IMPROVING ESTIMATES OF AQUIFER PROPERTIES IN THE MISSISSIPPI ALLUVIAL PLAIN USING BOREHOLE AND SURFACE NUCLEAR MAGNETIC RESONANCE

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Borehole and surface nuclear magnetic resonance (NMR) geophysical data were collected as part of a U.S. Geological Survey (USGS) regional water availability investigation of the Mississippi Alluvial Plain (MAP). NMR methods were used to estimate hydraulic properties and characterize subsurface hydrostratigraphy. Results were compared to logs from other geophysical methods including borehole gamma, electrical-resistivity, and electromagnetic-induction; transient electromagnetics (TEM); and waterborne electrical resistivity. Slim-borehole NMR tools were used in polyvinyl chloride-cased wells to measure hydraulic properties in the formation surrounding the borehole, including total-, mobile-, and bound-water contents, estimates of pore-size distribution, and hydraulic conductivity with depth. Conventional gamma and electric logs were complementary to the NMR and used for quality assurance.

Surface NMR (sNMR) measurements were made at several sites near Money, MS using a variety of circular and figure-eight loops with sensitivity to depths of 30-60 m. The sNMR data produced estimates of volumetric water content and pore-size distribution. The interpreted hydrostratigraphic layers from the sNMR measurements were consistent with the presence and thickness of a confining-type unit overlying a more coarse-grained aquifer and were validated by observations from nearby boreholes and TEM surveys.

It is important to collect multiple types of geophysical data to constrain the many possible characterizations of the subsurface. The combined multi-technique dataset is useful to assess quality of data from an individual method, interpret hydrostratigraphy, and constrain relationships between geophysical measurements and aquifer properties. In this study, NMR results will be compared to resistivity values from airborne and land-based TEM or waterborne electrical resistivity surveys. The goal of the comparison is to establish a relation between resistivity and NMR results and facilitate development of a petrophysical relationship between the resistivity and hydraulic conductivity. Resistivity values could then be used as a cost-effective surrogate for aquifer hydraulic conductivity values input into regional groundwater models.