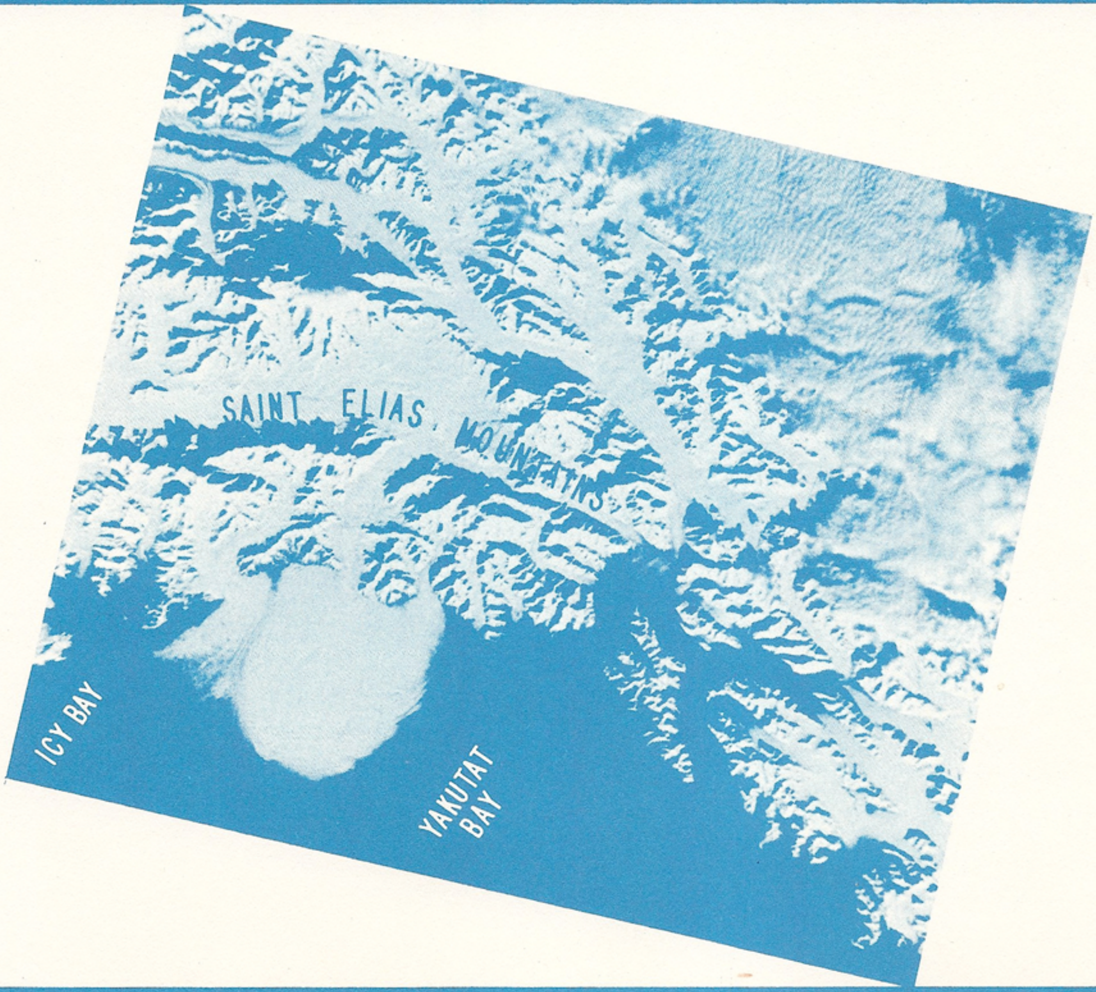
UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

INTERIM REPORT ON THE ST. ELIAS, ALASKA EARTHQUAKE OF 28 FEBRUARY 1979



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Menlo Park, California
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Introduction

On 28 February 1979 an earthquake with surface wave magnitude (M_S) of 7.7 (W. Person, personal communication, 1979) occurred beneath the Chugach and St. Elias mountains of southern Alaska (fig. 1). This is a region of complex tectonics resulting from northwestward convergence between the Pacific and North American plates. To the east, the northwest-trending Fairweather fault accommodates the movement with dextral slip of about 5.5 cm/yr (Plafker, Hudson, and others, 1978); to the west, the Pacific plate underthrusts Alaska at the Aleutian trench, which trends southwestward (Plafker 1969). The USGS has operated a telemetered seismic network in southern Alaska since 1971 and it was greatly expanded along the eastern Gulf of Alaska in September 1974. The current configuration of stations is shown in Figure 9. Technical details of the network are available in published earthquake catalogs (Lahr, Page and others, 1974; Fogleman, Stephens and others, 1978). Preliminary analysis of the data from this network covering the time period September 1, 1978 through March 10, 1979, as well as worldwide data for the main shock will be discussed in this paper.

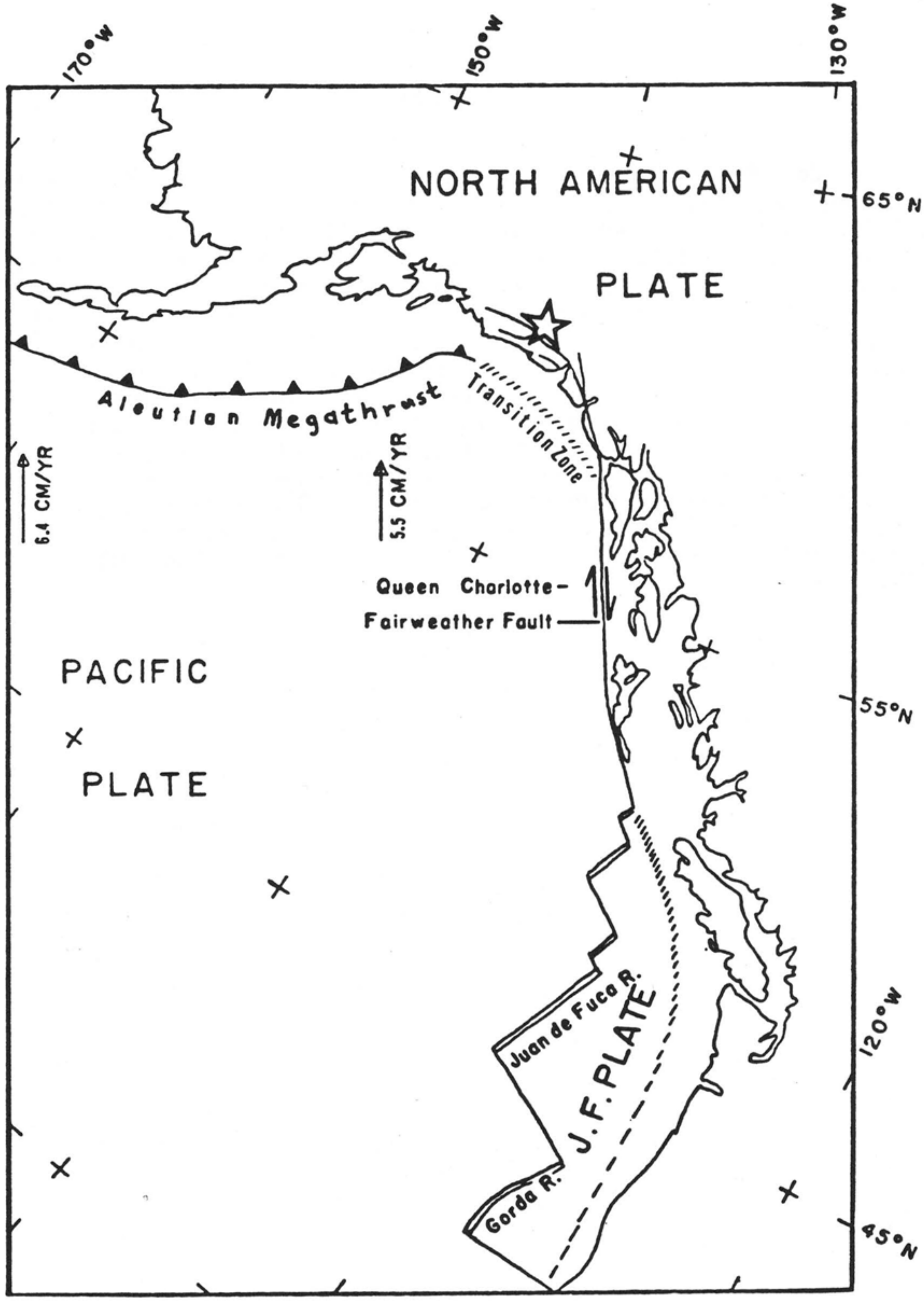

Figure 1. Current motion of Pacific plate with respect to North American plate. Juan de Fuca (J.F.) plate also shown. Star indicates epicenter of the earthquake of 28 February, 1979.

Acknowledgments

We wish to thank Jim Savage, Sam Stewart and Bob Page for critically reviewing this manuscript.

