



# **Tying Together Lab and Field Measurements of Vs and Resistivity for Levee Evaluation**

NHERI@UTexas 3D Levee Imaging Workshop

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# Outline

## **FIELD AND LABORATORY MEASUREMENTS OF RESISTIVITY**

- Laboratory Measurement Methods – Benchmark Soils
- Factors Affecting Resistivity
- Comparison of Field and Laboratory Values

## **FIELD AND LABORATORY MEASUREMENTS OF VS**

- Laboratory Measurements
- Factors Affecting Shear Wave Velocity
- Comparison of Field and Laboratory Values



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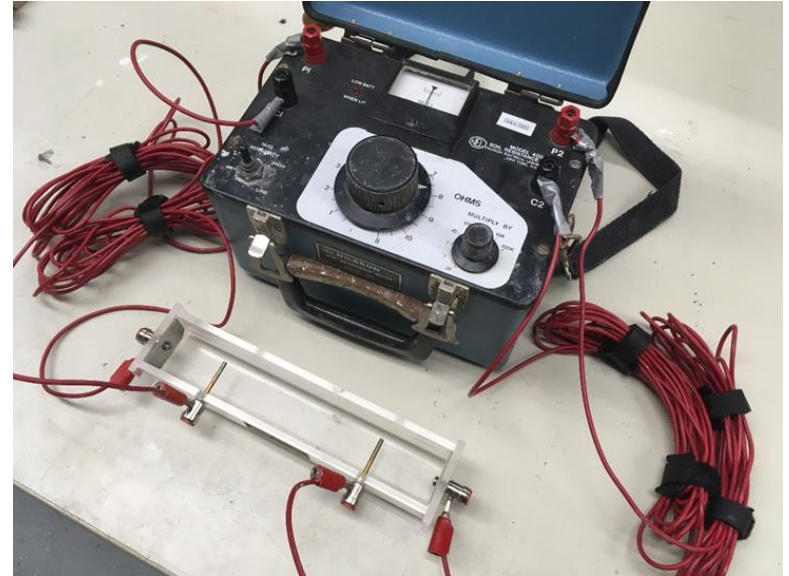
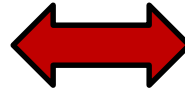
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# Field and Laboratory Measurements of Resistivity



**Resistivity measurements indicate the relative ability of a medium to carry electrical currents.**



# Resistivity of Soils and Rocks

## Typical Electrical Resistivities of Earth Materials

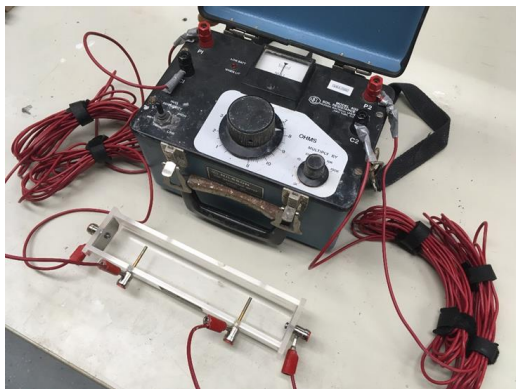
Material	Resistivity ( $\Omega\text{m}$ )
Clay	1-20
Sand, wet to moist	20-200
Shale	1-500
Porous limestone	100-1,000
Dense limestone	1,000-1,000,000
Metamorphic rocks	50-1,000,000
Igneous rocks	100-1,000,000



# Laboratory Measurements of Resistivity

## EQUIPMENT

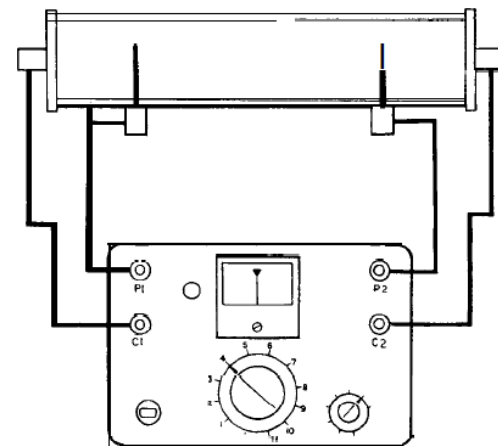
- 4-Terminal Resistance Meter (Nilsson 400 or Miller 400A/D)
- M.C. Miller Large Soil Box (1.5" W, 8.75" L, 1.25" D)
- Stainless steel current distribution plates, brass pins, and test leads



## SETUP

- 2-electrode method (ASTM G187-12a or AASHTO T-288)
- 4-electrode method (ASTM G57-06)

### 4-Electrode Wenner Array





## RESISTIVITY IN LARGE SOIL BOX:

$$\textit{Resistivity} = \textit{Resistance} \left( \frac{A}{L} \right)$$

A=cross-sectional area=12.8 cm<sup>2</sup>

L=separation between pins=12.8 cm

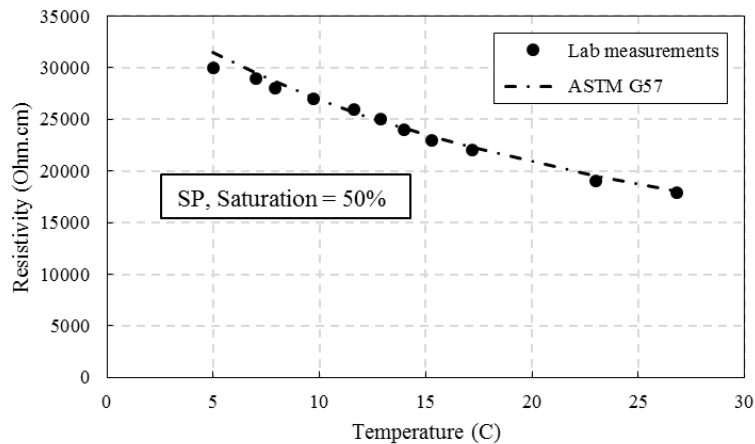
$$\textit{Sample Resistivity}(\Omega \cdot \textit{cm}) = \textit{Measured Resistance}(\Omega) \times 1\textit{cm}$$



## RESISTIVITY IS A FUNCTION OF:

- Water type (presence of salts or other chemicals)
- Temperature
- Water content
- Density or porosity

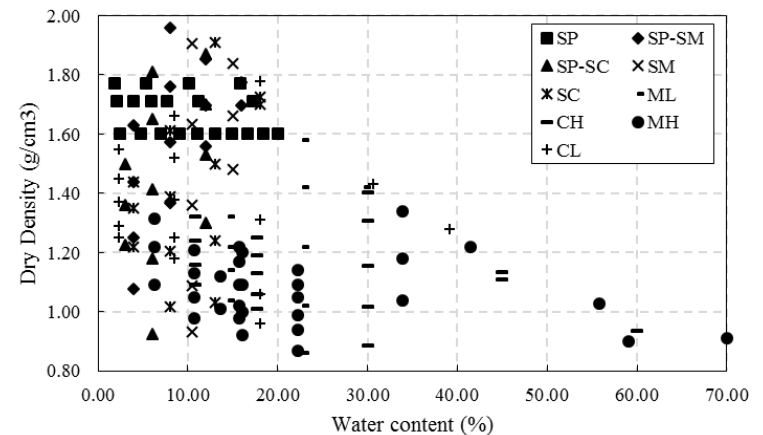
### TEMPERATURE



### WATER

Water Type	Resistivity ( $\Omega.cm$ )
Distilled	7520
Tap (AR)	7550
Well (AR)	8370
Well (TX)	7110
Ground (Loke, 1999)	1,000-10,000
Sea	20

