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Neotectonic activity in the broken foreland of the NW Argentine Andes (Candelaria range, -26° lat, -65° long): New Insights from seismic refraction tomography, electrical-resistivity survey and geomorphic analysis

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The unambiguous identification and characterization of active faults are crucial for seismic hazard assessment, particularly in seismically active regions with spatially and temporally disparate tectonic activity and rapid climate-driven modification of geomorphic features related to seismogenic processes. The broken foreland uplifts in the NW Argentine Andean region constitute such an environment, where Quaternary deposits and landforms record ongoing deformation. Neotectonic features in the broken foreland in Argentina are widely distributed and highly disparate in time. The north-south trending Candelaria basement-cored range and its adjacent basins have experienced Quaternary shortening and uplift, which are accommodated along several seismogenic fault strands, some of which appear to be associated with reactivation of Cretaceous rift structures.
We used digital elevation models with a resolution of 5 m and 12.5 m and combined them with satellite-image analysis and geomorphic mapping to characterize surface ruptures. We also obtained geomorphic indicators of uplift to identify tectonic activity, including different tectonically modified generations of alluvial fans and their associated changes in the fluvial network. Offsets in Quaternary alluvial-fan conglomerates of up to 15 m form pronounced vertical topographic breaks both on the eastern and the western flanks of the Candelaria range; this suggests repeated surface rupture in the past, and thus potential earthquake hazard.
In order to better constrain the geometry of these faults, we acquired a total of four 2D electrical resistivity tomographic images and three seismic refraction profiles perpendicular to the strike of the inferred fault scarps.
The resulting electrical resistivity cross-sections show a significant horizontal contrast in resistivities below the inferred fault-scarp location at the surface. The seismic refraction survey reveals a similar anomaly zone with lateral changes in P-wave velocities. The consistency between electrical resistivity results and seismic-refraction tomography, as well as the inferences made based on geomorphic mapping suggest that the prominent scarps and breaks in the topography are the expression of active reverse faults. All Taken together, our results suggest that the pronounced scarp on the western range flank is produced by a fault that moved along a gently inclined clayed detachment horizon before it propagated to the surface; in addition, the eastern scarp is rooted in a different fault that is much steeper and may be associated with an inversely reactivated Cretaceous normal fault.