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Commonwealth of Massachusetts
Department of Public Works
W. F. Callahan, Commissioner

U. S. Department of the Interior
Geological Survey
W. E. Wrather, Director

Cooperative Geologic Project

Geologic Interpretation of Seismic Data
Relocation Route 1, Cut, Stations 34-52
Copper Mine Road area and Northern Portion of 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

Relocation of the Newburyport Turnpike, Route 1, in Topsfield, Mass., will require a long relatively deep cut between stations 34 and 52. In order to obtain preliminary information on the depths to bedrock and on the nature of the subsurface materials at this site, reconnaissance seismic work was performed in October 1949. Because this reconnaissance work indicated that bedrock might be relatively near the surface over an extensive area where cuttings were to be made, a more detailed seismic study of the area was made in November 1949. The results of both the reconnaissance and detailed seismic work are included in this report. The work was done as part of a cooperative program of the Massachusetts Department of Public Works and the U. S. Geological Survey.

Surface Geology

At this location the base line of the proposed road traverses an area of moderate relief with many small irregular knobs and depressions. The surface formation over most of this area is fine wind-blown sand from a few

inches up to a few feet in thickness. This material is underlain by till that in many places contains numerous small angular fragments of rock. Medium to large boulders occur sporadically on the surface of the ground. Some of the small depressions in the vicinity of the base line contain stratified sand and are probably small kettles. Bedrock is not exposed along or in close vicinity to the base line.

The surface geology of the site and the surrounding area, and the surface configuration of the location, suggest that most of the site is underlain at shallow depth by an irregular bedrock surface. The geology of the region suggests that this bedrock is largely a tough, finely crystalline dark-colored rock (melanite) with minor amounts of granite.

Seismic Traverses

The plan of the seismic traverses is shown on sheet 2. With the exception of traverses GG-HH, II-JJ, XX-YY, and C-D, the traverses for the more detailed survey were each approximately 220 feet long. Traverses GG-HH, II-JJ, and XX-YY were each 110 feet long, and traverse C-D was 345 feet long.

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

A,	station	50+60						
B,	"	47+30						
B^1,	"	47+35						
C,	70	feet	to	the	right	(east)	of	station 51+30
D,	70	"	"	"	"	"	"	47+85
D^1,	70	"	"	"	"	"	"	47+90
E,	60	"	"	"	left	(west)	"	50+30
F,	60	"	"	"	"	"	"	47+00
F^1,	60	"	"	"	"	"	"	47+05
G,	station	44+05						
G^1,	"	44+00						

H,	70	feet	to	the	right	(east)	of station	44+60
I,	60	"	"	"	left	(west)	" "	43+75
I^1,	60	"	"	"	"	"	" "	43+80
J,	60	"	"	"	"	"	" "	40+50
K,	station 40+70							
GG,	55	feet	to	the	right	(east)	" "	34+60
HH,	55	"	"	"	left	(west)	" "	34+60
II,	55	"	"	"	right	(east)	" "	36+80
JJ,	55	"	"	"	left	(west)	" "	36+80
KK,	105	"	"	"	"	"	" "	34+60
LL,	105	"	"	"	"	"	" "	36+80
MM,	80	"	"	"	"	"	" "	39+00
NN,	55	"	"	"	"	"	" "	39+00
00,	station 39+00							
PP,	25	feet	to	the	"	"	" "	41+15
QQ,	35	"	"	"	right	(east)	" "	41+15
RR,	35	"	"	"	"	"	" "	43+35
SS,	25	"	"	"	left	(west)	" "	43+35
UU,	15	"	"	"	"	"	" "	45+55
TT,	30	"	"	"	right	(east)	" "	45+55
VV,	20	"	"	"	"	"	" "	47+75
WW,	25	"	"	"	left	(west)	" "	47+75
XX,	55	"	"	"	right	(east)	" "	49+95
YY,	55	"	"	"	left	(west)	" "	49+95

Depths to Bedrock

The approximate depths to bedrock below the shot points are:

A,	10	feet		I,	8	feet			00,	14	feet
B,	7	"		I^1,	8	"			PP,	18	"
B^1,	8	"		J,	8	"			QQ,	8	"
C,	9	"		K,	15	"			RR,	7	"
D,	8	"		GG,	14	"			SS,	4	"
D^1,	8	"		HH,	18	"			UU,	8	"
E,	8	"		II,	9	"			TT,	11	"
F,	7	"		JJ,	11	"			VV,	8	"
F^1,	8	"		KK,	13	"			WW,	10	"
G,	8	"		LL,	14	"	(minimum)		XX,	10	"
G^1,	9	"		MM,	12	"			YY,	8	"
H,	5	"		NN,	13	"					

The depth values to bedrock for shot points A to J inclusive are based on an average till velocity of 2500 feet per second, a value that was obtained when the shorter lines of the more detailed survey were run. The value for shot point K represents accurate time-travel data. The till velocities appear to range from 2500 to 3000 feet per second, using a till velocity of 3000 feet per second would yield depth values one to two feet greater for the A to J shot points.

Geologic Interpretation of Seismic Data

The geologic sections as interpreted from the surface geology, the calculated depths to bedrock at the shot points, and the velocity curves are shown on sheets 1 and 2.

The general contour of the bedrock surfaces, as shown by sections A-B to I-J inclusive, sheet 1, is based on good seismic velocity data. However, because the depth values at the shot points, as mentioned above, may be from one to two feet deeper than those shown on the section, the bedrock profiles may be one to two feet lower on the sections. The positions of the bedrock surfaces on the geologic sections are shown by smooth curves. These curves show only the major configurations for the detectors were too widely spaced to pick up many small knobs, points and ridges.

Geologic sections GG-HH to XX-YY inclusive, sheet 2, show only the very generalized broad configurations of the bedrock surface. Undoubtedly many

small ridges, knobs, pinnacles and depressions occur at altitudes above or below those represented by the smooth curves. In the vicinity of shot points LL the bedrock surface is represented by a dotted line; here the bedrock surface is probably at a somewhat greater depth, but the velocity data were too uncertain to place it more accurately. Indicated bedrock velocities along the shorter (220 foot) traverses are appreciably lower (12,500 feet per second) than those along the longer (330 foot) traverses, and are also lower than should be expected for the kinds of rock involved; such crystalline rocks commonly have seismic velocities of 15,000 to 18,000 feet per second. The apparently anomalous low velocities along the shorter traverses suggest that the upper part of bedrock may be in an appreciably more shattered condition than the lower part. For the shorter traverses, the upper part of the bedrock would have greater influence on determined apparent velocities than the deeper portion would have.