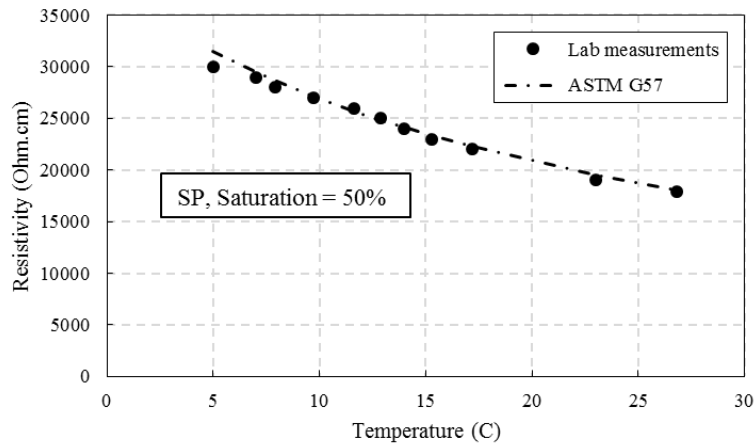
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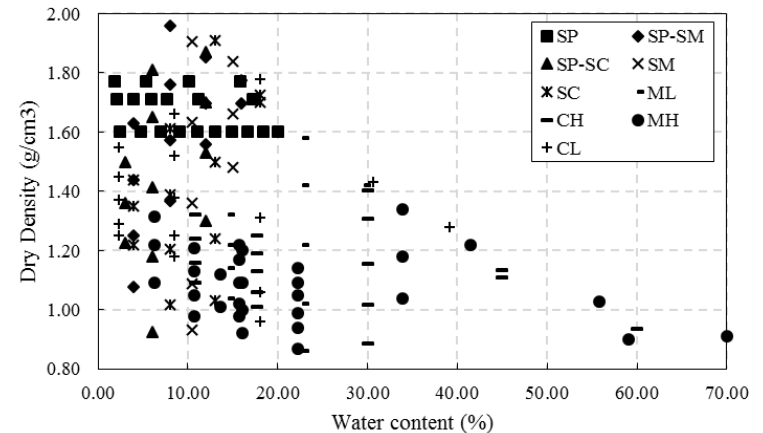
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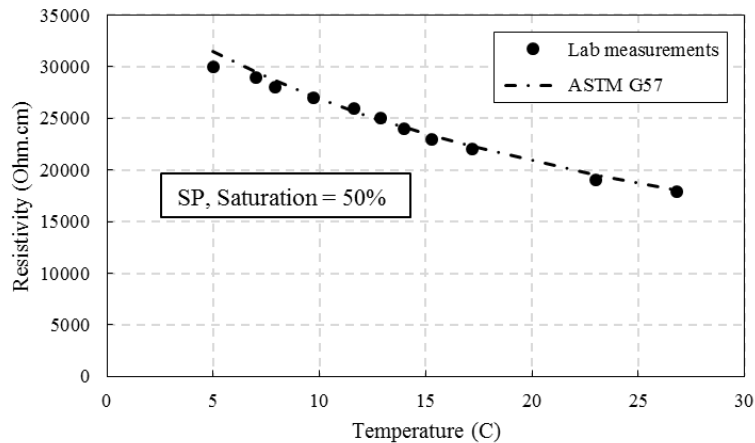
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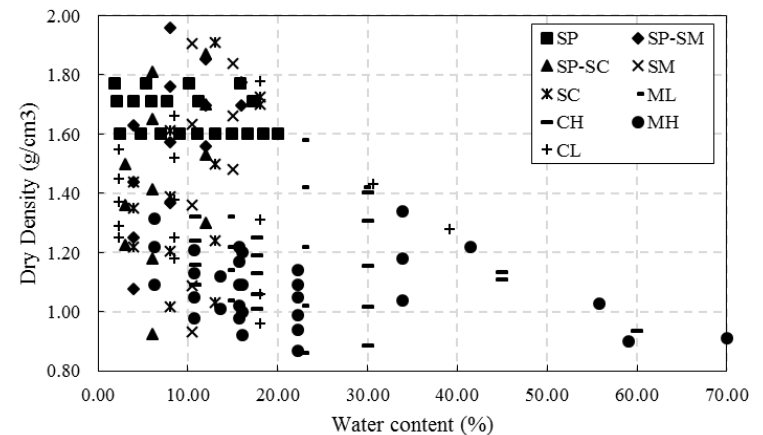
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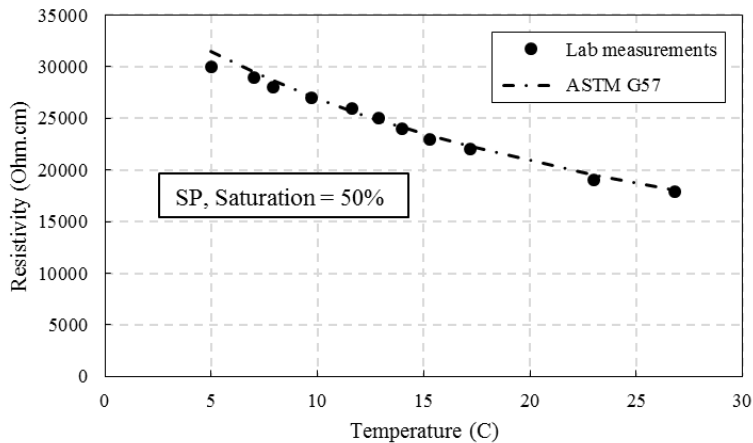
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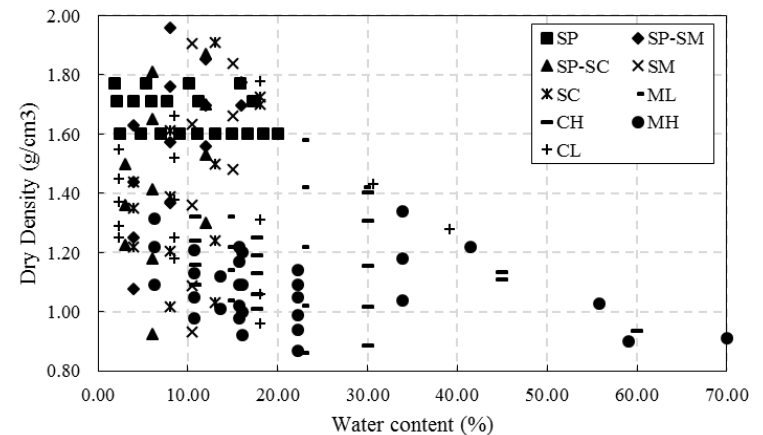
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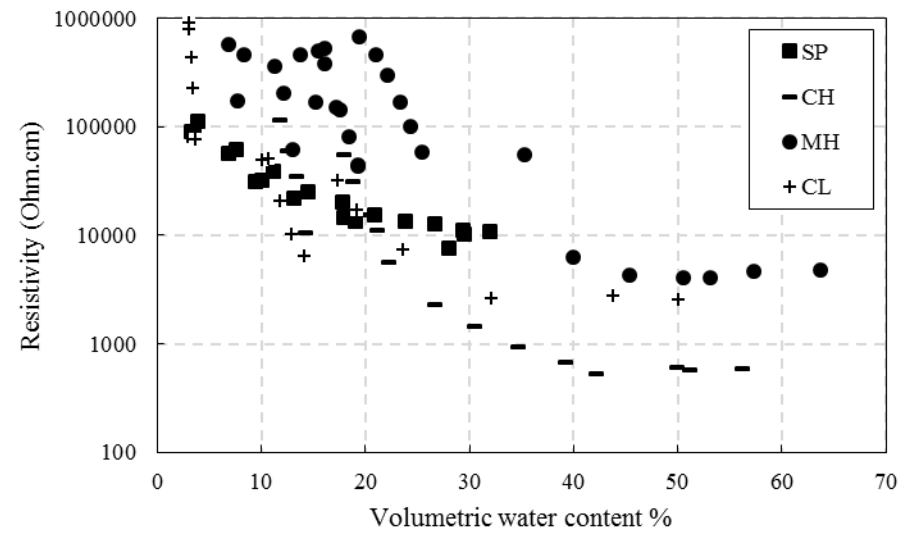
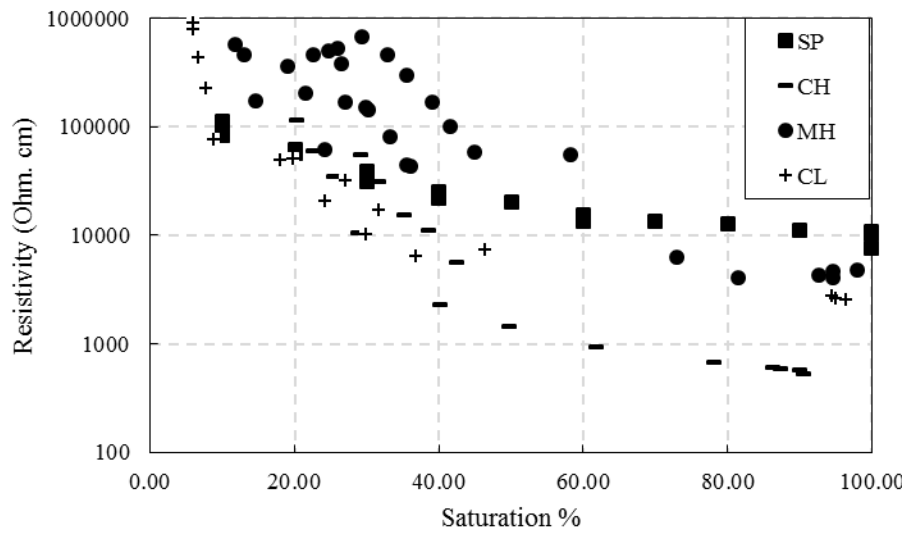
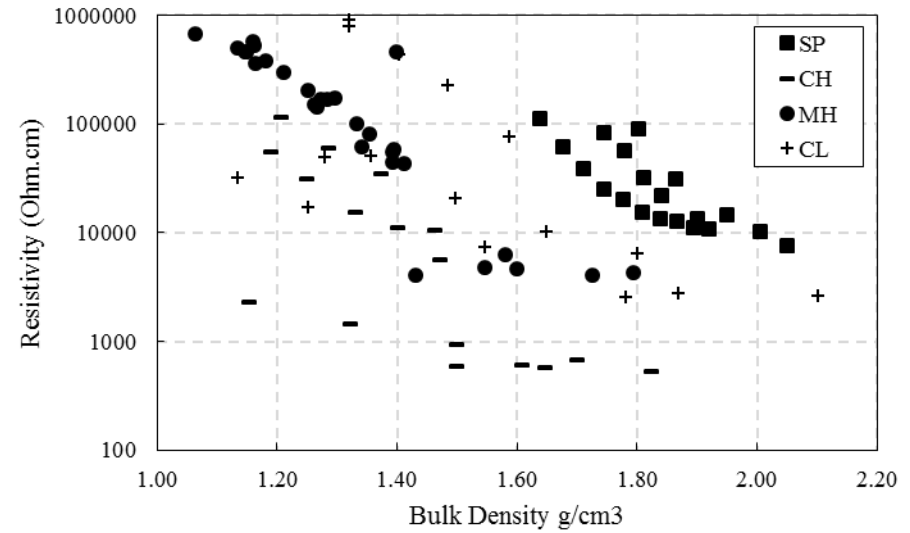
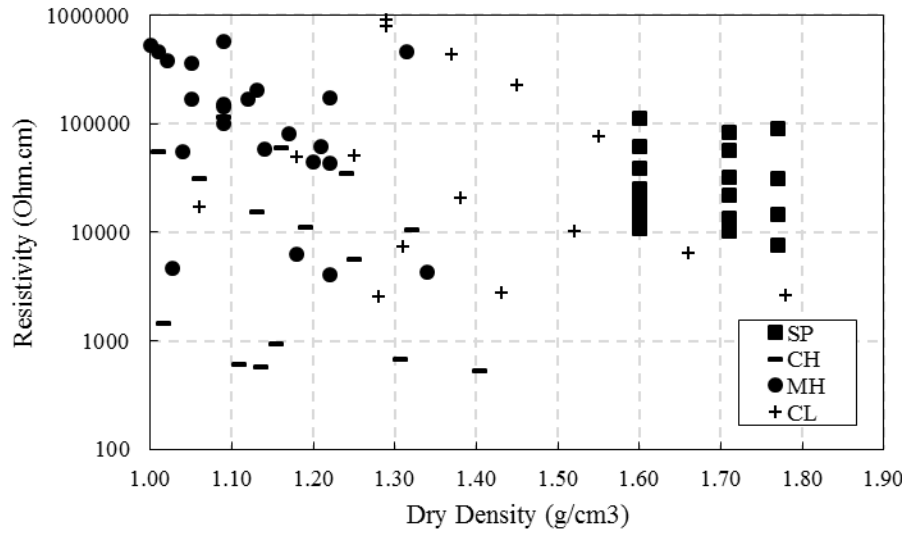


