3D Resistivity Imaging of Geotechnical Properties at a Construction Site

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New Parking Garage Structure with Concerns of Drainage Rates In Soils

Purpose

A multi-story parking garage structure was built for a hospital in east Texas, U.S.A. over an existing parking lot. This type of new construction involves advanced knowledge of the subsurface conditions for safety, excavation planning and both structure and drainage design. Three-dimensional (3D) Electrical Resistivity Imaging (ERI) was used to map clay and sandy-clay deposits previously identified in limited locations by shallow boreholes. 3D resistivity imaging models provided unprecedented new information for the structure design and project planning.

Direct Applications

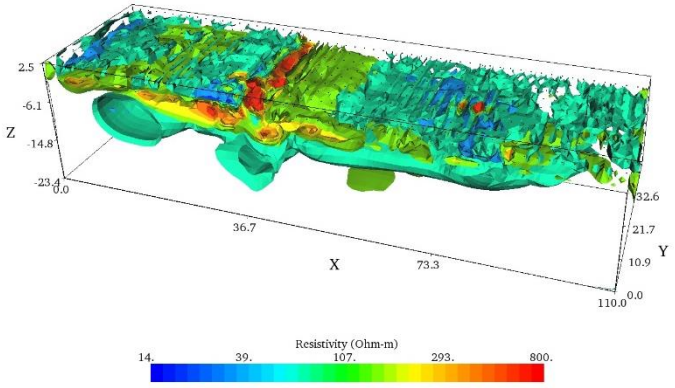
To 3D map the soil types and water content below ground in flat or rugged terrain with direct application to civil and geotechnical engineering, groundwater exploration, environmental remediation, archeological reconnaissance, and mineral exploration projects.

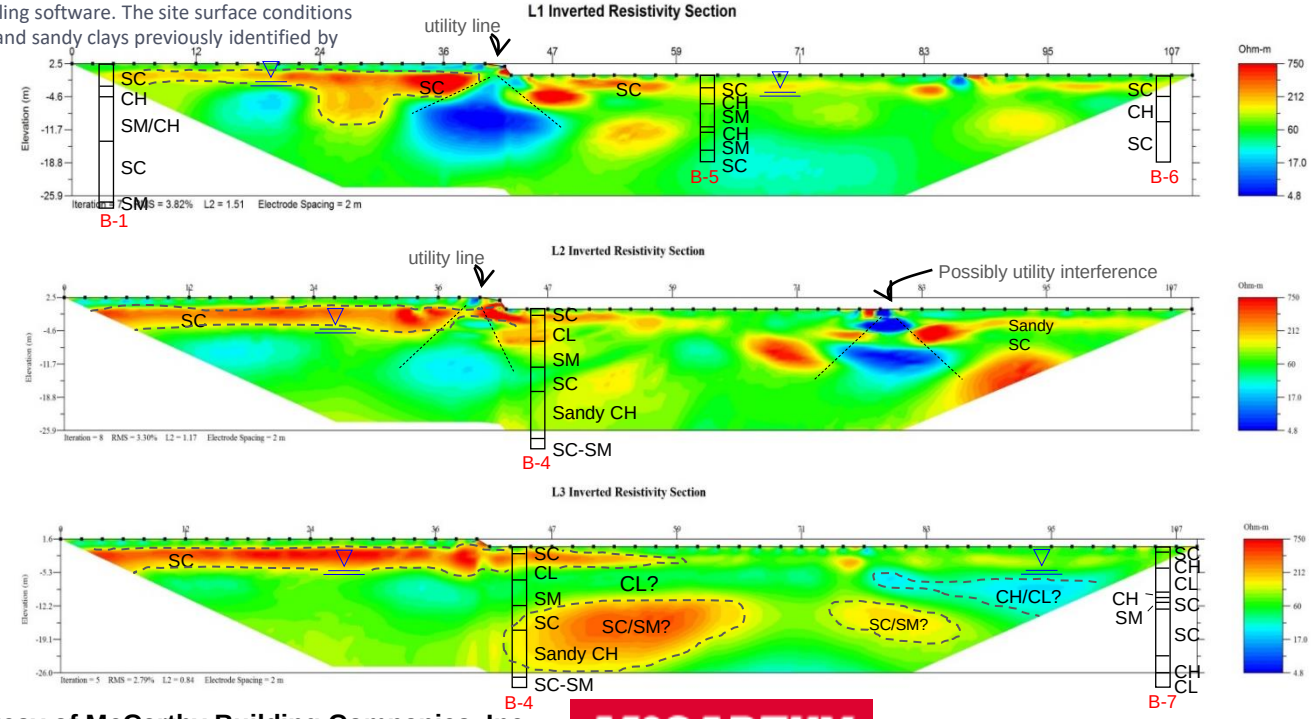
Survey

The 3D ERI survey was completed on March 30th of 2017. The 3D ERI survey consists of nine parallel two-dimensional profiles using a combination of both Dipole-Dipole and Strong-Gradient™ arrays. All arrays were collected with the SuperSting™ R8 WiFi, Switchbox 56, and the FlexLite Passive Electrode Cables with 56 electrodes. The in-line electrode spacing was 2m and the cross line electrode spacing was 4m. Nine parallel transects formed a 3D model with 504 total electrodes. This model was run with the AGI EarthImager™ 3D resistivity/IP inversion modeling software. The site surface conditions consisted of nearly 6 inches of asphalt pavement over clay and sandy clays previously identified by limited shallow borings.

Results

3D electrical resistivity imaging successfully mapped expansive clays and faster draining sandy-clays as well as the shallow water table. Available shallow borings were correlated with the 3D ERI survey results. The 3D inverted resistivity model showed that there was no presence of shallow local bedrock that could raise the cost of the excavation and potentially change the design of the parking garage structure.





