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Geological Survey
W. E. Wrather, Director

Cooperative Geologic Project

Geologic Interpretation of Seismic Data

Relocation Route 1 Cut, Stations 25-36

Ballard Estate

in Topsfield, Mass.

by

James E. Maynard, Geologist, U. S. Geological Survey

and

Rev. Daniel Linehan, S. J., Seismologist, Weston College

5 pages of text
4 plates /



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Seismic Series # _____

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General Statement

This investigation was undertaken to determine the surface and subsurface conditions between stations 25 and 36 of the proposed relocation of the Newburyport Turnpike, Route 1, Topsfield, Mass. Reconnaissance seismic work was performed at the site in September 1949. Because that work showed bedrock near the surface over an extensive area where a deep cut was to be made, a more detailed program of seismic work was performed in September, October and November 1949. This report comprises all of the seismic work performed at the site. It was done as part of a cooperative project of the Massachusetts Department of Public Works and the United States Geological Survey.

Surface Geology

At this location the base-line from south to north traverses the steep face of an escarpment that faces Nicols Brook, and then gradually rises across the uplands to a point near the crest of a flat till hill. The configuration of the land over much of the location is irregular with small knobs and depressions. The surface formation over most of the area is fine wind-blown

sand from a few inches to several feet in thickness. This material is underlain by sandy to clayey till in some places containing many small angular fragments of rock. Medium to large boulders occur at only a few places on the surface of the ground. Some of the small depressions contain stratified sand, and are probably small kettles. Only one exposure of bedrock was located close to the road site. This is an exposure of coarse pink granite occurring from 12 to 12 feet west of the base-line between stations 29+12 and 29+60. The surface geology of the surrounding area, however, suggests that most of the site is underlain by melanite (a dark-colored rock similar in texture to granite). That bedrock is relatively shallow over most of this site is suggested by the general configuration of the land, the presence of many small angular fragments of melanite and granite in the till, and the sparse somewhat stunted vegetation.

Seismic Traverses

The plan of the seismic traverses is shown on sheet 1.

Nineteen seismic traverses were made at this location. The length of each of these traverses is:

A-B',	330 feet	AA-CC,	220 feet
B-C,	330 "	BB-DD,	220 "
A'-J,	330 "	CC-DD,	110 "
D-E',	330 "	CC-EE,	220 "
E-F,	330 "	DD-FF,	220 "
D'-K,	330 "	EE-FF,	110 "
H'-G,	330 "	EE-GG,	220 "
I-H,	330 "	FF-HH,	220 "
G'-L,	330 "	GG-HH,	110 "
AA-BB,	110 "		

The shot points for each of the traverses were located as follows:

A,	station	31+80							
A',	"	31+85							
B,	"	28+55							
B',	"	28+50							
C,	"	25+25							
D,	80 feet to the right (east) of station	32+13							
D',	80 " " " " " " " "	32+18							
E,	80 " " " " " " " "	28+80							
E',	80 " " " " " " " "	28+85							
F,	80 " " " " " " " "	25+50							
G,	50 " " " left (west) " " " "	32+15							
G',	50 " " " " " " " "	32+10							
H,	50 " " " " " " " "	28+80							
H',	50 " " " " " " " "	28+85							
I,	50 " " " " " " " "	25+50							
J,	station	35+15							
K,	80 feet to the right (east) " " " "	35+50							
L,	50 " " " left (west) " " " "	35+40							
AA,	55 " " " right (east) " " " "	28+00							
BB,	55 " " " left (west) " " " "	28+00							
CC,	55 " " " right (east) " " " "	30+20							
DD,	55 " " " left (west) " " " "	30+20							
EE,	55 " " " right (east) " " " "	32+40							
FF,	55 " " " left (west) " " " "	32+40							
GG,	55 " " " right (east) " " " "	34+60							
HH,	55 " " " left (west) " " " "	34+60							