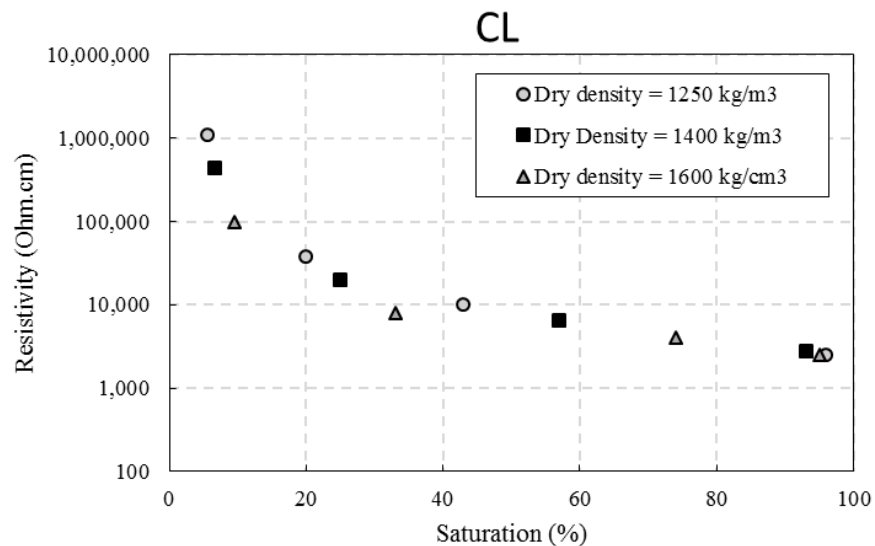
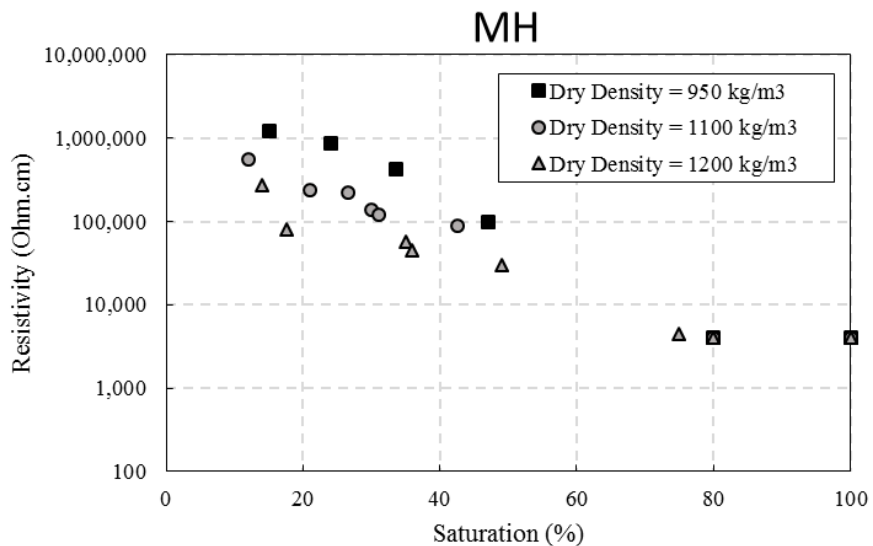
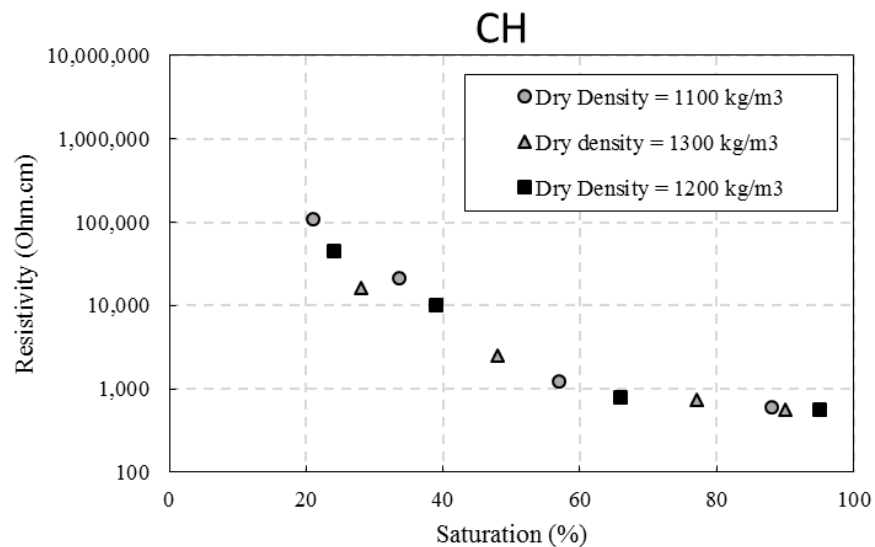
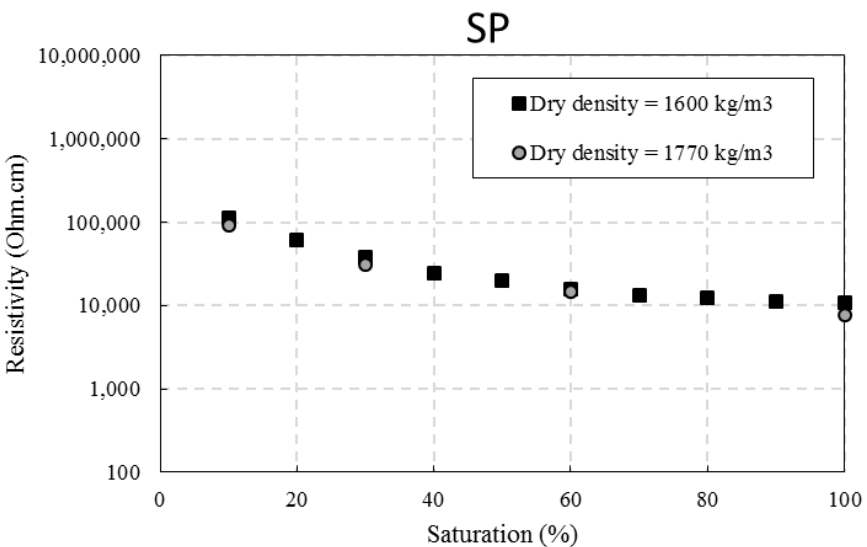
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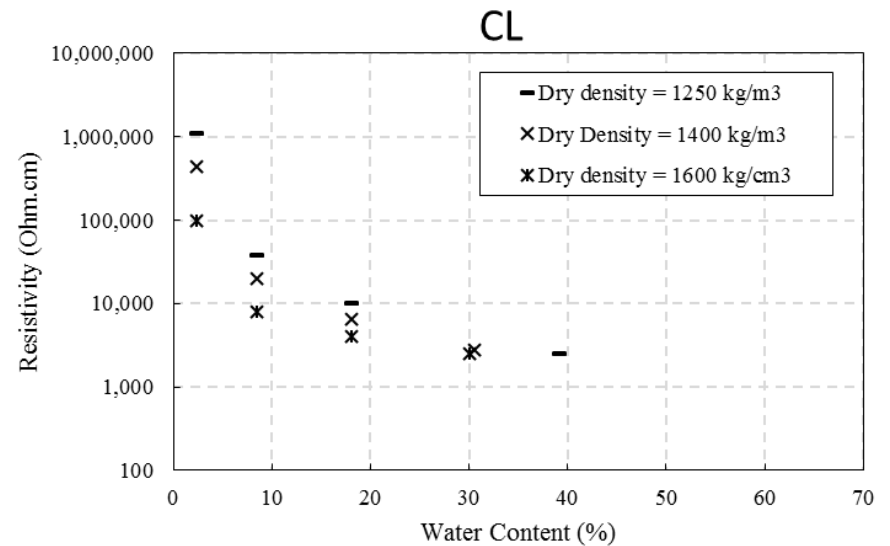
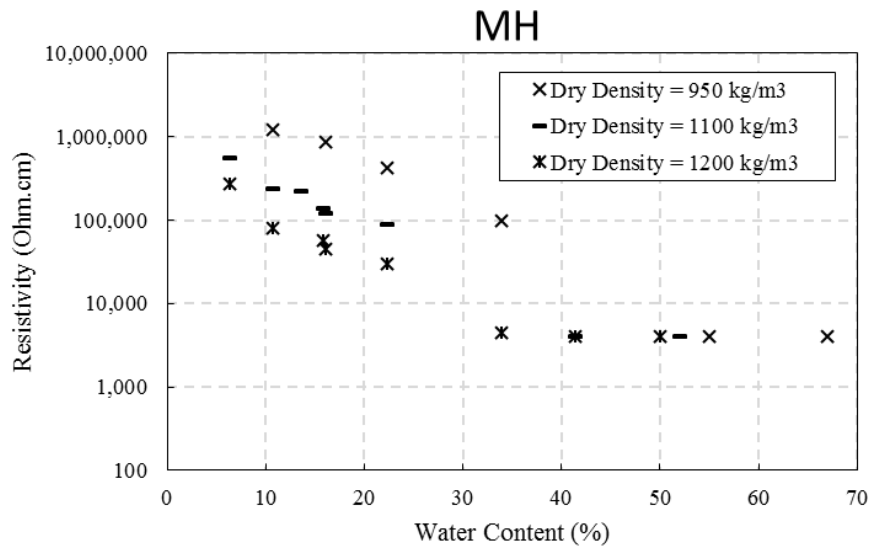
