United States Department of Agriculture

Natural Resources Conservation Service

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Subject: SOI -- Geophysical Assistance --

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PURPOSE:
Ground-penetrating radar (GPR) was used to determine the depths to bedrock within three soil map units. Data will be used to document the composition of these soil map units.

PARTICIPANTS:
Jim Doolittle, Research Soil Scientist, USDA-NRCS, Newtown Square, PA
Dave Turcotte, Soil Survey Project Leader, USDA-NRCS, Dover-Foxcroft, ME

ACTIVITIES:
All field activities were completed during the period of 25 to 27 September 2000. Surveys were conducted in cultivated fields near the town of Exeter in Penobscot County.

BACKGROUND:
In areas that were previously mapped as Bangor and Dixmont soils, soils underlain by para rock fragments and soft bedrock have been encountered. The area is underlain by the Waterville Formation and consists of phyllites, metasiltstone, calcareous metasiltstone, and pelitic limestone. Soils have a particle-size control section that ranges from 10 to 18 percent clay. Three new soil series are being proposed for a shallow, somewhat excessively drained soil (Monson-like), a moderately deep, well-drained soil (Elliotsville-like) and a deep, well drained soil (Dixmont-like).

Ground-penetrating radar was used to characterize the depths to bedrock in three map units. The map units are: 34A, 136B, and 55B. Map unit 34A is a complex that consists of a moderately deep, well-drained soil and a deep, moderately well drained soil on 0 to 3 percent slopes. Map unit 136B is a consociation of a moderately deep, well-drained soil on 3 to 8 percent slopes. Map unit 55B is a complex that consists of a shallow, somewhat excessively drained soil and moderately deep, well-drained soil on 3 to 8 percent slopes. Para rock fragments and soft bedrock underlie all three units.

EQUIPMENT:
The radar unit is the Subsurface Interface Radar (SIR) System-2, manufactured by Geophysical Survey Systems, Inc.[1] Morey (1974), Doolittle (1987), and Daniels (1996) have discussed the use and operation of GPR. The SIR System-2 consists of a digital control unit (DC-2) with keypad, VGA video screen, and connector panel. A 12-volt battery powered the system. This

[1] Manufacturer's names are provided for specific information; use does not constitute endorsement.

unit is backpack portable and, with an antenna, requires two people to operate. A 400 MHz antenna were used in this study. The scanning time was of 60 nanoseconds (ns). Hard copies of the radar data were printed in the field on a model T-104 printer.

FIELD PROCEDURES:

Radar surveys were completed by pulling the 400 MHz antenna by hand across cultivated fields that had been mapped as proposed soil map units 34A, 136B, and 55B. Soil delineations were selected to cover a large geographic range. At the request of the soil survey project leader, transect were of varying lengths and cross the breadth of most map units.

Although, GPR provides a continuous profile of subsurface conditions, interpretations were restricted to observation points. For each transect, observation points were spaced at uniform time intervals (either 10 or 15 sec depending on the size of the unit). At each observation point, the radar operator impressed a dashed, vertical line on the radar profile. This line identified an observation point on the radar record. The distance between observation points was about 12 or 18 meters.

Each radar traverse was stored as a separate file on a hard disc. Radar files were printed, reviewed and the bedrock surface was identified. At each observation point, the depth to bedrock was interpreted from the radar profile. Calibration trials were performed to determine the velocity of propagation and the observation depth of the GPR.

DISCUSSION:

Calibration of GPR:

Ground-penetrating radar is a time scaled system. This system measures the time that it takes electromagnetic energy to travel from the antenna to an interface (e.g., bedrock, soil horizon, stratigraphic layer) and back. To convert the travel time into a depth scale, either the velocity of pulse propagation or the depth to a reflector must be known. The relationships among depth (D), two-way pulse travel time (T), and velocity of propagation (V) are described in the following equation (Morey, 1974):

$$V = 2D/T \qquad [1]$$

The velocity of propagation is principally affected by the dielectric permittivity (E) of the profiled material(s) according to the equation:

$$E = (C/V)^2 \qquad [2]$$

Where C is the velocity of propagation in a vacuum (0.3 m/nanosecond). Velocity is expressed in meters per nanosecond (ns). A nanosecond is one billionth of a second. The amount and physical state of water (temperature dependent) have the greatest effect on the dielectric constant of a material.

