SEISMIC REFRACTION SURVEY
RIPPABILITY STUDY

US 95A SILVER SPRINGS to FERNLEY

LYON COUNTY

August 2008
E.A. 73455

NEVADA DOT
GEOTECHNICAL ENGINEERING

MATERIALS DIVISION

SEISMIC REFRACTION SURVEY
RIPPABILITY STUDY

LYON COUNTY

US 95A SILVER SPRINGS to FERNLEY
Milepost LY 45.00 to Milepost LY 46.00

August 2008

E.A. 73445

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SEISMIC REFRACTION SURVEY

General

During the month of July 2006, the NDOT Geotechnical Section conducted surface seismic refraction survey on three separate rock cuts along highway US 95A, north of Silver Springs (US 50), between milepost LY 45.00 and milepost LY 46.00, in Lyon County, Nevada.

Five runs were performed on area FSS-1 on the east side of US-95A; two south to north, one center, and two north to south. The geophone line was strung horizontally across the cut slope face at 15-foot spacing in a north-south orientation, at approximately Station "P"446+70, 110 feet right, to"P"448+80, 90 feet right.

Three runs were performed on area FSS-3 on the east side of US-95A; one each south to north, center, and north to south. The geophone line was strung at 20-foot spacing across the slope face in a north-south orientation, at approximately Station "P"468+10, 130 feet right, to"P"470+90, 120 feet right.

Three runs were performed on area FSS-4 on the west side of US-95A; one each south to north, center, and north to south. The geophone line was strung at 10-foot spacing along the west side of the old roadway in a north-south orientation, at approximately Station "P"471+20, 120 feet left, to"P"473+00, 110 feet left.

Purpose and Scope

The purpose of this survey investigation was to provide information regarding the rippability of the rocks in the existing rock cuts, utilizing seismic refraction techniques. The scope of this investigation included site reconnaissance, research of available geologic literature pertaining to the site, conducting surface seismic refraction survey, and report preparation.

Project Description

This section of the roadway was built under NDOT Contract Nos. 592 and 624 in 1940 and 1941. NDOT is planning to flatten slopes and install guardrail on both sides of the roadway between mileposts LY 44.25 and LY 54.58 on US 95A. The NDOT Roadway Design Division

requested information regarding rippability of rock slopes in the project area to provide material for the slope widening. These rock cuts are located between milepost LY 45.00 and milepost LY 46.00.

Geology of the Slopes

The slopes are primarily igneous rock (basalt). The degree of weathering varies across each individual slope. Spacing of joint sets at different locations varies widely from one millimeter to a several millimeters. Most joints are filled with fine sand and silt. Photographs of the slopes are included in the Appendix.

Seismic Equipment and Field Procedures

A Bison Series 900012-channel seismograph was used to collect seismic refraction data. The geophones were planted at 10-foot, 15-foot, and 20-foot intervals on the face of the slopes, in generally the north-south direction, and parallel to the highway alignment. A sledge-hammer and metal striking plate were used to generate the energy source. The layout for the seismic work included series of forward and reversed seismic lines "reversed-profile shooting" with the striking plate at a distance equal to the spacing of the geophones from the end-geophones, or equidistant from the middle geophones. The signals received by the geophones were digitized by the seismograph equipped with "signal enhancement". The signals were stacked 10 times for each seismic line.

Field Seismograph Records

The field seismograph records contain data representing the time it takes for compressional energy (P-wave) generated by the seismic source to travel a path through the subsurface and back up to the geophones on the surface. The first arrival of compressional energy including first point of movement or point of maximum curvature at each geophone is marked on the enclosed Bison Series charts and was used to determine the position of refracting surfaces. Arrival times versus shotpoint-to-geophone distance (Time-Distance) were plotted manually. The slopes of these time-distance segments are inversely proportional to the apparent velocity of sound in that layer of the Earth. The time-distance plots of data obtained from the seismograph records are included in Appendix A.

Results

The time-distance plot is an interpretation of the seismograph records to obtain an approximate evaluation of the state of rippability of the rock slopes. The velocities on the time-distance plots can be compared with charts relating rippability to seismic velocity in rock. One example of a chart such as this is the Caterpillar Tractor Company Ripper Performance Charts. These charts help to determine difficulties that may be encountered in the excavation of rock slopes. There are possibly more massive rocks with fewer or less continuous joints at depth in the slopes that could be more difficult to excavate.

Limitations

Because of the inherent limitation in the seismic refraction method, the seismic survey alone can not be considered definitive in evaluating rock slope rippability. Drilling or coring with a drill rig and/or the excavation of test trenches with a bulldozer with ripper or backhoe may be required to provide additional information regarding rippability of the rock slopes at this site.

References

Dobrin, M.B., 1976, Introduction to Geophysical Prospecting (3rd ed.): New York, McGraw-Hill.

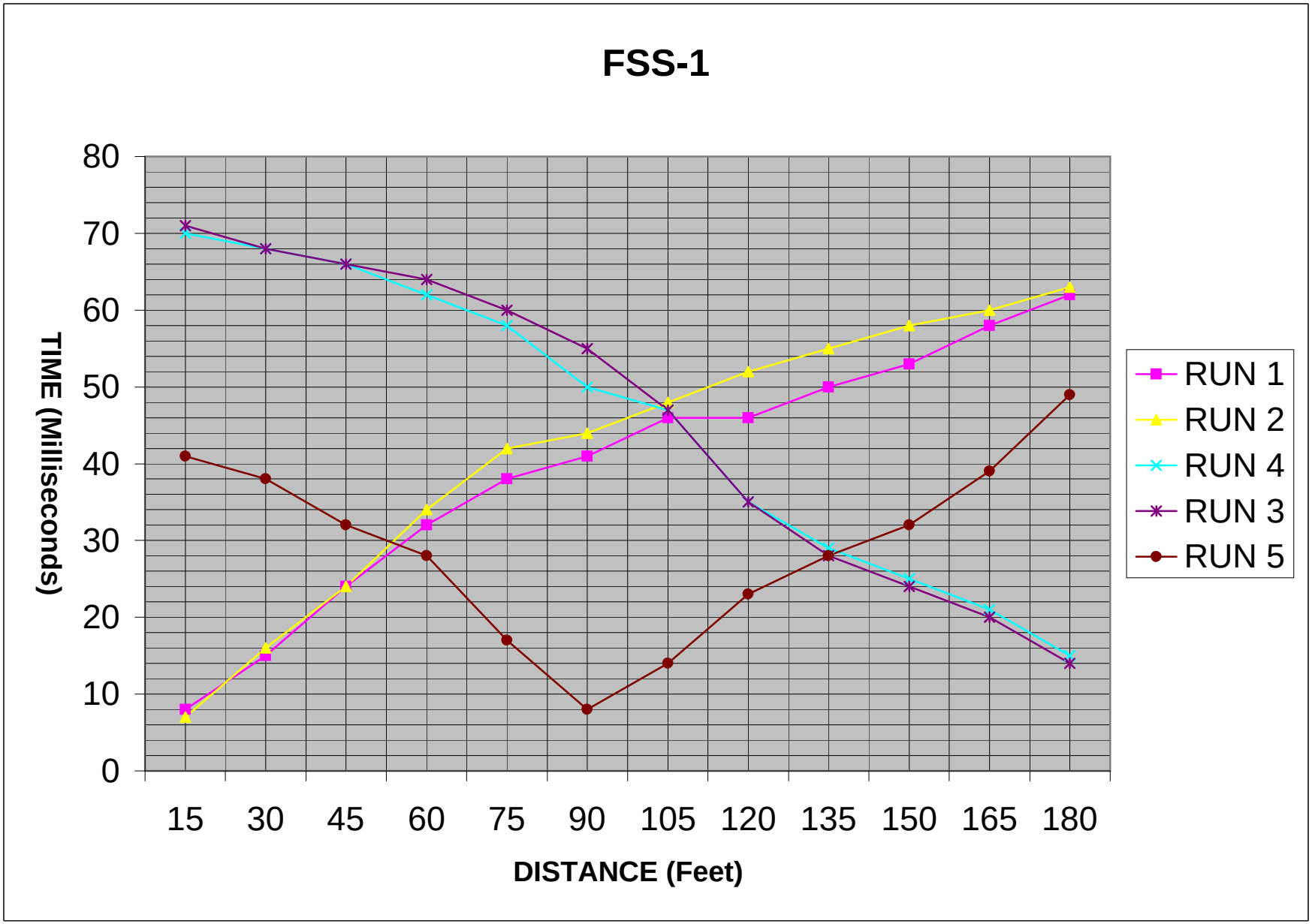
U.S. Department of the Interior, Application of Seismic-Refraction Techniques to Hydrologic Studies, 1988, United States Government Printing Office, Washington.