We are grateful to the numerous individuals and institutions in the U.S. and Canada that responded promptly to our requests for first motion data. In particular we wish to acknowledge the information provided by John Derr and Waverly Person of the National Earthquake Information Service.

Dave Boore provided valuable assistance in estimating the moment of the earthquake. Robert Koyanagi kindly supplied copies of the seismograms used in this computation, and Jerry Eaton provided information on the instrument response.

Travis Hudson, Tom Miller, and S. M. Nelson of the Alaskan Geology Branch, U.S. Geological Survey carried out an air reconnaissance of the earthquake epicentral region on March 2 and kindly provided us with their observations. Frank Ryman and Gail Rainy of Yakutat made an overflight of the Yakutat Bay and Russell Fiord area on the morning after the earthquake at the request of one of us (Plafker) to evaluate the effects of the earthquake in that area.

We thank Robert Eppley, Wayne Jorgensen and the entire staff of the NOAA Tsunami Warning Center for their assistance in maintaining our recording equipment in Palmer, Alaska, as well as making their seismic data available to us.

We are indebted to all of those who have spent time fabricating, installing, and maintaining the seismograph network in Alaska, particularly John Roger and Marion Salsman.

This study was supported jointly by the U.S. Geological Survey and by the National Oceanic and Atmospheric Administration, under which a multi-year program responding to needs of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) office.

TECTONIC SETTING

With respect to the North American plate, the Pacific plate is moving to the northwest at 5 to 6 cm/yr (Minster, Jordan, and others, 1974), parallel to the Fairweather-Queen Charlotte right-lateral fault system. There is geologic evidence to suggest that for the past 100,000 yrs strike slip motion on the Fairweather fault has kept pace with the Pacific plate motion (Plafker, Hudson, and others, 1978). If this is the case, the continental block between the Transition zone and the Fairweather fault (Yakutat block) (fig. 2) must be moving along with the Pacific plate and colliding with Alaska. The distribution of convergent motion among the various faults is not known, but clearly the north-northwest-oriented horizontal compressive stresses will likely result in oblique thrust faulting on the Transition zone, thrust faulting along the eastwest-trending (Pamplona, Sullivan, Chugach-St. Elias, Coal Glacier, and Duke River) fault zones and right-lateral faulting on the northwest-trending Denali and Totschunda faults.

Another indication of complexity in the eastern Gulf of Alaska comes from the regional extent of the Benioff zone as inferred from the depths of seismic events. Figure 3 shows isobaths of the Benioff zone, a planar distribution of hypocenters that occur near the upper surface of that portion of the Pacific plate which has been thrust beneath Alaska (Lahr, 1975). Over the past 10 million years hundreds of kilometers of Pacific plate have been thrust beneath Alaska in this region. Note that west of about 143.5 W the trench is well defined, and the Benioff zone is present, whereas to the east of 143.5 W the trench and Benioff zone are absent. The lack of seismicity from which to infer the existence of a subducted portion of the Pacific plate in the east may be related to the regional distruption caused by northward movement of the "Yakutat block" and the resulting collision between two continental masses. (Plafker, Hudson, and others, 1978).

GEOLOGIC SETTING

The part of the Chugach and Saint Elias Mountains that includes the epicentral region is characterized by five linear, fault-bounded tectono-stratigraphic sequences that are increasingly younger from north to south (figs. 2 and 11). These are: (1) An extensive area of early and middle Paleozoic sedimentary and volcanic rocks between the Hubbard and Totschunda faults. The rocks are extensively intruded by plutons that range in age from Pennsylvanian to Tertiary and are locally overlain by andesitic volcanic rocks of late Cenozoic age associated with the Wrangell Mountains volcanoes. (2) Between the Border Ranges fault and the Hubbard and Totschunda faults is a terrane of compositionally diverse metavolcanic and metasedimentary rocks of late Paleozoic age. The rocks in general, are increasingly more schistose and metamorphosed towards the Border Ranges fault (MacKevett and Plafker, 1974; Campbell and Dodds, 1978; MacKevett, 1978; Plafker, unpublished data). The bedded rocks are intruded by large, foliated quartz diorite and granodiorite plutons of Jurassic and Cretaceous(?) age as well as smaller Tertiary plutons and are overlain locally by Upper Triassic to Cretaceous sedimentary and volcanic rocks and upper Cenozoic andesitic lavas. (3) Between the Border Ranges fault and Contact/Fairweather fault system are Cretaceous flysch and mafic volcanic rocks that have been highly deformed and

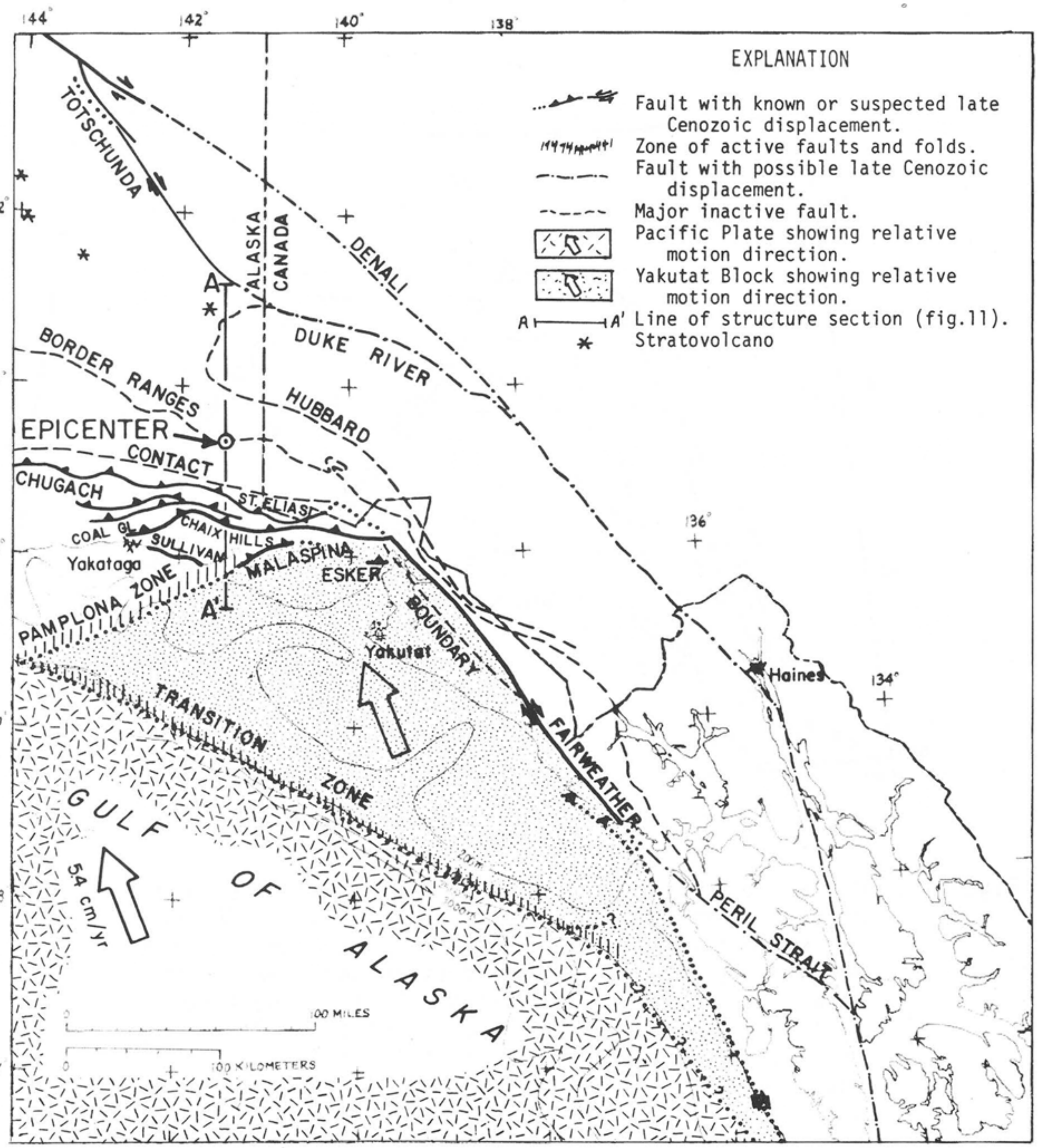

Figure 2. Map showing the tectonic setting of the 28 February 1979 earthquake. Onshore faults after Plafker, Hudson, and others (1978); Campbell and Dodds (1978); and unpublished data. Offshore structure after Plafker, Bruns, and others (1978) and unpublished data. Direction and rate of Pacific plate relative motion after Minster and others (1974). Circle indicates epicenter of the earthquake of 28 February 1979.

