power consumption of the toroidal field coils, is not really relevant, since a practical fusion reactor would almost certainly use superconducting coils. Thus, when viewed in context, our definition of Q_p appears reasonable for judging the proximity to reactor conditions, taking into account the fact that an economical pure fusion reactor would need to operate at $Q_p \gtrsim 10$, to compensate for the ~ 30 percent efficiency in converting neutron energy to electricity.

Conclusion

Using neutral beam injectors developing a total power of as much as 2.4 MW, we reached central ion temperatures as high as 6.5 keV and central electron temperatures $\gtrsim 4.0$ keV, both the highest yet achieved in a tokamak device. During D^0 injection into a D^+ plasma, the equivalent D-T energy gain factor Q_p reached 0.02, the maximum reached in a controlled fusion experiment. At the highest temperatures and lowest densities, the ion collisionality parameter, ν_i^*, reached a minimum of ~ 0.02 and was below 0.1 over much of the plasma, for the first time well into the collisionless regime relevant to reactors, yet the ion thermal conductivity appeared consistent with neoclassical theory within our uncertainties of a factor of 3 to 5. Indeed, the temperatures reached would not have been possible with the available injection power had the direst predictions of anomalous transport theories obtained. Agreeably, and somewhat surprisingly, the electron thermal conductivity appeared to be suppressed in the central plasma during high-power injection. Under some conditions, impurity radiation seriously degraded the electron energy confinement, but the severity of the impurity problem was substantially reduced by the use of graphite limiters. Unbalanced injection engendered rotation of the plasma core, and new density fluctuations were observed at the lower collisionalities (corresponding to higher values of $P_b/\bar{n}_e$), but neither phenomenon appeared to deleteriously affect stability or energy containment. Without exception, these findings are encouraging regarding the practicality of fusion as a power source.

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Yakataga Gap, Alaska: Seismic History and Earthquake Potential

William R. McCann, Omar J. Pérez, Lynn R. Sykes

One of the world's major earthquake belts (Fig. 1) follows the boundary between the Pacific and North American plates from offshore British Columbia to southern Alaska and thence to the Aleutian island arc. Most of the movement between the two plates occurs during great earthquakes—events of surface wave magnitude, M_s, greater than 7.8. The repeat time of great shocks along some of the major plate boundaries of the world varies from about 40 to 500 years. Since much of the plate boundary in Fig. 1 ruptured in large shocks during the last 40 years, most of it appears to have a low potential for large shocks during the next few decades.

Nevertheless, Tobin and Sykes (*1*), Kelleher (*2*), and Sykes (*3*) identified four segments of this plate boundary that had not been the locations of large earthquakes for many decades. They concluded that these segments, which they called seismic gaps, were some of the most likely sites of future large shocks. One of the gaps they delimited ruptured in 1972 during the large southeast Alaska earthquake of magnitude 7.6 (Fig. 1).

The locations and magnitudes of at least 12 large earthquakes along some of the simple plate boundaries of the world have been successfully forecast (*4*–*6*) since Fedotov (*7*) introduced the concept of the seismic gap in 1965. The gap concept by itself, however, does not permit an estimate of the time of occurrence of a future large shock that is precise enough to be called a prediction, which we take to involve precise estimation of time of occurrence, place, and size. Only a small part of the gap in southern Alaska, shown in Fig. 1 near 60°N, 143°W, ruptured during the recent Saint Elias earthquake of M_s 7.7 on 28 February 1979 (*8*). The remaining area, here called the Yakataga seismic gap, its seismic history, and its potential for a future shock are the main focus of this article.

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Repeat Times of Large Earthquakes

In southeast Alaska and along offshore British Columbia, motion between the Pacific and North American plates is accommodated by right-lateral strike-slip motion (*1*) such that the Pacific plate moves in a N15°W direction (heavy arrows in Fig. 1) with respect to North America (*1*, *9*, *10*). Farther west, the Pacific plate is thrust (subducted) beneath the North American plate along the Aleutian trench. The Yakataga gap is located in a transition zone between these two regimes of plate interaction.

In southern Alaska the computed rate of plate movement is about 6 centimeters per year (*9*, *10*). Thus, about 5 meters of

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Summary. A 250-kilometer-long seismic gap in southern Alaska, which is situated along the boundary between the North American and Pacific plates, ruptured in two great earthquakes in 1899. Within the gap, earthquakes of moderate size form a ring of activity around a region of very low seismicity. The number of shocks of magnitude 6 or larger in this ring appears to have increased significantly since the 1958 earthquake, which occurred on the adjacent part of the plate boundary. This space-time pattern is similar to long-term patterns that preceded several large earthquakes in Japan. A shock of magnitude 7.7 on 28 February 1979 ruptured only a small part of the seismic gap. The remaining part, which already may have stored sufficient strain to generate a great shock, warrants intensive study to evaluate its potential for such an event.