Department of the Army Corps of Engineers, Geophysical Exploration, 1979, Engineering Manual, EM1110-1-1802.

Blaricom Richard, Practical Geophysics, 1980, Northwest Mining Association, Spokane, WA.

APPENDIX A

VELOCITY CHARTS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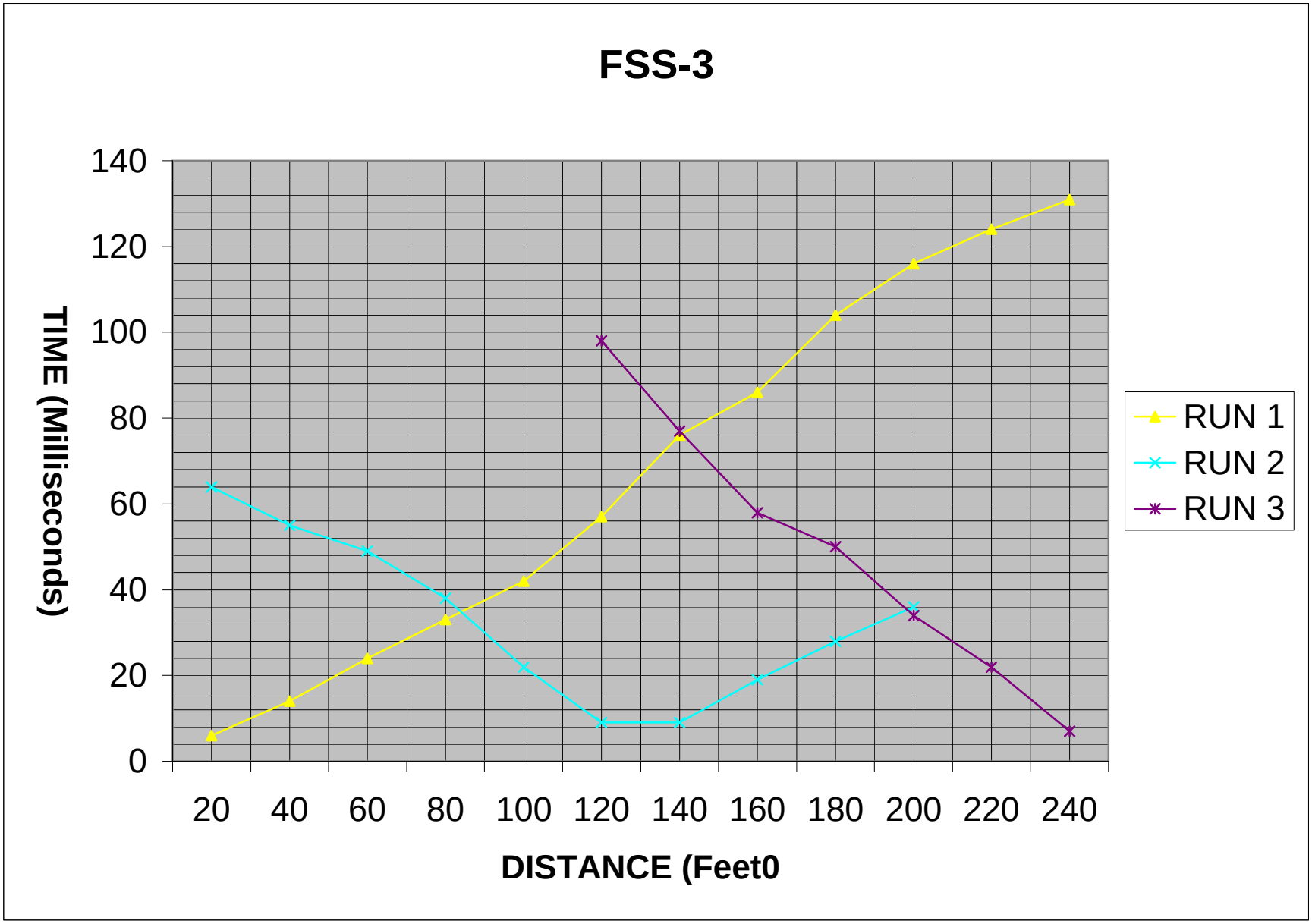
70
60
50
40
30
20
10
0
15
30
45
60
75
90
105
120
135
150
165
180
DISTANCE (Feet)
RUN 1
RUN 2
RUN 4
RUN 3
RUN 5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120
100
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60
40
20
0
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80
100
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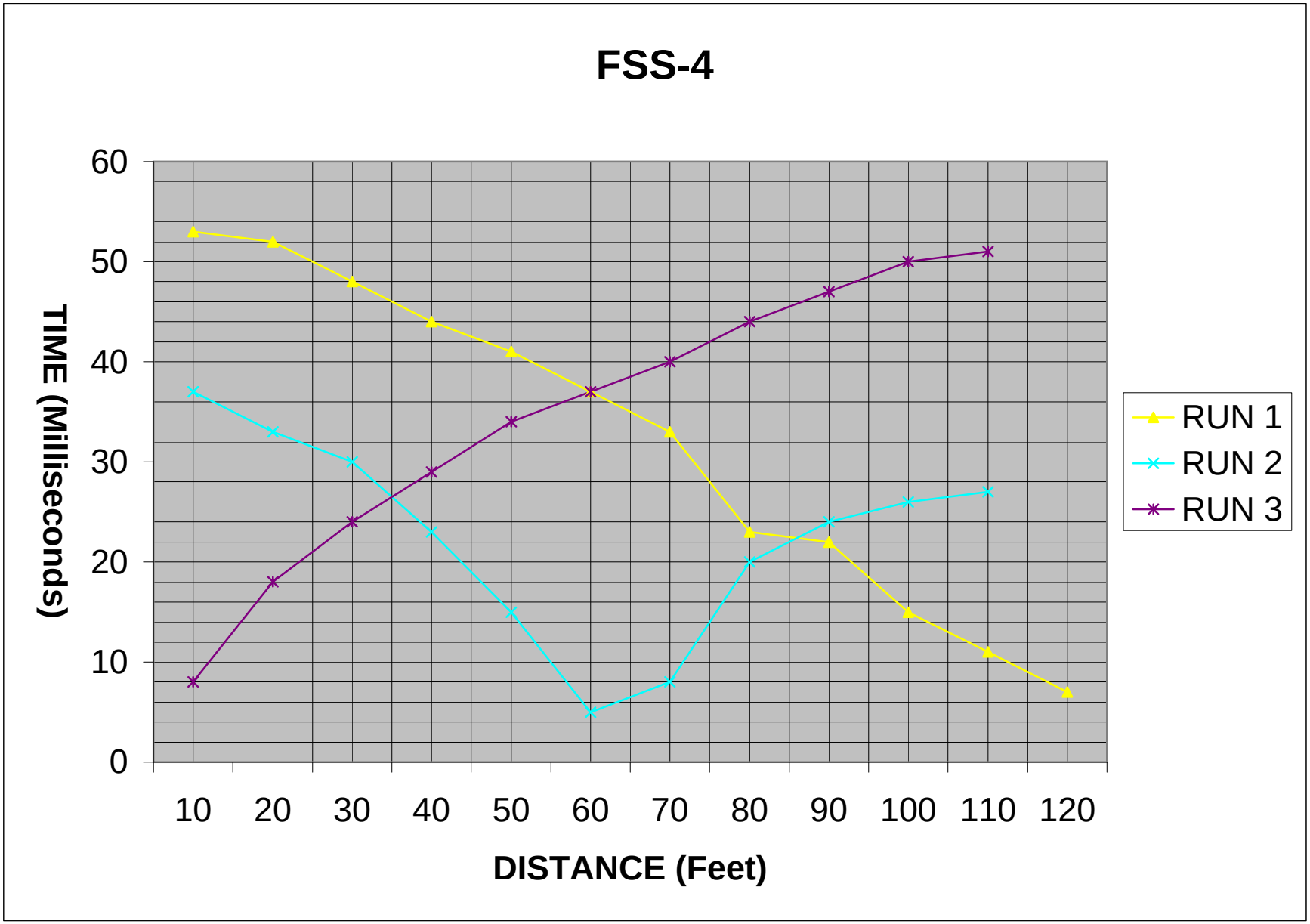
