the stronger responses are much more likely to be due to sulphide mineralization.

Broad, weak in-hole conductors are mostly likely due to carbonaceous argillite horizons. Another possibility is thin conductive horizons sub-parallel to the drill hole.

Careful correlation of these borehole EM results with the detailed geology of each hole is essential to the understanding of the Remi system.


TX LOOP = 300 × 200 m
D1
D2
D3
20
40
10 S conductance
100 m
100
100
100
200
200
200
PLATE MODEL
(100 × 100 m)
0
50
100 m


PHASE (1800 Hz)
-20°
-10°
0
10°
20°
30°
0
50
100
150
200
250
DEPTH (m)
D1
D2
D3
3°
THEORETICAL RESPONSE

A brief discussion of each hole follows:

<u>WE-13</u>:

- holes 17, 18, 13 and 22 are within this loop.
- broad moderate to weak in-hole responses at 95m, 130m, and 155m are superimposed on each other.
- the response at 130m. is the strongest in-hole response (approx. 10 degree phase), which is significant.
- broad zones of poor conductivity could be due to extensive stringer mineralization.

<u>WE-14</u>:

- hole 16 is also within this loop.
- hole is blocked at 230m. depth.
- abnormal response curves due to severe topography effects. Hole was drilled downslope resulting in the bottom of the hole being closer to the loop at approx. the 200m. depth.
- no significant conductors detected.

<u>WE-15</u>:

- holes 19 and 21 are also within this loop.
- a study of this hole suggests there are numerous minor conductors (sulphide stringers?) in this hole.
- the most significant responses are: the narrow in-hole response at 75m. (approx. 3 degree phase), the very narrow off-hole response at 185m. depth (1 degree phase), and the broad in-hole response centered at 250m. depth. (approx. 5 degree phase). These three zones are likely the centers of sulphide stringer mineralization.

<u>WE-16</u>:

- hole 14 is also within this loop.
- abnormal response curves due to severe topography (same as explained in hole 14).
- a narrow moderate strength (4 degree phase) off-hole response occurs at 100m. depth.
- the high frequency 3623hz badly affected by noise.

WE-17: Sect 14E

- holes 13, 18 and 22 are also within this loop.
- the noisy appearance of the phase response suggests the presence of numerous minor conductors (sulphide stringers?) in and immediately adjacent to the hole. The best of these responses are: minor off-hole response at 66m. depth, minor in-hole response at 90m depth and off-hole response at 150m.* *

WE-18:

- holes 17, 13 and 22 are also within this loop.
- a moderate strength (3 degree phase) off-hole response occurs at 50m. depth approx. 10m. from the hole.
- moderate strength in-hole responses at 120m. and 135m. depths are significant (3 to 4 degree phase). The conductor at 135m. depth is likely dipping steeply north sub-parallel to the hole. (Response is changing to off-hole deeper in the hole.)

WE-19:

- holes 15 and 21 are also within this loop. Hole 19 passes below hole 15.
- A - very narrow weak off-hole response at 120m. depth (close to hole).
- B - broad weak in-hole response centered at 180m. depth (lithology change?).
- C - good indications of an off-hole response beginning to appear at the end of the hole.

WE-20:

- separate 200m. by 400m. loop used due to length of hole.
- hole blocked at 300m. depth unfortunately.
- moderate strength (5 degree phase) off-hole response at 160m. depth approx. 60m. from hole. Conductor is likely off to the side of the hole and may dip steep north. ** N

WE-21:

- holes 15 and 19 are within the same loop.
- the very narrow, weak off-hole response at 60m. and 170m. depth are too small to be of any significance.
- a significant off-hole response is occurring at the end of this hole (15 degree phase), at the 330 to 340m. depth. Although the response is only partially delineated, it's probably safe to say that the conductor is at least 40m. from this hole.

WE-22: sect 14E

- holes 17, 18 and 13 are within this loop.
- a narrow, moderate strength (10 degree phase) off-hole response at 65m. depth is within 10m. of the hole.
- a moderate strength (10 degree phase) in-hole response at 185m. appears to have a width of approx. 10m.
- good indications of a significant off-hole response building at the bottom of the hole (15 degree phase). This off-hole conductor is likely quite a distance (80m?) from the bottom of the hole. Difficult to judge since response is only partially recorded. *

CONCLUSION AND RECOMMENDATIONS

Correlating these borehole EM results with the detailed geology of each hole is essential to fully understand the significance of off-hole and in-hole responses recorded by the Remi system.

Off-hole responses created by conductors a long way from the hole have a long low amplitude wavelength that at times can be difficult to separate accurately from the background response of the hole.

Experience elsewhere in the Sicker rocks has shown that typically mineralized horizons (ore grade) create clear cut phase anomalies ranging from 4 to 20 degrees at the highest frequency.

In-hole anomalies at the West claims have been in the above range, thus there should be a good explanation observable in the drill core, (possibly stringer sulphide mineralization). In evaluating the stronger off-hole responses, one must consider the causes for the in-hole responses before recommending more drilling. Holes 21 and 22 indicate a significant off-hole response at the bottom of the holes, perhaps dipping steeply north.

G. Hendrickson

Grant A. Hendrickson, P.Geoph.

REFERENCES

Bernard, J., January 1988: Test of Remi Hole-to-Surface Electromagnatic Equipment at Chemainus, B.C., Canada. B.R.G.M. Report.

B.R.G.M. Report, September 1988: Operating Procedures of Remi Hole-to-Surface Frequency EM Method.

Borehole Geophysics for Mining and Geotechnical Applications, Geological Survey of Canada Paper 85-27. Edited by P.G. Killeen, 1986.

STATEMENT OF QUALIFICATION

Grant A. Hendrickson

- B.Science, U.B.C. 1971, Geophysics option.
- For the past 18 years, I have been actively involved in mineral exploration projects throughout Canada and the United States.
- I am a registered Professional Geophysicist with the Association of Professional Engineers, Geologists and Geophysicists of Alberta.
- I am an active member of the S.E.G., E.A.E.G., and B.C.G.S.

Dated at Delta, British Columbia, this 8 day of MARCH, 1989.

G. Hendrickson

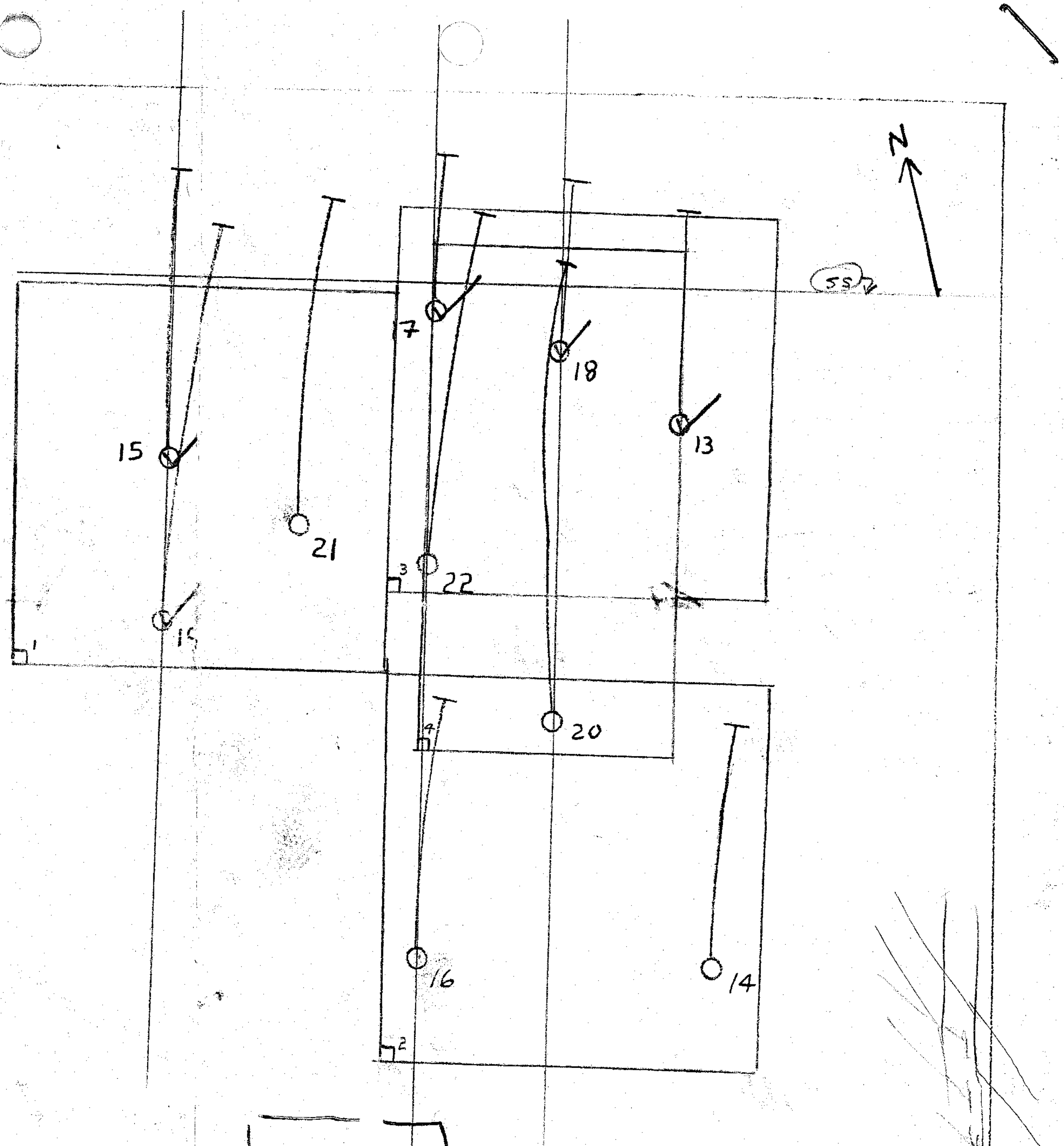
Grant A. Hendrickson, P.Geoph.

TO/STAN

HOLE	DEPTH (m)
13 ✓	230.7
14 ✓	270.9
15 ✓	308.2
16 ✓	288.0
17 ✓	171.6
18 ✓	177.7
19 ✓	410.6
20	587.3
21 ✓	348.6
22 ✓	376.5
	3,170.1 m

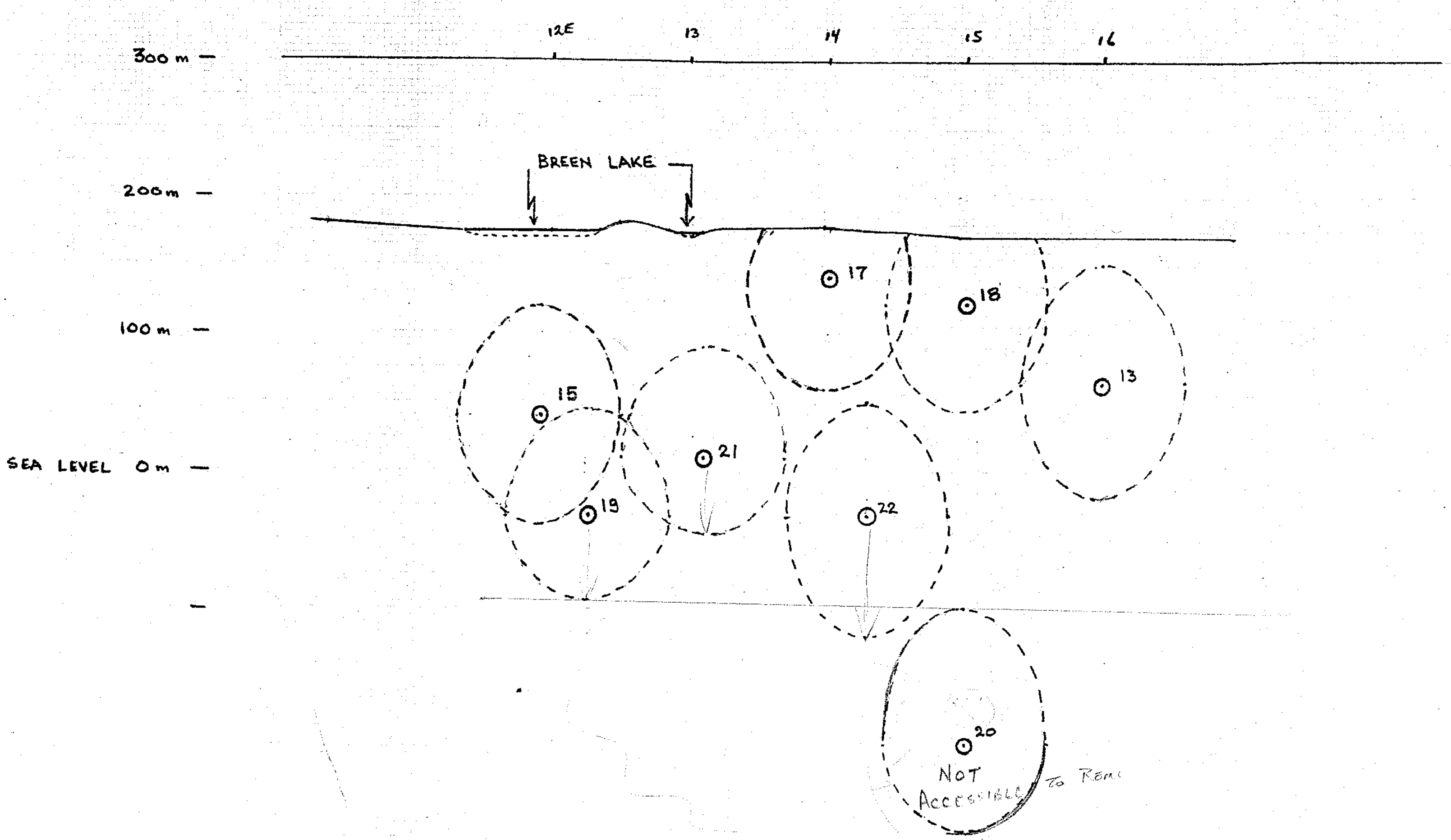
DIP ALL HOLES -45°

0 100 200
metres
1:5000



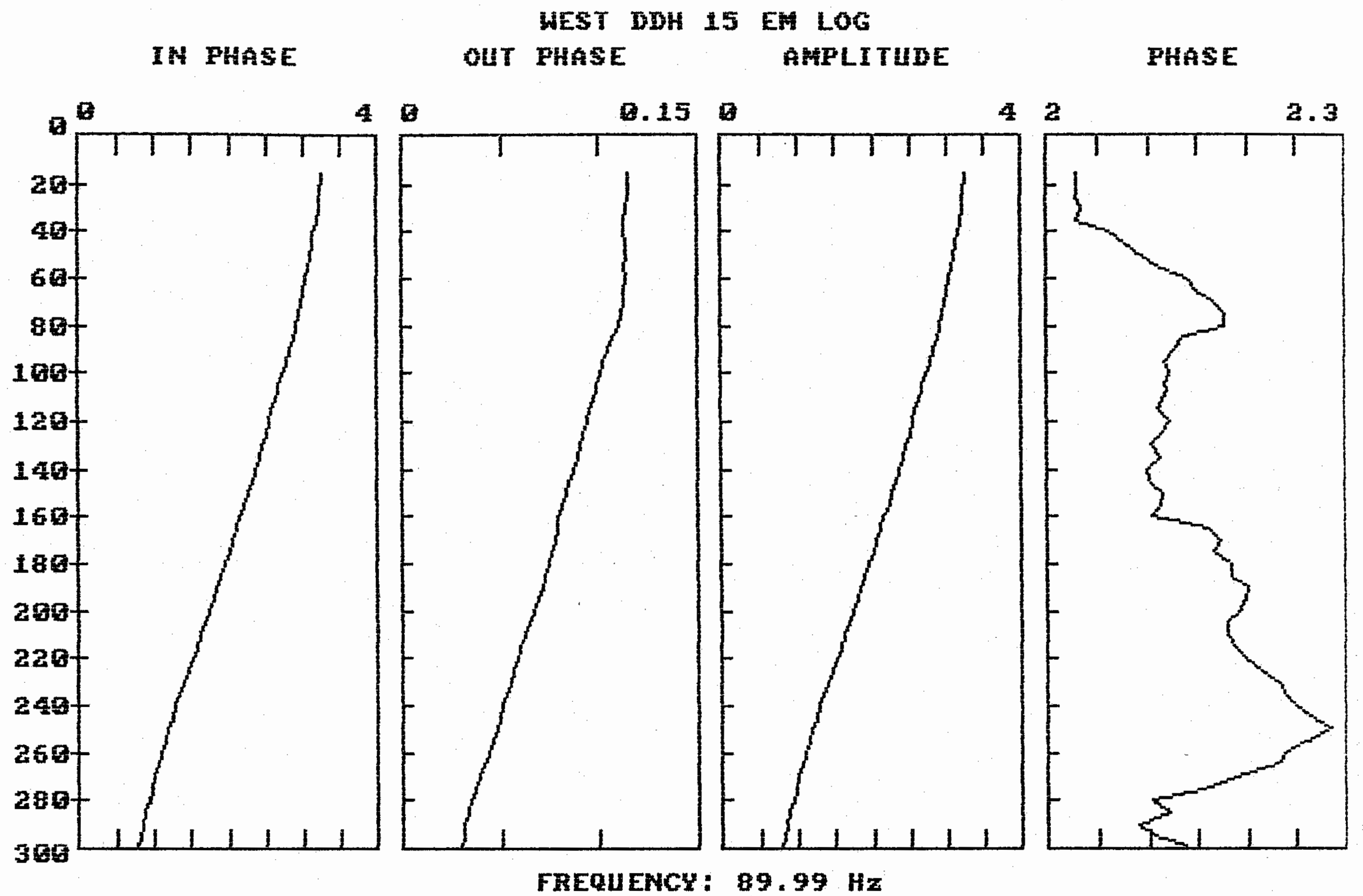
AREA I
DRILL HOLE LOCATIONS

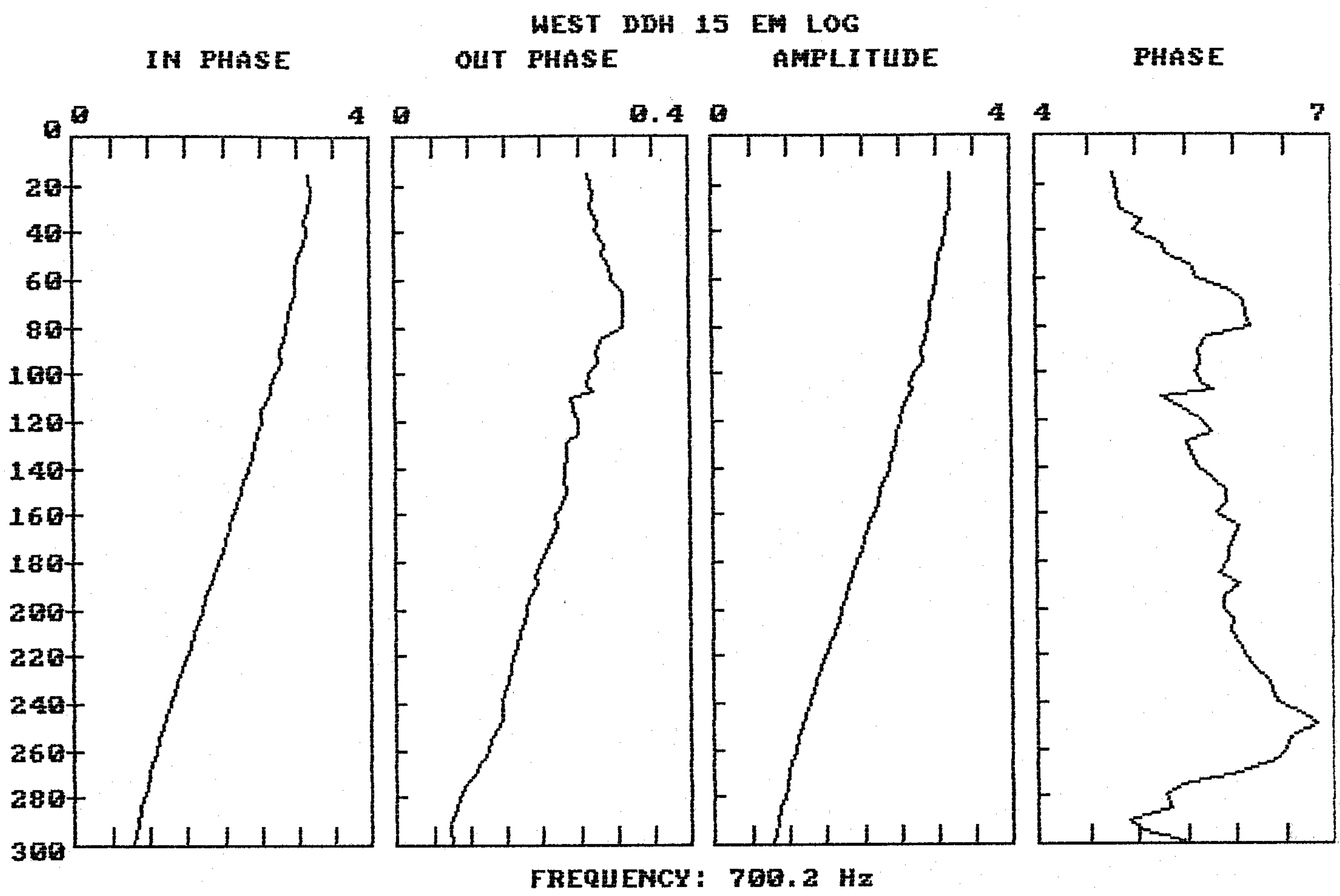
13	16+00E, 6+16S
14	16+32E, 10+39S
15	11+92E, 6+54S
16	13+96E, 10+37S
17	14+00E, 5+34S
18	15+00E, 5+63S
19	11+90E, 7+80S
20	15+00E, 8+50S
21	13+00E, 7+03S
22	14+00E, 7+30S



300 m
200m
100 m
SEA LEVEL 0 m
12E
13
14
15
16
BREEN LAKE
17
18
13
15
21
19
22
20
NOT ACCESSIBLE

5.S.


