Fault scarps along the Atacama Trench possibly linked with the great 1877 tsunamigenic earthquake observed during the JCATE expedition

D. Melnick[1], X. Peng[2], M. Du[2], H. Zhang[2], V. Cortés-Rivas[1], O. Ulloa[1], M. Urbina[1], E. Veloso[3], M. Carvajal[1], E. Contreras-Reyes[1], P. Peña[3], M. Moreno[1]

[1]Millennium Institute of Oceanography, Chile, [2]Institute of Deep-Sea Science and Engineering, China, [3]Sernageomin, Chile

It has been commonly inferred that great megathrust earthquake ruptures may reach the trench. However, geological and geophysical observations of unequivocal trench ruptures have been so far made only after the 2011 Tohoku earthquake, and model results suggest slip to the trench likely participated in the 2025 Kamchatka tsunami. Whether trench ruptures are a hallmark of great megathrust earthquakes or only characteristic of some segments with distinct tectonic boundary conditions remains an open question with important implications for tsunami hazards and seismic-cycle models. Here, we present geomorphic and geologic observations from the Atacama trench made during the 2026 JCATE Expedition using the manned submersible *Fendouzhe*, which suggest past great earthquakes were associated with tens of meters of megathrust slip at the trench. We present evidence from 10 dives made across the plate-boundary thrust during Leg 2 between 20-23S surveying >50 km of seafloor. We found steep, up to 8-m-high fault scarps, broken blocks of unconsolidated siltstone, and fresh open cracks, and associated these features with seismic deformation across the main frontal thrust limiting the Nazca and South American plates. We integrate the geometry of the megathrust from seismic reflection profiles and tsunami records to infer that slip of at least 20 m reached the trench during the great M8.8-9 earthquake that affected this region in 1877.