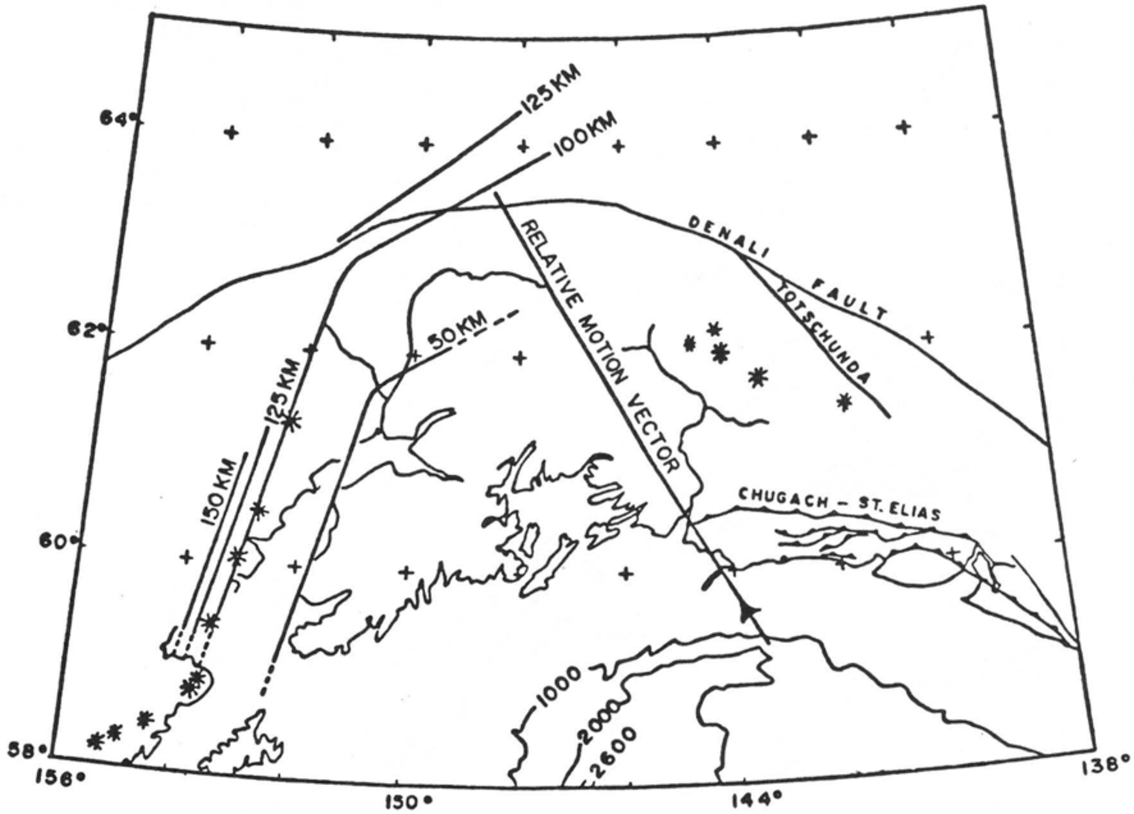

Figure 3. Map of south central Alaska region showing the extent of the underthrust Pacific plate. 50, 100, 125 and 150 km contours are given for the upper surface of the Benioff zone. The Denali and Totschunda faults are shown (after Richter and Matson, 1971). The thrust faults, sawteeth on upper plage, are after Plafker (1967). Depth contours are in fathoms. Relative motion vector shown is portion of small circle about pole at 54°N and 61°W.

variably metamorphosed from zeolite to amphibolite facies (MacKevett and Plafker, 1974; Campbell and Dodds, 1978; Plafker and Hudson, unpublished data). Intrusive rocks within this sequence include widespread small stocks, sills, and dikes of felsic rocks, dikes of basaltic composition, and large layered gabbro plutons all of Tertiary and possible Upper Cretaceous age. (4) The Contact fault and Chugach-Saint Elias system bound a narrow belt characterized by epidote-amphibolite facies metavolcanic and metasedimentary rocks of probable Cretaceous age in the eastern part of the belt with Paleocene basalt and clastic sedimentary rocks in the western part (Plafker and Hudson, unpublished data). Both sequences are cut by small felsic Tertiary plutons. (5) South of the Saint Elias fault system are thick Tertiary basinal sediments that lap onto structural highs of Late Cretaceous flysch and melange along the northeastern margin of the basin and locally offshore (Plafker, 1967; Plafker, Bruns, and others, 1978). The basin sequence includes more than 12,000 m of Eocene and younger continental, paralic, and marine predominantly clastic sediments that are locally intruded by mafic plugs and dikes.

The Tertiary sequence on land and extending offshore to the Pamplona zone is commonly folded into a series of tight, asymmetric anticlines with steep to overturned faulted south limbs and intervening broad synclines (Plafker, 1967). In contrast, the coeval sedimentary rocks on the Yakutat block to the east of the Pamplona zone are relatively unaffected by late Cenozoic folding and faulting except locally along the block margins (Plafker, Bruns, and others, 1978).

Surface faults with known or suspected Cenozoic displacement in the region affected by the earthquake are shown on Figure 2. These include the dextral Fairweather fault and the system of east- to northeast-trending, north-dipping thrust or oblique thrust faults that probably take up the strike-slip motion at the northwestern end of the Fairweather fault. This system includes the Saint Elias, Coal Glacier, Chaix Hills, Esker Creek, Malspina, and Sullivan faults. The northernmost of these structures, the Saint Elias fault, emplaces Paleocene bedded rocks and Cretaceous metamorphic rocks over Eocene and Cretaceous bedded rocks along a thrust fault that dips roughly 30° N where it is exposed along the south flank of Mt. Saint Elias. The Coal Glacier fault is a splay of the Saint Elias fault that also dips about 30° N and has Eocene rocks overriding younger Eocene and late Cenozoic strata along a thrust with dips of 30° or more to the north. The Chaix Hills fault can be traced almost continuously from its junction with the Fairweather fault near the head of Yakutat Bay to the area west of Icy Bay. It dips 30°-60° N where visible at the surface and juxtaposes Cretaceous and Eocene rocks on the north against Eocene and Neogene rocks to the south. The Esker fault juxtaposes Cretaceous and Eocene strata along a plane that is not exposed at the surface. The Sullivan fault is a thrust in Neogene strata that cuts the south flank of a major anticline. The Malaspina fault is a thrust fault in Neogene strata that was penetrated by petroleum exploration wells at the south margin of the Chaix Hills. Both the Esker Creek and Sullivan faults may have moved during the 1899 Yakutat Bay earthquakes based on observed earthquake-related shoreline uplift that occurred on their relatively upthrown blocks (Thatcher and Plafker, 1977). None of the faults mapped in the area have surface expressions indicative of recent displacement; such features, however, are not likely to be well preserved in this area of rugged topography, extensive ice and snow cover, rigorous alpine climate, and high precipitation.

EARTHQUAKE HISTORY

The rupture zones of earthquakes in Alaska of magnitude 7.3 or greater since 1931, as inferred from the location of aftershocks, are illustrated in Figure 4. Since the entire Pacific-North American plate boundary will periodically be subject to ruptures during major earthquakes as the Pacific plate moves northward, gaps along the boundary that have not ruptured in the recent past are thought to have the greatest potential for earthquakes in the future. In papers written prior to 1972, two "gaps" were identified in southern Alaska--one near Sitka and another between about Yakutat Bay and Kayak Island (Tobin and Sykes, 1968; Kelleher, 1970; Sykes, 1971). In 1972 the Sitka gap was filled (Page 1975), leaving only the Yakutat-Kayak gap. This latter gap was the site of a sequence of large earthquakes during 1899 and 1900. Reevaluation of data from that sequence by Thatcher and Plafker (1977) indicates that four events with magnitudes (M_S) of 8.5, 7.8, 8.4 and 8.1 occurred in a 13 month interval with a total moment of more than 3.8 x 10 dyne-cm. They attribute the 14 m of vertical uplift observed at Yakutat Bay to the 8.4 M_S event. Although instrumental epicentral control is poor for these shocks, the absence of a tsunami suggests that faulting was most likely onshore rather than offshore.

The rupture zone of the 28 February 1979 St. Elias earthquake shown on Figure 4 is tentatively determined from the aftershock data available at this time. There appears to be a remaining unruptured zone between this event and the 1964 Alaska earthquake. Due to the extreme complexity of this region as compared to most plate boundaries, caution should be exercised in applying the gap hypothesis to infer a simple recurrence pattern.

SEISMICITY OF THE ST. ELIAS REGION

The seismicity of the St. Elias region is known above a magnitude of about 4.0 since the Alaska Tsunami Warning Seismograph Network was established in September 1967. Figure 5 shows the epicenters of the 25 events reported in the Preliminary Determination of Epicenters (PDE) of the U.S.G.S. from January 1, 1969 through January 30, 1979. During this interval there has been an average of 1.3 PDE events greater than or equal to magnitude 4.0 per year, with the number in one year varying from 0 to 4, and the largest earthquake having a magnitude of 5.5. m_b (5.9M_L). The seismicity has been concentrated in a zone about 40 km wide and extending 90 km northeast from the mouth of Icy Bay.

