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Paleoearthquake activity along the Irtysh fault (Eurasia Stable Continent, Kazakhstan) through geomorphological and trenching analyses

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The Asian plate interiors are known to host strong earthquakes with magnitudes up to M≈8, especially around the border area between Mongolia, Russia, Kazakhstan and China. Their recurrence times are long, because of the low slip rates of faults smaller than 1 mm/yr.
Our study region in eastern Kazakhstan is set in the frame of the Indian-Eurasian collision zone situated on the Eurasian craton where plate tectonic forces are induced by the indentation of the Indian plate into Eurasia. As a consequence, in the foreland, a set of very long and large strike-slip fault zones are developed and, in the western side of the collision area, they have in common a dextral sense of shear.
The Irtysh Fault Zone (IFZ) is a 250+ km long basement set of faults that marks a major tectonic block boundary between different units with magmatic rocks and thick deposits of Paleozoic age and bounds to the south the Altai Mountains. The formation of the IFZ dates back into the Late Paleozoic times during collision between Siberia-Kazakh cratons and it was repeatedly reactivated in later times (e.g. Oligo-Miocene). Thanks to tectonic-morphological analyses, we document that the IFZ is one potential source of large earthquakes in easternmost Kazakhstan. Those analyses revealed, at different spots along the IFZ, the occurrence of a set of lineaments offsetting lithologies or deflecting streams and other landscape features. Geophysical data (GPR and seismics) helped then to identify trenching sites across those main traces where we excavated a series of paleoseismic trenches. In some of them, 14C-dated Holocene-Late Pleistocene deposits are clearly faulted. Those recent deposits include organic soils, loess layers and colluvium directly overlying the Paleozoic rocks. Surprisingly, no older Pleistocene rocks have been found suggesting complete erosion during/after glacial periods.
Our findings lead to the conclusions that the IFZ is clearly active along several strands of its trace in bedrock. During the Holocene, it hosted earthquakes with surface rupture displacements of up to 2.0 meters, suggesting events with a magnitude around M≈7 and leading to a preliminary slip rate between 0.25 and 0.4 mm/a (along the southern trace of the fault). Additional investigations should be undertaken to precise the surface fault segmentation, the paleoearthquake calendar, the slip rate, and their potential evolution along-strike, in order to constrain future seismic hazard analyses with fault models in this region of Eastern Kazakhstan.