potential slip may have accumulated in the gap since the last great earthquake occurred in the area in 1899 if seismic slip is not a significant fraction of the total plate movement and if the main plate boundary, in fact, passes through the gap. As discussed later, we conclude that a zone about 250 kilometers long and extending about 100 kilometers downward and parallel to the dip ruptured during two great earthquakes in 1899. Using an estimated seismic moment of 2×10^{28} dyne-cm (*11*) for each of the two events, we calculate an average slip of about 5 m. Thus, the computed average slip in the events of 1899 is comparable to the potential slip that appears to have been built up during the last 80 years by plate motion. Although only preliminary estimates are available for the seismic moment of the earthquake of 28 February 1979, values of 1×10^{27} to 7×10^{27} dyne-cm, a rupture area of 50 by 60 km (*8*), and a rigidity of 3.4×10^{11} dyne/cm^2 yield an average slip of about 1 to 7 m. Repeat times calculated from simple plate tectonic considerations should not be taken too literally, since the rate of plate motion is uncertain by at least 10 percent, the seismic moments may be uncertain by a factor of 1.5, and deformation is undoubtedly spatially complex near the junction of the subduction and strike-slip regimes.

The repeat time of great shocks in the Yakataga area may well be much less than that for the areas involved in the great Chilean and Alaskan earthquakes of 1960 and 1964, in which the average slip was much greater—about 20 m (*12*). The 1960 and 1964 earthquakes are also characterized by rupture zones that are very long (700 to 1000 km) and wide (120 to 290 km downdip), by very large seismic moments, and by magnitudes on Kanamori's scale (M_w) of 9.2 to 9.5 (*13*). Very great shocks of this type appear to occur only on long, linear sections of subduction zones. Another requirement appears to be a shallow dip and hence a long zone of plate interaction from the surface to a depth of about 40 km (*14*). Earthquakes located near major changes in the style and geometry of plate movements, as in the Yakataga region, however, appear to be typified by rupture zones that are not more than about 75 to 150 km long, by magnitudes less than 8.1 to 8.5, and by an average slip of a few meters. Since earthquakes like the 1899 sequence are associated with slip of only a few meters, repeat times of 50 to 100 years are calculated from the rate of plate movement. The repeat time for the rupture zone of the 1964 Alaskan earthquake, as calculated from the seismic moment (*13*) and rate of plate movement, is about 220 years. Similarly, earthquakes along the southwest coast of Mexico, where the rate of underthrusting appears to change markedly along the arc, are characterized by magnitudes less than 8.1, lengths less than 100 km, average slip of a few meters, and repeat times of about 30 to 100 years.

Hence, the repeat time of a large shock at a given place along a plate boundary is a function not only of the average rate of plate movement but also of the amount of slip in large earthquakes. The average slip in large shocks and their maximum size appear to be strongly correlated with the downdip length of plate contact and with tectonic heterogeneity on a scale of tens to hundreds of kilometers. The latter does not seem to be unreasonable, since marked changes in the strike, rate, or style of deformation along a plate boundary can lead to stress concentrations that would trigger shocks sooner than on a more linear and homogeneous plate boundary.

Small and moderate-size shocks in southern Alaska from 1964 to 1979 are shown in Fig. 2. The region between 141° and 145°W has been nearly quiescent for small shocks since at least 1964. This doughnut-like distribution of shocks surrounding a region of near quiescence is similar to patterns observed before several large earthquakes (*15*, *16*). These facts, as well as the occurrence of the

