Back-propagating super-shear rupture in the 2016 M7.1 Romanche transform fault earthquake

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Rupture propagation of an earthquake strongly influences potentially destructive ground shaking. Variable rupture behaviour is often caused by complex fault geometries, masking information on fundamental frictional properties. Geometrically smoother ocean transform fault (OTF) plate boundaries offer a favourable environment to study fault zone dynamics because strain is accommodated along a single, wide zone (up to 20 km width) offsetting homogeneous geology comprising altered mafic or ultramafic rocks. However, fault friction during OTF ruptures is unknown: no large (MW>7.0) ruptures had been captured and imaged in detail. In 2016, we recorded an MW 7.1 earthquake on the Romanche OTF in the equatorial Atlantic on nearby seafloor seismometers. We show that this rupture had two phases: (1) up and eastwards propagation towards the weaker ridge-transform intersection (RTI), then (2) unusually, back-propagation westwards at super-shear speed toward the fault's centre. Deep slip into weak fault segments facilitated larger moment release on shallow locked zones, highlighting that even ruptures along a single distinct fault zone can be highly dynamic. The possibility of reversing ruptures is absent in rupture simulations and unaccounted for in hazard assessments.