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# 400 MHz GROUND-PENETRATING RADAR, ITKILLIK RIVER, NORTH SLOPE, ALASKA

by

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## INTRODUCTION

During July 2001 DGGS and U.S. Army Cold Regions Research & Engineering Laboratory (USACRREL) personnel conducted a ground-penetrating radar (GPR) study of point bar deposits on the Itkillik River in the foothills of the central Brooks Range, Alaska. The objective of the study was to delineate the internal architecture of a point bar and compare it to published descriptions of sandy-bar deposits in other fluvial systems. A second goal of the exercise was to demonstrate that the GPR technique is a useful tool for visualization of shallow active sedimentation. The unprocessed data revealed apparent sloping accretionary and scour-and-fill geometries that change with relation to stream-flow direction.

The Itkillik River flows northward from its source in the central Brooks Range to the Arctic Ocean. Unlike most North Slope braided streams, which are deposits of gravel and cobble-dominated reworked outwash, the Itkillik alluvium consists of sandy deposits of late Pleistocene Itkillik glaciation. The sandy point bar chosen for the study is on the west side of the river approximately five miles north of the river's emergence at the mountain front, near Itkillik Lake (68.48°N, 149.97°W). The bar sediments consist of sand and gravel predominantly smaller than 2 cm. The westernmost portion of the bar is lightly vegetated with willows and is very slightly elevated, less than 0.5 m above the rest of the bar. Dunes less than 0.5 m in amplitude and ripples less than 0.1 m in amplitude, which probably formed during flood stage when the entire bar was submerged, were seen within fine-grained sand on the brushy western part of the bar. To the north, large vegetated dunes greater than 5 m in amplitude were seen on the west bank of the river.

## METHODS

A GPR survey grid was established on the nonvegetated sandy portion the bar (fig. 1). Three grid transects 80 to 115 m long and spaced 30 m apart were oriented roughly parallel to the river. Five perpendicular transects 40 to 60 m long were spaced 20 meters apart and ended abruptly at the water's edge. All eight lines were profiled using a 400 MHz transducer and GSSI System 2000 provided by USACRREL (fig. 2). Data collection with a time range of 100 nanoseconds corresponded to a total pulse penetration depth of approximately 6 m. GPR instrumentation, data collection guidance, and data processing were provided by USACRREL.

## RESULTS

All profiles displayed a very strong, continuous horizon at about 3 m depth, below which only few very faint reflections are visible. The three profiles oriented parallel to the river are dominated by near-horizontal, parallel reflections with only slight undulations. A shallow, near-horizontal reflection on lines 6 and 7 rises gently toward the surface at the south end of the lines, where the transects approached the river bank. A similar, gently west-dipping horizon on the five perpendicular profiles rises to the surface at the river's edge. All five profiles oriented perpendicular to the river show east-dipping horizons that often join or terminate against other dipping reflectors. Lenticular-shaped reflection patterns 1 to 2 m wide are also visible.

The continuous, near-horizontal horizon apparent on all profiles is interpreted to be the contact between older (Pleistocene) coarse outwash deposits below and finer-grained younger (Holocene) reworked outwash deposits above. At only 3 m depth, the horizon is too shallow to represent bedrock and is unlikely to be the top of permafrost, which would be depressed or absent beneath the river.

The near-surface horizons that gently rise to meet the river water level probably represent the shallow ground-water table. This horizon, and most reflectors beneath it, is interrupted on the southwestern portion of the grid area, most likely due to vegetative disturbance of layers.

The most striking features on the profiles are the undulating horizons and the lenticular bedforms. These probably represent minor scour hollows cut into underlying bar sediments, characteristic of scour-and-fill processes during flood events. These are more evident on the east-west trending profiles, suggesting that scour long axes are oriented parallel to the mean flow direction of the river. The east-dipping reflections are interpreted to be lateral accretion surfaces typical of migrating point-bar deposits, and indicate eastward bar progradation. Low-relief accretion surfaces such as these are typically associated with shallow channels.

