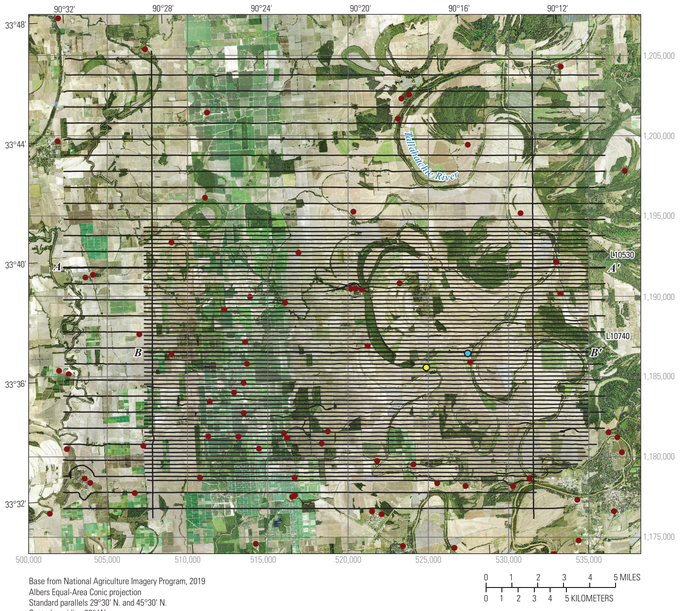
U.S. Department of the Interior
U.S. Geological Survey

Prepared in cooperation with the
USDA Agricultural Research Service

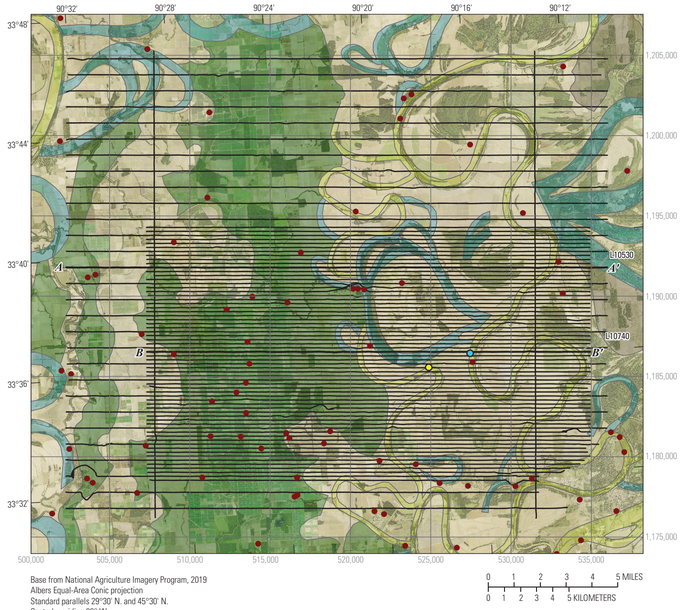
Scientific Investigations Map 3449
Sheet 1 of 2

Figure 3A. Airborne survey flight lines (black lines), section profile lines (sheet 2), borings (red dots), managed aquifer recharge study sites (yellow and blue dots), and aerial photo of the region.



Base from National Agriculture Imagery Program, 2019
Albers Equal-Area Conic projection
Standard parallels 29°30' N. and 45°30' N.
Central meridian 96° W.
World Geodetic System of 1984

Figure 3B. Airborne survey flight lines (black lines), section profile lines (sheet 2), borings (red dots), managed aquifer recharge study sites (yellow and blue dots), and surficial geologic map transparency overlying an aerial photo of the region.



