A model of transmissivity and hydraulic conductivity from electrical resistivity distribution derived from airborne electromagnetic surveys of the Mississippi River Valley Alluvial Aquifer, Midwest USA

Scott J. Ikard1, Burke J. Minsley2, James, R. Rigby3, Wade H. Kress3

1. U.S. Geological Survey, Oklahoma-Texas Water Science Center, 1505 Ferguson Lane, Austin, TX, USA

Email: [sikard@usgs.gov](mailto:sikard@usgs.gov)

<https://orcid.org/0000-0002-8304-4935>

2. U.S. Geological Survey, Geology, Geophysics and Geochemistry Science Center, Denver Federal Center, Lakewood, CO, USA

Email: [bminsley@usgs.gov](mailto:bminsley@usgs.gov)

[https://orcid.org/0000-0003-1689-1306](https://gcc02.safelinks.protection.outlook.com/?url=https%3A%2F%2Forcid.org%2F0000-0003-1689-1306&data=04%7C01%7Csikard%40usgs.gov%7C633c2559d41144c251ba08d9f75042c7%7C0693b5ba4b184d7b9341f32f400a5494%7C0%7C0%7C637812746353484839%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C3000&sdata=5dp%2BJkSel9Ndy%2BsX0NMs0%2B8In5%2F3X0gyJdj9%2BiKxuX4%3D&reserved=0)

3. U.S. Geological Survey, Lower Mississippi Gulf Water Science Center, 640 Grassmere Park Drive, Nashville, TN, USA

Emails: [jrigby@usgs.gov](mailto:jrigby@usgs.gov); [wkress@usgs.gov](mailto:wkress@usgs.gov)

<https://orcid.org/0000-0002-5611-6307>; <https://orcid.org/0000-0002-6833-028X>

**Abstract**

Groundwater-flow models require the spatial distribution of the hydraulic conductivity parameter. One approach to defining this spatial distribution in groundwater-flow model grids is to map the electrical resistivity distribution by airborne electromagnetic (AEM) survey and establish a petrophysical relation between mean resistivity – calculated as a nonlinear function of the resistivity layering and thicknesses of the layers – and aquifer transmissivity compiled from historical aquifer tests completed within the AEM survey area. The petrophysical relation is used to transform AEM resistivity to transmissivity and to hydraulic conductivity over areas where the saturated thickness of the aquifer is known. The U.S. Geological Survey applied this approach to gain better understanding of the aquifer properties of the Mississippi River Valley alluvial aquifer. Alluvial-aquifer transmissivity data, compiled from 160 historical aquifer tests in the Mississippi Alluvial Plain (MAP), were correlated to mean resistivity calculated from 16,816 line-kilometers (km) of inverted resistivity soundings produced from a frequency-domain AEM survey of 95,000 km2 of the MAP. Correlated data were used to define petrophysical relations between transmissivity and mean resistivity by omitting from the correlations the aquifer-test and AEM sounding data that were separated by distances greater than 1 km and manually calibrating the relation coefficients to slug-test data. The petrophysical relation yielding the minimum residual error between simulated and slug-test data was applied to 2,364 line-km of AEM soundings in the 1,000-km2 Shellmound (Mississippi) study area to calculate hydraulic property distributions of the alluvial aquifer for use in future groundwater-flow models.