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TITLE: Seismic Sources in the Cook Inlet Region of Alaska

ABSTRACT Earthquakes affecting the Cook Inlet region may be classified on the basis of their location: within the overthrust North American plate, on the Aleutian megathrust, and within the subducting Pacific plate. The megathrust is the only source zone with the potential for great earthquakes, such as the 1964 event (M_W 9.2) that ruptured the Aleutian megathrust between Prince William Sound and Kodiak Island and regionally caused severe shaking and significant elevation changes. Estimates of the return time for another event of this size in this location are very uncertain and vary from about 200 to 1350 yr. In any case, assessment of the current seismic hazard from potentially damaging megathrust shocks must focus on the probabilities of (1) smaller earthquakes within the 1964 rupture zone, and (2) more distant great earthquakes on adjacent segments of the megathrust which might re-rupture parts of the 1964 zone. The instrumental earthquake record since 1900, exclusive of the 1964 sequence, includes four events approaching M 7 on this portion of the megathrust. The uplift history of Middleton Island suggests that the eastern end of the 1964 rupture zone may break again in a great earthquake within the next few decades.

Beneath the western Kenai Peninsula, Cook Inlet, and the volcanoes west of Cook Inlet, the subducted Pacific plate is a continuous source of earthquakes termed a Wadati-Benioff zone (WBZ). This 20- to 25-km-thick seismic zone dips to the northwest and lies at about 35 to 55 km depth below Anchorage and Kenai and at about 100 to 125 km depth beneath the volcanoes. Although WBZ events worldwide approach magnitude 8, there are relatively few above magnitude 6. Along the entire Aleutian arc since 1900 there are 8 events with tabulated depths greater than 50 km and $M \geq 7$. Because all occurred prior to 1945 there is substantial uncertainty in their location and depth. If they are assumed to have occurred in the WBZ, and if activity is distributed uniformly along the arc, then an average of one earthquake with $M \geq 7$ might be expected beneath the Cook Inlet region about every 125 yr.

Earthquakes in the crust above the subducting plate -- as mapped from the regional network since 1971 -- correlate poorly with mapped surface faults. Of the major mapped fault systems in the region, only the Castle Mountain fault exhibits unequivocal geologic and seismic evidence of activity; during the the m_b 5.7 1984 Sutton earthquake, a 14-km-long segment ruptured. Although there is no clear evidence of slip within the last 10,000 yr on any of the other fault systems, they should not necessarily be regarded as dead. Ancient faults may provide zones of weakness within the crust which might be re-activated by modern tectonic stresses in infrequent moderate-to-large earthquakes.