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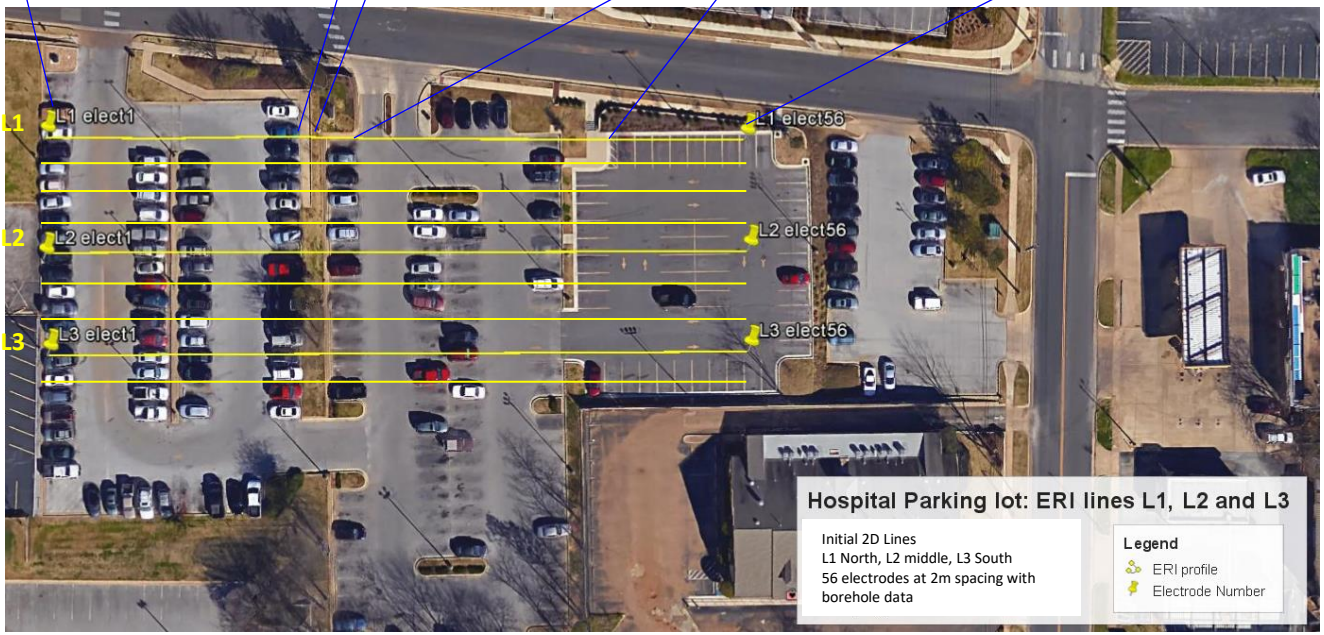

Drilling of asphalt/concrete for electrode stake installation

Installing electrode stake in asphalt/concrete for ERI survey

Installation of passive cable for ERI survey

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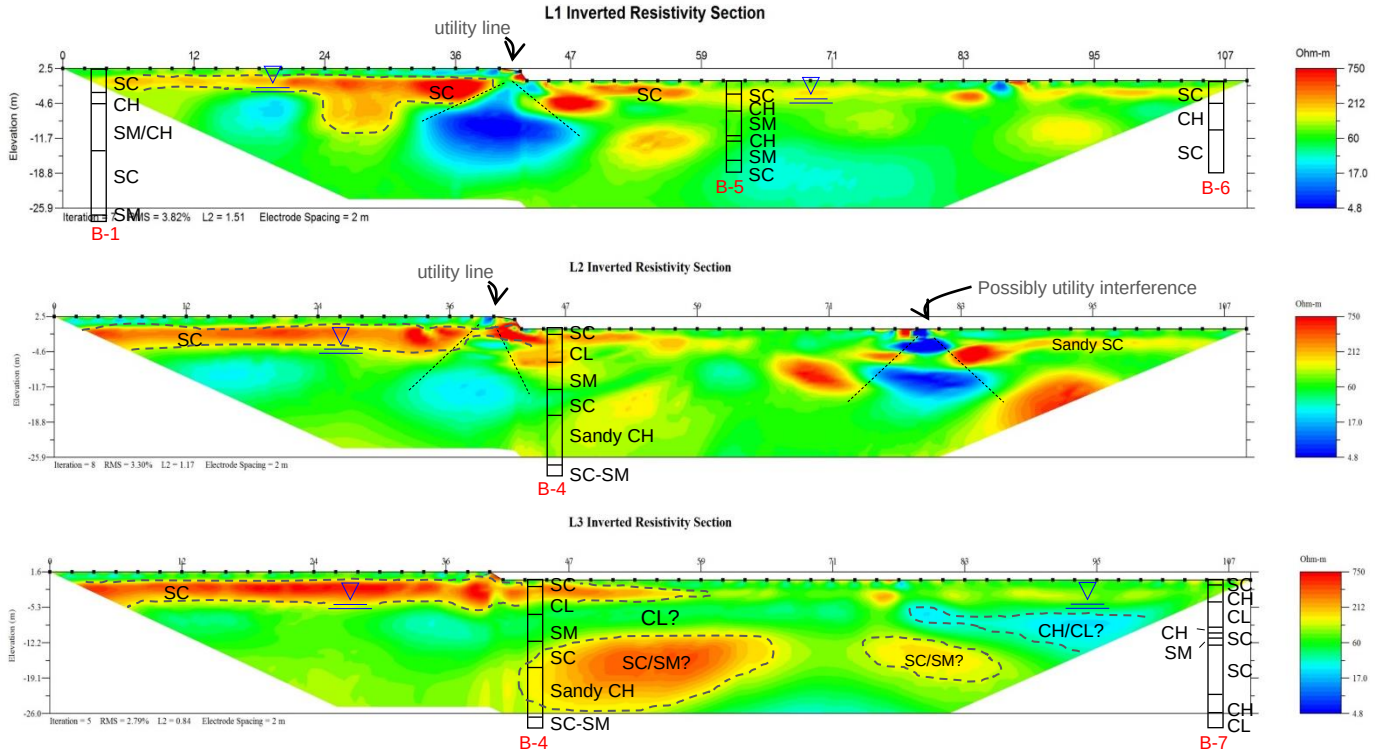

Key to Soil terms
SC: Clayey sands, sand-clay mixtures
CH: Inorganic clays of high plasticity, fat clays
SM: Silty sands, sand-silt mixtures
CL: Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays

Date: March 30, 2017
Site: East Texas, USA-Undisclosed Hospital Parking Garage
Equipment: SuperSting R8 WiFi with SwitchBox 56 with passive land cables spaded at 2m. Dipole-Dipole, Strong-Gradient and Dipole-Gradient arrays
Software: EarthImager 2D with a finite element inversion model
Results: Electrical resistivity imaging successfully delineated the presence of expansive clays and clayey-sands and a shallow water table in a fine-grained soil environment in previously undocumented areas. Available upfront borings correlate well with ERI survey results.

