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Investigating the Tectonic Complexity of the Bulnay-Tsetserleg Fault Junction in Mongolia Using a Temporary Seismic Network

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Mongolian tectonics is shaped by the far-reaching effects of the Indo-Eurasian collision, which drives deformation and stress over 2000 km behind the Himalayan front. During the 20th century, Mongolia experienced four earthquakes with magnitudes greater than 8, making it an exceptional location for studying intraplate seismicity, predominantly with strike-slip components. Among these events, the Tsetserleg-Bulnay fault system recorded the largest intraplate earthquake doublet, with two magnitude 8 earthquakes occurring 14 days apart in 1905, rupturing more than 500 km of fault. The surface rupture, remarkably well-preserved due to the region's low erosion rate, has enabled extensive paleoseismic investigations. Despite this, the junction between the two faults remains unclear at the surface, and the fault structures at depth are still poorly constrained, leaving the interactions between fault segments not well understood.

In the present day, the significant microseismic activity affecting the Bulnay and Tsetserleg faults is anomalous given the low regional deformation rate and overall Mongolian seismicity. This persistent microseismicity could be interpreted as aftershocks that illuminate the faults'structures more than a century later. By tracking this microseismicity with precision, we aim to map the faults'3D geometry at depth and address the key questions: how do these faults interact, why did the Bulnay earthquake occur only 14 days after the Tsetserleg earthquake, and why is its epicenter located 150km west of the junction zone?

In 2024, the French Atomic Energy Commission (CEA) and the Mongolian Institute of Astronomy and Geophysics (IAG) collaborated to strategically deploy a temporary seismic network, TDBnet, at the Bulnay-Tsetserleg junction. This network, comprising 10 geophones in addition to 5 broadband stations, operated altogether for five months, complementing the national network, and recorded local seismicity with unprecedented resolution. The collected data are being processed to automatically detect seismic phases using state-of-the-art methods, including the PhaseNet artificial neural network implemented in Seisbench. The detected events are then precisely located using an absolute location method, followed by an absolute relocation corrected with a Source Specific Station Time approach as proposed in the NonLinLoc-SSST framework. We present the experiment along with preliminary results, including a precisely determined earthquake epicenter map.

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