Jim Doolittle file

United States Department of Agriculture
Soil Conservation Service **Chester, PA 19013**

Subject: Ground-Penetrating Radar (GPR) studies in Rhode Island and Plymouth County, Massachusetts 4 to 7 April 1993.

Date: 12 April 1993

To: Richard Scanu
State Soil Scientist
USDA-Conservation Service
Amherst, Massachusetts

Purpose:
To conduct soil research and investigation projects using ground-penetrating radar.

Participants:
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Jim Doolittle, Soil Specialist, SCS, Chester, PA
Peter Fletcher, Soil Scientist Project Leader, SCS, Middleboro, MA
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Kipen Kolesinskas, State Soil Scientist, SCS, Storrs, CT
Sytze Van Heteren, Geologist, Boston University, Boston, MA
Dick Hutchins, IRM Staff, SCS, NENTC, Chester, PA
Everett Stuart, Assistant State Soil Scientist, SCS, Warwick, RI
Jim Turenne, Soil Scientist, SCS, Middleboro, MA

Activities:
On 5 April, several areas within a silt mantled outwash plain were examined with GPR at locations on the campus of the University of Rhode Island and near the village of Slocum, Rhode Island. The purpose of these surveys was to detect buried ice wedge casts and kettles. On 6 April, a cranberry bog in Coventry, Rhode Island was surveyed. The purpose of this study was to determine the depth, volume, and subsurface topography of the peat in preparation for leveling. On 7 April, water table studies were conducted within Myles Standish State Forest, Plymouth, Massachusetts with the 500 and 120 mHz antennas. On 8 April, several areas of water-reworked till or "flow till" were profiled with GPR.

Equipment:
The radar units used in this study were the Subsurface Interface Radar (SIR) System-8 manufactured by Geophysical Survey Systems, Inc. The system was powered by a 12-volt vehicular battery. A Model 38 video display unit with a SONY Model TCD-D3 digital tape-corder was used. The models 3110 (120 mHz) and 3105 (500 mHz) antennas were used in the field studies. Model 3110 (120 mHz) and 3102 (500 mHz) antennas were used in the field studies reported in this paper. The Model 705DA transceiver was used with the Model 3110 antenna.

Discussion:

Detection of buried ice wedge casts and kettles

A 30 by 30 meter grid was established across a site on a silt mantled outwash plain containing a buried kettle. The grid interval was 3 m. The purpose of this study was to chart variations in the depth to a lithologic discontinuity and to assess directions of subsurface water flows. This information will be used in a paper being prepared for the Second Government User Workshop on GPR which will be held at Ohio State University in October 26 to 28, 1993.

The study sites was located in an areas of Enfield silt loam, 0 to 3 percent slopes (EfA). Enfield is a member of the coarse-silty over sandy or sandy-skeletal, mixed, mesic Typic Dystrochrepts family. Included with this soil in mapping are small areas of Bridgehampton soils. Bridgehampton is a member of the coarse-silty, mixed, mesic Typic Dystrochrepts family.

With a scanning time of 80 nanoseconds (ns), a 500 mHz antenna was used to profile the subsurface to an observation depth of about 2.25 m. The velocity of propagation was calculated at 0.20 ft/ns.

Figure 1 is a representative radar profile from the study site. The horizontal and vertical scales are in meters and measure distances along the transect line and depths, respectively. The interface separating the coarse-silty eolian mantle from the sandy outwash provides a distinct reflection across the profile. Small breaks in this interface (see A in Figure 1) may represent ice wedge cast and avenues for preferential flow. Often, these breaks have small, narrow, v-shaped openings, which overlie multiple, superimposed reflected signals.

In Figure 1, within the eolian mantle, a subsurface interface is distinguishable. This interface may represent the Bw horizon. In Figure 1, a distinct depression, possibly a small, buried kettle, is evident between observation points 9 and 12.