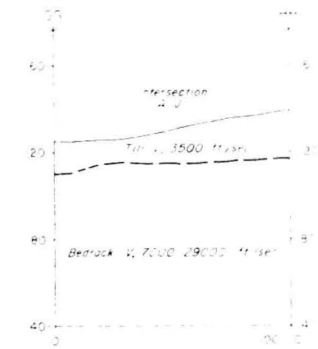
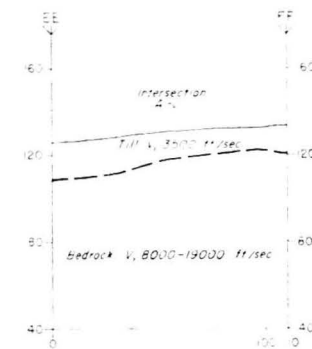
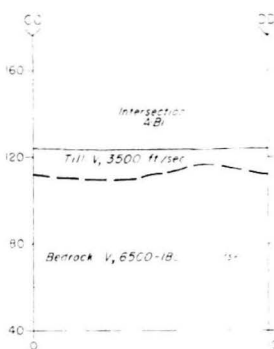
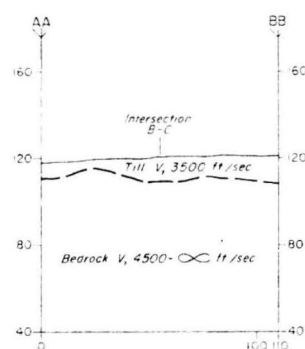
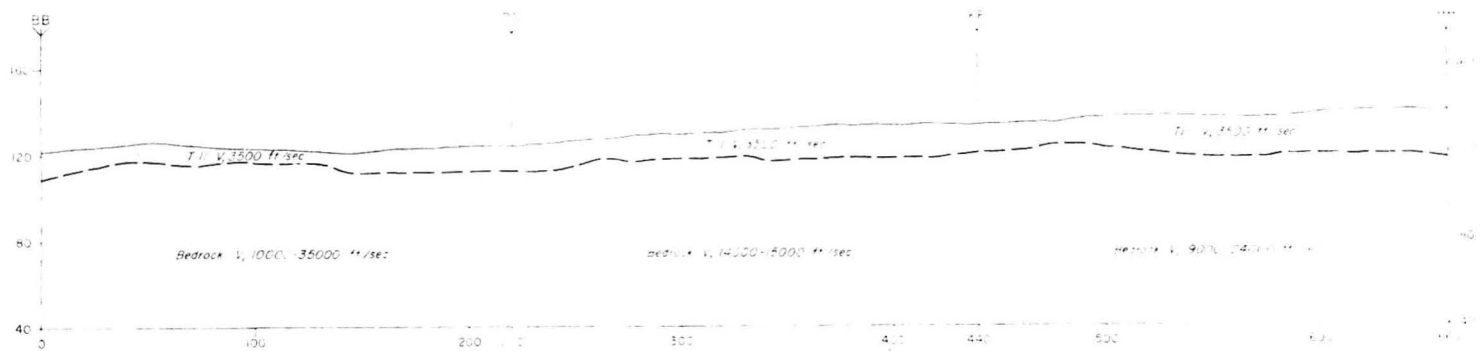
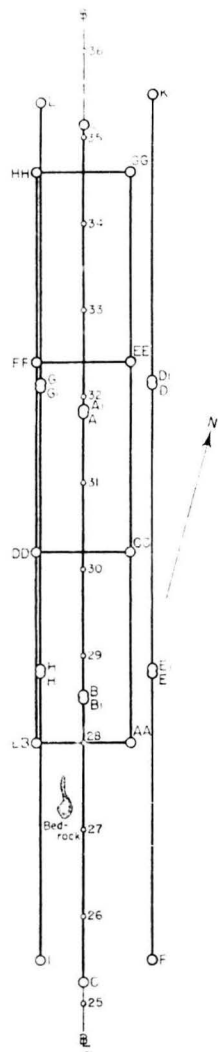
Depths to Bedrock

The approximate depths to bedrock below the shot points are:

A,	14 feet	F,	12 feet	AA,	7 feet
A',	14 "	G,	15 "	BB,	13 "
B,	7 "	G',	15 "	CC,	12 "
B',	7 "	H,	9 "	DD,	12 "
C,	11 "	H',	9 "	EE,	17 "
D,	13 "	I,	12 "	FF,	13 "
D',	13 "	J,	12 "	GG,	15 "
E,	12 "	K,	10 "	HH,	22 "
E',	12 "	L,	19 "		

Geologic Interpretation of Seismic Data

The geologic sections along the seismic traverses as interpreted from the surface geology and the seismic data are shown on sheets 1, 2, 3, and 4. The sections show an irregular bedrock surface that varies from about 4 to 23 feet in depth. Although the bedrock surface is indicated on the sections by smooth curves, it is probable that many more small ridges, benches or knobs are present, some of which may be at altitudes markedly above those represented by the smooth boundary lines. The bedrock surface along the long reconnaissance lines was too near the surface of the ground to yield sufficient points on the time-travel plot for the accurate determination of the till velocities. Hence, the depths to bedrock at shot points A, B, C, D, E, F, G, H, I, J and K, were calculated using a 3500-foot per second till velocity, the velocity obtained when the shorter lines of the detailed survey were run. For this reason these depths may be somewhat shallower than indicated. The depth value at FF may be either 12 or 16 feet; the smaller values are shown on the section. Likewise the depth value GG may be either 14 or 16 feet; the small values in this case also are shown on the section.



PLAN OF TRAVERSES
SCALE 1" = 100' ± 1'
Letters refer to points on map and in cross-sections. Numbers refer to D.P.W. stations on baselines

INTERPRETATIVE GEOLOGIC SECTIONS ALONG SEISMIC TRAVERSES	
TOPSFIELD	ROUTE NO 1
RELOCATION RTE 1 CUT STAS. 25-36	
S. A. L. 1" = 40' ± 1'	DR. JAMES E. MAYNARD
W. W. L. 1" = 40' ± 1'	W. W. L. 1" = 40' ± 1'
W. W. L. 1" = 40' ± 1'	W. W. L. 1" = 40' ± 1'
SEPT. OCT. 1949	NOV. 1949

