CURVED FAULT STRIATIONS PRESERVE THE DIRECTION OF DYNAMIC RUPTURE PROPAGATION

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Slip-parallel grooves (striations) on fault surfaces are considered a robust indicator of fault slip direction, yet their potential for recording details of earthquake rupture dynamics has received little attention. During the 2016 Kaikōura earthquake, 10-plus meters of dextral strike-slip on the steeply-dipping Kekerengu fault exhumed $>$200 m^2 of fresh fault exposure (free faces) where it crossed deep gullies in bedrock. Inscribed upon these surfaces, we observed individual striae up to 2 m long, all of which had formed during the Kaikōura earthquake. These were typically curved. Collectively, the striae recorded a rotation of the co-seismic slip vector that was common between sites. Using simulations of spontaneous dynamic rupture on a vertical strike-slip fault we reproduce the observed, curved morphology of striae on the Kekerengu fault. Our models assuming strike-slip pre-stress reveal that vertical tractions are induced co-seismically by fault slip in the so-called cohesive zone. These result in some local dip slip and temporal changes in slip direction. We show that the sense of striae curvature is sensitive to the direction of rupture propagation. To match the geometry of Kekerengu fault striae, our simulations require the rupture propagating from south-west to north-east, which agrees with the known rupture direction of the Kaikōura earthquake. Our study highlights the potential for fault striae to record aspects of earthquake rupture dynamics, including the rupture propagation direction of paleo strike-slip earthquakes.