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GREAT EARTHQUAKES AND TSUNAMIS AT THE ALASKA SUBDUCTION ZONE: GEOARCHAEOLOGICAL EVIDENCE OF RECURRENCE AND EXTENT

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Abstract

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GREAT EARTHQUAKES AND TSUNAMIS AT THE ALASKA SUBDUCTION ZONE: GEOARCHAEOLOGICAL EVIDENCE OF RECURRENCE AND EXTENT

The incidence of plate-boundary earthquakes at the Alaska subduction zone (ASZ) in the late Holocene is reconstructed from geological evidence of abrupt land-level change and archaeological evidence of village abandonment. Bracketing radiocarbon ages on uplifted and down-dropped coastal deposits indicate that great earthquakes at the eastern end of the ASZ occurred about 800, 1400–1500, 2200–2300, 2700, 3100–3200, and 3600–3700 years ago. Evidence for an event about 1900 years ago, and the possibility that the 2700 cal. yr B.P. event was a closely spaced series of three earthquakes, is restricted to parts of Cook Inlet. Geological evidence from the central part of the ASZ is fragmentary, but indicates that this segment likely ruptured in 1400–1500 cal. yr B.P. and in the triple event at about 2700 cal. yr B.P. The geological record at the western end of the ASZ has limited time-depth. Evidence for ruptures about 500, 1000, and 1300 years ago suggests that this area displays semi-independent behavior.

Analysis of stratigraphic descriptions and 324 radiocarbon ages from 82 prehistoric Native villages and camps in eight sub-regions on the coast of the Gulf of Alaska reveal region-wide downturns in site activity that are largely coeval with paleoseismic episodes. Hiatuses in site occupation at about 800, 1500, and 2200 years ago in Prince William Sound and the Kenai Fjords and Kachemak Bay regions suggest that this is a coherent tectonic unit. The more fragmentary older record reveals hiatuses at about 2700–2800 years ago (Kachemak Bay), and 3500-3600 years ago (Prince William Sound). The last three events are also recorded in the Kodiak archipelago, and the great earthquake at about 3200 cal. yr B.P. is also apparently recorded there. Downturns in site activity in the western sub-regions also occurred about 700, 1200–1300, and 1800 years ago. If these all record the aftermath of great earthquakes and their attendant tsunamis, the average recurrence interval for plate-boundary earthquakes at the western end of the ASZ is about 400 years.

Non-Technical Summary

We analyzed records from 84 prehistoric sites on the coast of southern Alaska and found that episodes of village abandonment closely match geological evidence of major earthquakes. Sites in Prince William Sound and on the Kenai Peninsula show similar times of abandonment, but sites in the Kodiak-Katmai area show a different pattern. These results suggest that large earthquakes occur on average about every 700-800 years in the former area, but about every 400-500 years in the latter. Only about half of the plate-boundary earthquakes in the last 4000 years were as large as the one that devastated the state in 1964.

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Introduction

On March 27th, 1964, the second largest earthquake of the 20th century struck southern Alaska. This megaearthquake (M_w=9.2; Kanamori, 1977) was produced by strain release at the locked interface of the subducting Pacific plate and overriding America plate. The resulting rupture propagated westward for more than 800 km from an epicenter in Prince William Sound to just west of the Kodiak Archipelago, and inland for a distance of more than 100 km from the Aleutian Trench to the northern shores of Cook Inlet and Shelikof Strait (Fig.1).

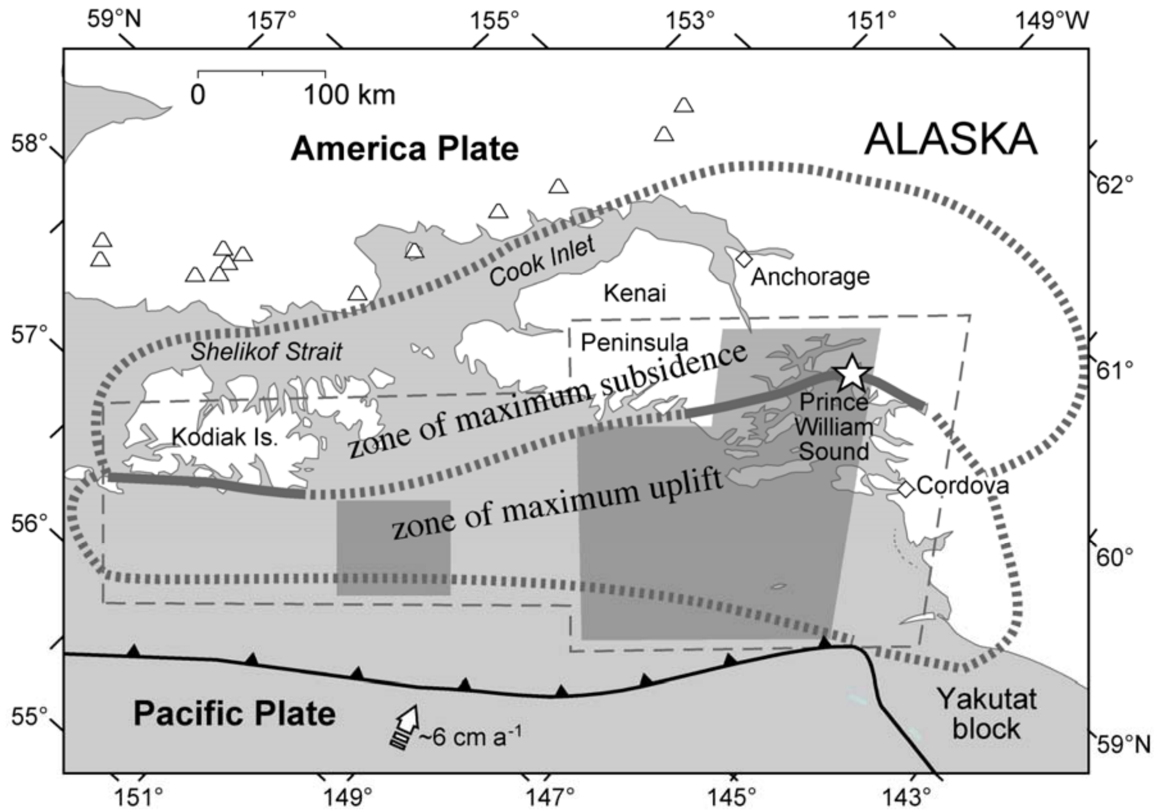

Figure 1. The Alaskan subduction zone showing: the plate boundary (barbed black line), and the epicenter (star), rupture zone (thin dashed line), asperities (subfault zones with >10 m coseismic slip, shown by dark shading), and areas of crustal uplift and subsidence (heavy dashed lines) associated with the 1964 M_w = 9.2 earthquake. Open triangles mark volcanoes in the Alaskan arc. Sources of information: Plafker and Rubin, 1992; Johnson et al., 1996.

Coseismic deformation of the Alaska continental shelf and slope generated a Pacific-wide tsunami, which in concert with local tsunamis produced by subaerial and submarine landslides accounted for 106 of the 115 deaths directly associated with this earthquake in Alaska (Lander, 1996).

The economy and population of southern Alaska has grown substantially since 1964, and there are continuing concerns for the safety of people and property should a 1964-style earthquake recur at this plate boundary. An appraisal of future seismic hazard in southern Alaska therefore should focus on two major research questions:

1) *When is the next great earthquake likely to occur?*
2) *Will the rupture area and slip pattern be the same as in 1964? (or, how big will it be?)*

Investigations of late Holocene paleoseismic evidence in coastal areas at the eastern end of the 1964 rupture zone suggest that the mean recurrence interval of large earthquakes there is about 700 – 800 years (Plafker et al., 1992; Combellick, 1994; Plafker and Rubin, 1994), but the length of subduction zone that ruptured in individual events is not known, so the range of magnitudes cannot be firmly established.

A recent federal evaluation of the seismic hazard in Alaska (Wesson et al., 1999) treats the 1964-rupture area as a coherent segment of the Alaskan megathrust. But, as the authors of this report note, the real situation may be more complex, as the 1964 earthquake may have propagated westwards across several adjacent segments of the Alaska subduction zone. If these segments consistently rupture concurrently then the seismic assessment by Wesson et al. (1999) is valid. If the segments primarily rupture independently, however, then plate boundary earthquake intervals and magnitudes in southern Alaska need to be reevaluated.

The objective of this study is to attempt to determine the chronology and rupture length of great earthquakes at this subduction zone by integrating published paleoseismic information with archaeological evidence of Native village abandonment. We assess the utility of the latter source of information at a variety of spatial scales, and attempt to discriminate between seismic versus non-seismic causes of village desertion and population exodus in an attempt to expand our understanding of the history of great earthquakes in this area.

Geological evidence of paleoseismic activity

In the aftermath of the 1964 earthquake investigators from the United States Geological Survey demonstrated that the spatial extent and local intensity of this event could be reconstructed from geological evidence of coseismic land-level change. Strain release at the plate interface resulted in small-scale deformation of the surface of the upper plate above the rupture zone (Plafker, 1965; 1969). In coastal areas this deformation produced concomitant changes in local relative sea level. The magnitude of the deformation can be reconstructed, for example, by measuring changes in the elevation of intertidal biotic communities relative to tidal limits. Such evidence is commonly preserved in coastal sedimentary archives, and may be used to investigate the extent and magnitude of prehistoric great earthquakes.

In areas close to the convergent margin the upper plate is uplifted during great earthquakes (Plafker, 1965; 1969). On coasts subject to severe wave impacts the recurrence of seismic events can be estimated by dating organic material in relict beach deposits on raised marine terraces or from the base of the overlying terrestrial deposits (Plafker and Rubin, 1978). In estuaries and deltas great earthquake frequency can be established dating the abrupt contacts between uplifted tidal flat deposits and the overlying marsh or forest soils (Plafker et al., 1992). In areas further removed from the plate boundary great earthquakes produce instantaneous subsidence. This is recorded in low-energy coastal environments by abrupt contacts between peat (indicative of a high intertidal or supra-tidal elevation prior to the earthquake) and the overlying tidal-flat mud (Atwater et al., 1995). Earthquake recurrence is determined by dating sequences of peat-mud couplets (Atwater and Hemphill-Haley, 1997).

The geological record of plate-boundary earthquakes in southern Alaska

The investigation of paleoseismic evidence in southern Alaska in the immediate aftermath of the 1964 Alaska earthquake by Plafker (1969) has been supplemented in the last few decades by surveys at more than 30 sites (Fig. 2).

We used these published sources to develop a great earthquake sequence for each site, retaining only those radiocarbon ages that were linked by the original investigators to evidence of paleoseismic activity (i.e. sharp contacts between contrasting lithologies, such as peat-mud couplets). Although abrupt changes in lithology on tectonically active coasts may be the result of rapid fluctuations in relative sea level prompted by eustatic or regional isostatic change, we assume that all contacts identified by the original investigators as potentially of tectonic origin were correctly assigned. Low precision (quoted errors >150 years) and out-of-sequence ages or repetitive-sequence ages were rejected. The latter are often indicative of unstable sites such as slumped channel banks. We utilized lithologic indicators and local crustal deformation patterns in the 1964 earthquake to determine the direction of land-level change at a site that was then used to group ages into a maximal (pre-earthquake) or minimal (post-earthquake) class. The resultant database is presented in Appendix A.

Most of the ages in the database are derived from bulk samples of peat taken immediately below the upper contact of a buried marsh or forest soil in areas inferred to have been subject to repeated coseismic subsidence. In addition to the problems involved in identifying and correlating evidence of coseismic uplift or subsidence of variable magnitude from coastal environments with variable preservation potential, it is also apparent that radiocarbon dating of these events may be problematical. Conventional radiocarbon ages commonly have relatively low precision, and the conversion of these ages to the calibrated time scale may produce limiting ages that are longer than great earthquake recurrence times at some subduction zones (Nelson, 1992).

Peat accumulation in these subarctic marsh environments is relatively slow, and the quoted mean radiocarbon age may therefore predate the earthquake by several decades. In these circumstances trees or marsh plants killed by sudden salt-water immersion more accurately indicate the age of the subsidence event, and radiocarbon ages on tree stumps or plant macrofossils were therefore preferred over peat ages at sites where both were available.

Because of the slow rate of accumulation of organic matter, the basal peat horizons on uplifted marine surfaces yield mean radiocarbon ages that may postdate the uplift event by several decades, but in this case ages from buried tree stumps (commonly spruce or hemlock) are a less accurate indicator of the age of the earthquake. This is a function of the fact that coniferous trees represent a late stage in the ecological succession on the newly uplifted surfaces. No colonization by spruce or hemlock had taken place, for example, on the marshes and tidal flats at the Copper River delta that were raised above the high-tide some 30 years earlier (Thilenius, 1990; 1995). Studies of successional sequences on deglaciated substrates in southern Alaska (Crocker and Major, 1955) suggest that forest development on the Copper River delta may take about a century. A comparison of bulk peat ages with radiocarbon ages on the outer rings or roots of tree stumps at the same stratigraphic level in areas of coseismic uplift indicates that the latter are on average about 80-120 years younger than the peat. To incorporate this lag into the radiocarbon age we added 100 years to the quoted mean radiocarbon ages of tree stumps in horizons immediately overlying beach sand or intertidal mud.

The 100-year correction was applied only in those cases where the stratigraphic position of the tree stump could be surmised from the description in the original field report. Although trees in coastal forests die from a variety of natural causes, in some cases death may be linked to later phases of the great earthquake tectonic cycle. On the Copper River delta, for example, surface areas that are raised during a great earthquake gradually subside into the intertidal zone during the interseismic phase of the earthquake cycle. As the surface drops below the high-tide limit, trees growing on the surface die and peat deposition ceases as marsh plants are killed by salt-water exposure. Thus a relict tree stump at or below a gradational contact between peat and tidal flat mud does not indicate a seismic event, and these ages were eliminated.

The corrected radiocarbon ages were converted to sidereal time using the INTCAL98 radiocarbon calibration data set of Stuiver et al. (1998). Probability density functions (pdfs) of individual calibrated ages (based on 50-year intervals) were calculated from annual probability data generated by the CALIB 4.3 program. The pdfs of maximal and minimal ages bracketing inferred paleoseismic events were calculated using the minimal weighted range overlap procedure recommended by Biasi and Weldon (2003). This method estimates the true age of an event dated by multiple calibrated pdfs as:

$$min(E_1(t), E_2(t), \ldots\ E_n(t)),$$

where n is the total number of maximal or minimal radiocarbon ages constraining event E.

A plot of the resultant constraining pdfs (Figure 3) shows a complex array of potential earthquake-bracketing ages. Although we recognize that even high-precision AMS ages on *in-situ* material at lithological contacts that can be unequivocally ascribed to coseismic crustal warping cannot prove that buried marsh soils at sites along hundreds of kilometers of coastline were

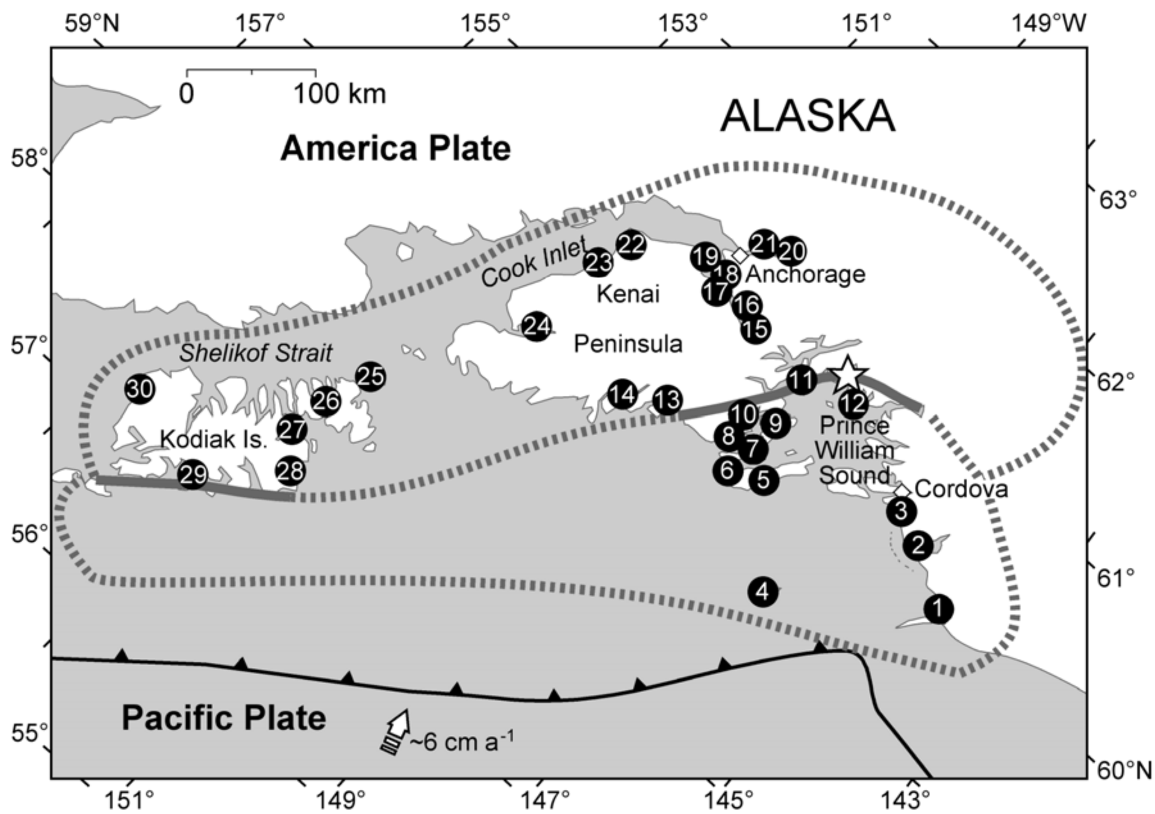

Figure 2. Sites in southern Alaska displaying geological evidence of abrupt sea-level change. Deformation zones as in Fig. 1.

Sites and sources:

Copper River delta: **1.** Katalla (Richards, 2000) and Cape Suckling (Plafker, 1969);**2.** Copper River delta (Reimnitz, 1966; Plafker and Rubin, 1992; Plafker and Rubin, 1994); **3.** Eyak River and Little Glacier (Reimnitz, 1966);

Middleton Island: **4**. Middleton Island (Plafker, 1969);

Prince William Sound: **5.** MacLeod Harbor (Plafker 1969); **6.** Patton Bay (Plafker, 1969); **7.** Latouche Island (Plafker, 1969); **8.** Puget Bay (Chaney, 1997); **9.** Knight Island (Chaney, 1997); **10.** Nowell Point (Plafker, 1969), and Junction Island (Chaney, 1997); **11.** Perry Island (Plafker, 1969); **12.** Columbia Bay (Plafker, 1969);

Kenai Fjords: **13.** Seward (Plafker, 1969); **14.** Aialik Bay (Mann & Crowell, 1996);

Cook Inlet, Turnagain Arm: **15.** Portage (Combellick, 1991; Bartsch-Winkler & Schmoll, 1992); **16.** Girdwood (Combellick, 1991, 1993; Bartsch-Winkler & Schmoll, 1992; Hamilton & Shennan, 2005b); **17.** Hope (Bartsch-Winkler & Schmoll, 1992; **18.** Ocean View, Anchorage (Bartsch-Winkler & Schmoll, 1992; Hamilton et al., 2005) **19.** Chickaloon Bay (Combellick, 1991; Bartsch-Winkler & Schmoll, 1992; Combellick & Reger, 1994);

Cook Inlet, Knik Arm: **20.** Palmer Hay Flats (Combellick, 1991); **21.** Goose Bay (Combellick, 1991; Combellick and Reger, 1994);

Cook Inlet, Kenai Peninsula: **22.** Kenai River Flats (Combellick & Reger, 1994; Hamilton and Shennan, 2005a); **23.** Kasilof River Flats and **24.** Fox River Flats (Combellick and Reger, 1994);

Kodiak Archipelago: **25.** Shuyak Island; **26.** Afognak Island; **27.** Anton Larsen Bay; **28.** Chiniak Bay; **29.** Sitkalidak Island; **30.** Sturgeon Lagoon (sites 25-31: Gilpin, 1995).

submerged during a single great earthquake (Nelson, 1992), we infer that concordant ages at neighboring sites are likely a product of the same event (or a series of closely-spaced events). Conversely, discordant ages at neighboring sites are likely a product of independent ruptures, the geographical limits of which may demarcate tectonic segments of the plate interface.

In addition to the great earthquake sequence derived from this analysis (Fig. 3), we plot the chronology (2-sigma ranges) developed by Plafker and Rubin (1994) from ages on post-seismic deposits at the Copper River delta. The raw radiocarbon ages associated with coseismic deformation from the two most recent earthquakes (prior to 1964) at this site were published by Plafker *et al*. (1992), and are incorporated into our pdf analysis in Figure 3; the raw radiocarbon ages of earlier events have not yet been published.

Chronology of great earthquakes at the Alaskan subduction zone

The penultimate great earthquake at the Copper River delta, which occurred about 800 years ago, is recorded at sites extending westward from the delta to the central coast of the Kenai Fjords National Park (Mann and Crowell, 1996), and northward into upper Cook Inlet (Combellick, 1993; 1994; Combellick and Reger, 1994). There is, however, no evidence that this earthquake propagated along the plate boundary to the west of this area (Fig. 3).

The plate boundary in the western area (i.e., the Kodiak archipelago) appears to have slipped most recently about 500 years ago (Fig. 3). Gilpin (1995) dates this event to about AD 1550, slightly later than our estimate. This rupture may have extended eastwards to Fox River Flats on the western Kenai Peninsula (Fig. 3), but the sudden sea-level change recorded at Palmer Hay Flats and Goose Bay in Knik Arm in upper Cook Inlet at about this time may be a product of movement on a nearby upper-plate fault (Hauessler et al., 2002).

There is localized evidence of land-level change on Kodiak Island about 1000 cal. yr B.P., but we concur with Gilpin (1995) that the previous great earthquake at the western end of the 1964-rupture area likely occurred about 1300 - 1400 years ago (Fig. 3). Geological evidence of crustal deformation from this time period can be found from eastern Kodiak Island to the central part of the Kenai Peninsula.

This event may be contemporaneous with, or have occurred shortly after, the antepenultimate earthquake (“II”, Plafker and Rubin, 1994) recorded at the Copper River delta (Fig. 3). Ages on uplifted tidal flats there, and relict stumps in Prince William Sound and Puget Bay, along with buried marsh soils in Turnagain Arm, Kenai and Kasilof River deltas show that this earthquake occurred about 1400 years ago (Fig. 3).

According to Plafker and Rubin (1994), the preceding coseismic deformation event at the Copper River delta (their “III”; Fig. 3) occurred about, or shortly before, 2000 to 2300 years ago. There are buried peats dating from about 2200 – 2300 years ago at Ocean View and Girdwood in Turnagain Arm,

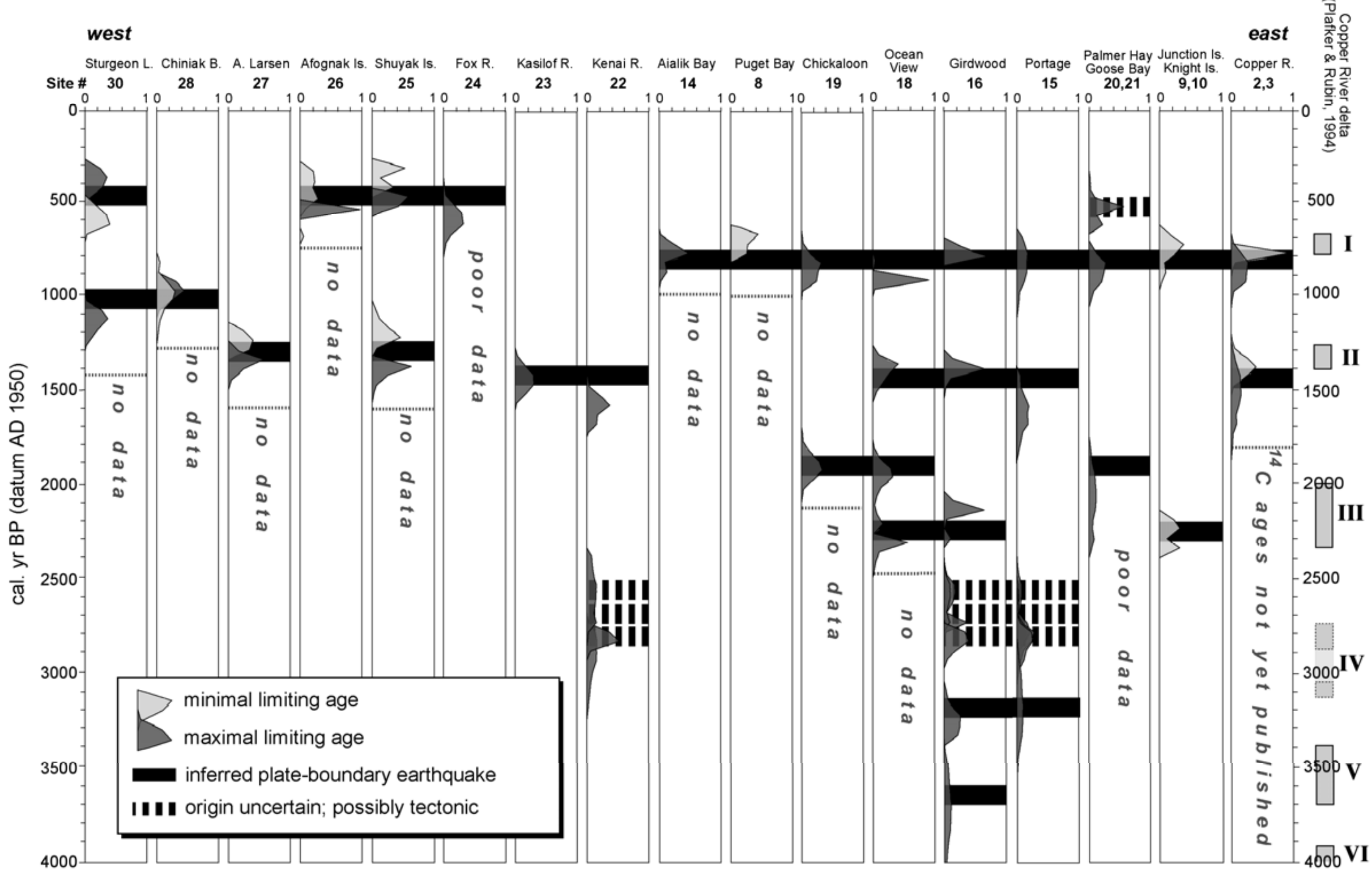

Figure 3. Ages of plate-boundary earthquakes at the Alaska subduction zone inferred from geological evidence of episodes of abrupt sea-level change. Site locations are shown in Figure 2. The thin dotted and hatched lines mark the maximum time-depth of evidence in each region. Periods beyond these limits are marked ‘no data’.

and relict stumps from this period in Prince William Sound (Fig. 3), which suggest that a great earthquake likely ruptured at least the eastern segment of the Alaska megathrust at this time. At Ocean View, however, this peat is overlain by a marsh soil with an abrupt upper contact that dates from about 1900 years ago (Fig. 3). A buried soil of about the same age occurs on the western shore of Turnagain Arm, at Chickaloon Bay. The absence of evidence of this younger event from southern Turnagain Arm (Girdwood, Portage) and the Copper River delta is puzzling. Was this great earthquake restricted to a central segment of the Alaskan megathrust, with only a 300 – 400-year interval between it and its predecessor?