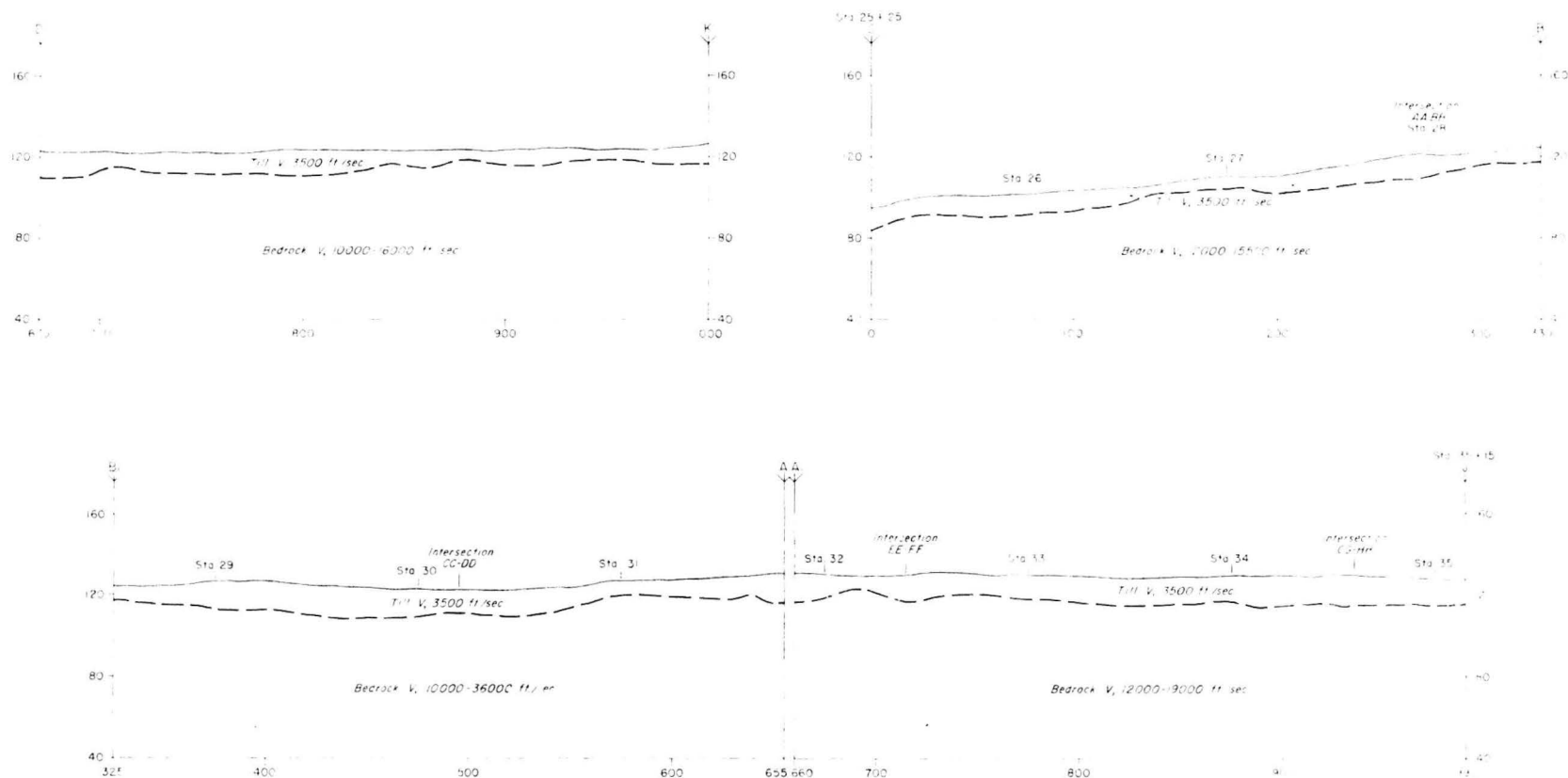
The image contains two geological cross-sections, labeled AA and FF, showing velocity profiles. Both plots have a vertical axis on the left ranging from 0 to 160 and a horizontal axis at the bottom ranging from 0 to 600. Each plot features two data series: a dashed line representing 'Tuff V, 3500 ft/sec' and a solid line representing 'Bedrock V'.

Diagram AA (Top):

- The dashed line (Tuff V) starts at approximately 100 on the vertical axis, remains relatively flat until about 200, then shows a slight dip and recovery, ending near 100.
- The solid line (Bedrock V) starts at approximately 110, peaks slightly around 120 near x=100, and then fluctuates between 110 and 120 across the entire horizontal range.
- Labels for 'Bedrock V' are placed at three intervals: '8000-52000 ft/sec' (x=0-200), '16000 ft/sec' (x=200-400), and '5000-24000 ft/sec' (x=400-600).
- Vertical markers labeled 'CC' and 'EE' are positioned at approximately x=220 and x=440, respectively.