The GPR technique was extremely effective for this application. Data collection along the 7-line grid took only about 8 man-hours. Only minor processing of the records was necessary. The horizontal scales were normalized and a bandpass filter (100-700 MHz) was applied. Most interpretation was accomplished using the unprocessed files, as signal penetration was adequate to distinguish between active point-bar sediment packages. The internal geometries of the bar revealed in the radar reflections are useful for illustrating the reservoir-scale structure of a modern fluvial sand body.

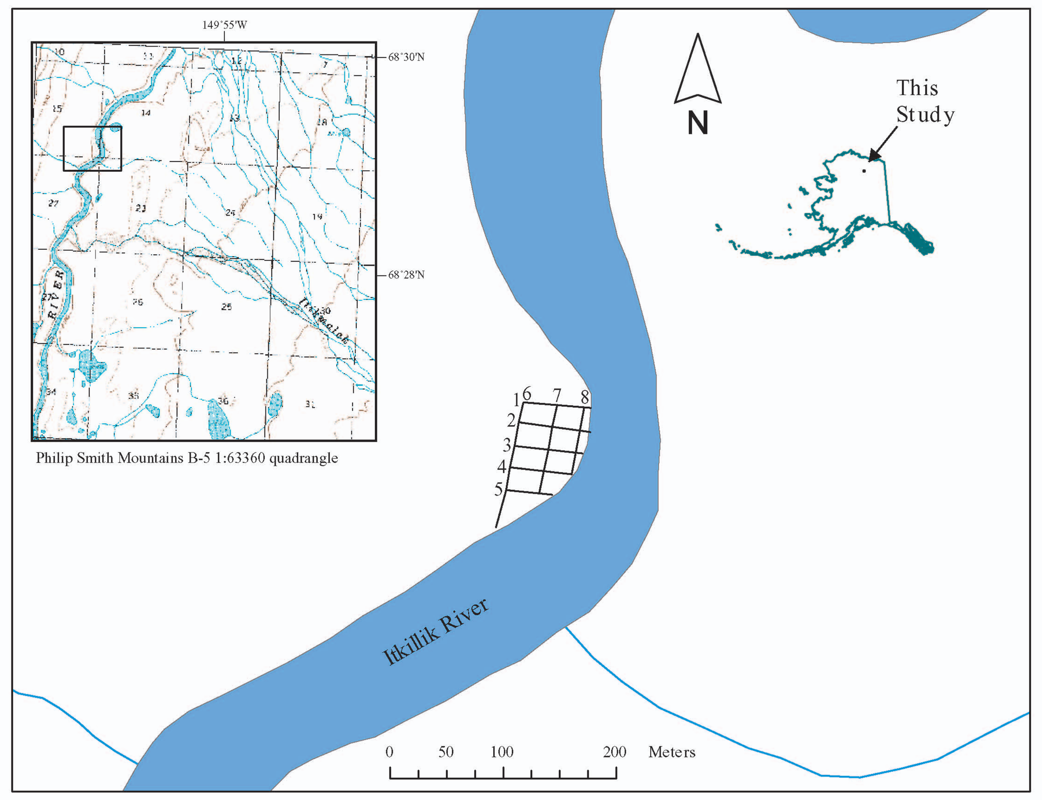



Figure 1. *Sandbar GPR grid location and layout.*

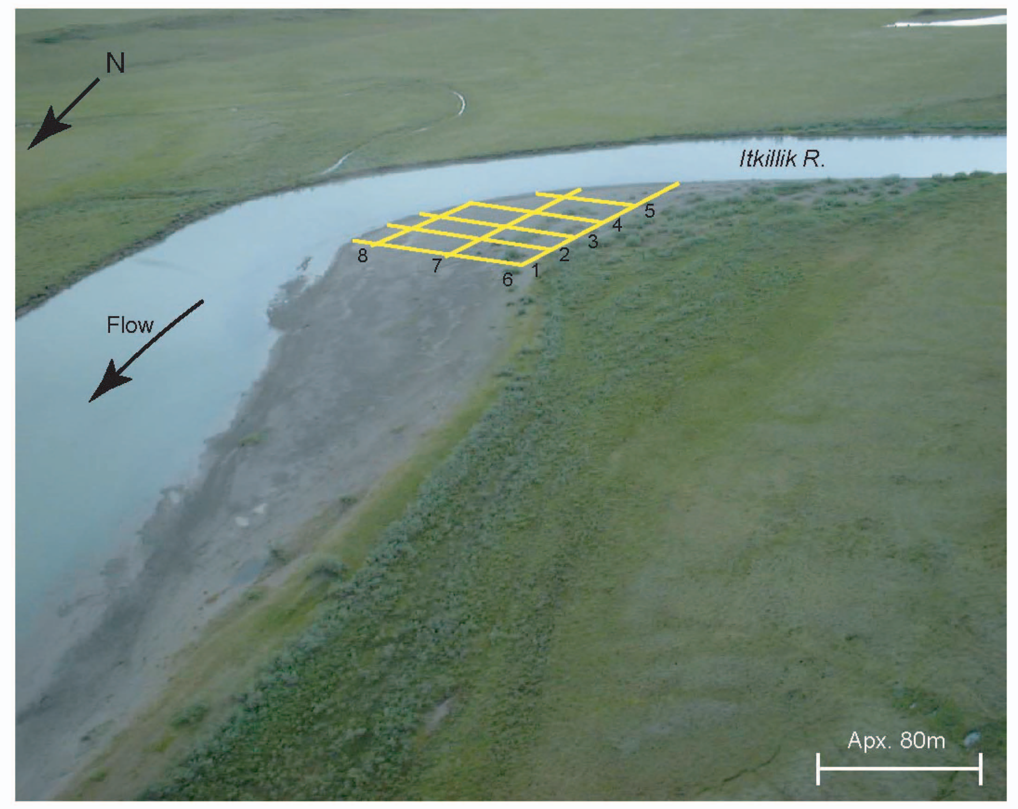
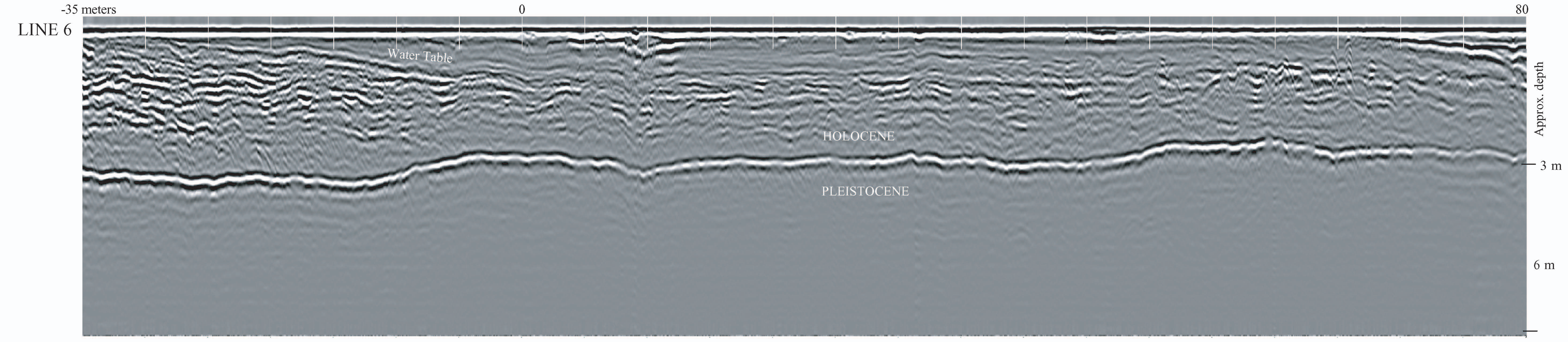