The epicenters of events located with data from the USGS station network for Sept. 1, 1978, through Dec. 31, 1978, are plotted in Figure 6 with symbol size proportional to magnitude. The symbol indicates the quality of the location (see Fogleman, Stephens and others, 1978 for quality definition). The average magnitude of these 198 events is 1.6 and they form a complete sample above a magnitude of about 1.8. The number greater than or equal to magnitude 2.0 is 48, representing a rate of 144 per year during this time interval. This is roughly 2 orders of magnitude greater than the average occurrence rate of 1.3 per year found for magnitude 4.0 or greater events during the past 10 years, as would be expected for a b-value of 1.0. Of these events, the deepest nine have depths between 20 and 35 km and the average

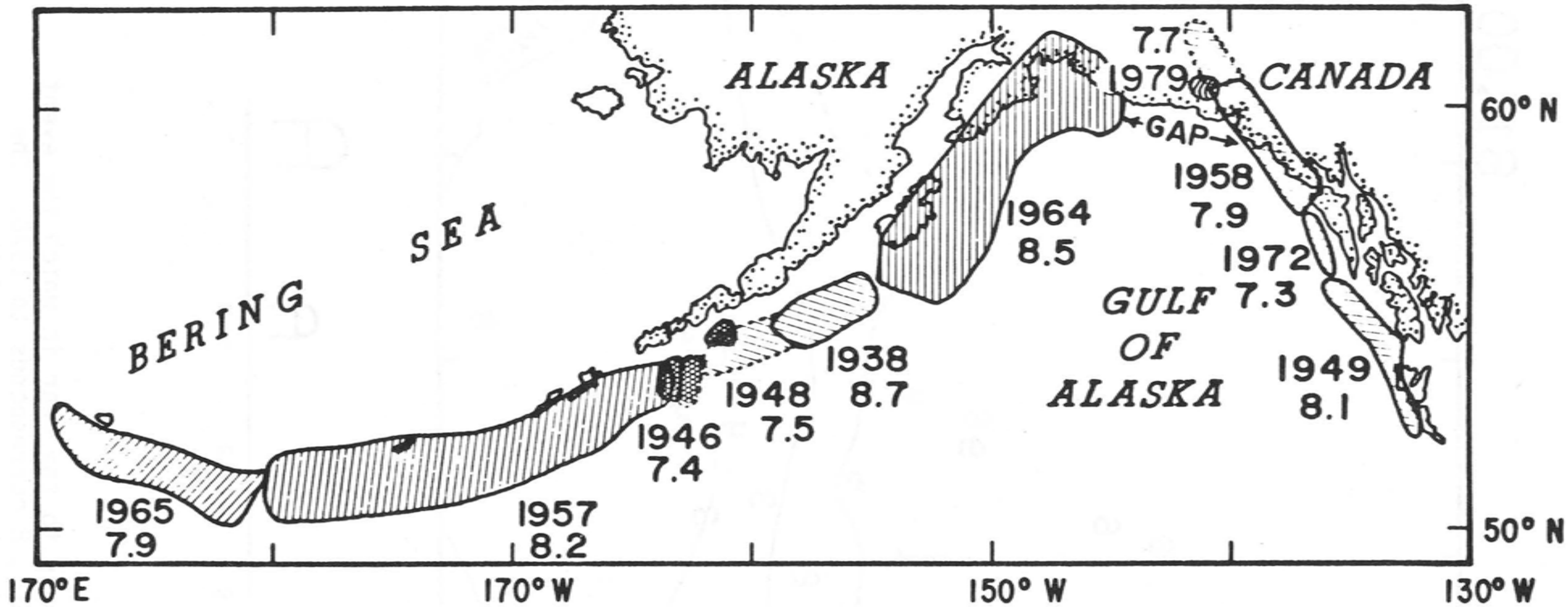

Figure 4. Aftershock zones of earthquakes of magnitude 7.3 or greater since 1938. Dashed where extent of zone is uncertain. Dates and magnitudes given. Figure from Page (1975). The February 28, 1979, event is the first to occur between the rupture zones of the 1958 Fairweather earthquake and the 1964 Prince William Sound earthquake since the 1899-1900 series of great earthquakes near Yakutat Bay. Approximate rupture zone of earthquake of 28 February 1979 is shown.

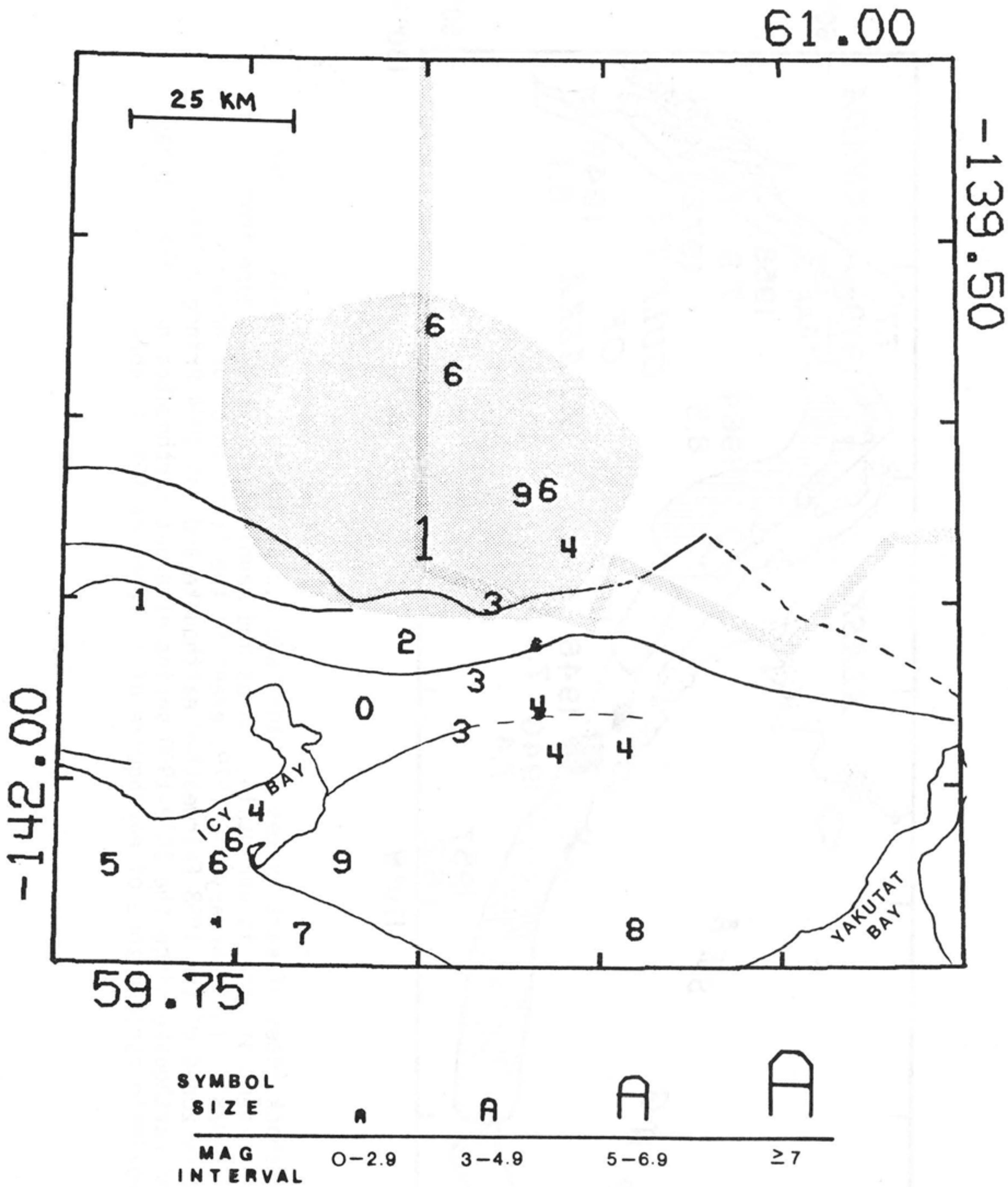

Figure 5. The symbol corresponds to the year in which the event occurred; for example, 8 corresponds to 1978. The only event in 1969 is near the center of the map. The stippled region is approximate rupture zone of earthquake of 28 February 1979. The United States-Canada border and faults shown in Figure 1 are included for reference.