Similar uncertainties surround uplift event IV (Fig. 3) at the Copper River delta. According to Plafker and Rubin (1994), this event occurred about 2800 to 3000 years ago, but the AMS radiocarbon ages that they report from this event form two distinct sub-groups (2750 – 2880 cal. yr B.P.; 3050 – 3130 cal. yr B.P.). Buried soils at Girdwood and Portage that date from about 3100 – 3200 years ago (Combellick, 1994) suggest that a great earthquake ruptured at least the eastern part of the Alaska subduction zone at this time. At some sites in southern Turnagain Arm the buried soil from this event years ago is overlain by three soils that predate event III at the Copper River delta. At both Girdwood and Portage the oldest of these three soils contains tree stumps and detrital wood and dates to about 2800 years ago; i.e. akin to the younger cluster of AMS ages associated with event IV at the Copper River delta. The two younger soils are muddy peats, and date from about 2500 – 2700 years ago. An equivalent, essentially coeval stratigraphic sequence has been described at the Kenai River delta (Combellick and Reger, 1994).

Given that the recurrence interval of inferred great earthquakes at the Alaska megathrust in the last 2500 years averages about 700 years (Fig. 3), it seems unlikely that a segment of the subduction zone would rupture three times in about 300 years. Do any of these three buried soils result from regional subsidence during a plate-boundary earthquake? Alternatively, are any the product of local movements on upper-plate faults, or do one or more represent non-tectonic forcings? For example, did isostatic loading or unloading during a Neoglacial period trigger rapid changes in relative sea level on the Kenai Peninsula?

The oldest coseismic uplift event recorded at the Copper River delta in the last 4000 years dates from prior to 3400 – 3700 years ago (Plafker and Rubin, 1994; "V"). It is probably correlative with the lowest peat at Girdwood, which is dated by a single, low-precision radiocarbon age (Combellick, 1991) to about 3500 – 3700 cal. yr B.P.

The geological data that are available for reconstructing the incidence of great earthquakes at the Alaska subduction zone are variable in quality and time-depth, and many questions remain about the age and extent of these events. While these uncertainties will almost certainly be reduced by further exploration of sensitive coastal sites, there is an untapped source of information that may clarify the paleoseismic record of this subduction zone. That data source consists of the stratigraphic records and radiocarbon chronologies of the archaeological sites that have been excavated around the margins of the Gulf of Alaska over the course of the last several decades.

The archaeological record of paleoseismic events in southern Alaska

The archaeological record from the Gulf of Alaska holds considerable promise as a source of paleoseismic information, because Native village sites were almost invariably on the shore, reflecting the maritime focus of the economy and the relative ease of travel by sea. Villages consisted of groups of semi-subterranean houses near the water, usually only a few meters above sea level. For example, the village at Palugvik on the south shore of Hawkins Island in Prince William Sound was situated on two tombolos bracketing a small bay (de Laguna, 1956). Not only are the people living in such locations at risk during a great earthquake from tectonic and landslide tsunamis, but the village may be uninhabitable for decades after a great earthquake because of abrupt changes in relative sea level and loss of local food resources.

Extensive midden deposits, composed largely of discarded shellfish remains and other domestic refuse, mark the sites of former large villages such as Palugvik. Scattered house pits with thinly strewn cultural debris mark small villages and seasonal camps (de Laguna, 1956; 1975; D.W. Clark, 1984; Mobley et al., 1990; Haggarty, et al., 1991; Erlandson et al., 1992; Crowell, 2000).

As Knecht notes, the middens of the prehistoric coastal villages of the Kodiak archipelago reveal "long periods of relative stasis and very brief periods of rapid change in an overall pattern of punctuated equilibrium" (1995, p. 745). The most severe changes are marked by depositional breaks and culturally sterile strata, which indicate partial or complete abandonment of villages. Hiatuses in site occupation in southern Alaska may reflect cultural factors, such as warfare, or environmental causes, such as volcanic eruptions, river floods, global sea-level changes, local glacier advances, diseases, or loss of local food resources.

We suggest that the dominant cause of <u>widespread</u> village abandonment around the margins of the Gulf of Alaska was likely to have been plate-boundary earthquakes. The Sumatera great earthquake of December 26, 2004, for example, tragically demonstrated that tectonic tsunamis, particularly when enhanced by coseismic subsidence of the coastal zone, decimate coastal populations. After such a disaster the survivors may settle elsewhere, so both the date of initial occupation and temporary or final abandonment of a settlement can be potential sources of paleoseismic information. Three Native villages in the Kodiak archipelago, for example, were severely damaged as a result of the subsidence and tsunamis generated by the 1964 earthquake. Two of these villages (Afognak, Kaguyak) were abandoned, and the survivors moved elsewhere (Plafker and Kachadoorian, 1966; Saltonstall and Carver, 2002).

In areas of net tectonic uplift settlements may form a progressive, punctuated series on a staircase of relict back-beaches above the present shoreline. In contrast, coseismic subsidence may lead to flooding and erosion of old village sites. The archaeological record in these areas will consequently have limited time-depth as a result of site attrition (Crowell and Mann, 1998; Saltonstall and Carver, 2002).

This is not the first attempt to link paleoseismic and archaeological records in southern Alaska. For example, Winslow and Johnson state that there is "an inverse correlation between prehistoric settlement size and numbers and geologically inferred earthquakes" (1989, p. 314) in the Shumagin Islands, which lie about 400 km to the west of the 1964 rupture. They argue that the size and number of sites were much reduced in the aftermath of great earthquakes, which produced gaps of 200-400 years in the occupation sequence. Similarly, Maschner (1999), notes that there is a gap in the occupation of the Lower Alaska Peninsula about 2200 to 2500 years ago that is attributable to a major seismic event in the region, and Saltonstall and Carver (2002) show the impacts of previous great earthquakes on the village site at Settlement Point on Afognak Island. In addition, the transitions between cultural phases in southern Alaska may be a product of the socio-economic impacts of great earthquakes (e.g. Maschner, 1995).

Whereas previous investigators have primarily attempted to integrate seismic and cultural history in Alaska to explain shifts in site tenancy and cultural traditions, our objective is the opposite; we hope that the rich archaeological archive of southern Alaska will shed light on the paleoseismic history of the region. We recognize that this is a novel approach in this region, and that our interpretation of evidence is often speculative, but the success of this approach as a complement to geological investigations of paleoseismic activity at other convergent margins (e.g. Hutchinson and McMillan, 1997; Goff and McFadgen, 2001) is sufficient reason to apply it in southern Alaska.

The geo-archaeological approach to paleoseismology is rooted in the premise that changes in site tenancy as a result of seismic activity can be inferred from midden stratigraphy and from radiocarbon ages on cultural deposits (Hutchinson and McMillan, 1997). If a village is abandoned in the immediate aftermath of a great earthquake, then the midden should reveal stratigraphic evidence of rapid land-level change or inundation by high-energy waves. Where such direct evidence is absent, earthquake-related abandonment may be inferred if hiatuses in occupation are concurrent with known paleoseismic events.

Archaeological excavations normally expose only a small fraction of the village area, however, so we are commonly forced to derive site-wide conclusions from a limited spatial sample. Accumulation of material associated with houses, hearths, and food waste is evidence of site occupation, and closely spaced or overlapping radiocarbon ages derived from this cultural material likely reflects continuous occupation. Archaeologists rarely date culturally sterile strata in middens, and periods of abandonment must therefore generally be interpolated from limiting ages on bracketing cultural units. These periods may be apparent as gaps in the radiocarbon record or be veiled under the tails of radiocarbon age probability distributions associated with periods of occupation. Variation in the overall probability distribution of ^{14}C ages at a site or in a local area can thus serve as a proxy index for site activity.

In order to construct such a proxy, we compiled evidence from published and unpublished reports from excavated archaeological sites in the area that experienced abrupt land-level changes in 1964. We noted evidence of sterile layers (e.g. beach gravels, tephras, marsh peat, forest soils) in midden stratigraphy, and developed a database of radiocarbon ages from these reports. These data were supplemented with information from an archaeological radiocarbon database covering the central and western parts of the 1964 earthquake area at http://faculty.washington.edu/fitzhugh/FitzHome.html.

We retained only those radiocarbon ages accepted by the original excavators (a few exceptions are noted) that were obtained on samples of charcoal or other terrestrial oganics (thus avoiding the oceanic reservoir effect associated with marine organisms), and which had quoted errors of less than 150 ^{14}C years. Elevated sites (>15m above sea level), and those dating from the historic or protohistoric period (≤250 ^{14}C yr B.P.) were also deleted from the database. The complete database is presented in Appendix B.

Calibrated ages (with a datum of A.D. 1950) were derived from the radiocarbon ages by means of the CALIB 4.3 program (Stuiver et al., 1998). Probability density functions (pdfs) of calibrated ages (generalized to 50-year intervals) were calculated from annual data generated by CALIB 4.3. The calibrated pdf's for individual sites and the regional weighted mean pdf value are plotted.

Because of the inherent non-linearity of the radiocarbon age – sidereal age relationship, we calculated the pdf for a sample of 1000 random radiocarbon ages with mean ages from 0 – 4000 yr B.P., and with a 1-sigma error equivalent to that in the Alaskan archaeological data (70 years). The resultant pdf is shown in Fig. 4. Deviations of the observed weighted mean pdf values from the expected values are plotted for each region.

The resulting plots show potential occupation periods for individual sites and groups of sites in eight regions along a coastal transect from Prince William

Sound to the Kodiak Archipelago and neighboring parts of the Alaska Peninsula (Figure 5). We assume that abrupt changes in the regional pdf index mark changes in site habitation patterns. A sharp, persistent drop in the pdf index therefore likely indicates widespread village abandonment in the region. Arrows on each regional plot mark the initiation of these phases. Finally, we compare the chronological patterns of abandonment in each region, and investigate the possible causes of these hiatuses.

Figure 4. Probability density function derived from calibration of 1000 randomly generated radiocarbon ages to the sidereal time scale using the decadal terrestrial calibration for the Northern Hemisphere. Range = 0 –4000 ^{14}C yr B.P.; 1-sigma = 70 years; laboratory error=1. Note: values are recalculated to match the number of radiocarbon samples (=315) in the southern Alaskan archaeological data set.

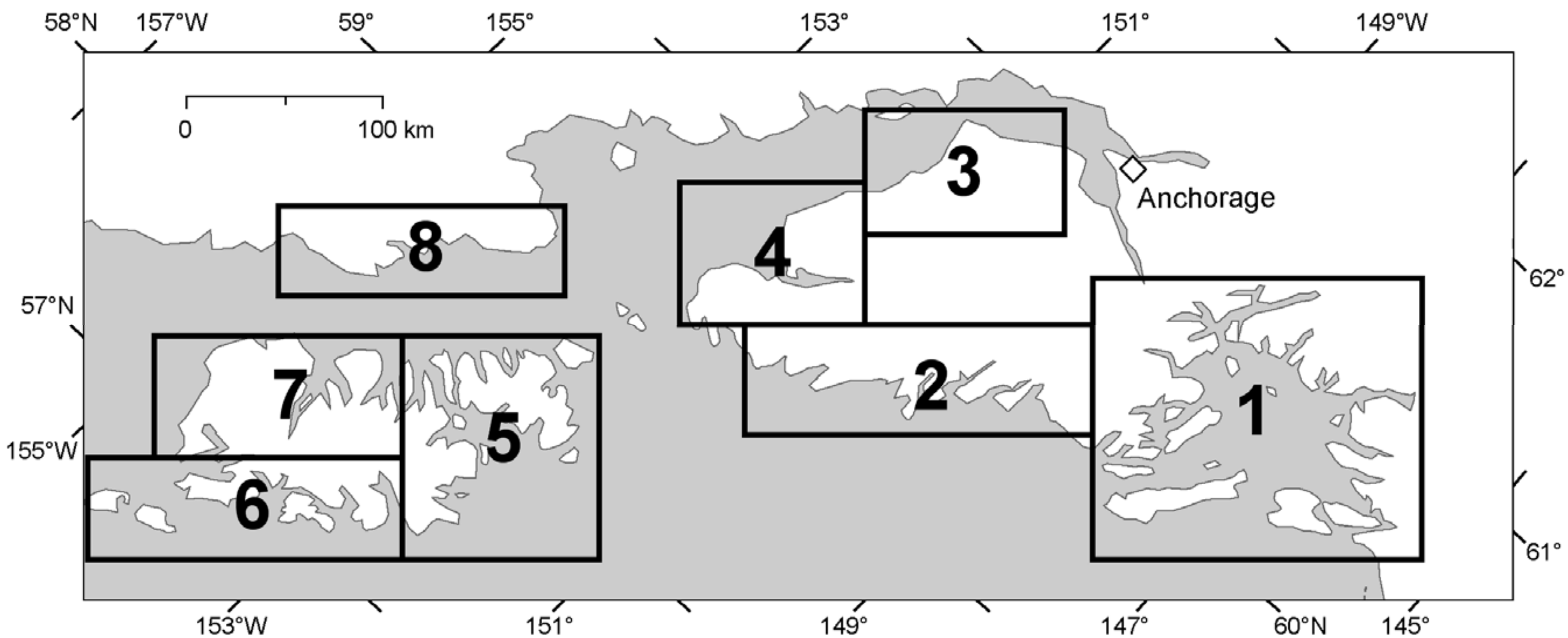

Figure 5. Regional subdivisions of southern Alaska adopted for investigation of archaeological evidence of paleoseismic activity:

1: Prince William Sound
2: Kenai Fjords
3: Kenai Peninsula
4: Kachemak Bay
5: Eastern Kodiak archipelago
6: Southwestern Kodiak archipelago
7: Northwestern Kodiak archipelago
8: Katmai

Archaeological Data

Region 1: Prince William Sound

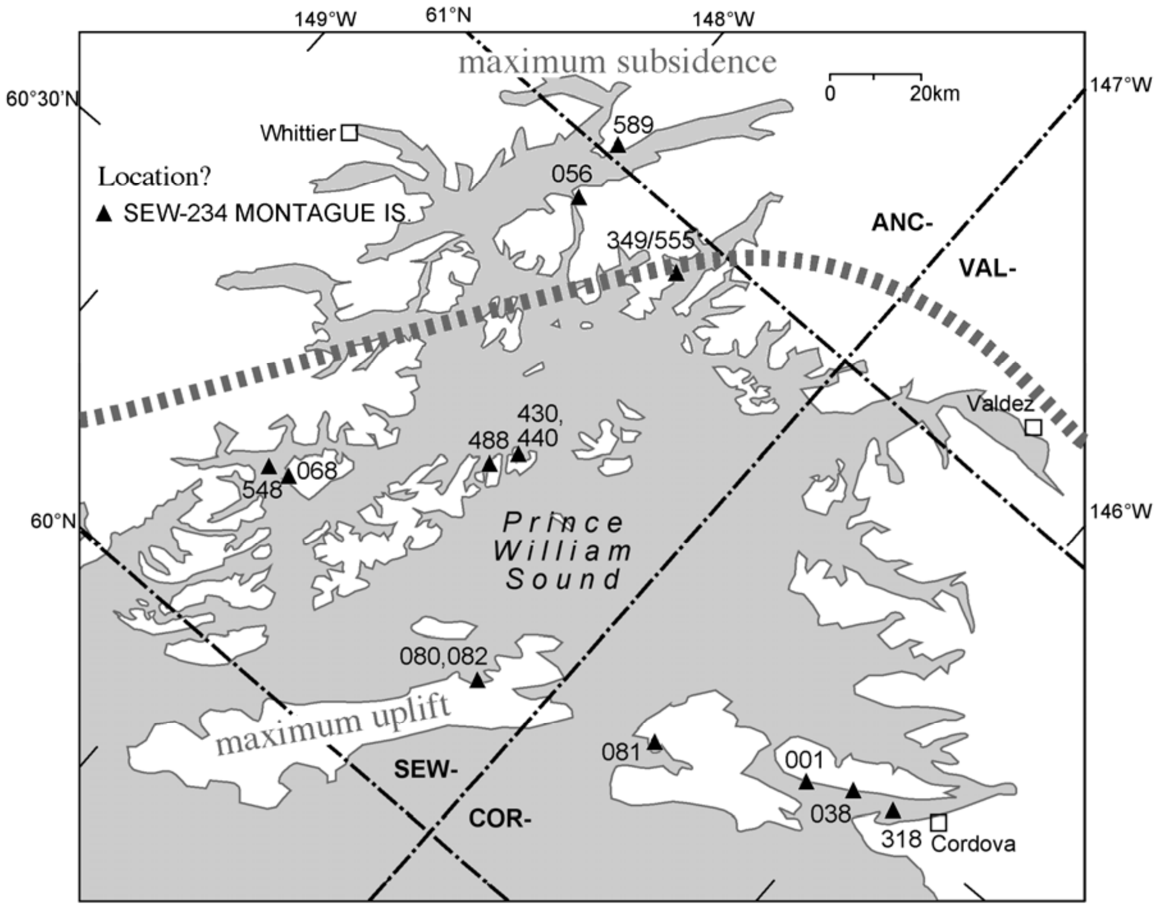

Figure 6. Radiocarbon-dated archaeological sites in Prince William Sound. Zones of maximum uplift and subsidence in the 1964 earthquake are marked. The hatched line indicates the “hinge line” (zero crustal deformation) for this earthquake.

Relatively few sites have been excavated in this extensive area, perhaps a result of the fact that pre-contact Native populations were low, and archaeological sites, in consequence “are consistently smaller than those reported on Kodiak and the Aleutians” (de Laguna, 1956; p. 255-6). The stratigraphy and chronology of each site are described below. Calibrated age distributions for sites that have yielded radiocarbon ages are shown in Figure 7. The calibrated probability density function for all sites in the region is shown in Figure 8, and deviations from random expectation in Figure 9.

Sites

ANC-589: A hearth dating from the late prehistoric underlain by beach deposits from a site in the intertidal zone on College Fjord (Dotter, 1988).

COR-001: The Palugvik site on Hawkins Island was excavated in the early 1930's (Laguna, 1956). At that time the midden ranged from just below the high tide limit to about 3 m above this datum. The early prehistoric occupation of this site was dated from one sample. De Laguna (1976) rejected this date, but Yarborough and Yarborough (1991), suggest that the date be accepted because of similarities in the artifact assemblage in this component and contemporaneous material at SEW-056, and we have accepted their suggestion. This early prehistoric occupation layer is separated from the later prehistoric layer by a thin gravel layer. The base of the midden rests on peat, so the gravel layer may well be a cultural deposit (gravel was commonly used as a flooring material to improve the drainage in houses on saturated substrates), but it might also represent a tsunami deposit. The early prehistoric occupation predates the inferred great earthquake at about 2200-2300 years ago, and the late prehistoric occupation occurred in the interval between this event and the inferred great earthquake at about 1400 cal. yr B.P. If the gravel layer that separates the two occupational phases is a tsunami deposit, then it likely is a product of the earlier great earthquake.

COR-038: Cultural remains at the winter village of Tauxtvik on Hawkins Island extend below the high tide limit (Dotter, 1988), and overlie a silty sand layer. Occupation postdates the great earthquake about 800 years ago.

COR-080: A late prehistoric occupation from a shallow midden recorded in an intertidal test pit at Nuucingnsaaq (Dotter, 1988).

COR-081: A small site on Hawkins Island; stratigraphy unknown (Dotter, 1988).

COR-318: A single radiocarbon date from a thin midden on one of a group of rocky skerries in Orca Inlet indicates that the site was inhabited sometime between about 400 – 750 cal. yrs. B.P. (Dotter, 1988). The cultural material overlies sand which may be an uplifted beach (or tsunami deposit) dating from the penultimate great earthquake in Prince William Sound (Fig. 7b).

SEW-056: The Uqciuvit site occupies a sloping terrace just above a beach in the sheltered waters of Esther Passage. The site was initially occupied about 4400 years ago (Yarborough and Yarborough, 1991; 1998), but was apparently unoccupied from 2500 - 3200 years ago (Fig. 7b), when local glaciers advanced to within 7 km of the location.

A layer of gravel exposed in excavations near the beach separates the two later occupational phases at this site. The bracketing radiocarbon ages (Fig. 7b) indicate that the gravel represents a beach formed following coseismic subsidence associated with the inferred great earthquake about 1400 cal. yr B.P.

(~1600 years ago, according to Yarborough and Yarborough, 1991). As the authors of this report note, however, "there is no evidence of a hiatus in occupation of the site corresponding with another earthquake about 850 years ago" (Yarborough and Yarborough, 1991, p. 228).

SEW-068: A site in the upper intertidal zone in Kake Cove. The thin beach gravel is underlain by a peaty soil with scattered cultural materials (Reger et al., 1992). Radiocarbon ages on two wooden artifacts suggest that the site dates from the interval between the inferred great earthquakes at about 1400 cal. yr B.P. and 2200 - 2300 cal. yr B.P. (Fig. 7b).

SEW-080/082: A large site complex at the northern end of Montague Island with variable stratigraphy. One of the test pits displays a thick late-prehistoric midden overlying sterile gravel, which in turn is underlain by gravelly clay admixed in part with undated cultural material (Dotter, 1988). The gravel layer likely represents a beach uplifted during the 800 cal. yr B.P. earthquake.

SEW-234: A shallow midden admixed with a gravel substrate. This site was occupied from the late prehistoric into the early historic period (Dotter, 1988).

SEW-349, SEW-553/555: The skerries comprising part of this site complex in Unakwik Inlet have extensive but thin midden deposits overlying clayey substrates (Dotter, 1988). Two radiocarbon ages indicate that occupation brackets the 800 cal. yr B.P. earthquake.

SEW-430: The matrix of this stratified midden exposed at the mouth of a rockshelter consists of fine-textured soils (Haggarty et al., 1991). The apparent lack of cultural detritus in the middle part of the stratigraphic sequence suggests that the site was uninhabited for several millennia after 4500 years ago, but was then re-occupied in the interval between 500-700 cal. yr B.P., possibly in the aftermath of the penultimate earthquake in Prince William Sound.

SEW-440: This is a well-dated site located on a tombolo on Eleanor Island in an area that was uplifted by about 1m in the 1964 earthquake. Linda Yarborough states that the site "appears to have been occupied during two distinct time periods during the past two millennia" (1997; p. 36), but also notes that test pit stratigraphy indicates another hiatus in tenancy lasting for several hundred years during the later occupation. The radiocarbon ages from the site can be grouped into three phases (Fig. 7c), which supports the latter interpretation. The breaks between these phases correlate with inferred great earthquakes at 800 cal. yr B.P. and 1400 cal. yr B.P.

The earliest evidence of occupation (Fig. 7c) is found in beach gravel overlying a peaty organic layer. It is tempting to suggest that the gravel was emplaced by the tsunami generated by the great earthquake at about 2200 –2300 cal. yr B.P. Analysis of the cultural detritus suggests that site use was sporadic in the earliest occupation. During later phases the site appears to have been more-or-less continuously occupied as a marine fishing camp (L. Yarborough, 1997), but gravel layers higher in the stratigraphic sequence indicate potential disruption of the site by tsunamis.

SEW-488: As with SEW-440, test pits at this tombolo on Knight Island revealed cultural layers interdigitated with sterile organic, gravel and tephra deposits. Basal layers at the site consist of forest soils and woody debris. Scattered artifacts suggest that the site was intermittently occupied, but for the most part these organic deposits are sterile. In the overlying cultural layers historic artifacts were frequently found intermingled with much older artifacts, suggesting that the stratigraphy has been disturbed, either by wave action prior to the 1964 uplift, or by cleanup activities following the *Exxon Valdez* oil spill (L. Yarborough, 1997). The frequent reversals in radiocarbon ages displayed in the stratigraphic sequences in some test pits are further evidence of disturbance.

In one pit (N21), however, the stratigraphy appears to be intact and the radiocarbon ages are in sequence, and we have plotted these in Fig. 7c. The resulting temporal pattern suggests that the site was substantially occupied only in the aftermath of the 800 cal. yr B.P. earthquake. A sandy horizon in a thick organic deposit at the base of this test pit is bracketed by three radiocarbon ages[1] that suggest that it was emplaced by the tsunami generated by this earthquake.

SEW-548: Located on a small islet near Chenega, this site yielded evidence of occupation postdating the 800 cal. yr B.P. earthquake. The midden rests on beach gravel.

<u>Temporal pattern of site occupation and abandonment in Prince William Sound</u>

Although the site occupancy pattern in Prince William Sound is based exclusively on radiocarbon ages from Uqciuvit (SEW-056) for the period prior to about 2600 cal yr B.P., from 2600 cal. yr B.P. to the protohistoric period (<500 cal. yr B.P.) the pattern reflects region-wide occupation. Four intervals of substantially reduced site activity, as measured by the distribution of radiocarbon ages, occur in the past 4000 years (Figs. 8a, 9a).

Widespread changes in site occupation, including abandonment of village sites, may have occurred about 800, 1300, 2300 and 3600 years ago (Fig. 9a). The absence of radiocarbon ages from the interval between about 2600 years and 3400 years could be a result of several factors. It may be that there was a much reduced population in the region at this time and sites from this interval are rare, or that sites dating from this period have been subject to erosion as a result of sea-level changes, and have consequently been erased from the record.

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[1] above sandy horizon: 820±60 [Beta-89048],
below sandy horizon: 910±90 [Beta-89049] and 990±60 ^{14}C yr B.P. [Beta-89050].

It is apparent from the distribution of radiocarbon ages at individual sites (Fig. 7) that the occupation pattern at SEW-056 contrasts with some of the other sites. If we exclude SEW-056, a much more pronounced variation in occupation patterns is apparent (Fig. 8b, 9b). From these data it would appear that there was concurrent abandonment of sites at about 800 cal. yr B.P. and 1400 cal. yr B.P., and less prominently, at about 2300 cal. yr B.P. These ages are coeval with the inferred ages of the last three prehistoric great earthquakes at the Copper River delta. There is no evidence, however, that the subsidence episode recorded in upper Cook Inlet at 1900 – 2000 cal. yr B.P. had deleterious impacts on village sites in Prince William Sound.