WEST DDH 15 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
0
4
0
0.15
0
4
2
2.3
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
FREQUENCY: 89.99 Hz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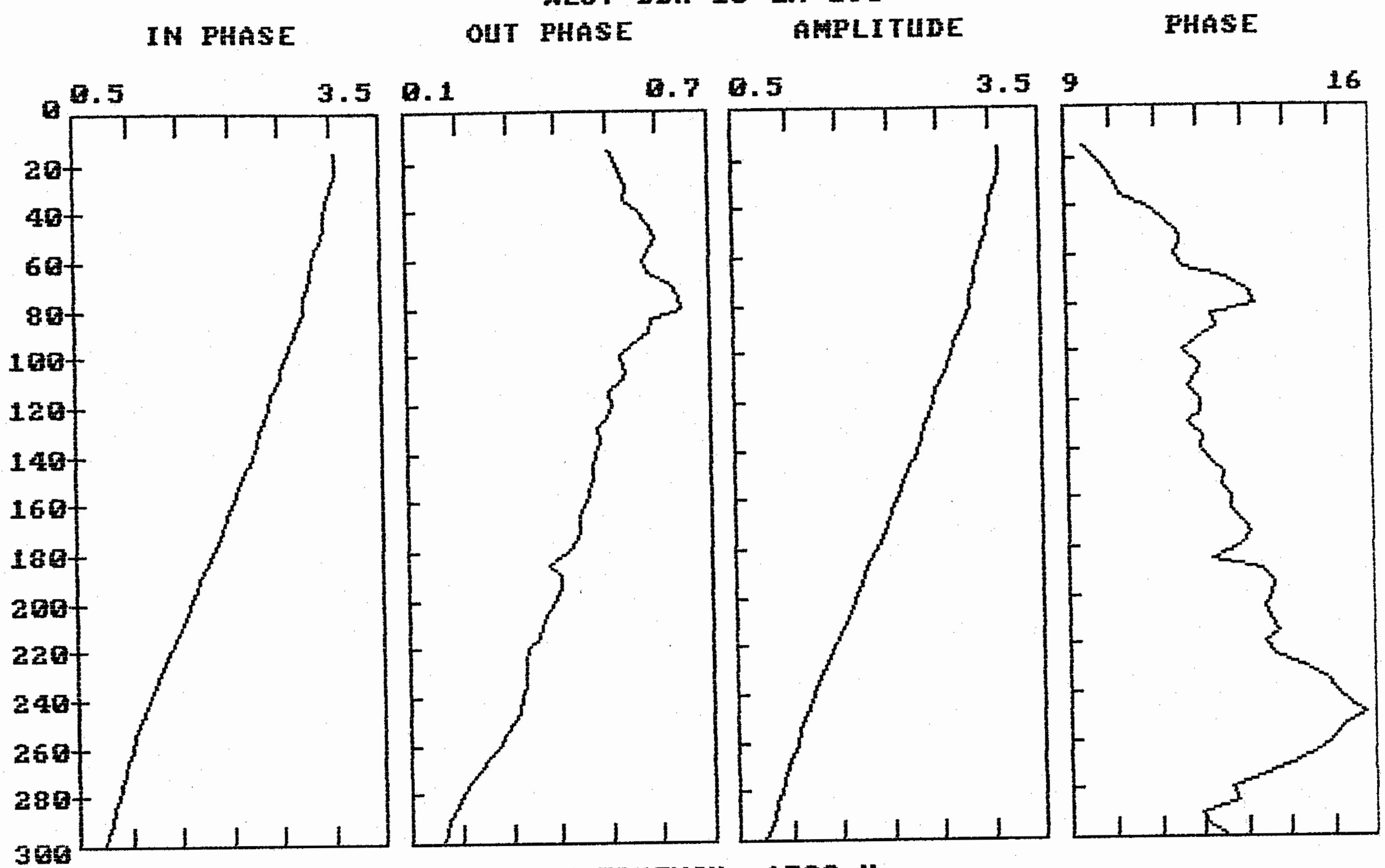
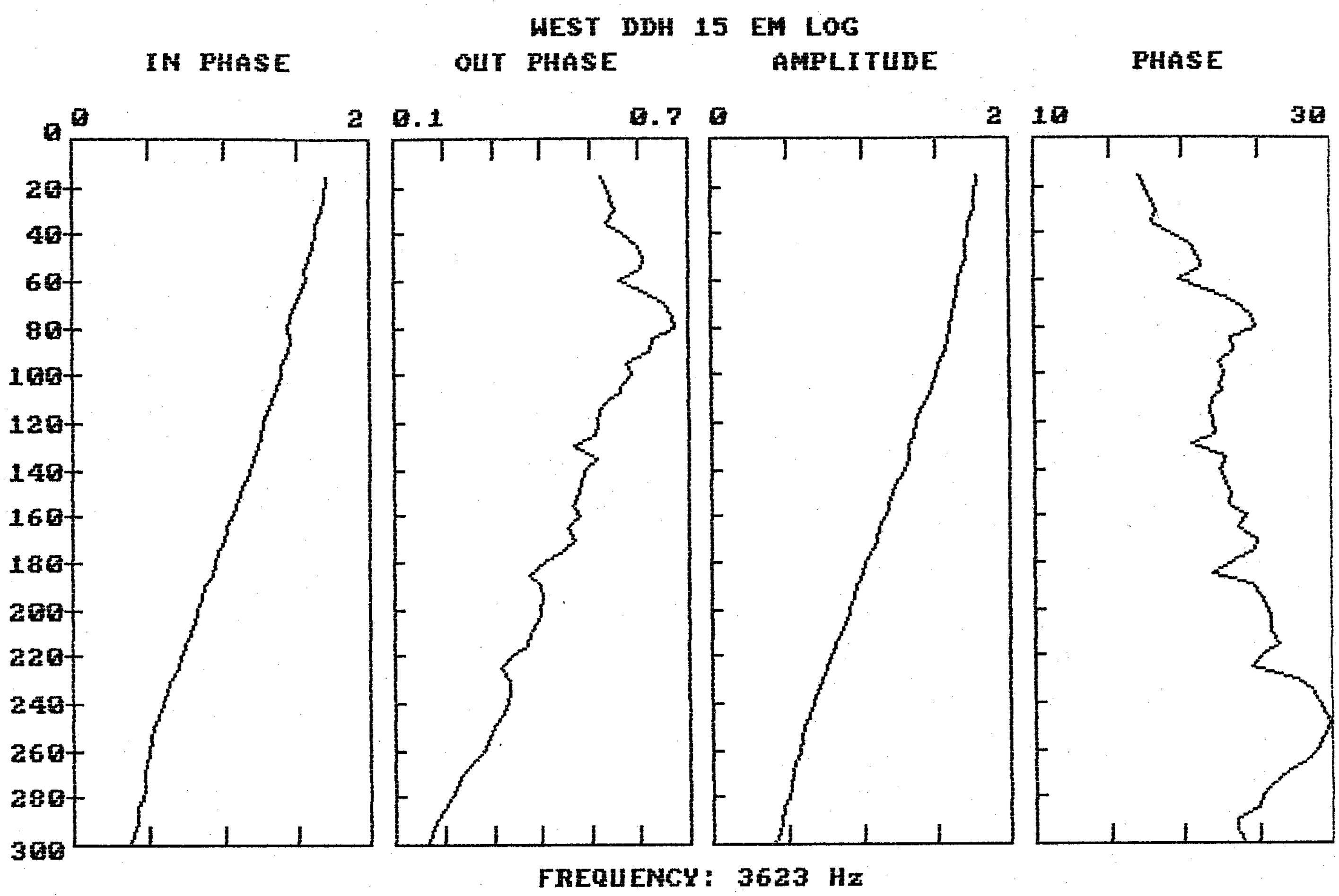
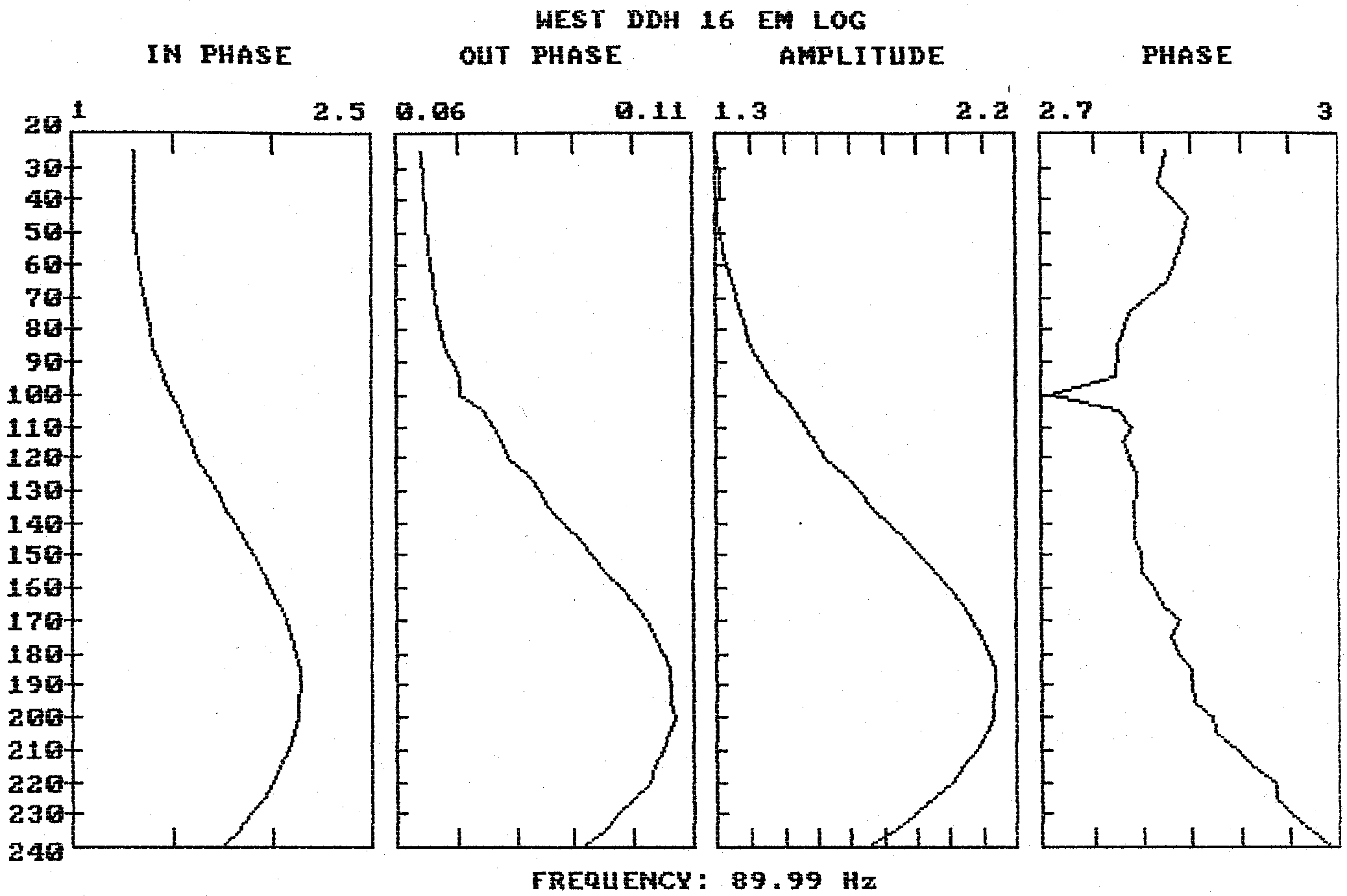
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
0
4
0
0.4
0
4
4
7
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
FREQUENCY: 700.2 Hz

WEST DDH 15 EM LOG

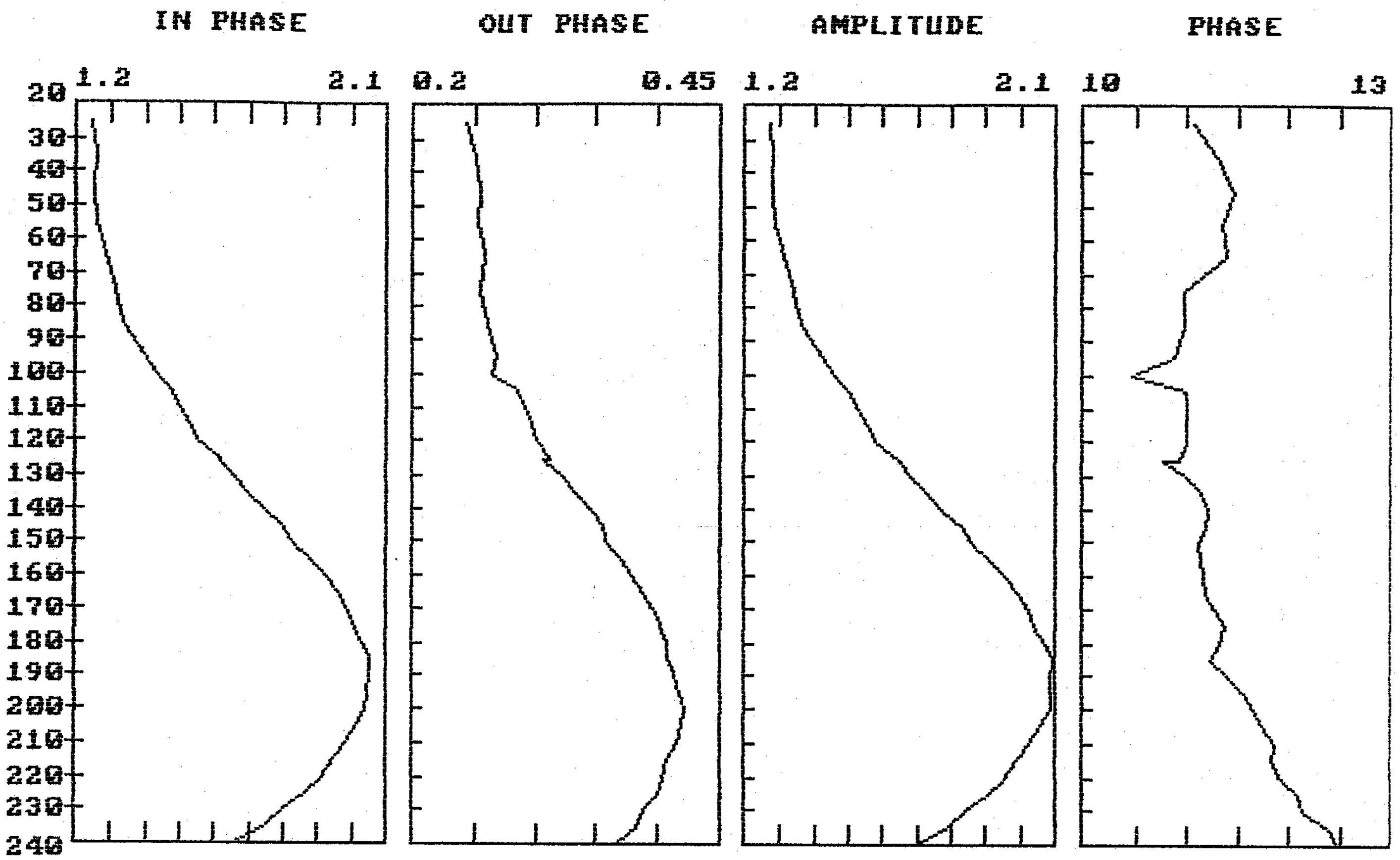


FREQUENCY: 1798 Hz

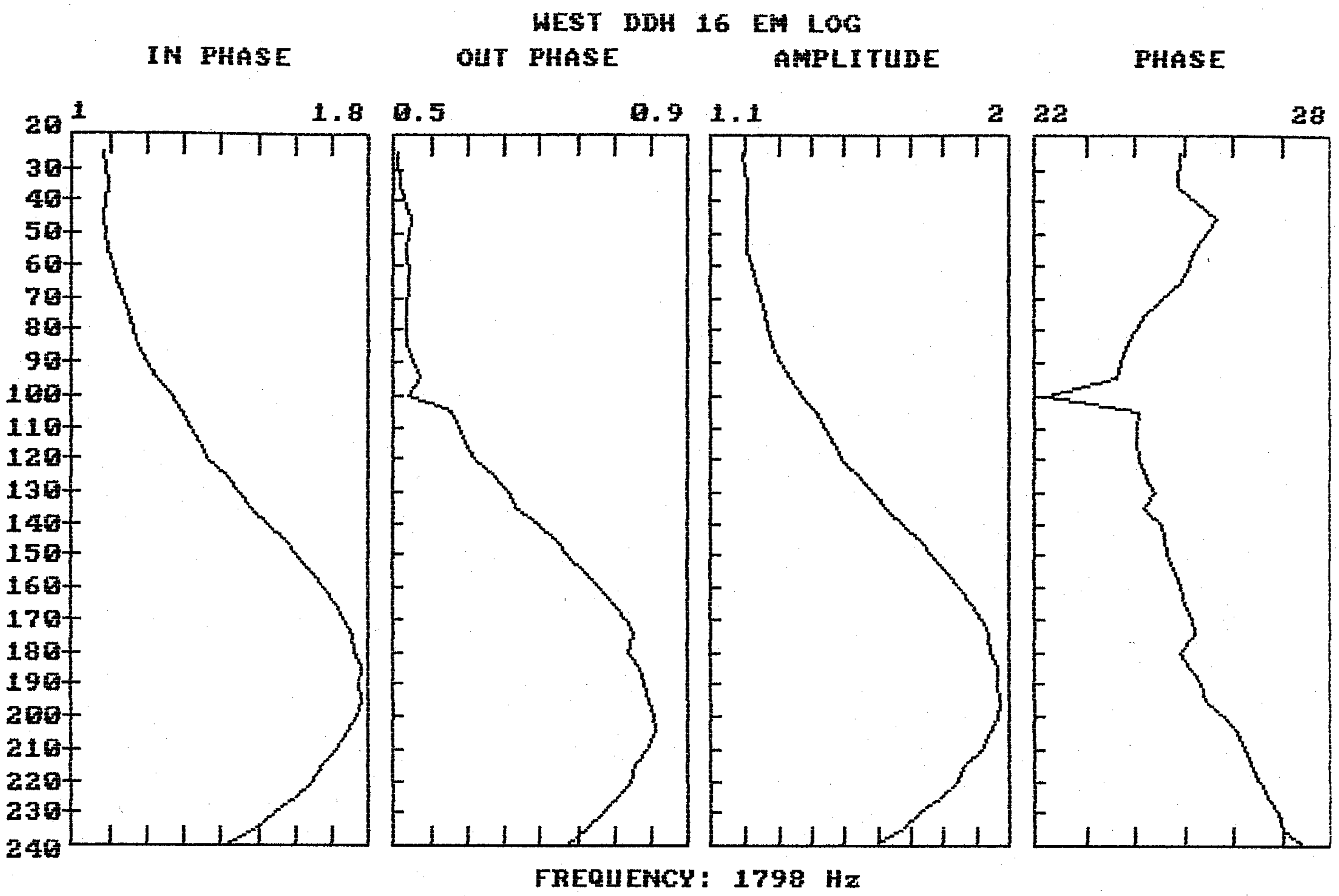

WEST DDH 15 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
0
2
0.1
0.7
0
2
10
30
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
FREQUENCY: 3623 Hz


WEST DDH 16 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
1
2.5
0.06
0.11
1.3
2.2
2.7
3
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
FREQUENCY: 89.99 Hz