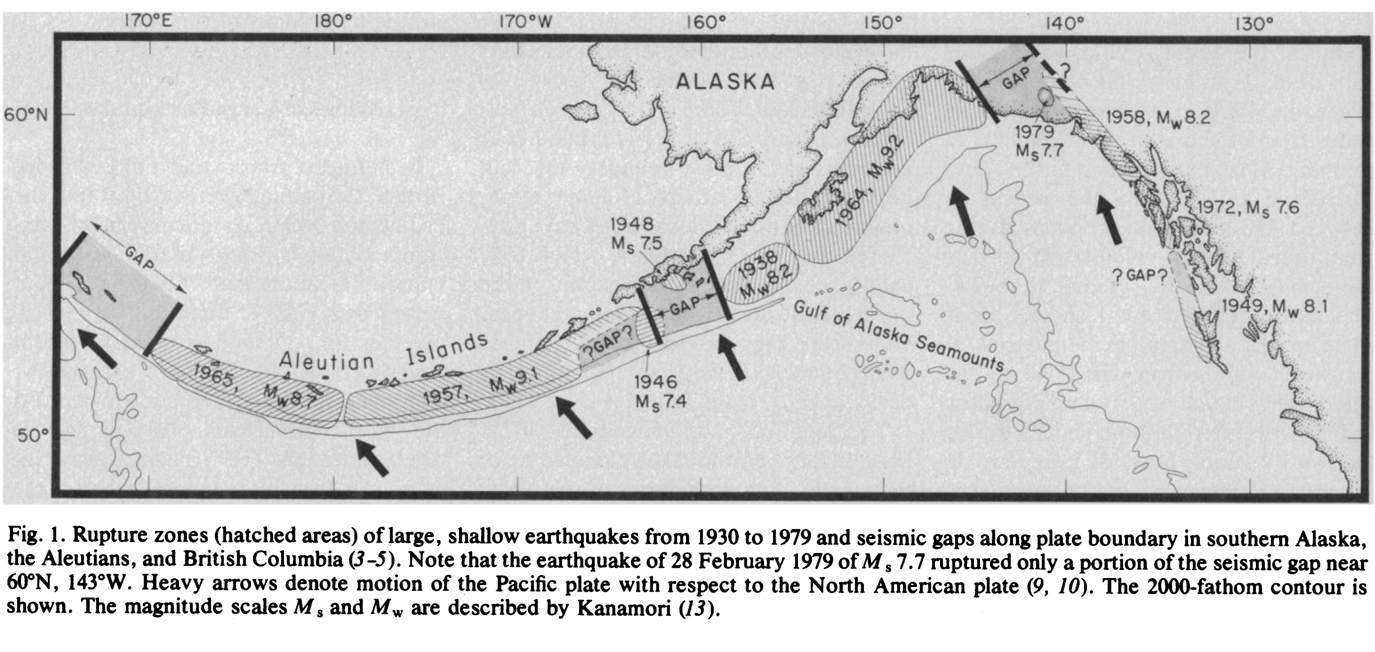


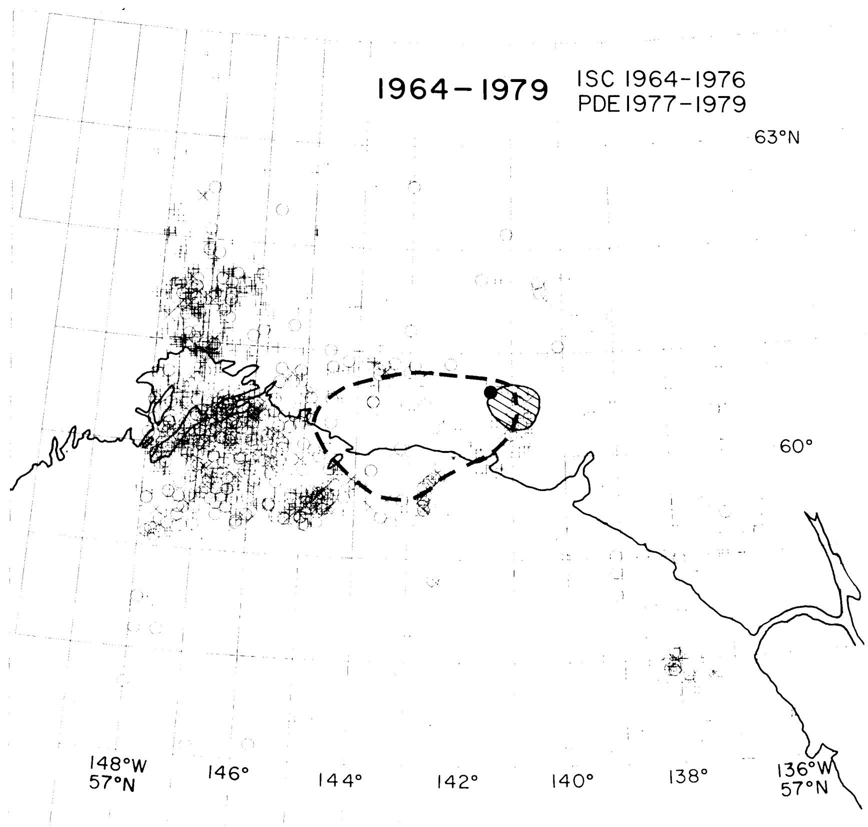
Fig. 1. Rupture zones (hatched areas) of large, shallow earthquakes from 1930 to 1979 and seismic gaps along plate boundary in southern Alaska, the Aleutians, and British Columbia (*3-5*). Note that the earthquake of 28 February 1979 of M_s 7.7 ruptured only a portion of the seismic gap near 60°N, 143°W. Heavy arrows denote motion of the Pacific plate with respect to the North American plate (*9*, *10*). The 2000-fathom contour is shown. The magnitude scales M_s and M_w are described by Kanamori (*13*).

large shock on 28 February 1979, led us to make a more detailed investigation of the history of large earthquakes and the seismic potential of this region.

Tectonics of Southeast Alaska

Focal mechanism solutions 1 to 4 in Fig. 3 and the observed surface breakage during the southeast Alaska earthquake of 1958 (*17*) indicate a predominance of right-lateral strike-slip motion along the Queen Charlotte–Fairweather fault system as far north as Yakutat Bay. All of the other mechanism solutions in Fig. 3 indicate a predominance of thrust faulting. The mechanism solutions and the tectonics of this area are described more fully by Perez and Jacob (*18*).