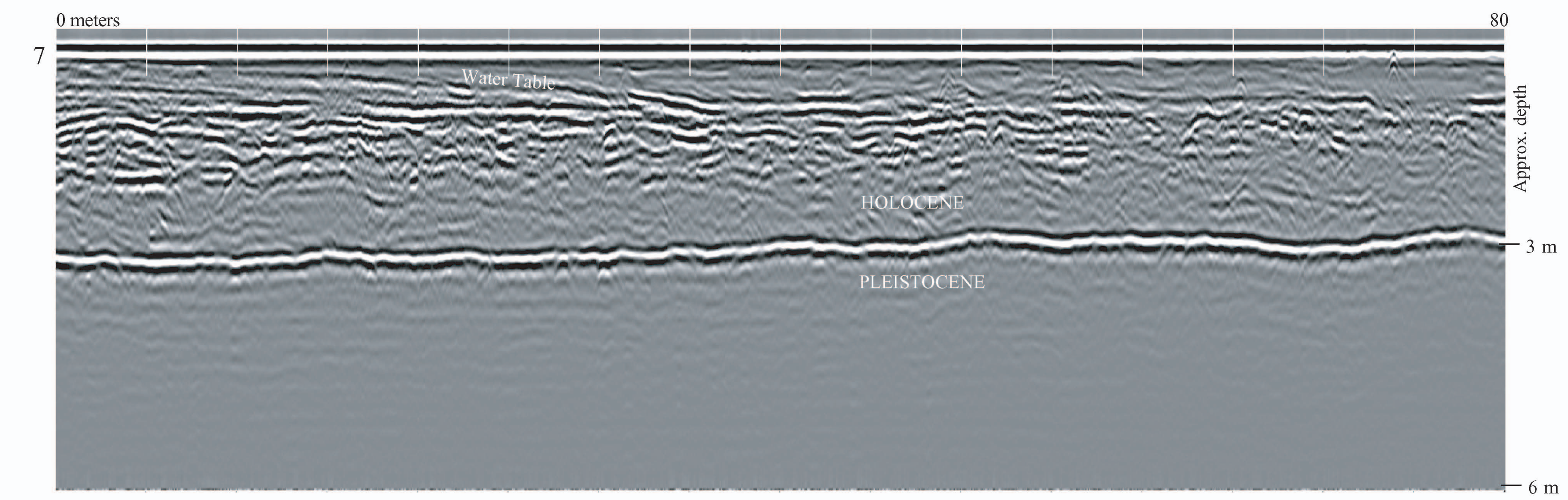

Figure 2. *View southeast of sandbar showing location of GPR grid.*

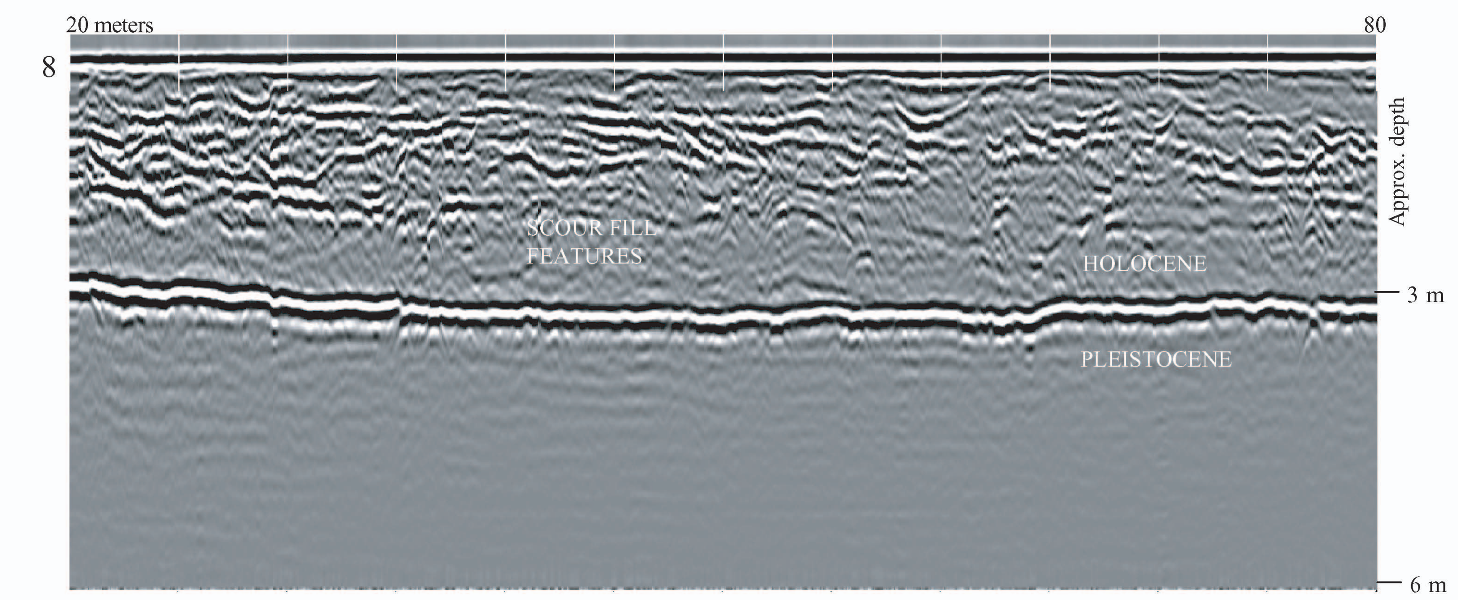
Figure 3. *Operation of the GSSI System 2000 and 400 MHz transducer (right).*