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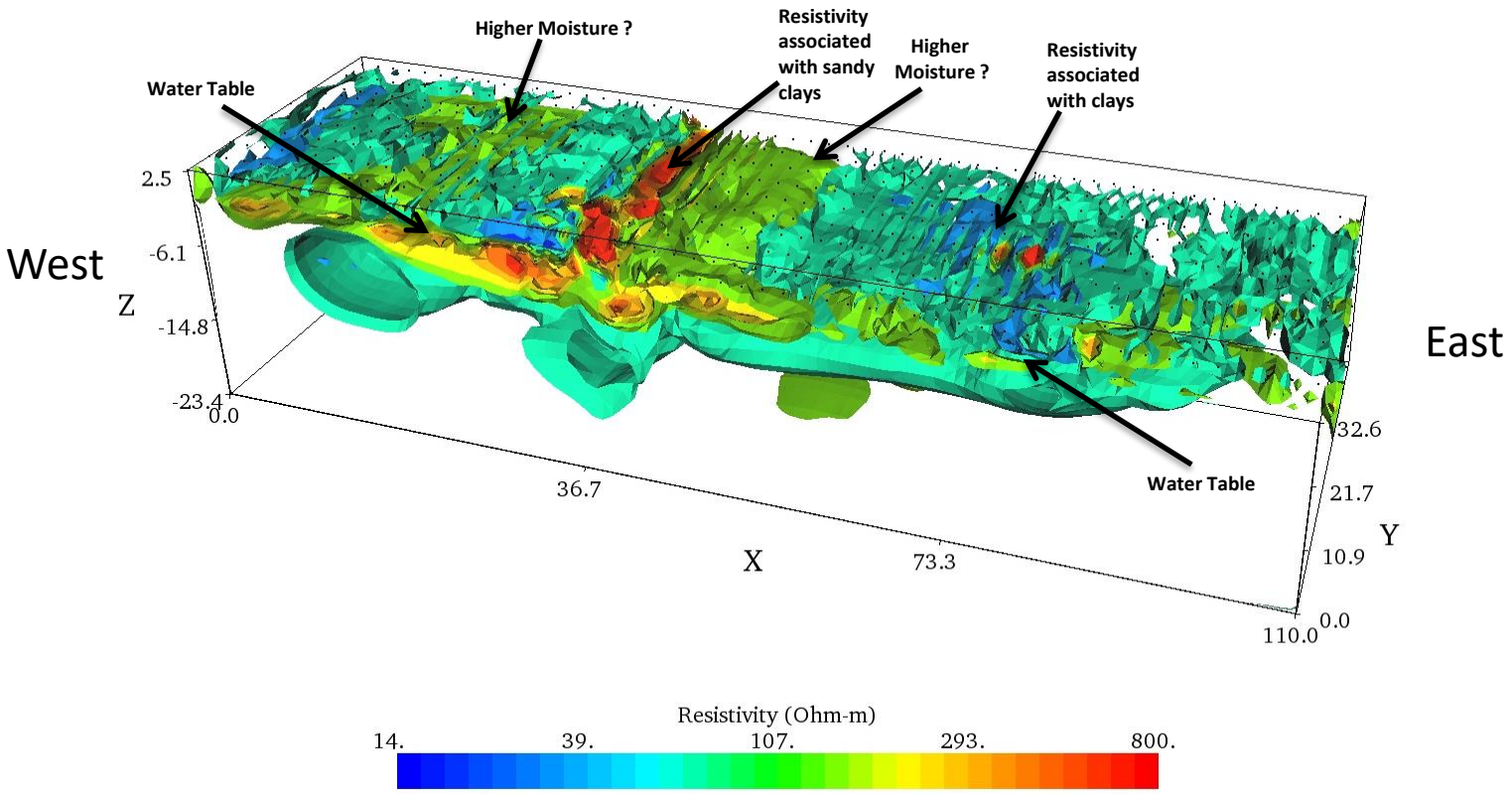
All resistivity values as iso-contours