200
220
240
DISTANCE (Feet0
RUN 1
RUN 2
RUN 3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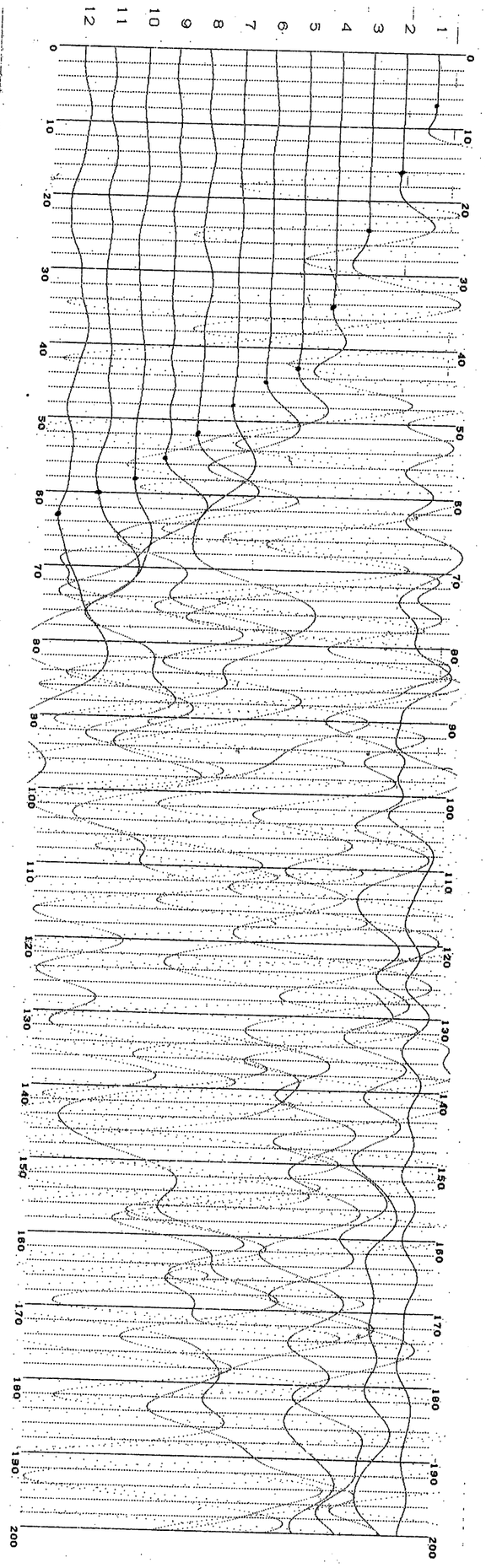
50
40
30
20
10
0
10
20
30
40
50
60
70
80
90
100
110
120
DISTANCE (Feet)
RUN 1
RUN 2
RUN 3

APPENDIX B

SEISMOGRAPH READOUT STRIPS



BISON 9000 SERIES

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Delay(ms) DFhc Out
Channels 12 DFlc Out
Samples 002000
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+ 02	M	0010	11	+ 08	H	0010	10
+ 03	H	0010	13	+ 09	H	0010	09
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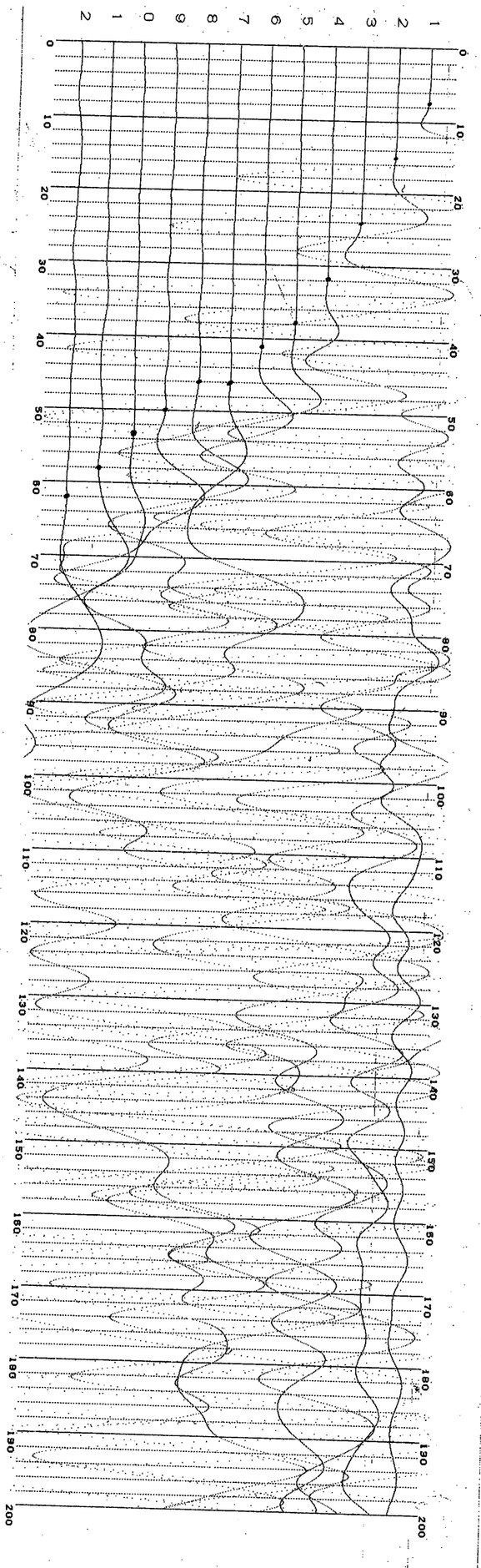
+ 06	H	0010	11	+ 12	H	0010	09



