United States Department of Agriculture

Soil Conservation Service

Northeast NTC
160 East 7th Street
Chester, PA 19013

Subject: Ground-penetrating Radar Field Study, Hancock County, Maine

Date: May 16, 1988

To: Rodney F. Harner
National Leader
National Soil Survey Quality Assurance Staff
Soil Conservation Service
Midwest National Technical Service Center
Federal Building, Room 345
100 Centennial Mall North
Lincoln, NE 68508-3866

File code: 430-13

Purpose:

To compare the relative precision of conventional soil surveying tools with the ground-penetrating radar (GPR) for determining the depth to bedrock in areas of moderately coarse textured tills. Also, to obtain field data needed to construct computer generated diagrams of the depth to bedrock and to evaluate soil-landscape relationships in areas of Caribou soils.

Participants:

James A. Doolittle, Soil Specialist (GPR), SCS, Chester, PA
Dennis J. Lytle, Ass't. State Soil Scientist, SCS, Orono, ME
Keith O. Roble, Ag. Engineer, SCS, Presque Isle, ME
Robert V. Rourke, Senior Soil Scientist, U of Maine, Orono, ME
Daniel G. Schmidt, District Conservationist, SCS, Ellsworth, ME

Activities:

Arrangements had been made with the U.S. Geological Survey to use two 80 MHz antennas. These antennas are arranged in a bistatic mode and have high powered transmitter and receiver. These antennas were assembled and loaded into my vehicle at the USGS Water Research Office in Hartford, Connecticut on 29 April 1988.

GPR field studies were conducted in North Penobscot on 2 and 3 May 1988 and in Presque Isle on 4 and 5 May 1988. The USGS's antennas were returned to Hartford on 6 May 1988.

Discussion:

North Penobscot

A 300 foot transect line with observation flags spaced at 5 foot intervals was established in a cultivated field in North Penobscot, Maine. The field had been the site of an earlier bedrock study with the

GPR (see my trip report to Ronald E. Hendricks of 15 July 1986). A GPR survey was conducted along the transect line using the 120 MHz antenna and the 705 DA transceiver. The two-way scanning time was set at 55 and 110 nanoseconds, which, assuming a velocity of propagation of 0.24 ft/ns, provided a scanning depth of 6.6 and 13.2 feet.

A screw auger was used to determine the depth to bedrock at every other observation flag (10 foot interval; 31 observations). A back-hoe was used to excavate a 300 foot long trench down to bedrock along the transect line. The depth to bedrock at the first observation site (0.0 feet) was used to scale the radar imagery.

Table 1 compares the results obtained with thew Back-hoe (ground-truth), screw-auger, and GPR. The GPR is more precise than conventional surveying tools for determining the depth to bedrock in areas of moderately coarse textured tills. The average difference in depth to bedrock measurements between the scaled radar imagery and the ground-truth measurements was 2.4 inches. Sixty-four percent of the scaled radar imagery was within 0 to 2 inches of the actual depth to bedrock. Eighty-seven percent of the scaled radar imagery was within 0 to 4 inches of the actual depth to bedrock.

The average difference in depth to bedrock measurements between the screw-auger and the ground-truth measurements was 30.1 inches. Only seven percent of the screw-auger measurements were within 6 inches of the actual depth to bedrock. Sixty-eight percent of the screw-auger measurements varied by more than 10 inches from the actual depth to bedrock.

Data from this study will be incorporated into an article which is being prepared on using the GPR to determine the depth to bedrock.

Presque Isle

The Caribou series (fine-loamy, mixed, frigid Typic Haplorthods) is deeper to bedrock and has more clay and soluble salts in the lower part of its profile than the soils at the North Penobscot site (Lyman and Tunbridge series). Areas of Caribou soils are more conductive, attenuating, and depth restricting to the radar signals.

Field studies were conducted to determine the most suitable antenna for the investigation of Caribou soils. The 80 and 120 MHz antennas with the 705DA and 705DA2 transceivers were used. The 120 MHz antenna with the 705DA transceiver provided the best balance of probing depth and resolution of subsurface features. In an attempt to eliminate background noise at high gain settings, the 80 MHz was towed at variable distances behind the 4WD vehicle. Towing the antenna at distances of 10 and 100 feet behind the vehicle made little difference in the levels of background noise recorded on the graphic profiles. It was concluded that the present arrangement of towing the 80 MHz antenna at a distance of 10 feet behind the vehicle does not significantly influence the levels of background noise, is more maneuverable, and will be continued.

The USGS's dual 80 MHz antennas were found to be incompatible with our control unit and the evaluation of these units were terminated without a statement on this equipments effectiveness for soil survey operations.

All data has been turn over to Dr. Mary Collins of the University of Florida for the construction of two-dimensional contour plots and three-dimensional block diagrams of the depth to bedrock in the surveyed area of Caribou soils.

James A. Doolittle
Soil Specialist (GPR)

cc: Mary Collins, Assoc. Prof., U of Florida, Gainesville, FL
Earling Gamble, Soil Scientist, SCS, NSSQAS, Lincoln, NE
Dennis Lytle, Ass't. State Soil Scientist, SCS, Orono, ME
Robert Rourke, Senior Soil Scientist, U of Maine, Orono, ME

TABLE 1

PRECISION OF SOIL SURVEYING TOOLS FOR DETERMINING THE DEPTH TO BEDROCK

Observation Site	Relative Elev. (ft)	Depth to Bedrock Backhoe (inches)	Depth to Bedrock Screw-auger (inches)	Depth to Bedrock Radar (inches)
0	0.0	89	28	91
5		89		84
10	0.37	44	32	44
15		66		69
20	0.15	68	23	64
25		74		73
30	0.29	75	35	62
35		45		42
40	0.27	38	37	40
45		42		43
50	0.17	41	38	40
55		40		41
60	0.43	52	30	48
65		45		43
70	0.41	48	25	40
75		40		39
80	0.51	43	23	42
85		42		43
90	0.61	50	15	45
95		47		46
100	0.63	48	25	47
105		51		47
110	0.69	49	37	49
115		57		54
120	0.75	51	35	48
125		56		56
130	0.85	63	26	60
135		63		63
140	0.89	68	37	65
145		65		65
150	1.01	60	25	61
155		54		55
160	0.91	54	25	55
165		56		56
170	0.91	51	28	49
175		47		48
180	0.91	42	24	42
185		38		39
190	0.81	35	29	36
195		36		40
200	0.75	33	27	35
205		39		40
210	0.77	40	28	41

Observation Site	Relative Elev. (ft)	Depth to Bedrock Backhoe (inches)	Screw-auger	Radar
215		36		36
220	0.51	40	26	39
225		44		44
230	0.35	53	29	54
235		57		60
240	0.25	71	26	66
245		53		56
250	0.31	68	24	66
255		86		84
260	0.05	81	24	85
265		88		89
270	0.11	94	26	98
275		85		95
280	0.17	87	33	96
285		87		93
290	0.25	88	25	88
295		93		93
300	0.35	89	34	90