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United States Department of Agriculture

Soil Conservation Service

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Subject: GPR Survey at Rockwell Mound Date: August 27, 1990

To: Dr Duane Esarey
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Lewistown, IL 61542

Enclosed find the materials requested for your presentation at the Midwest Archaeological Conference in Evanston, Illinois.

GROUND-PENETRATING RADAR SURVEY

The GPR unit used in this study was the SIR System-8 manufactured by Geophysical Survey Systems, Inc.[1]. Components used include the Model 4800 control unit, Model DT6000 tape recorder, Model SR 8004H graphic recorder, Model 07/3 power distribution unit, and the Model 3110 (120 MHz) antenna. Description of the GPR and its field use have been described in detail by Olson and Doolittle (1985) and Doolittle (1987).

A 90- by 100-m grid was established across Rockwell Mound. The grid interval was 10 m. A transit was used to establish grid corners and to determine surface elevations at each grid intersect point. Elevations were not tied to a benchmark and therefore the lowest ground-surface point was taken as the 0.0-m datum.

In addition to the grid on Rockwell Mound, a transect was established normal to the long axis of a nearby sand dune. Radar imagery from this transect was compared with imagery from Rockwell Mound.

Although the radar provides a continuous output of subsurface features, measurements were made systematically using the discrete observation points (grid intersections) to map the thickness of the "fill" materials and the topography of the paleosurface. Coincidence of grid points with the radar images was established by electronically impressing reference marks on the graphic profile as the radar antenna passed each grid intersection.

The RADAN software developed by Geophysical Survey Systems, Inc.[1], was used to provide terrain correction of the radar data. Terrain correction adjusts the radar profile to approximate the topography of the ground surface through data datum corrections.

A computer software program was used to plot the GPR data and to provide detailed two- and three-dimensional plots of surface and subsurface conditions. Using the software program SURFER developed

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1.Trade names have been used to provide specific information and do not constitute endorsement by the authors.

by Golden Software, Inc. [1.], computer-generated contour maps and surface net maps were constructed to help characterize the present surface and to reconstruct the paleosurface.

Figure 1 is a radar profile of line X = 50 m from Rockwell Mound. This profile has been terrain corrected by the RADAN software program. The relief along this transect line is 4.9 m. The horizontal scale in Fig. 1 represents unit of distance travelled and depends upon the speed of antenna advance along the transect line. The dash vertical lines represents the grid intersections. Each line is 10 m apart. These lines represent the intersection of line X=5 with the Y axis lines (0 to 10). The vertical scale is a time scale based on the velocity of signal propagation. A scanning time of 130 nanoseconds (ns) provided a scanning depth of about 4.1 m. A depth scale (in meters) has been provided along the left border of this figure. Based on three ground-truth auger measurements made along the mound's periphery, the estimated dielectric constant of the mound's coarse and moderately-coarse textured materials is 4.875. The velocity of radar wavelet propagation is 0.0625 m/sec.

Four distinct subsurface layers (A, B, C, and D) have been identified in Fig. 1. Layers A and B are continuous across the upper part of the mound and are believed to represent layers of basket-loaded fill materials (A) and a buried surface of a midden (B).

The high amplitude (exceptionally dark image) of the reflected signals from the interface separating Layers A and B signifies an abrupt, highly contrasting boundary. This interface is believed to represent the upper surface of the "buried midden" and "humic layer" described by Esarey (1987). In 1986 a trench was excavated on Rockwell mound and a midden and a humic zone were described by Dr. Esarey. A radar transect passed close to the location of this filled trench and the depth to Layer B conform to the depth described for the midden. At a maximum, Layer B is buried beneath 1.9 m of presumed basket-loaded fill materials (Layer A).

Images from basket-loaded fill materials are believed to be evident in Layer A. Numerous, discontinuous reflections are apparent above the interface separating layers A and B. The intermediate amplitudes (less intense shades of gray) of these reflections are from earthen materials which less contrasting than the buried surface (dark gray and black images). These radar signatures are believed to have been caused by the accumulation of basket-loaded sands from different nearby source areas along the Illinois River. In addition, these reflections appear to decrease in number and intensity upwards, towards the present soil surface. Dr. Esarey (1987) observed "basket-loading which became progressively less distinct in the upper levels."

Layers C and D may represent former artificial and/or natural features of the mound. It is speculated that Layer C may represent the "sterile soils" observed 3.5 m below the mounds summit by Esarey (1987). However, owing to the greater depths of these layers and the lack of sufficient observations, no further interpretations of these layers will be made at this time.