Figure 4. *Northward view of sandbar location.*

SOUTH NORTH

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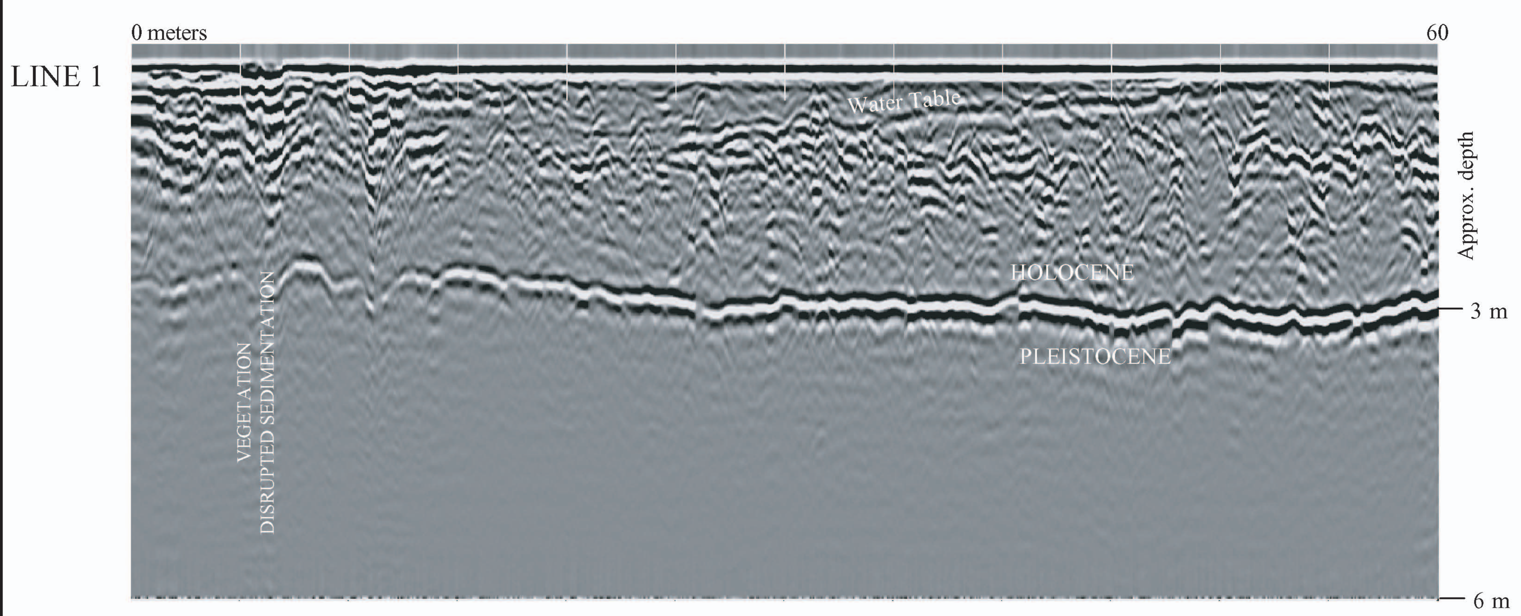