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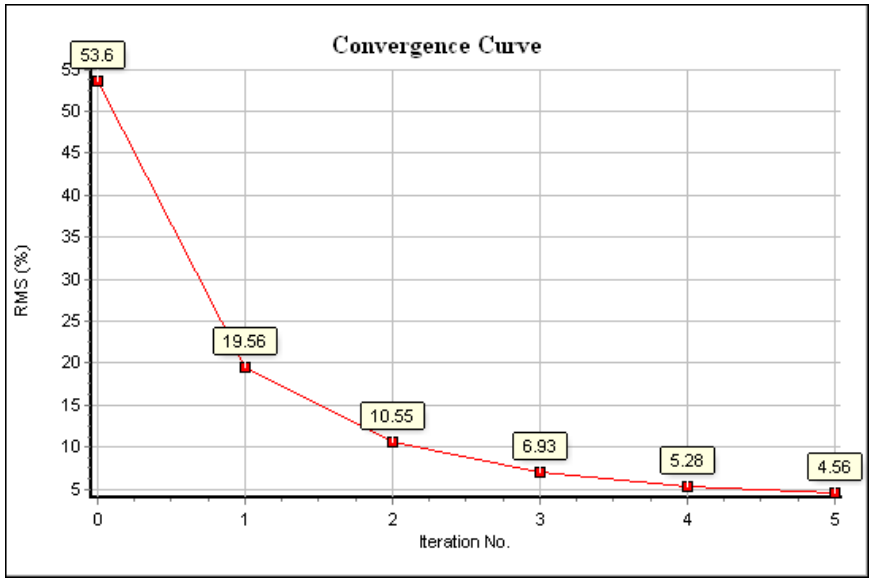
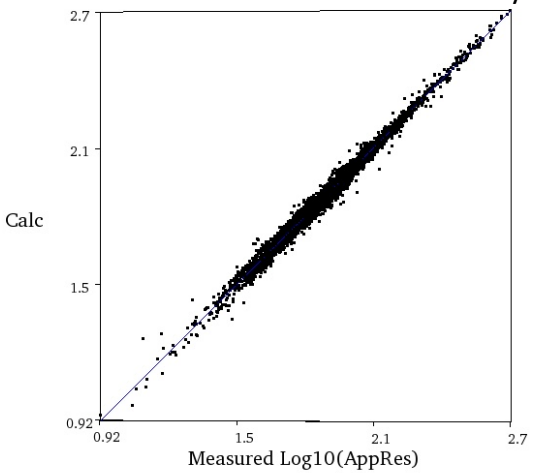
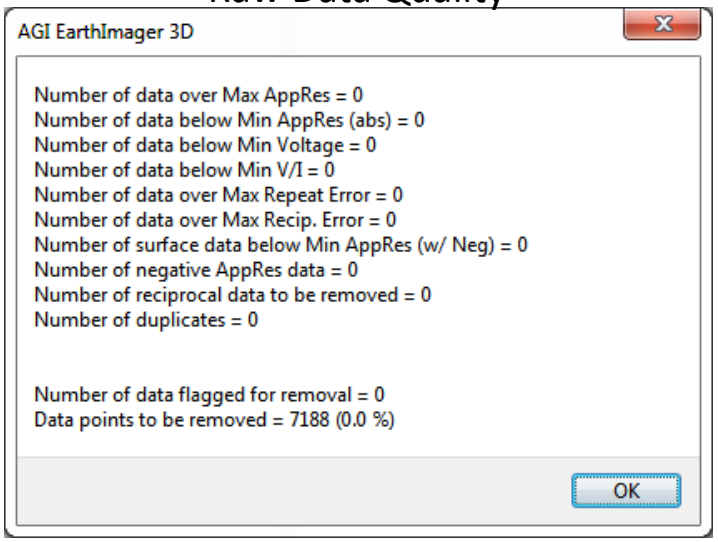


Measured vs Calculated Resistivity



Iteration No. 5. RMS = 4.6%. L2 = 0.8

Raw Data Quality



Full 3D Model of 83,912 m^3
560 total electrodes installed
7,188 resistivity measurements
Finite Element Cells = 89,964

These plots show that the raw data are very clean and the resulting finite element model fits the raw data well

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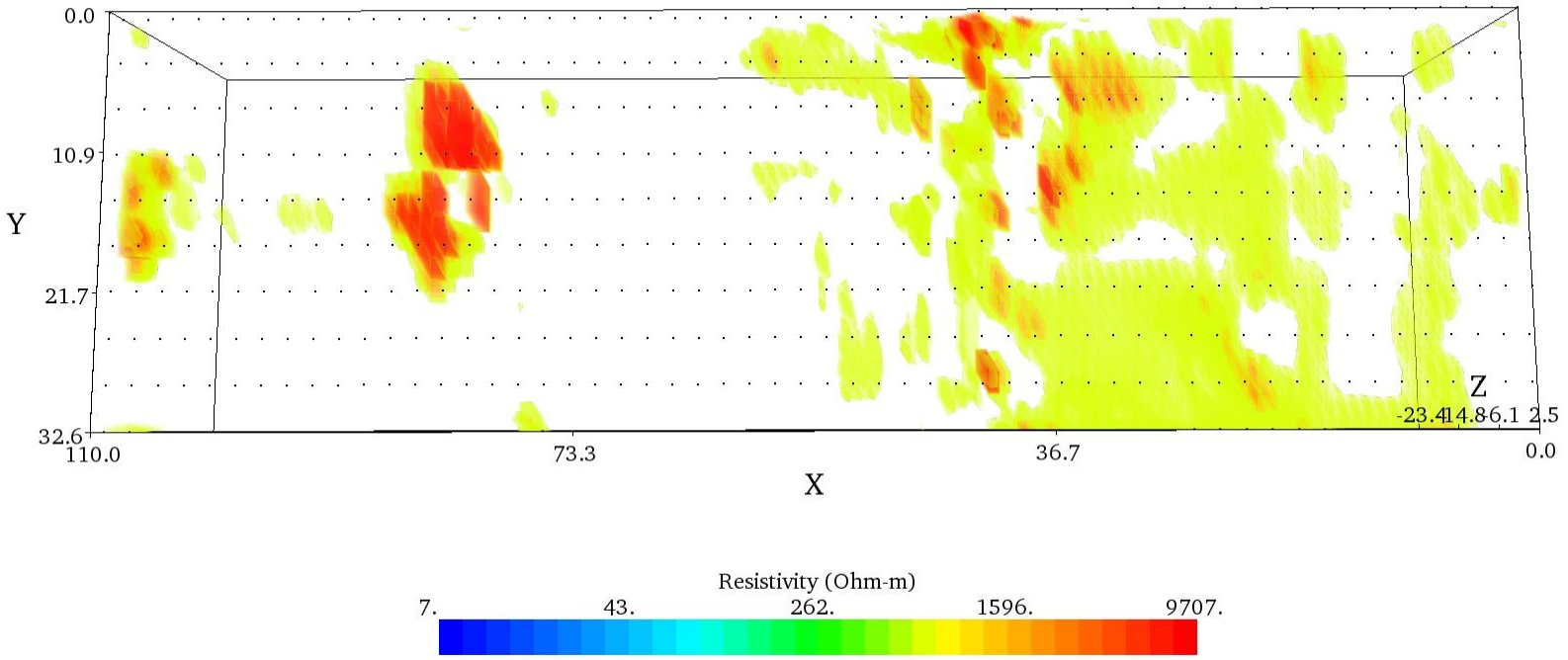
Resistivity values closely associated with Sandy Clay found in boreholes



