Using a Digital Cone Penetrometer to Locate Clandestine Grave Sites

Abstract

Law enforcement officials face the problem of locating suspected burial sites connected to criminal activity. Two case studies describe the collection of soil compaction data and subsequent analysis to locate a test burial at a research site. Forensic scientists use the RockWorks software from RockWare, Inc. to analyze the data and display three-dimensional views of the relative compaction logs at the sampling locations, interpolated compaction for the entire project area, 3D fence diagrams, interpolated maximum penetration depths, and calculated volumes of unconsolidated and highly consolidated regions. Soil compaction data and interpolated models clearly define the burial site. Results support the use of this method in criminal investigations.

Keywords

Forensic scientists, clandestine graves, soil compaction, cone penetrometer, burial sites

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Case Study #1

The first study began by establishing a 2 meter by 2 meter project area with a 0.5 meter grid spacing.

Figure 1: 2-meter x 2-meter area with survey flags positioned at 0.5-meter grid intervals.

Step 1: Collecting the Data

The soil compaction meter (aka cone penetrometer) was then pushed into the ground at each of the survey stations.

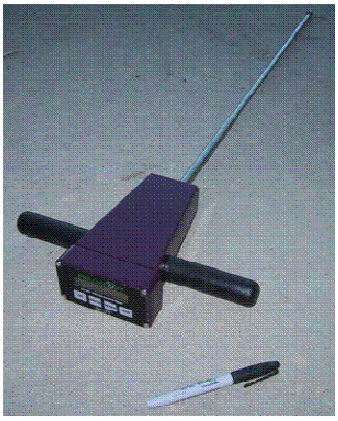

Figure 2: Spectrum Technologies Field Scout Model SC900 soil compaction meter.

Figure 3: Author pushing soil compaction meter into the ground.

Step 2: Downloading the Data

The penetrometer was then connected to a laptop computer via a serial cable.

Figure 4: Spectrum Technologies Field Scout Model SC900 soil compaction meter connected to laptop computer via a serial cable.

Step 3: Downloading the Data (continued)

The penetrometer data was then downloaded (as an ASCII file) via the Spectrum Technologies data transfer program.

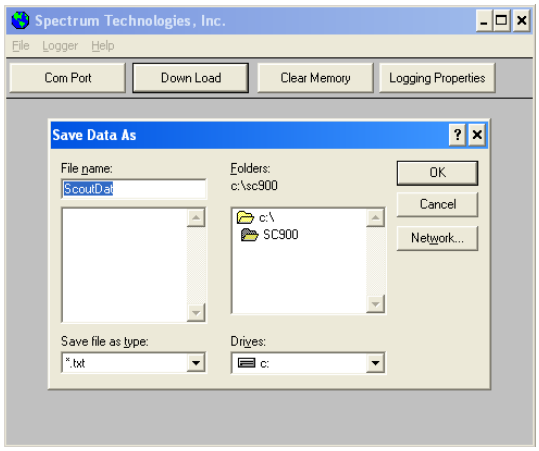

Figure 5: Spectrum Technologies Field Scout download software menu.

Step 4: Loading the Data into RockWorks

The penetrometer data file was then converted to separate borehole files via the RockWorks Penetrometer Import option (located within the File/Import/Penetrometer).