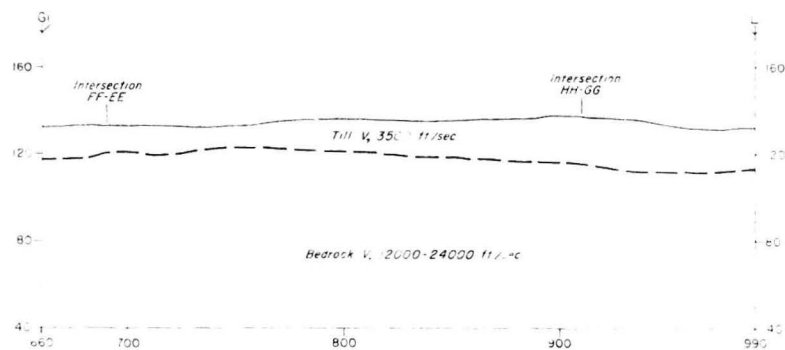
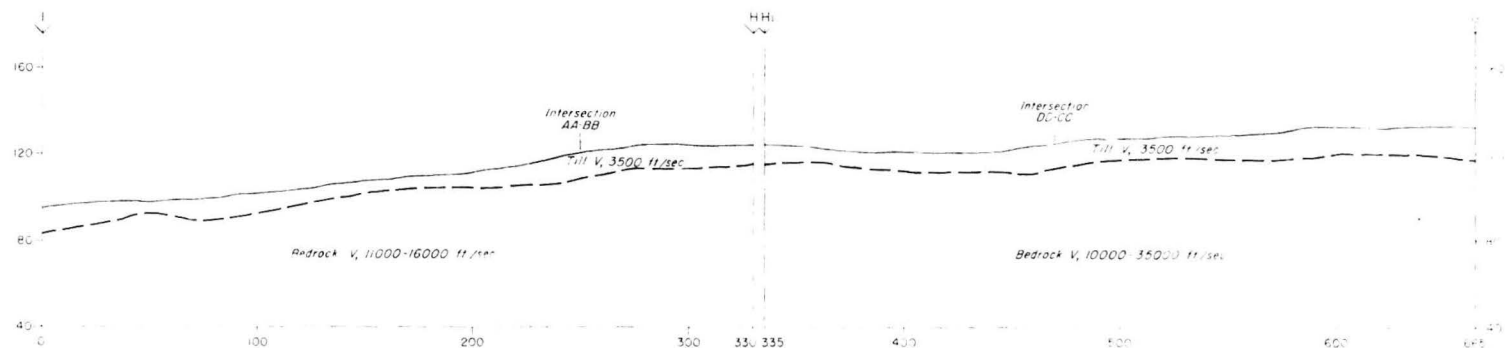
Diagram FF (Bottom):

- The dashed line (Tuff V) starts at approximately 80, rises to about 100 by x=200, peaks at approximately 110 around x=350, and then fluctuates between 100 and 110.
- The solid line (Bedrock V) starts at approximately 90, rises steadily to about 120 by x=350, and then remains relatively flat around 110-120.
- Labels for 'Bedrock V' are placed at two intervals: '10000-23000 ft/sec' (x=0-350) and '6000-24000 ft/sec' (x=350-600).
- A vertical marker labeled 'EE' is positioned at approximately x=330.



PLAN OF TRAVERSES	
SCALE	1" = 100'
Letters refer to points of interest as shown on plan	

INTERPRETATIVE GEOLOGIC SECTIONS ALONG SEISMIC TRAVERSES			
TOPSFIELD		ROUTE NO. 1	
RELOCATION RTE 1 CUT STAS. 25-36			
STA. NO.	STATION	DATE	BY
25+25	25+25	10-1-10	W. J. B. / J. W. B.
26+00	26+00	10-1-10	W. J. B. / J. W. B.
27+00	27+00	10-1-10	W. J. B. / J. W. B.
28+00	28+00	10-1-10	W. J. B. / J. W. B.
29+00	29+00	10-1-10	W. J. B. / J. W. B.
30+00	30+00	10-1-10	W. J. B. / J. W. B.
31+00	31+00	10-1-10	W. J. B. / J. W. B.
32+00	32+00	10-1-10	W. J. B. / J. W. B.
33+00	33+00	10-1-10	W. J. B. / J. W. B.
34+00	34+00	10-1-10	W. J. B. / J. W. B.
35+00	35+00	10-1-10	W. J. B. / J. W. B.
36+00	36+00	10-1-10	W. J. B. / J. W. B.



PLAN OF TRAVERSES

SCALE: 1" = 40' HORIZ.

Geologic section I-I' is shown in plan view.

INTERPRETATIVE GEOLOGIC SECTIONS ALONG SEISMIC TRAVERSES

TOPSFIELD

ROUTE NO 1

RELOCATION RTE 1 CUT STAS. 25-36

SCALE: 1" = 40' HORIZ.

BY: JAMES E. MAYNARD

Checked by: DANIEL N. HARRIS
Reviewed by: W. H. STEADMAN

DATE: 10/1/63

ED: 10/1/63