WEST DDH 16 EM LOG

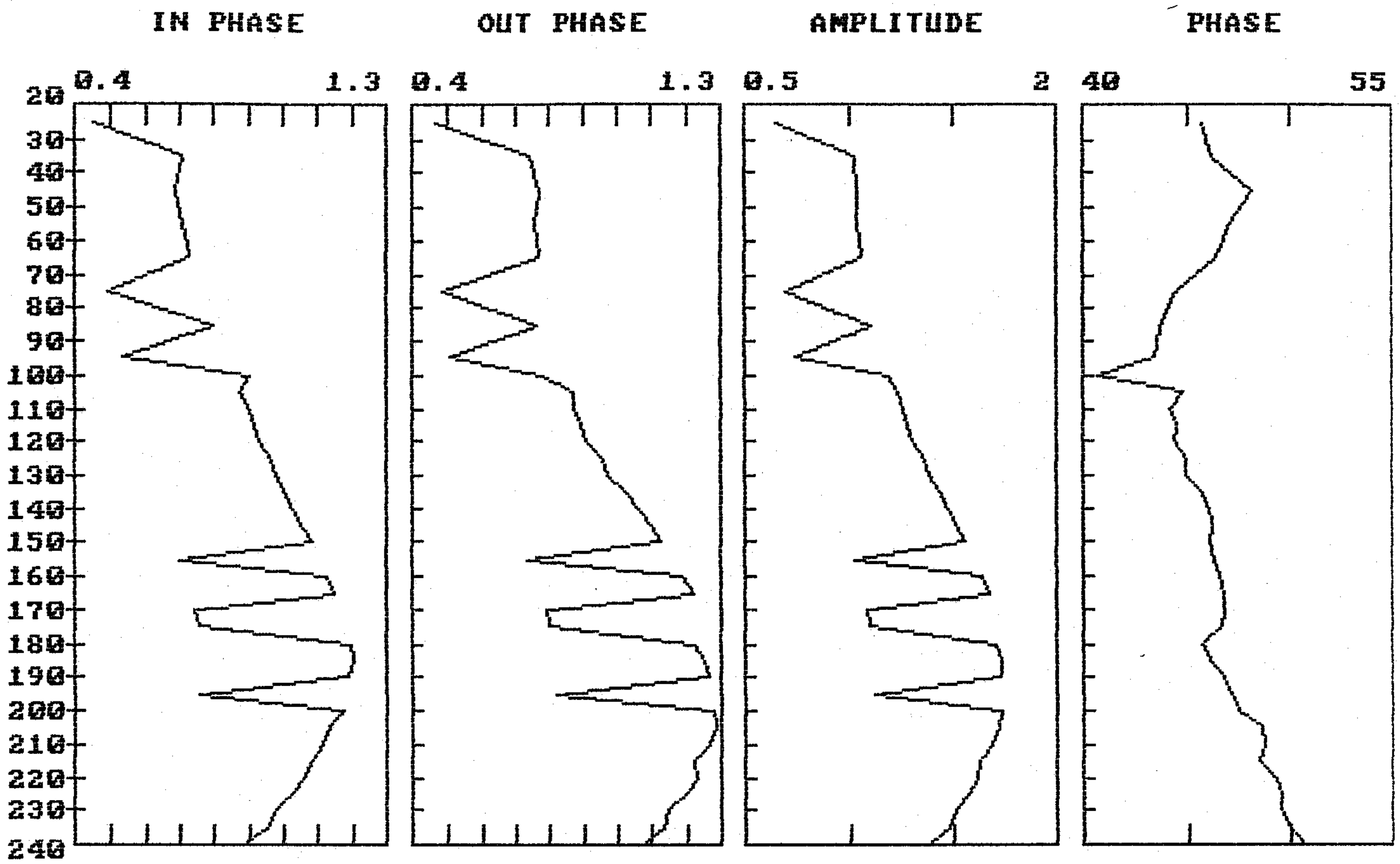


FREQUENCY: 700.2 Hz



WEST DDH 16 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
1
1.8
0.5
0.9
1.1
2
22
28
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
FREQUENCY: 1798 Hz

WEST DDH 16 EM LOG



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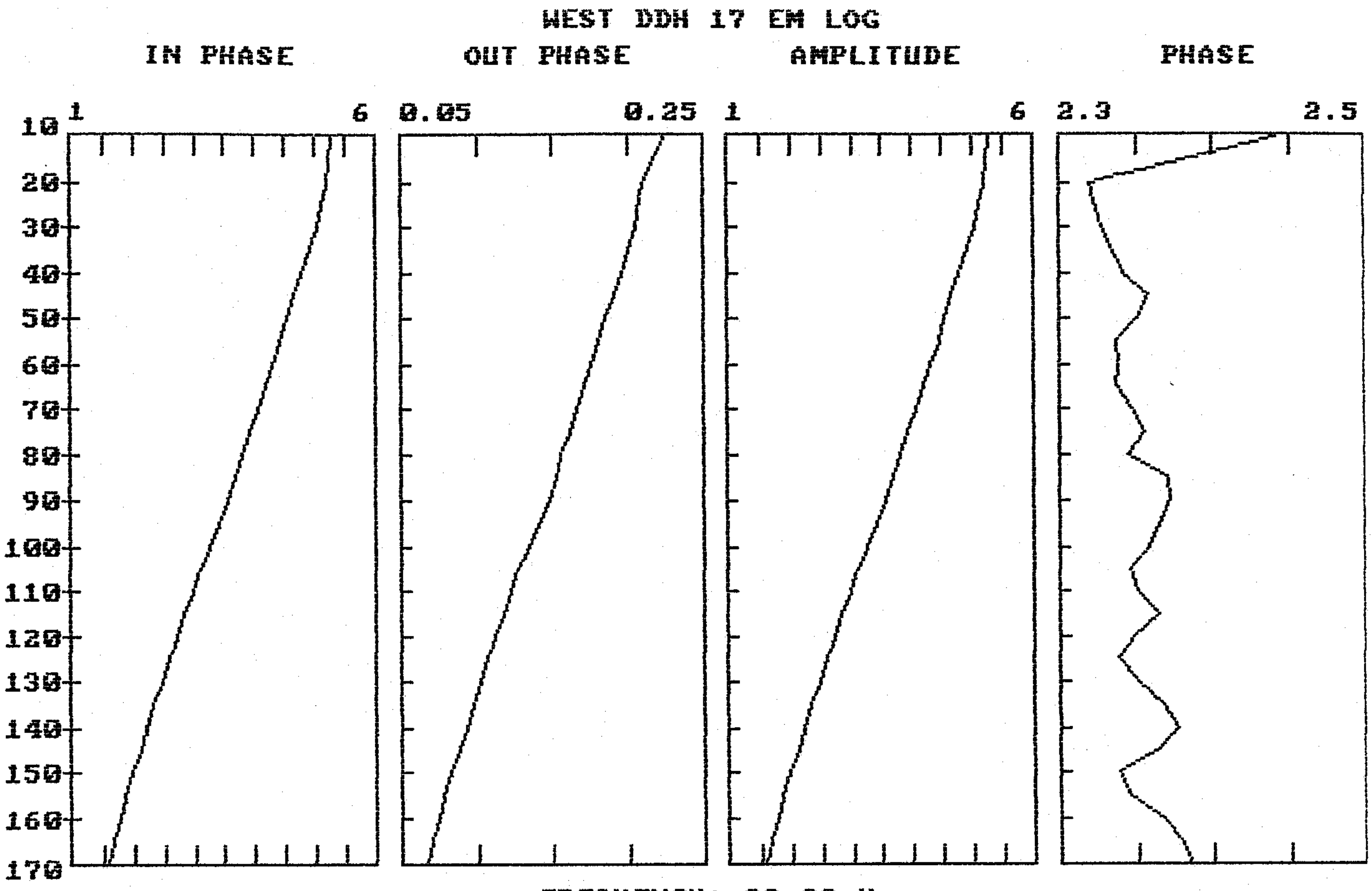

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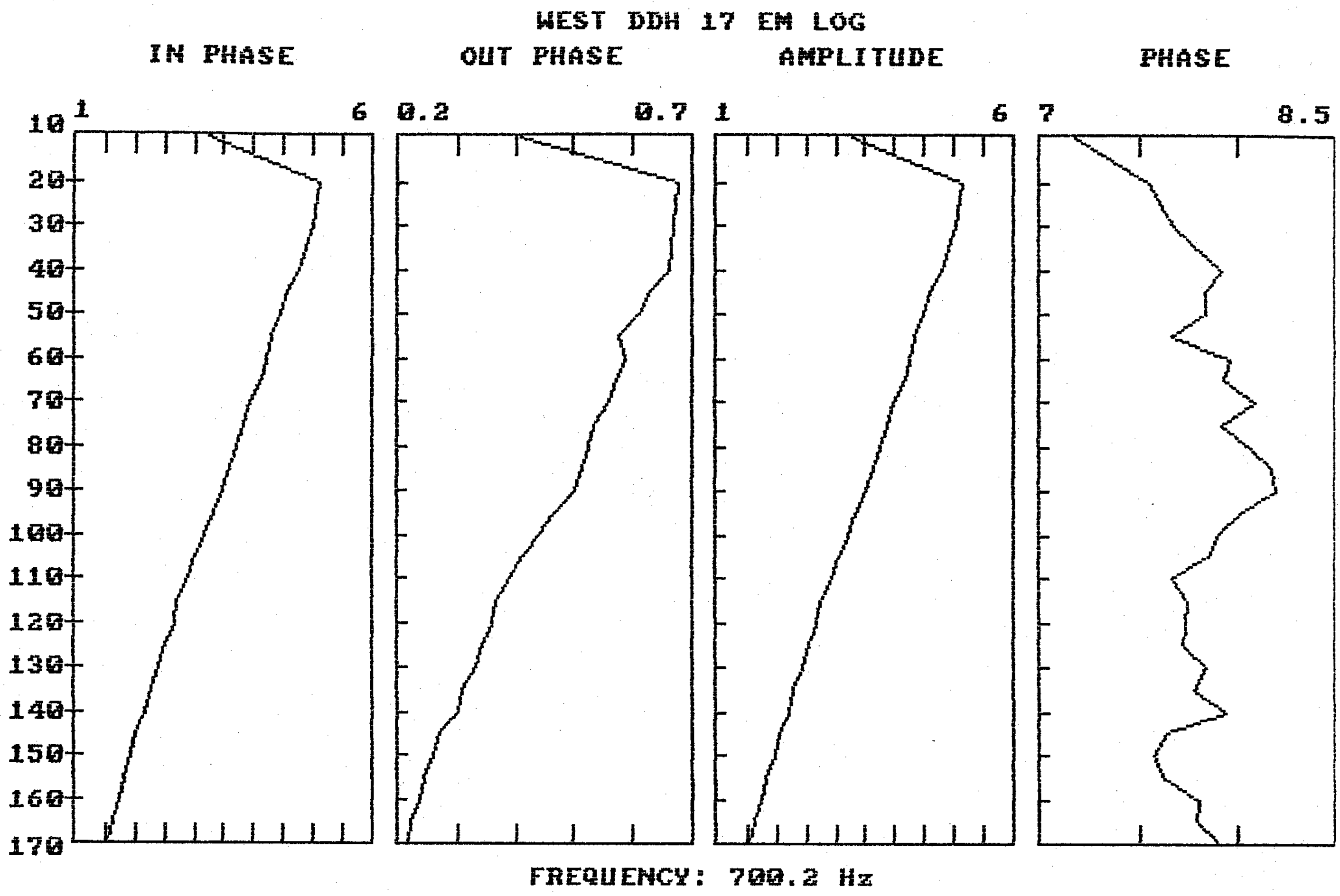
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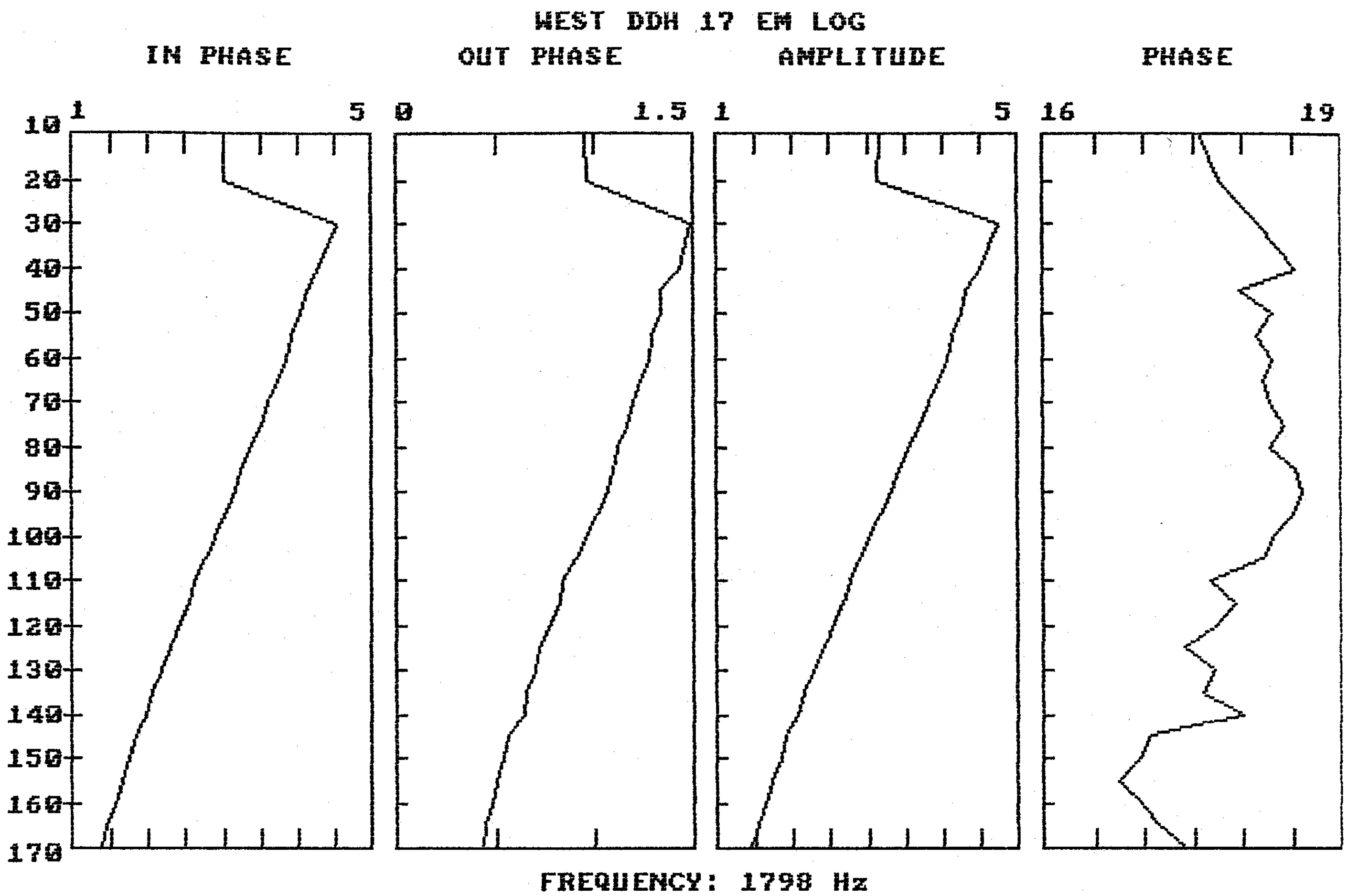
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
1
6
0.2
0.7
1
6
7
8.5
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
FREQUENCY: 700.2 Hz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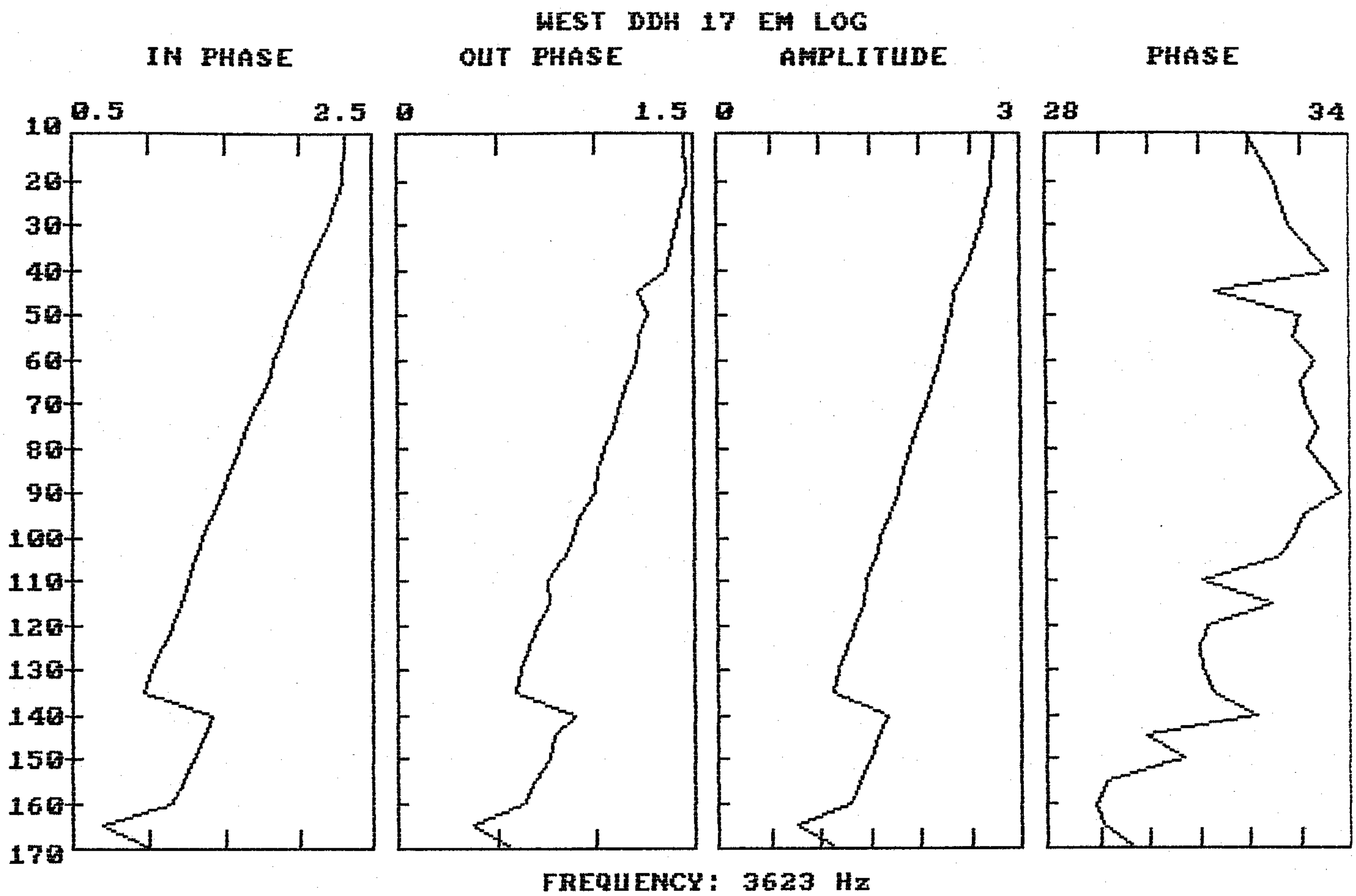
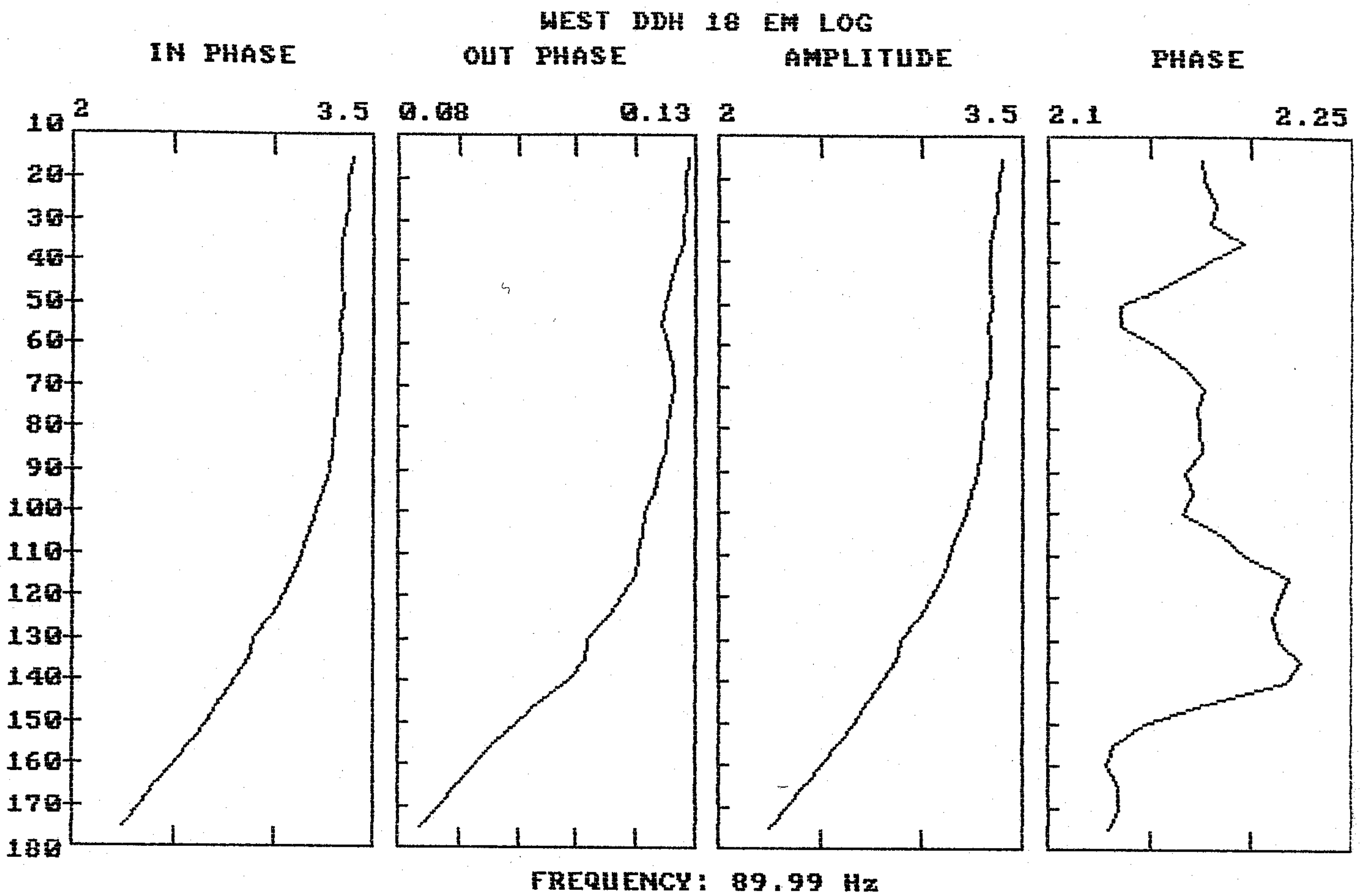
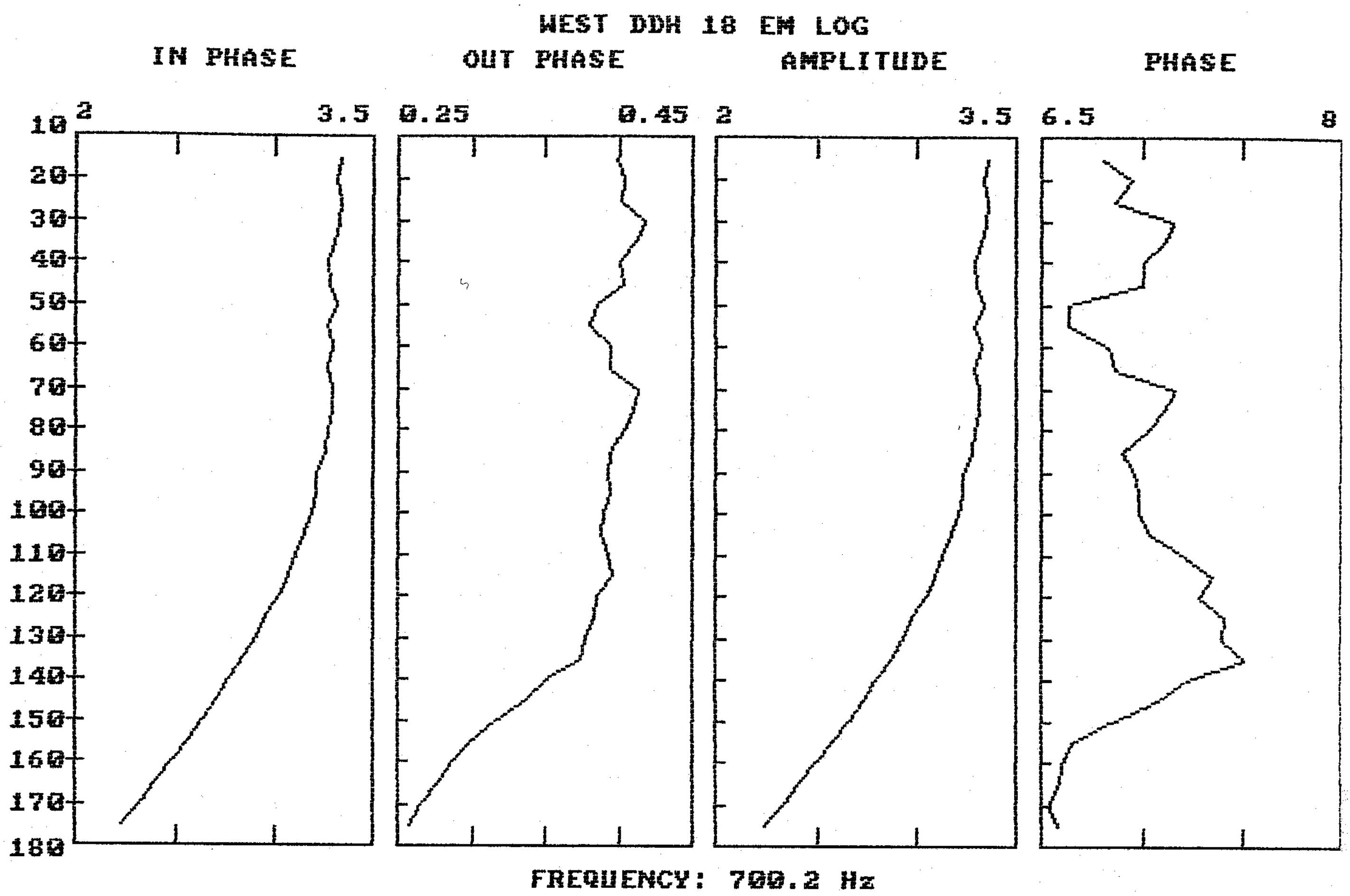
OUT PHASE
AMPLITUDE
PHASE
1
5
0
1.5
1
5
16
19
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
FREQUENCY: 1798 Hz