The velocity of propagation and the depth scale were determined by comparing the interpreted depths to known reflectors (buried metallic reflector) on the radar profile with the measured depths. Based on the measured depth and the two-way travel time to these interfaces, and equation [1], the velocity of propagation was estimated to be about 0.1093 m/ns. The dielectric permittivity was 7.5. A scanning time of 60 ns was used in this investigation. Using equation [1], scanning time of 60 ns, and a propagation velocity of 0.1093 m/ns, the maximum depth of observation was estimated to be about 3.3 m.

Calibration trials were completed with a 120, 200, and 400 MHz antennas. The desired depth of observation was less than 3 m. The 400 MHz antenna provided the best balance of resolution and depth of observation.

Interpretation of radar profiles:

The soil/bedrock interface was identifiable and traceable on all radar profiles. However, this interface did not consist of smooth and continuous high amplitude reflectors that are indicative of an abrupt and highly contrasting boundary. The soil/bedrock interface did consist of numerous segmented reflectors of varying amplitudes that suggest a boundary consisting of both paralithic and lithic materials. Though the soil/bedrock interface was identifiable, because of its varying expression, depth estimates were considered close but less precise than commonly made.

Profiles observed in shallow soil pits contained numerous rock fragments of variable size and hardness. In these observations, the upper part of the bedrock was so highly fractured that it could not be considered a lithic or paralithic contact. Because of the abundance of similar rock-type fragments in the overlying soil, the often highly fractured bedrock surface, and the varying degree of hardness exhibited by both rock fragments and the underlying bedrock, the soil/bedrock interface was unaccustomedly vague.

RESULTS:
The results of this investigation are summarized in Appendices 1 and 2. Appendix 1 summarizes the interpreted depths to bedrock for each transect. Depths are expressed in meters. For each transect a file number and the map unit symbol have been provided. Appendix 2 summarizes interpreted depths by soil depth classes. For each transect a file number and the map unit symbol have been provided. In addition, for each transect, the number of observations (obs) as well as the frequency are given for each depth class. Depth classes are shallow (0 to .5 m), moderately deep (.5 to 1.0 m), deep (1.0 to 1.5 m) and very deep (>1.5 m). Where bedrock was exposed at the surface the observation depth was 0 and the depth class was "outcrop."

While slopes and landform positions did vary, the basic statistics for the three map units were remarkably similar. A total of seven transects were conducted in areas that had been mapped as map unit 34A. Collectively these transects provided 169 equally spaced observations. Based on these interpretations, the averaged depth to bedrock is 1.03 m with a standard deviation of 0.27 m. Interpreted depths to bedrock ranged from about 0.3 to 1.6 m. One-half of the observations had interpreted depths to bedrock between about 0.9 and 1.2 m.

A total of seven transects were conducted in areas that had been mapped as map unit 55B. Collectively these transects provided 159 equally spaced observations. Based on these interpretations, the averaged depth to bedrock is 1.08 m with a standard deviation of 0.37 m. Interpreted depths to bedrock ranged from 0.0 to about 2.0 m. One-half of the observations had interpreted depths to bedrock between about 0.8 and 1.3 m.

A total of fourteen transects were conducted in areas that had been mapped as map unit 136B. Collectively these transects provided 418 equally spaced observations. Based on these interpretations, the averaged depth to bedrock is 1.06 m with a standard deviation of 0.28 m. Interpreted depths to bedrock ranged from about 0.3 to 2.3 m. One-half of the observations had interpreted depths to bedrock between about 0.9 and 1.3 m.