The variations in occupation patterns at individual sites in Prince William Sound may be a product of differential crustal deformation patterns during great earthquakes (sites near the hinge line are less impacted than those in areas of substantial subsidence, for example), or the variable exposure of sites to tectonic or landslide tsunamis. Villages located on the shores of narrow passes, such as Uqciuvit in Esther Passage, for example, may have only limited exposure to tsunamis.

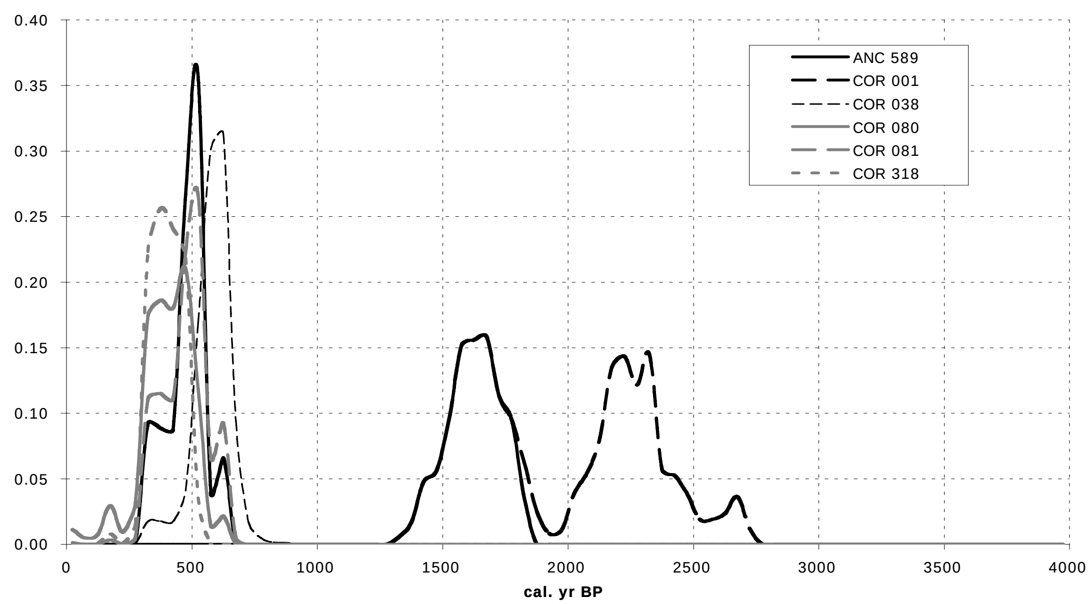

Figure 7a. Probability density functions of calibrated radiocarbon ages dating prehistoric villages and camps in Prince William Sound.

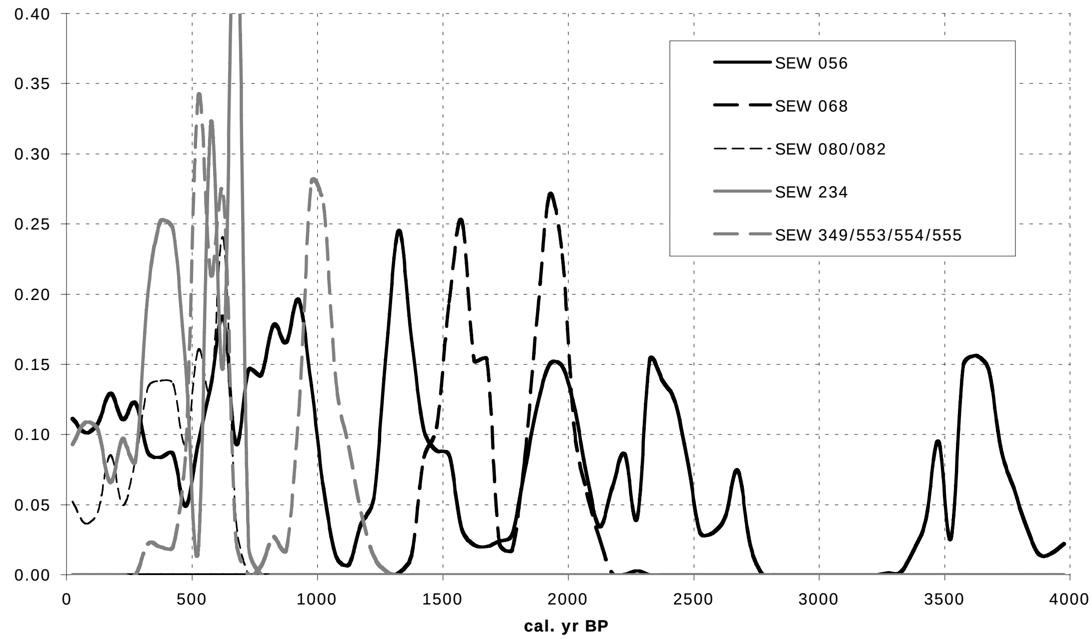

Figure 7b. Probability density functions of calibrated radiocarbon ages dating prehistoric villages and camps in Prince William Sound.

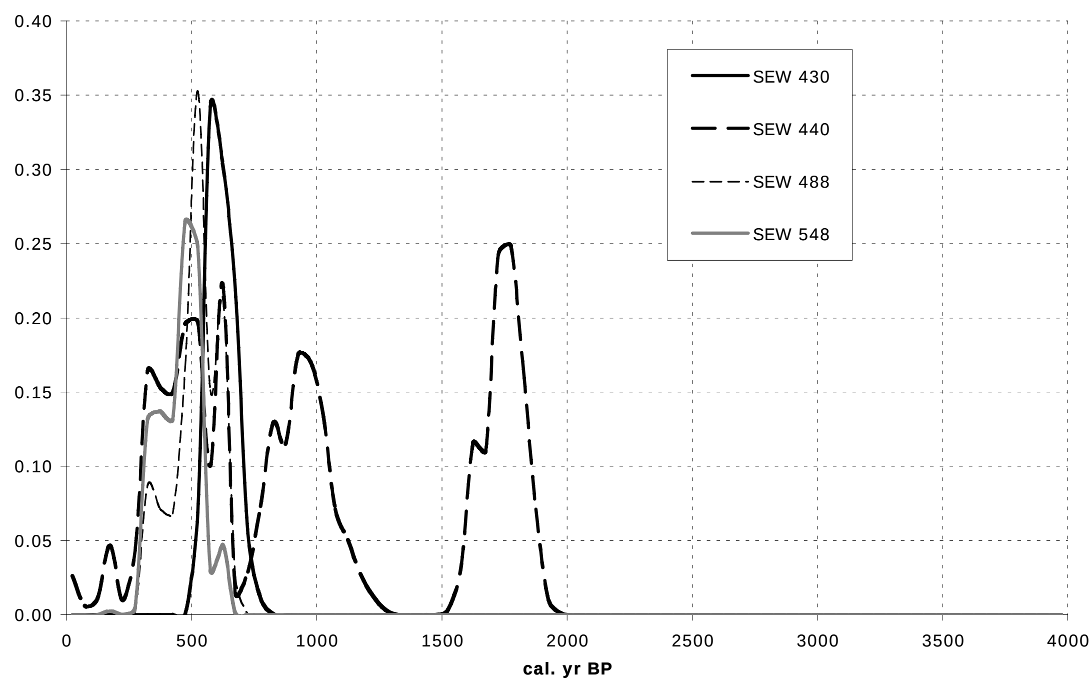

Figure 7c. Probability density functions of calibrated radiocarbon ages dating prehistoric villages and camps in Prince William Sound.

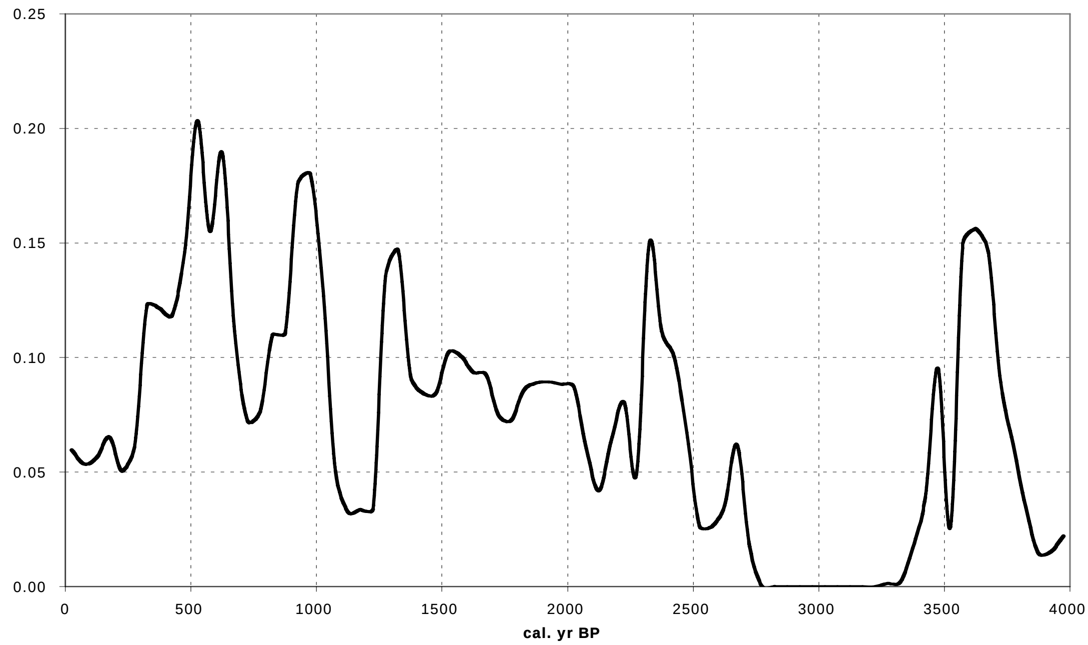

Figure 8a. Composite probability density function of calibrated radiocarbon ages dating prehistoric villages and camps in Prince William Sound (including SEW 056).

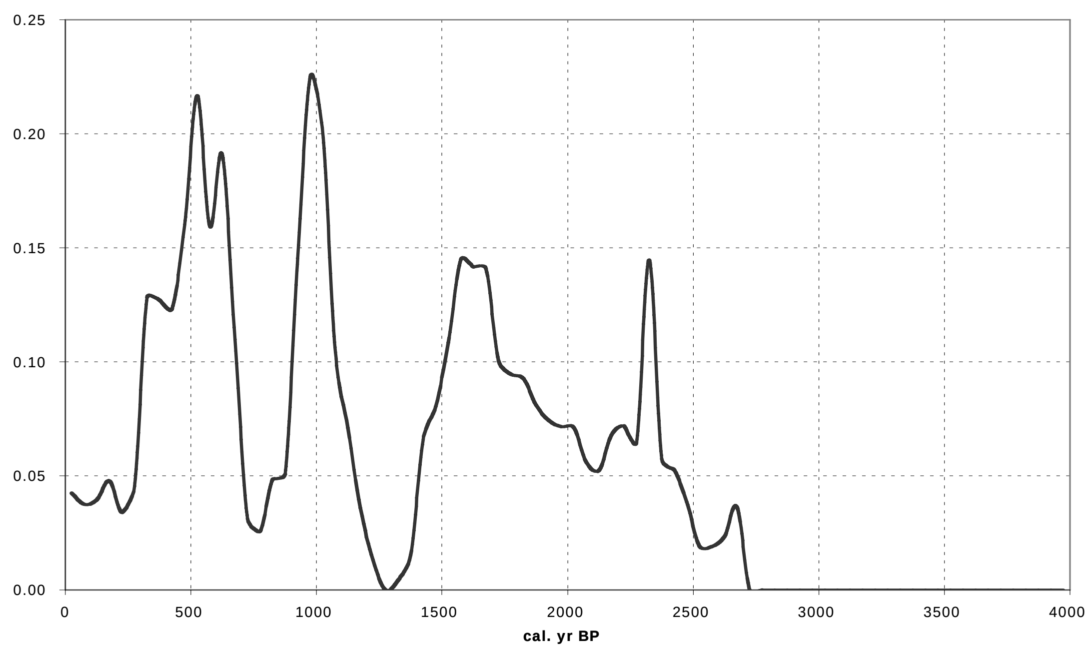

Figure 8b. Composite pdf of calibrated radiocarbon ages dating prehistoric villages and camps in Prince William Sound (excluding SEW 056).

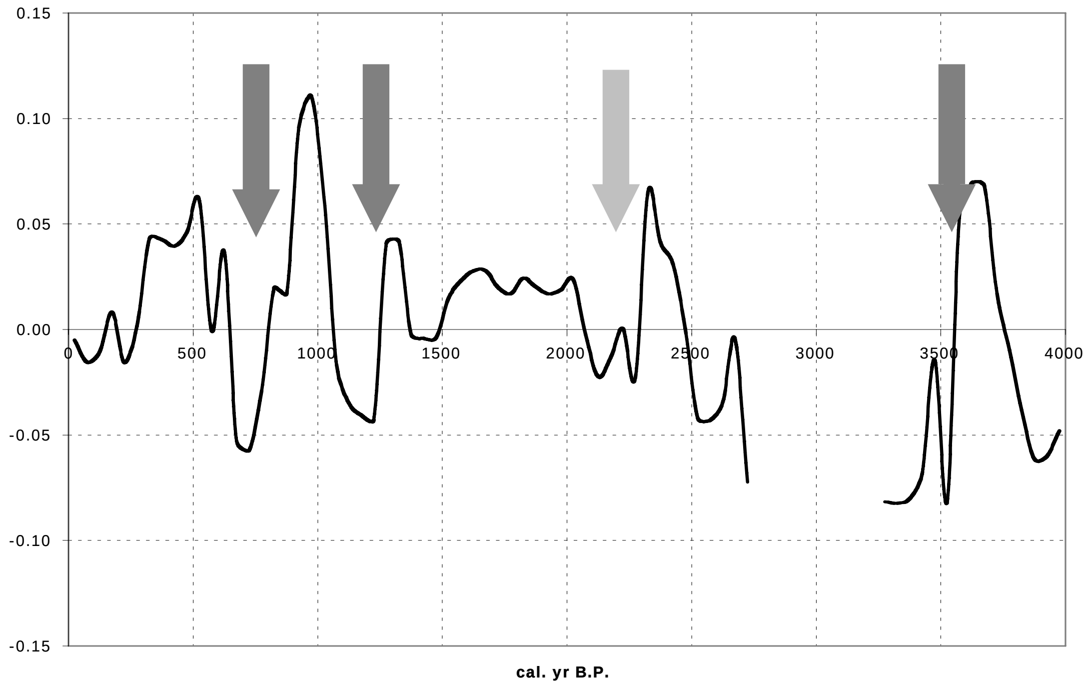

Figure 9a. Deviation of composite probability density function from expected values in Prince William Sound (including SEW-056). Dark arrows indicate initiation of inferred episodes of significantly reduced site activity; light arrow indicates potential minor episodes.

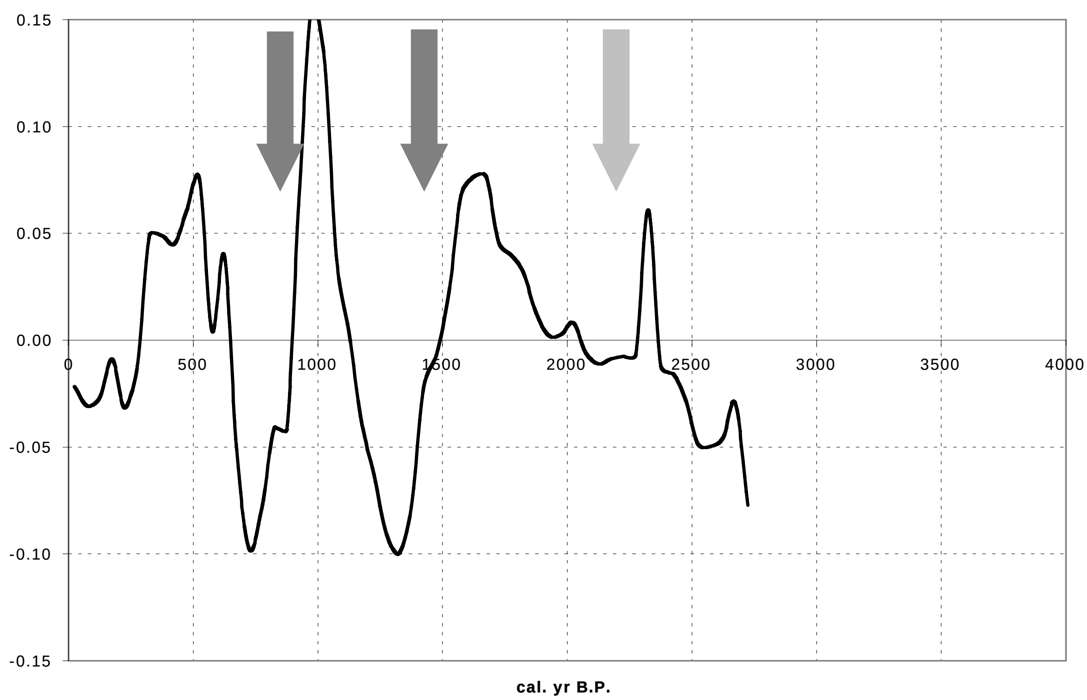

Figure 9b. Deviation of composite probability density function from expected

values in Prince William Sound (excluding SEW 056). Arrows as in Fig. 9a.

Region 2: Kenai Fjords

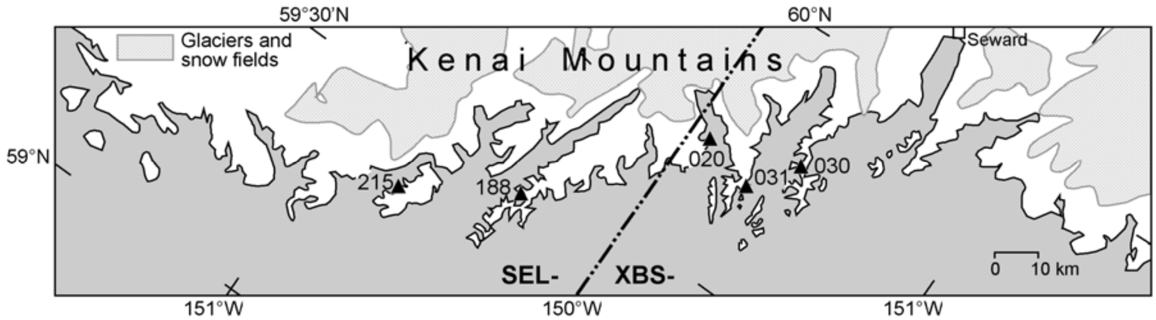

Figure 10. Radiocarbon-dated archaeological sites in Kenai Fjords.

Five prehistoric sites have been excavated and dated in this region, all in the central segment (Fig. 10). The sites lie along the axis of the zone of maximum subsidence (about 2m) in the 1964 earthquake (Plafker, 1969).

Sites

SEL-188: This site lies at an elevation of 1 – 2 m above the high tide limit, immediately behind a boulder beach, with an extension at a higher elevation (Betts et al., 1991). A layer of flat-lying, slightly imbricated granite slabs separates two distinct cultural strata. Two radiocarbon ages from the base of the midden (Fig. 11) suggests that the site was occupied for a short time about 1600 years ago, and again, perhaps after a hiatus, about 1300 years ago. Nine ages from the upper midden place a later occupation between about 600 - 700 years ago (Fig. 11). The layer of granite slabs is most likely a floor or other cultural artifact, but there is a slight possibility that it is a lag deposit from a prehistoric tsunami.

SEL-215: An intertidal site on Nuka Island that would have been supratidal prior to 1964. Beach cobbles now armor the underlying peat and cultural deposits. An 8-m trench across the site revealed two peat layers with scattered artifacts and faunal remains separated by a layer of gravelly peat (Reger et al., 1992). Five of the seven radiocarbon determinations from the upper peat indicate that this occupation likely postdates the 800 cal. yr. B.P. earthquake, but two ages overlap this event (Fig. 11). The gravelly peat is likely the armored surface that developed as a result of coseismic subsidence during that earthquake.

XBS-020: Likely a seasonally occupied village on a relict spit in Northwestern Lagoon. The site was initially occupied shortly after the penultimate earthquake about 800 cal. yr B.P. and lasted until ice advanced to within some 200 m of the site at the Little Ice Age maximum (Crowell and Mann, 1996; 1998)

XBS-030: This old village site sits on a relict storm berm about 50 m inland of the present beach. Three radiocarbon ages on charcoal from the lowest cultural layer below culturally sterile beach gravels suggest that the site may have been occupied initially as early as 1100 years ago, and continued to be occupied, at least sporadically, up until the 800 yr BP earthquake and tsunami (Crowell, 2003). A second occupation above the beach gravel layer post-dates 650 years ago (Fig. 11), and indicates that the hiatus in occupation at this site probably lasted little more than a century (Crowell and Mann, 1998; Crowell, 2003).

XBS-031: A small site on a relict spit some 70 m inland (Crowell and Mann, 1998) yielding a single radiocarbon age that indicates that the site was occupied in the interval between 500 to 650 years ago.

<u>Temporal pattern of site occupation and abandonment in Kenai Fjords</u>

Most of the excavated sites in the Kenai Fjords area sit on relict beaches that appear to have formed in the aftermath of the penultimate earthquake about 800 years ago (Fig. 4). These sites likely became available for occupation a century or two after this event as relative sea levels progressively stabilized following coseismic subsidence. Some sites bear witness to earlier occupations (SEL-188, XBS-030), but the pattern of occupation in the period preceding this earthquake is highly uncertain (Figs. 12, 13), as only three samples of older cultural materials have been dated in this region.

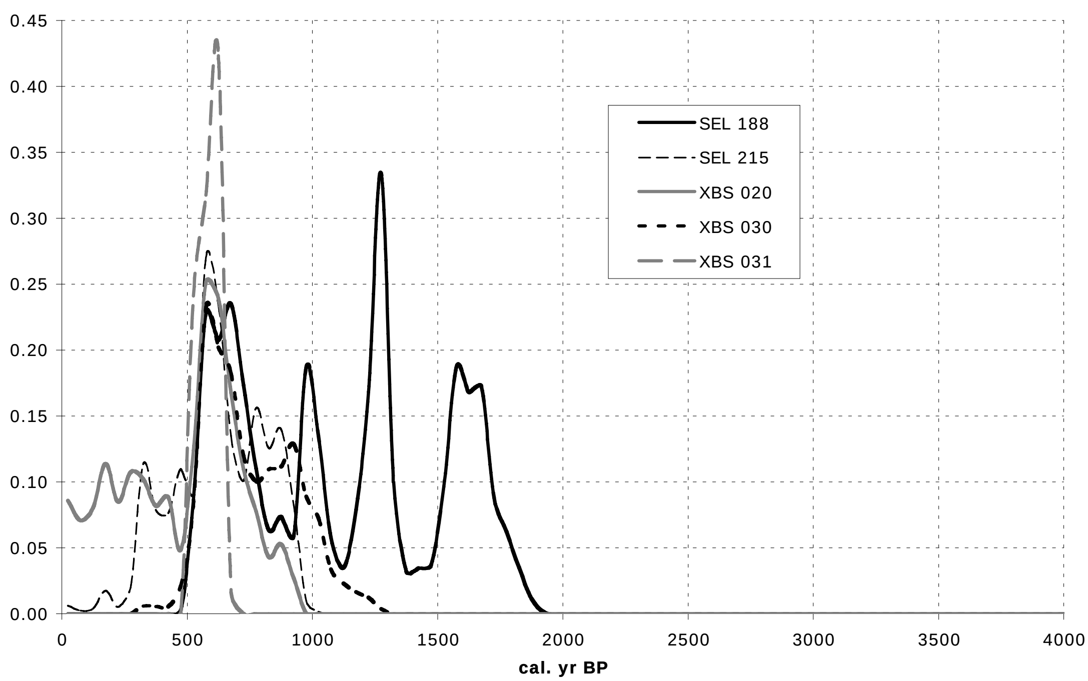

Figure 11. Probability density functions of calibrated radiocarbon ages dating prehistoric villages and camps in Kenai Fjords.

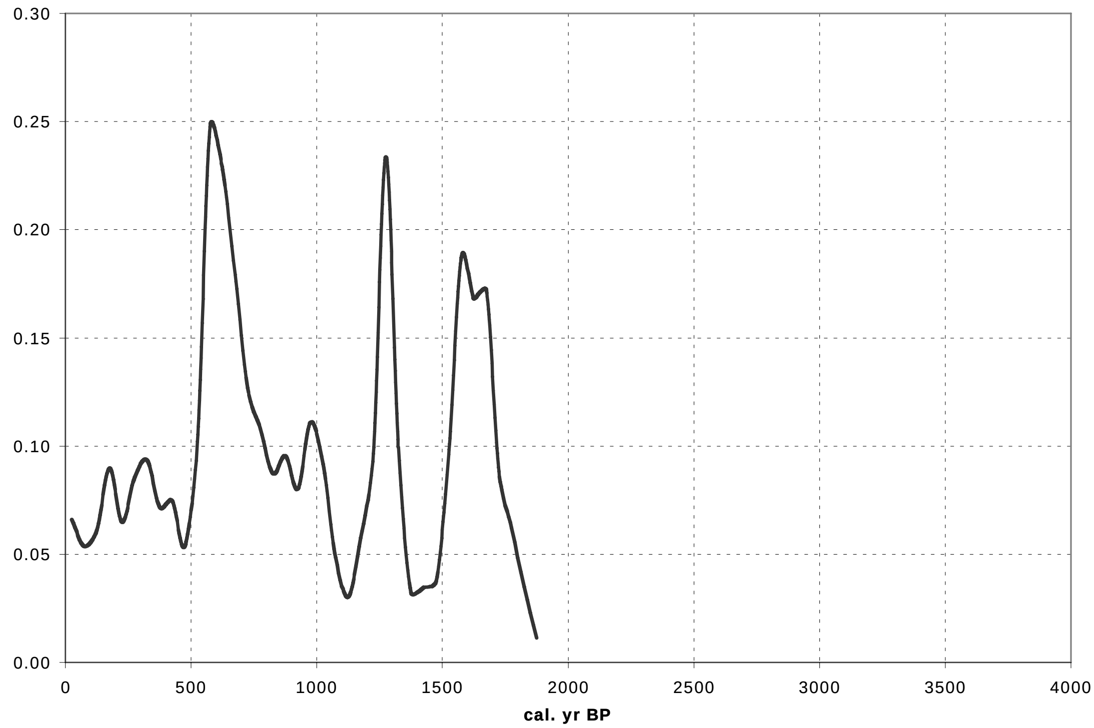

Figure 12. Composite probability density function of calibrated radiocarbon ages dating prehistoric villages and camps in Kenai Fjords.