Plafker *et al.* (*17*) indicate that the Fairweather fault has taken up most of the motion between the North American and Pacific plates for at least the last 100,000 years. We take the main plate boundary to follow the Fairweather fault and the rupture zones of the large earthquakes of 1899, 1958, 1964, and 1979 (see Fig. 1). We conclude that the main plate boundary from Yakutat Bay to Prince William Sound is located between 59½° and 61°N. This is based on our interpretation of the rupture zones of great



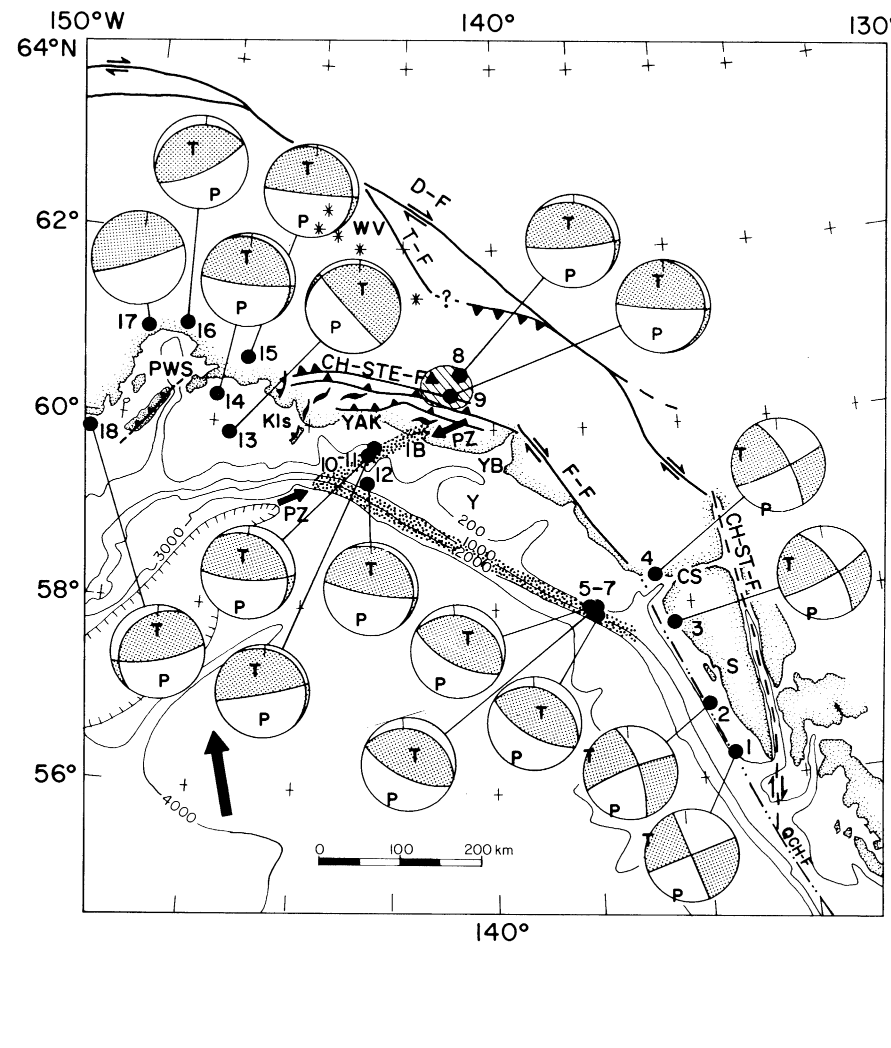


Fig. 2 (top). Earthquakes in southern Alaska (136° to 148°W, 57° to 64°N) from January 1964 to 31 January 1979, reported by various agencies. The dashes surround a region that has been nearly quiescent for events above magnitude 4.0 since 1964. The filled circle and hatched region denote the epicenter and rupture zone of the large shock of 28 February 1979. Symbols denote magnitudes as follows: (+) $m_b < 4.0$, (○) $4 \le m_b < 5$, (×) $5 \le m_b < 6$, (*) $m_b \ge 6$, where m_b is the body-wave magnitude. The concentration of activity west of about 145°W represents the easternmost part of the aftershock zone of the great 1964 earthquake. Fig. 3 (bottom). Focal mechanisms (*18*) and major faults (*29*) in southern and southeast Alaska and in adjacent parts of Canada (*18*). Shaded areas in the focal mechanisms represent compressional first motion; *P* and *T* denote inferred axes of maximum and minimum principal stress. The triangle and hatched area indicate the epicenter and rupture zone (*8*) of the earthquake of 28 February 1979. The Pamplona fault zone (*PZ*) is denoted by the stippled area between small arrows. The Yakutat block (*Y*) is bounded by the Pamplona zone, the long stippled area trending northwest, and the Fairweather fault (*F-F*). Other areas are *KIs*, Kayak Island; *YAK*, Yakataga district; *IB*, Icy Bay; *YB*, Yakutat Bay; *S*, Sitka; *PWS*, Prince William Sound; and *CS*, Cross Sound. Asterisks denote Wrangell volcanoes (*WV*) of Quaternary age. Faults are *D-F*, Denali; *T-F*, Totschunda; *CH-STE-F*, Chugach-Saint Elias; *CH-ST-F*, Chatham Strait; and *QCH-F*, Queen Charlotte. The heavy arrow represents motion of the Pacific plate with respect to the North American plate (*9, 10*). Submarine contours are in meters.