As always, it was my pleasure to work in Maine and with members of your fine staff.

With kind regards,

James A. Doolittle
Research Soil Scientist

cc:
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References:
Daniels, D. J. 1996. Surface-Penetrating Radar. The Institute of Electrical Engineers, London, United Kingdom. 300 p.

Doolittle, J. A. 1987. Using ground-penetrating radar to increase the quality and efficiency of soil surveys. 11-32 pp. In: Reybold, W. U. and G. W. Peterson (eds.) Soil Survey Techniques, Soil Science Society of America. Special Publication No. 20. 98 p.

Morey, R. M. 1974. Continuous subsurface profiling by impulse radar. p. 212-232. *IN:* Proceedings, ASCE Engineering Foundation Conference on Subsurface Exploration for Underground Excavations and Heavy Construction, held at Henniker, New Hampshire. Aug. 11-16, 1974.

Appendix 1.

Depth to bedrock (m) as interpreted from GPR records. Files represent transect numbers. MU represents map units.

File #5	MU 34A
OBS.	DEPTH
1	1.18
2	0.59
3	0.43
4	0.39
5	0.43
6	0.63
7	0.39
8	0.59
9	0.79
10	0.83
11	0.59
12	0.51
13	1.18
14	1.38
15	0.98
16	1.18
17	0.91
18	0.91
19	0.91
20	1.14
21	0.87
22	0.98
23	0.94
24	0.75

File #12	MU 34A
OBS.	DEPTH
1	1.22
2	1.10
3	0.98
4	0.79
5	1.34
6	0.75
7	0.67
8	0.47
9	0.59
10	0.83
11	1.10
12	0.91
13	1.14
14	1.18
15	0.91
16	0.98
17	1.10
18	1.34
19	1.46
20	1.34
21	1.18

File #14	MU 34A
OBS.	DEPTH
1	0.59
2	0.91
3	1.18
4	1.06
5	1.02
6	0.75
7	0.79
8	1.06
9	1.30
10	1.50
11	1.57
12	1.42
13	1.14

File #15	MU 34A
OBS.	DEPTH
1	1.26
2	1.14
3	1.10
4	1.06
5	0.75
6	1.02
7	0.91
8	0.51
9	0.71
10	1.18
11	0.87
12	1.10
13	1.06
14	1.22
15	1.14
16	1.42
17	1.06
18	0.91
19	1.46
20	1.10
21	1.34
22	1.14
23	1.18
24	1.10
25	0.98
26	1.06
27	1.10
28	1.10
29	0.94
30	1.18
31	1.14
32	1.14
33	1.18
34	1.02
35	1.18
36	1.30
37	1.22
38	1.06
39	1.06

File #20	MU 34A
OBS.	DEPTH
1	1.57
2	1.65
3	1.38
4	1.50
5	1.42
6	1.57
7	1.22
8	1.26
9	1.42
10	1.38
11	1.42
12	1.57
13	1.38
14	1.22
15	1.42

File #25	MU 34A
OBS.	DEPTH
1	0.79
2	0.71
3	0.94
4	1.02
5	0.98
6	1.10
7	1.10
8	1.30
9	0.59
10	0.79
11	0.75
12	0.87
13	0.83
14	0.67
15	0.91
16	1.18
17	0.91
18	1.06
19	1.06
20	0.87
21	1.26
22	0.91
23	0.67
24	0.87
25	1.30
26	1.02
27	0.94
28	1.18
29	0.98
30	1.10
31	0.91
32	0.67
33	1.06
34	0.79

Appendix 1.

Depth to bedrock (m) as interpreted from GPR records. Files represent transect numbers. MU represents map units.