Traverses were conducted with the 500 mHz antenna along east-west trending grid lines. At each grid intersect (121), the depth to outwash and the thickness of the eolian silt mantle were estimated from the radar profiles. Data were used to construct two-dimensional plots of the soil surface (Figure 2, upper) and the depth to outwash deposits (Figure 2, lower). It is evident from this figure that the location of the buried kettle and included area of Bridgehampton soils have been masked by the eolian mantle and are not readily apparent or manifested in the topography.

Three-dimensional surface nets of the soil surface (Figure 3, upper) and the depth to outwash deposits (Figure 3, lower) were also constructed from the data collected at this site. These figures represent alternative approaches for displaying the data.

Within the 900 square meter study site, 15% (138 square meters) of the area was Bridgehampton soil and 85 % (762 square meters) was

Enfield. Areas of Bridgehampton soils were located within the silt mantled kettle.

Survey of Cranberry Bog
The cranberry bog was located in an area of Adrian muck (Aa) in Coventry, Rhode Island. Adrian soil is a member of the sandy-skeletal, mixed, mesic Terric Medisaprists family. The bog was irregular in shape with maximum dimensions of 1650 and 660 feet. A fifty foot interval was used in the construction of the grid. A 120 mHz antenna was used in this investigation. Verification of the depth to mineral soil materials was confirmed at six observation sites with a soil auger. Depth to mineral soil materials will be estimated from the radar profiles and charted in a two-dimensional contour plot by Jim Turenne.

Water Table Study.
A 30 meter transect line with observation flags placed in the ground at 3.0 m intervals was established across the boundary of two map units: Carver coarse sand, 3 to 8 percent slopes (M.U. 252), and Deerfield loamy coarse sands, 0 to 3 percent slopes (M.U. 256) in Plymouth County. Carver is a member of the mesic, uncoated, Typic Quartzipsamments and Deerfield is a member of the mixed, mesic Aquic Udipsamments family. The purpose of this investigation was to compare the interpretability of radar profiles charted with the 500 and 120 mHz antennas.

Radar profiles obtained with the 500 mHz and 120 mHz antennas are displayed in figures 4 and 5, respectively. In these coarse textured soils, both antennas were able to obtain reflections from observation depths of about 5.5 m. The 500 mHz antenna provides superior resolution of subsurface features. More subsurface features and strata were evident on radar profiles collected with the 500 mHz antenna than on those collected with the 120 mHz antenna. However, on radar profiles collected with the 500 mHz antenna (see Figure 4), the image of the water table is indistinct and partially masked by strata. In comparison, images of the water table and major subsurface strata are more distinct and interpretable on profiles obtained with the 120 mHz antenna. The 120 mHz antenna appears to be a more suitable antenna for water table investigations.

Flow till
Ground-penetrating radar transects confirmed the complexity of soils and subsurface strata in areas underlain by moderately-coarse textured "flow till" and coarse-textured outwash. This generalization about a unique landscape is significant in itself.

In areas of flow till, though numerous subsurface strata were detected with GPR, the identity of individual stratum was difficult to decipher from radar profiles alone. In some areas, the occurrence of reflections from foreset beds were used to identify outwash deposits. However, in areas lacking buried foreset beds, distinction of flow till from outwash was ambiguous. In many area, without substantial probings, the identification of subsurface layers and the separation of flow-till and outwash was difficult to unravel through GPR interpretations alone.

