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Depth of interplate asperities and its role on outer-rise tensile faulting

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Shallow reverse outer-rise events are among the evidences of strongly-coupled plate interfaces. In contrast, the association of normal outer-rise events with interplate asperities is not straightforward. Great normal earthquakes may occur in the outer-rise of weakly-coupled interplate settings where strong slab-pull forces are in effect. The 1977/08/19 (Mw=8.3) Sumba earthquake falls in this category. Normal earthquakes may also follow the failure of strong interplate asperities. Great thrust earthquakes of 1952/11/04 (Mw=9.0) Kamchatka, 1963/10/13 (Mw=8.5) Kurile, 1965/02/04 (Mw=8.7) Rat Island (Aleutian), and 2006/11/15 (Mw=8.3) Kurile were followed by tensional outer-rise events. The last two interplate earthquakes, 1965/02/04 (Mw=8.7) and 2006/11/15 (Mw=8.3), were followed by the major and great normal outer-rise events of 1965/03/30 (Mw=7.6) and 2007/01/13 (Mw=8.1) respectively.

However, interpretation of moderate and smaller outer-rise normal earthquakes may require different processes such as plate bending. The asperity distribution of the 2006/11/15 (Mw=8.3) interplate earthquake and the apparent correlation between the location of its shallow asperities in the forearc and the distribution of its normal aftershocks in the outer-rise raised the possible link between the depth of asperities and the occurrence of outer-rise normal aftershocks. We analyzed the effect of asperity depth variations on the outer-rise faulting using the stress transfer concept. The imparted normal Coulomb stresses due to failure of synthetic and real interplate asperities support the hypothesis that normal outer-rise aftershocks are closely linked to the failure of shallow near-trench asperities. Depth of asperity is crucial in this regard.

Thrust failure of shallow subducted seamounts is among the main causes for such normal aftershocks. Wet sediments in the shallow parts of subduction zones prevent generation of strong near-trench couplings. But, in cases that shallow strong couplings exist, we should expect normal aftershocks following the rupture of shallow strong asperities. The geometrical distribution of imparted tensile stresses strongly suggests that such tensile outer-rise faultings should dip away from the trench. These smaller normal events should not be mixed up with the larger outer-rise events that are generated due to slab-pull forces.