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+ 03	H	0010	13	+ 09	H	0010	09
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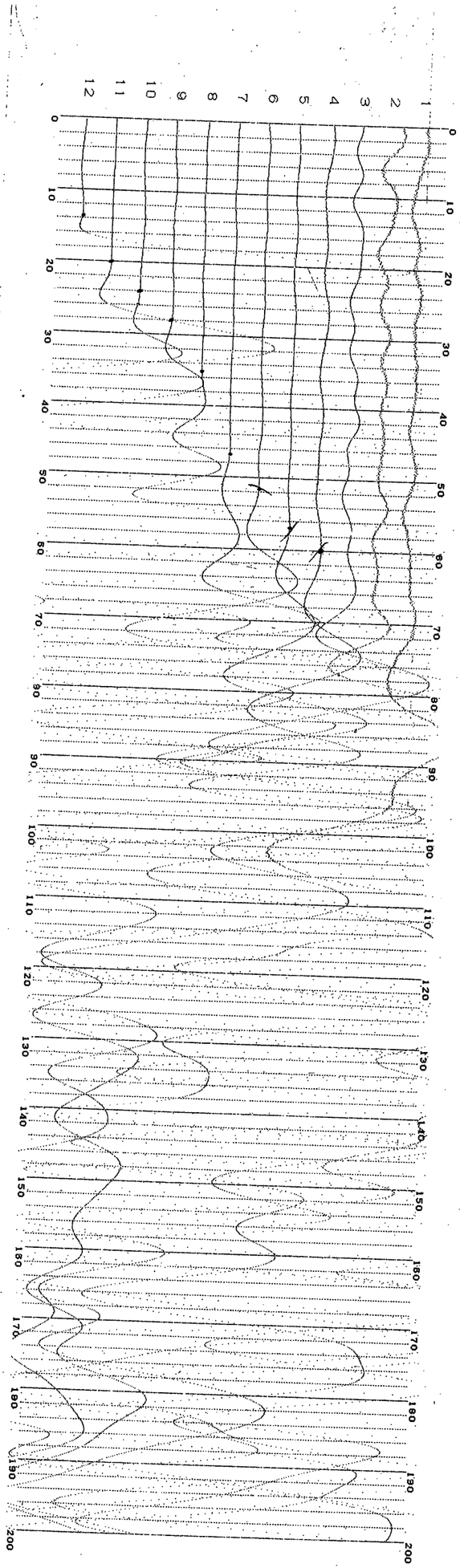

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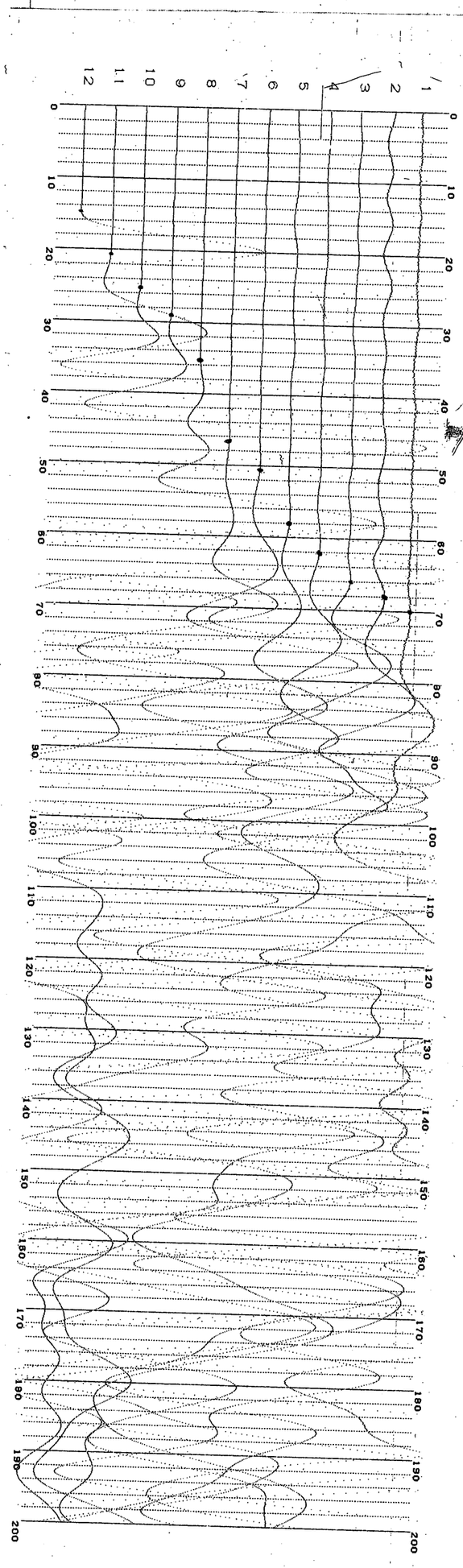
+	06	H	0010	10					