With kind regards

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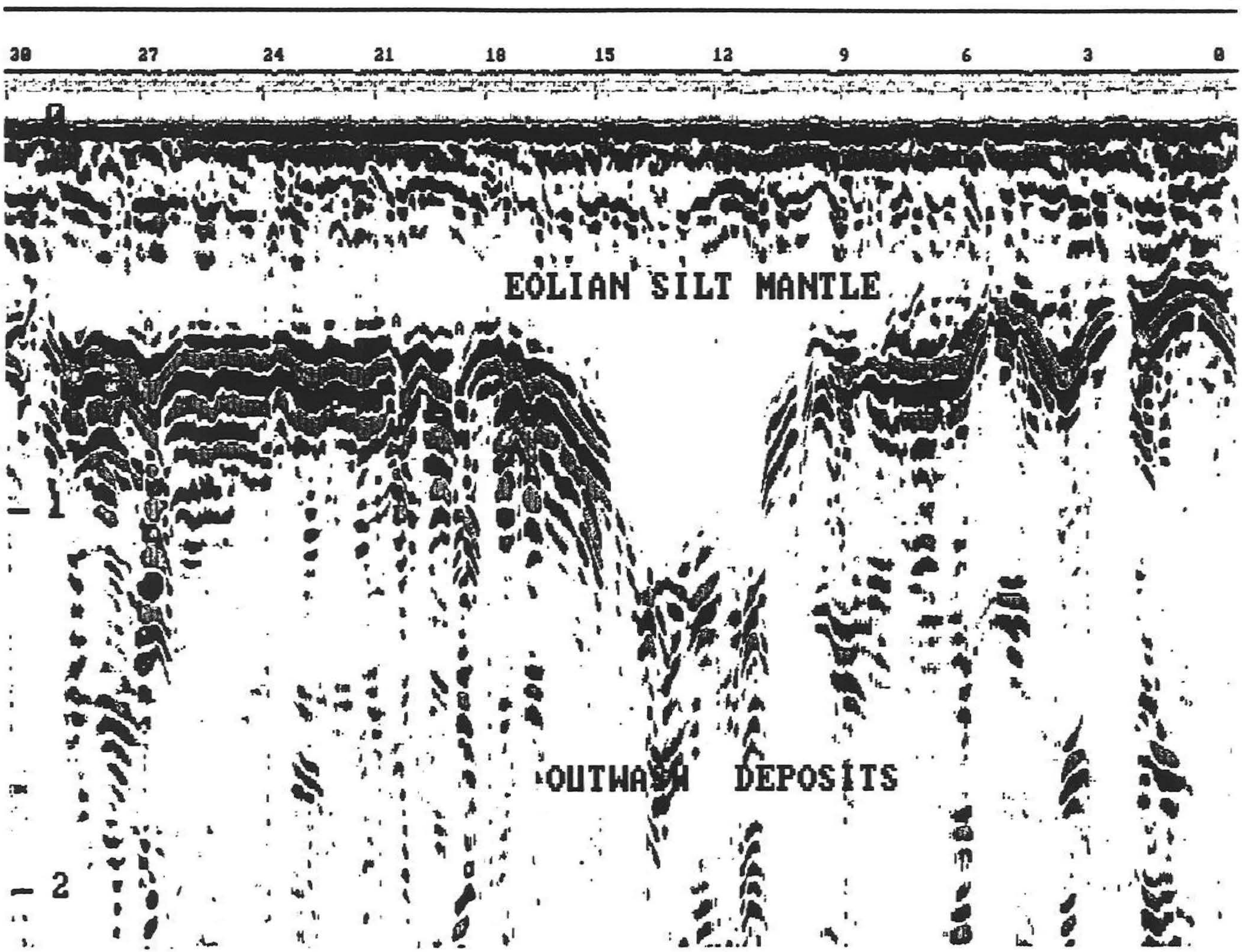
30
27
24
21
18
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6
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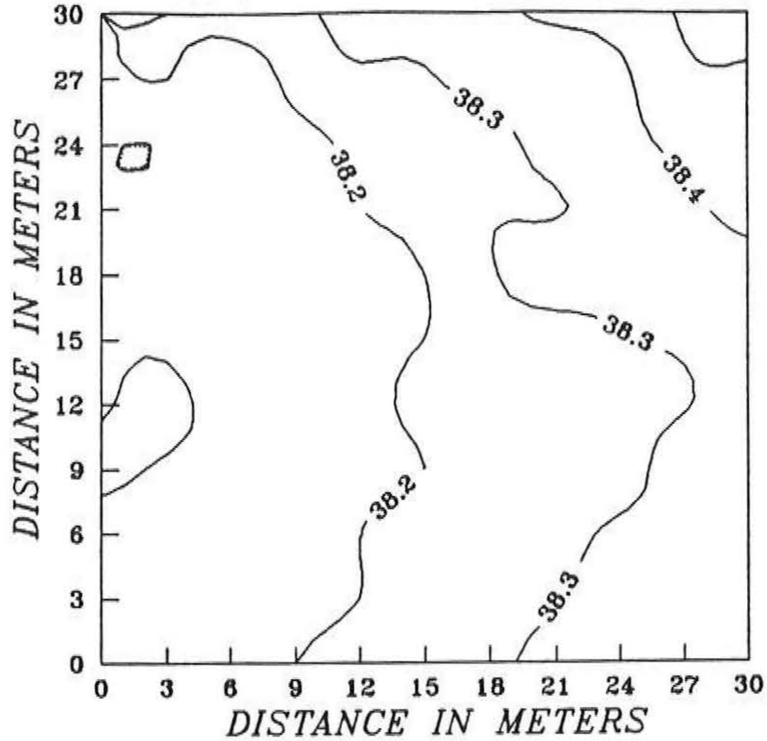
EOLIAN SILT MANTLE
1
OUTWASH DEPOSITS
2