File #28 MU 34A

OBS.	DEPTH
1	1.30
2	0.63
3	1.30
4	1.42
5	0.75
6	1.14
7	1.06
8	0.79
9	1.02
10	0.98
11	1.42
12	1.22
13	1.10
14	0.79
15	0.79
16	0.55
17	0.71
18	0.91
19	1.18
20	1.10
21	1.14
22	1.06
23	0.98

File #3 MU 55B

OBS.	DEPTH
1	1.50
2	0.98
3	0.98
4	1.42
5	0.83
6	0.94
7	0.94
8	0.63
9	0.59
10	0.79
11	0.43
12	0.39
13	0.43
14	0.39
15	0.91
16	1.10
17	1.18
18	0.71
19	0.94
20	1.06
21	1.14
22	1.06
23	1.10
24	1.06
25	1.38
26	1.06
27	1.18
28	0.67

File #11 MU 55B

OBS.	DEPTH
1	0.98
2	0.00
3	0.35
4	1.06
5	0.98
6	1.06
7	0.71
8	1.06
9	0.79
10	0.67
11	0.91
12	0.94
13	0.59
14	0.63
15	0.98
16	1.18
17	1.02
18	1.06
19	0.83
20	1.22
21	1.38
22	0.91
23	0.51
24	0.47
25	0.71
26	0.94
27	0.98
28	0.39
29	0.71
30	0.94

FILE #17 MU 55B

OBS.	DEPTH
1	1.06
2	1.14
3	1.30
4	1.54
5	1.38
6	1.06
7	1.02
8	1.10
9	1.34
10	0.98
11	1.18
12	1.34
13	1.26
14	1.18
15	1.61
16	0.83
17	1.61
18	1.34
19	1.42
20	1.46
21	1.30
22	1.50
23	1.50

FILE #19 MU 55B

OBS.	DEPTH
1	1.38
2	1.65
3	1.34
4	1.30
5	1.26
6	1.34
7	1.57
8	1.73
9	1.26
10	1.38
11	1.69
12	1.34
13	1.34
14	1.57
15	1.50
16	1.61
17	1.46
18	1.77
19	1.77
20	1.34
21	1.54
22	1.97
23	1.38
24	1.14
25	1.34

FILE #22 MU 55B

OBS.	DEPTH
1	1.18
2	1.26
3	1.26
4	0.91
5	1.06
6	1.38
7	1.73
8	1.57
9	1.85
10	1.54
11	1.42
12	1.10
13	1.18
14	1.85
15	0.98
16	1.18

Appendix 1.

Depth to bedrock (m) as interpreted from GPR records. Files represent transect numbers. MU represents map units.

FILE #23 MU 55B

OBS.	DEPTH
1	0.98
2	1.46
3	0.91
4	1.54
5	0.79
6	0.59
7	0.91
8	0.63
9	1.06
10	1.26
11	1.18
12	0.39
13	0.79
14	0.67
15	1.10
16	0.79
17	1.18
18	0.79
19	0.71
20	1.26
21	0.87
22	0.51
23	1.06

FILE #26 MU 55B

OBS.	DEPTH
1	1.22
2	0.79
3	1.18
4	0.47
5	0.43
6	0.43
7	0.75
8	1.38
9	1.42
10	0.59
11	0.59
12	0.79
13	0.94
14	0.67

File #1 MU 136B

OBS.	DEPTH
1	1.50
2	1.14
3	1.26
4	0.75
5	0.98
6	1.06
7	0.79
8	0.28
9	1.10
10	1.06
11	1.06
12	0.98
13	1.38
14	0.47
15	0.79
16	1.34
17	1.38
18	1.02
19	1.10
20	0.75
21	0.79
22	0.98
23	0.51
24	0.87
25	1.10
26	1.57
27	0.98
28	1.54
29	1.14
30	1.26
31	1.38
32	1.22
33	1.18
34	1.18
35	1.10
36	0.35
37	0.87
38	1.18
39	0.87
40	0.94
41	1.06
42	1.26
43	1.06
44	1.14
45	0.59
46	1.50
47	1.57
48	1.10
49	1.14
50	1.22
51	1.30