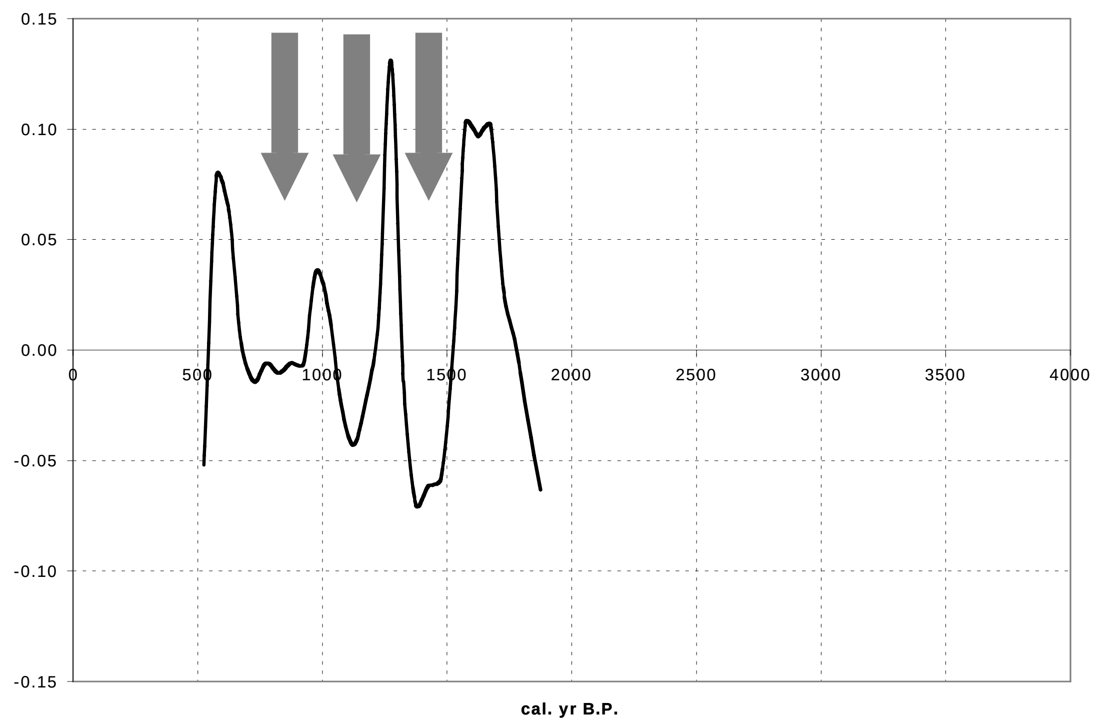

Figure 13. Deviation of composite probability density function from expected

values in Kenai Fjords. Arrows indicate inferred hiatuses in site activity.

Region 3: Kenai Peninsula

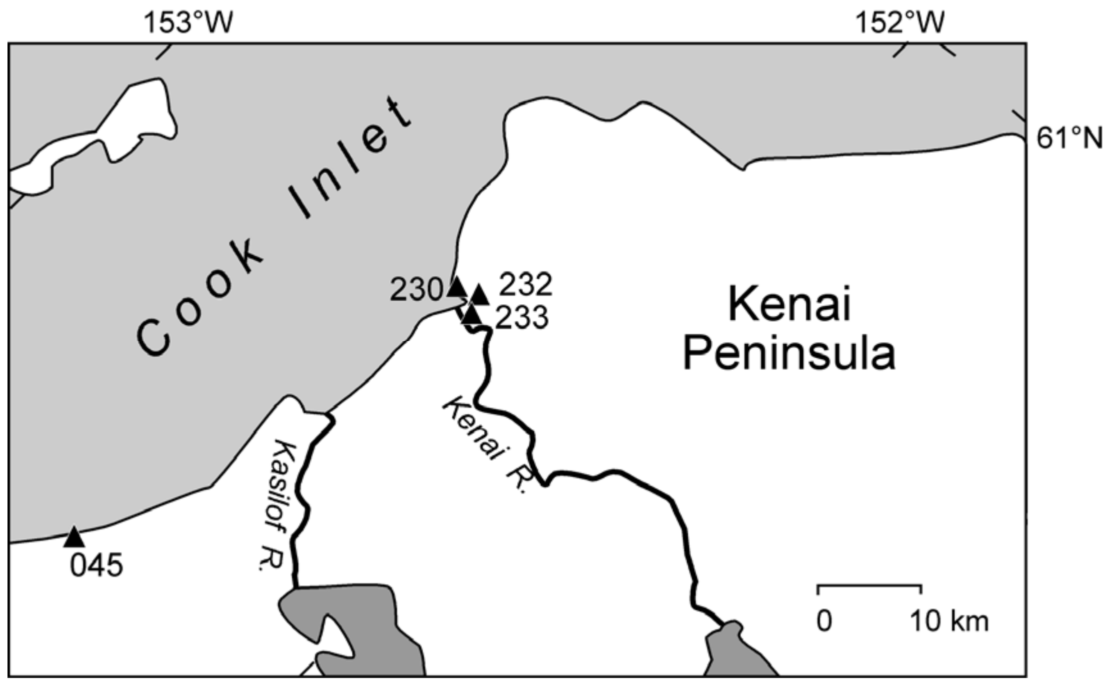

Figure 14. Radiocarbon-dated archaeological sites on Kenai Peninsula.

The excavated coastal sites in this area date from the latest prehistoric to the early historic period (Reger, 1987; Reger and Boraas, 1996), and are thought to be camps established by Dena'ina people from the hinterlands of Upper Cook Inlet. Because of their limited time-depth (≤ 600 years; Figs. 15, 16) these sites contribute little to an analysis of great earthquake incidence.

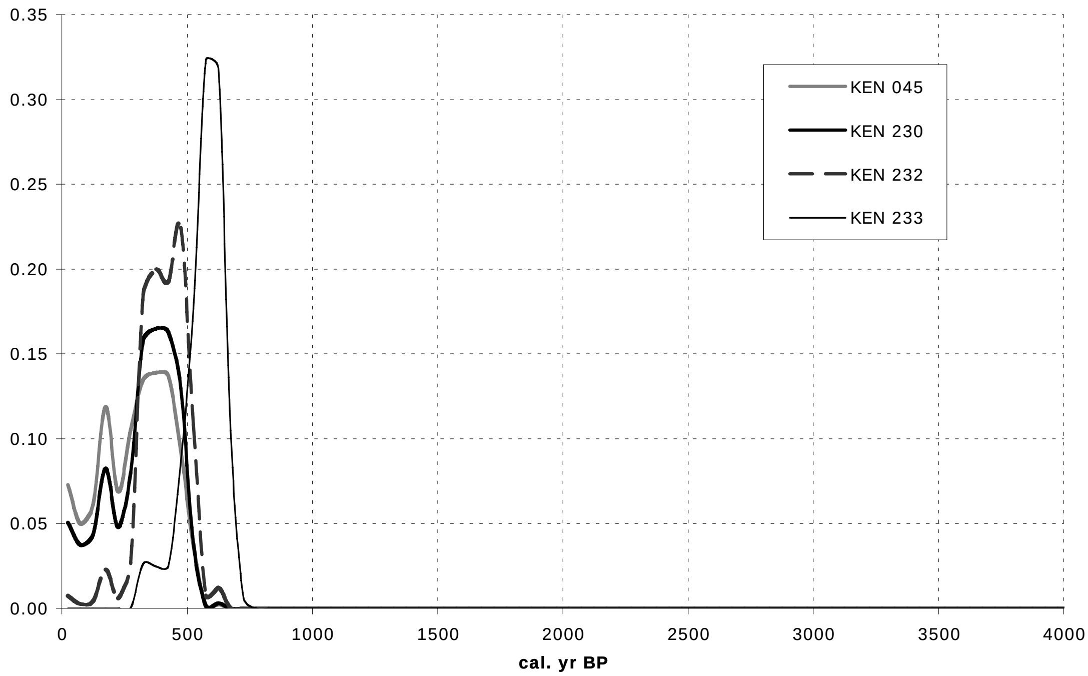

Figure 15. Probability density functions of calibrated radiocarbon ages dating prehistoric occupation of villages and camps on Kenai Peninsula.

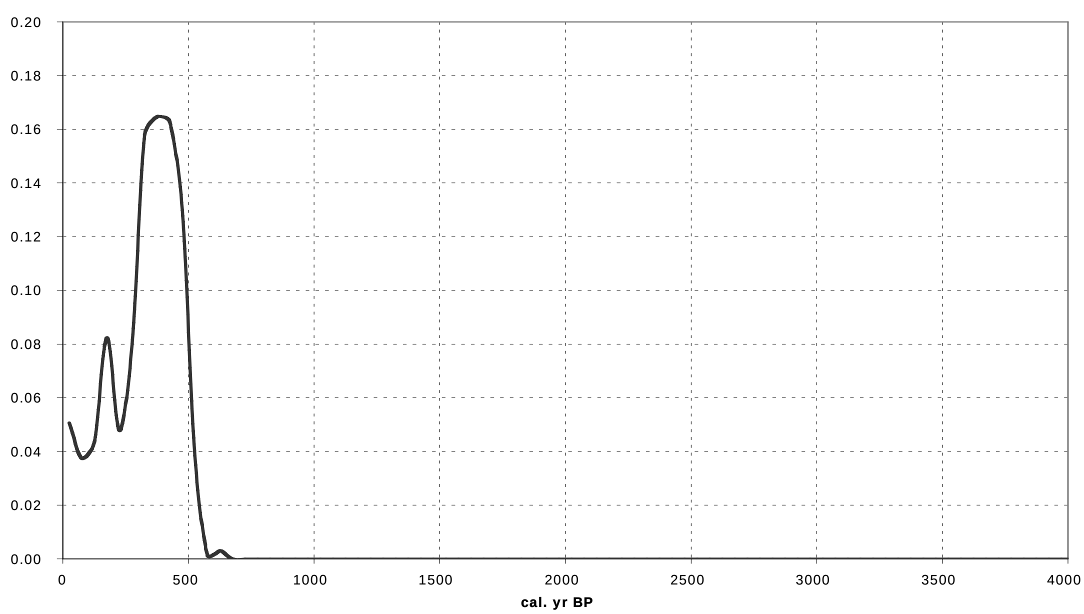

Figure 16. Composite probability density function of calibrated radiocarbon ages dating prehistoric occupation of villages and camps on

Kenai Peninsula.

Region 4: Kachemak Bay

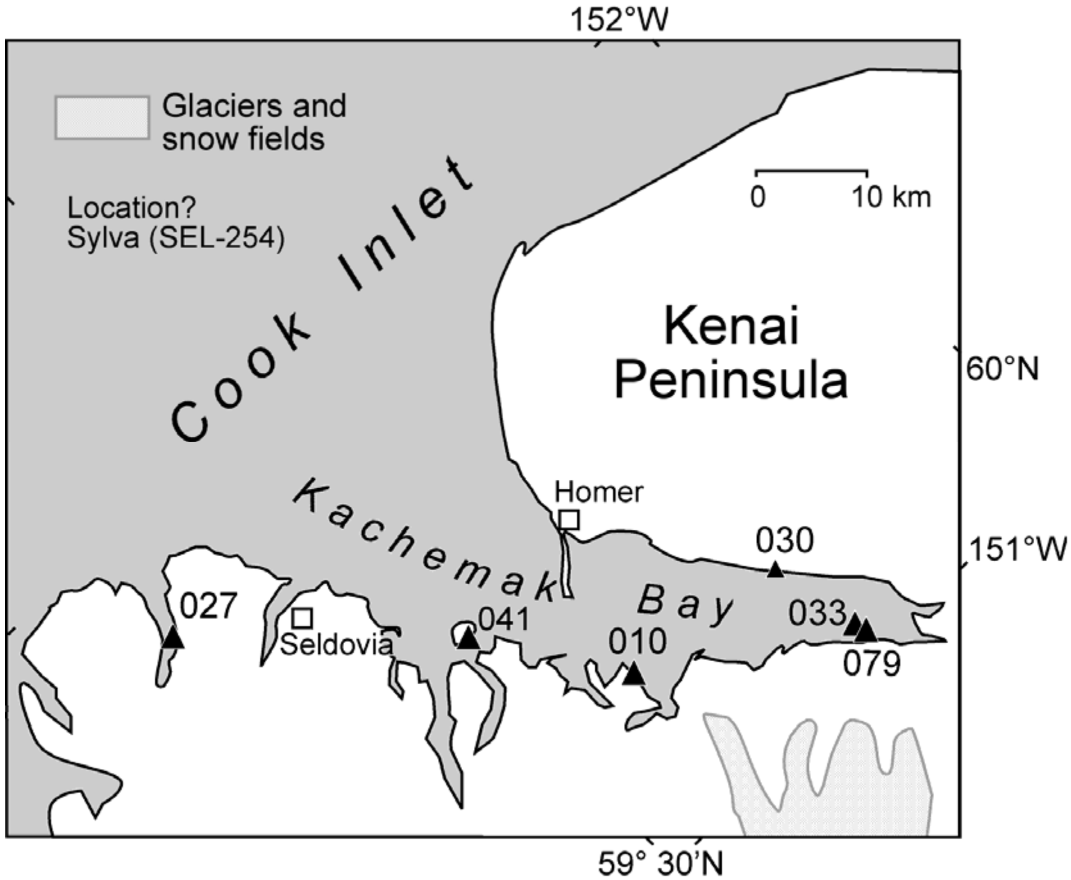

Figure 17. Radiocarbon-dated archaeological sites in Kachemak Bay.

Sites

SEL-010: The 2 m-thick midden at Halibut Cove is separated into two units separated by a thin layer of sterile deposits (Alaska Heritage Resources Survey [AHRS} site form). Eight radiocarbon samples from this site date the occupation to about 400 to 2000 years ago, with a distinct hiatus at about 800-900 cal. yr BP.

SEL-027: A thin (≤0.7 m) midden overlying a thick gravel unit adjacent to the modern beach in Port Graham. Three radiocarbon ages indicate that the midden material dates from the interval between about 400 to 700 years ago (Fig. 18).

SEL-030: Three radiocarbon samples date the occupation of this site at the mouth of Cottonwood Creek to the interval from about 1400 –1850 years ago (AHRS, Workman and Workman, 1997).

SEL-033: This 2-m deep midden on Chugachik Island was first occupied about 4500 years ago. The site appears to have been occupied most recently about 1400-1500 years ago (AHRS).

SEL-041: The historic midden at the Fox Farm site is separated from the prehistoric midden by a sterile layer. The base of the midden sits on a relict beach (Workman, 1992). On a bluff above the Fox farm site a thin midden marks an occupation dating from about 1000 years ago (AHRS).

SEL-079: The midden at Seal Beach lies between the beach and rock-shelter. Only two of the five radiocarbon determinations from the site have been published (Mills, 1994). These bracket the occupation to about 1200 – 1800 years ago.

SEL-245: The Sylva site borders a tidal slough in Aurora Lagoon. Three of the four occupation layers at the site appear to be older than 4000 years. The final occupation at the site appears to date to about 900 - 1000 cal. yr BP (AHRS).

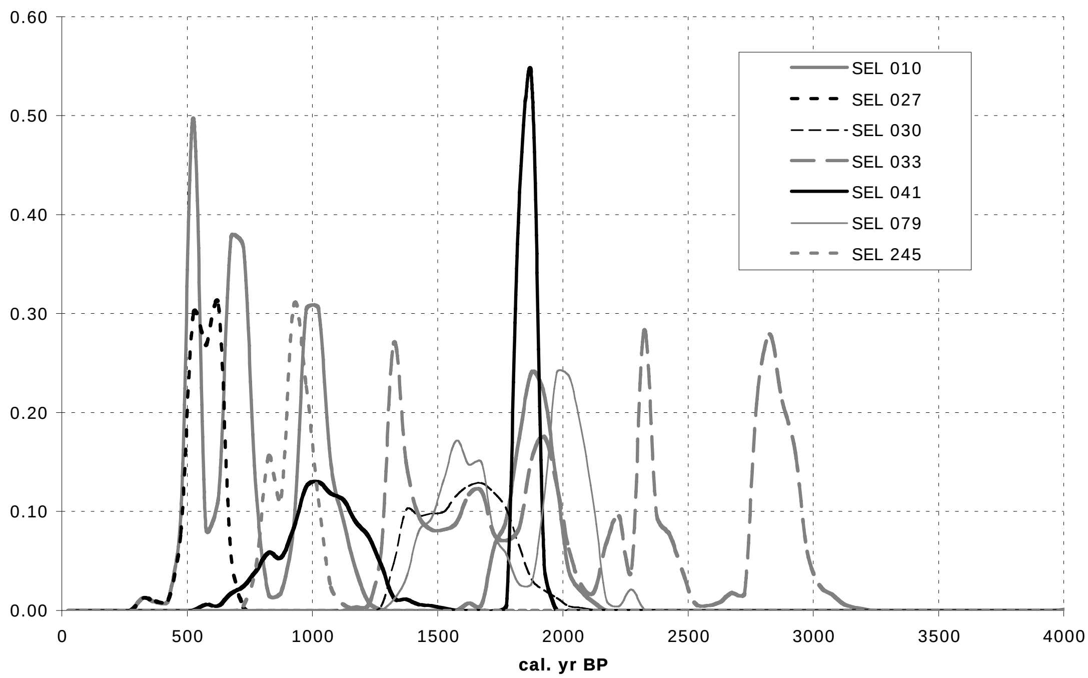

Figure 18. Probability density functions of calibrated radiocarbon ages dating prehistoric villages and camps in Kachemak Bay.

<u>Temporal pattern of site occupation and abandonment in Kachemak Bay</u>

The sites on the shorelines of Kachemak Bay lie about 50 km arcward of the Kenai Fjord sites. Unlike the latter, however, only one of the seven prehistoric sites that have been dated on the shores of the bay appears to have been settled in the aftermath of the 800 cal BP earthquake (SEL 027). Some sites (e.g. SEL-033) have been occupied for much longer periods.

The settlement history of the bay shows several episodes or phases of reduced activity in the last three millennia (Figs. 19, 20). The most severe reductions appear to have occurred about 900, 2200, and 2700 years ago. All of these episodes can be closely correlated with major slip events at the plate boundary. A more gradual reduction in site activity occurred about 1800 to about 1300 years ago, with a fairly dramatic reduction about 1500 years ago. This matches the age of the inferred antepenultimate great earthquake at the eastern end of the Alaska subduction zone.

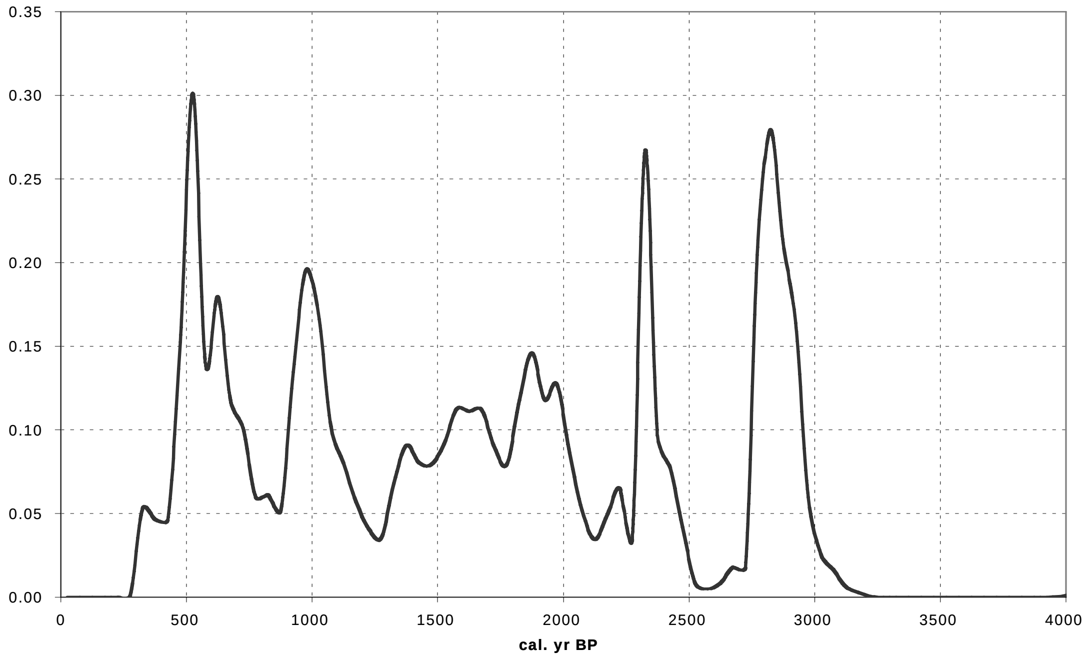

Figure 19. Composite probability density function of calibrated radiocarbon ages dating prehistoric villages and camps in Kachemak Bay.

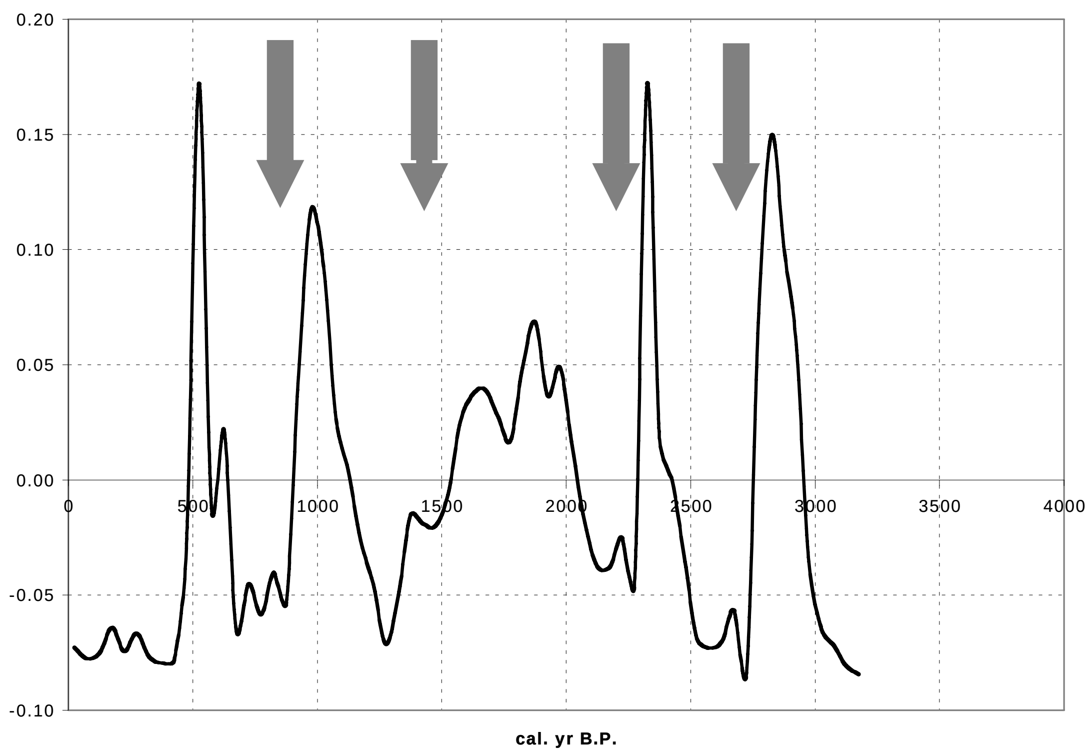

Figure 20. Deviation of composite probability density function from expected values in Kachemak Bay. Arrows indicate inferred hiatuses in site activity.

Region 5: Eastern Kodiak Archipelago

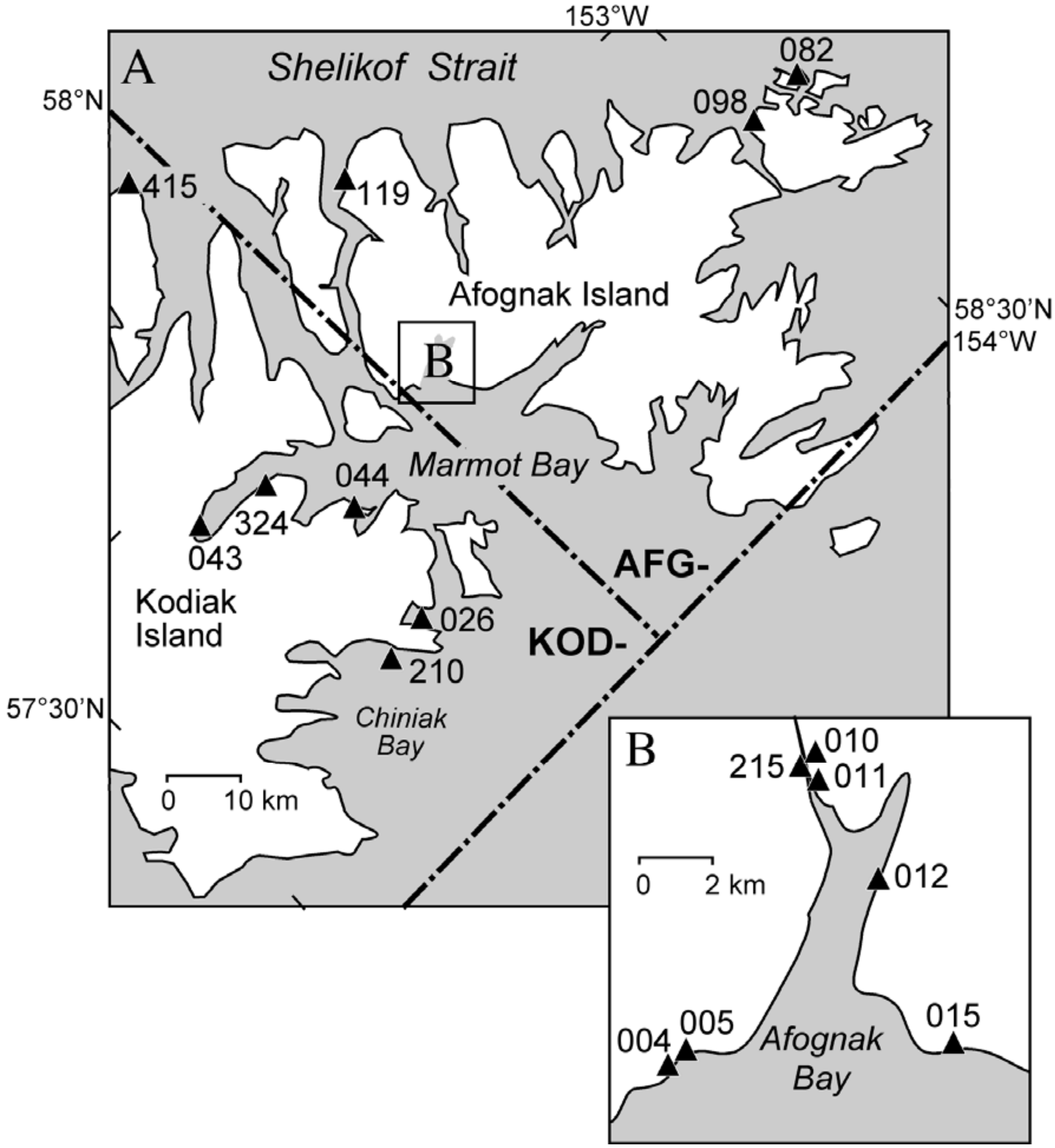

Figure 21. (A) Radiocarbon-dated archaeological sites in East Kodiak, and (B), around Afognak Bay.

