Preliminary Results of Hydrogeologic Framework Studies for Determining Surface Water - Ground Water Relationships in the Glaciated Region of Eastern Nebraska Using Airborne and Ground Geophysics

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Introduction

Project Objectives

- Understand ground-water and surface-water relationships in the Glaciated Region of eastern Nebraska
- Evaluate helicopter electromagnetic (HEM) surveying as a tool for mapping hydrogeology in three test areas with different glacial terrains
- Develop plans for future surveys that will cover large areas of eastern Nebraska

Relevance to Water in Nebraska

- Integrated ground-water and surface-water management – Define the connection
- Aquifer delineation – location, type, depth
- Water supply - 70 percent of Nebraskans live within the ENWRA area where water resources are severly limited
- Water quality - agricultural impact, salt water intrusion, surface water influence on ground-water supply and point source contamination

Materials and Methods

HEM Survey Firth, April 2007



Helicopter

- Digital video
- 2 GPS systems
- Barometric/radar altimeters

HEM Survey System (the "Bird")

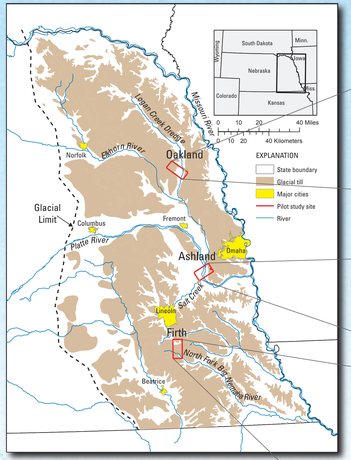
- Six EM frequencies from 400 - 100,000 Hz
- Internal total field magnetometer
- High Resolution GPS
- Laser Altimeter

HEM Survey Fremont, April 2007



ENWRA HEM Evalutation Sites

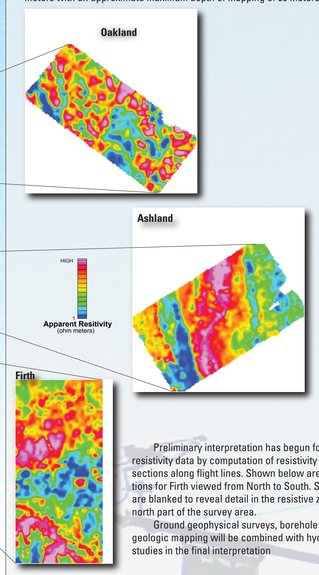
The HEM survey sites are shown here superimposed on the regional glacial drift map which gives an indication of the extent that bedrock is concealed.



HEM Surveys at Oakland, Ashland and Firth Sites

HEM Resistivity Maps

The color maps are of the apparent resistivity (ρ_a) at 100,000 Hz (100 kHz) which is most sensitive to a depth of about 2 meters. Variations in ρ_a reflect the surface geology which generally is low resistivity material, limiting the depth of exploration of the airborne resistivity mapping. The high resistivity (reds in color bar) for the Oakland and Firth maps is 20 ohm meters where approximate maximum depth of mapping is 60 meters. In the Ashland map, reds on the color bar (high) are 75 ohm meters with an approximate maximum depth of mapping of 80 meters.

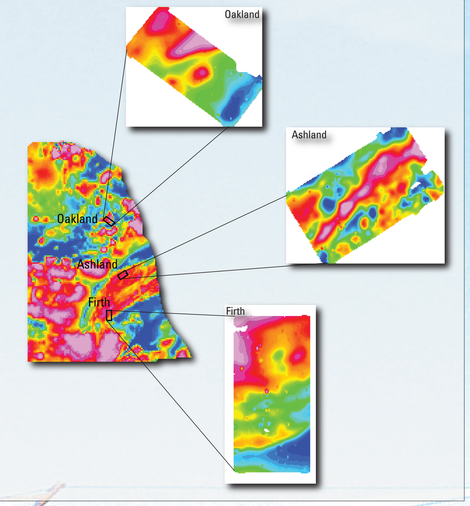


Preliminary interpretation has begun for the HEM resistivity data by computation of resistivity - depth sections along flight lines. Shown below are the sections for Firth viewed from North to South. Some lines are blanked to reveal detail in the resistive zone in the north part of the survey area.