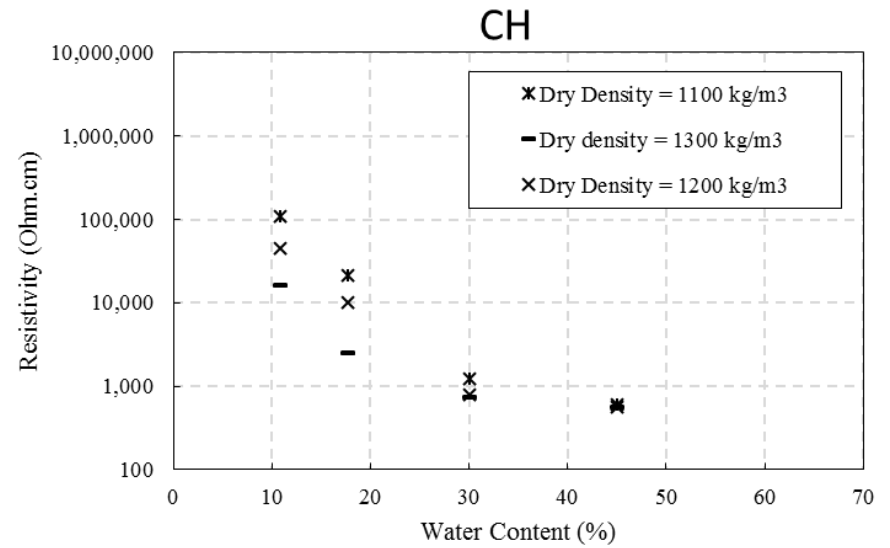
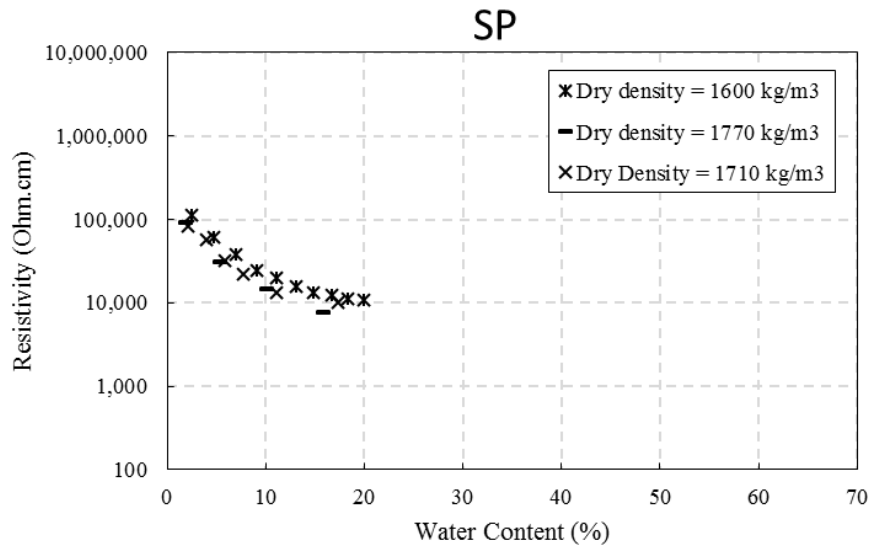
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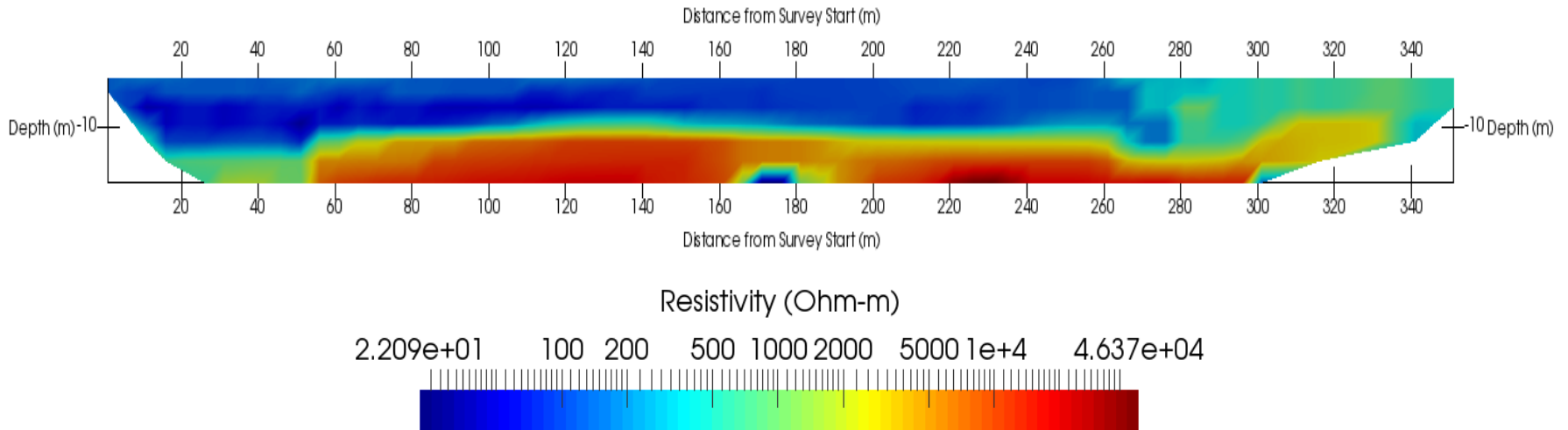
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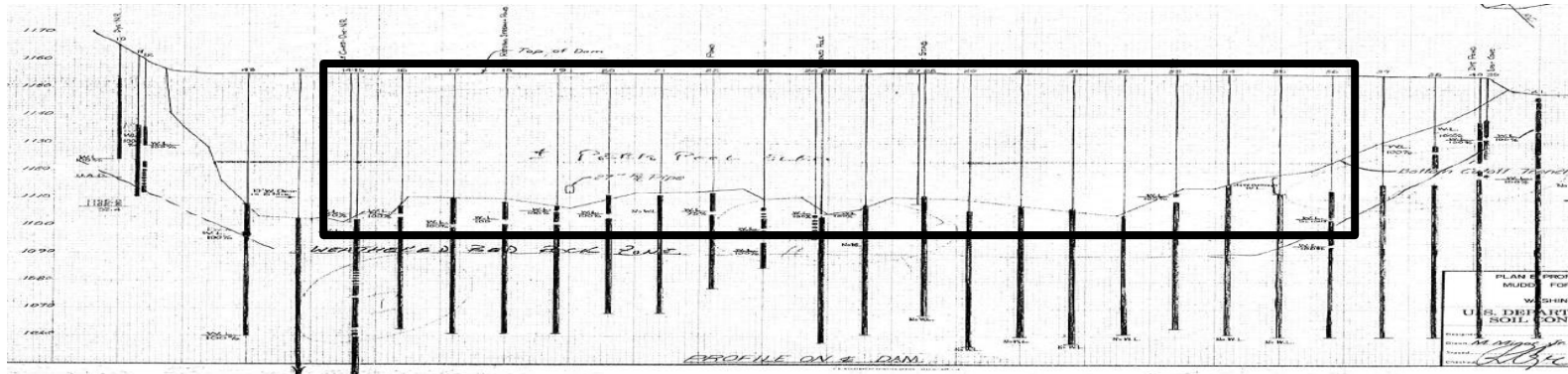
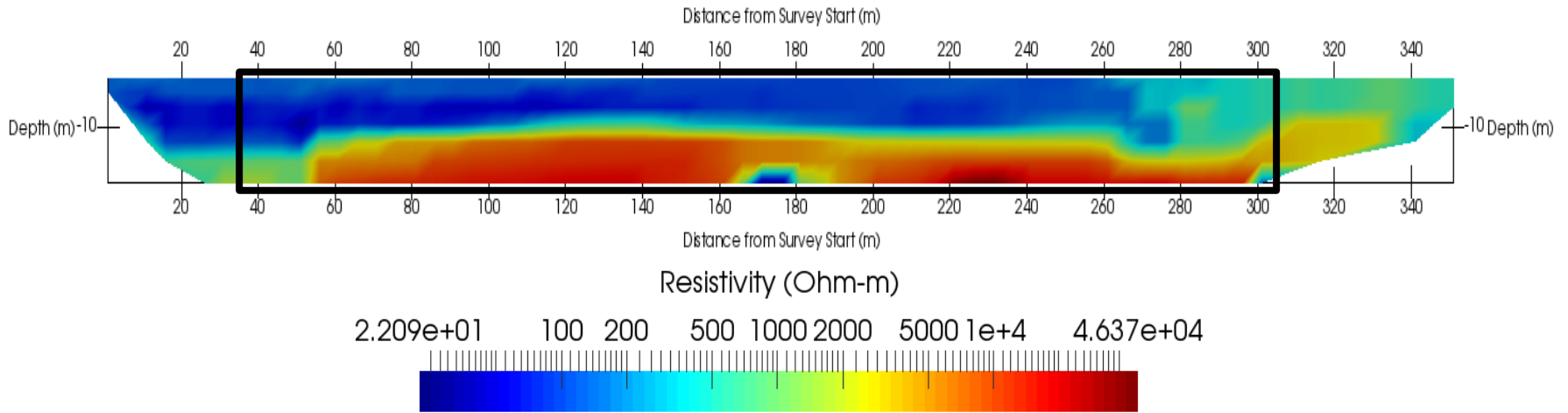