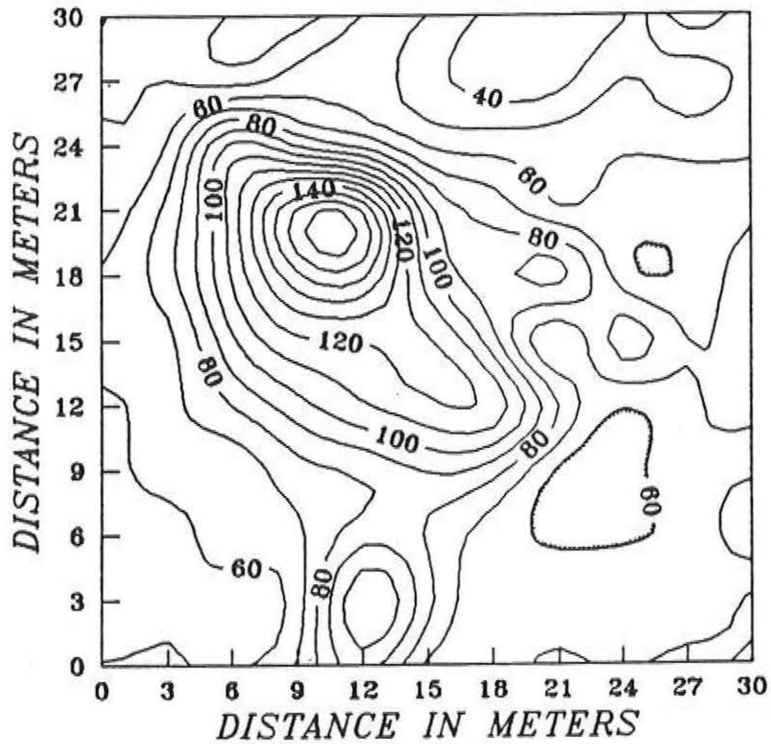
TOPOGRAPHY

CONTOUR INTERVAL = 10 CM



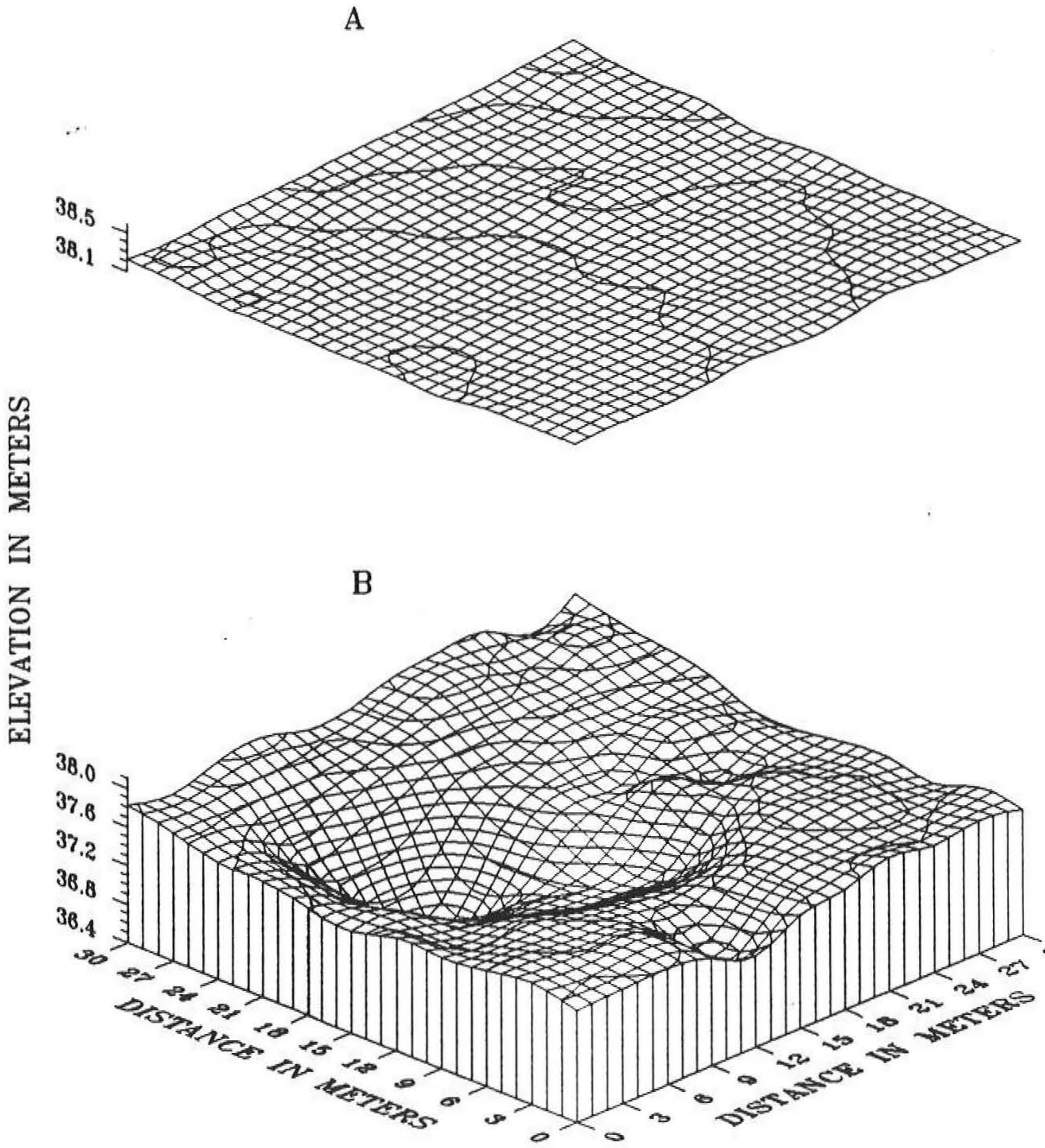