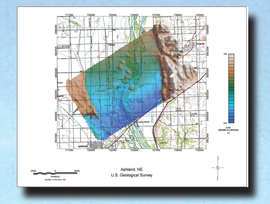
Ground geophysical surveys, borehole logs and geologic mapping will be combined with hydrologic studies in the final interpretation

Total magnetic field reduced to the magnetic pole

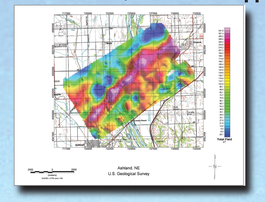
The HEM survey data includes magnetic field measurements which have been processed and reduced to the magnetic pole (as has the state map). The warmer colors are magnetic highs. The large magnetic responses (red areas) are mostly related to features in the crystalline bedrock. This part of the survey data can be used to infer deep bedrock features that may control shallower hydrologic features.



Digital Elevation Model for Ashland, (shallow mapping)



Total Magnetic Field for Ashland, (basement mapping)



HEM Supporting Data and Applications

Supporting Data

- Time domain surveys - 12 per Township
- Test holes with borehole geophysical logs - 10 to 12 per Township
- Monitoring wells - multi-level wells for quality and water levels with six per township
- Existing reports - bibliography, regional and local publications
- Well database - State of Nebraska registered wells database

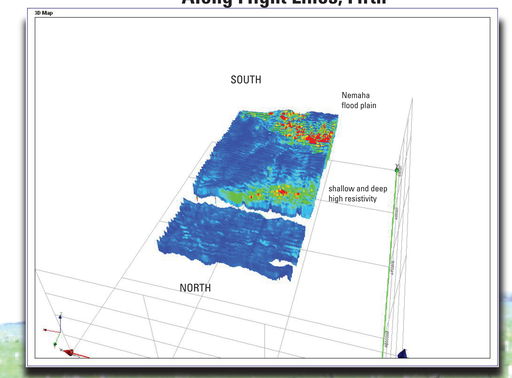
Relating HEM Surveys to Hydrogeology

- Extent and distribution of aquifers as they relate to surface water features
- Identification of potential areas of saline ground water
- Comparison of HEM to hydraulic conductivity

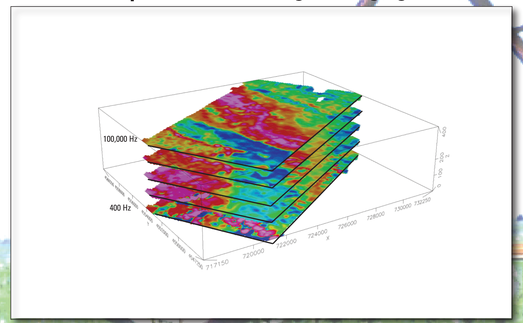
Comparison of Hydraulic Conductivity to HEM Resistivity

- Hydraulic conductivity is the ability of the sediment to allow water to move
- HEM resistivity values can be correlated with sediment type and water resistivity
- High hydraulic conductivity is related to high HEM resistivity values

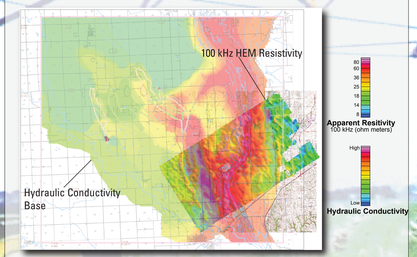
HEM Resistivity Depth Sections Along Flight Lines, Firth



Maps of Resistivity Values for Ashland HEM Survey at Different Frequencies Illustrating 3D Imaging



HEM Resistivity Overlain on Hydraulic Conductivity Map



Project Partners

- U.S. Geological Survey
- Conservation and Survey Division (University of Nebraska)
- Lower Platte South Natural Resources District
- Lower Platte North Natural Resources District
- Lower Elkhorn Natural Resources District
- Lewis and Clark Natural Resources District
- Nemaha Natural Resources District
- Papio-Missouri River Natural Resources District
- Nebraska Department of Natural Resources

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