WEST DDH 17 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
0.5
2.5
0
1.5
0
3
28
34
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
FREQUENCY: 3623 Hz


WEST DDH 18 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
2
3.5
0.08
0.13
2
3.5
2.1
2.25
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
FREQUENCY: 89.99 Hz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OUT PHASE
AMPLITUDE
PHASE
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3.5
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6.5
8
10
20
30
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50
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70
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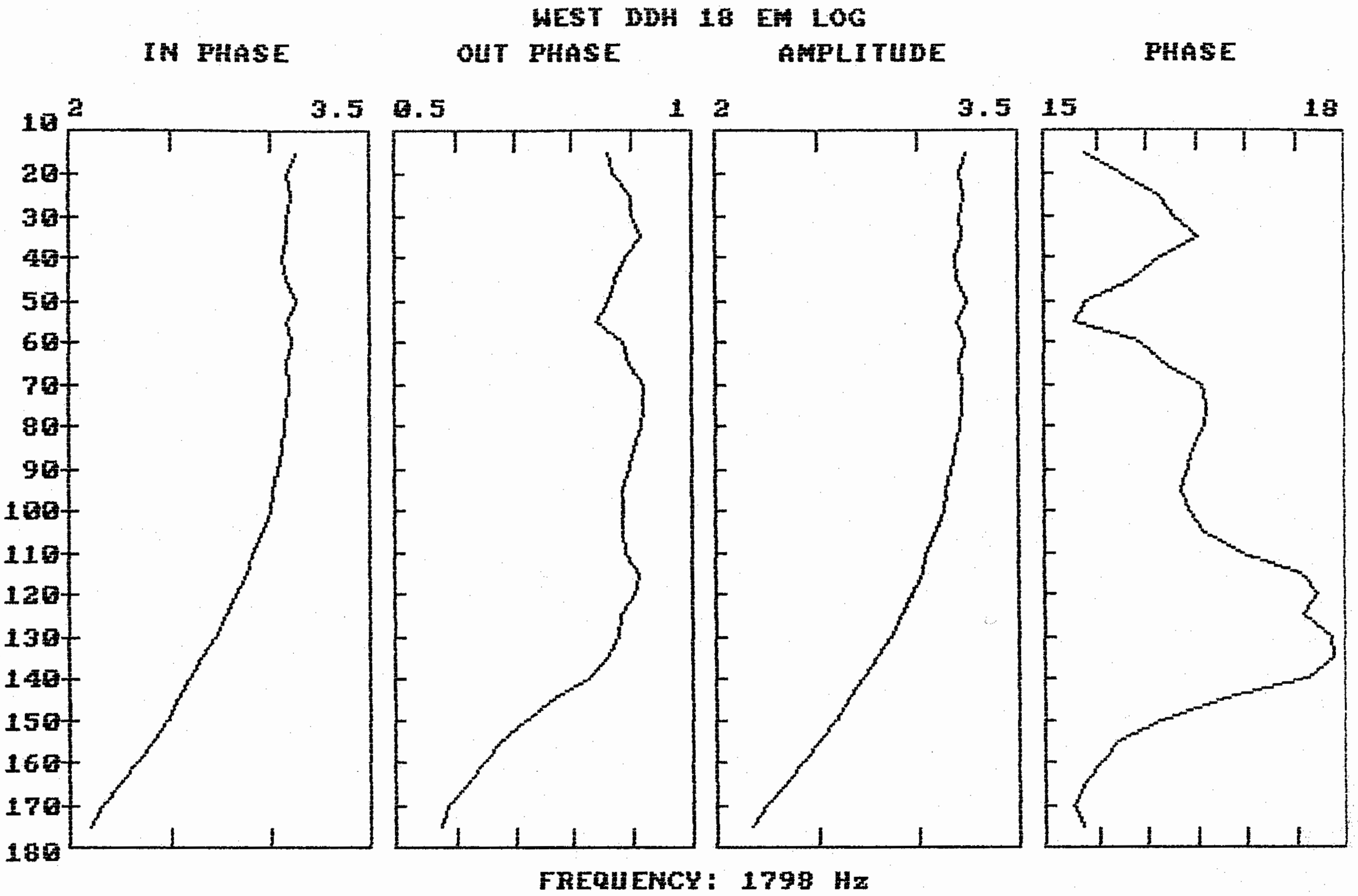
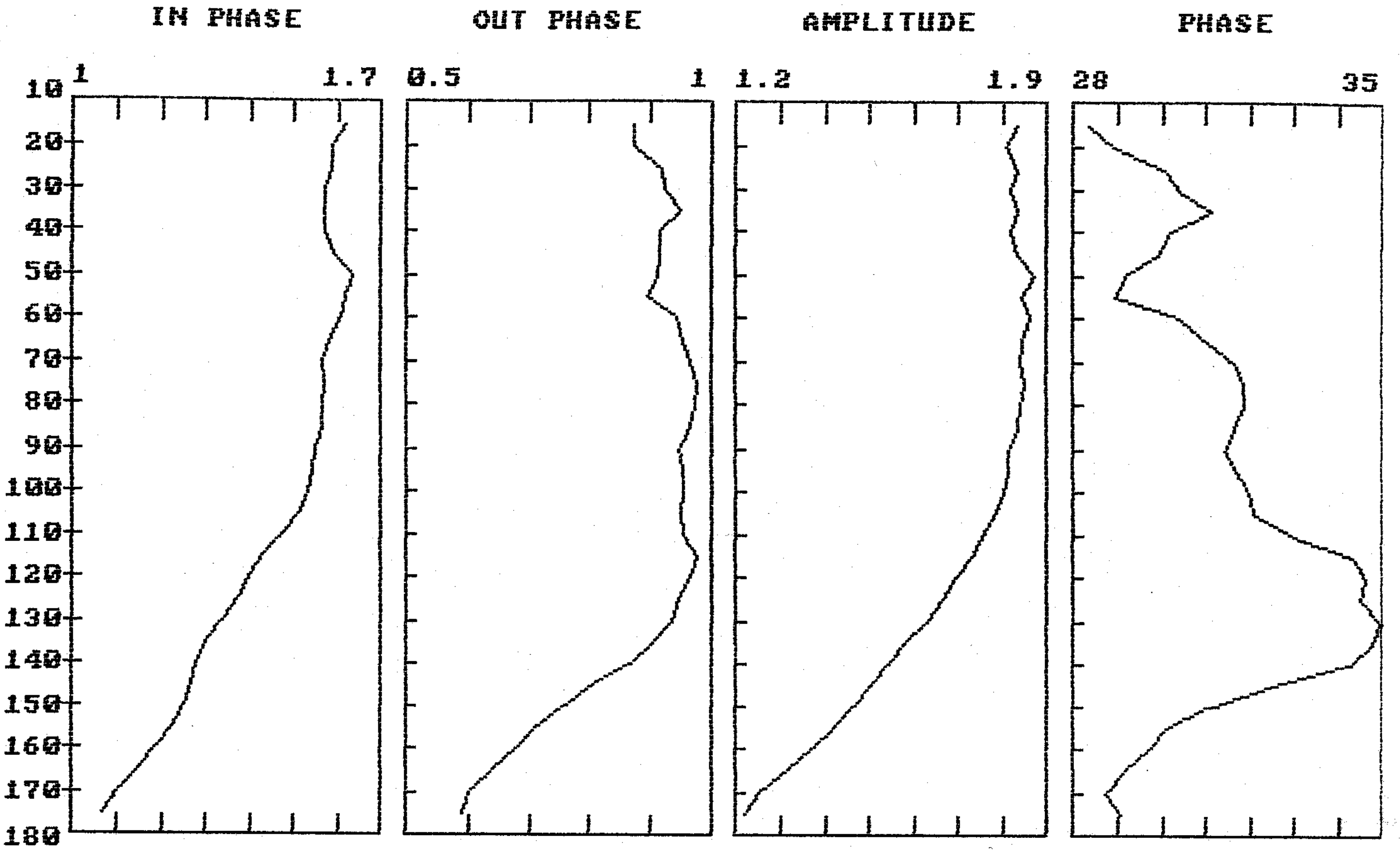
100
110
120
130
140
150
160
170
180
FREQUENCY: 700.2 Hz



WEST DDH 18 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
2
3.5
0.5
1
2
3.5
15
18
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
FREQUENCY: 1798 Hz

WEST DDH 18 EM LOG



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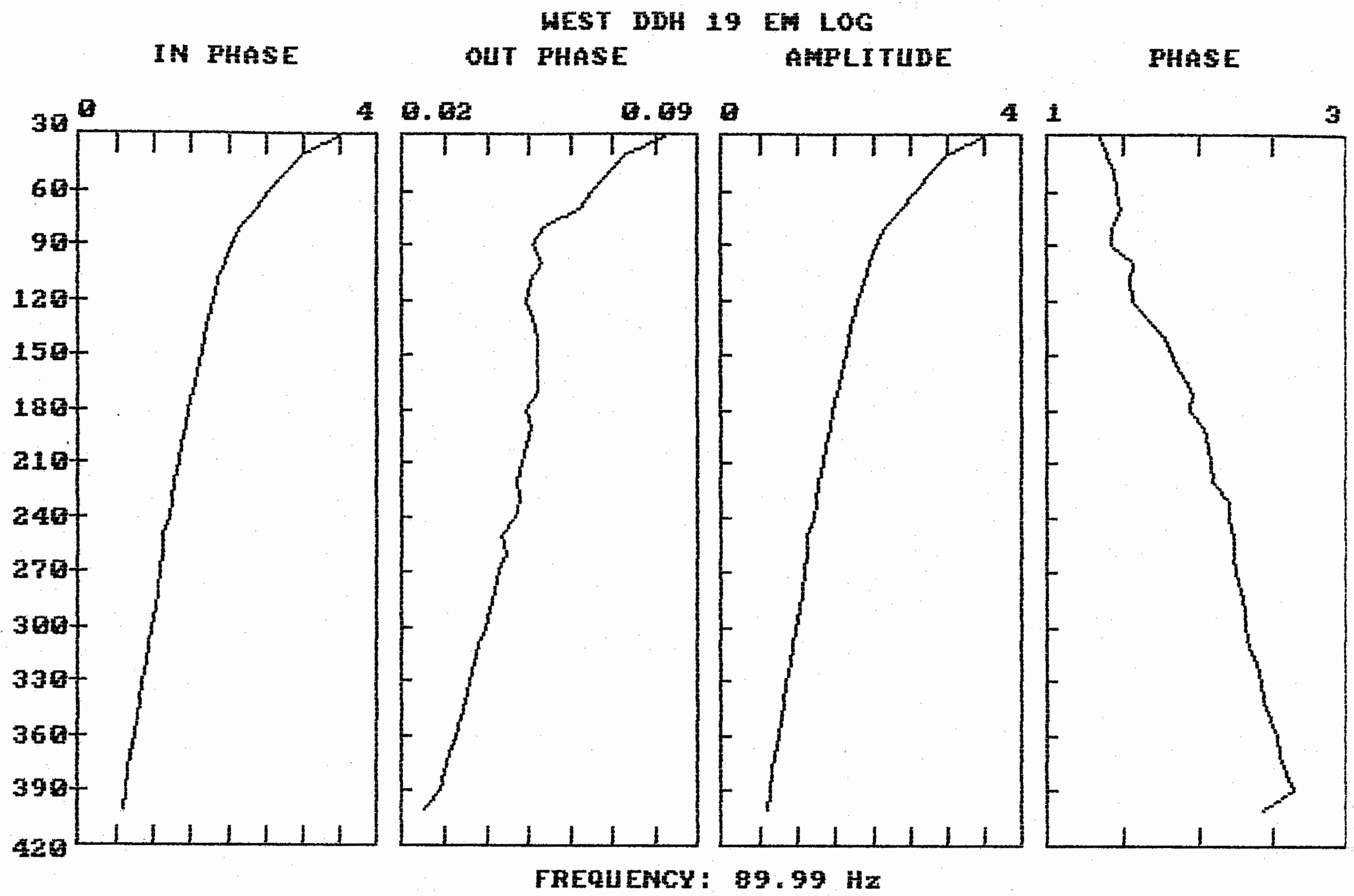
WEST DDH 19 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
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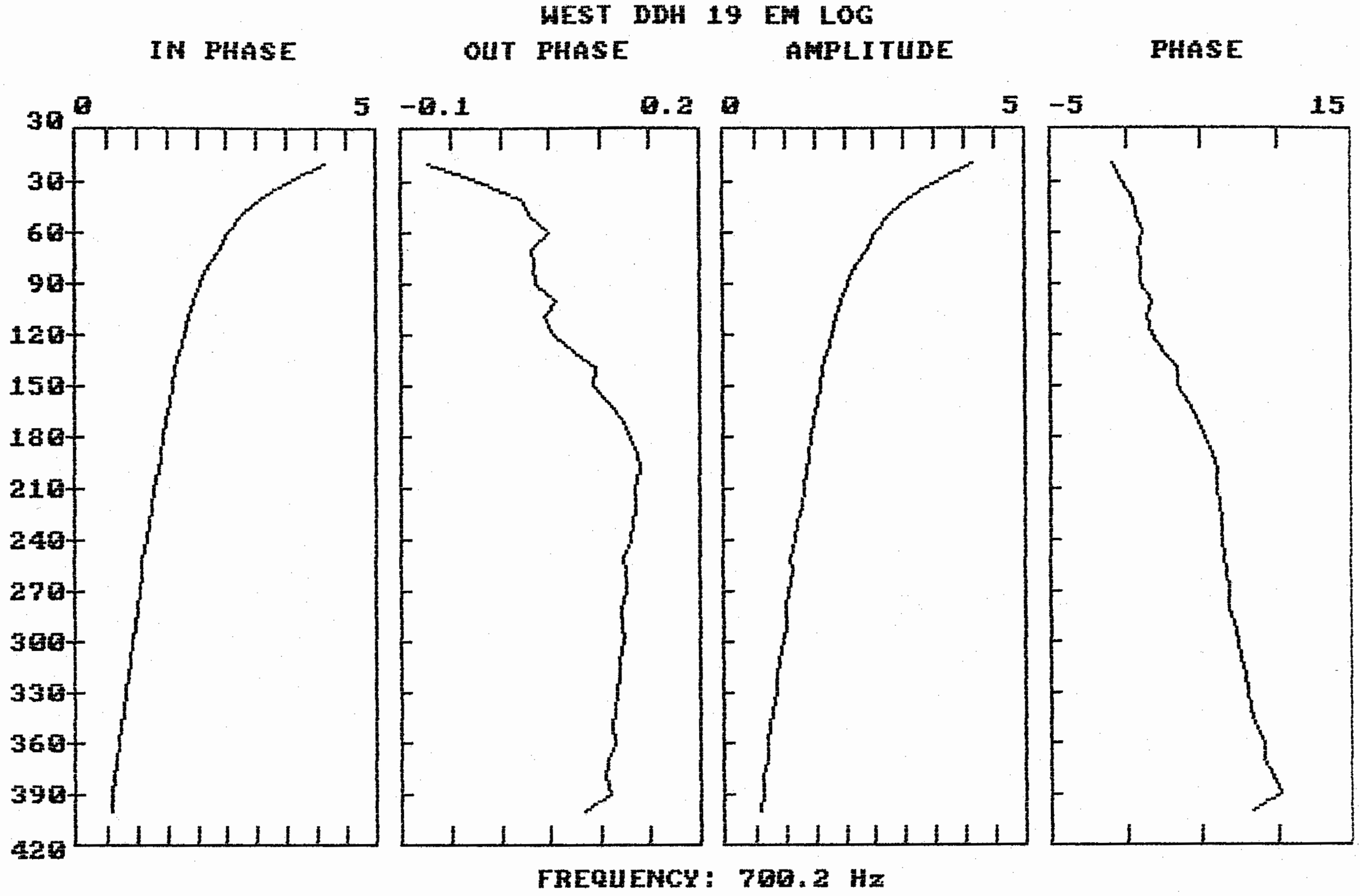
4
0.02
0.09
0
4
1
3
30
60
90
120
150
180
210
240
270
300
330
360
390
420
FREQUENCY: 89.99 Hz