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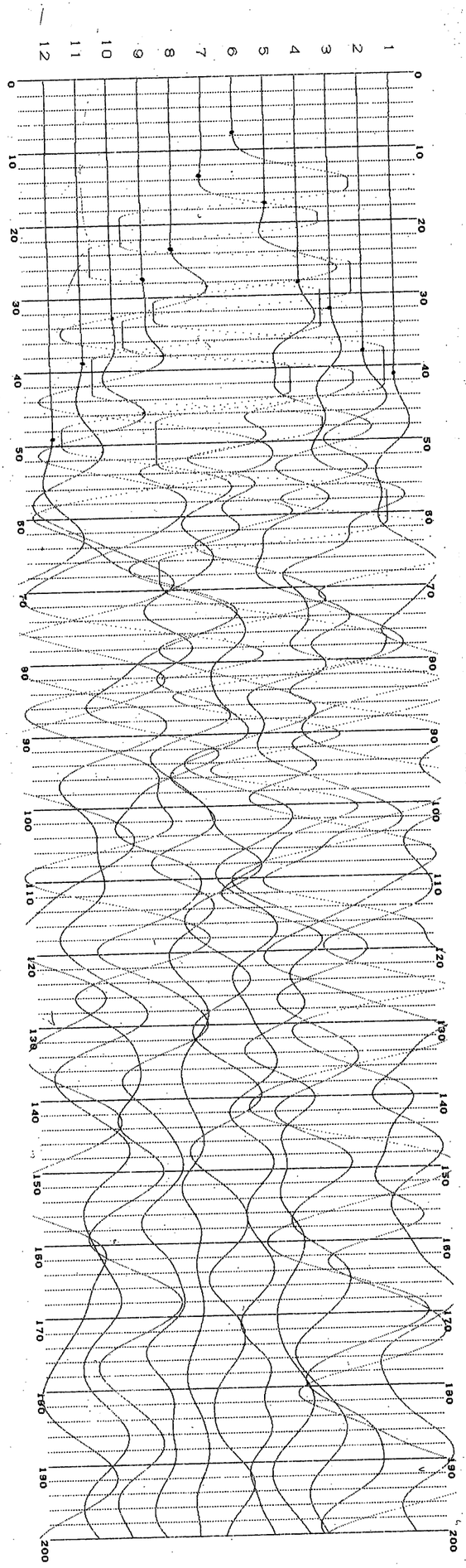

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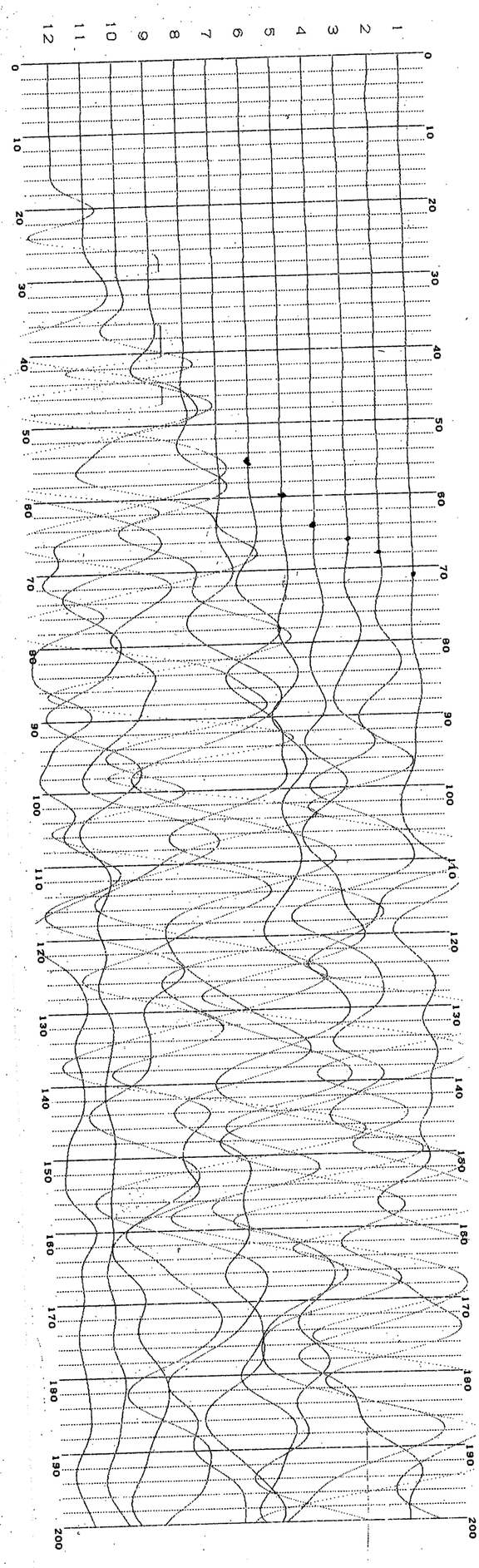

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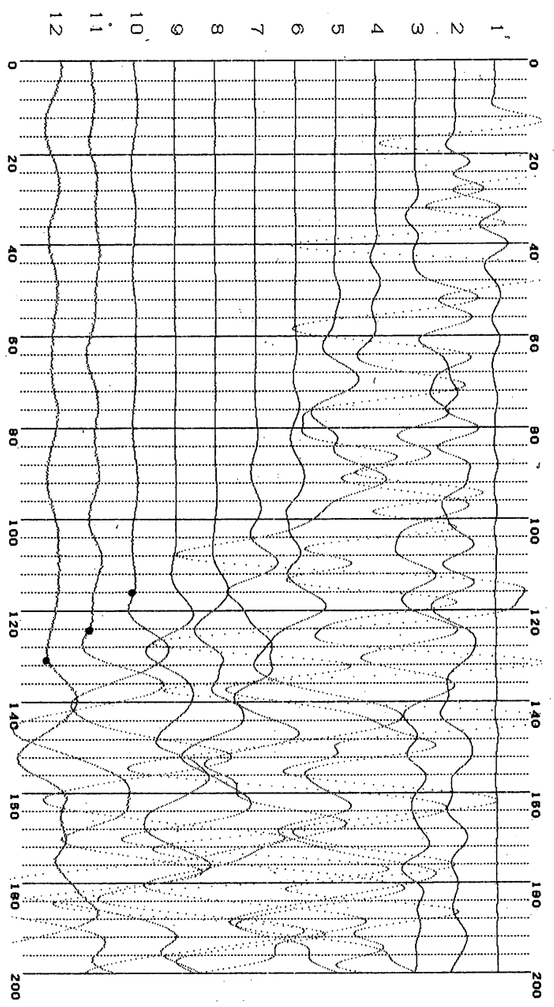

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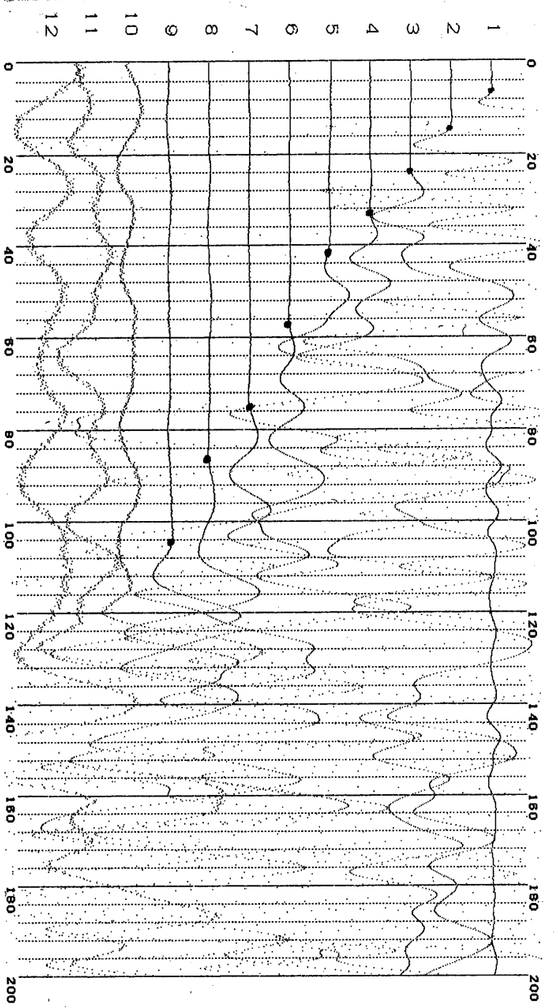