File #2 MU 136B

OBS.	DEPTH
1	1.22
2	1.02
3	0.98
4	0.98
5	1.50
6	1.22
7	1.18
8	1.06
9	0.94
10	0.91
11	0.98
12	1.06
13	1.14
14	1.18
15	1.14
16	0.94
17	0.51
18	1.14
19	1.46
20	1.34
21	1.10
22	1.02
23	0.79
24	0.75
25	0.91
26	0.98
27	1.02
28	0.98
29	0.83
30	0.94
31	1.06
32	0.98
33	0.94
34	0.83
35	1.42
36	0.87
37	0.98
38	1.57

Appendix 1.

Depth to bedrock (m) as interpreted from GPR records. Files represent transect numbers. MU represents map units.

File #4	MU 136B
OBS.	DEPTH
1	0.91
2	1.02
3	0.94
4	1.06
5	1.34
6	1.18
7	1.18
8	1.06
9	1.02
10	1.10
11	0.87
12	0.63
13	1.02
14	0.91
15	1.06
16	0.51
17	0.35
18	0.87
19	1.10
20	0.79
21	0.94
22	0.79
23	1.06
24	0.79
25	1.06
26	0.91
27	0.98
28	1.18
29	0.94
30	0.67
31	0.67
32	0.47
33	0.59
34	0.98
35	1.06
36	1.34
37	1.22
38	1.10
39	0.47
40	0.39
41	0.35
42	0.35
43	0.43
44	0.98
45	0.87
46	0.98
47	0.87
48	0.83
49	0.75
50	0.87
51	0.94

File #6	MU 136B
OBS.	DEPTH
1	1.18
2	1.10
3	0.87
4	1.02
5	1.22
6	1.06
7	0.91
8	1.30
9	0.87
10	0.94
11	1.06
12	1.02
13	0.83
14	1.06
15	0.94
16	0.71
17	0.91
18	0.98
19	0.94

File #7	MU 136B
OBS.	DEPTH
1	1.10
2	0.87
3	0.98
4	0.75
5	0.94
6	0.91
7	0.91
8	1.57
9	1.34
10	0.87
11	0.67
12	0.91
13	0.98
14	1.10
15	0.87

File #8	MU 136B
OBS.	DEPTH
1	0.98
2	0.91
3	0.91
4	1.06
5	1.34
6	1.26
7	0.51
8	1.18
9	0.75
10	0.63
11	0.91
12	1.30
13	0.71
14	0.39
15	0.43
16	0.94
17	0.87
18	0.98

File #9	MU 136B
OBS.	DEPTH
1	0.98
2	0.91
3	0.91
4	1.02
5	0.47
6	1.02
7	0.98
8	1.10
9	0.98
10	0.87
11	1.18
12	0.94
13	0.83
14	1.34
15	1.57
16	0.94
17	1.34
18	0.91
19	0.94

Appendix 1.

Depth to bedrock (m) as interpreted from GPR records. Files represent transect numbers. MU represents map units.

File #13	MU 136B
OBS.	**DEPTH**
1	0.91
2	0.98
3	1.06
4	1.46
5	0.71
6	1.18
7	1.14
8	0.71
9	1.18
10	1.26
11	1.46
12	1.46
13	1.42
14	1.06
15	0.91
16	1.26
17	0.79
18	1.30
19	1.42
20	0.87
21	1.22
22	1.22
23	0.79
24	0.87
25	1.38
26	0.94
27	0.91
28	0.47
29	1.14
30	0.87
31	1.22
32	1.10

File #15	MU 136B
OBS.	**DEPTH**
1	1.22
2	1.14
3	0.51
4	0.94
5	0.75
6	1.02
7	0.94
8	0.43
9	1.02
10	1.10
11	0.94
12	1.14
13	1.06
14	1.18
15	1.14
16	1.50
17	1.42
18	0.94
19	1.50
20	1.30
21	1.42
22	1.18
23	1.18
24	1.18
25	1.30
26	1.10
27	1.38
28	1.06
29	1.02
30	0.87
31	1.30
32	1.06
33	1.50
34	1.30
35	0.98
36	1.10
37	1.06
38	1.06
39	1.10
40	1.18
41	1.50
42	1.57
43	2.01
44	2.24
45	1.42
46	1.46
47	1.42
48	1.06
49	1.10
50	1.30
51	1.30
52	1.18
53	1.10