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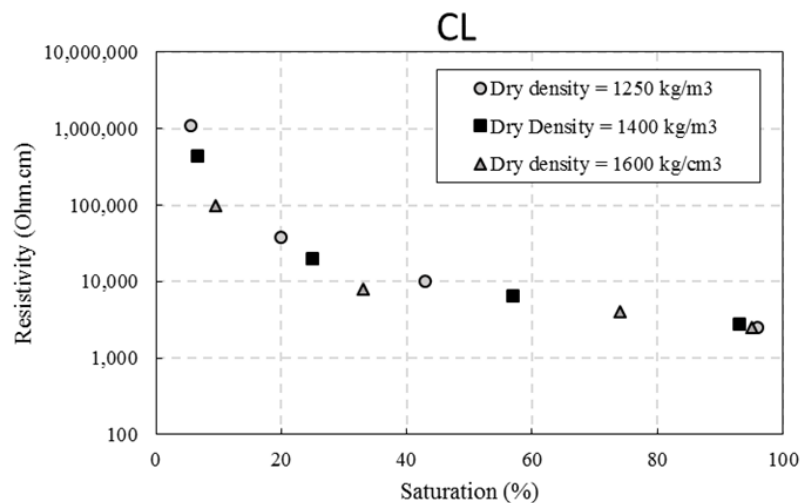
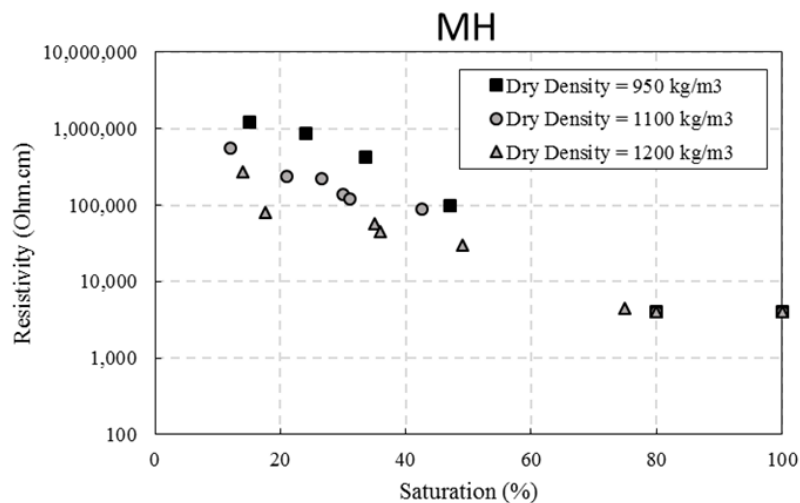
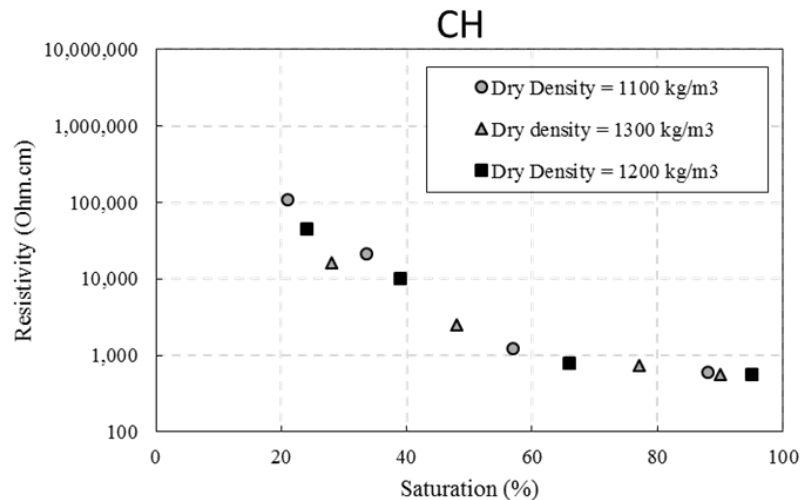
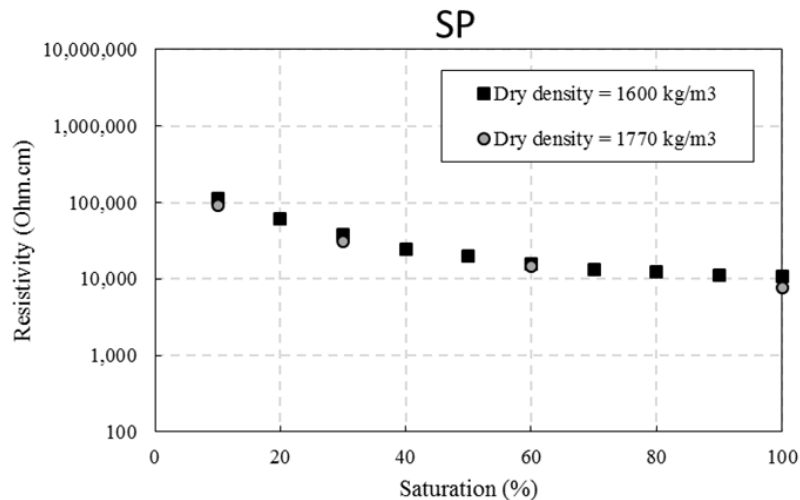


