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Characterization of the Emeelt active fault by 2D and 3D GPR survey for seismic hazard assessment of Ulaanbaatar, capital of Mongolia.

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Most of the Mongolian population lives in the capital (1.5 over 3 million), Ulaanbaatar (UB). Nearby lies two perpendicular active faults: Emeelt fault recently identified (40 km long, at 15 km W of UB) and Hustai fault (80 km long, at 30 km West of UB). Their lengths suggest that they could produce earthquakes of magnitude 6.5 to 7.5. Since 2005, increasing seismic activity along the Emeelt fault prompted a major effort for the study of seismic hazard.

In association to seismotectonic studies and magnetic survey, we have conducted two GPR campaigns (2010 and 2011). In our study we present the 2D and 3D GPR measurements performed along the Emeelt fault. Since the last large earthquake, the fault geomorphology has been smoothed due to erosion processes and low slip rate (likely less than 1mm per year), therefore the location of the fault plane near the surface is hidden in a several meters strip.

Two 3D GPR data-cubes have been realized using a 500 MHz antenna to image a buried stream channel, filled by sand, silt and alluvial deposits, which crosses the Emeelt fault. The aim is to follow the discontinuities of the bottom of the channel to precise the location of the fault at depth and to quantify the horizontal and vertical displacement of the channel by the fault. The maximum depth of the channel is about 2m. The cumulate displacement along this fault since the filling of the paleo-channel is expected to be about one to few meters, corresponding to one or two latest events. The first cube is 25 m in-line with a spacing of 25 cm and 26.5 m cross-line with a spacing of 1 m. The second cube is 24 m in-line with a spacing of 25 cm, and 18.25 m cross-line with a spacing of 3 m. Traces are recorded every 2 cm. Observations, done in 3 trenches dug at the same place, confirm the quality and the reliability of the GPR images. Moreover, several 50 MHz profiles, about 200 m long and perpendicular to the fault, have been acquired along a distance of about 5 km. Most of them display a strong reflection, which corresponds to the fault plane dipping NE. Those profiles give us complementary information such as the dip of the structure and precise the exact location of the fault nears the surface to help layout future paleoseismic campaigns.

All GPR data were processed using a modified Kirchhoff-based migration algorithm, to account for the topography. The migration has been performed with a constant velocity of 0.14m/ns for the data acquired in 2010 (dry context) and 0.09m/ns for the data acquired in 2011 (wet context). This new processing tool improves significantly the accuracy of dip angle and locates correctly the position of dipping reflectors. The contribution of 2D and 3D GPR data, after adapted processing, is significant for the study of active faults, especially in a smoothed morphology context.