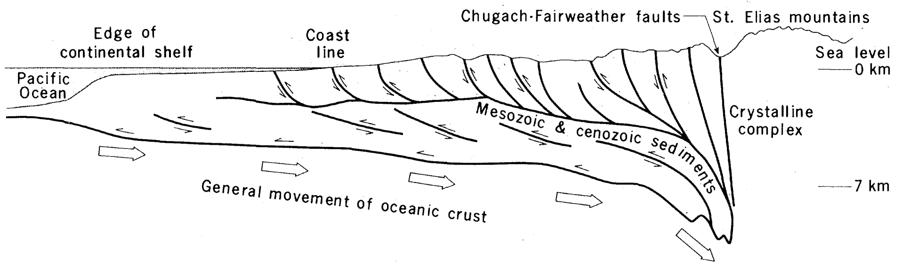


Fig. 4. Schematic structural cross section of plate convergence in the Gulf of Alaska (*21*). The large open arrows indicate the sense of relative motion of the Pacific and North American plates. As the Pacific plate is subducted beneath the North American plate, a series of imbricate reverse faults develop in upper plate in a décollement-style of deformation.

shocks in 1899, as discussed below, and the agreement of the focal mechanism solutions in this region (Fig. 3) with the calculated directions of plate movement (*9*, *10*).

The Yakutat block (Fig. 3) is moving at nearly the same relative velocity as the Pacific plate. Nevertheless, marine seismic reflection data (*19*) and earthquakes 5 to 7 in Fig. 3 indicate that some deformation is occurring along the continental margin between events 5 and 12 (*18*). While some deformation may occur along the Totschunda and Denali faults farther north, they have not been the locus of great earthquakes. They do not appear to take up the major plate movement (*18*).

Mechanisms 8 and 9 (Fig. 3) are for two earthquakes of $M_s \sim 5.7$ that occurred in 1965 and 1971 near the edges of the rupture zone of the earthquake of 28 February 1979. These solutions, as well as that for the 1979 event (*8*), indicate either motion along high-angle reverse faults dipping about 80° to the south or northerly oriented thrust motion along shallow dipping faults. The first possibility, however, is not consistent with the sense of vertical motion inferred to have occurred in Yakutat Bay (*20*) during great earthquakes of 1899 or with the sense of vertical motion on the Chugach–Saint Elias and nearby fault systems. In these cases (*20*–*22*) the northern block is uplifted with respect to the south, whereas the focal mechanisms indicate the opposite sense of vertical motion for the steeply dipping nodal plane. Therefore, we select the shallow dipping nodal plane as the fault plane. This choice of nodal planes is consistent with the Pacific plate being underthrust beneath Alaska in a direction about N15°W, as calculated from global plate motions (*9*, *10*).

The focal mechanism solutions, distribution of earthquakes, and geologic data are consistent with the tectonic interpretation of Stoneley (*21*), which is shown in Fig. 4 as a generalized cross section for the Gulf of Alaska. As in Fig. 4, the Pamplona zone, the Chugach–Saint Elias fault, and other major faults may be interpreted as imbricate reverse faults within the upper plate whose dip becomes shallower at great depth. Thus, one or more shallow-dipping thrust faults that constitute the main plate boundary now appear to be nearly quiescent for moderate-size shocks (Fig. 2). We infer that the zone of shallow thrusting moved during the earthquakes of 1899. It is not unreasonable to expect that as stresses build up for another great earthquake, stress concentrations, and hence moderate-size earthquakes, would occur along some imbricate faults, such as the Pamplona zone.

The style of deformation in Fig. 4 appears to be similar to that which occurred during the 1964 earthquake farther west. Motion during that event involved shallow thrusting accompanied by high-angle reverse faulting along the Patton Bay fault on Montague Island (*12*, *23*). Similarly, the reverse faulting that was inferred to have occurred in Yakutat Bay during the great shock of 10 September 1899 (*20*) can be interpreted as motion along one or more high-angle reverse faults that accompanied shallow-angle thrust faulting at depth. The observed surface displacements in Yakutat Bay in 1899 (*20*), even if they extended to a depth of 30 km, contribute only a small fraction to the seismic moment (*11*) for that shock. Thus, slippage during that event must have been much more extensive areally than reported by Tarr and Martin (*20*). The maximum deformation of 14 m observed in Yakutat Bay (*20*) is highly localized and may represent a stress concentration, which may have been stored over several seismic cycles. It is unlikely that each imbricate fault in Fig. 4 moves during each great earthquake that affects the main zone of shallow thrusting at depth.