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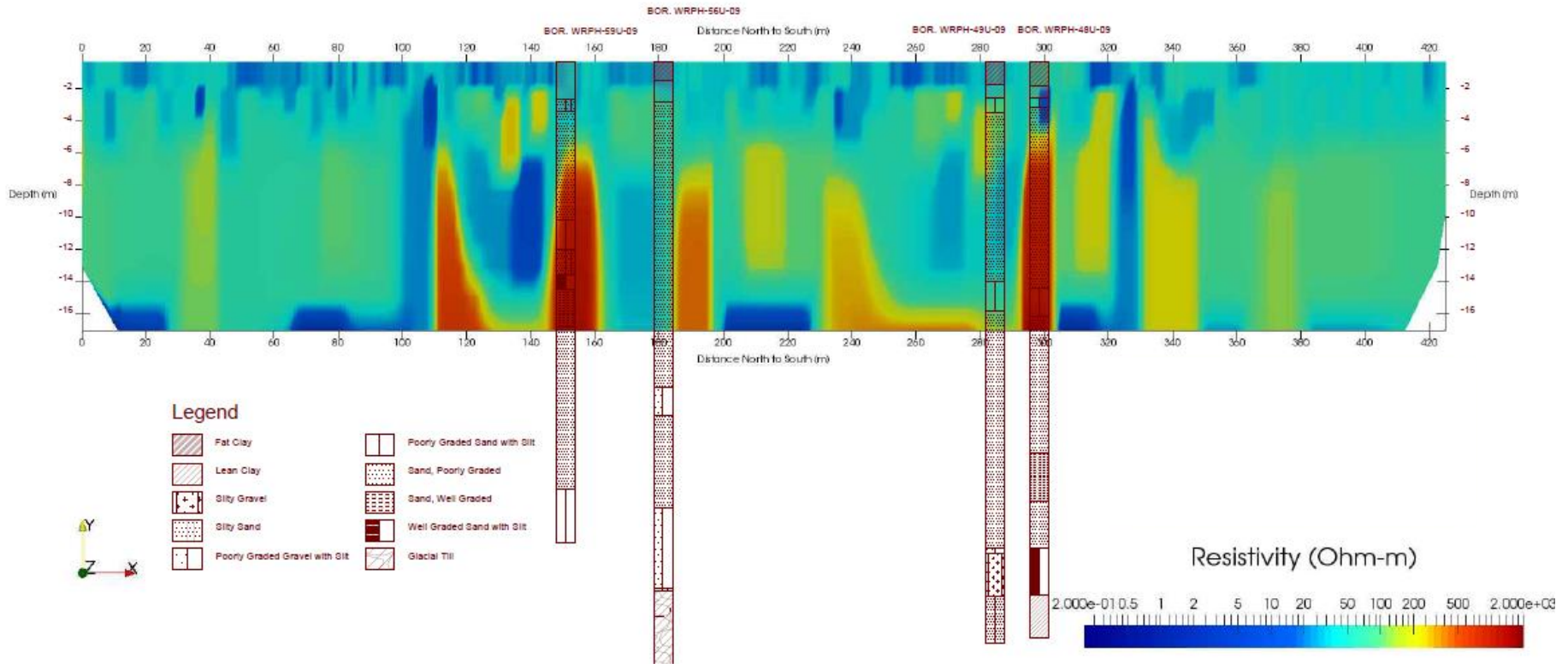