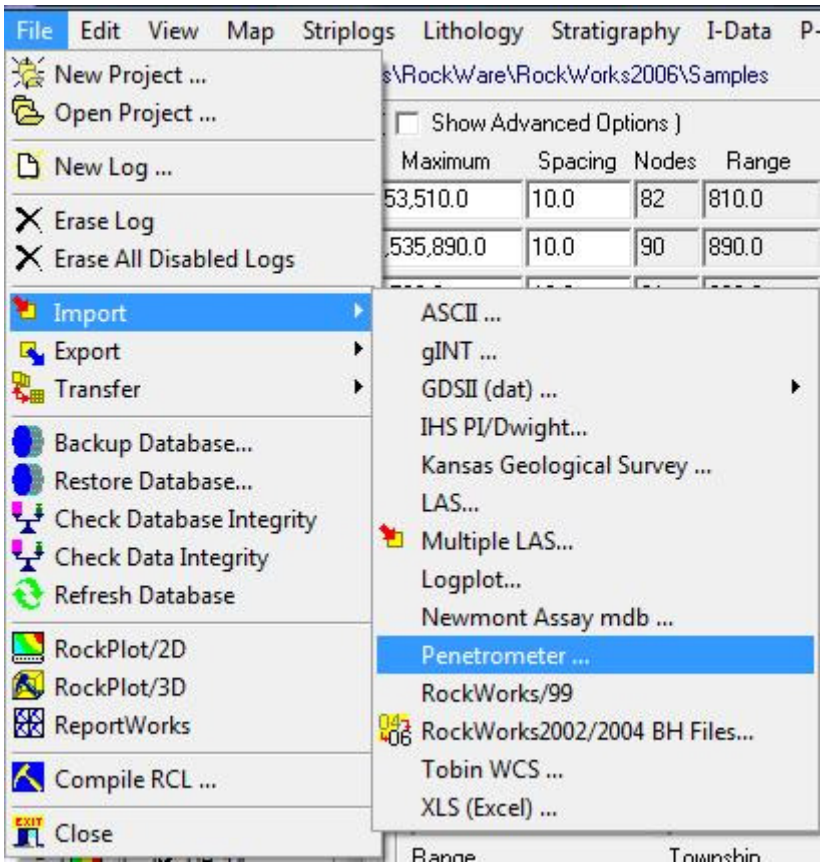

Figure 6: RockWorks penetrometer import menu.

Step 5: Creating Penetrometer Logs

The RockWorks Striplogs/Multi-Log 3D option was then used to create a 3-dimensional diagram showing the relative compaction below each survey station.

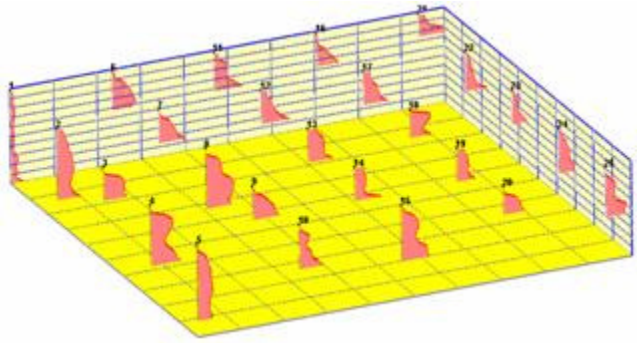

Figure 7: Cone penetrometer logs displayed within RockPlot3D.

Step 6: Creating a Compaction Model:

The RockWorks P-Data/Model option was then used to create a 3-dimensional solid model depicting interpolated compaction for the entire project area.

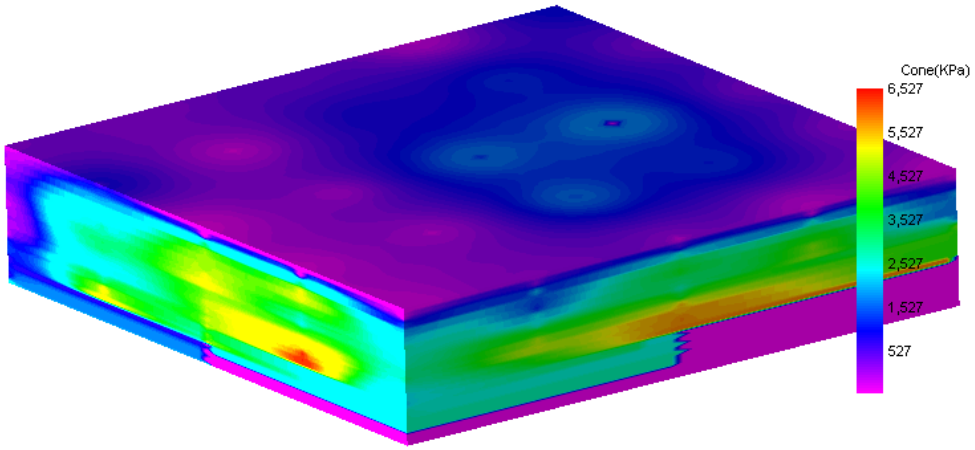

Figure 8: Interpolated compaction model. Purple zones at base of model depict regions where interpolation was not possible (no penetrometer data at these depths).

Step 7: Creating Fence Diagram

The RockWorks Geophysics/Fence option was then used to slice through the 3-dimensional model to create compaction profiles.

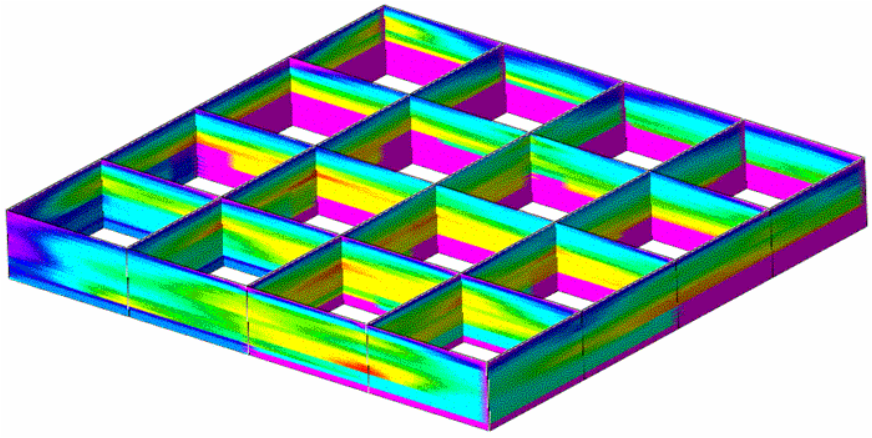

Figure 9: Soil compaction fence diagram.