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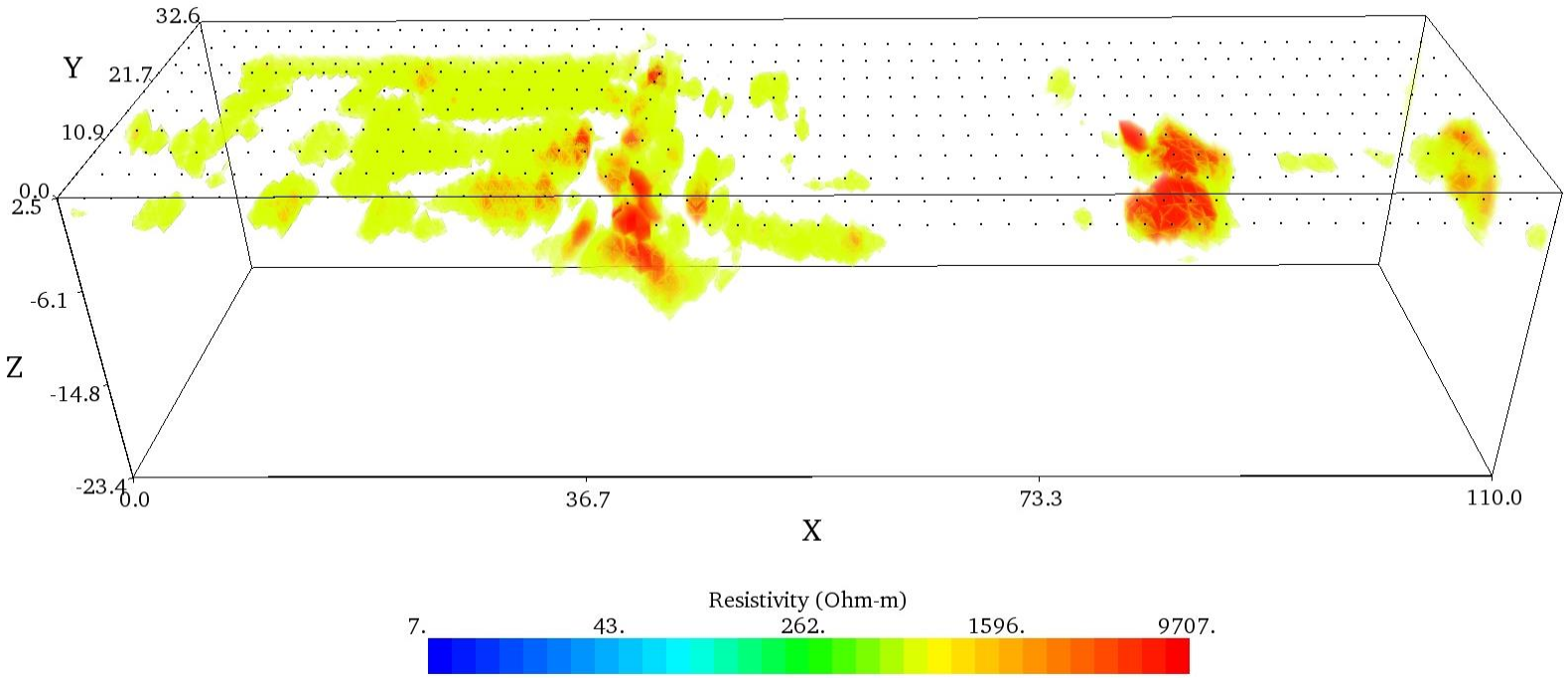

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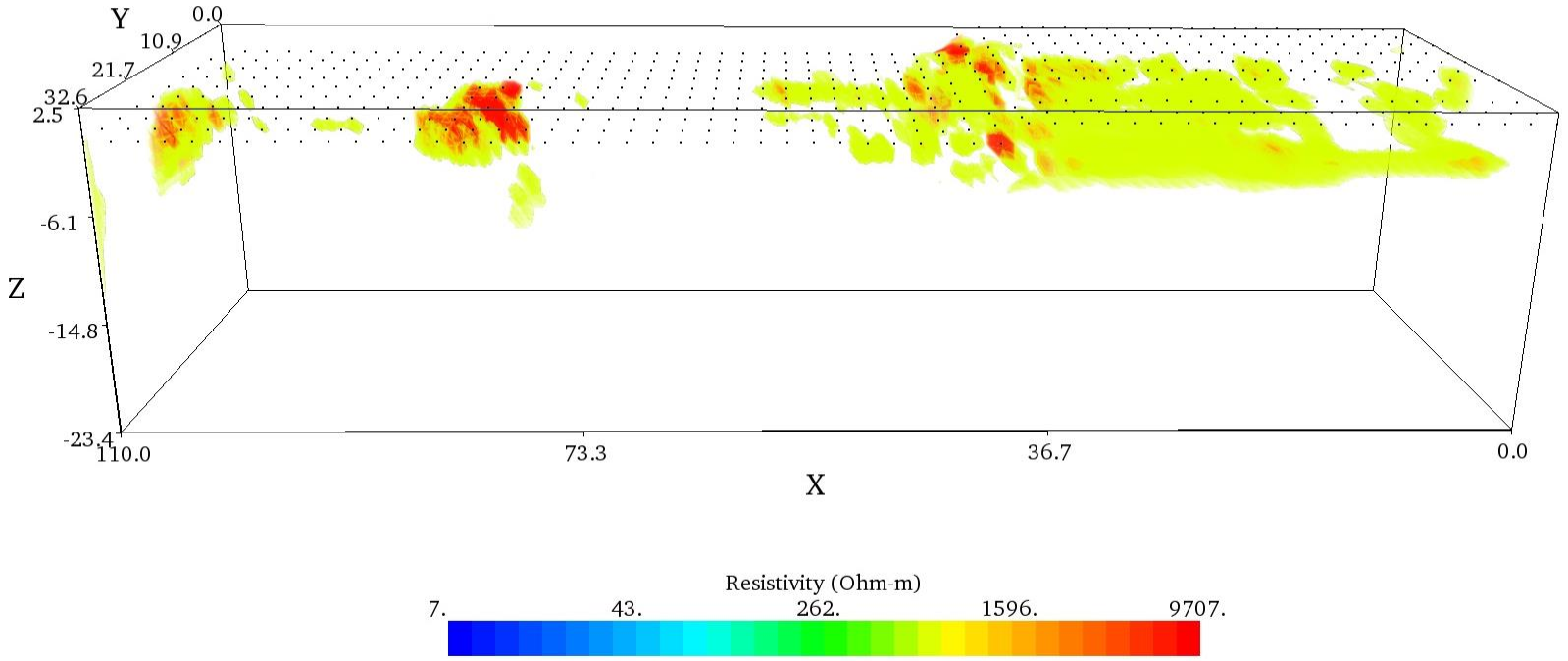

