# Investigating hydraulic connectivity within crystalline basement aquifers using electrical resistivity tomography and multiple hydraulic tests

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**Abstract**

Crystalline basement aquifers are characterized by complex flow pathways controlled by varying overburden stratigraphy and thickness as well as fracture network and connectivity within the crystalline rocks. Understanding the hydraulic connection within the fracture network and the overburden regolith is critical to predicting recharge/discharge and contaminant transport pathways. In this study, we combined geophysical imaging with multiple hydraulic testing to quantify hydraulic connectivity within the crystalline basement aquifers at the Ibadan Hydrogeophysical Research Site (IHRS) in Ibadan, Nigeria. The 50 m $\times$ 50 m field experimental site is first of its kind established in 2019 to investigate hydrological dynamics within these complex crystalline basement aquifers in sub–Saharan Africa. We acquired multiple parallel 2D electrical resistivity profiles which were also jointly inverted to obtain multiple 2D and 3D electrical resistivity tomograms of the subsurface. The resistivity tomograms were later constrained with lithological profiles from 4 test wells installed down to depths of 30 m at the site to create a conceptual model elucidating potential flow pathways. We also performed a series of 12 hours pumping tests and a NaCl tracer test to estimate flow and transport parameters including hydraulic conductivity, aquifer storage, yield, and groundwater travel time and to assess connection between the four test wells. The resistivity tomograms show 3 major resistivity zones interpreted as a clay-rich topsoil, a saturated weathered overburden, and a fractured basement rock. The delineated fractured bedrock shows an undulating topography with several primary fracture successions at 9, 14, 16 and 22 m. Hydraulic conductivities from pumping tests range from 2.6 x $10^{-7}$ to 1.2 x $10^{-5}$ m/s for the fractures and 1.7 x $10^{-10}$ to 6.4 x $10^{-6}$ m/s for the matrix while specific storage range from 3.5 x $10^{-8}$ to 1.8 x $10^{-3}$. Preferential flow is also observed with stronger connection between wells A and C. Results of this study provide a basis for detailed numerical study which will be focused on predicting recharge and solute transport under different flow and climate regime. This work will provide a scalable framework for a sustainable management of groundwater resources within the crystalline basements of Nigeria.

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