Sites

AFG-004: Charred material in hearth fill dates the Aleut Town prehistoric site to the interval between 750 – 1150 cal. yr B.P. (D. Clark , p.c. to Ben Fitzhugh, 2002). The house floors at this site may predate the hearth fill by at least a century.

AFG-005: Basal mid Holocene cultural deposits are sealed off from later cultural levels by a tephra layer (D. Clark, 1997). Two radiocarbon samples date one phase of this later occupation to about 500 – 700 cal. yr B.P. (Fig. 18a).

AFG-010: The Salmon Bend site is adjacent to the estuary of the Afognak River, at the head of Afognak Bay (Figure 17B). The occupation of this site is marked by >1m of cultural material beneath ash from the Novarupta eruption of 1912. Initial settlement of the site occurred likely prior to 1400 cal. yr B.P., as the older of the two radiocarbon ages at the site (1400±80 ^{14}C yr B.P.; Beta-170060) was derived from a sample above the house floor (Fig. 18a; D. Clark, p.c. to Ben Fitzhugh, 2002). The younger sample (1330±60 14C yr B.P.; Beta-170061) dates the top of the fill in the main house, immediately below a tsunami deposit (D. Clark, p.c. to Ben Fitzhugh, 2002).

AFG-011: A mid Holocene site (>3950 cal. yr B.P.; Fig. 18a) on the southern shore of Afognak Island, adjacent to Afognak Bay**.**

AFG-012: This site on the eastern shore of Afognak Bay was initially excavated by D. Clark and W. Workman. Further investigations at the site by Partlow (2000) yielded four radiocarbon ages which indicate that it was occupied in the late prehistoric (300-550 cal. yr B.P.; Fig. 18a).

AFG-015: The Settlement Point site is situated on a series of beach ridges at an exposed location on the southeastern shore of Afognak Island. Saltonstall and Carver (2002) note that subsidence associated with earthquakes in AD 1150 (800 cal. yr B.P.) and AD 1550 (400 cal. yr B.P.) caused inundation by tsunamis, flooding of the houses at the site, and subsequent erosion of cultural deposits by wave action. No cultural deposits were found above the tsunami deposits associated with the more recent of these earthquakes, indicating that the village was abandoned at this time, likely because of flooding by extreme high tides. A pdf (Fig. 18b) derived from twelve radiocarbon ages presented by Saltonstall and Carver (2002) indicates that the site was likely first settled after 650 cal. yr B.P. This suggests either that the post-seismic recovery phase at the site prior to settlement was much longer than previously estimated, or that the age of the antecedent earthquake may require revision. Similarly, the age of the terminal occupation of this site may need to be reappraised, as the pdf (Fig. 18b) shows that there is a high probability that the site was still occupied after 400 cal. yr B.P.

AFG-082: Several house depressions and a thin midden about 7 – 8 m above mean sea level lie above a cobble beach on Shuyak Island (Reger et al., 1992).

Two radiocarbon ages place the occupation of the site to the interval between about 1650 – 1900 cal. yr B.P. (Fig. 18b).

AFG-088: This site stretches for more than 80 m along the channel bank at the upper end of the Afognak River estuary. The site stratigraphy consists of gravelly and sandy soil containing cultural material with interdigitated tephra overlying a "soily gravel", which is underlain by glacial till (Clark, 1997). The site appears to have been occupied initially at some time between about 4000 years ago to 3500 years ago. Older strata are disturbed in one part of the site by a structure that dates from about 3200 to 2700 years ago. Whether the site was occupied in the gap between these dates is unknown.

AFG-098: This site on Shuyak Island was excavated by means of several test pits and a long trench that extended from the uplands behind the modern storm beach into the intertidal zone (Reger et al., 1992). Two cultural components were identified in the complex stratigraphy of the trench. The upper component consists of scattered artifacts and other cultural debris in the lower levels of a peaty soil that underlies the tephra of the AD 1912 Novarupta eruption. Six radiocarbon determinations indicate that the site was occupied at about the same time as AFG-015 (i.e., between about 300 – 650 cal. yr B.P.; Fig. 18b). The lower cultural component is found in the underlying gravelly soil, which in turn is underlain (at the western, intertidal end of the trench) by sterile beach gravel. Four radiocarbon ages place this earlier occupation in the interval between about 750 – 1200 cal. yr B.P. (Fig 18b). Reger et al. (1992) average the radiocarbon ages from each component, and suggest that the periods of occupation may have been separated by at least 300 years, but it is also possible that the two occupations are much closer together in time.

The hiatus between the two occupations likely coincides with the 800 cal. yr. B.P. earthquake at the eastern end of the subduction zone, but it is curious that no intervening beach gravel unit occurs at this site. We conclude that the site may have been abandoned for several decades or a century or two in the wake of the tsunami, but that the coseismic deformation in this area was much less than the 1 - 1.3 m of subsidence experienced in 1964. The lithology of the matrix of the lower occupation level suggests that people camped on a beach that developed and was tectonically uplifted in the aftermath of the inferred great earthquake about 1300 – 1400 cal. yr B.P. (Fig. 4).

AFG-119: A charcoal sample removed form the base of thin (≤0.4 m thick) midden exposed on a sea cliff suggests that site occupation began about 800-1050 cal. yr. B.P. (Haggarty et al., 1991).

AFG-215: As its name indicates, prehistoric occupation of the "Tsunami" site at the mouth of the Afognak River (Fig. 18b) was interrupted by marine inundation. As Lisa Peterson, the leader of the excavation crew, notes: "this event probably led to its abandonment, perhaps even the inhabitants perished". Initial occupation of the site took place about 1600-1700 years ago, and, as at neighboring sites (AFG-010, AFG-012) abandonment as a result of tsunami inundation occurred at, or shortly after, 1300-1400 cal. yr B.P. The site was only reoccupied several centuries later, at, or shortly after, 700-950 cal. yr B.P. (Fig. 18c).

KOD-026: This site extends for more than 100 m along the shore of Monashka Bay. The midden is about 2 m thick, and is underlain by sandy deposits and till. The three samples dated by Donta and D. Clark from the site (D. Clark, 1997) from the site indicate that the site was occupied at about 300-450 cal. yr B.P. and 1350 – 1700 cal. yr B.P. (Fig. 18c), but whether there was a hiatus in occupation between these bracketing dates is unknown.

KOD-043: The Kizuhyak site extends along the shore of Anton Larsen Bay, adjacent to KOD-044 (below). The 2 m-thick midden is underlain by beach gravel and overlain by ash from the 1912 Novarupta eruption. No stratification or gravel layers were noted in the midden in the excavation conducted by D. Clark in 1959 (D. Clark, 1979). The single radiocarbon age from the site (500-700 cal. yr B.P.; Fig. 18c) was obtained from a sample 0.5 m above the base of the midden. If the underlying gravel unit is a tsunami deposit, it was likely emplaced several centuries before this date.

KOD-044: The Crag Point site occupies a sloping area to an elevation of about 5 m above the high tide line (Jordan, 1992). The stratigraphic sequence at the site consists of a 1-2 m-thick midden beneath about 0.2 m of Novarupta tephra. The midden is underlain by a thin, sterile soil, which in turn is underlain by evidence of human occupation in the early Holocene. D. Clark (p.c. to Ben Fitzhugh, 2002) notes that a stony layer in the midden "suggests a gap in occupation of this part of the site" about 3100 years ago. The 14 radiocarbon determinations from the midden unit (Mills, 1994; Fig. 18c) form distinct groups, likely marking three occupational phases. These span the periods from about 3700 to 3100 years ago, about 2700 to 1600 cal. yr B.P., and about 1000 to 700 cal. yr B.P.

KOD-210: The Blisky site consists of at least three separate cultural components separated by ash-fall deposits at four loci on a series of sloping terraces and bluffs on Near Island, close to the town of Kodiak (D. Clark and A. Steffian, p.c. to Ben Fitzhugh, 2002). It likely functioned sporadically as a seasonal camp occupied by marine mammal hunters. The earliest, mid Holocene part of the site sits on a bluff at about 13 m elevation; the more recently occupied (from 2800-3300 years ago, about 2000 years ago, and in the late prehistoric; Fig. 18c) parts of the site are below 7-8 m.

KOD-324: This site was excvated by Crozier in the early 1980's. Little information is available on site stratigraphy, but it is known that the site was occupied in the interval between about 2700-3000 cal. yr B.P. (Fig. 18c)

KOD-415: Situated at 8 – 12 m elevation on the narrow neck of a rocky promontory at the northern tip of Uganik Island, the Horseshoe Cove site was apparently inhabited on three occasions, with a gap of at least two millennia between the two most recent occupations. The youngest midden component dates to about 500 – 900 cal. yr B.P.; a prior occupation dates to about 3100 cal. yr B.P. (Fig. 18c), and this is underlain by thin deposits marking a mid Holocene occupation (Saltonstall and Steffian, 2005).

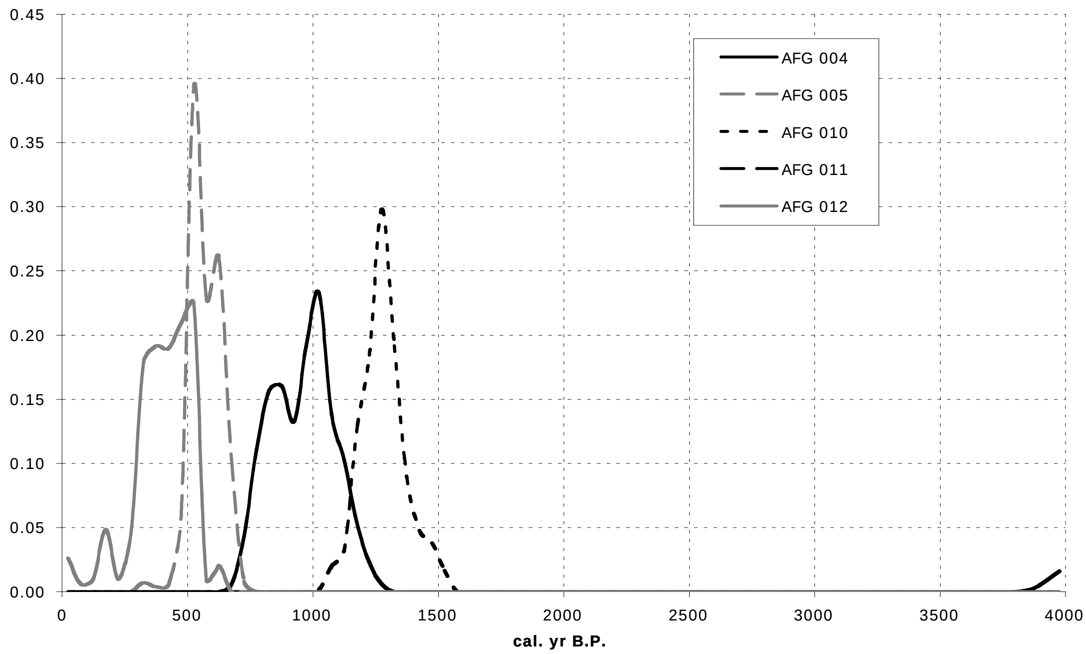

Figure 22a. Probability density functions of calibrated radiocarbon ages dating prehistoric villages and camps in East Kodiak.

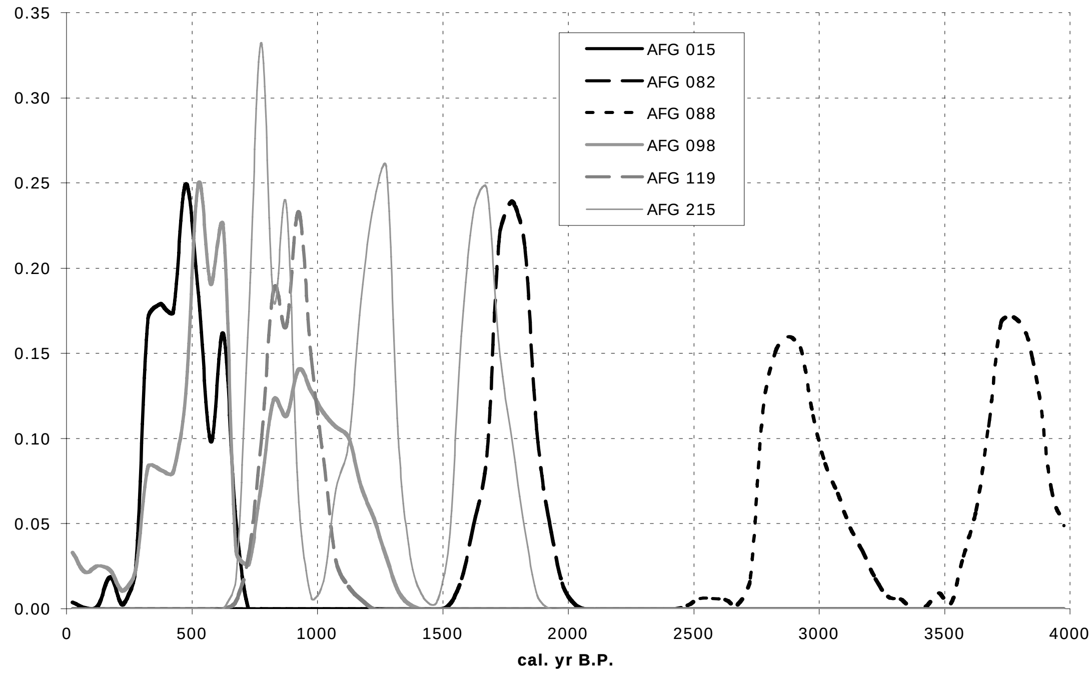

Figure 22b. Probability density functions of calibrated radiocarbon ages dating prehistoric villages and camps in East Kodiak.

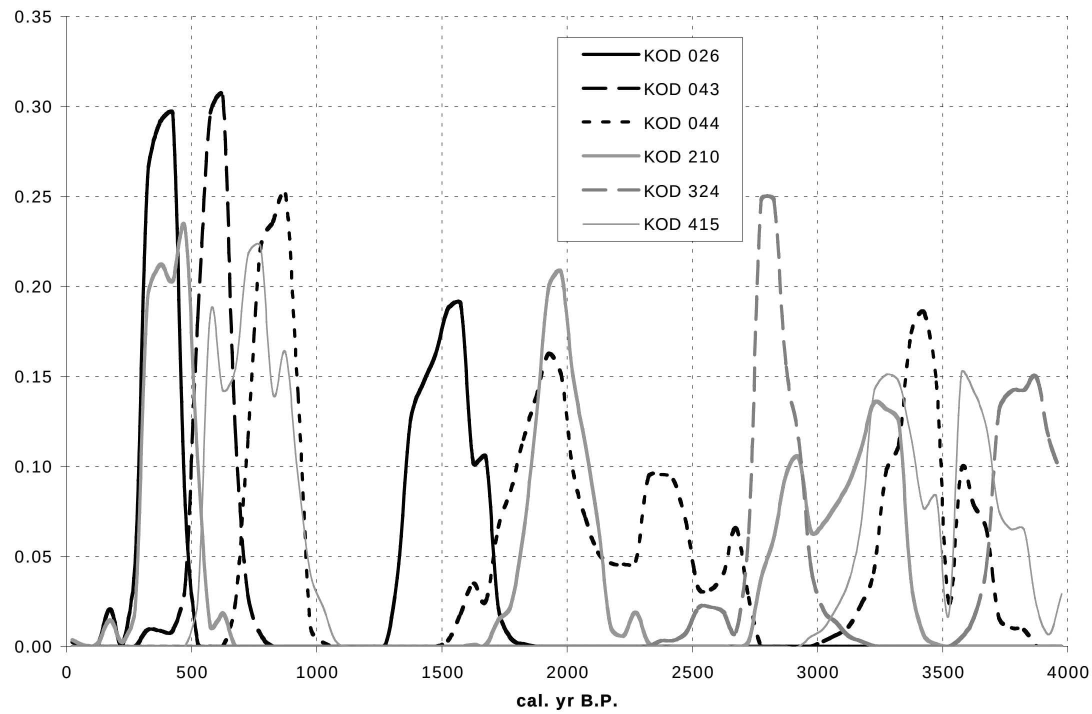

Figure 22c. Probability density functions of calibrated radiocarbon ages dating prehistoric villages and camps in East Kodiak.

<u>Temporal pattern of site occupation and abandonment in East Kodiak</u>

Although sites in the Afognak (AFG-) quadrangle have a time-depth of only about 2000 years, many sites on Kodiak Island (KOD-) yield records of phases of occupation extending back for more than 6000 years. Over the course of the last 4000 years there is substantial variation in the pdf index (Fig. 19). The deviation of the observed pdf from the expected values (Fig. 20) shows at least five, and perhaps as many as six abrupt changes in this period. This index suggests that villages and camps may have been vacated on a regional scale on at least five occasions in this interval. The most recent exodus began about 600 years ago. Previous inferred hiatuses began at or shortly after 1500(?), 2800, 3300 and 3500 cal. yr B.P. If we interpret the small drop in the pdf index at about 2300 years ago as marking another potential hiatus, there is a strong 500 to 600-year periodicity to this pattern (Fig. 20).

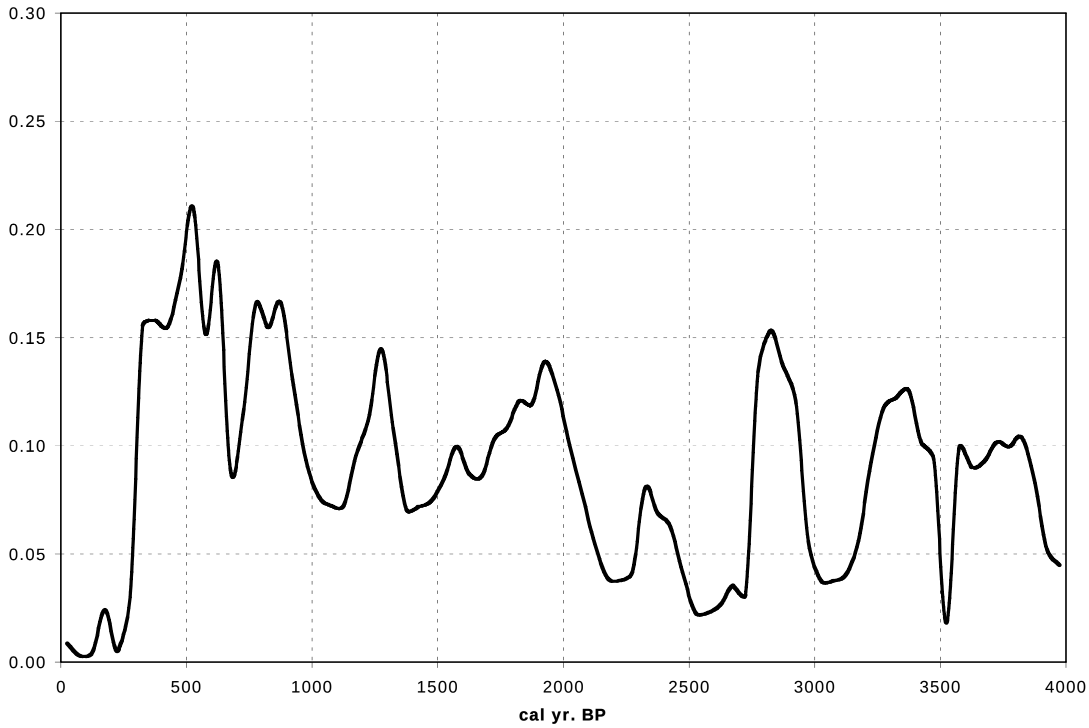

Figure 23. Composite probability density function of calibrated radiocarbon ages dating prehistoric villages and camps in East Kodiak region.

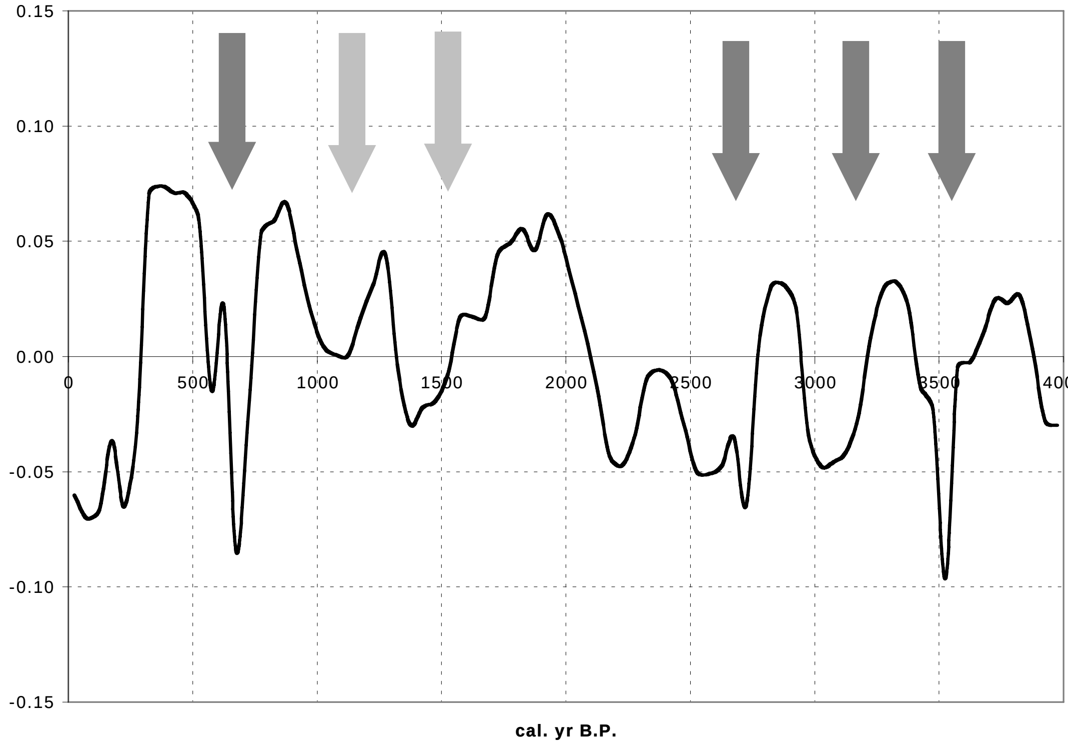

Figure 24. Deviation of composite probability density function from expected values in E. Kodiak. Arrows indicate inferred hiatuses in site activity.

Region 6: Southwestern Kodiak Archipelago

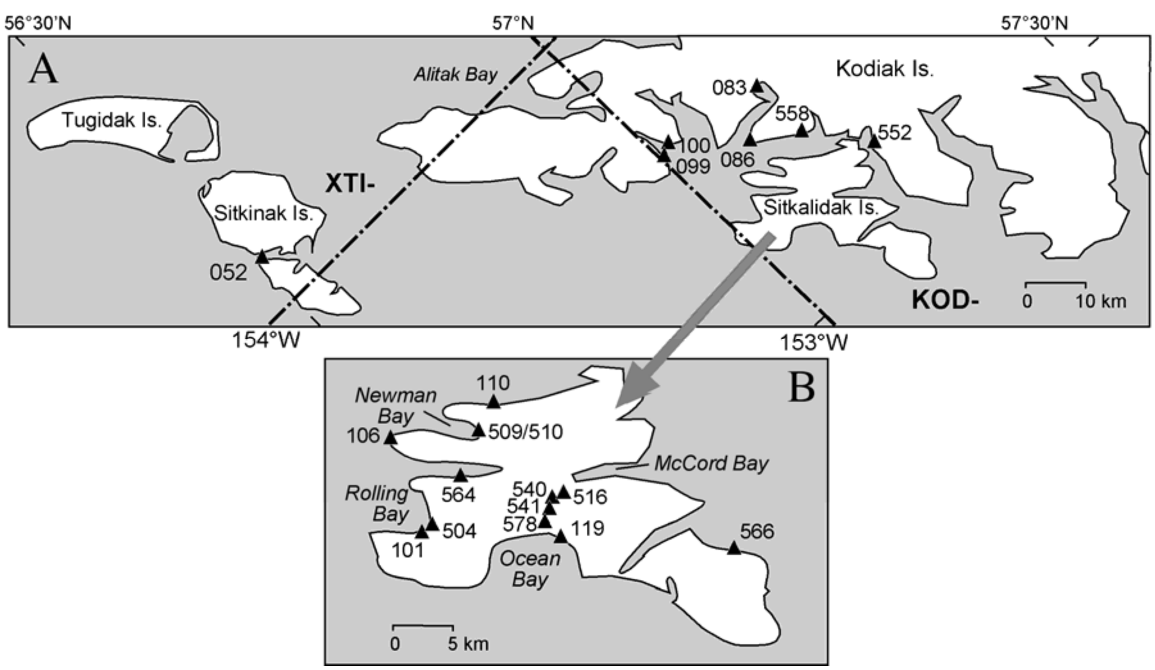

Figure 25. (A) Radiocarbon-dated archaeological sites in Southwest Kodiak, and (B), on Sitkalidak Island.

Unless otherwise noted, the descriptions below are based on unpublished site reports from the Sitkalidak Archaeological Survey. The results of this survey are summarized in Fitzhugh (2003).

Sites

KOD-083: The Russian village site at Three Saints Bay is underlain by a 1 – 1.5 m thick prehistoric midden that occupies about 1500 m^2 on a relict beach ridge. The basal material dates from 1850 – 2100 cal. yr B.P. (Clark, 1966a; Fig. 26a). Clark (1979) suggests that the site was abandoned at about AD 900 based on a date of 1119±49 (P-1043) on non-cultural materials in the upper part of the prehistoric deposits. The 2-sigma calibrated age range for this sample is 934 - 1170 cal. yr B.P.