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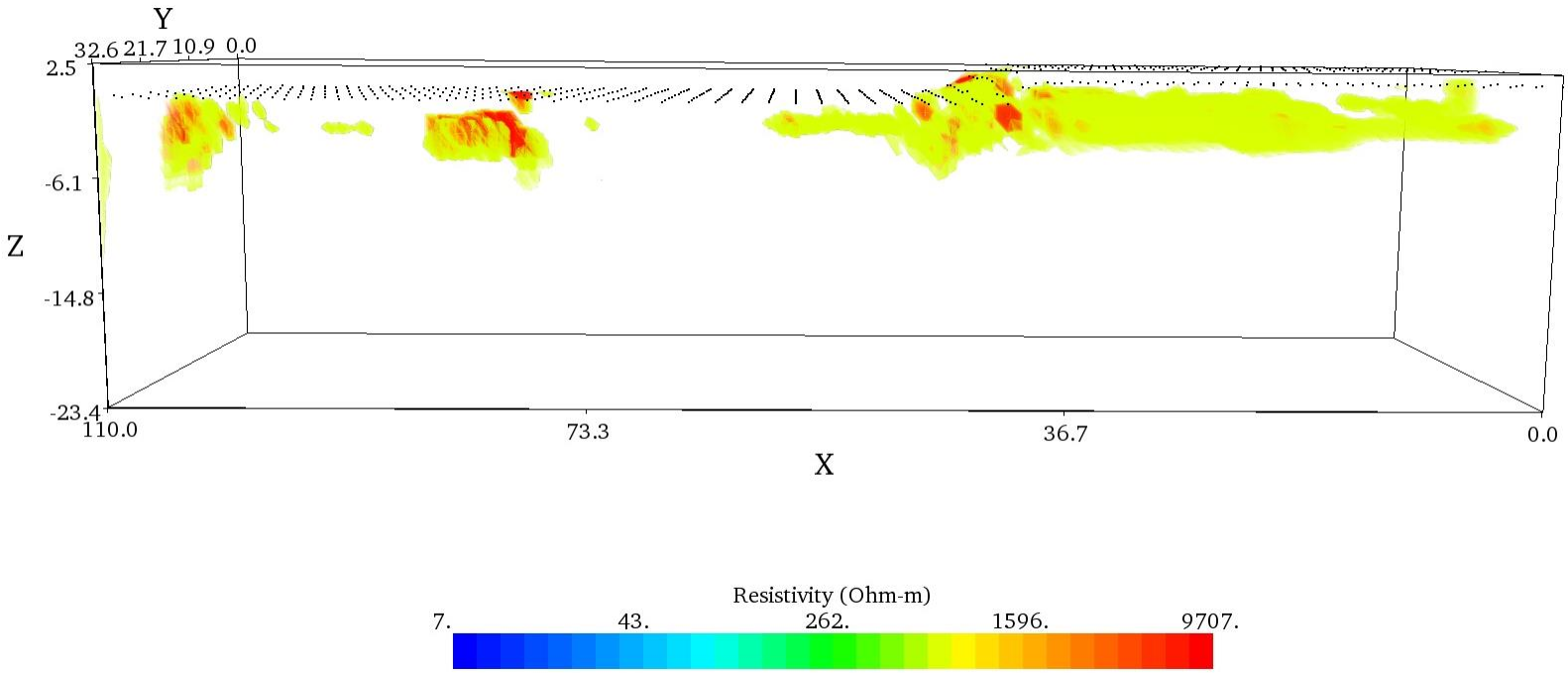

