Characterizing Delta Aquifers and Streams

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US Geological Survey - Lower Mississippi Gulf WSC
Mississippi Alluvial Plain Water Availability Project

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Project Components

- Groundwater levels
- Water budget
- Uncertainty and data worth
- Hydrogeologic Framework
Hydrogeologic Framework

- Framework
  - Recharge
  - Surface-water/groundwater exchange
  - Aquifer delineation

- Geophysical mapping
  - Borehole geophysical logs
  - Surface geophysical mapping
    - Ground-based
    - Waterborne
    - Airborne
Geophysical Properties

<table>
<thead>
<tr>
<th>Gamma-Ray</th>
<th>Resistivity</th>
<th>Cuttings</th>
<th>Geology</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Clay</td>
<td>MRVA</td>
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<td></td>
<td></td>
<td>Sand</td>
<td>Mississippi River Valley Alluvium</td>
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<tr>
<td></td>
<td></td>
<td>Coarse Sand</td>
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<td></td>
<td></td>
<td>Large Gravel</td>
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<td></td>
<td></td>
<td>Silty Clay</td>
<td>SPRT</td>
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<td></td>
<td></td>
<td>Sand</td>
<td>Sparta</td>
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<tr>
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<td>Sand</td>
<td>ZLPH</td>
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<tr>
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<td>Clay</td>
<td>VINON</td>
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</tbody>
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Jim Hoffman, MDEQ, written communication, 2016

Preliminary information—Subject to revision. Not for citation or distribution.
Hydraulic Properties

Permeability, in cm/sec

Grain Size, in mm

Clay ↔ Sand

Krinitzky and Wire, 1964
Surface Geophysical Mapping

- **Ground-based**
  - Shallow surveys ~30 ft below land surface
    - Tallahatchie River – 19.3 mi
    - Central Delta – 22.5 mi
  - Deep surveys ~300-600 ft below land surface
    - Tallahatchie River – 2 mi
    - Central Delta – 64 mi

- **Waterborne**
  - River Surveys ~60 ft below water surface
    - Tallahatchie – 37 mi
    - Quiver – 31 mi
    - Sunflower – 43 mi
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Geomorphology from Saucier (1994)
http://lmvmapping.erdc.usace.army.mil/
Sunflower River: Alternating high and low resistivity values

Tallahatchie River: Relatively higher resistivities

Quiver River: Relatively low resistivity values

High resistivity values are displayed as cooler colors and low resistivity values are warmer colors

Waterborne resistivity survey
Shallow ground-based resistivity survey

Lower resistivity values in areas with clay-rich Holocene backswamp deposits (Hb)

Higher resistivity values in areas with sandier Holocene point-bar deposits (Hpm)
Waterborne and shallow ground-based resistivity survey
Pilot Study

- Characterize the aquifer system
- Evaluate potential sources of groundwater recharge
  - Infiltration of precipitation and irrigation water
  - Surface-water/groundwater exchange
- Use geophysical data to develop a high-resolution hydrogeologic framework
Pilot Study

Waterborne resistivity profile
Pilot Study

Waterborne resistivity profile

Shallow ground-based resistivity profiles
Pilot Study

Waterborne resistivity profile

Deep ground-based resistivity profiles
Pilot Study

Waterborne resistivity profile

Shallow ground-based resistivity profiles

Deep ground based resistivity profiles

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Pilot Study

Deep ground-based resistivity, Profile 1
Deep resistivity profiles provide an image of the entire thickness of the alluvial aquifer as well as the base of the aquifer.
Three-dimensional image resistivity data from pilot study survey.

Low resistivity values in the gridded shallow ground-based survey indicate an area of surficial clays with high clay content.
Three-dimensional image resistivity data from pilot study survey.

Shallow ground-based resistivity shows good correlation to deep resistivity profiles.
Low resistivity values in the streambed indicate an area where surface-water/groundwater exchange could potentially decline.

Relatively higher resistivity values near the streambed indicate an area where surface-water/groundwater exchange could potentially increase.

Aquifer base Clay

Aquifer Sand
Large-Scale Mapping

Ground-based surveys

- Resistivity methods can be used to
  - Map near-surface sands and clays controlling recharge
  - Map the extent and thickness of the alluvial aquifer
  - Determine the degree of stream connectivity with the alluvial aquifer

How do we map the entire aquifer system?
Airborne Surveys
Potential Airborne Geophysical Survey for the MAP
Questions

Contact: Wade Kress wkress@usgs.gov

For more information:
https://www.usgs.gov/water/lowermississippigulf/map

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References

- Saucier, 1994, Geomorphology and quaternary geologic history of the Lower Mississippi Valley, vol 1. US Army Engineers Waterways Experiment Station, Vicksburg, MS, 398 pp