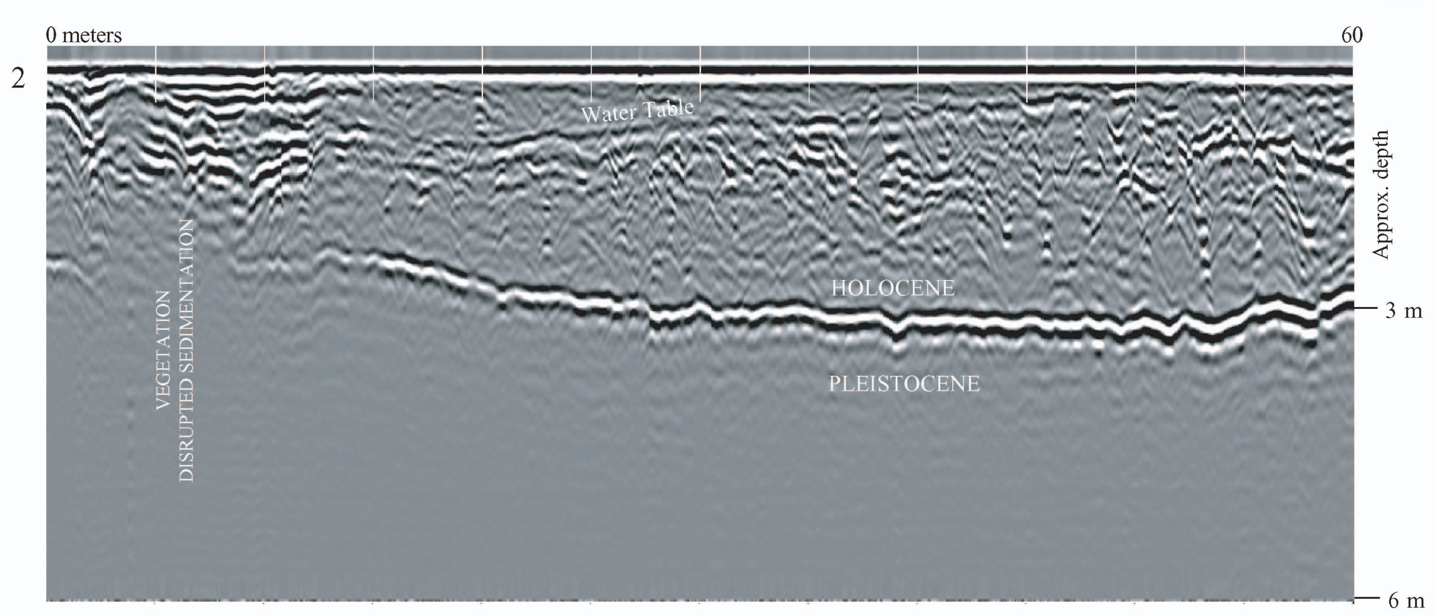


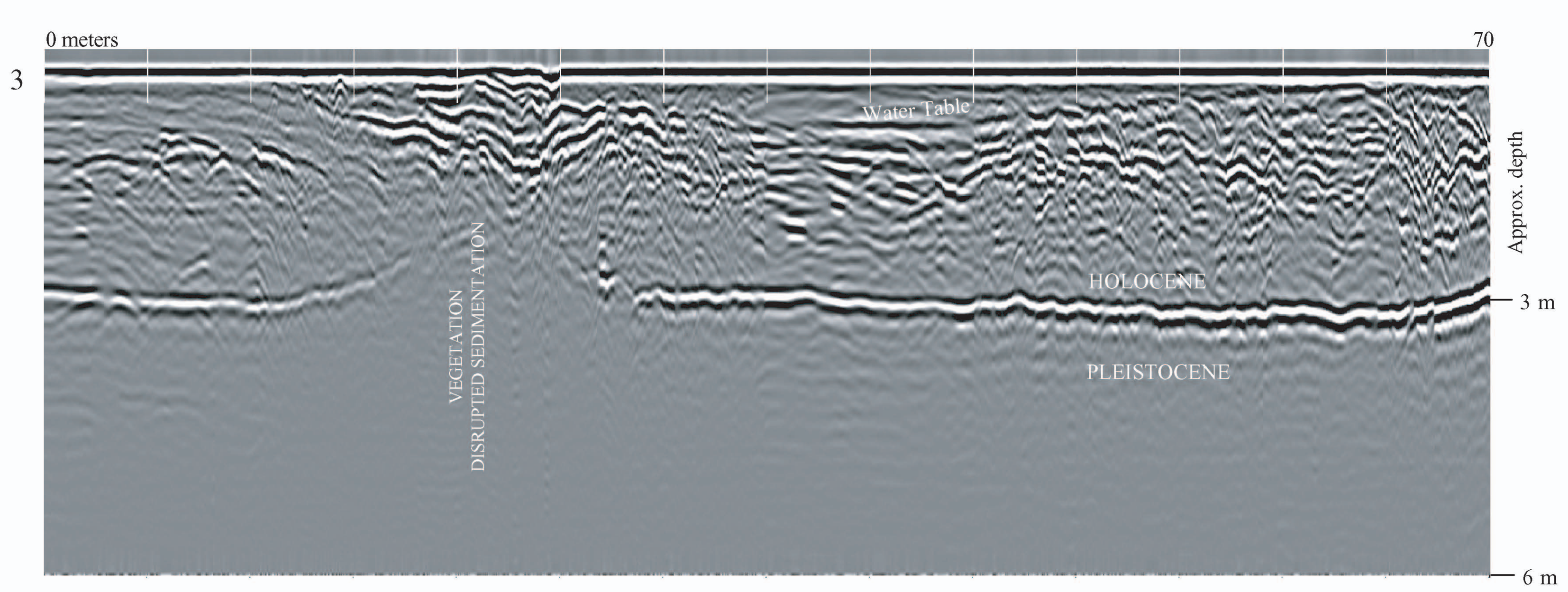


