Preliminary Results from Helicopter Electromagnetic Surveys Over a Paleovalley Aquifer in Eastern Nebraska

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Project Objectives
- Map shallow hydrogeologic units, in particular gravel and sand aquifers, within and below glacial deposits.
- Map potential groundwater recharge areas in a glacial setting.
- Compare connection between aquifers and streams, and between different aquifers.
- Understand the connection between aquifers and streams, and between different aquifers.
- Map potential groundwater recharge areas in a glacial setting.

Relevance to Water in Nebraska
- Shallow groundwater resources in eastern Nebraska, where groundwater resources are limited.
- Much of the groundwater resources in eastern Nebraska is from paleovalley aquifers within and below glacial deposits. These aquifers can be laterally discontinuous and are composed of high-velocity material that may not allow water to move in and out of the aquifer.
- The paleovalley aquifers have highly variable spatial and are hydrogeologically heterogeneous.
- Delamination of paleovalley aquifers is critical for management purposes. Contamination in the surface area will diffuse to these aquifers and degrade their water quality. The severity of this contamination may also be limited to the spatially confined nature of paleovalleys.

Helicopter Electromagnetic System
- Helicopter Electromagnetic (HEM) surveys were conducted at three pilot study sites. In 2007 to evaluate mapping technologies in a variety of geologic terrains.
- These surveys showed:
  - The maximum depth of mapping for HEM applications is controlled by the amount of 60 Hz or the glacial overburden.
  - Shallow (60 Hz) sand and gravel aquifers can be mapped in greater detail than possible using available remote-sensing techniques and at a lower cost than with a seismic profiling campaign.
  - Two new sites were flown in 2008: Swedeburg and Crete-Princeton-Adams areas.

Helicopter Electromagnetic System
- The transmitter and receiver are encased in a tube called a "tad" that is towed 30 m behind the helicopter.
- Six frequencies were transmitted (400, 1,800, 3,300, 8,200, 40,000, and 140,000 Hertz).
- The survey was in 2007 and 2008 used different frequency bands (e.g., 20,000 and 110,000 Hz for 2007, and 40,000 and 144,000 Hz for 2008).
- The helicoidal effect data has been collected with the Helicoidal data smoother algorithm to evaluate the correlation with streamflow hydrology. There is, however, and remote correlation with regional features in the 400-hertz baseline data in the east central US.
- High precision remote geographic positioner (both the helicopter and bird) and laser altimeter (on the bird) can create "adjacent" geophysical inversion maps.
- The flight path varies slightly to avoid known possible sources of cultural noise such as metal buildings and power transmission lines.

Preliminary Results
- Hydrogeologic features (paleovalleys) are mapped by the HEM apparent resistivity.
- Apparent resistivity maps show greater detail in spatial mapping than is available from well logs.
- Discrete resistivity units are mapped in the Swedeburg area, and:
  - The interpretation of the paleovalley features; as illustrated by the Crete-Princeton-Adams aquifer, is complex and will require an integrated interpretation based on hydrology, geology, and geophysics.

Swedeburg HEM Resistivity Maps
- This map shows the apparent resistivity of the subsurface as measured at 8,200 Hz. The survey area is ~ 78 km (30 mi) wide, and east and west across the paleovalley. These aquifers can be laterally discontinuous and are composed of high-velocity material that may not allow water to move in and out of the aquifer.
- The overlap between the Crete-Princeton-Adams Ground Water Reservoir (CPA GW) and the Nadler and Sallamado Wells (CPA GW) within a study area of 78 km (30 mi) wide, and east and west across the paleovalley. These aquifers can be laterally discontinuous and are composed of high-velocity material that may not allow water to move in and out of the aquifer.
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Crete-Princeton-Adams Paleovalley Aquifer Site
- The location of the paleovalley is indicated by high resistivity features that are consistent with regional observations and are mapped with the HEM data from this project.
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Swedeburg area viewing Todd Valley to the northeast.

Crete-Princeton-Adams groundwater reservoir within Lower Platte South Natural Resources District
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