File #16	MU 136B
OBS.	**DEPTH**
1	1.30
2	1.57
3	1.30
4	1.50
5	1.42
6	1.46
7	1.38
8	1.30
9	1.26
10	0.87

File #18	MU 136B
OBS.	**DEPTH**
1	0.98
2	1.57
3	1.50
4	1.42
5	1.42
6	1.26
7	1.30
8	1.42
9	1.18
10	1.42
11	1.42
12	1.18
13	1.46
14	1.46
15	1.26
16	1.34
17	1.18
18	1.46
19	1.46
20	1.42
21	1.34
22	1.54
23	1.46
24	1.22

Appendix 1.

Depth to bedrock (m) as interpreted from GPR records. Files represent transect numbers. MU represents map units.

File #21	MU 136B
OBS.	DEPTH
1	1.46
2	1.38
3	0.67
4	1.26
5	1.18
6	1.22
7	1.18
8	1.34
9	1.10
10	1.22
11	1.50
12	1.57
13	1.22
14	1.38
15	1.54
16	1.18
17	1.26

File #24	MU 136B
OBS.	DEPTH
1	0.59
2	1.18
3	0.79
4	0.87
5	1.10
6	0.75
7	0.91
8	0.91
9	0.91
10	0.67
11	0.71
12	0.67
13	0.39

File #27	MU 136B
OBS.	DEPTH
1	0.91
2	0.91
3	1.34
4	0.75
5	0.79
6	0.98
7	0.71
8	0.98
9	2.32
10	0.83
11	1.73
12	1.14
13	0.87
14	0.79
15	1.18
16	1.57
17	0.75
18	0.83
19	1.18
20	1.30
21	0.79
22	1.46
23	0.79
24	0.71
25	1.69
26	0.59
27	0.79
28	0.43
29	0.71
30	0.94

Appendix 2.

Tabulation of GPR data by soil depth classes for each transect (File #) and map unit (MU).

File #5 MU 34A

Depth Class	Obs.	Frequency
Shallow	4	0.17
Mod-Deep	15	0.63
Deep	5	0.21
Very Deep	0	0.00

File #12 MU 34A

Depth Class	Obs.	Frequency
Shallow	1	0.05
Mod-Deep	9	0.43
Deep	11	0.52
Very Deep	0	0.00

File #14 MU 34A

Depth Class	Obs.	Frequency
Shallow	0	0.00
Mod-Deep	4	0.31
Deep	8	0.62
Very Deep	1	0.08

File #15 MU 34A

Depth Class	Obs.	Frequency
Shallow	0	0.00
Mod-Deep	8	0.21
Deep	31	0.79
Very Deep	0	0.00

File #20 MU 34A

Depth Class	Obs.	Frequency
Shallow	0	0.00
Mod-Deep	0	0.00
Deep	8	0.67
Very Deep	4	0.33

File #25 MU 34A

Depth Class	Obs.	Frequency
Shallow	0	0.00
Mod-Deep	21	0.62
Deep	13	0.38
Very Deep	0	0.00

File #28 MU 34A

Depth Class	Obs.	Frequency
Shallow	0	0.00
Mod-Deep	10	0.43
Deep	13	0.57
Very Deep	0	0.00

File #3 MU 55B

Depth Class	Obs.	Frequency
Shallow	4	0.14
Mod-Deep	12	0.43
Deep	12	0.43
Very Deep	0	0.00