Step 8: Identifying Zones of Compaction

The RockPlot3D program was then used to render zones of low compaction invisible in order to highlight and compute the volume of highly compacted regions.

Step 9: Identifying Zones of Low-Compaction

Conversely, the RockPlot3D program was then used to render zones of high compaction invisible in order to highlight and compute the volume of unconsolidated regions.

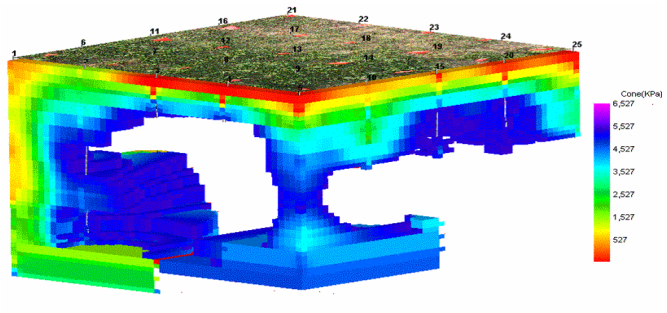

Figure 10: Zones of low compaction (i.e. <3,433KPa) combined with photograph (taken from ladder overlooking project area). Volume = 1.11 cubic meters. Color-scheme has been reversed to highlight low-compaction regions.

Case Study #2

Figure 11: Sampling a 8 x 6 meter area at the NecroSearch research site (buried pig depicted by flagging upslope from author's left foot).

Step 1: Creating Penetrometer Logs

The RockWorks Striplogs/Multi-Log 3D option was then used to create a 3-dimensional diagram showing the relative compaction below each survey station.

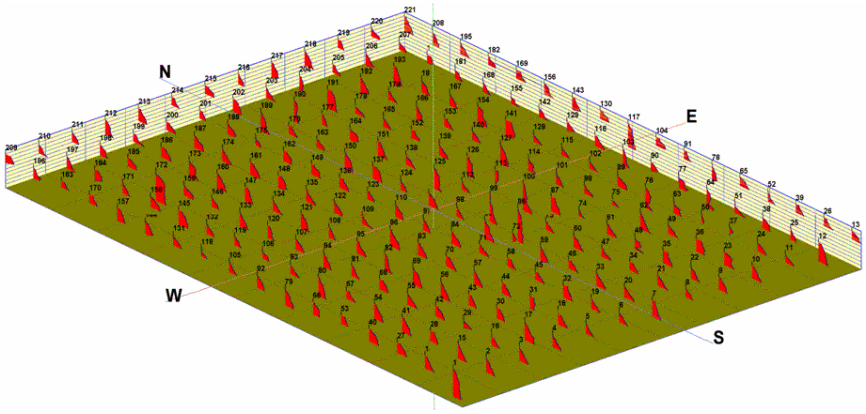

Figure 12: Cone penetrometer logs displayed within RockPlot3D.

Step 2: Creating a Maximum Penetration-Depth Model

A surface model was then interpolated based on the maximum depths of penetration.

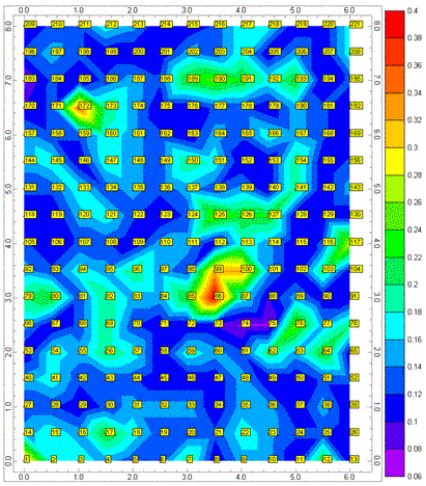

Figure 13: Interpolated maximum penetration depth surface model.