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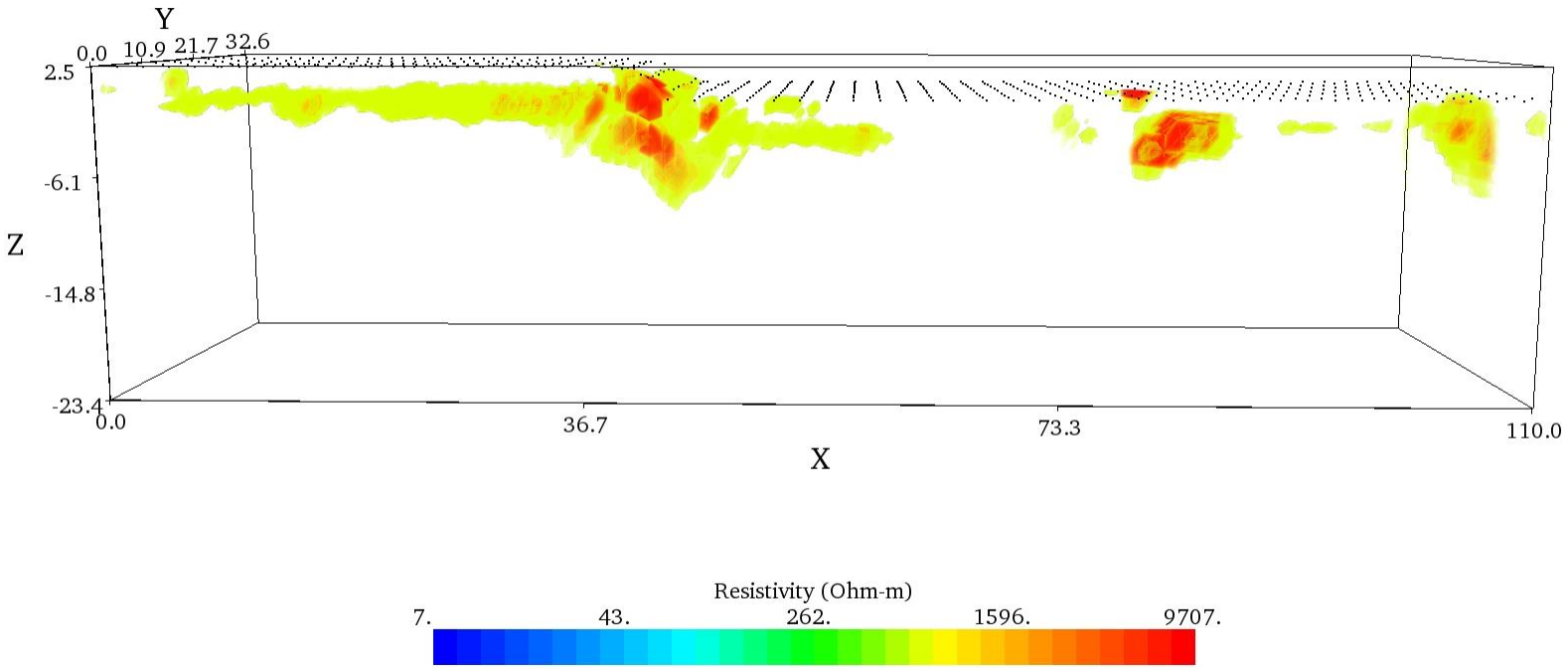

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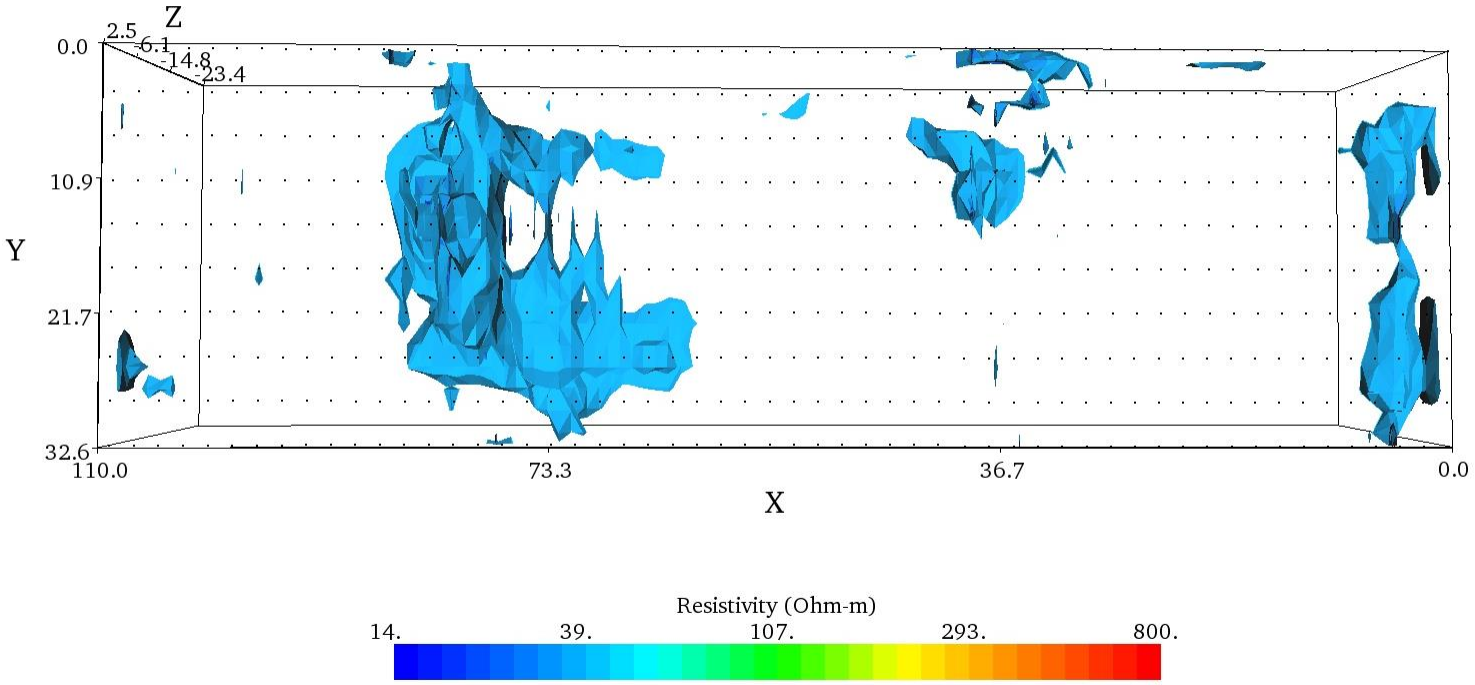
Resistivity values closely associated with Clays found in boreholes