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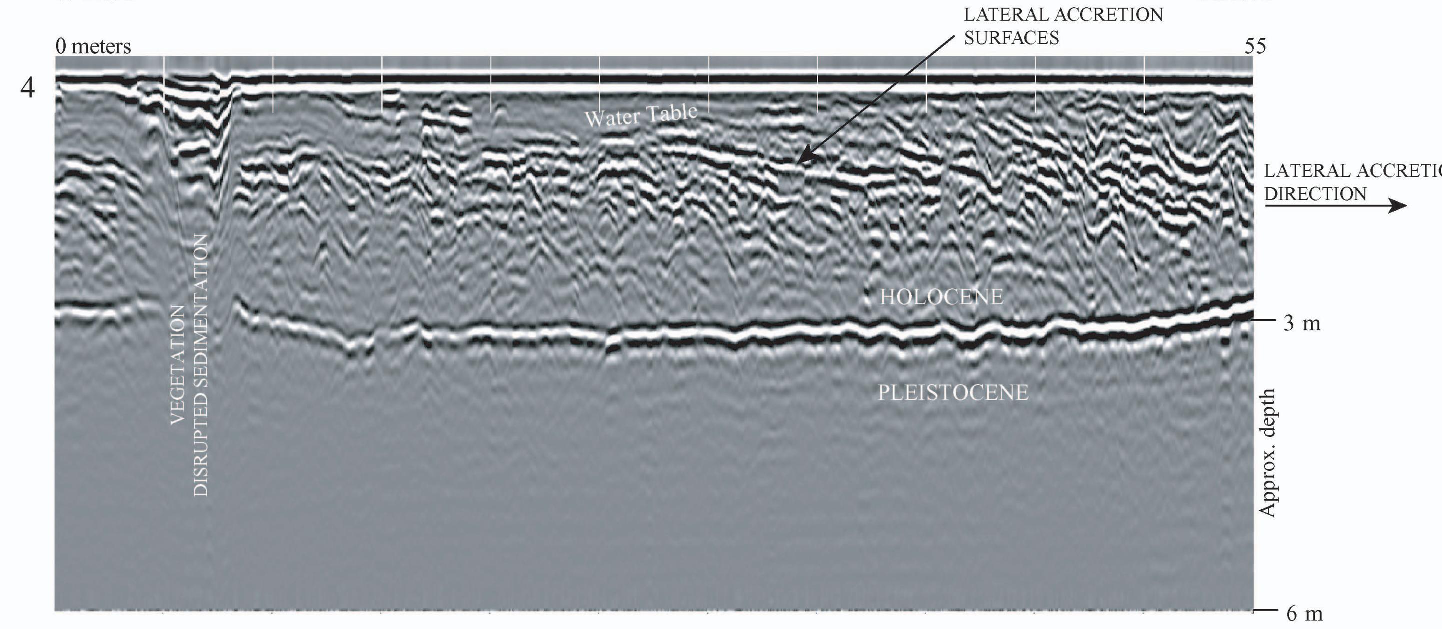