DEPTH TO OUTWASH DEPOSITS

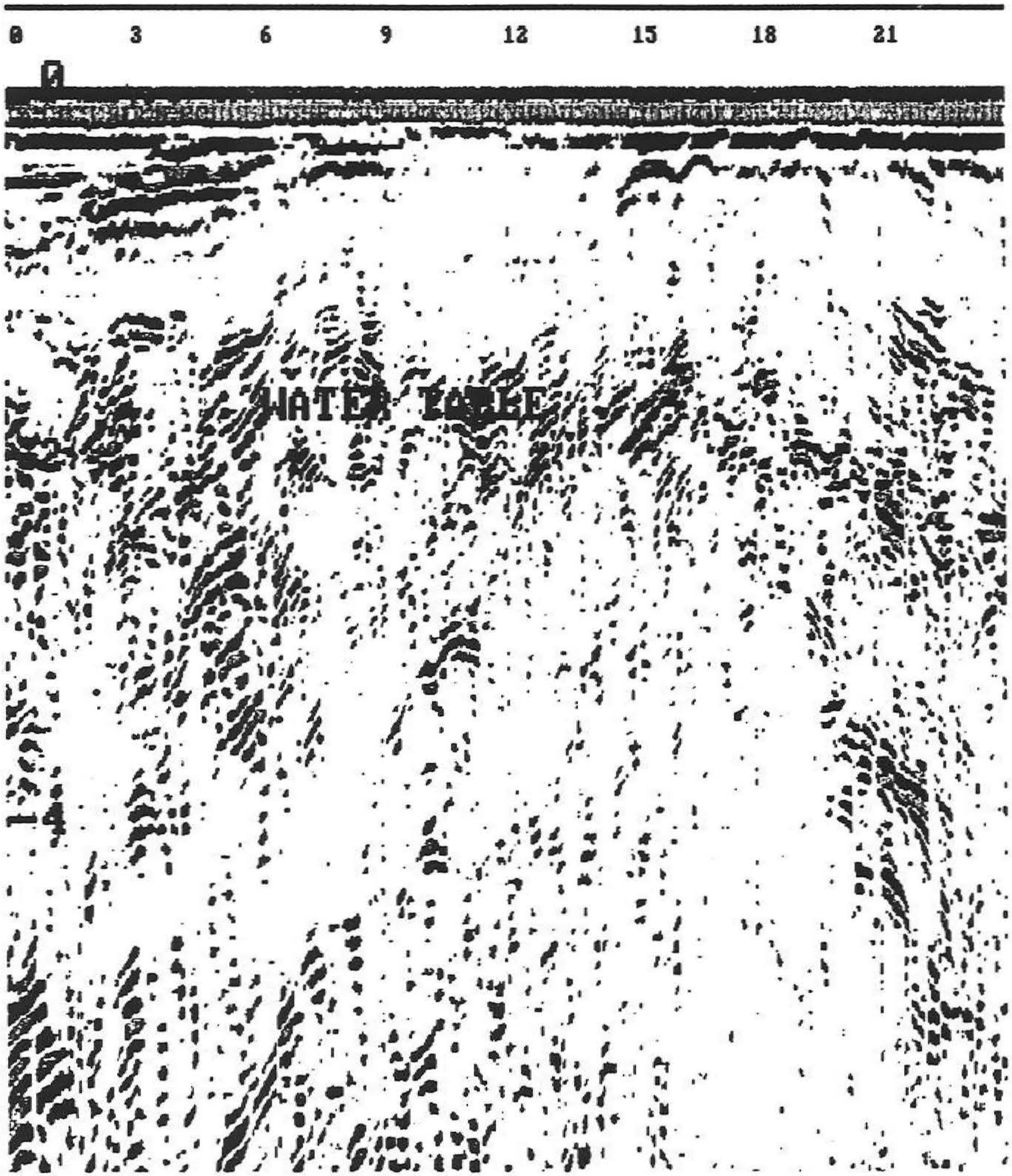
CONTOUR INTERVAL = 10 CM