Step 3: Creating a Maximum Penetration-Depth Model (Continued)

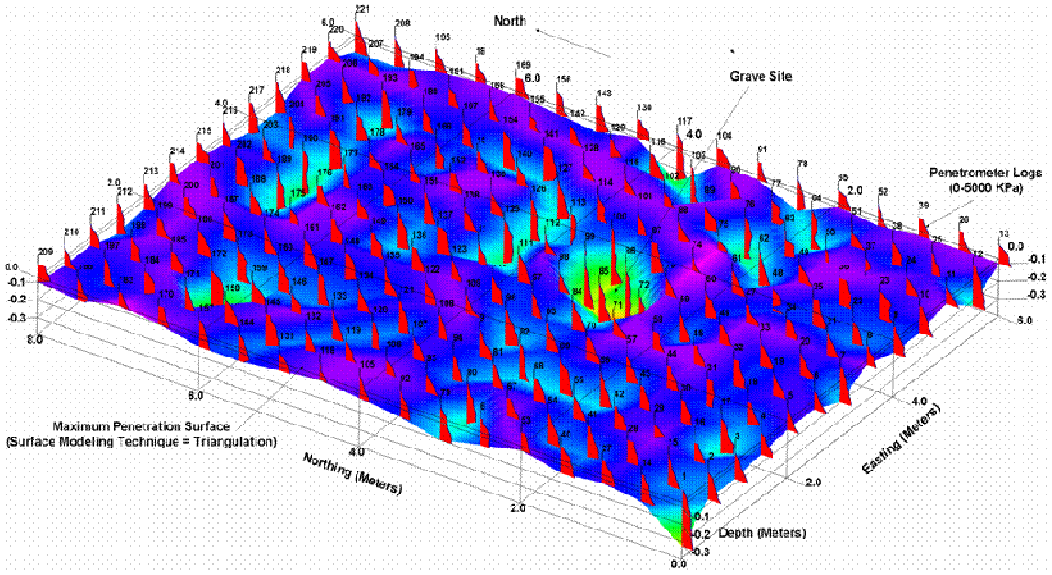

Figure 14: Interpolated maximum penetration depth surface model displayed as 3-dimensional surface combined with penetrometer logs.

Step 4: Creating a Compaction Model

The RockWorks P-Data/Model option was then used to create a 3-dimensional solid model depicting interpolated compaction for the entire project area.

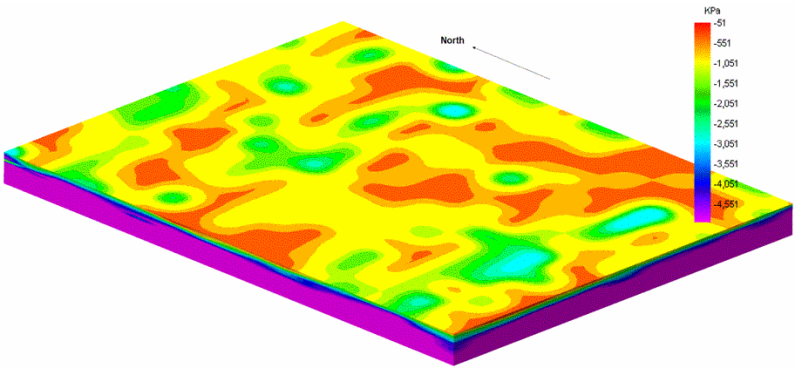

Figure 15: Interpolated compaction model. Purple zones at base of model depict regions where interpolation was not possible (no penetrometer data at these depths).

Step 5: Creating a Fence Diagram

The RockWorks P-Data/Fence option was then used to slice through the 3-dimensional model to create compaction profiles.

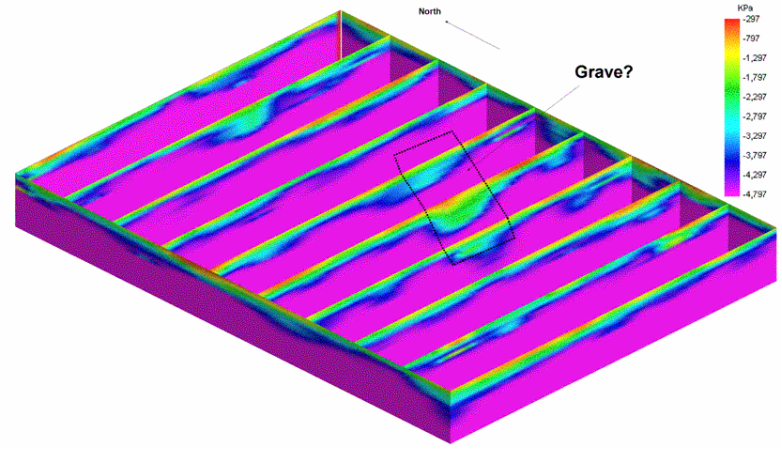

Figure 16: Soil compaction fence diagram.

References

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