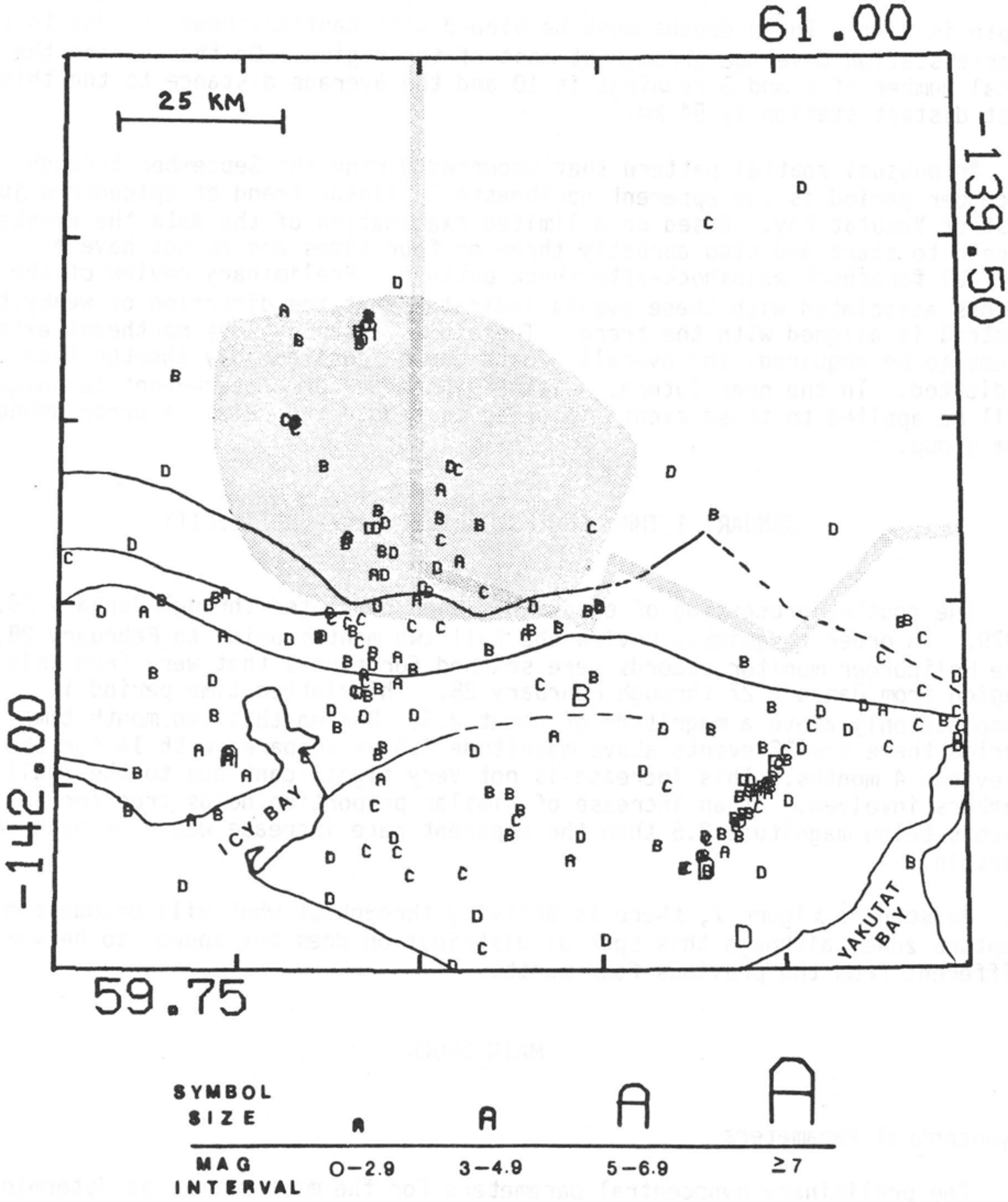

Figure 6. USGS local network epicenters for September 1, 1978 through December 31, 1978. The plot symbol represents the quality of relative hypocentral control and the size is proportional to magnitude. The stippled region is approximate rupture zone of earthquake of 28 February 1979.

depth is 9 km. These depths must be viewed with caution, however, due to the sparse station coverage throughout most of the region. On the average the total number of P and S readings is 10 and the average distance to the third most distant station is 54 km.

An unusual spatial pattern that occurred during the September through December period is the apparent northeasterly linear trend of epicenters just west of Yakutat Bay. Based on a limited examination of the data the events appear to start and stop abruptly three or four times and do not have a typical foreshock-mainshock-aftershock pattern. Preliminary review of the errors associated with these events indicates that the direction of weakest control is aligned with the trend. Therefore, although some northeast extent seems to be required, the overall length may be considerably shorter than indicated. In the near future, a joint-hypocenter or master-event technique will be applied to these events in order to reduce the relative error amongst the group.

JANUARY 1 THROUGH FEBRUARY 28, 1979 SEISMICITY

The routine processing of events has been completed through January 26, 1979. In order to quickly review the full two months prior to February 28, the Helicorder monitor records were scanned for events that were from this region from January 27 through February 28. This latter time period is complete only above a magnitude of about 2.5. During this two month time period there are 12 events above magnitude 2.5 as compared with 14 for the previous 4 months. This increase is not very significant due to the small numbers involved. If an increase of similar proportion holds true for the events below magnitude 2.5 then the apparent rate increase would be much more certain.

As seen in Figure 7, there is activity throughout what will become the rupture zone, although this spacial distribution does not appear to be very different from the previous four months.

MAIN SHOCK

Hypocentral Parameters

The preliminary hypocentral parameters for the main shock, as determined from regional stations, are:

Origin Time: 21:27:07.91 UT on 28 February 1979

Epicenter: 60° 37.2' N, 141° 30.5' W

Depth: 8 km

This solution is based upon P-phase arrival times at 25 stations within 350 km distance. For comparison, the hypocentral parameters based on both teleseismic

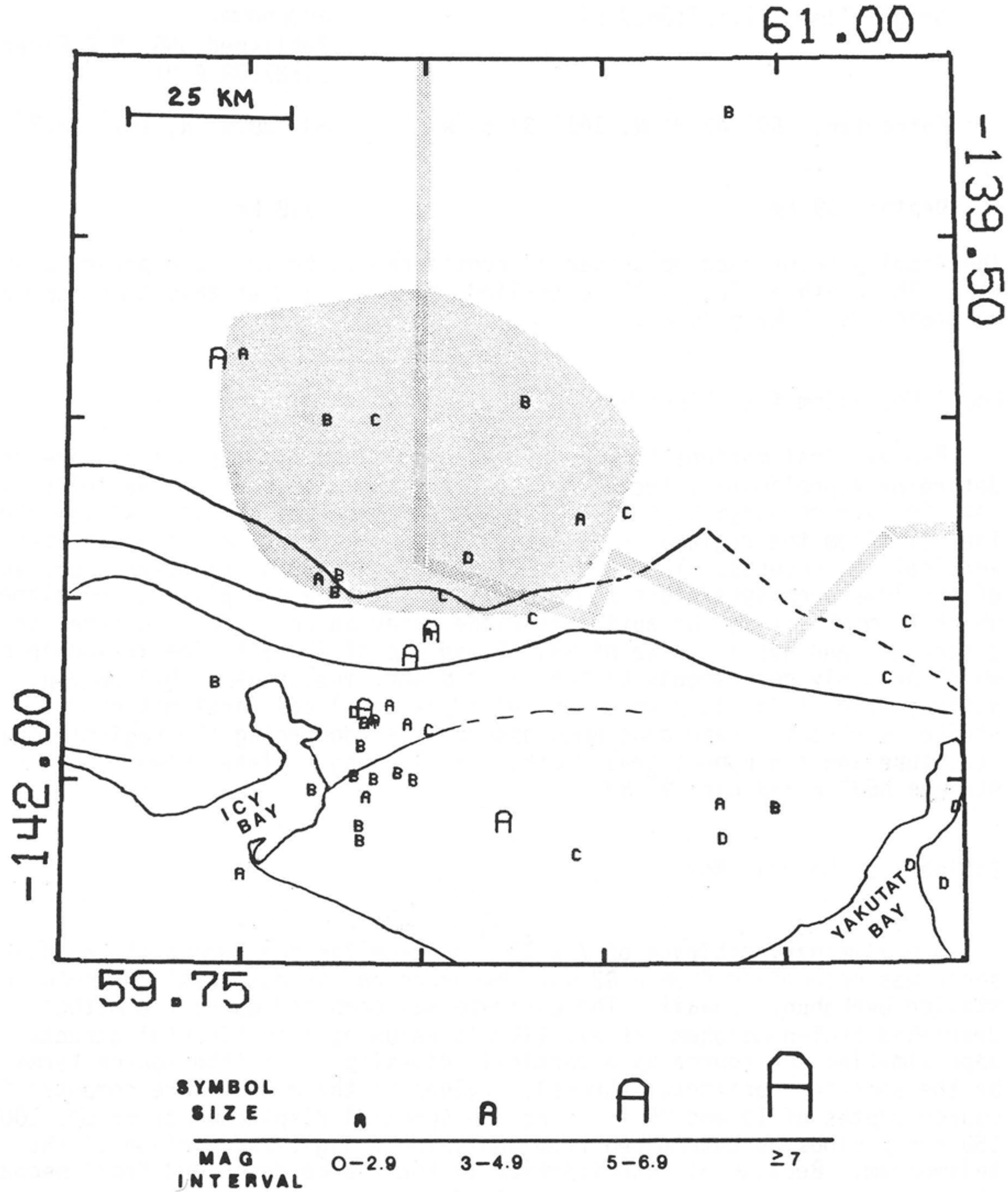

Figure 7. USGS regional network epicenters for 1 January 1979 through 28 February 1979 until immediately prior to the main shock at 21:27 U.T. Symbol description is the same as for Figure 6.

and limited regional data are (W. Person, personal communication, 1979):

Origin Time:	21:27:06.0 UT	Addendum: Published USGS PDE Parameters: 21:27:08.6 UT
Epicenter:	60° 43.2' N, 141° 33.6' W	60 38.9' N, 141° 36.7' W
Depth:	19 km	26.8 km

The locally determined epicenter is considered to be the more accurate of the two. The depth is less well controlled, however, and at this time our best estimate is 15 km ± 10 km.