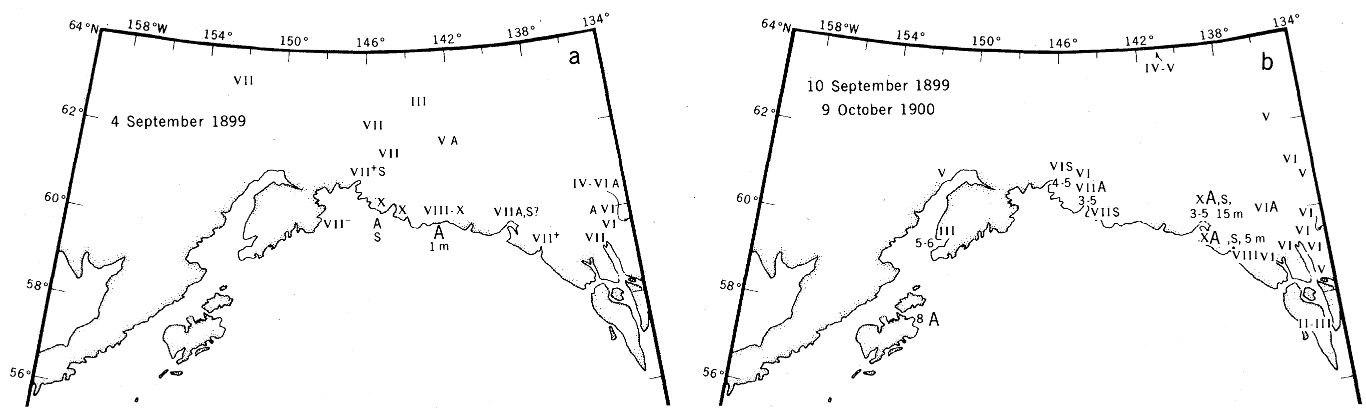


Fig. 5. Macroseismic effects inferred from the report of Tarr and Martin (*20*) for three great earthquakes in 1899 and 1900. Roman numerals indicate intensities on the modified Mercalli scale for shocks on (a) 4 September and (b) 10 September 1899. Arabic numerals in (b) denote intensities for the shock in 1900. Also indicated are observed uplift in meters, local sea waves (*S*), and aftershock (*A*); the size of the symbol qualitatively indicates numbers and strengths of aftershocks reported. Note the extensive region along the coast affected by the earthquake of 4 September 1899. Stippling denotes the region of strongest observed shaking, which is taken to approximate the rupture zone of the shock. The earthquake on 10 September 1899 appears to have ruptured an area to the east of that broken on 4 September. Events of 4 and 10 September appear to have ruptured most or all of seismic gap between the rupture zones of the 1958 and 1964 earthquakes. The shock of 9 October 1900 (b) appears to have occurred near Kodiak Island.

Seismic History of Southeast Alaska

Richter (*24*) locates three great earthquakes in 1899 and 1900 in the region near Yakataga and Yakutat Bay (Fig. 3). Figure 5 shows our interpretation of the modified Mercalli intensity inferred from reports in Tarr and Martin (*20*) for various positions throughout southern Alaska. It should be remembered that this region was very sparsely populated in 1899, and inferences about rupture zones may well be biased by this as well as by site conditions. Our results are in general agreement with the intensities inferred by Meyers *et al.* (*25*) with some significant exceptions. The highest intensities, which are found along the coast, appear to us to be lower than those inferred by them. These differences, however, do not change our interpretation of the regions that were most strongly affected by those great earthquakes.

The first shock (M_s 8.5) occurred on 4 September 1899 (3 September, local time) and was felt most strongly from localities west of Kayak Island to Yakataga, a distance of about 180 km. From a ship offshore (*20*) large avalanches were observed in the mountains between Icy Bay and Kayak Island (Fig. 3). This region and the zone of highest observed intensities are shaded in Fig. 5a. Many aftershocks were reported from the western end of the shaded area; few were reported from Yakutat Bay (*20*). One meter of uplift was reported at Yakataga (*20*). Since coseismic uplifts are generally smaller than horizontal motions during great earthquakes along subduction zones (*12*), the average slip on the plate boundary during this event was probably several meters, which agrees with that inferred earlier from the seismic moment. In previous studies, intensities near VIII have been successfully used as a guide to delimit the approximate zone of rupture (*4, 26*). The higher intensities, uplift, and distribution of aftershocks clearly associated with the 4 September event indicate that rupture probably extended along much of what is now the Yakataga seismic gap.