WEST DDH 19 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
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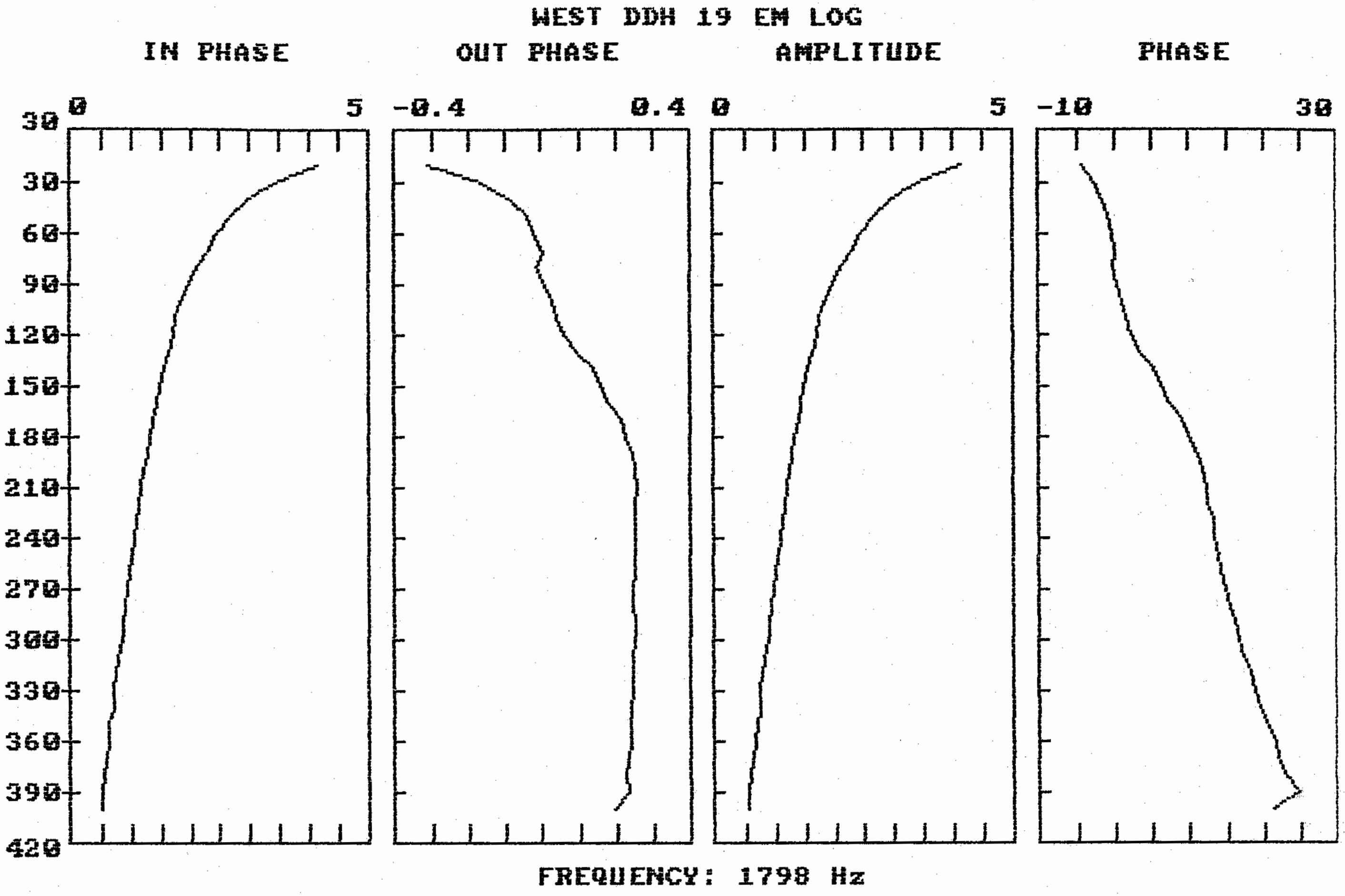
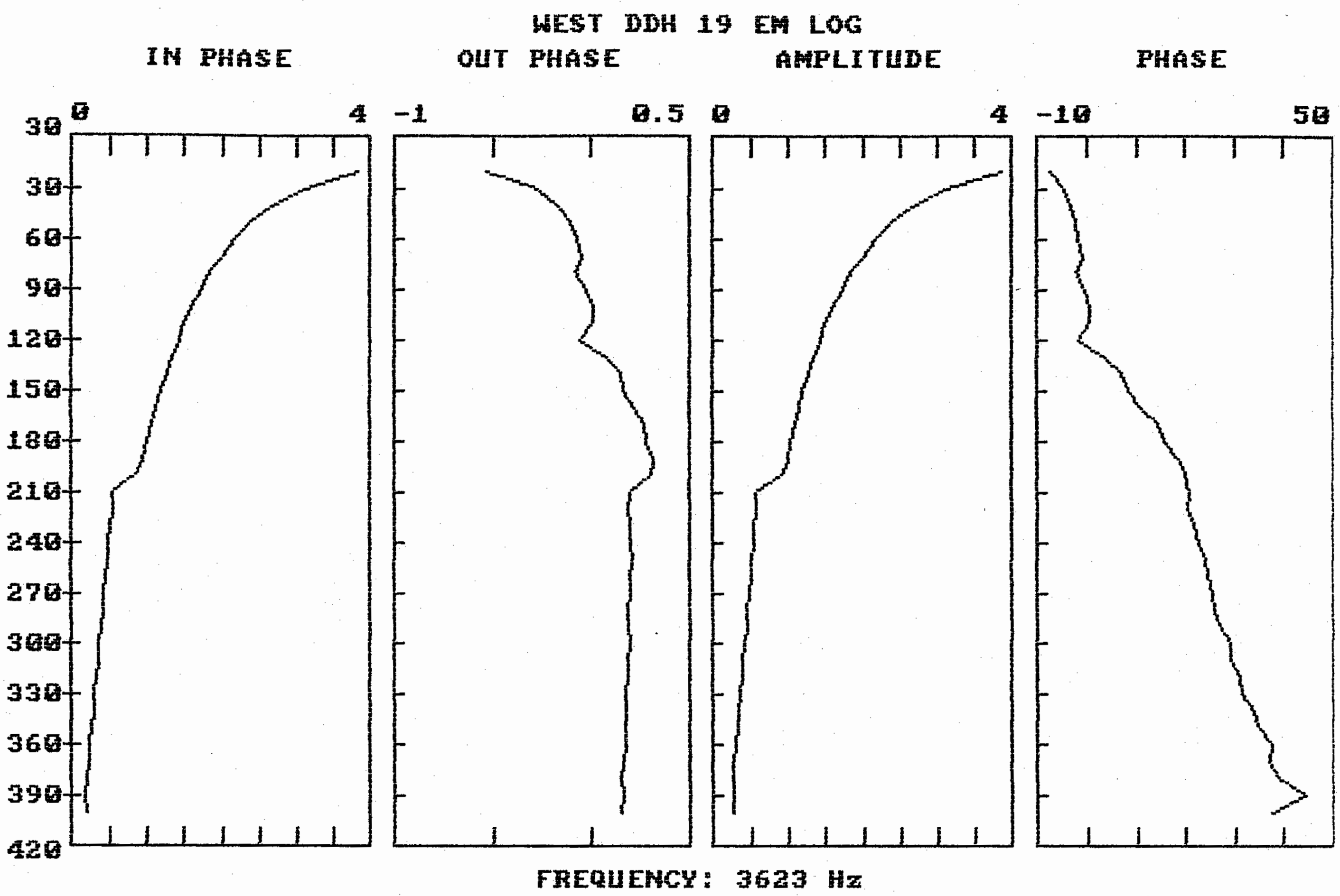
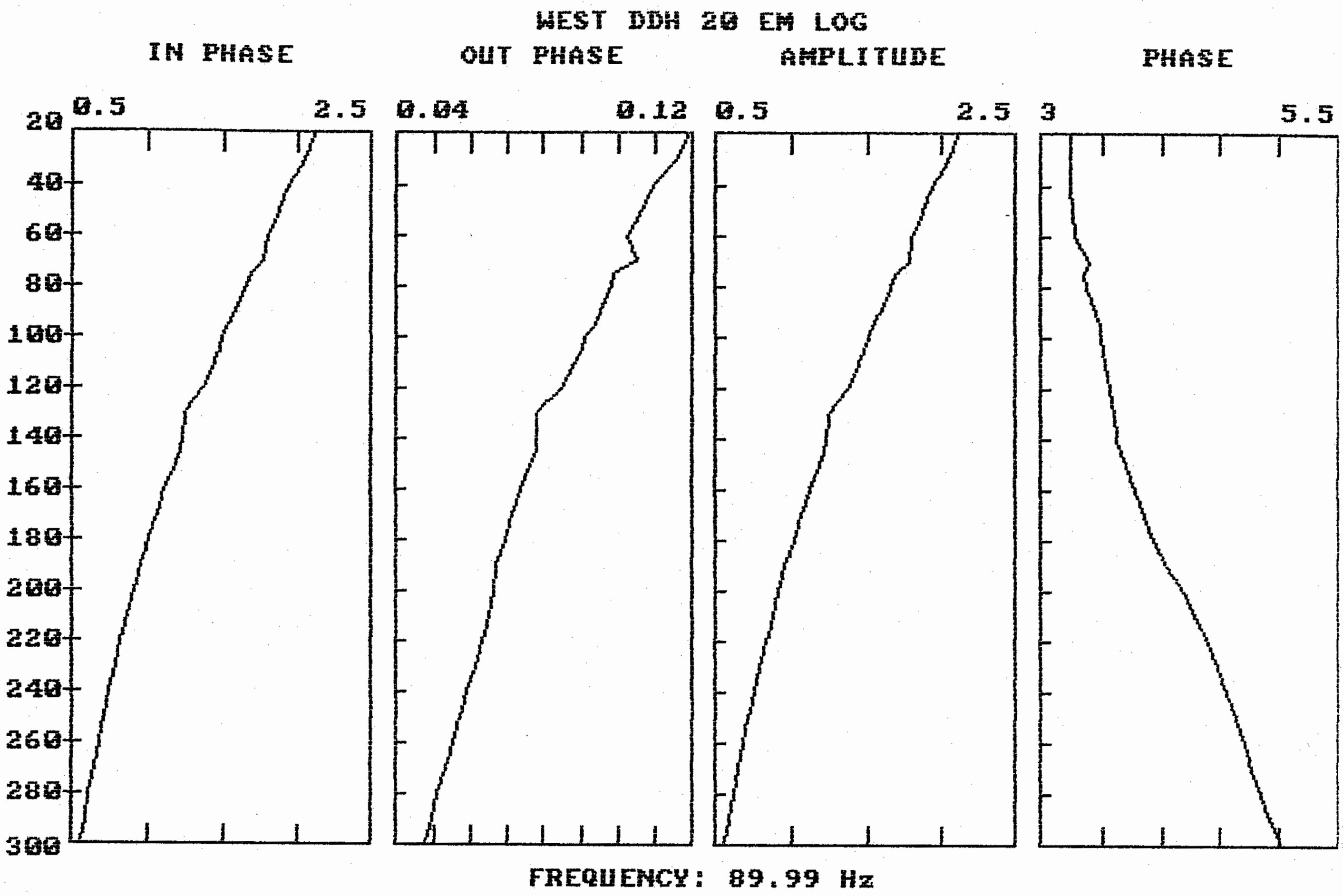
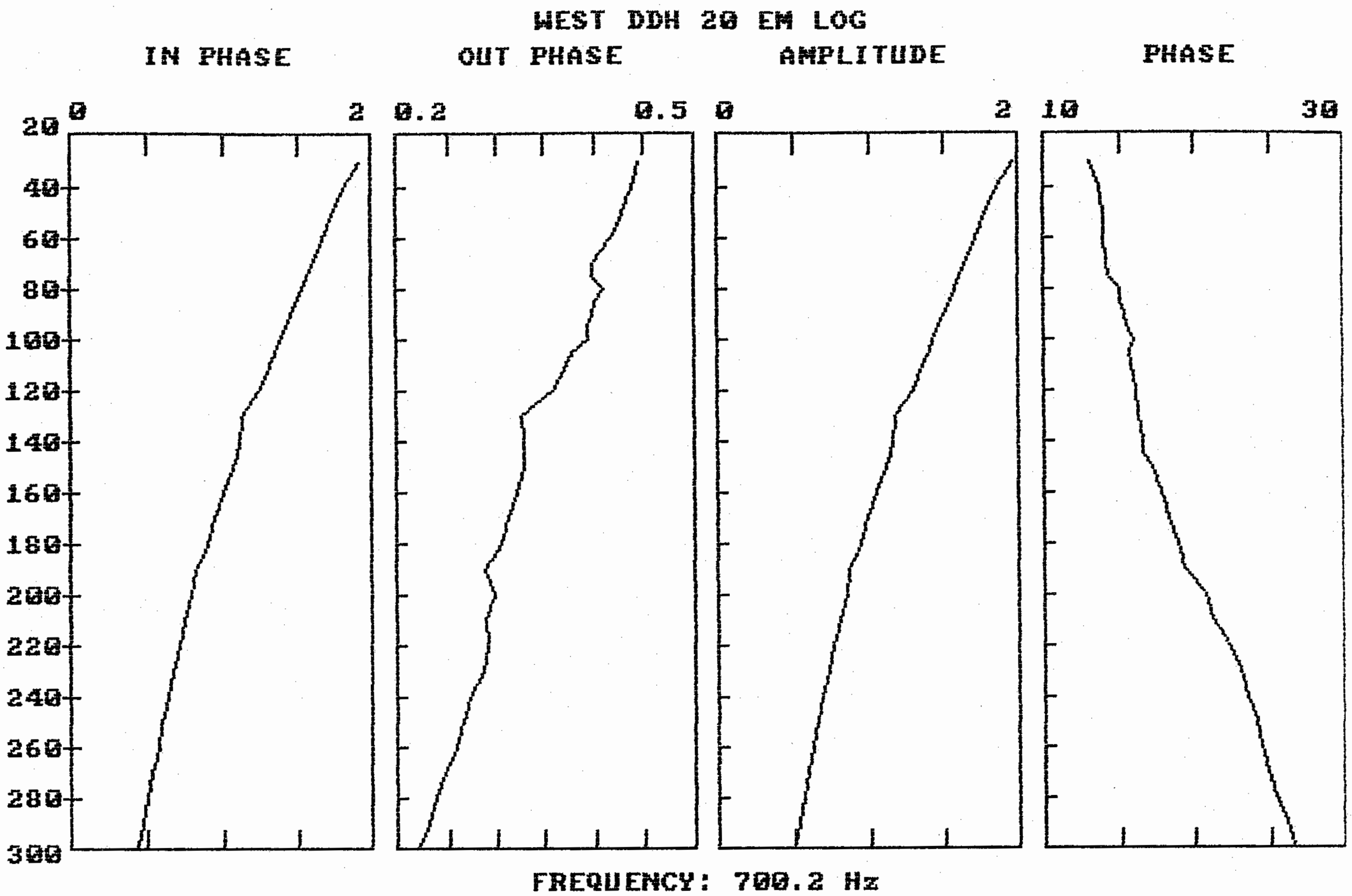
0.2
0
5
-5
15
30
30
60
90
120
150
180
210
240
270
300
330
360
390
420
FREQUENCY: 700.2 Hz

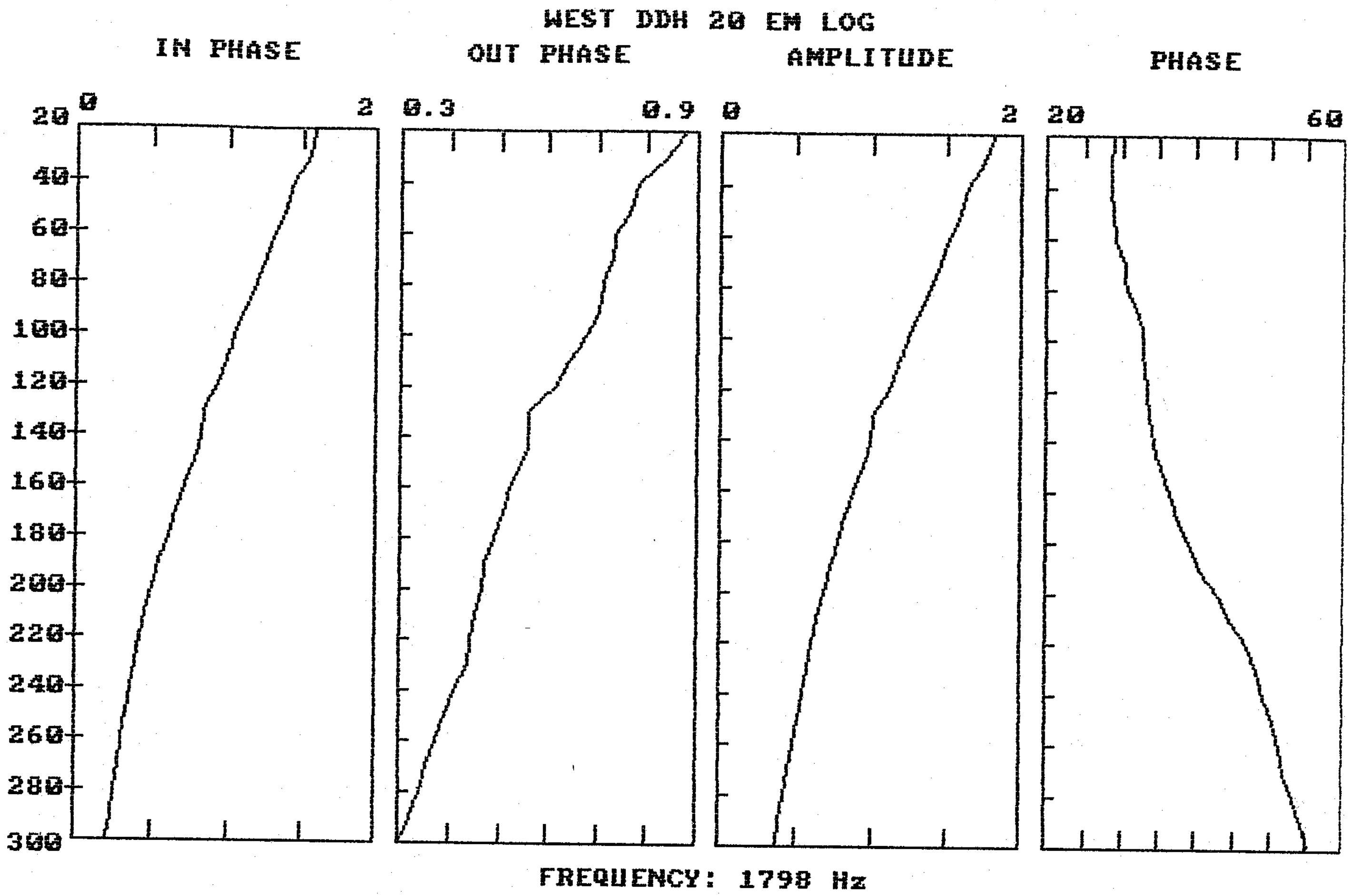


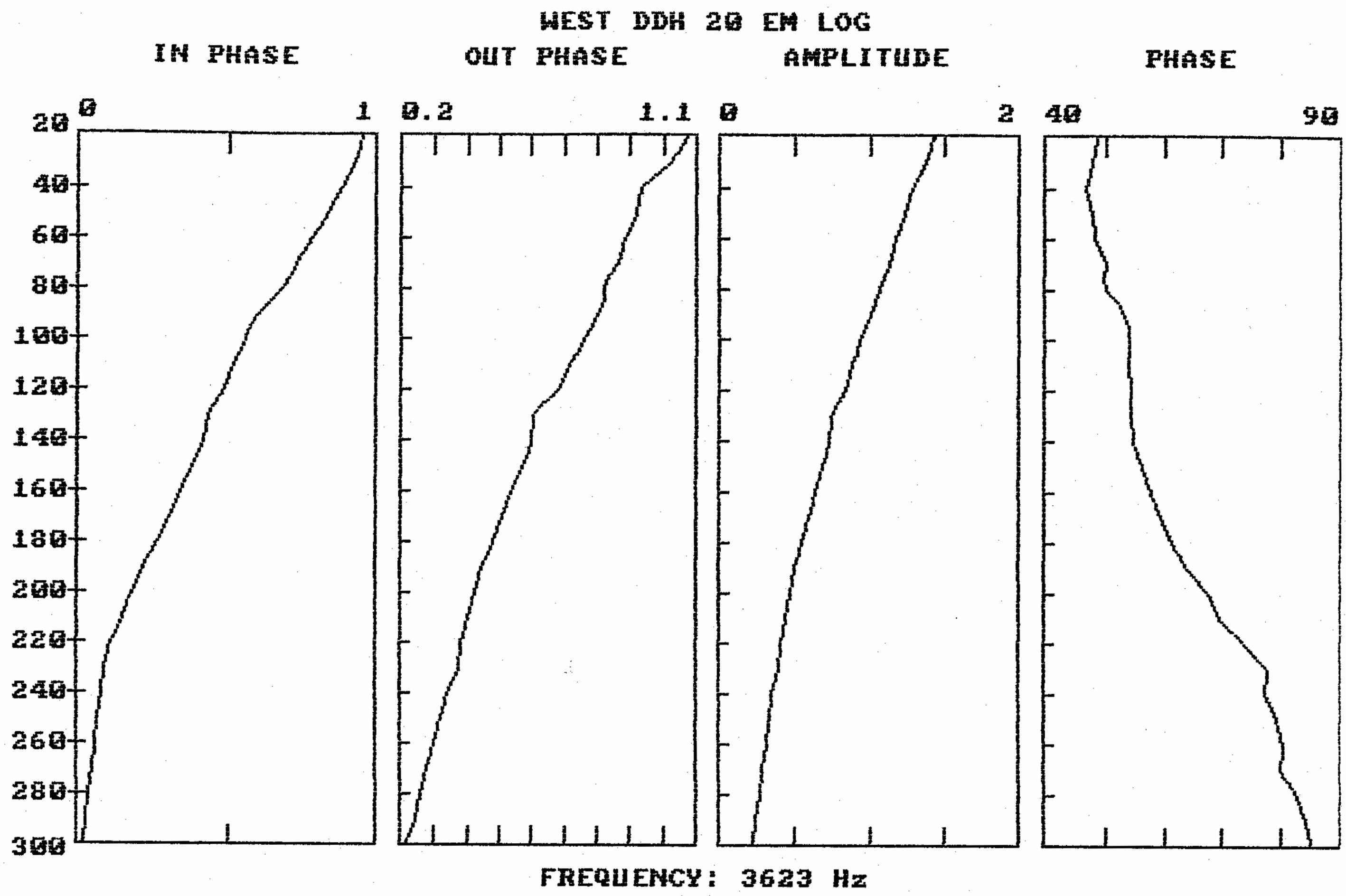
WEST DDH 19 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
0
5
-0.4
0.4
0
5
-10
30
30
30
60
90
120
150
180
210
240
270
300
330
360
390
420
FREQUENCY: 1798 Hz