Focal Mechanism from First Motion Data

P-wave first motions from both teleseismic and local stations were used to determine a preliminary focal mechanism for the main shock. The teleseismic data include readings from both long-and short-period vertical seismometers. The data from the regional stations within 400 km were read from short-period vertical instruments. The first motions, plotted on an equal-area projection of the lower hemisphere are shown in Figure 8. The steeply dipping plane, which is most likely the auxiliary plane based on geologic structure, is well controlled and has a strike of N81° E and dip of 82° SSE. The low-angle plane, which probably corresponds to the fault plane, must have a shallow dip, although the strike is poorly controlled by the local first motion data. The strike is strongly dependent upon assumptions concerning the regional crustal structure and the hypocentral depth. The low-angle plane shown in Figure 8 strikes N58° E and dips 9° NW.

Estimate of Seismic Moment

A preliminary estimate of 7 x 10^{27} dyne-cm for the moment of the main shock was determined from a G2 wave recorded on the east-west component of the station Uwekahuna, Hawaii. The estimate was computed using the method described by Ben-Menahem, et al. (1970), assuming a continental structure, and approximating the source by a vertical, dip-slip fault (the source terms would be the same for horizontal thrust). Values of the moment were computed for source depths of 10 and 25 km using the spectral displacements of 50, 100, and 150 sec periods as determined from analyzing a digitized portion of the seismogram. Because of uncertainties in the source depth and focal mechanism, the instrument response, the spectral displacements, and the earth's structure at the source, the moment could be as low as 2 x 10^{27} or as high as 2 x 10^{28}. The value of 7 x 10^{27} dyne cm is consistent with the average magnitude of 7.7 M_S.

The degree of complexity of the main shock rupture is not yet known. If the simple case of a single, shallow-dipping thrust plane is assumed, and if the distribution of the main shock and aftershocks define the area of rupture, then an estimate of the slip that occurred during the main shock can be computed from the moment. The area of rupture is approximately 60 km x 50 km,

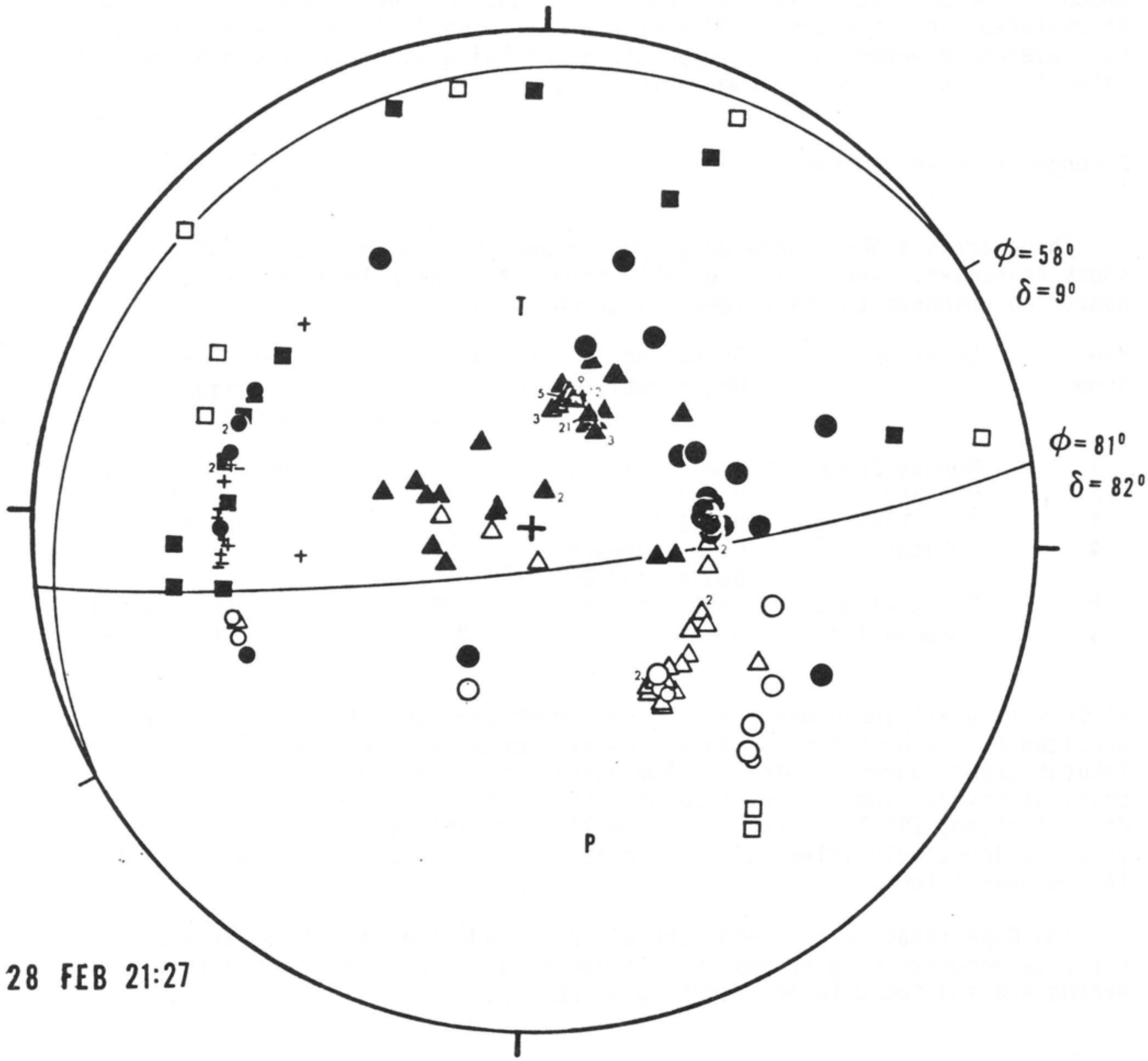

Figure 8. P-wave first motions plotted on an equal-area projection of the lower hemisphere. Compressions are represented by solid symbols, dilations by open symbols, and nodal arrivals by (+) and (-). Large and small circles correspond to readings from long- and short-period vertical seismometers, respectively, triangles to NEIS reported readings where the period of the instrument is not known, and squares to readings from short-period vertical stations at epicentral distances of less than 400 km. Small numbers next to a symbol give the total number of stations that plotted at approximately the same point. The strike (ϕ) and dip (δ) of the two planes are indicated, as well as the tension (T) and compression (P) axes.

or 3×10^{13} cm^2. Taking $\mu = 0.5 \times 10^{12}$ dyne/cm , and using the computed moment, the displacement on the fault would be about 4 1/2 meters. This amount of slip is sufficiently large to account for the strain that would have accumulated since the 1899-1900 series of earthquakes in this area, assuming that average movement of 5-6 cm/yr along the Fairweather Fault can be used to infer the rate of strain accumulation.

Strong-Motion Recordings

There are six SMA-1 accelerographs in operation within 250 km of the main shock epicenter. The following table summarizes their location, and the number corresponds to their identification on Figure 9.

Map Number	Location	Operating Organization	Approximate Distance to Epicenter (km)	Maximum Horizontal Acceleration (g)
1	Munday Creek	Shell Oil Co.	71	Not yet serviced
2	Icy Bay	U.S.G.S.	73	0.17
3	Cape Yakataga	U.S.G.S.	79	Did not trigger
4	Yakutat	Lamont-Doherty Geological Obs.	155	0.07
5	Kayak Island	Shell Oil Co.	185	Not yet serviced
6	Cordova (2)	U.S.G.S.	235	Did not trigger

At this time all instruments but Munday Creek and Kayak Island have been serviced following the main shock. Records obtained are from the Icy Bay and Yakutat accelerographs. The maximum acceleration recorded was 0.17 g (zero to peak) at Icy Bay and 0.07 g at Yakutat (R. B. Matthiesen, personal communication, 1979). These records will be digitized and have corrected accelerations, velocities, displacements, and as response spectra calculated in the near future.

