Implications for seismic hazard assessment from the characterization of active fault zones near Ulaanbaatar with electrical resistivity models

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SUMMARY

Within the Ulaanbaatar region, Mongolia, 120 earthquake events were recorded with a magnitude between 3.4 and 5.6 and 978 earthquake events had a magnitude between 2.5 and 3.4, for the period from 1994 to 2016. Several of these have been strongly felt by residents of Ulaanbaatar. Historical records, since 1905, show that Mongolia as a whole has experienced four major earthquakes with magnitudes larger than 8 and many moderate earthquakes with magnitudes larger than 5.5. The seismicity in Mongolia is concentrated along the Mongolian-Altai and Gobi-Altai, the Bulnay (north of the Khangai mountains), and around Mogod (east of the Khangai mountains).

In the west of the Ulaanbaatar region there are several prominent fault zones, some only identified very recently. The majority of the seismic events in this region are related to the Khustai, Sharkhai, and Avdar fault zones. Seismicity is typically detected in the upper ~16 km of the crust. These fault zones are 100+ km long and historical events are predicted to have produced vertical offsets of up to 10 m; some sections show a cumulative horizontal offset of up to 100 m. Based on paleo-seismic surveys, it is estimated that these fault zones could produce earthquakes up to magnitude 7. Therefore, these faults pose a serious threat and risk of damage to Ulaanbaatar.

In this presentation we aim to characterize the active fault zones near Ulaanbaatar with electrical resistivity models generated from magnetotelluric data. In mid-2024 we carried out measurements across the Khustai, Sharkhai, and Avdar fault zones and modeled the local features near the fault traces and the regional crustal features of the region. Preliminary models show several low-resistivity features (approximately <100 Ωm) in the near-surface. The upper crust (0-25 km depth) appears to have a generally high-resistivity (~10,000 Ωm), whereas the lower crust (25–50 km depth) appears to have a lower resistivity (approximately <100 Ωm).

We aim to give an integrated interpretation of the electrical conductivity structure of the subsurface with geomorphological and geological knowledge, geodetic measurements, paleo-seismic trenching, and near-surface ground-penetrating radar surveys. We also aim to discuss the relation with fault mechanical models and local fault damage zones, and the relevance of the low slip rate. Understanding the subsurface structure of the region and characterizing the active faults is an important step for assessing the seismic hazard.

Keywords: Electrical Resistivity; Fault; Hazard; Earthquake