WEST DDH 19 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
0
4
-1
0.5
0
4
-10
50
30
30
60
90
120
150
180
210
240
270
300
330
360
390
420
FREQUENCY: 3623 Hz

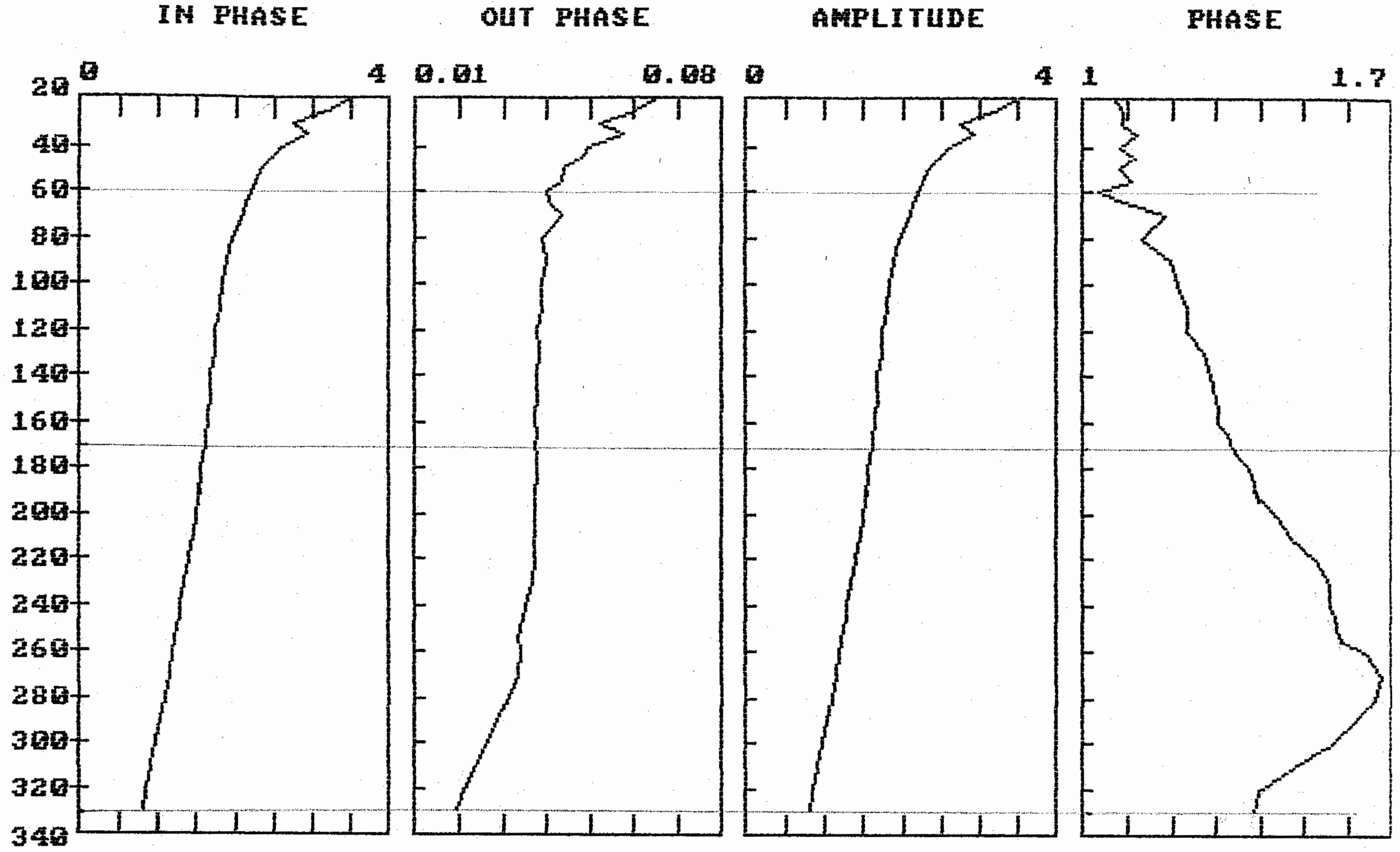

WEST DDH 20 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
0.5
2.5
0.04
0.12
0.5
2.5
3
5.5
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
FREQUENCY: 89.99 Hz


WEST DDH 20 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
0
2
0.2
0.5
0
2
10
30
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
FREQUENCY: 700.2 Hz

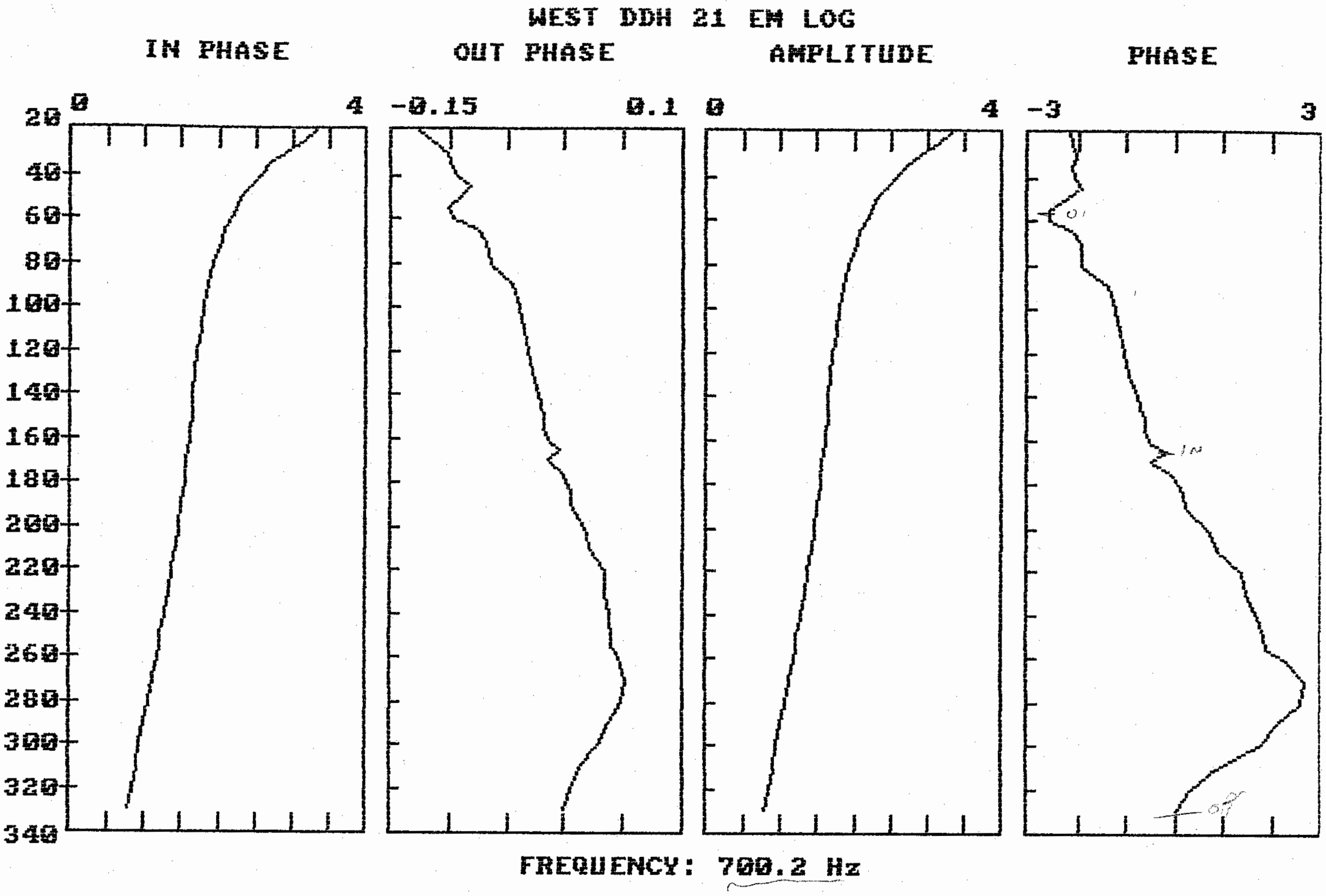

WEST DDH 20 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
0
2
0.3
0.9
0
2
20
60
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
FREQUENCY: 1798 Hz

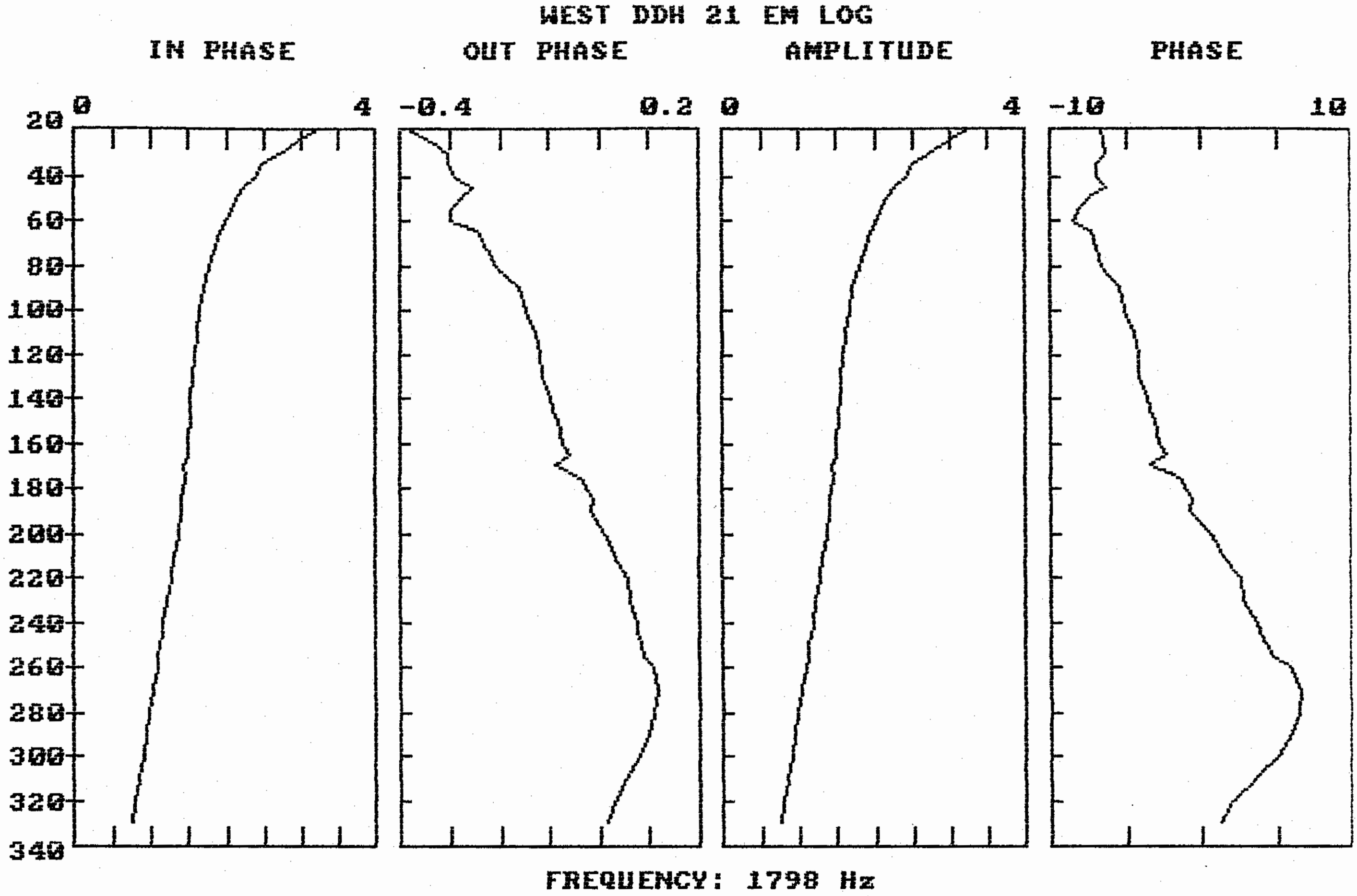

WEST DDH 20 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
0
1
0.2
1.1
0
2
40
90
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
FREQUENCY: 3623 Hz

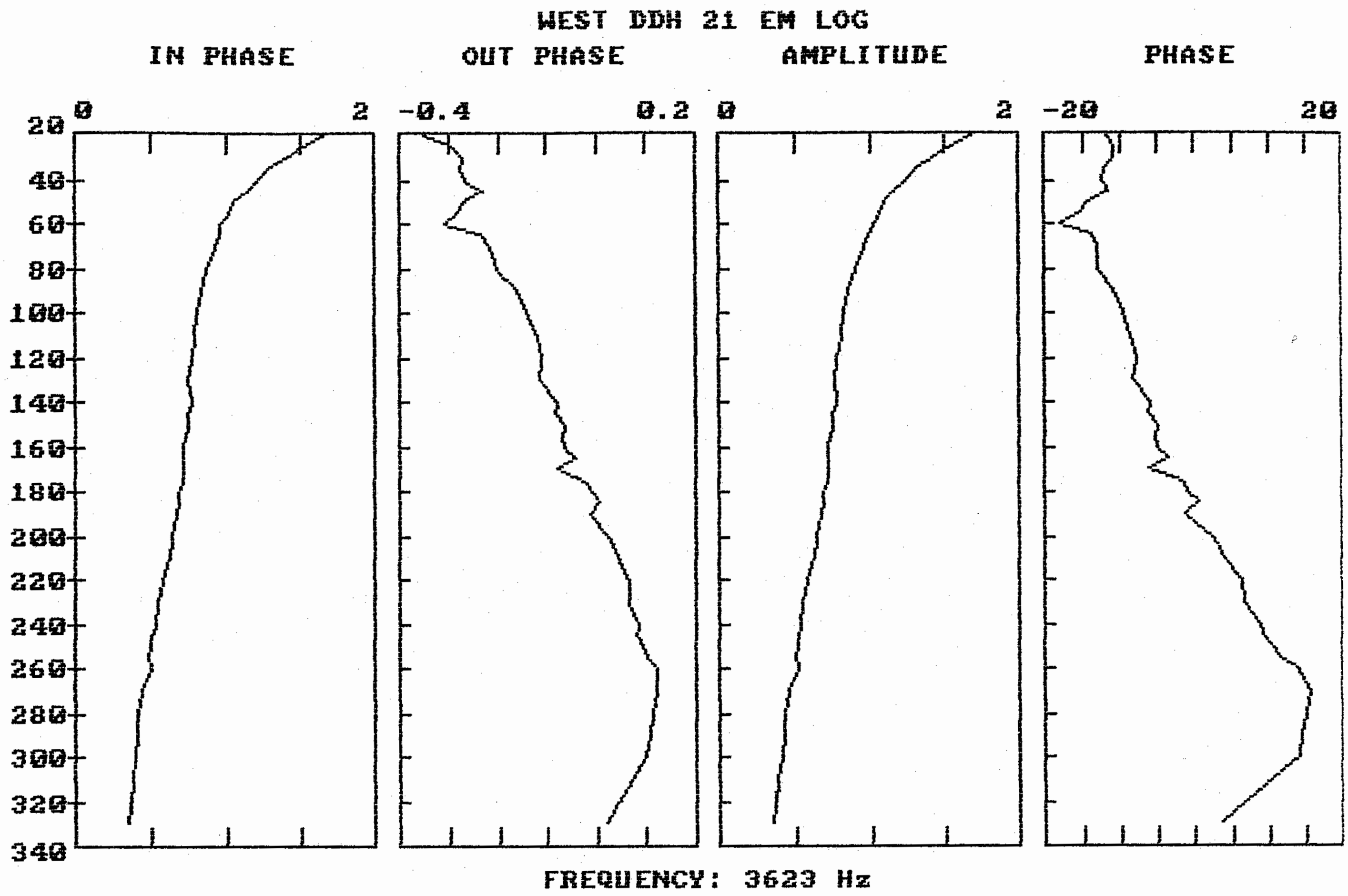
WEST DDH 21 EM LOG

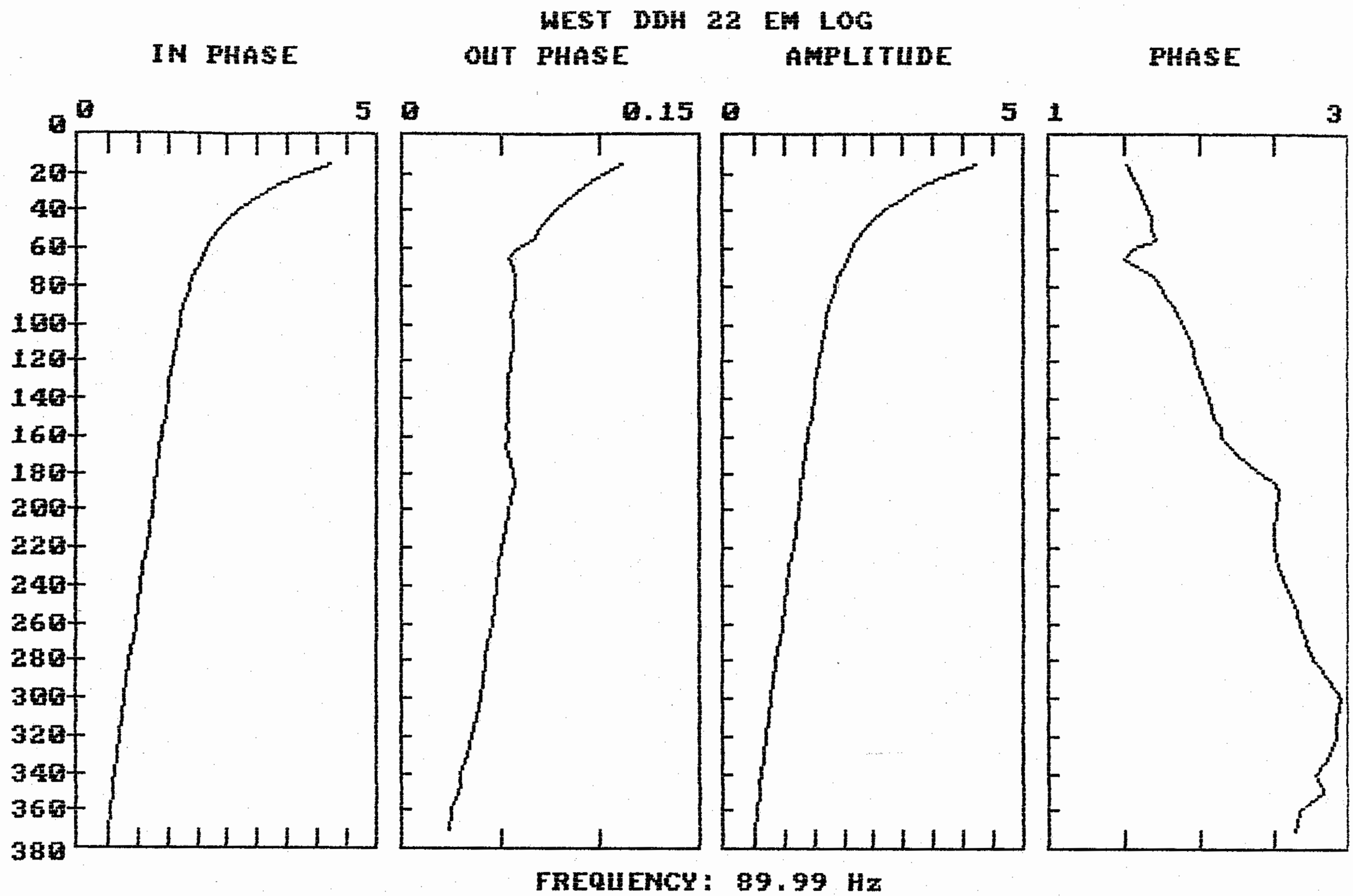


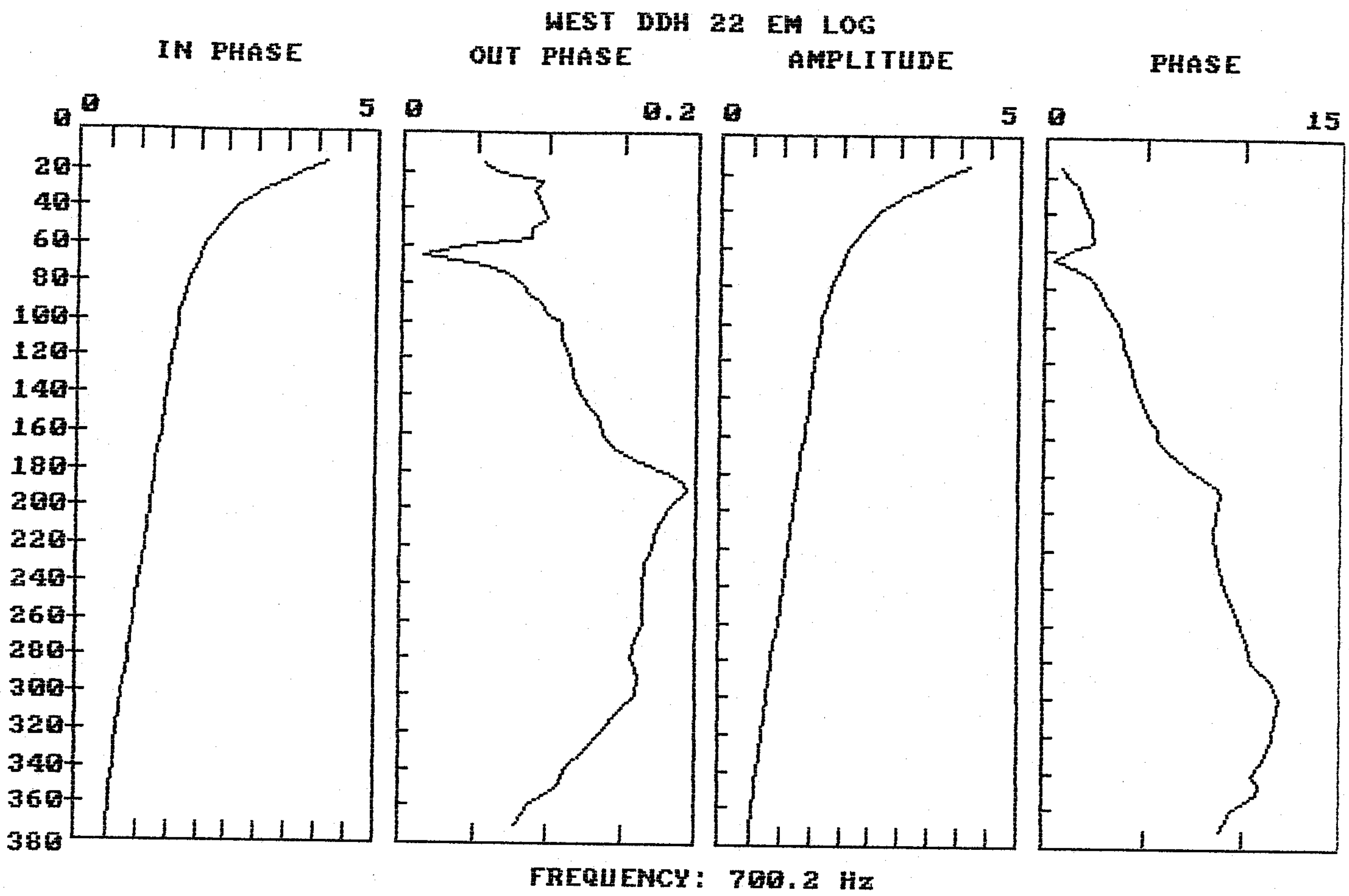
FREQUENCY: 89.99 Hz


WEST DDH 21 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
0
4
-0.15
0.1
0
4
-3
3
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
FREQUENCY: 700.2 Hz