The Cape Yakataga accelerograph did not produce a record and as a check the accelerograph trigger was sent to Menlo Park, California after the earthquake and found to be operating correctly.

AFTERSHOCKS

The epicenters of the main shock and 61 aftershocks are shown in Figure 10. This data set includes many of the largest events through March 10, 1979. These data are compatible with faulting on a plane dipping gently to the northwest, with the main shock rupture propagating updip and the dense cluster of aftershocks occurring near the surface outcrop of the plane. The isolated groups of aftershocks may represent events triggered on nearby faults, or they may possibly be on other splays of the main thrust zone. The region between the main shock and most of the aftershocks has been very quiet seismically, perhaps due to stress release on the rupture surface. A larger sample of aftershocks with careful control of relative location errors will be required to further clarify the nature of the faulting involved. With the

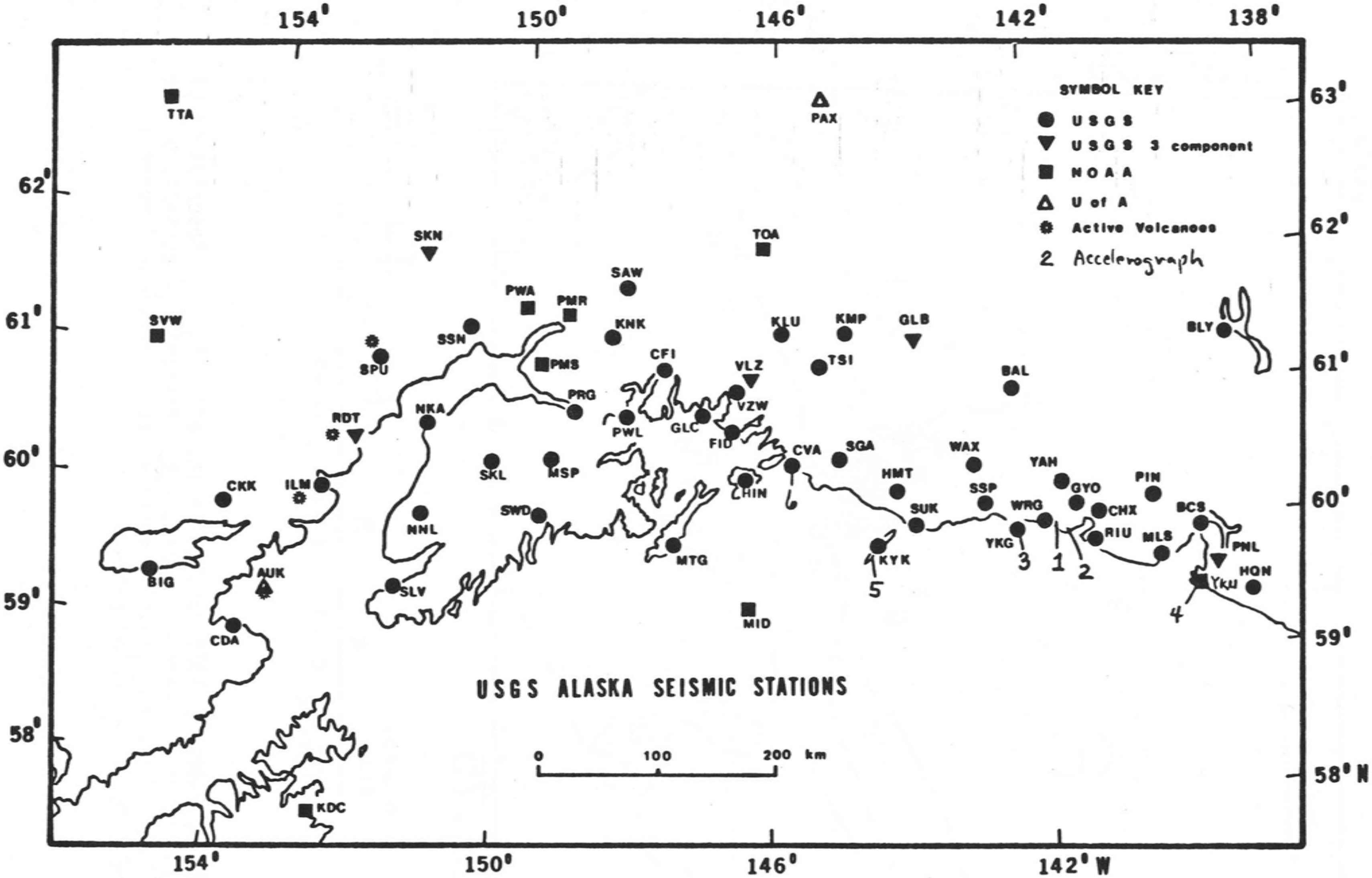

Figure 9. Map showing the seismic network in southern Alaska, as well as the closest accelerograph stations to the 28 February event.

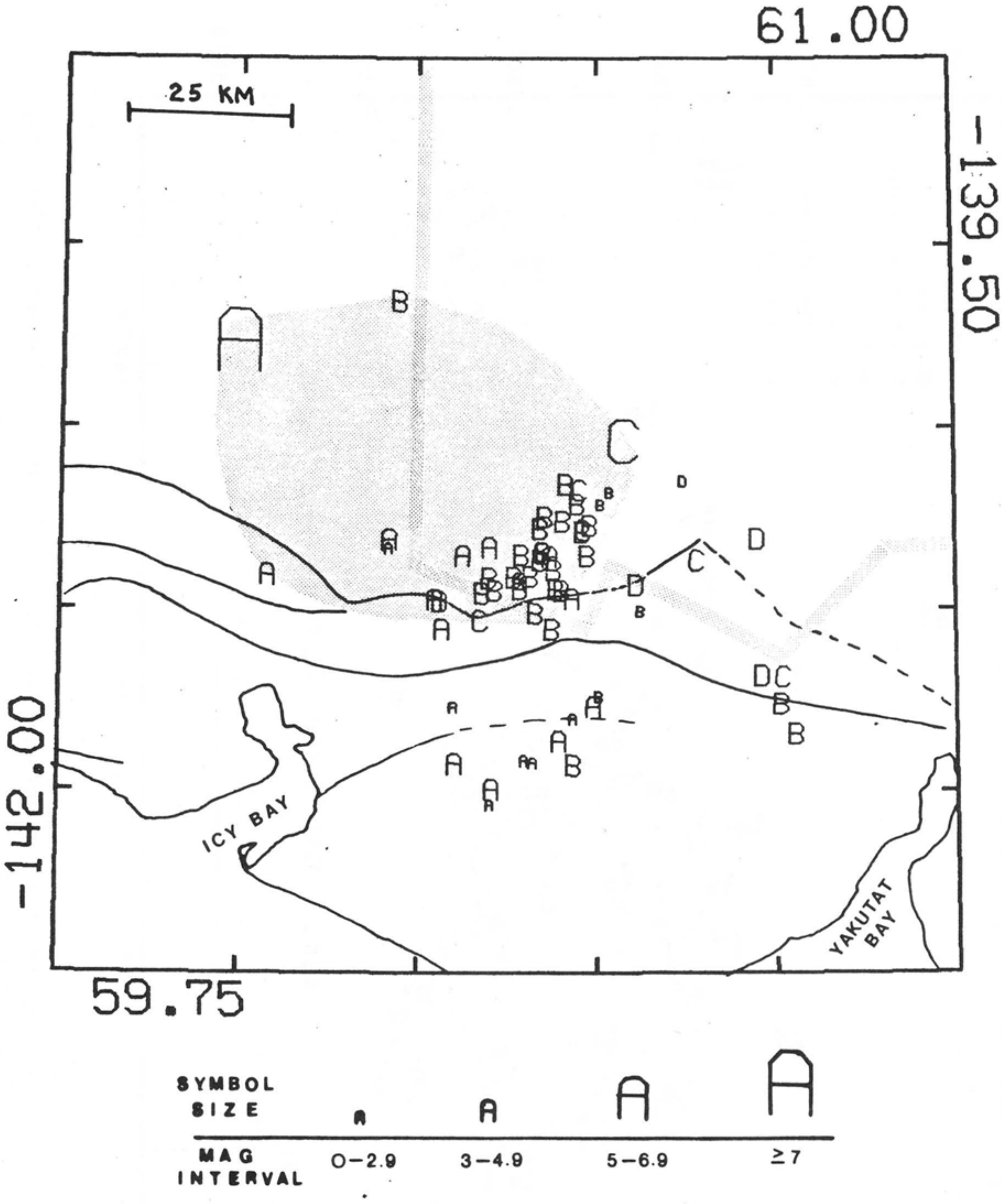

Figure 10. The 28 February 1979 earthquake and aftershocks. Description of symbols is the same as in Figure 6. Preliminary estimate of the extent of the rupture area referred to in previous figures is indicated by stippled pattern.

current regional stations it may not be possible to obtain adequate depth control to define the fault surfaces involved. Additional temporary stations to be installed next summer in the aftershock region will improve the situation considerably.