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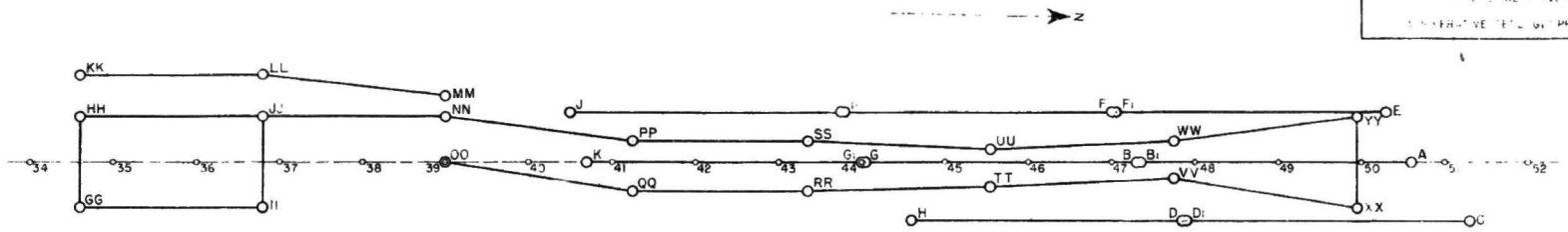
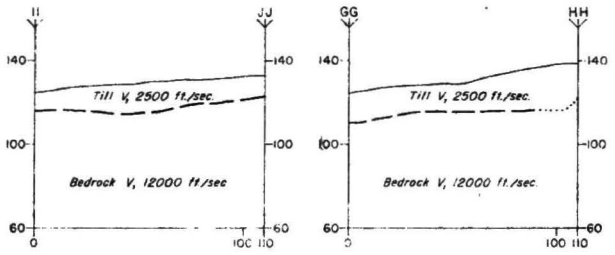
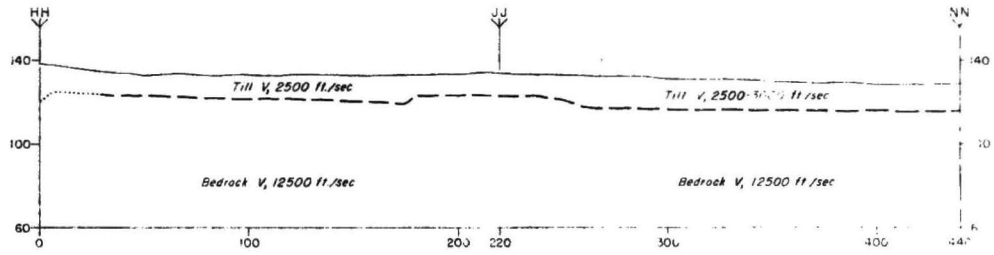
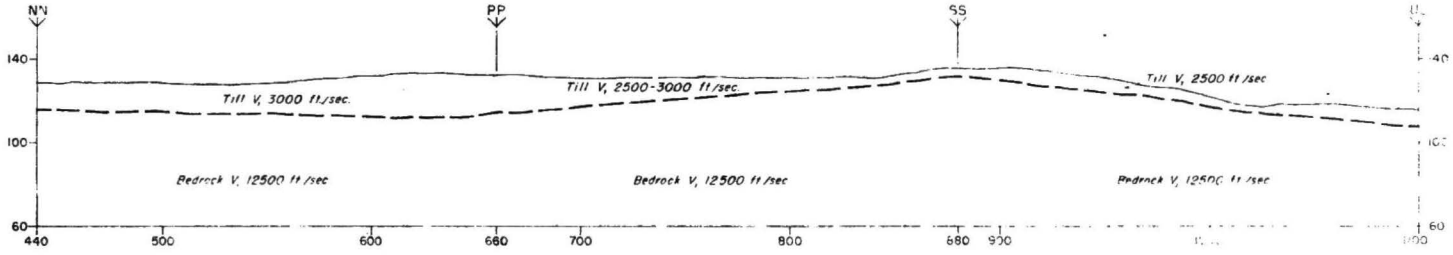
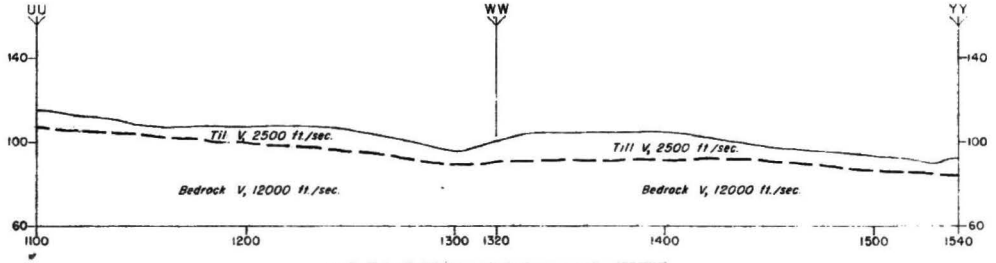