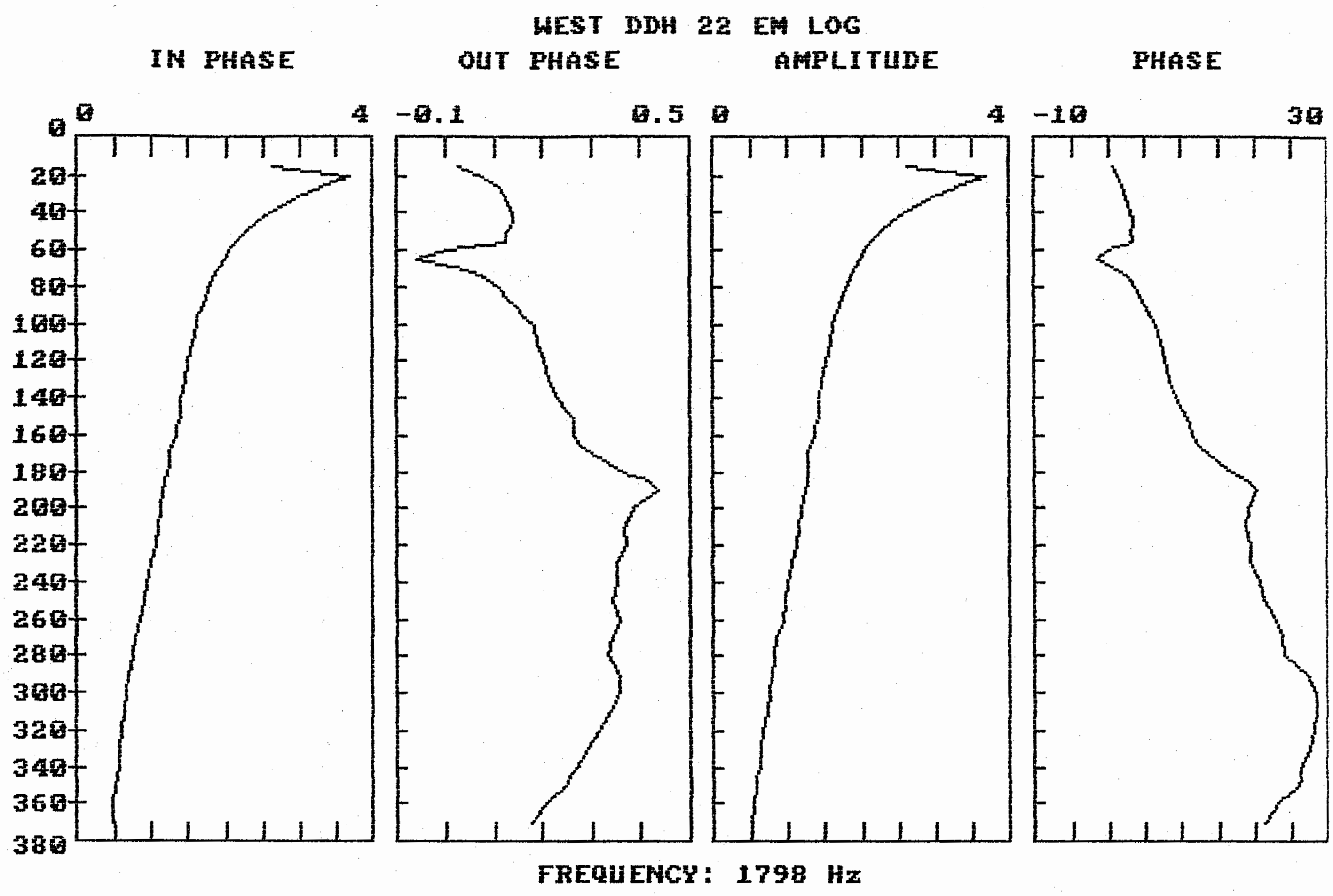

WEST DDH 21 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
0
4
-0.4
0.2
0
4
-10
10
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
FREQUENCY: 1798 Hz

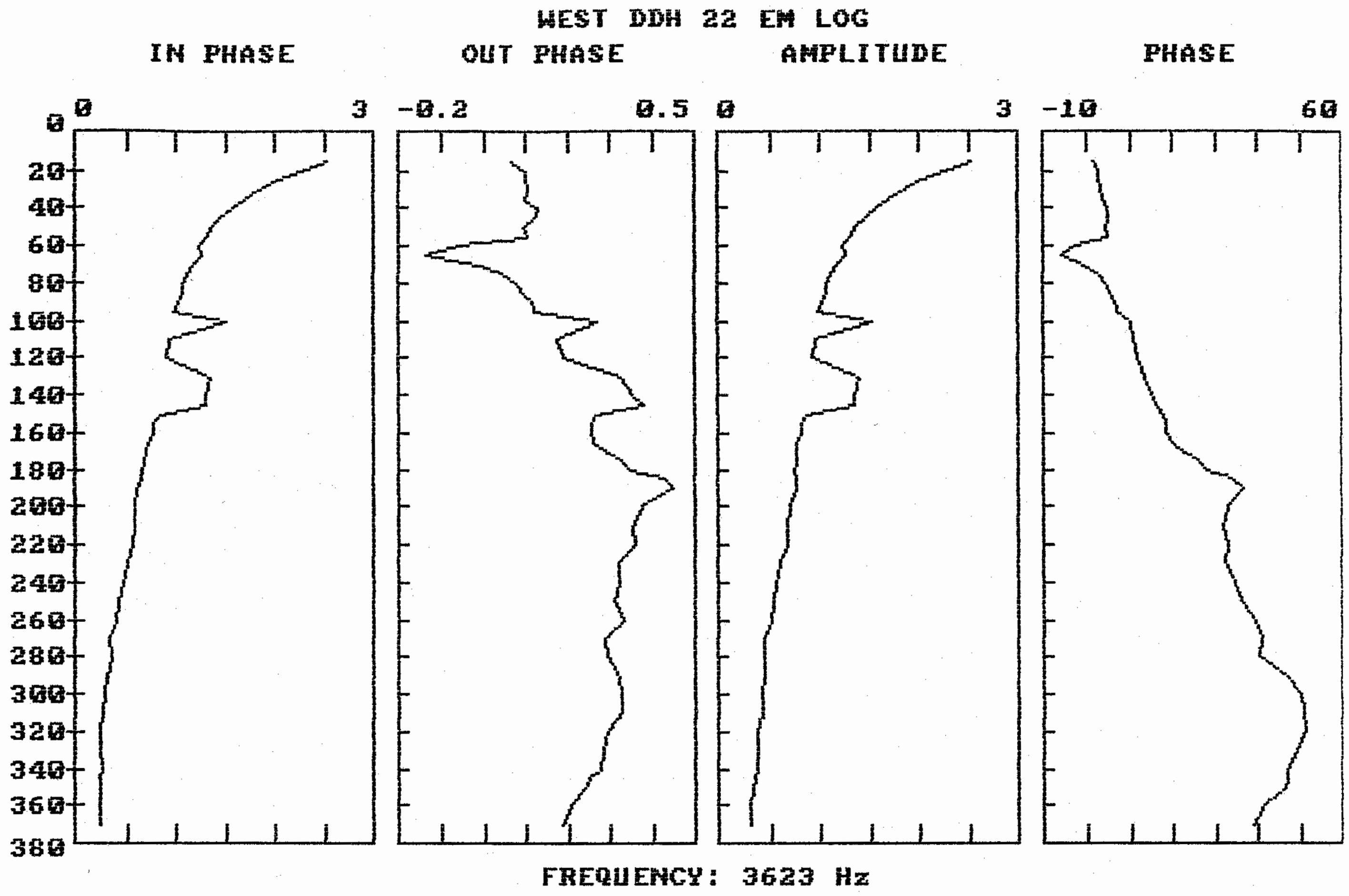

WEST DDH 21 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
0
2
-0.4
0.2
0
2
-20
20
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
FREQUENCY: 3623 Hz

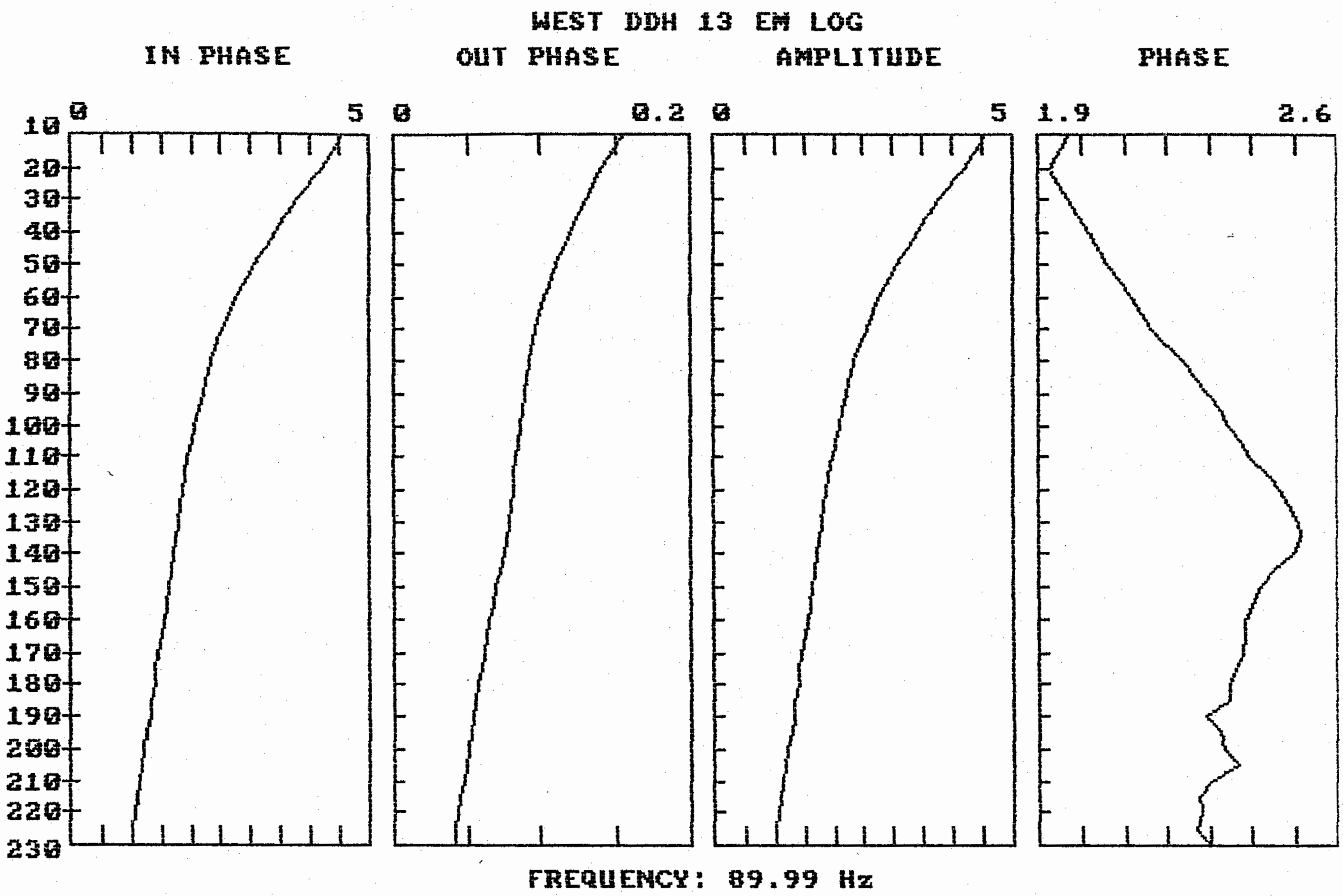

WEST DDH 22 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
0
5
0
0.15
0
5
1
3
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
FREQUENCY: 89.99 Hz

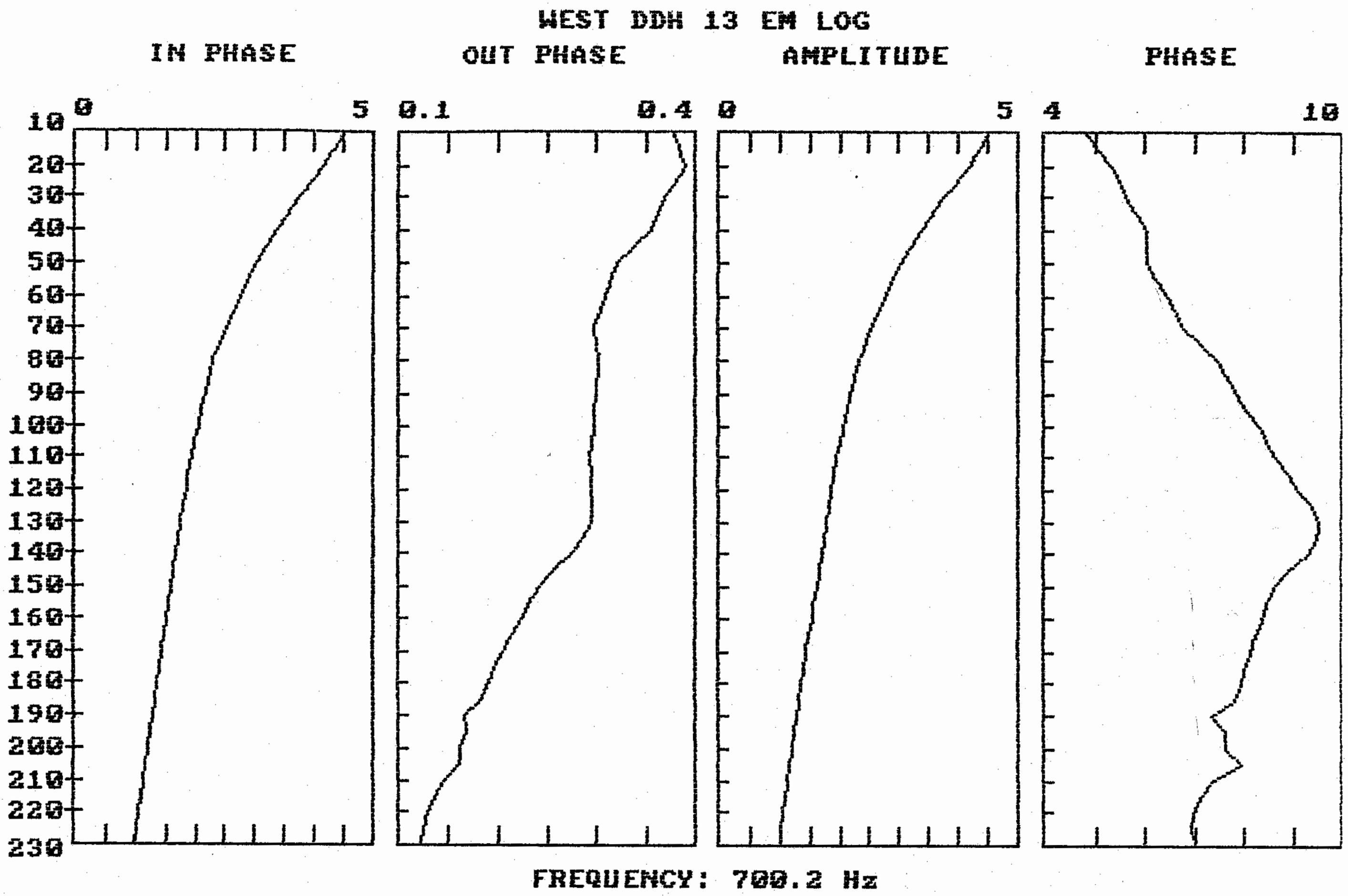


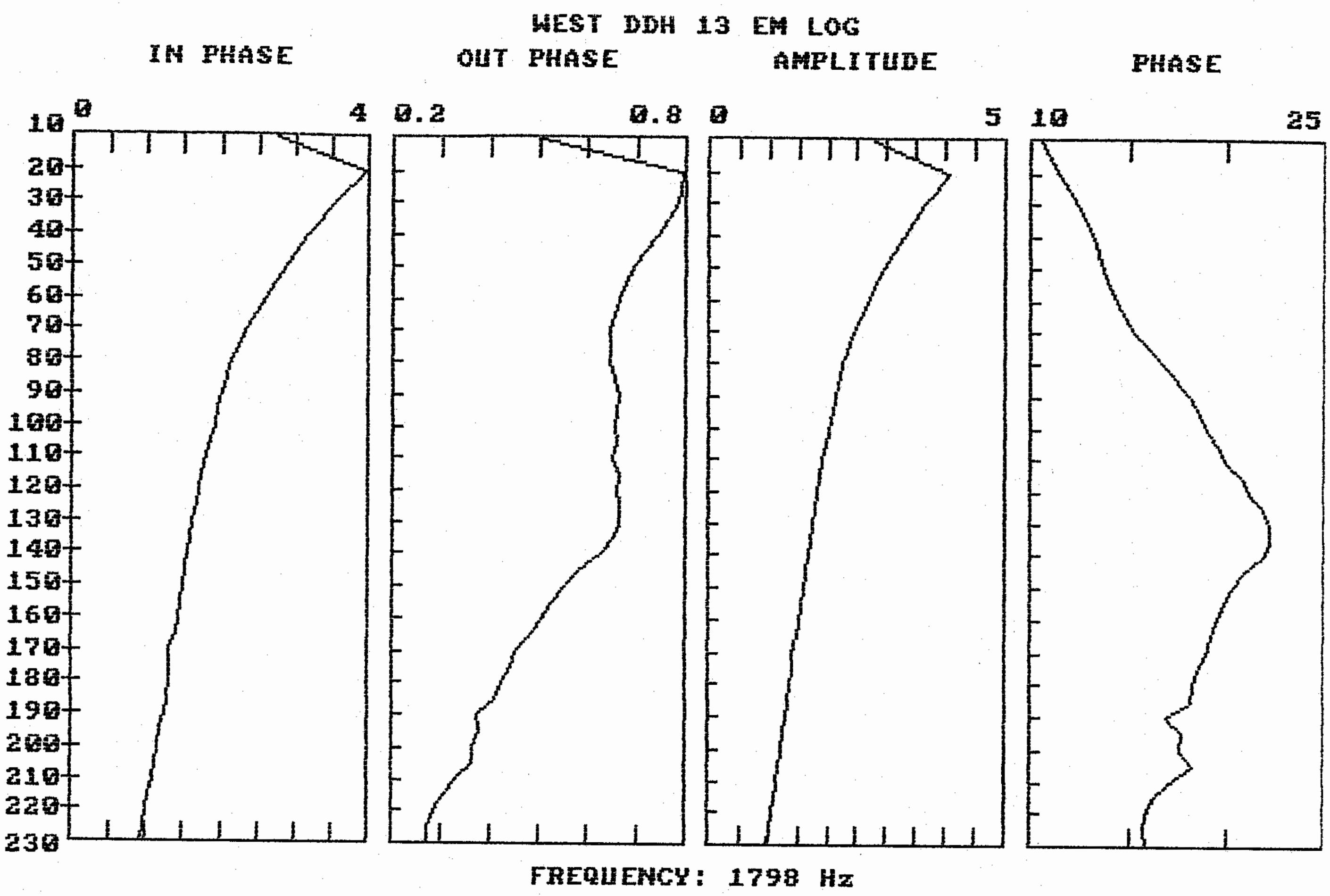
WEST DDH 22 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
0
5
0
0.2
0
5
0
15
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
FREQUENCY: 700.2 Hz


