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Morphotectonic analysis of the Chomache and Salar Grande Fault Zones (northern Chilean Atacama Desert) with focus on local fluvial adaptation to faulting

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Fault-related uplift is one of the possible drivers for the abandonment of ancient and, due to the desert's hyper-arid climate, pristinely preserved fluvial networks in the northern Chilean Atacama Desert. In this study, we examine fluvial features like paleochannels, fans and claypans which were blocked or offset by trench-parallel faults in the Coastal Cordillera. We focus on two fault strands within the Cordillera, the Chomache (CFZ), and the Salar Grande Fault Zones (SGFZ) 10 km north. By gaining a better understanding of the morphology and sedimentological properties of the features, we aim to quantify the vertical and horizontal displacement of these faults. Therefore, we conducted Ground Penetrating Radar (GPR) measurements with 100 MHz and 270 MHz antennas, terrestrial light detection and ranging (LiDAR) scans, differential global positioning system (dGPS) as well as drone-based structure-from-motion (SfM) measurements. For visualizing the tectonic framework, we also compared these data sets to findings from remote sensing methods.

The NW-SE striking dextral reverse faults of the CFZ offset Pleistocene surfaces and therefore indicate Holocene activity (Gonzalez et al., 2003). At the western segments of the Punta de Lobos fault, which is one of the CFZ's branches, the interpretation of radargrams indicates sediment layers of paleofans which warp up to the fault's footwall. Furthermore, by comparing the relative location of reflector fields linked to paleochannel infills, we could derive horizontal displacements ranging from a few metres up to 100 m. Drone elevation models visualize knickpoints also in the most recently blocked and deflected drainages in this area. By measuring the displaced channels' horizontal and vertical offsets as well as the relative height of knickpoints along the fault segments, we determined approximate slip vectors for displacement on the faults. Furthermore, the drone images give valuable information about the spatial extent and orientation of the fault-related crack fields.

We also apply the GPR and drone measurement techniques on parts of the seismically active SGFZ, a network of NW-SE oriented strike-slip faults, several subparallel normal faults and EW striking reverse faults (Gonzalez et al., 2003). Radargrams measured on the Salar perpendicular to the main strand of the SGFZ indicate a vertical offset of up to 4 m. Further south, radargrams of fault-parallel and -perpendicular measurements show blocked fan sediments which provide information about the fans' shape, sediment layering, relative timing of sedimentary deposits, as well as paleochannel gradients and shape.

Reference:
Gonzalez, G., J. Cembrano, D. Carrizo, A. Macci, and H. Schneider (2003): The link between forearc tectonics and Pliocene-Quaternary deformation of the Coastal Cordillera, northern Chile, Journal of South American Earth Sciences, 16, pp. 321-342.