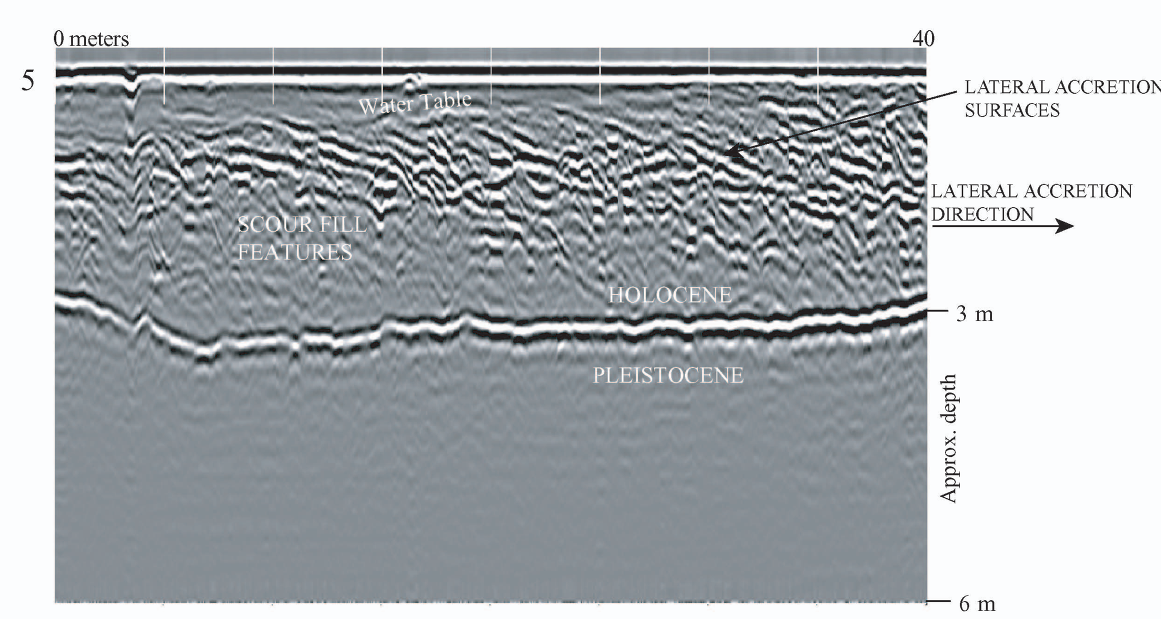


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