BISON 9000 SERIES

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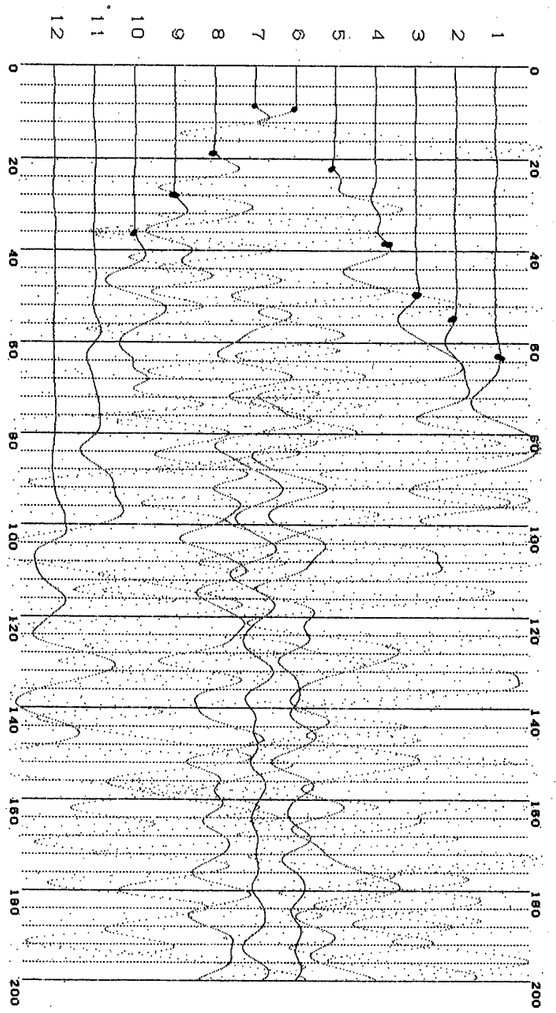

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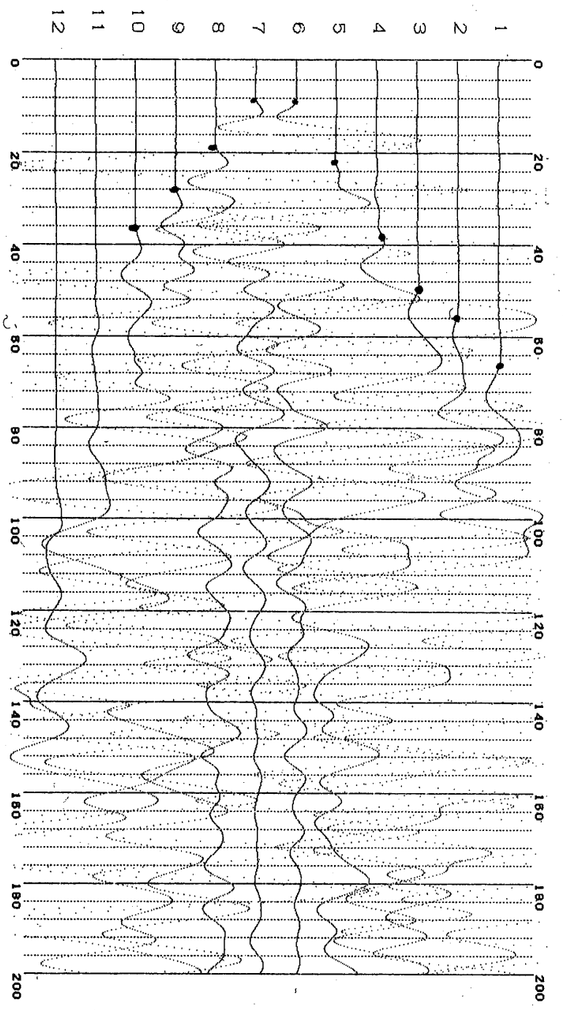

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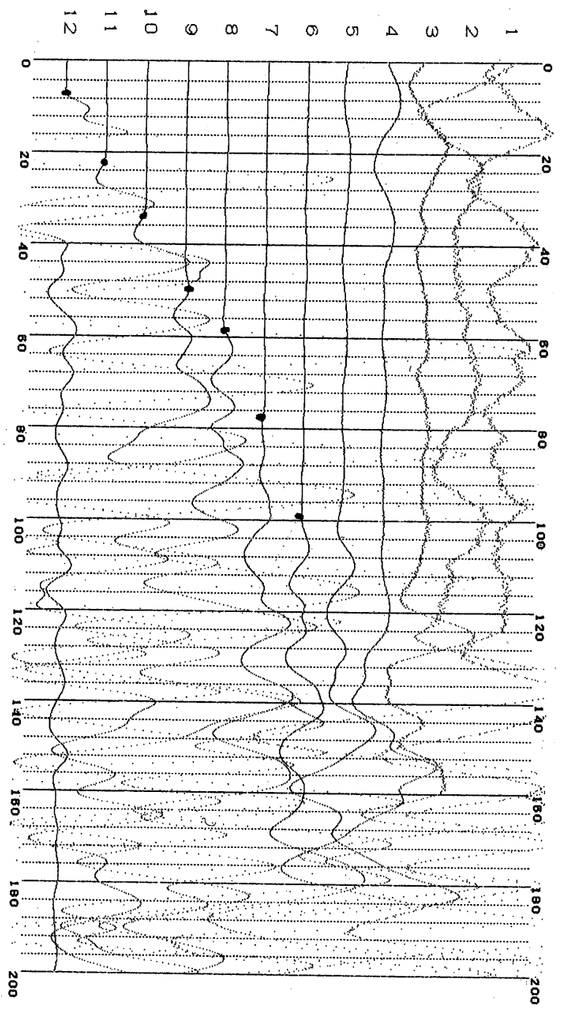

