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Strike-slip fault reactivation in the Western Alps due to Glacial Isostatic Adjustment

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The Western Alps represent the zone of highest seismicity density in metropolitan France. The seismicity is mainly located along two NE-SW strike-slip fault systems: the right-lateral Belledonne Fault and the left-lateral Durance Fault. Glacial Isostatic Adjustment (GIA) is one of the most common processes given to explain intraplate seismicity (e.g., Scandinavia, North America) and is also proposed as a cause of present-day deformation in the Alps. In order to test the impact of deglaciation from the Last Glacial Maximum on pre-existing vertical strike-slip faults in the Western Alps (Belledonne and Durance Faults), we use a finite-element approach to model fault reactivation throughout the deglaciation period, from ca. 18 kyr up to today. The models are tuned to fit present-day deformation rates observed by geodesy (uplift rate up to 2 mm/yr and horizontal radial extension). Simplified models (homogeneous icecap and Earth rheology) show that, under optimum conditions, GIA stress perturbations can activate a NE-SW right-lateral strike-slip fault such as the Belledonne Fault, requiring the fault to have been pre-stressed up to near-failure equilibrium before the onset of deglaciation. The maximum effect of GIA is 1.7 meters of right-lateral slip over 20 kyr, with a peak of displacement between 20 and 10 ka. These models indicate that GIA can result in a maximum slip rate of 0.08 mm/yr averaged over the Holocene, in association with earthquakes up to Mw = 7 (if all displacement is taken in one event). These results are consistent with local paleoseismicity and geomorphology evidence on the Durance fault. However, the impact of GIA on the left-lateral Belledonne Fault is poorly constrained by these simple models. Additional models based on realistic Alpine icecap reconstructions and regional rheology structures will also be presented, that allow us to test the specific effects of GIA on Holocene deformation along both the Belledone and Durance Fault systems.