KOD-099: The New Kiavak site represents a late prehistoric (300 – 500 cal. yr B.P.) occupation on the shore of the lagoon (D. Clark, 1966b) (Fig. 26a)

KOD-100: The midden mound at Old Kiavak is adjacent to KOD-099 and sits a few meters above the high tide line. Artifacts collected from patchy deposits in the upper midden indicate that the site was occupied briefly in the historic and late prehistoric periods (D. Clark, 1997). The only date on the late prehistoric material is derived from the charred fat of marine mammals, and the ocean reservoir effect is not sufficiently well constrained in this area to allow the age of this occupation to be determined with any confidence (D. Clark, 1997), so this sample has been omitted from our analysis. The earliest occupation occurred about 3500 years ago, when the bay was open to the sea. Artifacts from this period are sparse, however, and most of the cultural material appears to post-date this period. Clark (1997) considers occupation at the site to have been continuous until about 2200 cal. yr. B.P., but the bounding age of this occupation is poorly constrained. The radiocarbon sample (S-3488; 2750±130 ^{14}C yr B.P.) that dates the terminal phase of this occupation is a composite from 40 cm of midden material, and may be a mix of charcoal and marine organics. The thin sand and pebble layers in the midden in Trench B, on the side of the mound facing the shore (Clark, 1997; Fig. 13), may be products of storms or tsunamis. These may have produced brief exoduses from the site, but the ages of these events are unknown.

KOD-101: The Rolling Bay site is a very large (>1.5 ha) late prehistoric (300 – 550 cal. yr B.P.; Fig. 26a) village at about 7 m elevation on and adjacent to a tombolo on the southwestern shore of Sitkalidak Island. The site was excavated by Clark prior to the 1964 earthquake (Clark, 1966b). Vegetal layers in the midden that are inferred to be the remains of house roofs are separated by discontinuous sand laminae. These, and the single continuous sand layer that extends across an 8m-long trench, are likely flooring materials (Clark, 1979), although the last may be a product of marine inundation. The thick surface layer of sand and pea gravel that mantles the midden predates the 1964 tsunami, and is of unknown origin.

KOD-106: Located on the western tip of the Natalia Peninsula at an elevation of <10 m, this small village was initially occupied between about 700 – 950 cal. yr B.P. (Fig. 26a).

KOD-110: This large village site occupies an area >1 ha at an elevation of <5m on a spit on the southern shore of Sitkalidak Strait. Thick midden deposits, with a basal age of about 500 cal. yr B.P. (Fig. 26b), are capped by 1m of sand and gravel from the 1964 tsunami.

KOD-504: This is a small site perched on a ledge at about 14 m elevation above the inner lagoon marsh at the head of Rolling Bay. It was likely a seasonal or temporary settlement that was occupied at some time between 300-500 cal. yr B.P. (Fig. 26b).

KOD-509: The thin lens of charcoal in one of the 8+ house depressions suggests that this site on a bluff about 6 – 8 m elevation at the head of Newman Bay was occupied briefly at or about 650-900 cal. yr B.P. (Fig. 26b).

KOD-510: This site sits on a relict beach berm at about 2 – 3 m elevation at the head of Newman Bay. The site was occupied during the interval between 300-550 cal. yr B.P. (Fig. 26b).

KOD-516: One of a number of sites that sits on the upland margins of marshy freshwater lakes in the valley that runs between Ocean Bay and McCord Bay on Sitkalidak Island. KOD-516 lies at an elevation of 9-15 m, and the thin charcoal layer at the site dates its occupation to 1500-1800 cal. yr B.P., when the site probably overlooked a brackish lagoon or marine embayment (Fig. 26b).

KOD-540: In the same valley as KOD-516, but at a slightly lower elevation, this small hearth site was likely occupied at a somewhat later date, in the interval between 1250-1600 cal. yr B.P. (Fig. 26b).

KOD-541: Also located in the Ocean Bay – McCord Bay valley, this small site dates from the same period as KOD-540 (Fig. 26c).

KOD-552: Occupying a small sea stack at an elevation of 6 – 8 m in Midway Bay, near Old Harbor, this single housepit was occupied on two separate occasions. The basal occupation dates from 900 - 1150 cal. yr B.P. (Fig. 26c)

KOD-564: This is a multicomponent site covering a small landlocked island. Test pits excavated in two of the apparent house depressions revealed at least three distinctive occupations. The earliest occupation dates from about 6000 years ago; the site was most recently occupied about 1550-1950 cal. yr B.P. (Fig. 26c).

KOD-566: One of a number of site loci on a low (<7 m a.s.l.) bluff overlooking Taginak Bay on Sitkalidak Island. This locus was occupied in the interval between about 1350 – 1650 cal. yr. B.P. (Fig. 26c).

KOD-578: This site is located on a small mound in the Ocean Bay – McCord Bay valley. The presence of net sinkers in the excavated house floor suggest that the nearby lake was a tidal lagoon at the time that the site was occupied (1950 – 2300 cal. yr B.P.) (Fig. 26c)

XTI-052: Situated on a spit at the southern end of Sitkinak Lagoon, this site was occupied within the last 1000 years (Fig. 26c).

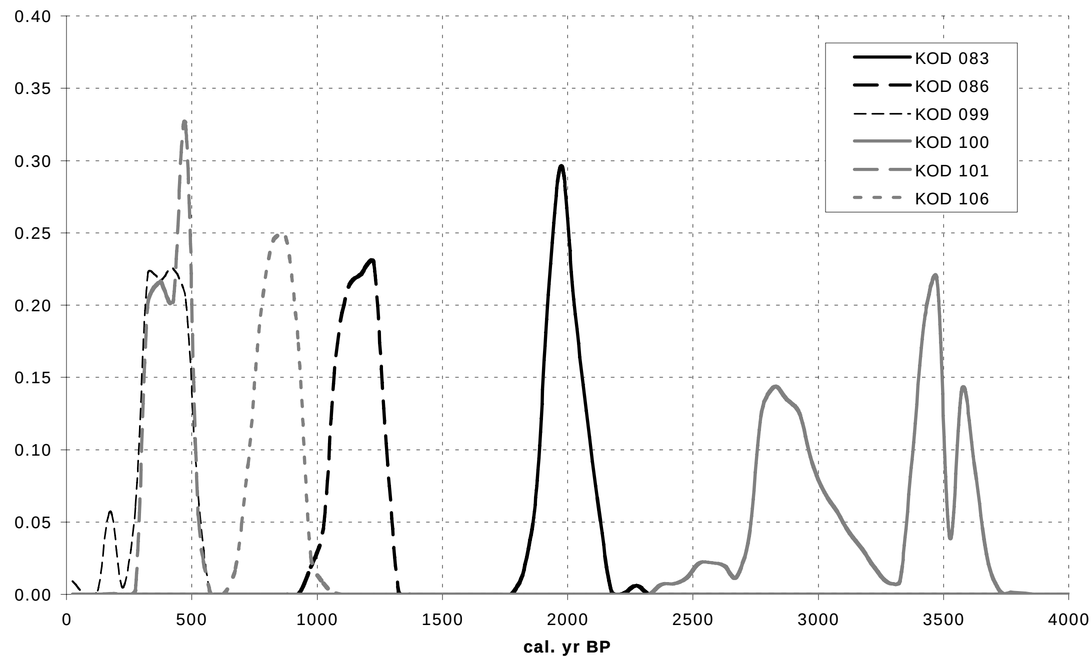

Figure 26a. Probability density functions of calibrated radiocarbon ages dating prehistoric villages and camps in Southwest Kodiak.

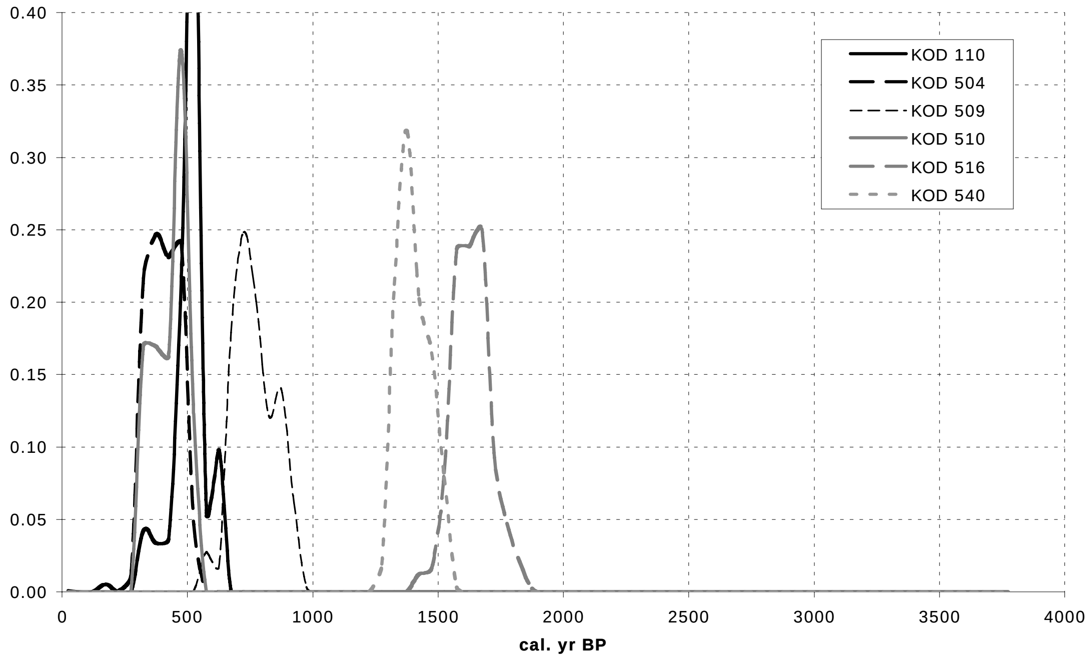

Figure 26b. Probability density functions of calibrated radiocarbon ages dating prehistoric villages and camps in Southwest Kodiak.

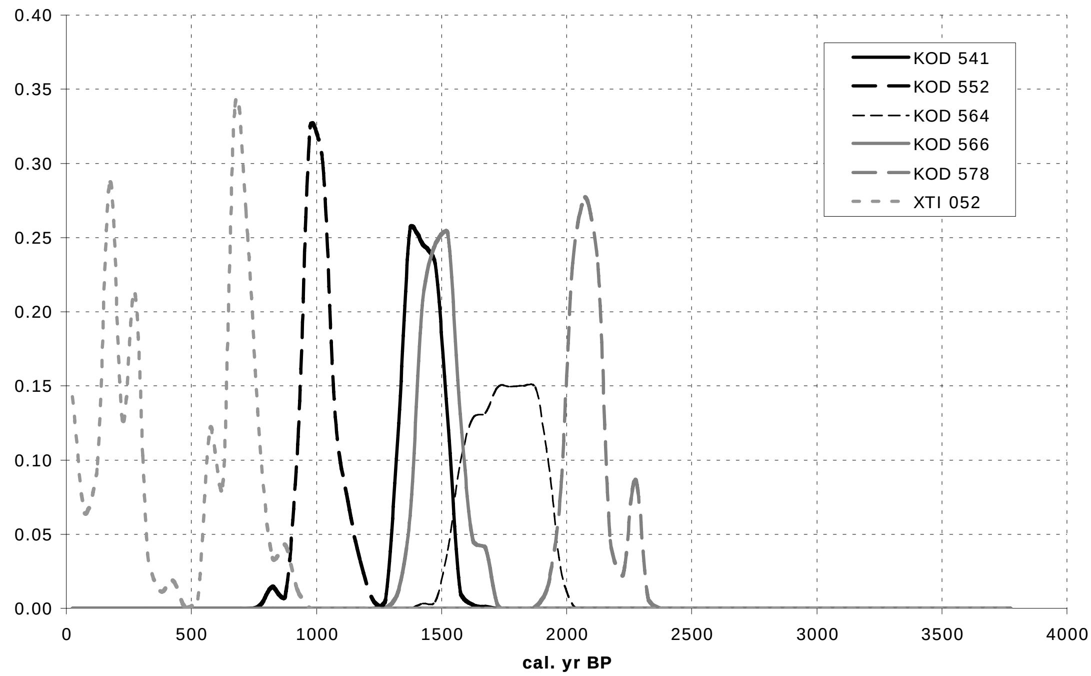

Figure 26c. Probability density functions of calibrated radiocarbon ages dating prehistoric villages and camps in Southwest Kodiak.

Temporal pattern of site occupation and abandonment in Southwest Kodiak

Radiocarbon ages from more than 20 excavated sites contribute to our understanding of the chronology of site occupation from the protohistoric period to 2300 cal. yr B.P. in Southwest Kodiak. The pdf proxy indicates that two major, and perhaps two minor episodes of site abandonment may have occurred in this interval (Figs. 27, 28). The former occurred at about, or shortly after, 650 and 1350 cal. yr B.P., and the latter at about 1800 and 2000 cal. yr B.P.

Inferences regarding phases of site occupation and episodes of abandonment from about 2300 to 4000 cal yr B.P., however, are much more tentative, as they are based entirely on the four terrestrial radiocarbon samples from Kiavak (KOD-100) that have small error terms. This site was apparently abandoned after 2700 cal. yr B.P. (perhaps as late as 2200 cal. yr B.P.; D. Clark, 1997), with another possible hiatus in occupation about 3350 years ago.

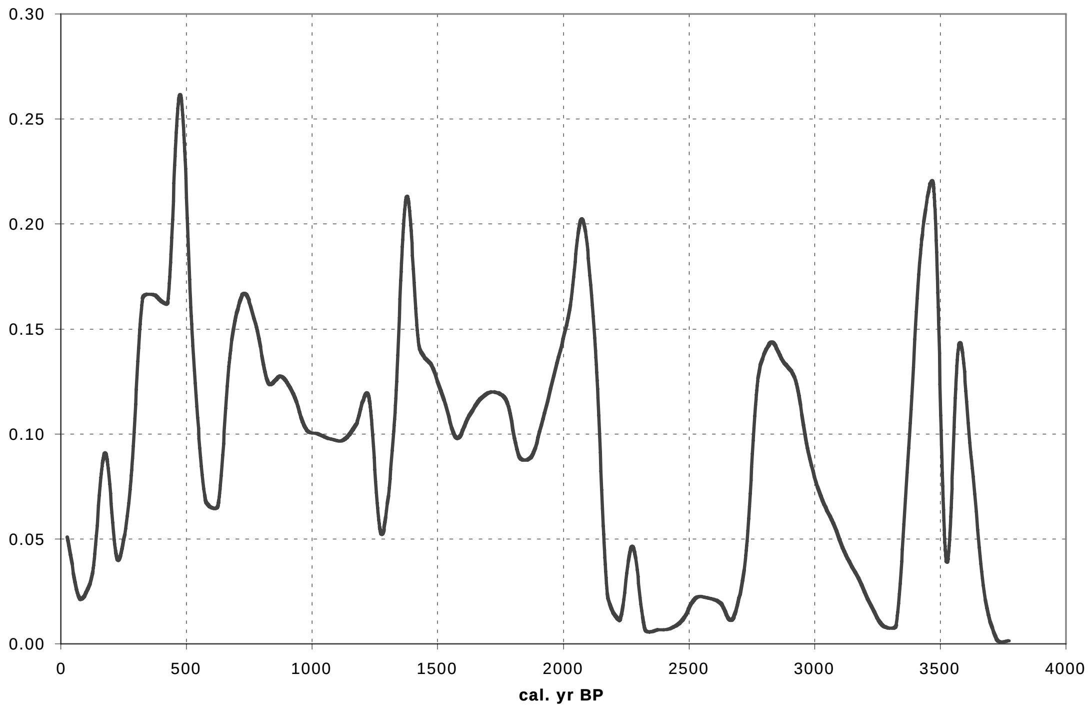

Figure 27. Composite probability density function of calibrated radiocarbon ages dating prehistoric villages and camps in Southwest Kodiak.

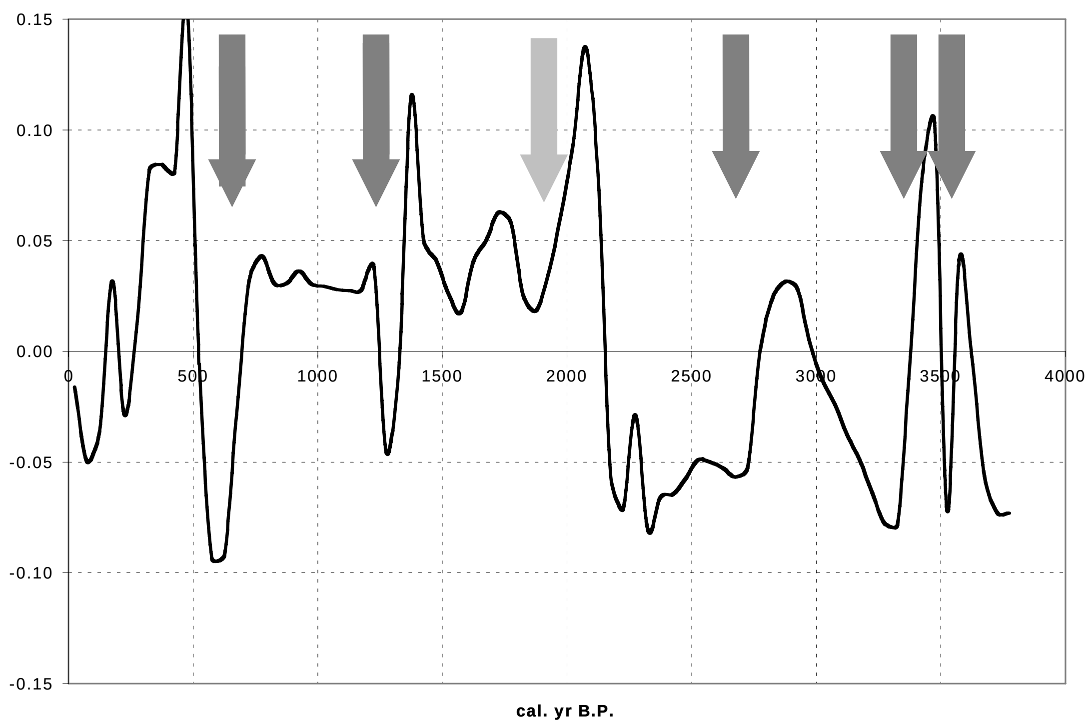

Figure 28. Deviations of composite probability density function from expected

values in Southwest Kodiak.. Arrows indicate inferred hiatuses in site activity.

Region 7: Northwestern Kodiak Archipelago

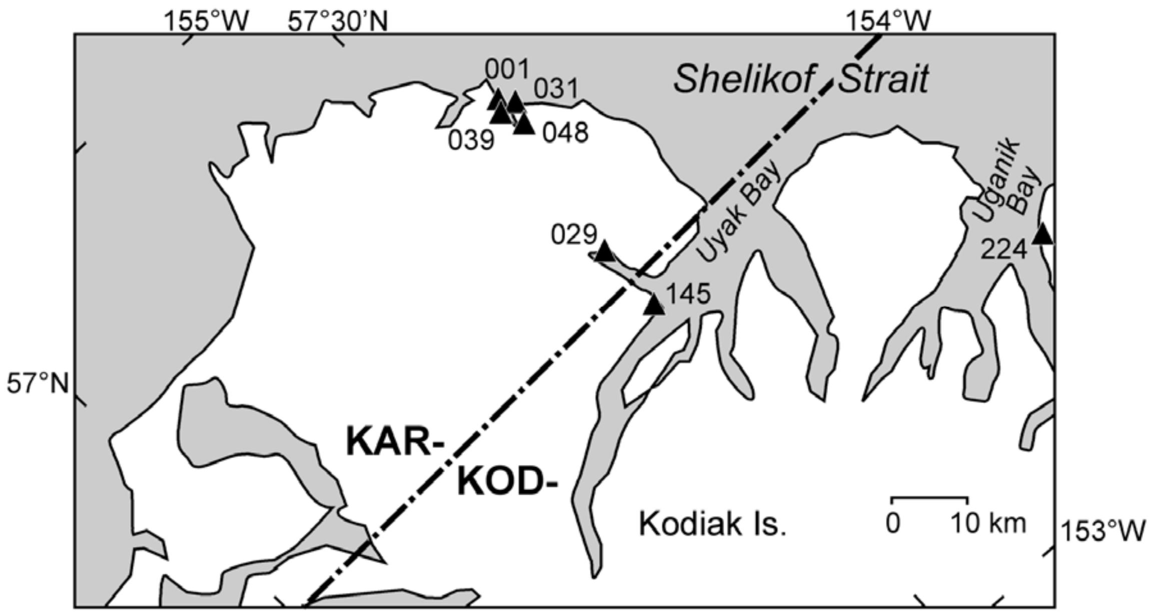

Figure 29. Radiocarbon-dated archaeological sites in Northwest Kodiak.

Most of the dated sites in the northwestern part of Kodiak Island lie on the shores of Karluk Lagoon (Fig. 29). Several sites have been intensively dated, and the excavators have recognized the critical influence of paleoseismic history on site occupation patterns and culture change (e.g. Knecht, 1995).

Sites

KAR-001: "New Karluk" or "Karluk One" is located on a spit at the mouth of Karluk Lagoon on the northwest coast of Kodiak Island (Fig. 29). A 4m-thick midden is comprised of house floors and collapsed sod roofs, plus shellfish and other food refuse. Eight radiocarbon ages on wooden planks indicate that the site has been occupied for about the last 800 years (Fig. 30). A 4cm-thick layer of sterile gravel overlies the lowest house floor, which lies directly on an old beach (Jordan and Knecht, 1988). Knecht (1995) dismisses the possibility that this is a cultural product. This may be a tsunami deposit, and "may reflect an earthquake (which) occurred in the Kodiak area between AD 1000 and 1280" (Knecht, 1995; p. 158). Alternatively, because it is separated from the old beach by only a thin layer of cultural material, it could be a storm deposit, or represent a brief episode of relative sea-level rise independent of tectonic influences.

KAR-029: Crozier (1989), excavated a house pit at this small site at the head of Larsen Bay, and obtained seven radiocarbon samples from a hearth feature. He noted that the house was first occupied about 1300 years ago, with a "(p)ossible hiatus or decrease in utilization" (Crozier, 1989, p. 88) between 700 to 900 years ago, followed by abandonment of the house about 450 years ago.

KAR-031: "Old Karluk" is on the northwest corner of Karluk Lagoon, and stratigraphy was mapped from an extensive beach exposure. A weathered tephra that is inferred to have been deposited about 3800 years ago separates mid Holocene (Ocean Bay) cultural deposits from late Holocene (Kachemak) cultural levels at this site (Knecht, 1995). The basal Kachemak occupation levels are dated by four radiocarbon ages (Fig. 30). Jordan and Knecht (1988) note that the oldest of these dates is derived from alluvial material in which artifacts are scarce. The more recent dates are from house floors and cultural debris. A layer of gravel that postdates the uppermost midden extends part way across the exposure, and may be a tsunami deposit. It is overlain by about 0.5m of soil. The artifact assemblage in the underlying midden, in combination with the most recent radiocarbon age, suggests that it is less than 800 years old, and may have been laid down at the same time as the inferred tsunami deposit at KAR-001 on the opposite shore of the lagoon, and at XMK-058 on the Katmai coast.

KAR-039: This fairly large village occupies a sloping terrace to about 8 m above mean sea level on the south shore of Karluk Lagoon (Jordan and Knecht, 1988). A single radiocarbon age indicates that the site was inhabited about 2800 years ago (Fig. 30).

KAR-048: No descriptions have yet been published for this site, but the single radiocarbon sample indicates an occupation between about 3100 – 3400 years ago.

KOD-145: Uyak is a large and complex site occupying a rocky point on the eastern shore of Uyak Bay (Fig. 29), excavated originally by Hrdlička (1944) and Heizer (1956). Later excavations of the eastern part of the site (Steffian, 1992) yielded evidence of occupation in the interval between about 950 – 1350 cal. yr B.P. (Fig. 30).

KOD-224: This site is a 6m-high mound on a spit adjacent to a lagoon on the west coast of Uganik Island (Nowak, 1979). Although the oldest layers at the site are at least 6000 years old, there is little stratigaphic evidence of hiatuses in occupation at the site. The most recent radiocarbon date from the site suggests that the site was inhabited until at least 1000 years ago (Fig. 30).

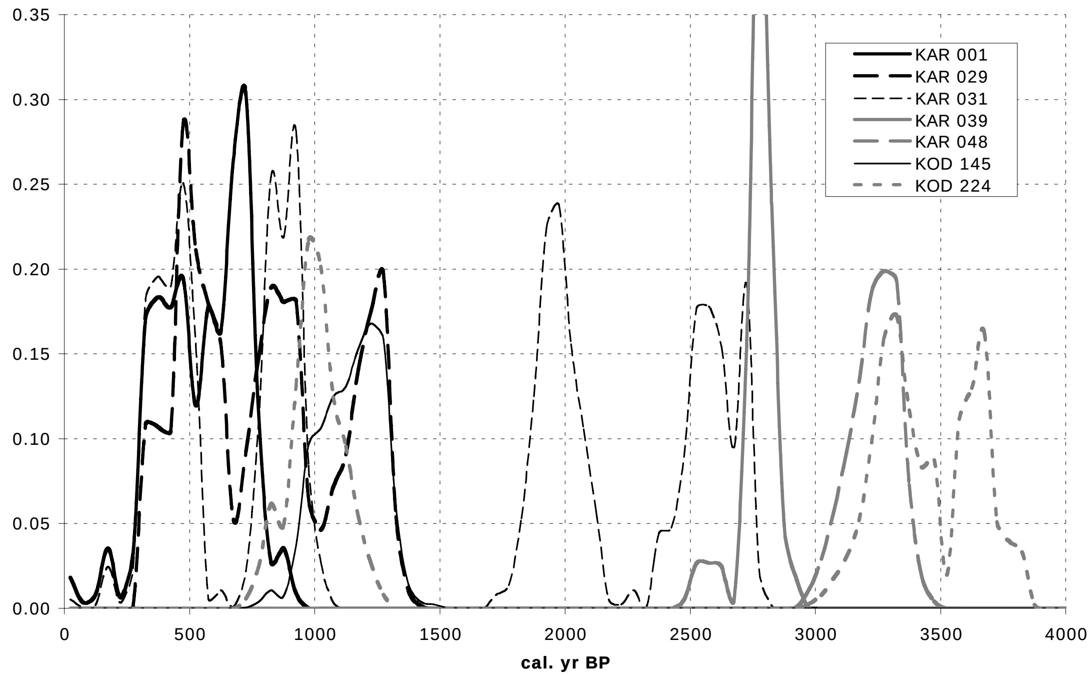

Figure 30. Probability density functions of calibrated radiocarbon ages dating prehistoric villages and camps in Northwest Kodiak.