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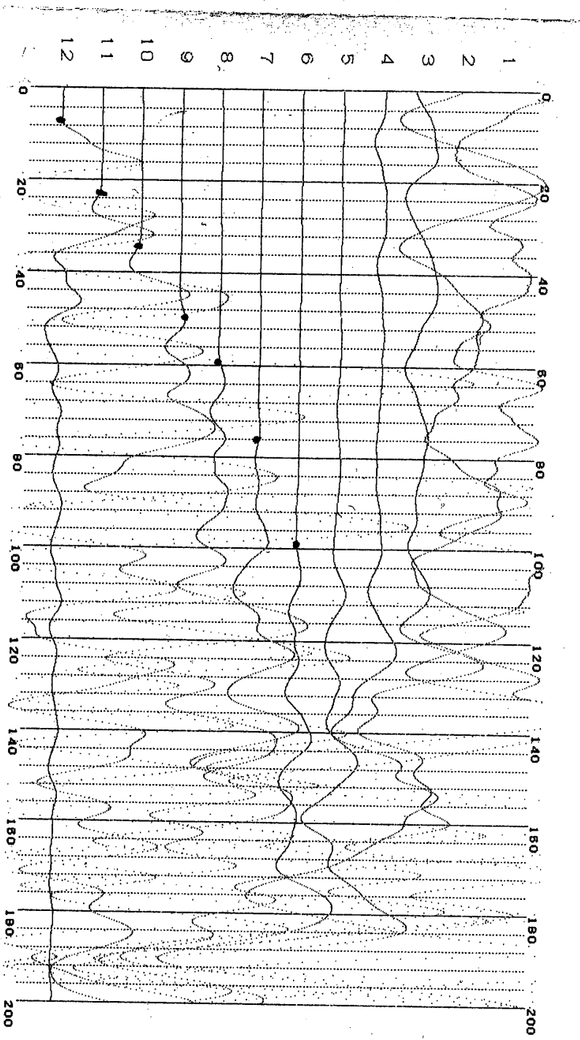

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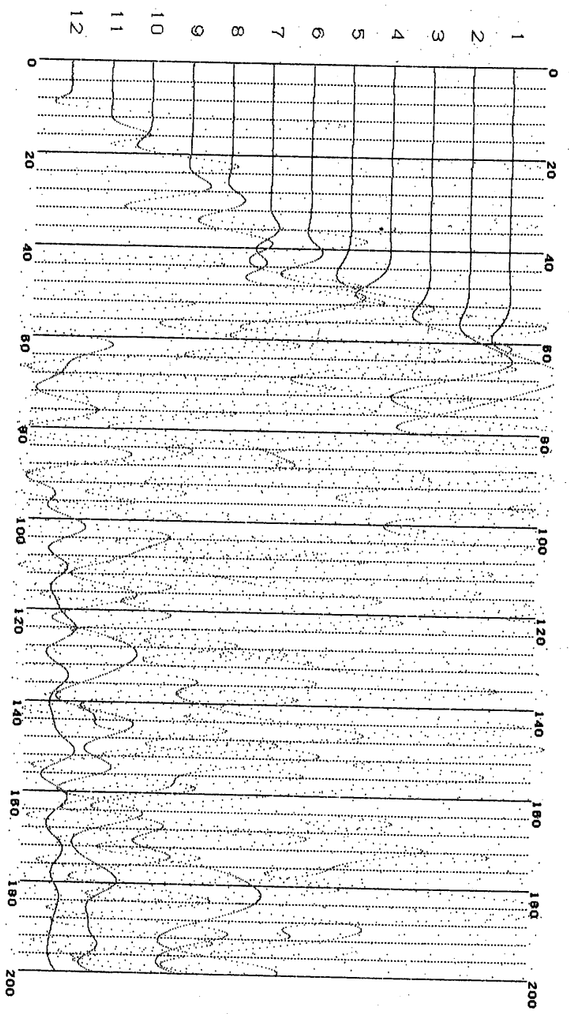

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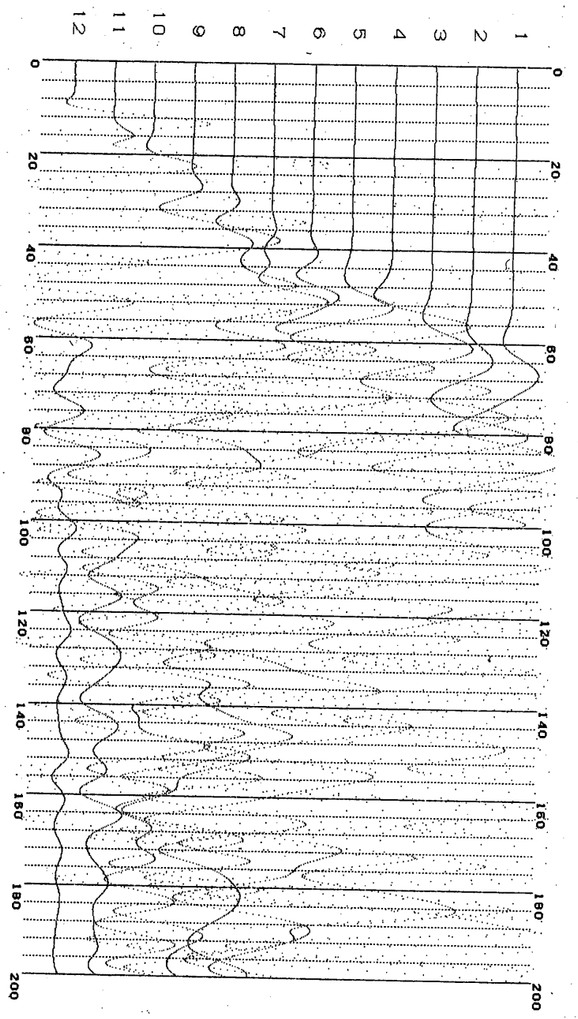

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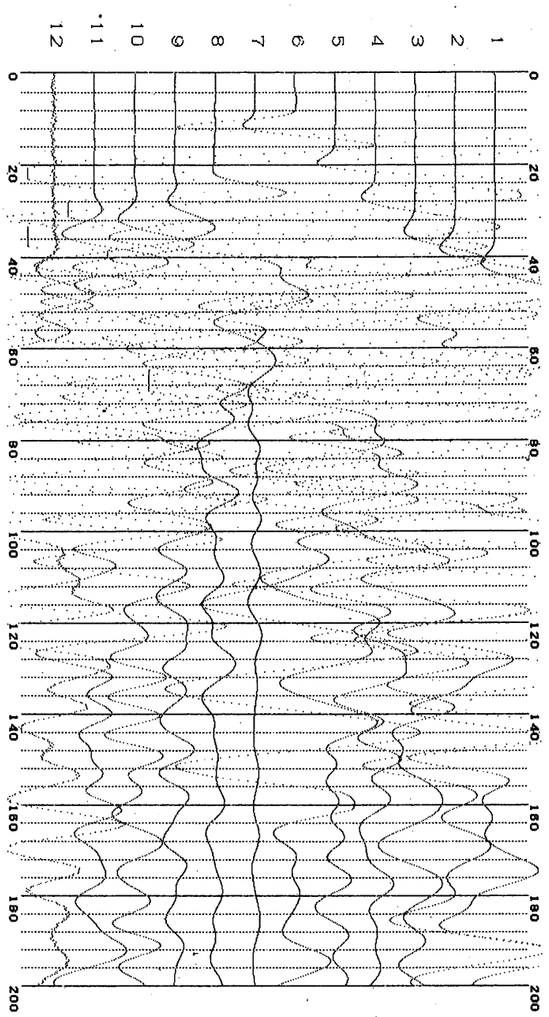