Layer B is continuous beneath the upper portion of Rockwell Mound. The image of this strongly contrasting feature appears to be strikingly artificial and is inconsistent with the natural stratigraphy observed with the radar in dune landscapes. Generally, sand dunes, formed from the accretion of migrating sands, have complex patterns of slip faces and are cross-stratified with observable foresets and topsets. These features were not apparent in the images from Rockwell Mound. In addition, while evident on radar profiles from sand dunes, these sets do not contrast with the surrounding coarse-textured matrix as strongly as did Layer B on Rockwell Mound.

The radar profile from a nearby, natural dune (Figure 2) is distinctly different from the profiles of Rockwell Mound. The relief of this dune is 7.9 m. The dune profile lacks the dark, highly contrasting, continuous layer which was apparent in the upper part of Rockwell Mound.

Several weakly expressed images are evident in the radar profile of the sand dune (Figure 2). These images include an unidentified soil interface along the dunes leeward margin, "A", sub-parallel foreset layers, "B", several point reflectors (possibly tree roots or buried pipelines), "C", a weakly expressed erosion surface or soil horizon which parallels the soil surface along the dune crest, "D", and layers of road fill, "E". The dip of sub-parallel foreset layers, "B", have been approximated in Fig. 2.

In Figure 3, both radar profiles are displayed. As the range, gain, and filtration settings are identical for these profiles, a comparison of the imagery is possible. Major interfaces within the mound are more evident and contrasting than the interfaces within the sand dune. These interfaces or surfaces appear to be arranged in a sequence of tiers within Rockwell Mound. In addition, the imagery of Rockwell Mound lacks the foreset layers evident in the sand dune. On the bases of these observations, it is believed that Rockwell Mound is not a naturally formed sand dune, but is an artifact constructed by Indians.

COMPUTER SIMULATED DIAGRAMS

Computer simulated two-dimensional contour maps (Figure 4) and three-dimensional surface net diagrams (Figure 5) summarize the form of the buried surface,"A", and the modern soil surface, ""B", of Rockwell Mound. In figures 4 and 5, all measurements are in meters. In all diagrams, the vertical scale has been exaggerated 6 times relative to the horizontal scale. The 0,0 intersect is located in the southwest corner of the mound. As discussed by Esarey (1987), the east side of the mound has been graded away for a street (right and upper right borders of the diagrams in figure 4 and 5, respectively), and a retaining wall and sidewalk have truncated the mound's south edge (lower and lower right borders of the diagrams in figure 4 and 5, respectively).

It is estimated from these simulated diagrams that about 7535 cubic meters of basket-filled materials (A in Figure 1) have been dumped over the buried surface (B in Figure 1) to create the present surface of this mound (Figures 4B and 5B). The modern surface is

broader, more concentric, and averages about 0.9 m higher than the buried surface.

A distinct north-northwest/south-southeast trending ridge is apparent in the buried surface (Figure 4A and 5A). The north-northwest portion of this ridge conforms with the area of a suspected "ramp-like projection" discussed by Esarey (1987). The pronounced indentation of the buried surfaces 0.5 m contour line (Figure 4A) may have been caused by slope wash and erosion.

References

Doolittle, J. A. 1987. Using ground-penetrating radar to increase the quality and efficiency of soil surveys. IN Soil Survey Techniques, Soil Sci. Soc. Am. Special Publ. No 20. pp 11-32.

Esarey, D. 1987. Havana's hidden mound. Illinois Antiquity 19(1): 6-10.

Olson, C. G., and J. A. Doolittle. 1985. Geophysical techniques for reconnaissance investigations of soils and surficial deposits in mountainous terrain. Soil Sci. Soc. Am. J. 49:1490-1498.

I hope that this information will be of help to you. I can adjust, modify, color, or what ever, any of these figures. Please advise as to your desires. I believe that we have the makings of a good little paper. I think that we have something positive to contribute...a successful GPR survey of a suspected Indian mound, possibly the first use of "terrain corrected" radar profile in the field of archaeology, and a study which demonstrates the compatibility of GPR and computer graphics. Let me know your thoughts.

With kind regards.