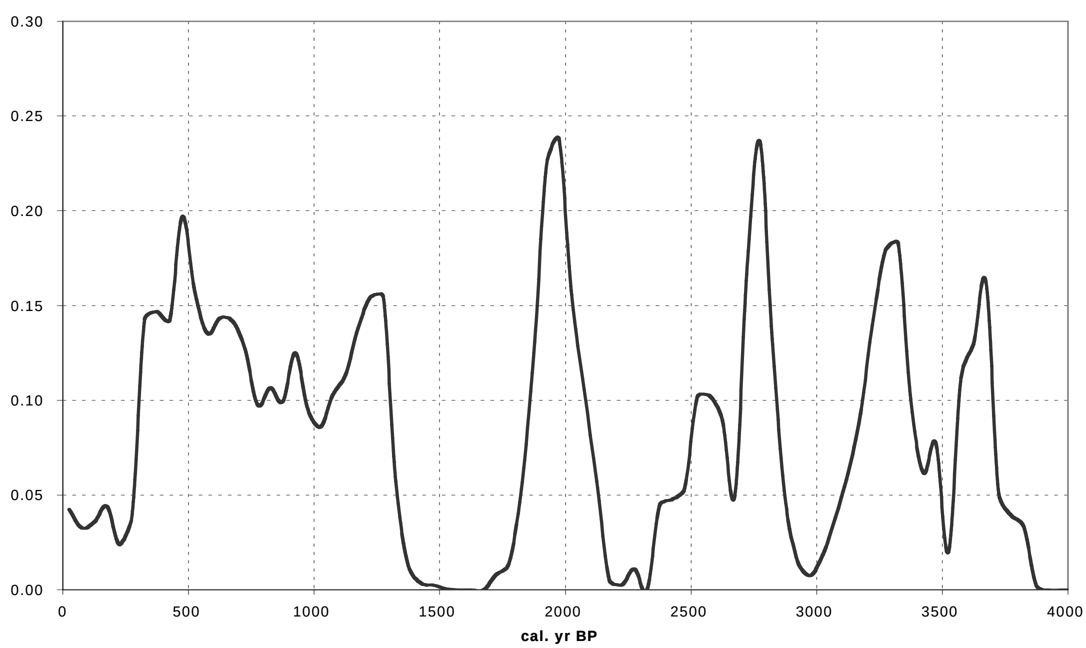

Figure 31. Composite probability density function of calibrated radiocarbon ages dating prehistoric villages and camps in Northwest Kodiak.

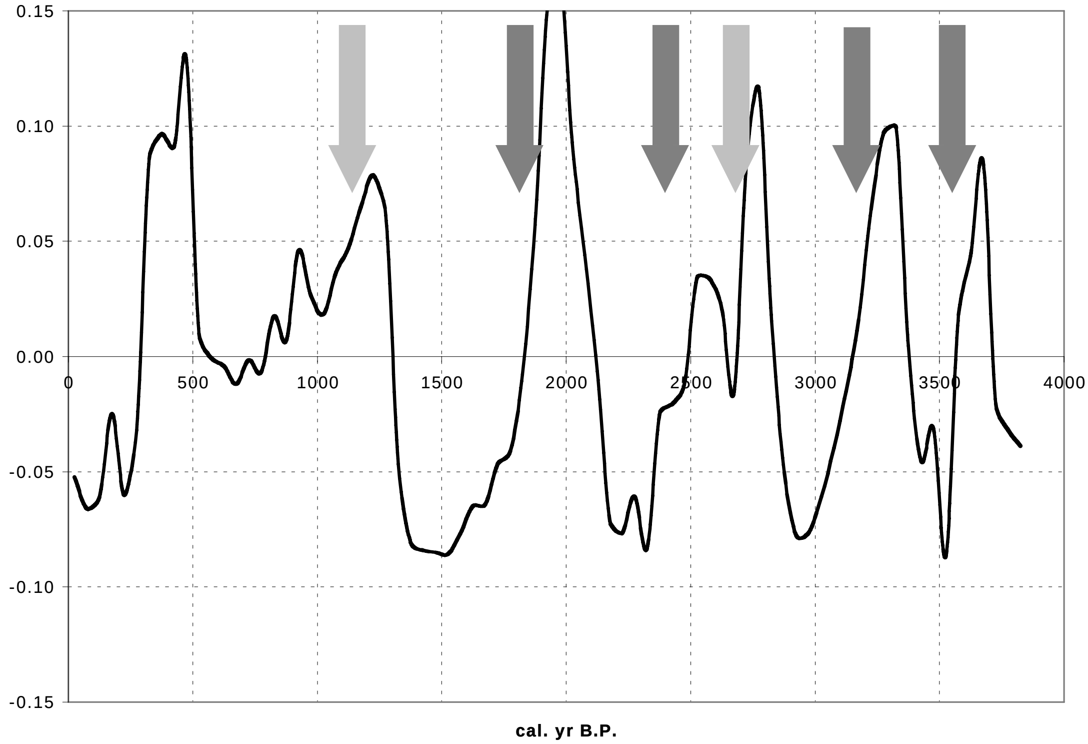

Figure 32. Deviation of composite probability density function from expected values in Northwest Kodiak. Arrows indicate inferred hiatuses in site activity.

<u>Temporal pattern of site occupation and abandonment in Northwest Kodiak</u>

The overall distribution of calibrated radiocarbon ages in Northwest Kodiak (Figs. 31, 32) suggests that there may have been least five episodes of site abandonment in the region in the last 4000 years. The slow decline in the pdf proxy from about 1300 years ago to about 600 years ago may be a product of a number of environmental or cultural factors, but the abrupt changes in the probability distribution about, or shortly after 1800, 2450, 2700, 3300, and 3600 cal. yr B.P. may reflect the influence of great earthquakes at these times.

Region 8: Katmai

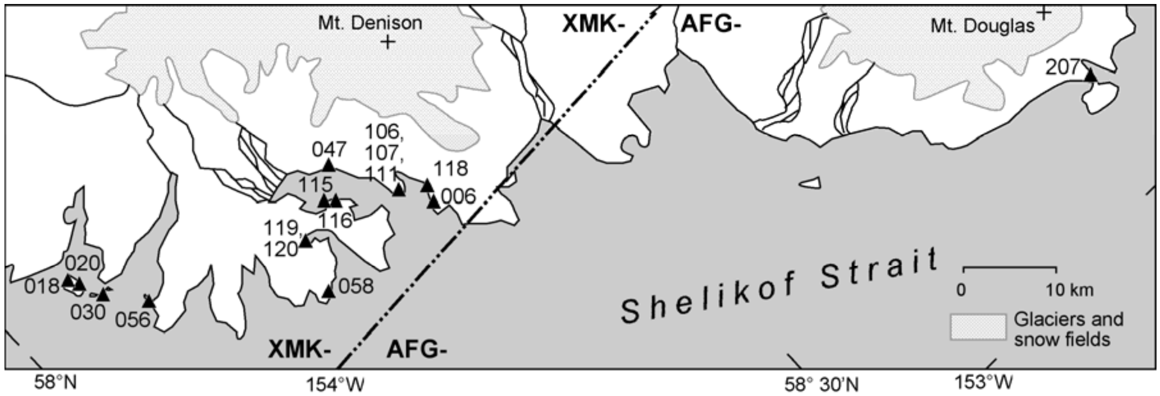

Figure 33. Radiocarbon-dated archaeological sites in Katmai.

Although several archaeological sites in the Afognak (AFG) quadrangle have been tested, only one (AFG-207) has been dated. All the other dated precontact low-elevation coastal sites in the Katmai region lie in the XMK quadrangle.

Sites

AFG-207: The Sukoi Terrace site sits at an elevation of 12-15 m above a lagoon formed by a tombolo-spit complex linking the Katmai mainland to Cape Douglas. The excavation by Crowell and Mann (in prep.) revealed several strata bearing cultural materials interdigitated with tephras and coarse sands. The site likely lies above the local tsunami run-up limit, so the sand layers are likely a result of aeolian deposition. Only two of the strata containing cultural material have been dated. These indicate that the site was occupied, perhaps continuously, for about two millenia from about 1800 years ago to 4000 years ago.

XMK-006: The aboriginal cultural deposits at the Kukak Village site occupy relict beach ridges behind the modern shoreline (G. Clark, 1977). This is the largest archaeological site on the Katmai coast (Crowell and Mann, in prep), and midden deposits are 1.5 m thick in places. The radiocarbon ages from the site indicate that occupation may have extended from about 550 years ago to about 1500 years ago (Fig. 34a).

XMK-018: The Takli site lies about 5m above the high tide line. The midden lies beneath a thick Novarupta ash deposit (G. Clark, 1977). Cultural detritus is admixed into the underlying soil. Radiocarbon ages from the site indicate that the site was initially occupied in the mid-Holocene and abandoned at, or shortly after, 2800 years ago.

XMK-020: The Hook Point site sits on a bluff about 5m above high tide. Site stratigraphy consists of two main cultural strata developed in fairly fine-textured soil beneath Novarupta ash. The basal material of the uppermost cultural stratum is gravelly, and this layer yielded a calibrated radiocarbon age of about 1350 - 1700 cal. yr. B.P. The underlying stratum is distinct, and a single sample from the upper part of this unit yielded an age of about 3450 – 4000 cal. yr B.P. (Fig. 34a).

XMK-030: This site on Mink Island has excavated very recently, and no details of stratigraphy are currently available to the authors of this report. The 21 radiocarbon ages from the site, however, indicate that the location was inhabited in the interval between 300 – 950 cal. yr B.P., for a short period about 1400 - 1500 cal. yr B.P., from 1800 - 2100 B.P., and prior to 3700 cal. yr B.P. (Fig. 34a)

XMK-047: A small site adjacent to a shingle beach. A single radiocarbon age dates the terminal occupation to some 600 to 700 years ago (Crowell and Mann, in prep).

XMK-056: The Russian Anchorage site is an extensive midden on a bench and mound with surface elevations range from 6 – 10m above mean high tide in the adjacent cove. Crowell (2001) identified several occupational phases. Two of the younger (<4000 cal. yr B.P.) occupations are dated by single radiocarbon samples. The most recent occupation postdates 550 – 700 years ago, and the upper boundary of another cultural layer dates to about 1700 - 1950 years ago.

XMK-058: Dekin et al (1993) reported a series of split radiocarbon ages from a 1m-thick midden at this site, which occupies a slope above a small cove near Cape Gull. One test pit revealed a layer of beach cobbles up to 0.2m thick between two occupation layers, the lower of which is also underlain by beach cobbles. The cultural material bracketing the upper beach cobble layer returned overlapping radiocarbon ages from the interval between 510 – 650 years ago. If this gravel layer is a tsunami deposit, it may correlate with the gravel deposits of about the same age at KAR-001 and KAR-031, on the opposite shore of Shelikof Strait. A split pair of ages from another test pit suggests that the initial occupation of the site occurred about 650 – 700 years ago.

XMK-075: No data available on site stratigraphy.

XMK-106: Much of the site lies at or above 10 m, but the test pit was located on the lower part of the site. The oldest cultural remains at the site are over 6000 years old, but one of the more recent house floors is dated by a single radiocarbon determination to about 1400-1500 years ago (Crowell and Mann, in prep).

XMK-107: A small midden above a cobble beach, the occupation is dated by a single radiocarbon age to about 600 years ago (Crowell and Mann, in prep).

XMK-111: An extensive midden on a relic beach about 1 m above the high water mark. An eroding section of midden shows about 0.5 m of pebbly midden beneath the Katmai tephra. The pebbly midden is underlain by complex stratigraphy, including other possible cultural deposits. A single radiocarbon age dates the occupation to about 3450 - 3650 years ago (Crowell and Mann, in prep).

XMK-113: Situated at the limit of tidal influence, about 1.7 km from the mouth of the Kinak River, the site occupies two levels: a lower bench just above the high water mark, and a terrace about 5-6 m higher. The peat covering the lower bench contained some cultural detritus, which returned an age of <350 years. A single radiocarbon age from the thin midden on the upper terrace suggests that this site was occupied at some time between 750 – 950 years ago (Crowell and Mann, in prep).

XMK-115: This site occupies a terrace 2 m above the high tide limit in Aguchik Island Cove. The stratigraphy at this site is akin to that at XMK-111. A single radiocarbon age places the occupation to approximately the same time period, about 3700 – 4000 years ago (Crowell and Mann, in prep).

XMK-116: The site is located on a tombolo on Aguchik Island. A thin (~0.2 m thick) midden underlies Novarupta ash. A single radiocarbon age places the occupation at about 3000 – 3300 years ago (Crowell and Mann, in prep).

XMK-119: An eroding face of the Kaflia River south midden, situated on a terrace about 4 m above the high tide limit revealed two cultural strata beneath the Novarupta ash. The contact between the two dates to about 3450 – 3700 years ago (Crowell and Mann, in prep). The age of the younger occupation has not yet been determined.

XMK-120: This midden occupies a bench about 9 m above mean high tide on Kaflia Bay. The stratigraphy is similar to that at XMK-119, directly across the bay. A sample from the upper part of the midden indicates that the younger occupation dates to the interval between about 350 – 550 cal. yr B.P. (Crowell and Mann, in prep).

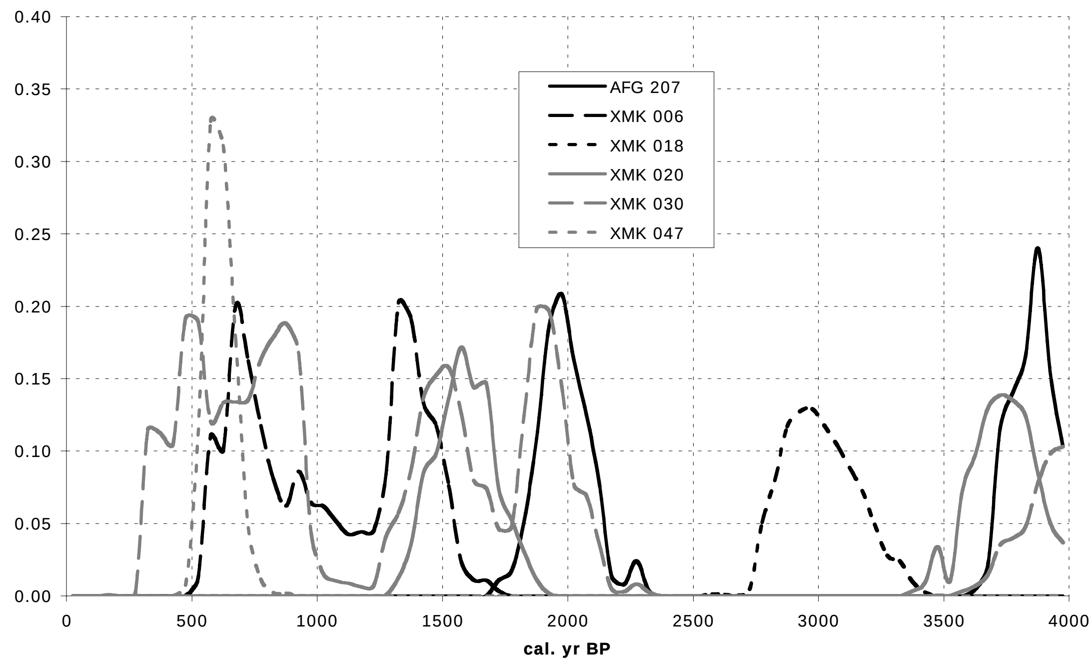

Figure 34a. Probability density functions of calibrated radiocarbon ages dating prehistoric villages and camps in Katmai.

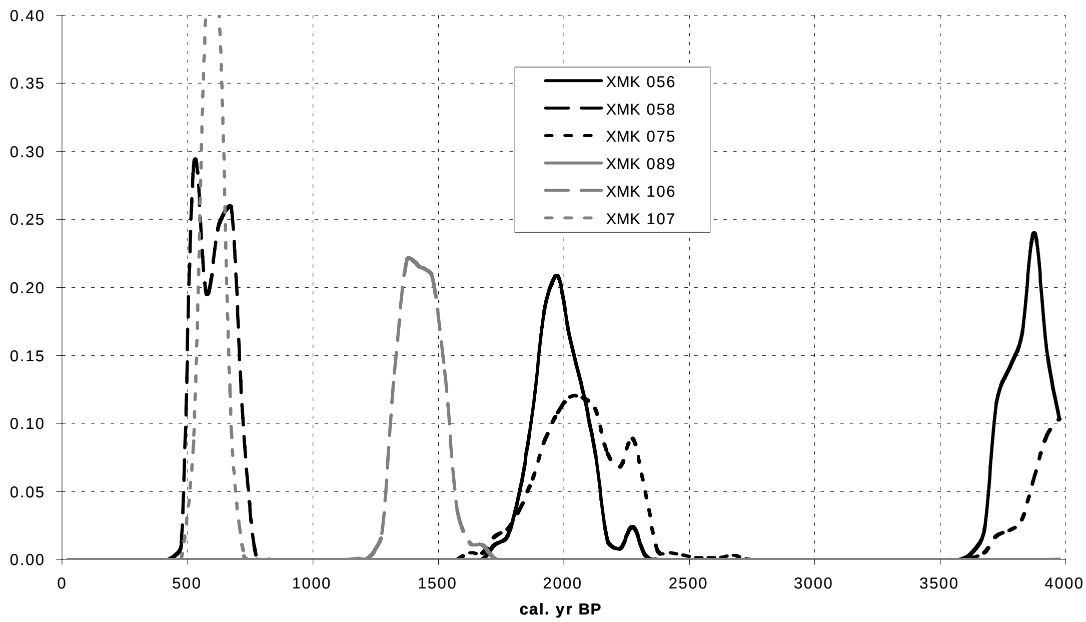

Figure 34b. Probability density functions of calibrated radiocarbon ages dating prehistoric villages and camps in Katmai.

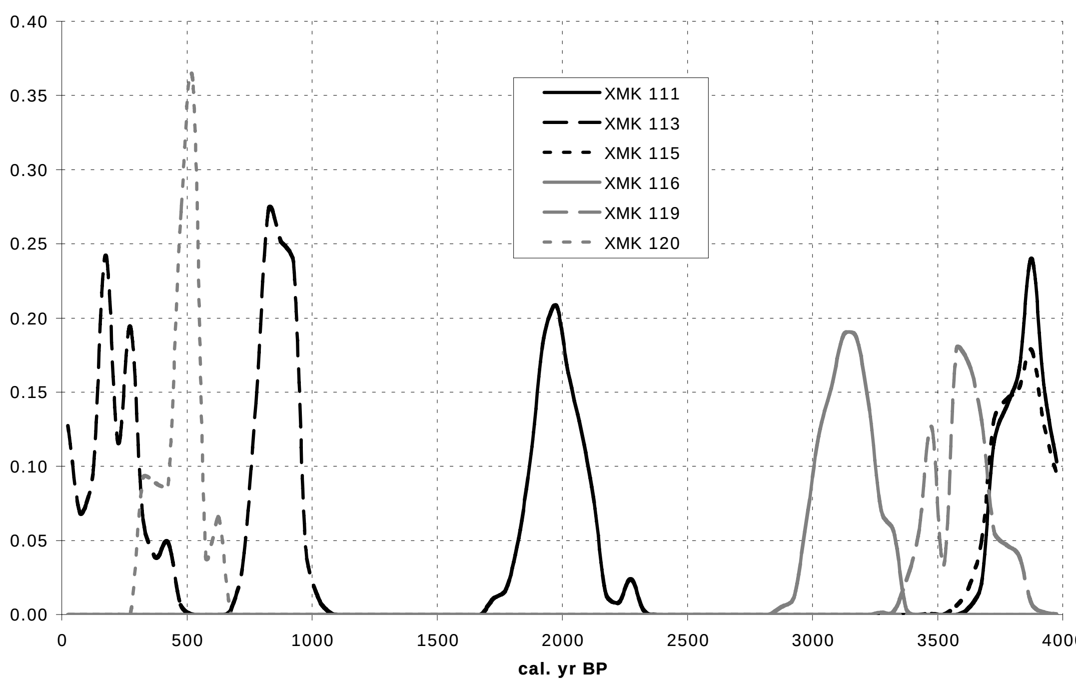

Figure 34c. Probability density functions of calibrated radiocarbon ages dating prehistoric villages and camps in Katmai.

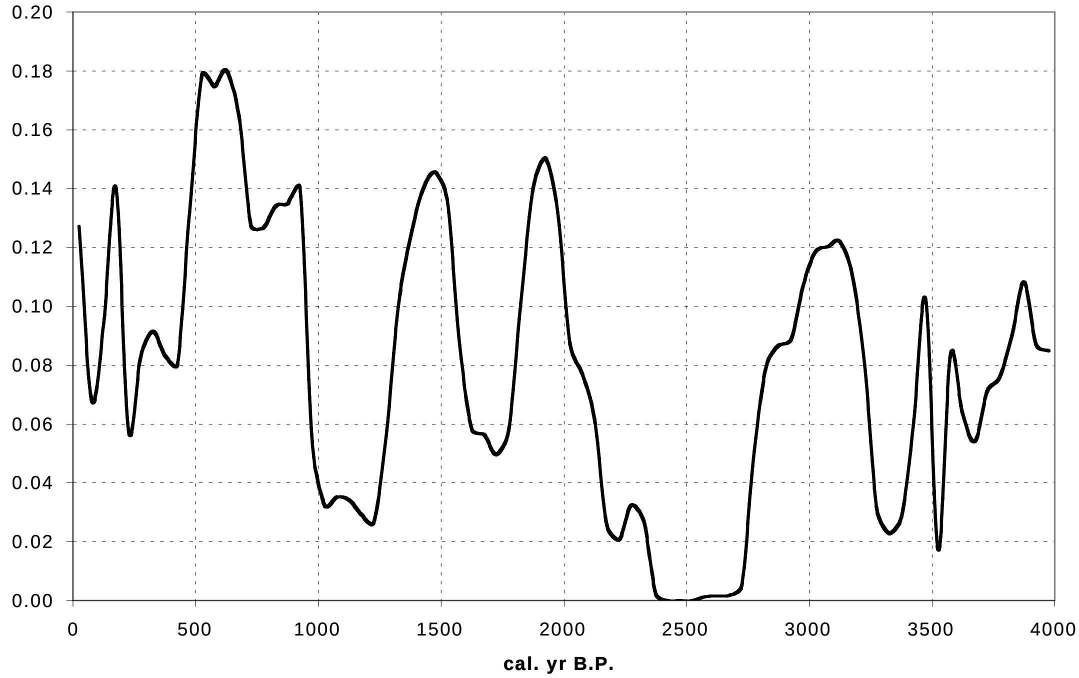

Figure 35. Composite probability density function of calibrated radiocarbon ages dating prehistoric villages and camps in Katmai.

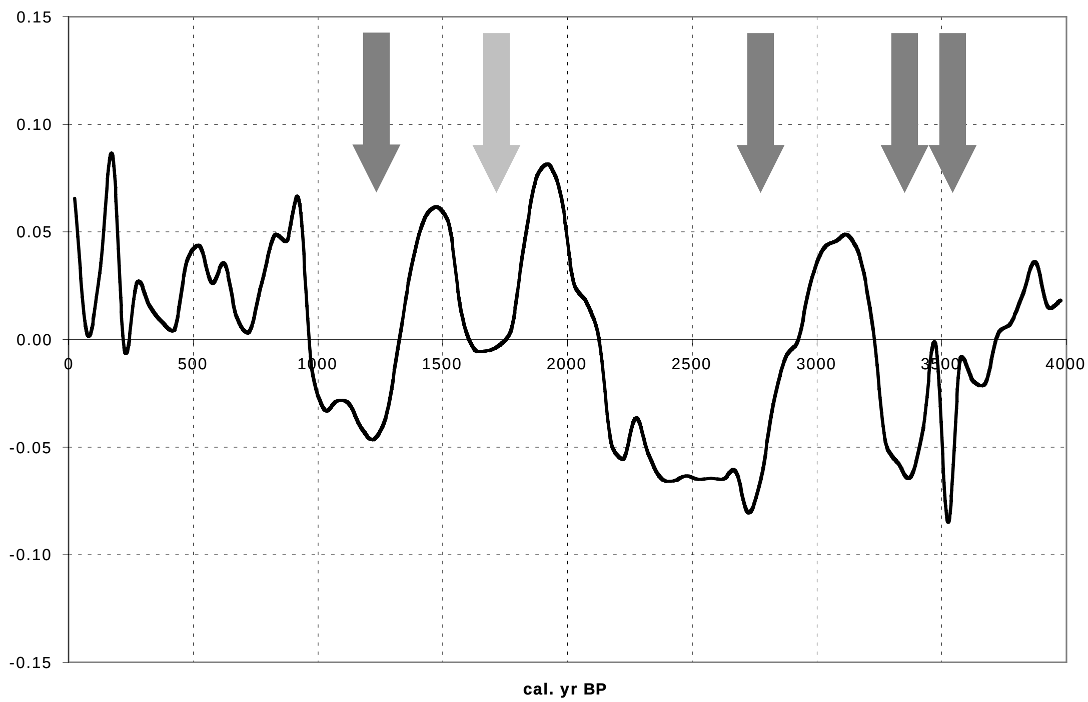

Figure 36. Deviations of pdf of observed calibrated radiocarbon ages from expected values in Katmai. Arrows indicate inferred hiatuses in site activity.

Temporal pattern of site occupation and abandonment in Katmai

The deviations of the observed calibrated radiocarbon ages in the Katmai region from expected values (Fig. 36), suggests that there may have been as many as five episodes of site abandonment in the region in the last 4000 years. Abrupt declines in this index about, or shortly after 1350, 1850(?), 2850, 3500, and 3600 cal. yr B.P. may all potentially reflect the region-wide influence of great earthquakes.

Discussion and Conclusions

Geological evidence of great earthquakes

Plafker and Rubin (1994) proposed a chronology of great earthquake incidence at the Alaskan subduction zone based on evidence of coseismic uplift from the Copper River delta, close to the eastern boundary of the 1964 rupture zone. They furnish a minimum age for each earthquake by dating organic materials deposited shortly after each episode of coseismic uplift. Our analysis of depositional sequences associated with coseismic deformation at other sites in the 1964 rupture zone suggests that the Copper River delta earthquake chronology is likely also applicable in Prince William Sound, adjacent parts of the Kenai Fjords region and upper Cook Inlet (Fig. 3). Radiocarbon determinations from organics deposited shortly before the earthquake in these areas (Combellick, 1991; 1993; 1994; Combellick and Reger, 1994) suggest that the 1964 great earthquake was preceded by similar events about 800, 1400, 2200-2300, 2700-2800, 3200-3300, and 3600-3700 years ago.

It is less certain, however, that this chronology is applicable in areas further to the west. This is due, in part, to the paucity and low caliber of the geological evidence in some of these areas. For example, the eastern shore of central and lower Cook Inlet subsided by about 0.5 m in 1964 (Plafker, 1969), and the geological imprint of previous coseismic land-level changes should therefore be visible in the tidal marshes of the deltas of the Kenai, Kasilof and Fox Rivers. But evidence of small land-level changes in high-energy deltas can be readily removed or overprinted by riverine floods and channel avulsions, and these tidal marshes exhibit complex depositional sequences as a result of interactions between these processes (Combellick, 1994; Combellick and Reger, 1994). The patchy geological evidence from these deltas means that the history of great earthquakes in this area is less well known than in areas further east. Although the great earthquakes at about 1400 cal. yr B.P. and 2700-2800 cal. yr B.P. seem to be recorded at the Kenai delta, neither the 800 cal. yr B.P. nor the 2200-2300 cal. yr B.P. events are firmly recorded here.