Another great (M_s 8.4) earthquake occurred in southern Alaska on 10 September 1899. It was preceded by a large (M_s 7.8) foreshock (*24*) and was followed by aftershocks that were strongly felt near Yakutat Bay (Fig. 5b). Coseismic uplift, which locally measured as much as 15 m, was observed (*20*) near Yakutat Bay. Significant deformation may have extended to the west of Yakutat Bay into an area of large glaciers that was not studied by Tarr and Martin (*20*). Since the intensities in Fig. 5b drop off rapidly to the southeast of Yakutat Bay, the rupture zone of the earthquake of 10 September may have extended more to the west of Yakutat Bay than to the southeast.

The rupture zone of the large shock of 10 July 1958 may have extended as far west as 140.3°W (Fig. 6). Hence, the 1958 shock may have reruptured a portion of the zone that broke in 1899. Although most of the rupture zone of the 1958 earthquake involved strike-slip motion, several aftershocks at its northern end (*3*) delineate an east-west trend from 139.5° to 140.3°W along 60.3°N. The aftershock zone of the 1979 earthquake abuts the western end of this zone.

Richter (*24*) locates a great earthquake on 9 October 1900 near Yakataga. Thatcher and Plafker (*11*) assign it a magnitude of 8.1. The strongest intensities and the only reports of aftershocks, however, are from the vicinity of Kodiak Island (Fig. 5b) (*20*). Hence, this event appears to be located several hundred kilometers to the southwest of the Yakataga gap and appears to have no direct connection with the shocks of 1899. The historical record does indicate that the two great earthquakes of 1899 probably ruptured much or all of the plate boundary between the rupture zones of the 1964 and 1958 earthquakes. Thatcher and Plafker (*11*) reach a similar conclusion from a study of the seismic moments of the shocks of 1899.

Seismic Potential of the Yakataga Seismic Gap

In a study of several great earthquakes near Japan, Mogi (*15*) finds that large ($M_s \geq 6$) shocks tend to cluster in a ring surrounding the rupture zone of the coming great shock for 10 to 20 years prior to its occurrence. The rupture zone itself tends to become quiescent for large shocks (but not necessarily for smaller shocks) during the same period. Kelleher and Savino (*16*) report a similar doughnut pattern but find that the region interior to the ring of higher activity tends to be quiescent for several decades before great earthquakes. They find that activity is also concentrated near the epicenter of the coming earthquake.

The patterns of activity in southern Alaska resemble in many ways those described above. During the past 21 years, six shocks of magnitude 5.9 or greater have occurred (Fig. 6) around the periphery of the zone of near quiescence shown in Fig. 2. One of these (1970) was of magnitude 7.0. The 1958 and 1964 earthquakes bound the eastern and western sides of the gap (Figs. 1 and 6). Also, the event of 28 February 1979 is located along the eastern side of the doughnut pattern. No shocks of magnitude 6 or larger, however, are reported in standard catalogs in the gap between the 1958 and 1964 earthquakes for the 25-year period from 1933 through 1957. These catalogs are probably complete for $M_s \geq 7$ for that period and for $M_s \geq 6$ since about

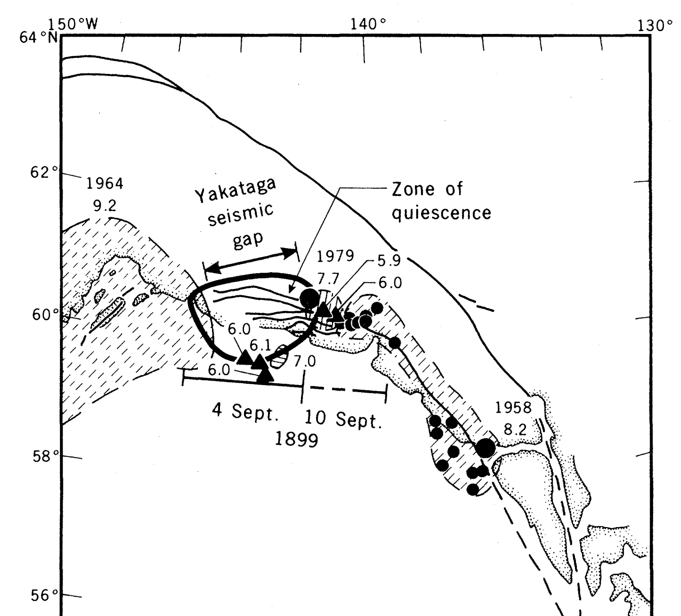


Fig. 6. Earthquakes of magnitude 5.9 or larger near the Yakataga seismic gap from January 1958 to February 1979. Note that seven of these events are situated at the edges of the zone of near quiescence for small shocks (heavy solid line) shown in Fig. 2. Large circles denote the epicenters of main shocks of large events in 1958 and 1979; small circles, aftershocks of the 1958 earthquake; triangles, shocks of magnitude 5.9 to 7.0. Faults are from (*29*). Inferred lengths of the rupture zones of two great earthquakes in 1899 are indicated. Hatching indicates the rupture zones of the 1958 and 1964 earthquakes. Numbers below dates are magnitudes.