PLAN OF TRAVERSES

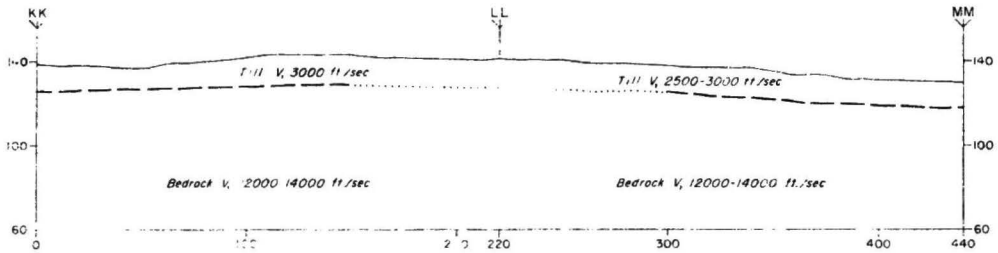
SCALE: 1 INCH = 100 FEET

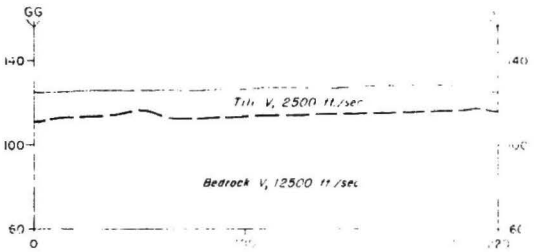
Letters refer to shot points at ends of traverses
Numbers refer to D.P.W. stations on baselines.

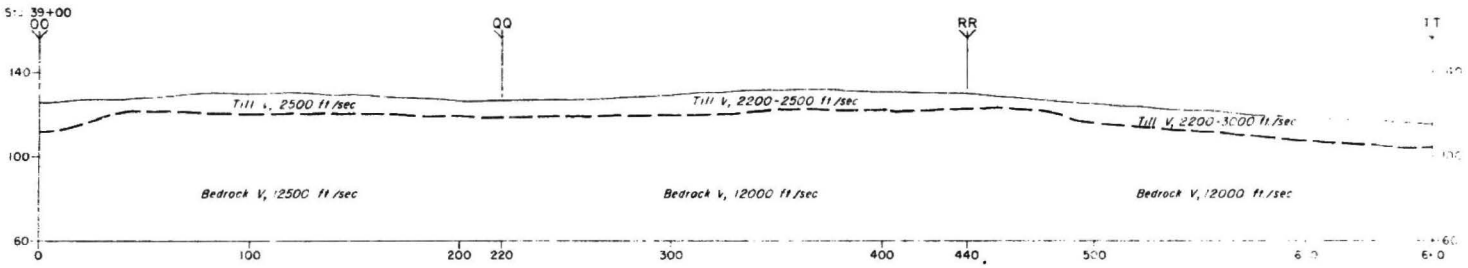
NOTE
Dotted portions of sections indicate inconclusive seismic data

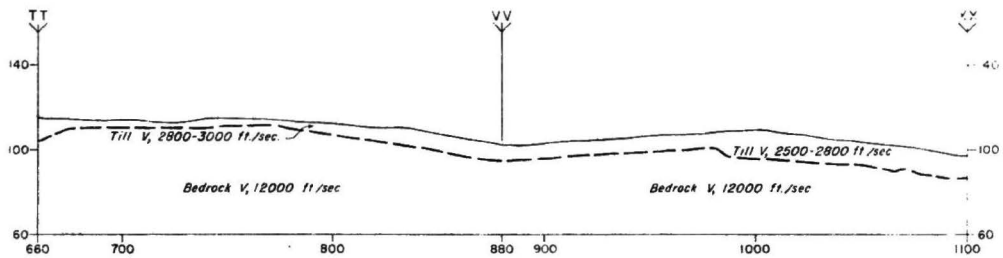
INTERPRETATIVE GEOLOGIC SECTIONS ALONG SEISMIC TRAVERSES

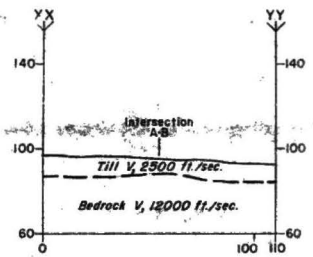
TOPSFIELD	ROUTE NO 1
RELOCATION RTE. 1 STAS. 34-52 (COPPER MINE ROAD AREA)	
SCALE 1 INCH = 40 FEET	GEOLOGY BY JAMES E MAYNARD
↓ Shot point	SEISMIC DATA BY JOHN EL LINEHAN
V. Apparent seismic velocity (ies) in feet per second	ENGINEERING BY W H STEADMAN
	DATE OCT. [illegible] 1947 SHEET [illegible]











