First Geologic Slip Rates Along Patagonia's Fastest Slipping Crustal Faults

Gregory P. De Pascale, Francisca Sandoval, Sebastian Perroud, Mario Persico, & Angelo Villalobos

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Major strike-slip faults in Patagonia (Chile and Argentina) are first-order elements within the Neotectonic framework of Southern South America. The Liquiñe-Ofqui fault zone (LOFZ) is a intra-volcanic arc dextral structure than is ~1,2000 km-long, whereas the Magallanes Fault System (MFS) is a Plate Boundary sinistral structure between the Scotia and Southern American Plates. Although these faults are proven seismogenic structures (e.g. Mw 6.2 along the LOFZ in 2007; Mw 7.5 and 7.8 along the MF in 1949), geophysical models provide the only estimates of slip-rates. This is partially due to dense vegetation supported by ample precipitation, major Quaternary glaciations and volcanism. To better understand the neotectonics and seismic hazard framework, we conducted a multiyear remote sensing and field investigation to obtain the first geologic slip rates along these faults, both onshore and offshore. Using remote mapping including structure from motion (SfM) models and light detection and ranging (lidar)-derived topography combined with field observations allows us to map the southernmost 400 km of the LOFZ and obtain slip rates there. LOFZ has clear Quaternary displacements such as offset streams and including a novel offset glacial valley and separation of bedrock units that provide dextral slip rates of 3.6–18.9 mm/yr (Late-Cenozoic geologic) and 11.6–24.6 mm/yr (Quaternary geomorphic). Recent fieldwork allowed us to better constrain the vertical component along the LOFZ as well (up to the east) with a significant signature in the landscape suggesting rapid uplift (at least 1-3 mm/yr) directly above the subducted Chile Triple Junction and is coincident with some of the highest peaks of the range including the >4 km San Valentine. Moving south, along the MF, long-term Late-Cenozoic slip rates along the main MFS fault is 5.4 ± 3.3 mm/yr (2.1 to 8.7 mm/yr) based on geological separations found during regional geologic mapping. Along the MFS by combining displacements observed in SfM models with regional Late-Quaternary dating from the late Quaternary glacial records here, we obtain sinistral slip-rates of 10.5 ± 1.5 mm/yr (9.1 to 12.0 mm/yr) and 7.8 ± 1.3 (6.5 to 9.1 mm/yr) in Chile and Argentina respectively. Our new geologic and geomorphic slip rates from the LOFZ and MFS provide long-term evidence of these fast slipping faults and a better framework for understanding the neotectonics and seismic hazard in Patagonia.

Key Words
Chile, Crustal Faults, Patagonia, slip rates, earthquake geology, seismic hazard

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