Base from National Agriculture Imagery Program, 2019
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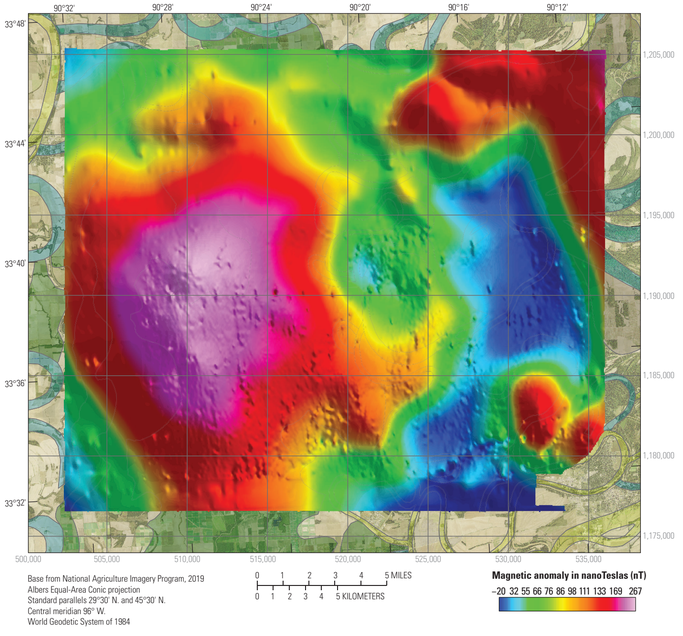
Figure 3C. Magnetic anomaly data (reduced to the pole) and surficial geologic map transparency overlying an aerial photo of the region.



Base from National Agriculture Imagery Program, 2019
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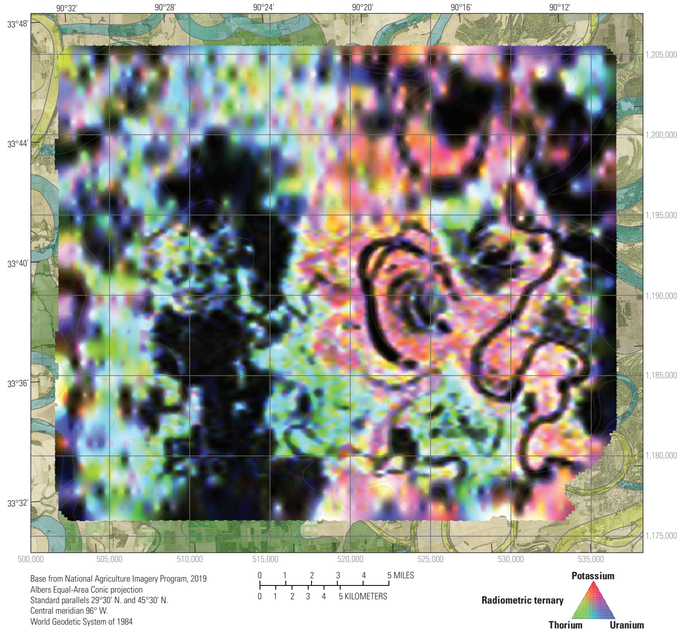
Figure 3D. Radiometric ternary data and surficial geologic map transparency overlying an aerial photo of the region.



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INTRODUCTION

In late February to early March 2018, the U.S. Geological Survey (USGS) acquired 2,364 line-kilometers (km) of airborne geophysical data in the Shellmound, Mississippi study area (fig. 1). The purpose of this survey is to contribute high-resolution information about subsurface geologic structure to inform groundwater models, water resource infrastructure studies, and local decision making. The Shellmound region hosts a managed aquifer recharge (MAR) pilot project, developed by the Agricultural Research Service of the U.S. Department of Agriculture. The MAR pilot project is investigating the use of bank filtration along the Tallahatchie River as a source for recharge in areas of significant groundwater decline. Direct injection into the Mississippi River Valley Alluvial aquifer (MRVA) occurs about 3 km from the extraction gallery. Understanding the structure of the aquifer, including both shallow and deep confining units, is important for the success of this pilot MAR study and may be even more important for potential future large-scale MAR projects and groundwater model development efforts.