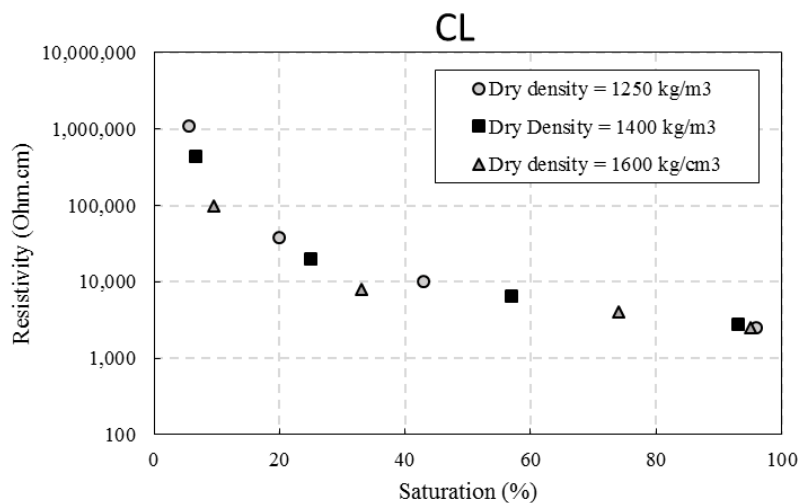
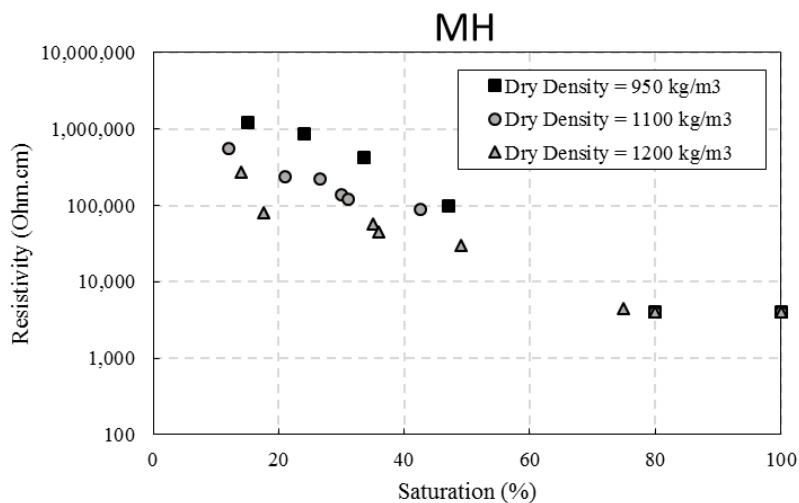
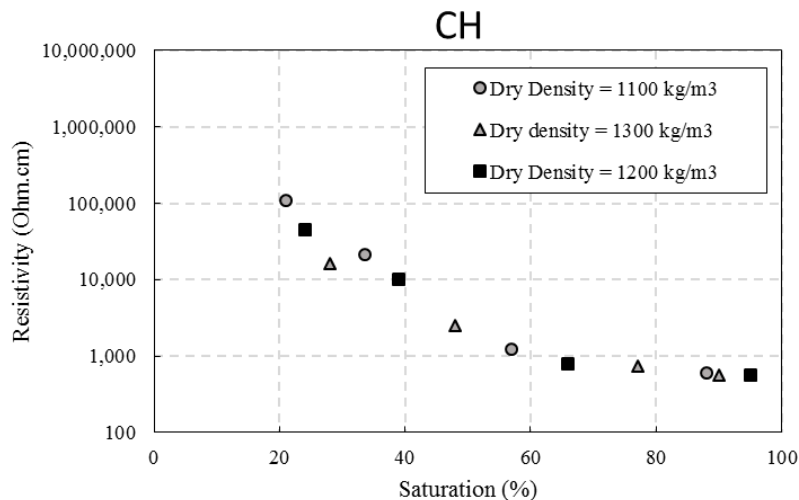
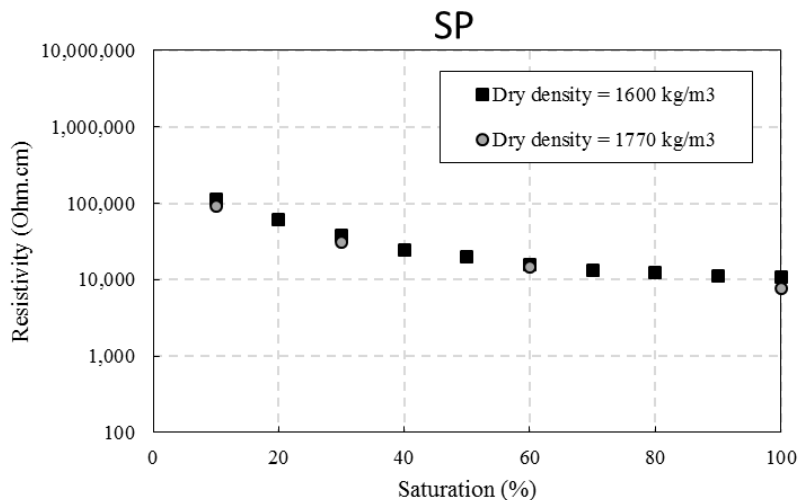


