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Subduction of high seafloor topography restricts great earthquake rupture

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Great subduction earthquakes often rupture hundreds of kilometres, with lengths exceeding the width of the seismogenic zone. In these events, subducted topographic features along the plate interface have been shown to alter rupture properties. We show that subducting topography forms an aseismic barrier to rupture propagation.

Thirteen historic great earthquakes, which have ruptured the majority of the South-American – Nazca plate margin over the last 150 years, were studied to investigate whether subduction of topography affects rupture limits. The rupture areas of these events were determined from aftershock locations and co-seismic subsidence. The exposed Nazca plate has significant topography, including ridges and seamount chains. These features were classified by their relief above the surrounding seafloor. Several linear features were defined, usually aligned West-East, parallel to the plate motion vector. We inferred the location of subducted topography within the subduction interface by projecting these features onto the margin. There is very strong correlation between subducted topography with relief of >1000m and the location of great earthquake rupture limits.

We also studied the release of seismic moment in intermediate earthquakes, to determine the nature of the interaction between topography and rupture along the Nazca margin. Rupture limits not associated with high subducted topography correlate with the locations of the largest seismic moment release. In contrast, rupture limits associated with high subducted topography have subdued moment release. We infer that subduction of topography creates a weak, aseismic zone in the subduction margin, which prevents rupture propagation and restricts the long-term background seismic activity.