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Decadal Seismicity Prior to Great Earthquakes at Subduction and Transform-Fault Plate Boundaries

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Decadal forerunning seismic activity is used to map great asperities that subsequently ruptured in very large, shallow earthquakes at subduction zones and transform faults. The distribution of forerunning shocks of magnitude $M_w > 5.0$ is examined for 50 mainshocks of $M_w 7.5$ to 9.1 from 1993 to 2020. The zones of large slip in many great earthquakes were nearly quiescent beforehand and are identified as the sites of great asperities. Much forerunning activity occurred at smaller asperities along the peripheries of the rupture zones of great and giant mainshocks. Asperities are strong, well-coupled portions of plate interfaces. Sizes of great asperities as ascertained from forerunning activity generally agree with the areas of high seismic slip as determined by others using geodetic and tide-gauge data and finite-source seismic modeling. Different patterns of forerunning activity on time scales of about 5 to 45 years are attributed to the sizes and spacing of asperities. This permits many great asperities to be mapped decades before they rupture in great and giant shocks. Rupture zones of many large earthquakes are bordered either along strike, updip, or downdip by zones of low plate coupling. Several bordering regions were sites of forerunning activity, aftershocks and slow-slip events. Several poorly coupled subduction zones, however, are characterized by few great earthquakes and little forerunning activity. The detection of forerunning and precursory activities of various kinds should be sought on the peripheries of great asperities. The manuscript can be found at <http://www.ldeo.columbia.edu/~sykes>