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The causal link of large shallow slip, long duration and moderate shaking of the Nicaragua 1992 tsunami earthquake

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Earthquakes rupturing up to close to subduction trenches have produced some of the largest tsunamis in history. Models indicate that the generation of these tsunamis require extraordinarily large near-trench sea-bottom displacement, but the underlying causes are disputed. They have been attributed to a wealth of factors prompting large shallow slip at the low-angle megathrust fault, the activation of steeper faults requiring smaller slip, or the triggering of ancillary energy sources. Although the postulated mechanisms are manifold, all of them coincide on the fact that the proposed causes and constraining factors are not universal but site-specific. As alternative to this local view, it has recently been proposed that the large near-trench slip could result from systematic upper-plate rock rigidity variations observed in worldwide subduction zones. Here we use a set of available controlled-source seismic data in the Middle America margin to obtain a model of upper-plate elastic rock properties across the rupture zone of the Ms7.0-Mw7.7 1992 Nicaragua tsunami earthquake. In combination with seismological data, our model shows that not only the required large shallow slip to generate the tsunami despite the moderate magnitude, but also the observed slow rupture propagation, long duration, high-frequency depletion, and magnitude discrepancy of this event, are all intrinsic physical attributes of near-trench rupture. The existence of a causal link between shallow slip and seismic record characteristics opens up new possibilities for tsunami early warning.