File #11 MU 55B

Depth Class	Obs.	Frequency
Outcrop	1	0.03
Shallow	3	0.10
Mod-Deep	18	0.60
Deep	8	0.27
Very Deep	0	0.00

FILE #17 MU 55B

Depth Class	Obs.	Frequency
Shallow	0	0.00
Mod-Deep	2	0.09
Deep	18	0.78
Very Deep	3	0.13

FILE #19 MU 55B

Depth Class	Obs.	Frequency
Shallow	0	0.00
Mod-Deep	0	0.00
Deep	15	0.60
Very Deep	10	0.40

FILE #22 MU 55B

Depth Class	Obs.	Frequency
Shallow	0	0.00
Mod-Deep	2	0.13
Deep	9	0.56
Very Deep	5	0.31

FILE #23 MU 55B

Depth Class	Obs.	Frequency
Shallow	1	0.04
Mod-Deep	13	0.57
Deep	8	0.35
Very Deep	1	0.04

FILE #26 MU 55B

Depth Class	Obs.	Frequency
Shallow	3	0.21
Mod-Deep	7	0.50
Deep	4	0.29
Very Deep	0	0.00

Appendix 2.
Tabulation of GPR data by soil depth classes for each transect (File #) and map unit (MU).

File #1 MU 136B

Depth Class	Obs.	Frequency
Shallow	3	0.06
Mod-Deep	15	0.29
Deep	30	0.59
Very Deep	3	0.06

File #2 MU 136B

Depth Class	Obs.	Frequency
Shallow	0	0.00
Mod-Deep	19	0.50
Deep	18	0.47
Very Deep	1	0.03

File #4 MU 136B

Depth Class	Obs.	Frequency
Shallow		0.14
Mod-Deep	26	0.51
Deep	18	0.35
Very Deep	0	0.00

File #6 MU 136B

Depth Class	Obs.	Frequency
Shallow	0	0.00
Mod-Deep	10	0.53
Deep	9	0.47
Very Deep	0	0.00

File #7 MU 136B

Depth Class	Obs.	Frequency
Shallow	0	0.00
Mod-Deep	10	0.71
Deep	3	0.21
Very Deep	1	0.07

File #8 MU 136B

Depth Class	Obs.	Frequency
Shallow	2	0.11
Mod-Deep	11	0.61
Deep	5	0.28
Very Deep	0	0.00

File #9 MU 136B

Depth Class	Obs.	Frequency
Shallow	1	0.05
Mod-Deep	11	0.58
Deep	6	0.32
Very Deep	1	0.05

File #10 MU 136B

Depth Class	Obs.	Frequency
Shallow	0	0.00
Mod-Deep	12	0.43
Deep	14	0.50
Very Deep	2	0.07

File #13 MU 136B

Depth Class	Obs.	Frequency
Shallow	1	0.03
Mod-Deep	12	0.38
Deep	19	0.59
Very Deep	0	0.00

File #15 MU 136B

Depth Class	Obs.	Frequency
Shallow	1	0.02
Mod-Deep	8	0.15
Deep	41	0.77
Very Deep	3	0.06

File #16 MU 136B

Depth Class	Obs.	Frequency
Shallow	0	0.00
Mod-Deep	1	0.10
Deep	8	0.80
Very Deep	1	0.10

File #18 MU 136B

Depth Class	Obs.	Frequency
Shallow	0	0.00
Mod-Deep	1	0.04
Deep	21	0.88
Very Deep	2	0.08

File #21 MU 136B

Depth Class	Obs.	Frequency
Shallow	0	0.00
Mod-Deep	1	0.06
Deep	14	0.82
Very Deep	2	0.12

File #24 MU 136B

Depth Class	Obs.	Frequency
Shallow	1	0.08
Mod-Deep	10	0.77
Deep	2	0.15
Very Deep	0	0.00

File #27 MU 136B

Depth Class	Obs.	Frequency
Shallow 1	0.03	
Mod-Deep	19	0.63
Deep 6	0.20	
Very Deep	4	0.13