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Post-glacial deformation of the eastern Magallanes-Fagnano transform fault system, Tierra Del Fuego, Argentina

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Tierra del Fuego is crosscut by a major transform fault, the Magallanes-Fagnano Fault that accommodates sinistral strike-slip motion between Scotia and South America plates. The present-day relative velocity between these plates estimated using GPS measurements is 5.9 ± 0.2 mm.yr-1. Major events occurred along this fault in 1879 and 1949. The 1949 magnitude was Mw ~ 7.5-7.8 with several aftershocks of similar magnitude, but the precise localization of corresponding rupture zones is not possible using seismological data. Since the onset of strike-slip, suggested at the Late-Miocene, glacial advances have rejuvenated most of the rupture markers. Until now, the Quaternary slip rate remained unknown and investigations regarding the last 1949 ruptures were scarce. In this work, we focus on the fault behavior associated with the post-glacial stress regime over its 80-km inland eastern section, using beryllium cosmogenic-nuclide dating, combined with high-resolution Pleiades imagery and fieldwork analyses of geomorphological markers. We identified a dead valley in which the drainage network has been abandoned following the retreat of a Wurmian glacier. We dated the abandoned drainage within the valley at < 18 ± 2 ky, which fixes the beginning of the tectonic deformation record. We quantified the sinistral offset accommodated by the fault across this valley of 115 ± 5 m. These results yield a minimum 6.4 ± 0.9 mm.yr-1 slip-rate since 18 ky. Our study shows that in this context geomorphic and instantaneous fault slip rates are mostly the same, suggesting a stable fault behavior since glaciers retreat. On the other hand, we mapped the superficial ruptures that resulted from the 1949 earthquake and its aftershocks. We measured several man-made features left-laterally shifted. Two fences are crosscut with horizontal displacements of respectively 4 m ± 0.2 m and 6.5 m ± 0.5 m. A third sinistral offset of 6.2 ± 1 m has been measured in the foundation of an abandoned broken bridge that spanned over the fault line. Therefore, we suggest that surface-ruptures length associated with the 1949 earthquake are greater than previously estimated. If these offsets are characteristic for main earthquakes along Magallanes-Fagnano Fault, their recurrence period should be in the order of one thousand years.