WEST DDH 22 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
0
4
-0.1
0.5
0
4
-10
30
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
FREQUENCY: 1798 Hz

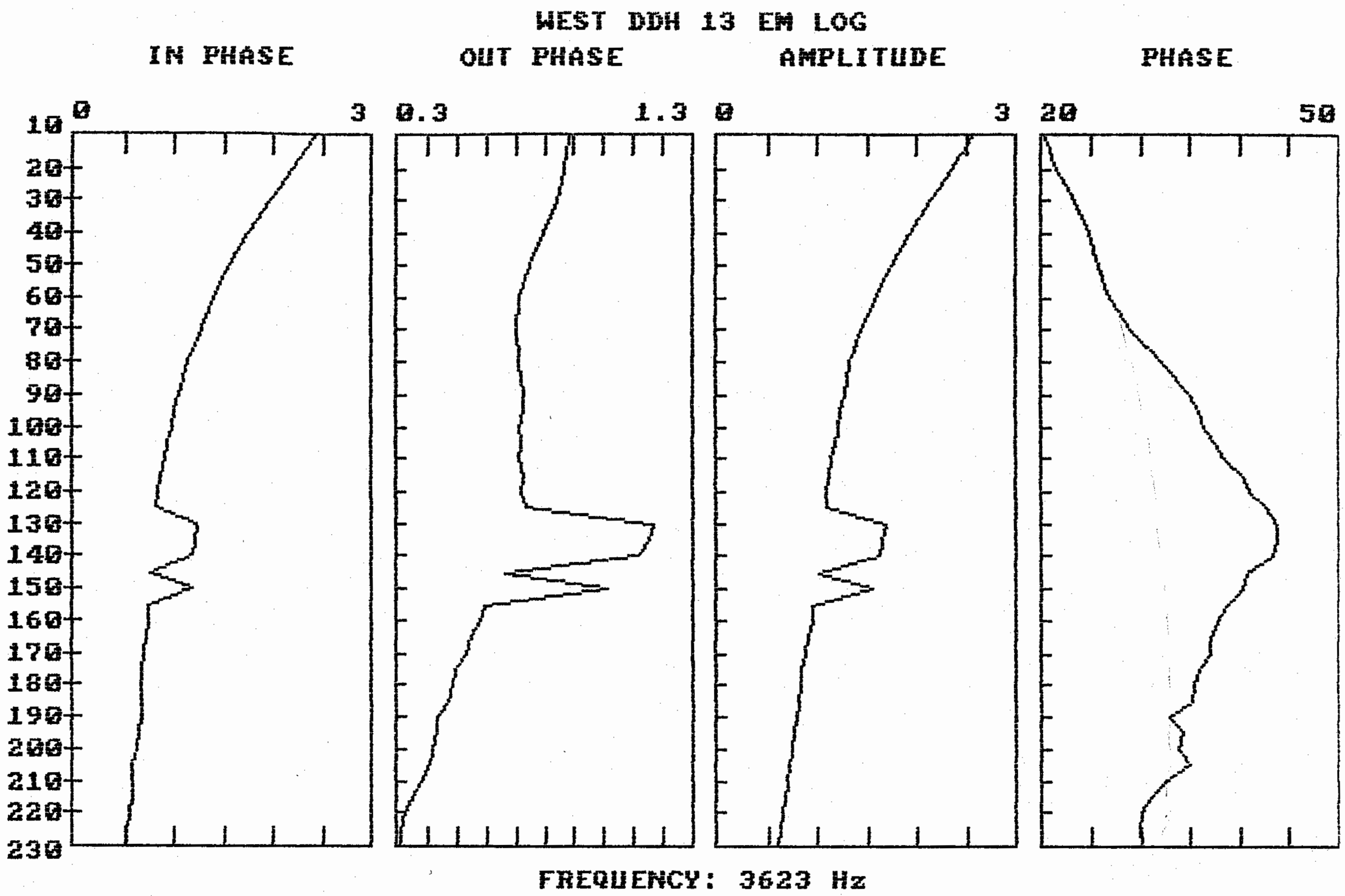

WEST DDH 22 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
0
3
-0.2
0.5
0
3
-10
60
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
FREQUENCY: 3623 Hz

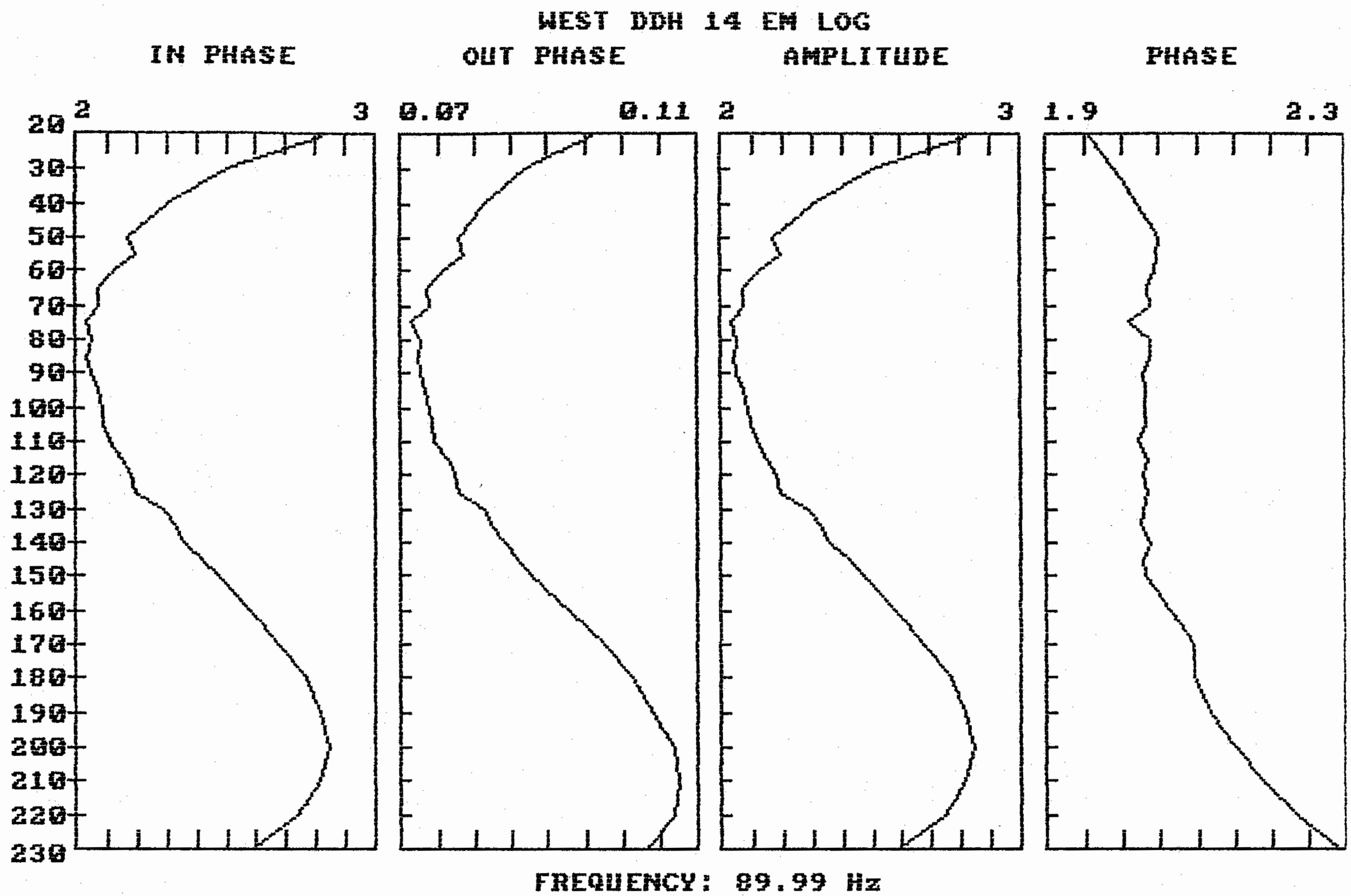

WEST DDH 13 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
0
5
0
0.2
0
5
1.9
2.6
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
FREQUENCY: 89.99 Hz

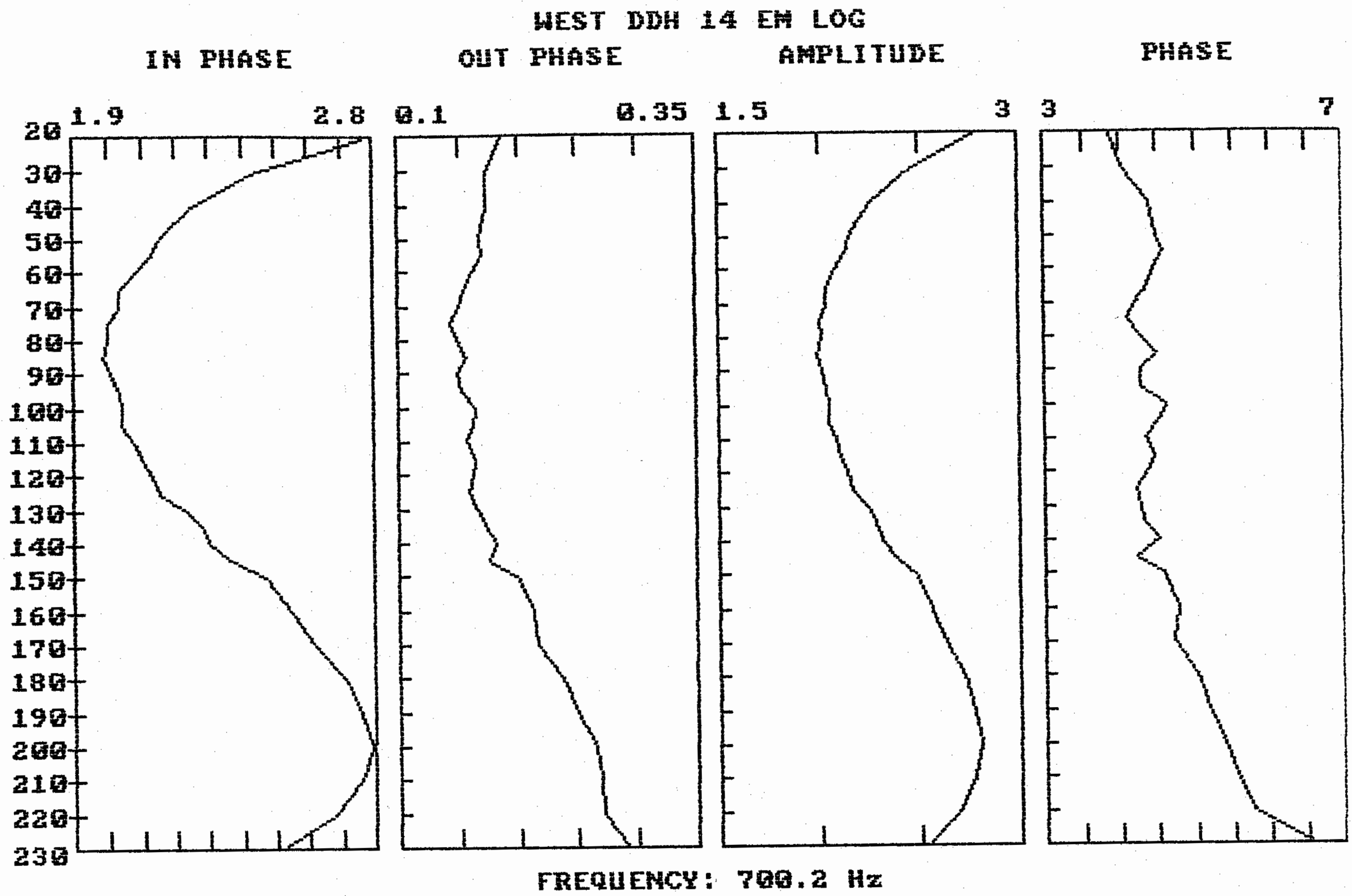

WEST DDH 13 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
0
5
0.1
0.4
0
5
4
10
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
FREQUENCY: 700.2 Hz

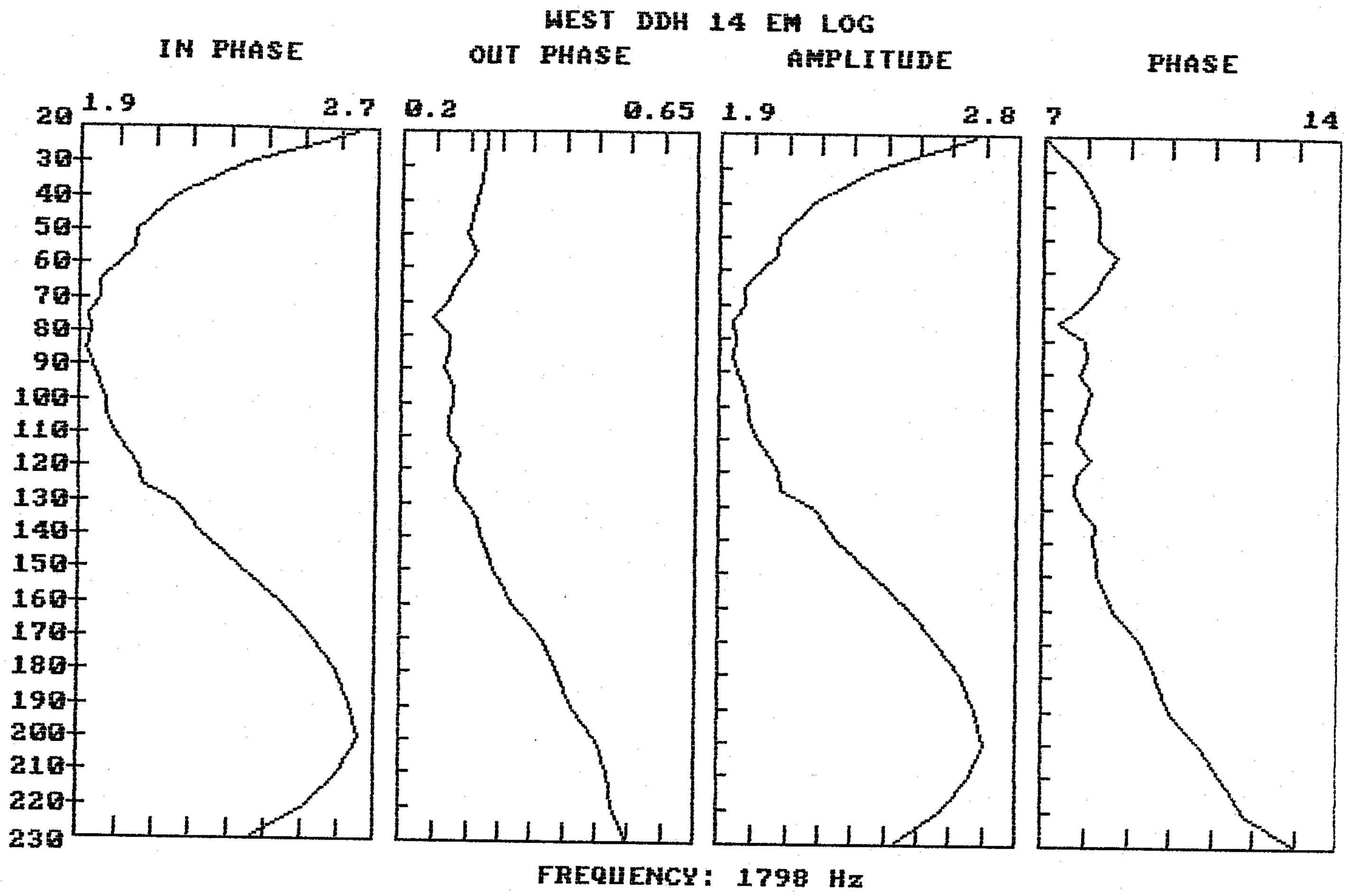


WEST DDH 13 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
0
4
0.2
0.8
0
5
10
25
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
FREQUENCY: 1798 Hz

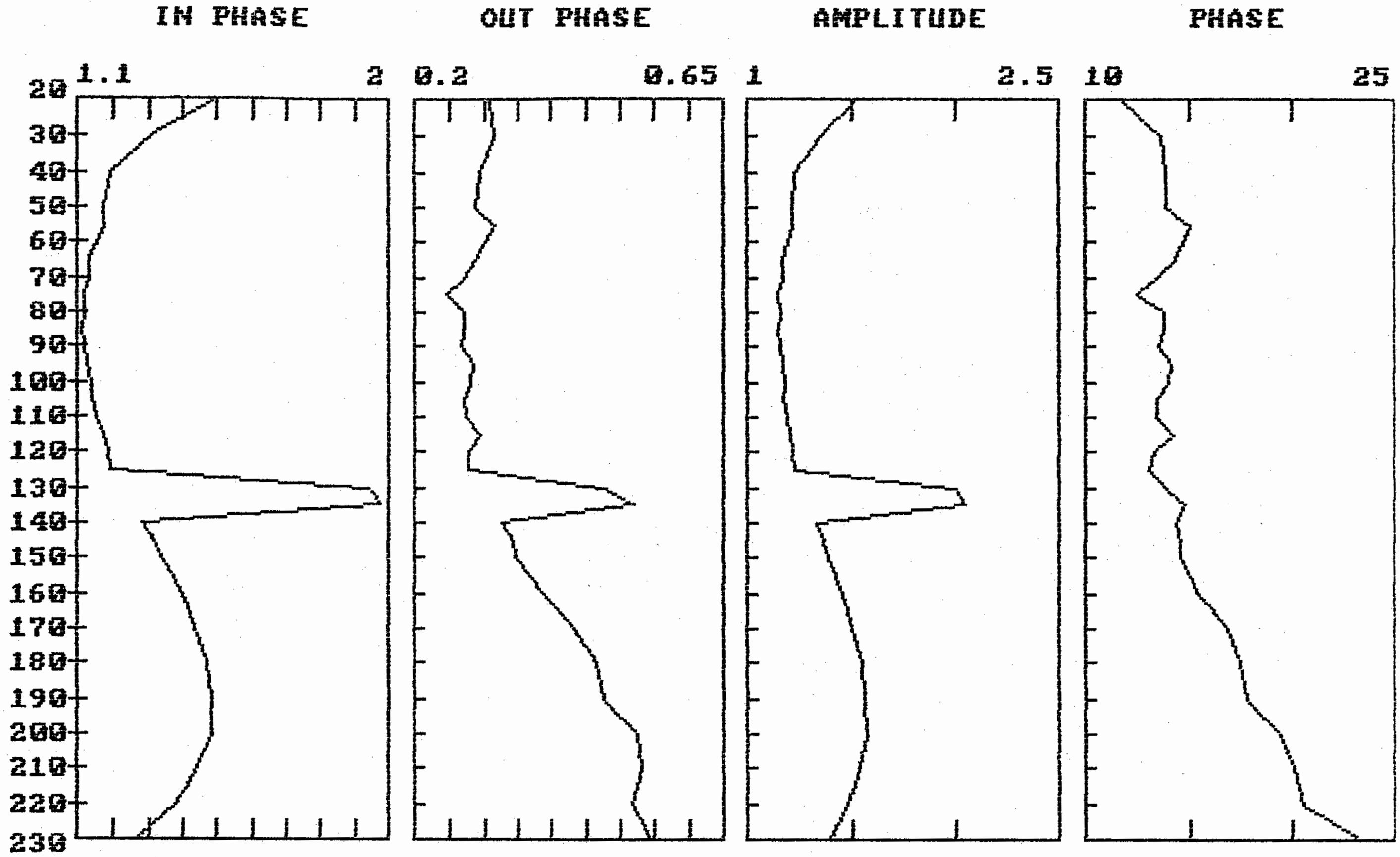

WEST DDH 13 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
0
3
0.3
1.3
0
3
20
50
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
FREQUENCY: 3623 Hz


WEST DDH 14 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
2
3
0.07
0.11
2
3
1.9
2.3
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
FREQUENCY: 89.99 Hz


WEST DDH 14 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
1.9
2.8
0.1
0.35
1.5
3
3
7
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
FREQUENCY: 700.2 Hz


WEST DDH 14 EM LOG
IN PHASE
OUT PHASE
AMPLITUDE
PHASE
1.9
2.7
0.2
0.65
1.9
2.8
7
14
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
FREQUENCY: 1798 Hz

WEST DDH 14 EM LOG



FREQUENCY: 3623 Hz