METHODS

The airborne geophysical data were acquired by CGG Canada Services, Ltd. (Mississauga, Ontario, Canada) with three different helicopter-borne sensors: the CGG RESOLVE frequency-domain airborne electromagnetic (AEM) instrument (fig. 2) to map subsurface geologic structure at depths up to approximately 100 meters (m), depending on the subsurface resistivity; a Scintrex CS–3 cesium vapor magnetometer that detects changes in deep geologic structure (hundreds of meters to kilometers below the surface) based on variations in the magnetic properties of different formations; and a Radiation Solutions RS–500 spectrometer that detects the abundance of the natural radioelements potassium, uranium, and thorium in the upper 20–30 centimeters (cm), used to determine differences in soil constituents (Burton and others, 2019).

The AEM, magnetic, and radiometric data were acquired along parallel, east-west flight lines, with 250-m flight line spacing in the core study area and 1,000 m spacing in an outer buffer region (figs. 3*A* and 3*B*). At a nominal sensor height of 30 m above the ground surface and a flight speed of 80 kilometers/hour (km/hr), raw AEM soundings were acquired approximately every 3 m along the flight paths. The magnetic and radiometric data were acquired at sample rates of 10 and 1 Hertz (Hz), respectively, for actual, nominal along-flight path data densities of 4 and 35 m.

The AEM data were subsequently averaged to 25-m output samples to reduce noise and manually edited to remove coupling effects from infrastructure such as powerlines, pipelines, and other man-made features. These data were inverted using Aarhus Workbench (Aarhus GeoSoftware, 2019) to produce models of subsurface electrical resistivity.

MAGNETICS AND RADIOMETRICS

The residual magnetic intensity (RMI) data as provided by CGG (Burton and others, 2019) were despiked followed by application of a Fourier domain-based reduction to the pole algorithm to produce the magnetic anomaly map displayed. Additional detail on data processing is available in Burton and others (2019). The magnetic features observed in the RMI data (fig. 3*C*) are sensitive to geologic structure below the depth of investigation of the AEM resistivity models.

The ternary radiometric map (fig. 3*D*) consists of the low-pass filtered equivalent thorium, equivalent uranium, and potassium concentration data provided by CGG (Burton and others, 2019). Black generally indicates areas with low concentrations of all three radioelements, often associated with surface water. High concentrations of all three radioelements are indicated by white areas. The relative abundance of potassium is generally elevated near the existing river channels.

LIST OF MAP UNITS

[Figures 3*B*, 3*C*, and 3*D*; surficial geology from Wacaster and others (2018); colors on the maps may locally appear lighter due to transparency effects over the aerial photography]

SURFICIAL GEOLOGY

- **Qb** — **Backswamp deposits (Holocene)**—Floodbasin
- **Qchm** — **Mississippi River abandoned channels (Holocene)**—Neck and chute cutoffs
- **Qcom** — **Mississippi River abandoned courses (Holocene)**
- **Qp** — **Point bar deposits (Holocene)**—Meander scroll
- **Qvl** — **Late Wisconsin stage valley train (Pleistocene)**

EXPLANATION OF MAP SYMBOLS

[Figures 3*A* and 3*B*]

- **Airborne survey flight line**
- A L10740 A′ — **Airborne survey flight line cross section and identifier**
- **Borehole**
- **Proposed Tallahatchie River extraction site**
- **Proposed MRVA aquifer injection site**

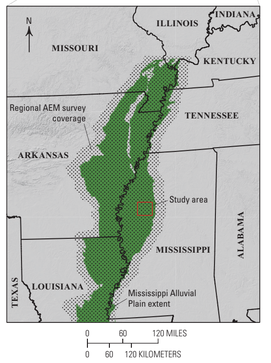

Figure 1. Location and extent of the regional airborne electromagnetic (AEM) survey (black dotted pattern) and the Shellmound airborne survey study area (red square). These features primarily lie within the Mississippi Alluvial Plain (shaded green) which extends south of the survey area.

Figure 2. CGG Canada Services, Ltd. RESOLVE, helicopter-borne, frequency-domain airborne electromagnetic instrument.

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High-Resolution Airborne Geophysical Survey of the Shellmound, Mississippi Area

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