PLAN OF TRAVERSES

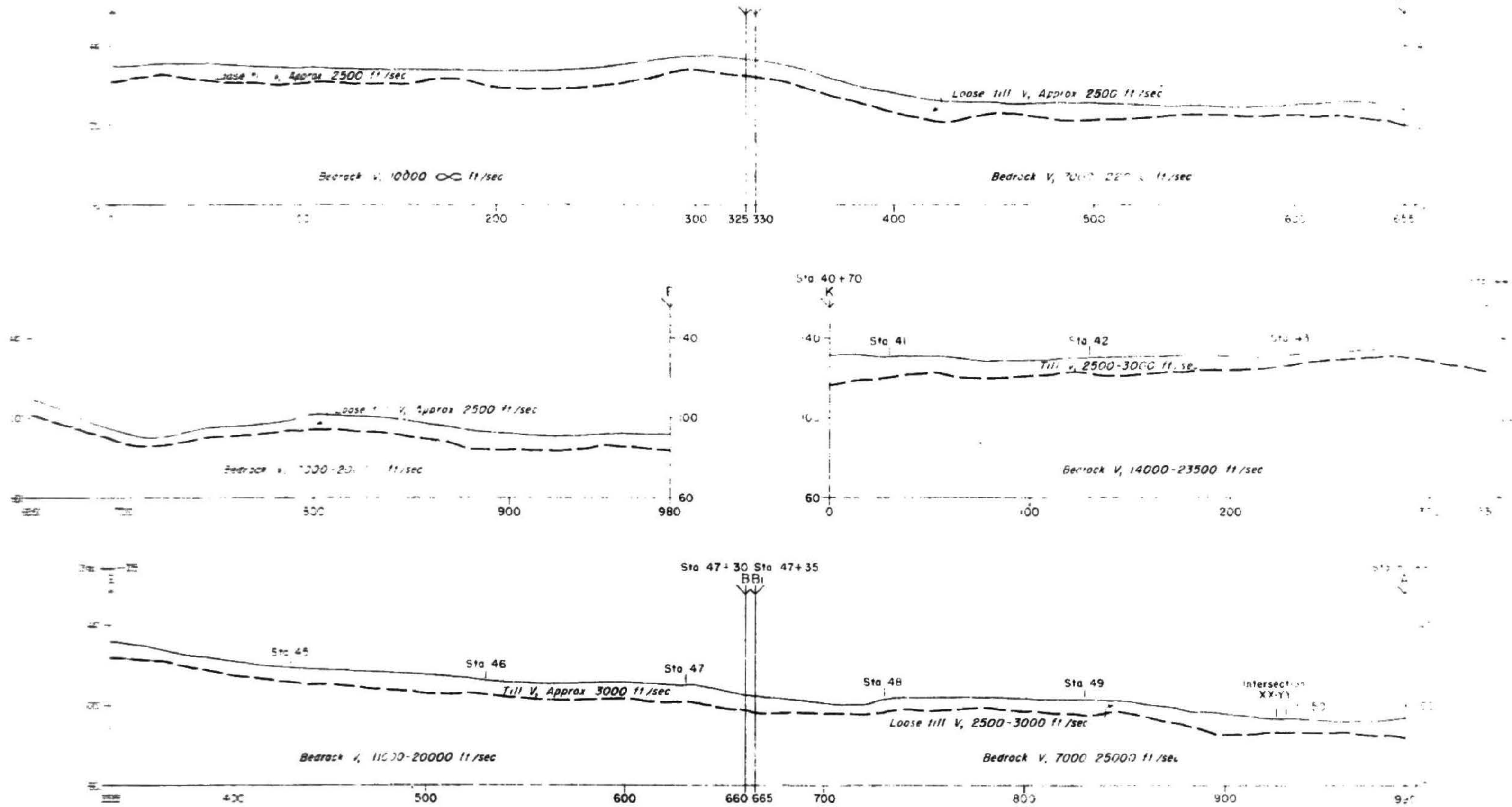
SCALE 1 INCH = FEET

Letters refer to shot points at ends of traverses

NOTE:
Dotted portions of sections indicate inconclusive seismic data

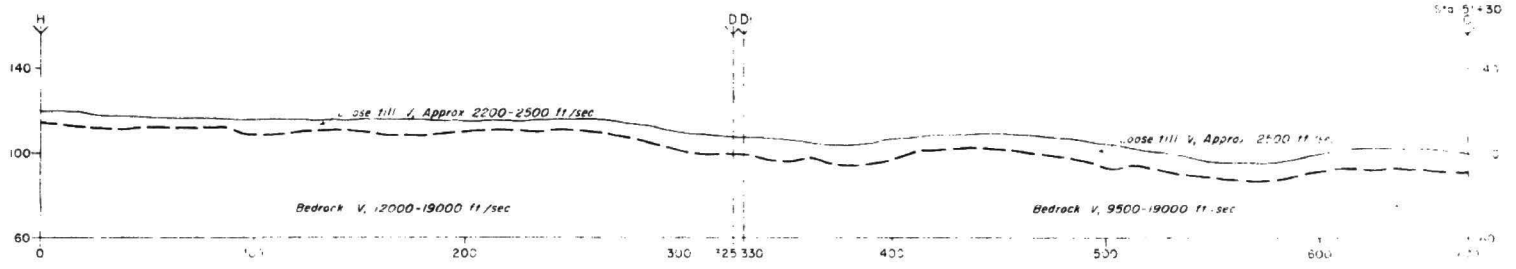
INTERPRETATIVE GEOLOGIC SECTIONS ALONG SEISMIC TRAVERSES

TOPSFIELD	ROUTE NO 1
RELOCATION RTE. 1 STAS. 34-52 (COPPER MINE ROAD AREA)	
SCALE 1 INCH = 40 FEET	GEOLOGY BY JAMES E. MAYNARD
V = apparent seismic velocity (vel. in feet per second	SEISMIC DATA BY DANIEL LINEHAN, S.J.
	ENGINEERING BY W.H. STEAD & G.J. OWEN
DATE OCT-NOV 1949	SHEET 2 OF 4



PLAN OF TRAVERSES
SCALE: 1 INCH= FEET
Letters refer to shot points at ends of traverses

INTERPRETATIVE GEOLOGIC SECTIONS ALONG SEISMIC TRAVERSES	
TOPSFIELD	ROUTE NO 1
RELOCATION RTE. 1 STAS 34-52 (COPPER MINE ROAD AREA)	
SCALE 1 INCH= 40 FEET	GEOLOGY BY JAMES E MAYNARD
↓ Shot point	SEISMIC DATA BY DAN E.
V. Apparent seismic velocity (res) in feet per second	ENGINEERING BY
	DATE OCT-NOV 1949 · SHEET 3 OF 4



PLAN OF TRAVERSES
SCALE 1 INCH = 400 FEET
Letters refer to shot points at the ends of traverses

INTERPRETATIVE GEOLOGIC SECTIONS ALONG SEISMIC TRAVERSES	
TOPSFIELD	ROUTE NO 1
RELOCATION RTE 1 STAS 34-52 (COPPER MINE ROAD AREA)	
SCALE 1 IN. = 40 FEET	GEOLOGY BY JAMES E. MAYNARD
S.P. = shot point V = Apparent seismic velocity (feet per second)	SEISMIC DATA BY DANIEL LINEHAN, C.E. ENGINEERING BY W.H. STEAD & J. OWEN
	DATE OCT.-NOV. 1949 SHEET 4 OF 4