A New Pilot Magnetotelluric Study of the Axial Fault Region of the New Madrid Seismic Zone

Kaushik Sarker, Chris H. Cramer, and Charles A. Langston

Abstract

We collected broadband magnetotelluric (MT) observations (0.00005 – 10,000 Hz) along three profiles across the Axial Fault region (SW arm) of the New Madrid seismic zone from December 2021 through March 2022 using new IRIS PASSCAL MT recorders. Two of the profiles are shallow focused cross-sections (0-10 km depth) near Steele and Caruthersville in the Missouri Bootheel. The third profile is a deep cross-section (down to a depth of 150 km) from Obion, TN to Wardell, MO (SE-NW from the east bounding faults of the Reelfoot Rift across the Axial Fault in the middle of the rift). The new data provides improved resolution, particularly at shallow depths, over the previous limited-frequency observations from the USGS and the IRIS MT TA data in the same region. The NW-SE Steele profile suggests a 2-3 km deep 50 ohm-m anomaly symmetric across the axial fault with a 10 ohm-m anomaly at 0.5 km depth at the base of the sediments. At a depth between 5 to 15 km an 80-100 ohm-meter broad anomaly seems to coincide with the fault region with 200 ohm-meter anomalies towards both ends of the profile, at this depth. The NW-SE Caruthersville profile, 15 km NE of the Steele profile, fills in near the axial fault along an existing longer USGS profile. It shows a 0.5 km deep base of the sediment anomaly. For a shallow inversion, the 2-20 km deep portion of the profile shows an almost continuous resistivity to the order of 10^4 ohm-m with around a 500 ohm-m zone possibly coinciding with the fault. The SE end of this shallow USGS profile through Caruthersville crosses the SE margin faults of the Reelfoot rift and may show a NW dipping lower resistivity zone associated with those faults, with lower resolution. For an 80 km deep inversion, the profile has a conductive layer of around 100 ohm-m starting at the depth of 30-40 km in the SE portion and a conductive anomaly at 60-70 km depth in the NW portion. The deep MT profile another 15 km NE of the Caruthersville profile is more broadly spaced and complements the very sparse IRIS long period MT TA observations crossing the Reelfoot Rift SE boundary into the Mississippi embayment. This deep profile appears to highlight a lower resistivity anomaly associated with the NW dipping east bounding faults of the rift (see the image on the right below).

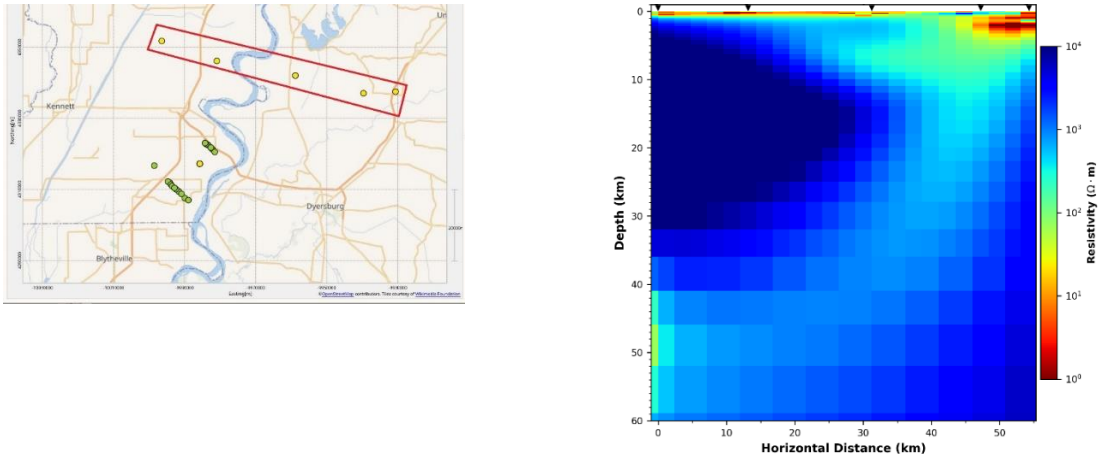

Figure: Deep MT profile NE of Caruthersville within red quadrangle (left) and the resistivity model cross-section (right)