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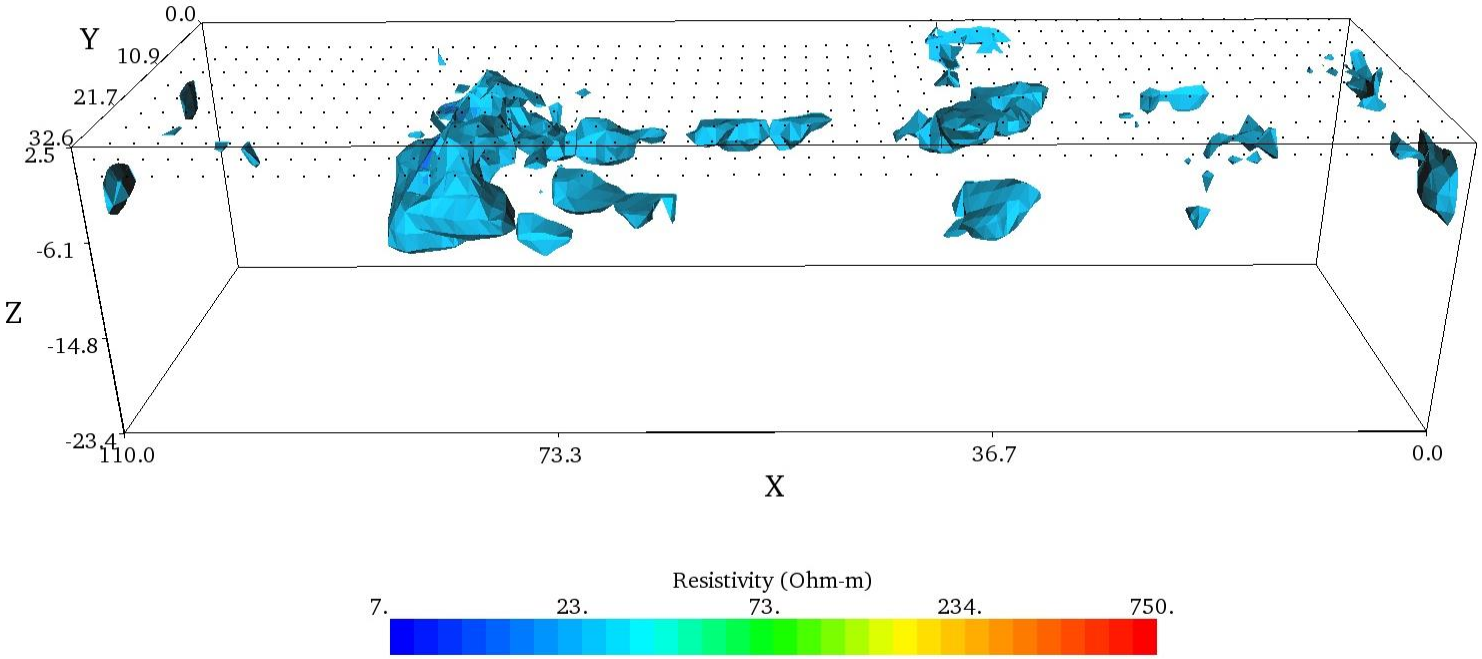

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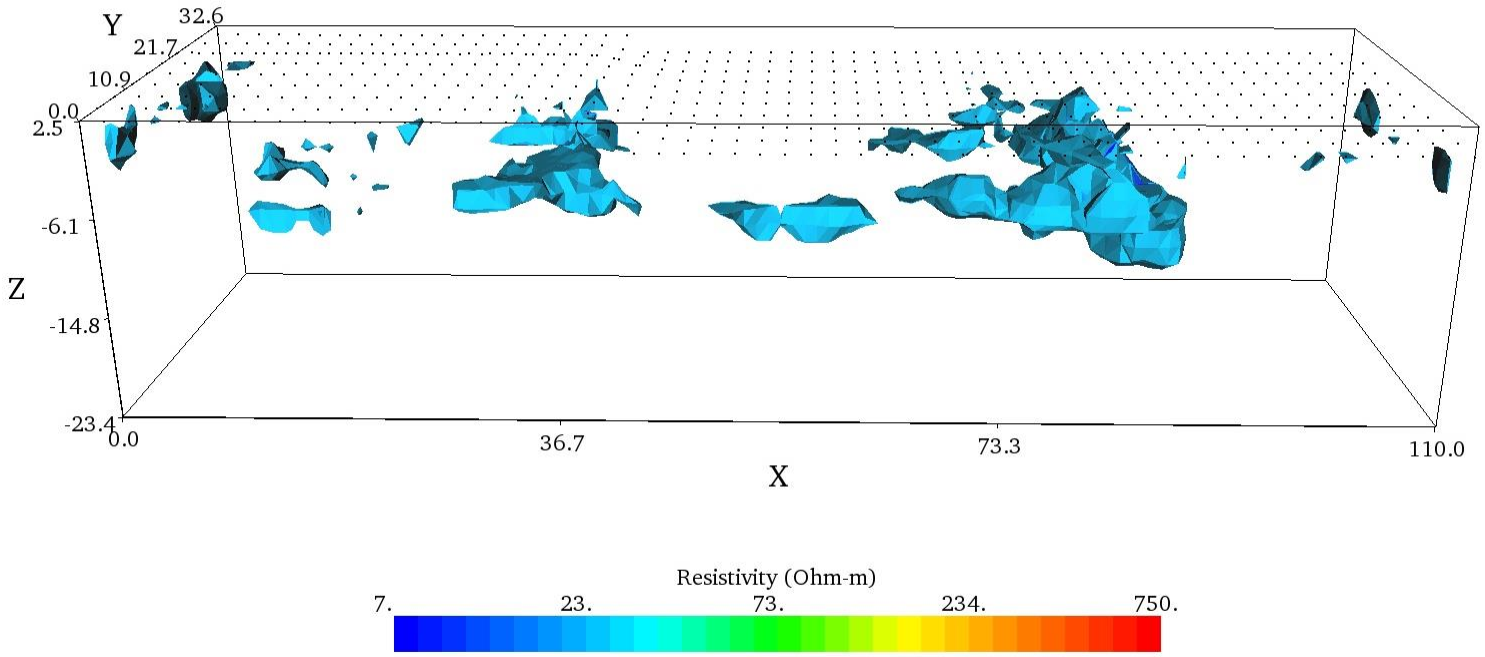

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