# Tying Together Field and Laboratory Measurements

## Mel Price-Wood River Levee









# Field and Laboratory Measurements of Vs

## Laboratory

- Bender Element Tests on Benchmark Samples
- Resonant Column

## Field

- MASW

# Field and Laboratory Measurements of Vs

## Laboratory

- Bender Element Tests on Benchmark Samples
- Resonant Column

## Vs depends on:

- Density or Void Ratio
- Confining Pressure

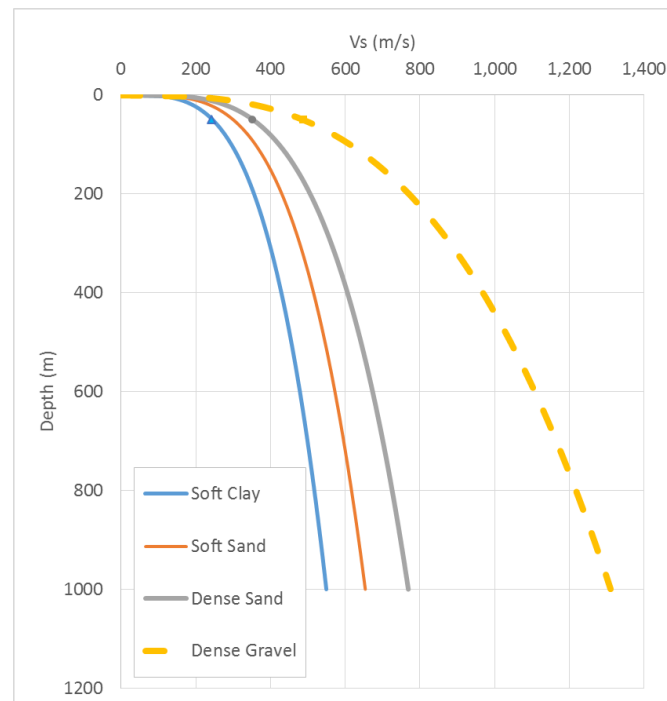
$$v_s = A_s (\sigma'_0 / P_a)^{n_s}$$

$A_s = v_s @ 1 \text{ atm}$

$n_s = \text{exponent of normalized effective mean stress}$

## Field

- MASW



## References:

- Menq (2003)
- Lin et al. (2008)
- Lin et al. (2014)
- Hardin & Richart (1963)

# Acknowledgements

**Behdad Mofarraj**

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