James A. Doolittle
Soil Scientist (GPR)

cc: (without enclosures)
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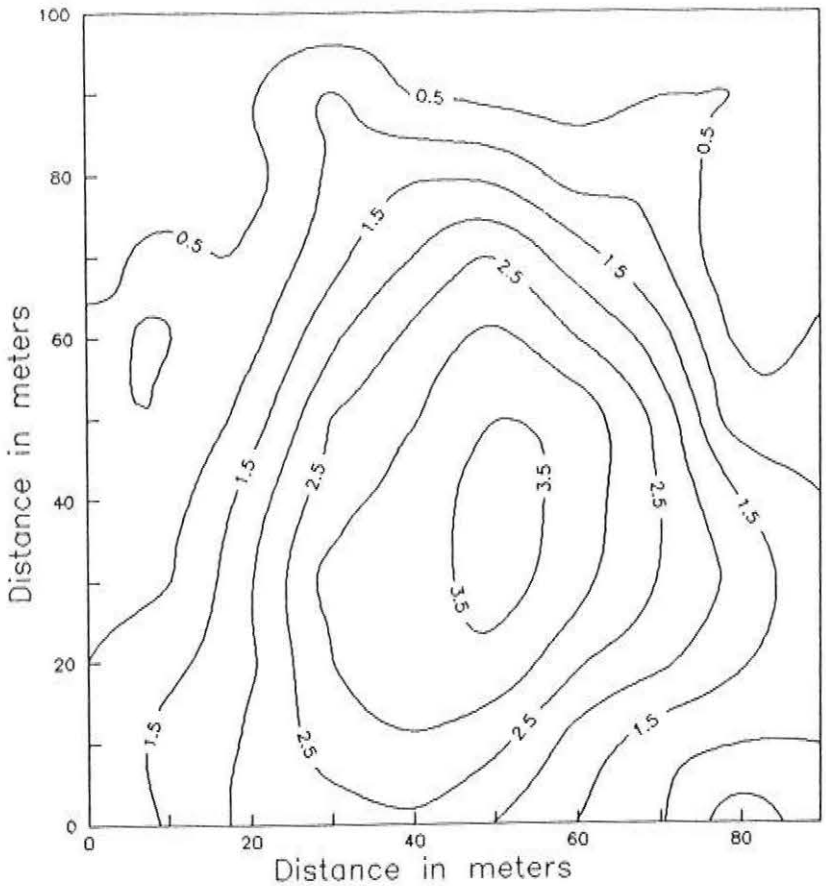
A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Distance in meters
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40
60
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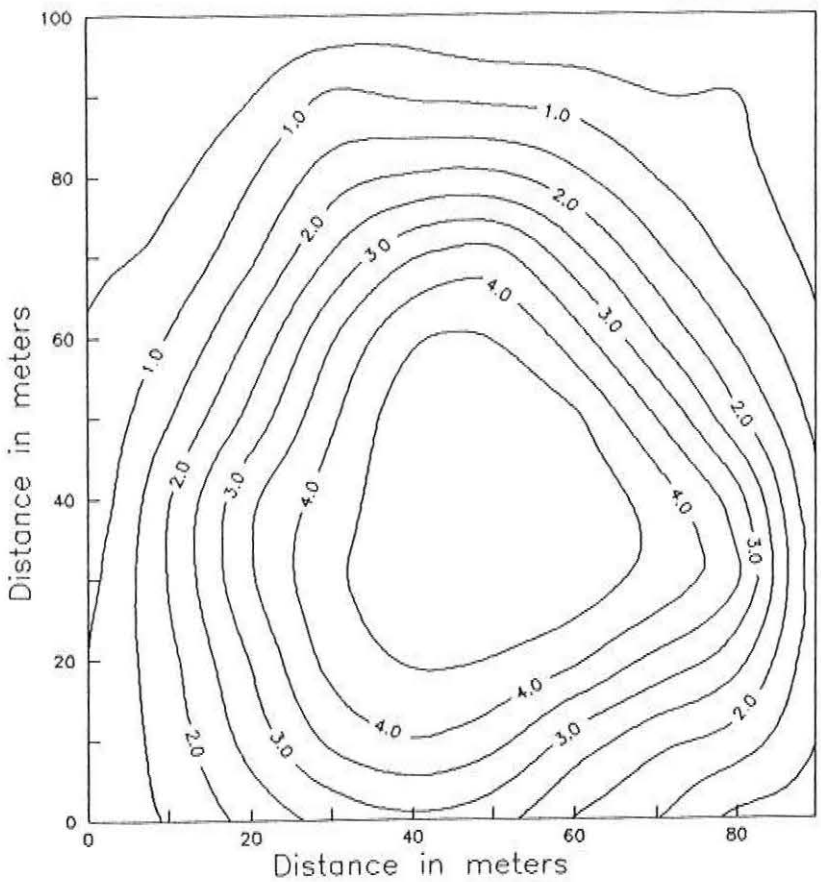
100
0.5
1.5
2.5
3.5