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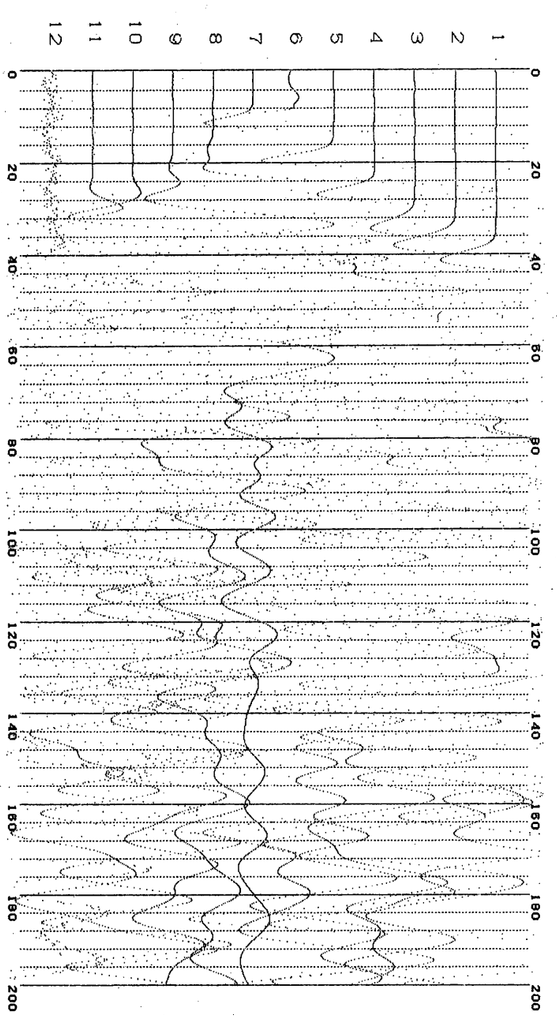

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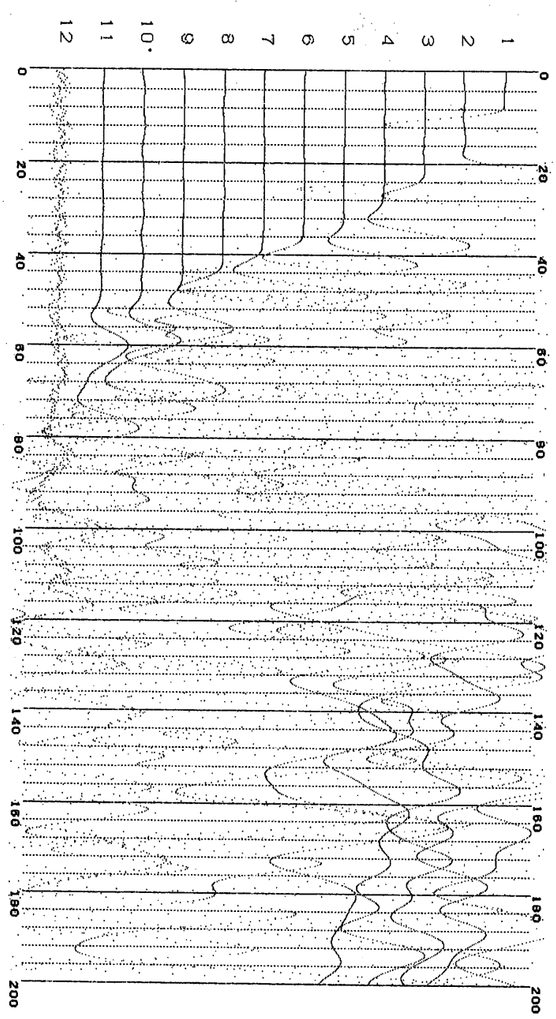
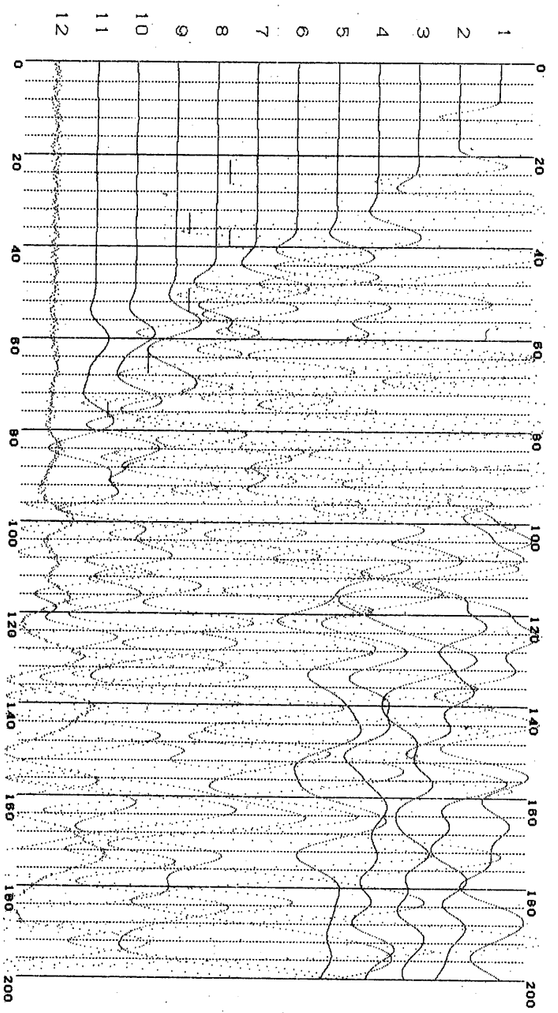
+	05	H	0010	13	+	11	M	0010	08
+	06	H	0010	13	+	12	O	0010	02



BISON 9000 SERIES

Record Name: FSS00016
Date 07:24:06 Time 11:53
Hi-cut 125 Lo-cut 32
Sample rt .100ms Stacks 0010
Delay(ms) DFhc Out
Channels 12 DFlc Out
Samples 002000
Rec len 200ms Agc Off
Time scale = 4.0 (ms)/division.

P	CH	GN	STK	EX	P	CH	GN	STK	EX
+	01	H	0010	14	+	07	M	0010	09
+	02	H	0010	14	+	08	M	0010	08
+	03	H	0010	14	+	09	M	0010	09
+	04	H	0010	14	+	10	M	0010	08
+	05	H	0010	14	+	11	M	0010	07
+	06	H	0010	12	+	12	O	0010	02



BISON 9000 SERIES

Record Name: FSS00016
Date 07:24:06 Time 11:53
Hi-cut 125 Lo-cut 32
Sample rt .100ms Stacks 0010
Delay(ms) DFhc Out
Channels 12 DFlc Out
Samples 002000
Rec len 200ms Agc Off
Time scale = 4.0 (ms)/division.

P	CH	GN	STK	EX	P	CH	GN	STK	EX
+	01	H	0010	15	+	07	M	0010	10
+	02	H	0010	15	+	08	M	0010	09
+	03	H	0010	15	+	09	M	0010	10
+	04	H	0010	15	+	10	M	0010	09
+	05	H	0010	15	+	11	M	0010	08
+	06	H	0010	13	+	12	O	0010	03

APPENDIX C

PHOTOGRAPHS

Slope FSS-1

Slope FSS-3

Slope FSS-4