SILT MANTLED KETTLE ON OUTWASH PLAIN

CONTOUR INTERVAL = 10 CM





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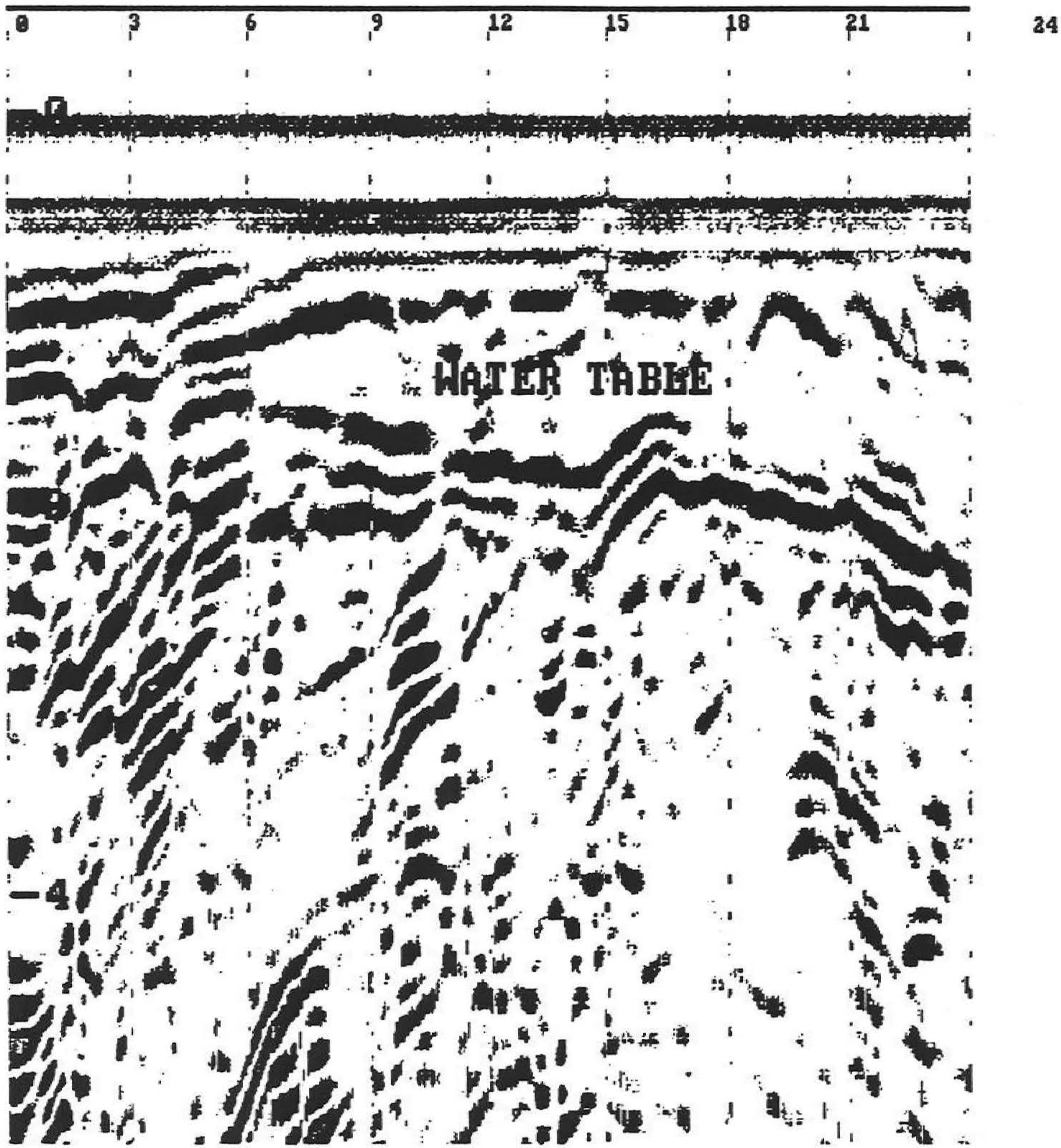
WATER TABLE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WATER TABLE