1946. Thus, a marked increase in the number of shocks of magnitude 6 or larger appears to have occurred about 1958 within the ring of higher activity that surrounds the zone of near quiescence in Fig. 2. It should be noted, however, that no events of that size are reported in standard catalogs within the zone of quiescence itself from 1908 through 1978. We find no evidence of a change in activity with time for events larger than magnitude 5 in the quiescent zone.

It is difficult to ascertain whether a change in activity for events smaller than magnitude 5 occurred in the Yakataga gap around 1958, since detection may not have been complete for events of that size before 1964. A surge of seismic activity occurred both on the periphery and within the zone of quiescence (Fig. 2) in the Yakataga gap following the great earthquake on the adjacent part of the plate boundary in 1964 (Fig. 1). These shocks appear to lie outside the aftershock zone of the 1964 event. Uplift associated with that earthquake (*23*) diminishes rapidly along the coast to the east of Prince William Sound (Fig. 3) and is less than 1 m to the east of Kayak Island. Hence, the Yakataga gap does not appear to have ruptured significantly during the 1964 earthquake; the surge in seismic activity in the gap in 1964 appears to have been triggered by the nearby great earthquake. A shock of magnitude 6.2 occurred in the Pamplona zone 3 months after the large 1958 earthquake. These surges in activity following the 1958 and 1964 shocks may be indicative of high stress concentrations on the periphery of and perhaps within the zone of near quiescence.

We found several other surges of seismic activity that occurred within 1 year of several great earthquakes and were located 100 to a few hundred kilometers from the nearest parts of the aftershock zones. These surges coincided with regions that in turn were parts of doughnut patterns that preceded great shocks which followed the surges by about 10 to 20 years. For example, the great earthquake (M_w 8.1) off northern Japan in 1952 was followed within 1 year by a surge of shocks about 200 km away in what became the southern end of the rupture zone of the great earthquake (M_w 8.2) of 1968. The location of this surge was also the site of a large (M_s 7.5) earthquake in 1960.

Seismic activity in the Yakataga gap was not distributed evenly in time during the last 15 years. The period 1964 to 1968 was characterized by rapidly decreasing activity for moderate-size events following the 1964 Alaska earthquake; after 1966 much of the gap was nearly quiescent for events above magnitude 4.0. In 1970, however, the Pamplona zone was the source of a swarm of earthquakes, the largest of M_s 7.0. After 1971 no events above magnitude 5 occurred in the Yakataga gap prior to the large (M_s 7.7) earthquake on 28 February 1979. In 1976 a few events with magnitudes near 4.5 occurred near the rupture zone of the 1979 event. Since 1958 the observed temporal pattern of seismicity in the Yakataga gap has consisted of bursts or swarms of activity with intervening periods of lower activity around the perimeter of the zone of near quiescence in Fig. 2. Wyss *et al.* (*27*) show several examples of surges in seismic activity, both preceded and followed by periods of quiescence, that they interpret as forerunning large shocks. In the Yakataga area we observed at least four surges of activity (1958, 1964, 1970, and 1979), any of which could have been interpreted as precursory effects. Also, we have not observed a sudden decrease in the number of small shocks within the zone of quiescence that resembles the changes reported by Ohtake *et al.* (*28*) prior to several earthquakes. Thus, we do not find any clear evidence in the Yakataga area for temporal changes on a time scale shorter than about 20 years.

Conclusion

Macroseismic data for the great earthquakes of 4 and 10 September 1899 indicate that much of the plate boundary between the 1958 and 1964 earthquakes ruptured at that time. The potential slip that may have been built up in the region from 1899 to the present is similar to the average slip associated with the 1899 events. Focal mechanism solutions and geologic studies indicate that convergent plate motion in the region is accommodated in shallow thrust planes, as in the zone to the west that ruptured in the 1964 Alaska earthquake. A large portion of this thrust zone has been nearly quiescent for events as small as magnitude 4.0 for the last 15 years. This zone of near quiescence is surrounded by a ring of activity. The number of larger earthquakes in the ring appears to have increased significantly since the 1958 earthquake on the adjacent plate boundary. This doughnut-like pattern resembles in many ways the spatial-temporal patterns that preceded several great earthquakes (*15, 16*). The spatial and temporal changes that we observe within the Yakataga gap, however, do not permit us to estimate precisely the time of occurrence of a future great shock that would rupture the gap. Intensified field studies are needed to identify effects that may be precursory to such an event. Nevertheless, the observation that this region ruptured in a series of large shocks in 1899, the calculation of a repeat time of about 80 years, and the occurrence of a large earthquake in the area in 1979 suggest that the Yakataga gap is likely to be the site of a great earthquake within the next 10 to 20 years.

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