B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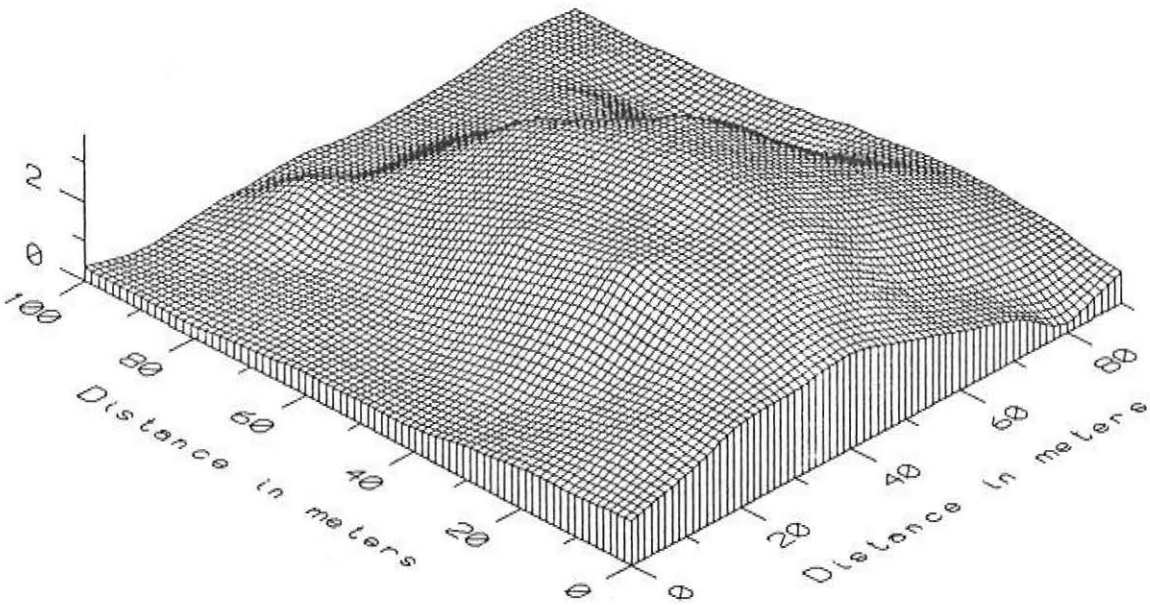
A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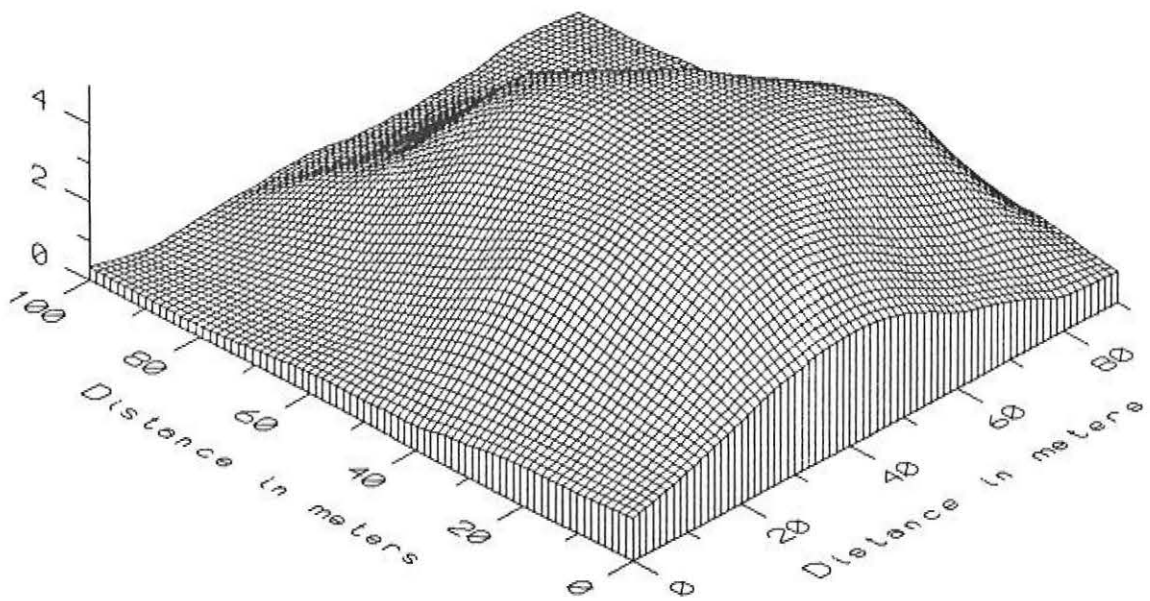
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