RESPONSIBLE FAULTS

Surface faults with known or suspected Cenozoic displacement in the region affected by the earthquake include the dextral Fairweather fault and the system of east- to northeast-trending, north-dipping thrust or oblique thrust faults that apparently take up the strike-slip motion at the northwestern end of the Fairweather fault (fig. 2). Some of these faults, and all the major faults that define terrane boundaries, are inferred to extend to considerable depths, and possibly to the base of the continental crust. As indicated schematically on the structure section (fig. 11), crustal thickness at the epicentral region may be reasonably close to the hypocentral depth of the main shock. This crustal thickness is based on projection of the top of the oceanic crust into the area as determined from three marine refraction lines on the adjacent continental shelf and slope (Bayer, Mattick and others, 1978). The data suggest Pacific Ocean crust has been underthrust beneath the continent at a low angle in the transition zone between the Fairweather transform and the Aleutian trench. Further north the oceanic crust and lithosphere presumably descends steeply beneath the andesitic volcanoes of the Wrangell Mountains which are inferred to mark the eastern end of the Aleutian volcanic arc (Plafker, 1969). Analysis of the Fairweather fault displacement history suggests that there is presently little, if any, relative motion between the Yakutat block and the Pacific plate and that the zone of compressive folding and faulting that extends from the Pamplona zone into the Chugach and Saint Elias Mountains may result from relative movement between the Yakutat block and North American plate at nearly the full relative displacement rate (Plafker, Hudson, and others, 1978).

The 28 February earthquake may have occurred by slip on one or more of the geologically young north-dipping thrust faults that have been mapped along the south side of the Chugach and St. Elias Mountains, along the interface between the oceanic and continental crusts, or by a combination of these. Of the surface faults, those most likely to have slipped during the earthquake are the Chugach-Saint Elias, Coal Glacier, Chaix Hills, or Malaspina faults.

An aerial reconnaissance made on March 2 indicated no significant earthquake effects anywhere within 40 km of the earthquake epicenter. There were extensive snow avalanches to the south and southeast of the epicenter off the northern flanks of Mt. Huxley, Mt. Saint Elias, and Mt. Augusta, and more limited avalanching on the south flank of Mt. Logan and King Peak. Surprisingly, there were no rock avalanches from these exceptionally high and precipitous mountains as would be expected for a shallow, large earthquake.

Weather conditions have prevented geologists from carrying out an aerial examination of the surface faults and other geologic effects on the south flank of Mt. Saint Elias for more than three weeks after the earthquake, and heavy snowfall during this period has undoubtedly obscured any ground effects that may have been visible after the event. However, an aerial reconnaissance of the Yakutat Bay area by residents of Yakutat indicated no avalanches and no

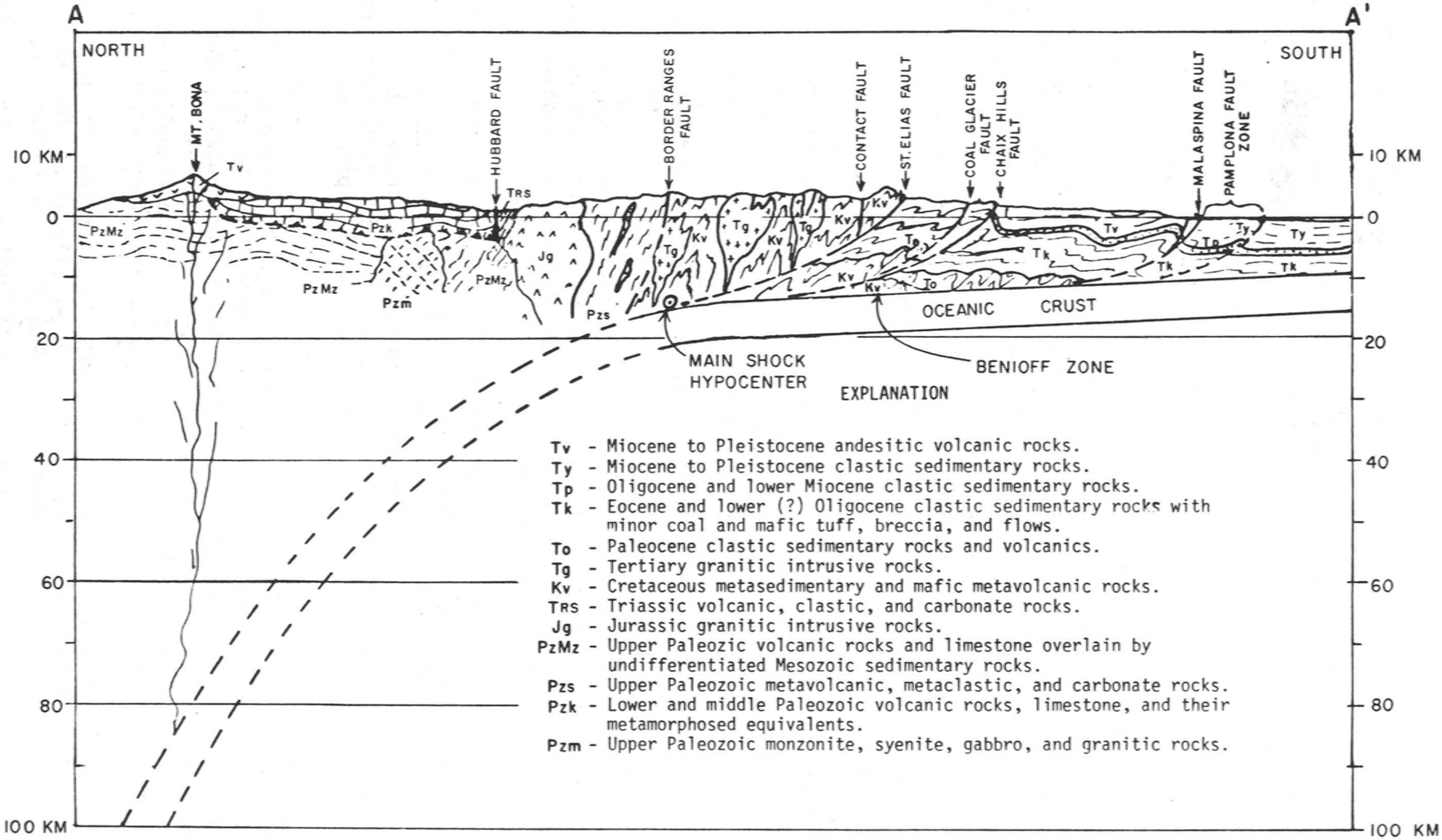

Figure 11. Diagrammatic structure section through the hypocenter of the 28 February 1979 earthquake showing fault systems along which the earthquake may have occurred. Geology after Plafker, Hudson, and others (1978); Plafker, Bruns, and others (1978); Mac Kevett (1978); Campbell and Dodds (1977); and unpublished data. See Figure 2 for location of section.

obvious shoreline changes or fault breaks in that area. It will not be feasible to enter the area to check for movement on the ground until the snow has melted, which is normally not until late July or August. The observed pattern of avalanches is reasonably consistent with what would be expected for an earthquake generated on a north-dipping fault that crops out at the surface south of the crest of the Saint Elias Mountains. Under these circumstances the greatest avalanche activity would be expected near the surface trace of the fault and the activity would decrease northward as the depth to the fault increased. The minimal amount of surface effects, however, suggests that the surface displacement, if any, may not have been large.

DISCUSSION

An important aspect of this earthquake is its relationship to the seismic gap identified in the eastern Gulf of Alaska. As discussed above, the gap hypothesis should be applied with caution in this unusual and complex region. However, if it is applied in a simple fashion, the only possible conclusion would be that a gap remains between the western limit of this event and the eastern limit of the 1964 Alaska earthquake focal region. The course of this faulting could be along the Pamplona Zone, the Chugach-Saint Elias system of faults, or the Transition Zone. Additional evidence suggesting that the offshore region may be the site of future earthquakes comes from the uplift history of Middleton Island (Plafker and Rubin, 1978). By their analysis, Middleton should be uplifted by about 3.5 meters within a short time interval as compared with the time required to cut a terrace.

The sequence of four earthquakes with magnitudes 7.8 and greater that occurred within a period of 13 months, at the turn of this century, may be very atypical of this region. Alternatively, it could represent a style of seismic energy release which will be repeated again. Such a possibility, combined with the remaining seismic gap and the history of uplift of Middleton Island make this region a prime candidate in which to carry out earthquake prediction and strong ground motion studies.

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