In the Kodiak archipelago geological evidence of coseismic subsidence at about 500 cal. yr B.P. appears to be fairly widespread (Fig. 3). An intervening event appears in the record on Kodiak Island, at about 1000 cal. yr B.P. In these western reaches of the Alaskan subduction zone, however, the geological record is limited to the last 1500-1600 years, and the incidence of prior great earthquakes cannot be determined.

Archaeological evidence of great earthquakes

A compilation of the archaeological evidence of partial or complete abandonment of prehistoric Native villages indicates a strong correlation with inferred paleoseismic events in areas east of Kachemak Bay (Fig. 37). If this is a causative relationship, then these hiatuses in site activity provide further constraints on the timing of great earthquakes at this end of the subduction zone. A comparison between the geological chronology, the archaeological chronology, and a random chronology tests the strength of this relationship (Table 1). We allocated the pre-1964 earthquakes (Fig. 3) to specific 200-year age intervals from 500 – 3900 years ago (1 = event; 0 = no event; 0.5 = overlapping intervals), and compared this series with the hiatuses in site occupation in each region (Fig. 37), and to random expectations. We generated the latter from series of random numbers between 0 and 1. "Earthquakes" are delimited by a critical threshold ≤0.412 (i.e., equivalent on average to 7 events in the 17 age intervals). This procedure was repeated for 100 runs of seven samples (equivalent to the number of archaeological regions, with the Kenai Peninsula omitted). The compatibility between the random series and the geological chronology ranges from 29.9 to 51.5% (95% confidence interval; Table 1).The episodes of site abandonment in Prince William Sound [minus SEW-056] the Kenai Fjords and Kachemak Bay display a strong concordance with the inferred earthquake record (Table 1). In the western parts of the Kodiak archipelago and the Katmai coast, however, the correlation is no better than random (Table 1), suggesting either that the earthquake chronology in this area differs from that at the eastern end of the 1964-rupture zone, or that other factors have a greater impact.

As noted earlier, an exodus or local population decline may be triggered by factors other than tectonics. Climate change, volcanism, disease, warfare, and ecological collapse have all had deleterious impacts on human populations and settlement patterns. In southern Alaska we have independent evidence of the functioning of only one of these alternative potential causes: climate change.

Patterns of late Holocene climate change in southern Alaska have been reconstructed from several proxies, such as pollen accumulation (Heusser et al., 1985), glacier margin fluctuations (Calkin et al., 2001), and lake geochemistry (Hu et al., 2001). These proxies for paleotemperature suggest that there have been three periods of climatic deterioration ("neoglacials") in the Gulf of Alaska region in the last 4000 years (Fig. 37c). It is likely that village sites near fjord heads were abandoned during each of these phases as glaciers advanced.

Unfortunately, the phases of glacial advance and retreat in southern Alaska often display local variations and are not tightly dated. The fluctuations in Late Holocene climate reconstructed by Heusser et al. (1985), Calkin et al. (2001) and Hu (2001) are in broad agreement, but may be out of phase by several centuries, so the potential effects of climatic variation on site habitability are difficult to determine. What is apparent, however, is that persistent neoglacial conditions can cause sites in sensitive locations such as fjord heads to be abandoned for lengthy periods. For example, the hiatus in site occupation in Prince William

Sound that began about 3500 years ago (Fig. 9) may have been prompted primarily by the great earthquake at that time, or by the combined effects of seismic activity and concurrent climatic deterioration, but the scarcity of sites during the next millennium (Fig. 9) is almost certainly a product of the harsh climatic conditions.

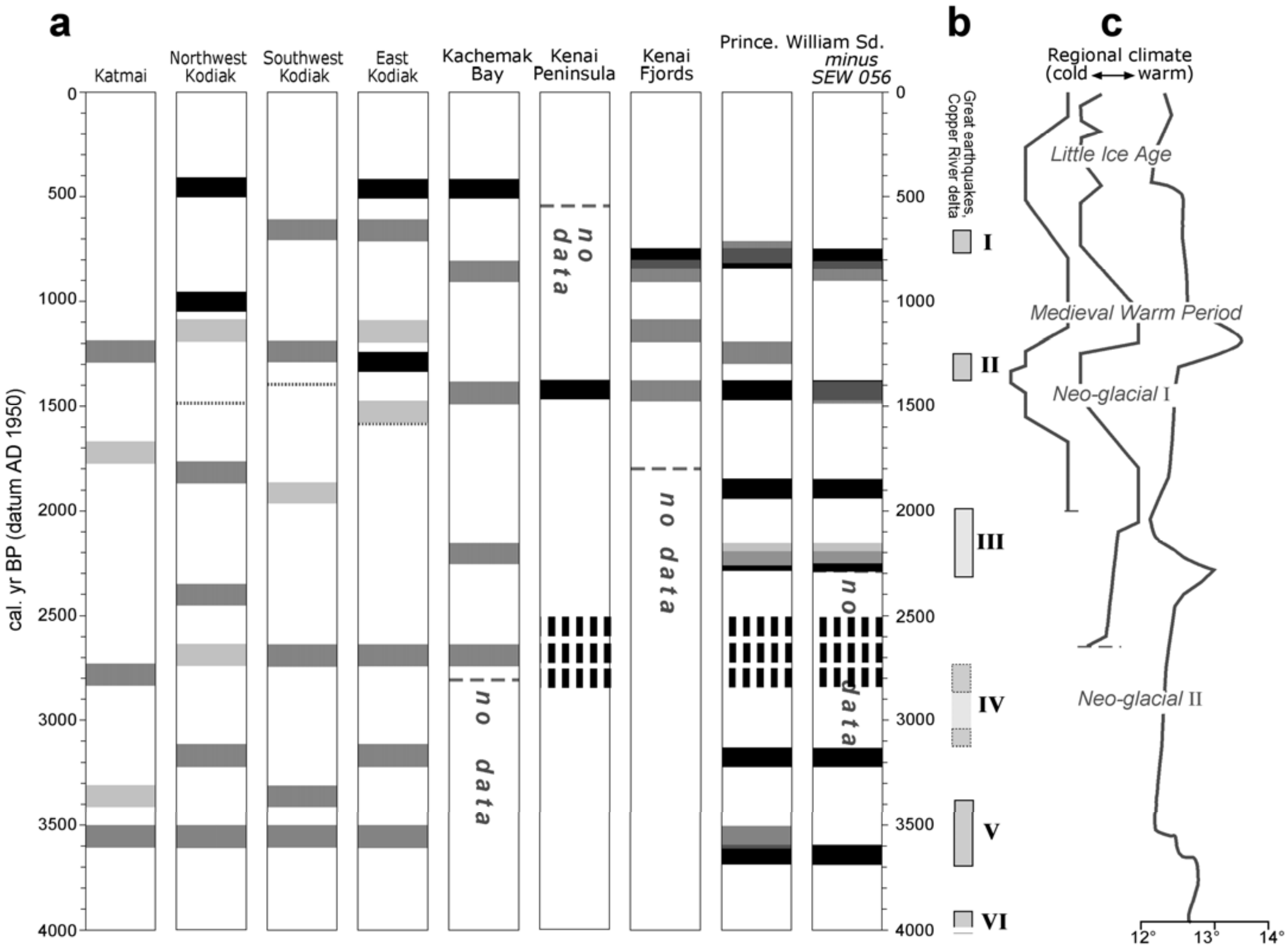

Figure 37 a) Ages of inferred great earthquake events in southern Alaska derived from geological and archaeological evidence of village abandonment from eight regions on a west-east transect along the Gulf of Alaska coast. Black boxes show best estimates of ages of paleoseismic events from geological evidence (from Fig. 3). Grey boxes mark the initial phases of inferred episodes of village abandonment (pale grey = weaker evidence). The thin dotted and hatched lines mark the maximum time-depths of geological and archaeological evidence ('no data') in each region; Minimal ages of inferred great earthquakes in the Copper River delta area, Alaska from post-seismic evidence (Plafker and Rubin, 1994); and, c) paleotemperature proxies from southern Alaska. From left to right: lake geochemistry, Alaska Range (Hu et al., 2001); glacial advances and retreats, Gulf of Alaska (Calkin et al., 2001); pollen assemblages (mean July temperature [°C]; Heusser et al., 1985).

Non-tectonic processes may operate independently of seismic events or in concert with them. While we cannot rule out non-tectonic processes as potential triggers of population decline, the striking similarity between the archaeological record of site abandonment at the eastern end of the subduction zone and the inferred seismic history of the area suggests that they may be subsidiary to tectonic causes in this area.

Given that such reductions in site activity should post-date the earthquake, hiatuses furnish minimum limiting ages for paleoseismic events. For the most part, the archaeological chronology at the eastern end of the subduction zone closely matches the paleoseismic evidence over the course of the last 2500 years, with the possible exception of the inferred great earthquake dated by geological evidence to about 1400 cal. yr B.P. Native villages and camps on the shores of Kachemak Bay, Kenai Fjords and Prince William Sound (excluding SEW-056) record an apparent dip in activity at a slightly earlier period.

Prior to 2500 years ago the archaeological record at the eastern end of the subduction zone is very fragmentary, but apparent downturns in site activity in Kachemak Bay about 2700 years ago, and at Uquicivit in Prince William Sound a, or shortly after 3600 years ago can both be correlated with inferred slip episodes on the Alaska megathrust.

Given that village abandonment and episodes of seismic activity are highly correlated at the eastern end of the Alaska subduction zone (Table 1), can the spatial limits of these ruptures be determined from the archaeological records of sites further west? It is apparent from Figure 37a that the record of 'gaps' in site occupation is somewhat less coherent in western regions than in eastern areas. In addition, with the exception of sites in the eastern Kodiak region the correlation between these gaps and inferred paleoseismic events at the eastern end of the subduction zone is relatively poor (Fig 37a; Table 1). This may be due to the fact that some of the western regions are less sensitive to the impacts of great earthquakes. If all previous great earthquakes mimicked the 1964 event, for example, the Katmai coast would lie inland of the crustal deformation zone (Fig. 1), and the coastline of southwestern Kodiak Island would sit astride the zero deformation isoline. Coastal villages in these areas might well be damaged by the tsunamis generated by great earthquakes, but they would be less subject to the effects of semi-permanent changes in local sea level than their counterparts elsewhere along the coast.

On the basis of the archaeological evidence we propose that at least three, and perhaps as many as five of the six great earthquakes that are inferred to have ruptured the Alaska convergent margin since 4000 cal. yr B.P. were equivalent in magnitude to the 1964 earthquake. We base this conclusion on the fact that at least three of the gaps in the village occupation record in the Kodiak archipelago closely match the temporal pattern of coseismic uplift at the Copper River delta (Fig. 37).

Table 1. Matches between times (200-yr intervals) of inferred great earthquakes and hiatuses in prehistoric village occupation in seven regions at the southern Alaska subduction zone, and 100 x 7 random trials.

Start interval ('000 yr)	***0.5***	***0.7***	***0.9***	***1.1***	***1.3***	***1.5***	***1.7***	***1.9***	***2.1***	***2.3***	***2.5***	***2.7***	***2.9***	***3.1***	***3.3***	***3.5***	***3.7***			
End interval ('000 yrs)	***0.7***	***0.9***	***1.1***	***1.3***	***1.5***	***1.7***	***1.9***	***2.1***	***2.3***	***2.5***	***2.7***	***2.9***	***3.1***	***3.3***	***3.5***	***3.7***	***3.9***	**Total # events**	**non-matches**	**% matches**
Geological evidence:	0	1	0	0	1	0	0.5	0.5	1	0	0.5	0.5	0	1	0	1	0	--	--	--
Archaeological evidence: Pr. Wiliam Sound (minus SEW056)	0	1	0	0	1	0	0	0	1									**7**	**1**	**85.7**
Kenai Fjords	0	1	0	1	1													**5**	**1**	**80.0**
Kachemak Bay	0	1	0	0	1	0	0	0	1	0	0.5	0.5						**9**	**1**	**88.9**
Eastern Kodiak	1	0	0	0	1	0	0	0	0	0	0.5	0.5	0	1	0.5	0.5	0	**12**	**5**	**58.3**
Southwestern Kodiak	1	0	0	0.5	0.5	0	0.5	0.5	0	0	0	1	0	0	1	1	0	**13**	**7**	**46.2**
Northwestern Kodiak	0	0	0	0	0	0	1	0	0	1	1	0	0	1	0	1	0	**12**	**6**	**50.0**
Katmai	0	0	0	0.5	0.5	0.5	0.5	0	0	0	0	1	0	0	1	1	0	**12**	**7**	**41.7**

Bernoulli Trials		
critical value	= 7/17	=0.41
	mean	**40..7**
	sigma	**14.6**
	mean+ 95% CI	**51.5**
	mean - 95% CI	**29.9**

A brief downturn in site activity at about 3500 - 3600 cal. yr B.P. is recorded in all these regions (Fig. 37), and may help delimit the timing of an earthquake in this interval that is not closely dated by geological evidence (Fig. 3). The episode of uplift at the Copper River delta represented by the older AMS age associated with event IV (about 3100 cal. yr. B.P.) in the Plafker and Rubin (1994) chronology, and by buried soils in Turnagain Arm (Fig. 3), is matched by gaps in the archaeological record in some areas of the Kodiak archipelago (Fig. 37), suggesting that this rupture may have propagated as far west as Kodiak.

A further region-wide downturn about 2700 years ago (slightly earlier in the Katmai record; Fig. 37) may well represent the after-effects of the first of the three subsidence episodes recorded at about this time at sites in Turnagain Arm and the Kenai River delta, and by the episode of uplift at the Copper River delta represented by the younger group of AMS ages associated with event IV in the Plafker and Rubin (1994) chronology (Fig. 3).

The inferred great earthquake at the eastern end of the subduction zone about 2200 - 2300 cal. yr B.P., however, seems to have had little impact on villages west of Kachemak Bay, and we tentatively conclude that the rupture did not extend as far west as the Kodiak archipelago.

A gap at about 1700 – 1900 cal. yr B.P in the archaeological record at the westernmost end of the subduction zone may represent the next great earthquake in the sequence (Fig. 37). Buried soils dating from about, or shortly after 1900 years ago are present at some sites in Turnagain Arm (Fig. 3), but no correlative uplift episode is known from the Copper River delta. In addition, no archaeological evidence of site abandonment is apparent in intervening areas such as eastern Kodiak and Kachemak Bay, so the status of this event is uncertain.

The next break in the village occupation sequence at the western end of the subduction zone occurs at about 1100 – 1300 cal. yr B.P. This occupational hiatus appears to postdate (by at least a century) a gap in occupation at sites east of Kachemak Bay (Fig. 37). The impact of this event in the Kodiak archipelago is reflected in archaeological site stratigraphy, particularly on the southern shore of Afognak Island, where at least two camps (AFG-010 and AFG-215) were overwhelmed by the resultant tsunami.

The penultimate great earthquake at the eastern end of the subduction zone, which occurred about 800 years ago, apparently led to abandonment of settlements as far west as Kachemak Bay. As in the previous case, archaeological sites in the Kodiak archipelago show evidence of a hiatus about a century later than sites to the east (Fig. 37). Again, there is a possibility that these gaps may be synchronous, but we tentatively conclude that they are independent.

Several sites in the Kodiak archipelago bear witness to two great earthquakes that bracket the 800 cal. yr. B.P. event. Saltonstall and Carver (2002) suggest that subsidence associated with the older of these, at about 1000 cal. yr. B.P., produced the tsunami and beach deposits that underlie the Settlement Point site (AFG-015) on Afognak Island. It may also have been responsible for the suspected tsunami deposit at New Karluk (KAR-001) on the northwest coast of Kodiak Island (Knecht, 1995), and forced the inhabitants of settlements at Three Saints Harbor (KOD-083) and Crag Point (KOD-044) to abandon those sites.

The later event, at about 500 cal. yr B.P., lies too close to the prehistoric-protohistoric threshold to be resolved by our analysis, although stratigraphic evidence indicates that several sites on the shores of Shelikof Strait were abandoned (e.g. KAR-029) or inundated by tsunamis (e.g. KAR-001, KAR-031, XMK-058) at about this time.

It is apparent from this discussion that, although there are local discrepancies in the apparent incidence of great earthquakes at the eastern end of the Alaska subduction zone, the chronology derived from episodes of abrupt uplift at the Copper River delta is generally applicable as far west as Kachemak Bay. This suggests that this segment of the Alaska megathrust generally behaves as a coherent unit. Geological evidence and ancillary archaeological data indicate that the Kodiak-Katmai segment is characterized by semi-independent behavior, and at least one, and perhaps as many as three of the last six prehistoric great earthquakes at this plate boundary did not propagate this far west. In addition, this area may generate large or great earthquakes independently of areas further east. If these inferences are correct, then the Alaska subduction zone displays more complex behavior than is commonly recognized, and further research is required to establish the precise limits of these ruptures, and their relationship to structural discontinuities in the subducting slab.

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Appendix A: Radiocarbon ages constraining inferred great earthquakes at the Alaska subduction zone

Site # (Fig. 2)	Location	Original site code (if known)	Land level change in 1964?	Site sequence #	Relation to quake (pre/post/ unknown)	Lab No. [or sample#]	14C age	1 - sigma error	Material dated	Reference	Accept / Reject [Reason for rejection]
1	Cape Suckling		Up		post?	W-376	390	160	rooted stump	Plafker, 1969	Reject [low precison]
1	Cape Suckling		Up		post?	W-1792	710	200	rooted stump	Plafker, 1969	Reject [low precison]
1	Katalla		Up		post?	-	440	90	rooted stump	Sirkin and Tuthill, 1972, in Richards, 2000	Reject [stratigraphic position unknown]
1	Katalla		Up		post?	-	1100	100	wood	Sirkin and Tuthill, 1972, in Richards, 2000	Reject [stratigraphic position unknown]
1	Katalla		Up		post?	-	1230	90	peat	Sirkin and Tuthill, 1972, in Richards, 2000	Reject [stratigraphic position unknown]
1	Katalla		Up		post?	I-7	3770	200	peat	Plafker, 1969	Reject [low precison]
2	Copper R. delta-Cudahy Slough		Up	II	post	LJ-938	700	30	rooted stump	Reimnitz, 1966	Accept

2	Copper R. delta-Pete Dahl Cutoff	Up	II	post	LJ-GAP 0032	700	50	rooted stump	Reimnitz, 1966 in Plafker, 1969	Accept
2	Copper R. delta-Alaganic Slough	Up	II	post	LJ-939	725	30	rooted stump	Reimnitz, 1966	Accept
2	Copper R. delta-Alaganic Slough	Up	II	post	W-6102	830	60	peat	Plafker et al., 1992; pers. comm. 2000	Accept
2	Copper R. delta-Alaganic Slough	Up	II	pre	W-6098	960	60	Carex	Plafker et al., 1992; pers. comm. 2000	Accept
2	Copper R. delta-Alaganic Slough	Up	III	post	W-6088	1500	80	peat	Plafker et al., 1992	Accept
2	Copper R. delta-Alaganic Slough	Up	III	pre	W-6085	1610	110	Carex	Plafker et al., 1992	Accept
2	Copper R. delta-Pete Dahl Cutoff	Up	III	post	LJ-GAP 0034	1700	100	rooted stump	Reimnitz, 1966	Reject [sig diff. from other ages at this contact]
3	Little Glacier	Up	?	post	LJ-GAP 0033	860	50	rooted stump	Reimnitz, 1972	Accept
3	Eyak River	Up	?	post	LJ-943	1360	50	rooted stump	Reimnitz, 1966	Accept
4	Middleton Is.	Up	II	post	W-1724	1350	200	wood	Rubin and Alexander, 1958 in Plafker, 1969	Reject [low precision]

4	Middleton Is.		Up	III	post	W-1401	2390	200	wood	Rubin and Alexander, 1958 in Plafker, 1969	Reject [low precision]
4	Middleton Is.		Up	VII?	post	W-1405	4470	250	wood	Rubin and Alexander, 1958 in Plafker, 1969	Reject [low precision]
5	PWS - Montague Is - MacLeod Harbor		Up		post?	W-1764	380	200	rooted stump	Plafker, 1969	Reject [low precision]
5	PWS - Montague Is - MacLeod Harbor		Up		post?	W-1590	560	200	rooted stump	Plafker, 1969	Reject [low precision]
6	PWS - Montague Is - Patton Bay		Up		post?	W-1766	600	200	wood	M.J. Kirkby, p.c. in Plafker, 1969	Reject [low precision]
6	PWS - Montague Is - Patton Bay		Up		post?	W-1770	2070	200	peat	M.J. Kirkby, p.c. in Plafker, 1969	Reject [low precision]
7	PWS - LaTouche Island		Up		post?	W-1591	230	200	rooted stump	Plafker, 1969	Reject [low precision]
8	Kenai Peninsula- Puget Bay	30	Up		unknown	Beta- 79474	130	50	rooted stump (wood)	Chaney, in Yarborough, 1997	Reject [bayhead bars of hybrid tectonic- fluvial origin?]

8	Kenai Peninsula-Puget Bay	27	Up		unknown	Beta-79471	290	40	rooted stump (wood)	Chaney, in Yarborough, 1997	Reject [bayhead bars of hybrid tectonic-fluvial origin?]
8	Kenai Peninsula-Puget Bay	29	Up		post?	Beta-79473	480	60	driftwood	Chaney, in Yarborough, 1997	Reject [bayhead bars of hybrid tectonic-fluvial origin?]
8	Kenai Peninsula-Puget Bay	26	Up	?	post?	Beta-79470	670	40	rooted stump (wood)	Chaney, in Yarborough, 1997	Accept
8	Kenai Peninsula-Puget Bay	28	Up		post?	Beta-79472	790	60	rooted stump (wood)	Chaney, in Yarborough, 1997	Reject [bayhead bars of hybrid tectonic-fluvial origin?]
9	Pr. William Sd-Knight Island	(near SEW-488-18)	Up	?	post?	Beta-79463	2120	40	peat	Chaney, in Yarborough, 1997	Reject [stratigraphy unknown]
9	Pr. William Sd-Knight Island	(near SEW-488-5)	Up	?	post?	Beta-79453	2510	60	rooted stump (bark)	Chaney, in Yarborough, 1997	Reject [stratigraphy unknown]
9	Pr. William Sd-Knight Island	(near SEW-488-6)	Up	?	post?	Beta-79454	2770	60	peat (under sample5)	Chaney, in Yarborough, 1997	Reject [stratigraphy unknown]

9	Pr. William Sd-Knight Island	(near SEW-488-7)	Up	?	post?	Beta-79456	2820	80	rooted stump (wood)	Chaney, in Yarborough, 1997	Reject [stratigraphy unknown]
9	Pr. William Sd-Bay of Isles	25	Up	?	post?	Beta-79469	2940	50	rooted stump (wood)	Chaney, in Yarborough, 1997	Reject [rooted well above base of forest soil]
9	Pr. William Sd-Bay of Isles	(near SEW-488-23)	Up	?	post?	Beta-79467	4230	70	peat (above tsunami sand)	Chaney, in Yarborough, 1997	Accept [tsunami record]
9	Pr. William Sd-Bay of Isles	(near SEW-488-22)	Up	?	post?	Beta-79468	4530	70	peat (below tsunami sand)	Chaney, in Yarborough, 1997	Accept [tsunami record]
10	Pr. William Sd-Junction Island	16	Up	?	post?	Beta-79462	730	50	rooted stump (wood)	Chaney, in Yarborough, 1997	Accept
10	Pr. William Sd- Nowell Point		Up	?	post?	W-1588	930	200	wood in peat on beach	Plafker, 1969	Reject [low precision]
10	Pr. William Sd-Junction Island	15	Up	?	post?	Beta-79461	2160	40	rooted stump (wood)	Chaney, in Yarborough, 1997	Accept
11	Pr. William Sd- Perry Is.		Up	?	post?	W-1589	3680	300	rooted stump	Plafker, 1969	Reject [low precision]
12	PWS - Columbia Bay		Up		post?	W-1592	1140	250	rooted stump	Plafker, 1969	Reject [low precision]
13	Seward		Down		post?	W-1720	~200		rooted stump	Plafker, 1969	Reject [precision unknown]

14	Kenai Peninsula-Aialik Bay		Down	II	pre	Beta-74353	780	60	rooted stump	Mann and Crowell, 1996	Accept
14	Kenai Peninsula-Aialik Bay		Down	II	pre	Beta-65022	810	50	rooted stump	Mann and Crowell, 1996	Accept
14	Kenai Peninsula-Aialik Bay		Down	II	pre	Beta-67121	890	70	rooted stump	Mann and Crowell, 1996	Accept
14	Kenai Peninsula-Aialik Bay		Down	II	pre	Beta-67122	900	50	rooted stump	Mann and Crowell, 1996	Accept
14	Kenai Peninsula-Aialik Bay		Down	II	pre	Beta-67123	920	50	rooted stump	Mann and Crowell, 1996	Accept
14	Kenai Peninsula-Aialik Bay		Down	II	pre	Beta-65024	940	80	rooted stump	Mann and Crowell, 1996	Accept
15	Turnagain Arm-Portage	TA8-12.7	Down	II	pre	GX-15218	885	120	peat	Combellick, 1991	Accept
15	Turnagain Arm-Portage	TA8	Down	III?	pre	GX-15404	1495	165	peat	Combellick, 1991	Reject [low precision]
15	Turnagain Arm-Portage	TA8	Down	IV?	pre	GX-15219	1695	80	peat	Combellick, 1991	Accept
15	Turnagain Arm-Portage	TA8	Down	V?	pre	GX-15405	2630	80	peat	Combellick, 1991	Accept
15	Turnagain Arm-Portage	TA8	Down	V?	pre	GX-15220	2675	80	peat	Combellick, 1991	Accept

15	Turnagain Arm-Portage	TA8	Down	V?	pre	GX-15221	2705	85	peat	Combellick, 1991	Accept
15	Turnagain Arm-Portage	TA8	Down	VI?	pre	GX-15222	3015	140	peat	Combellick, 1991	Accept
15	Turnagain Arm-Portage	TA8	Down	VII?	pre	GX-15223	4150	130	peat	Combellick, 1991	Accept
16	Turnagain Arm-Girdwood	92-31-2.1	Down		pre	Beta-50338	600	70	peat	Combellick & Reger, 1994	Reject [disturbed profile]
16	Turnagain Arm-Girdwood	A-1	Down		pre	W-175	700	250	rooted stump	Karlstrom, 1964	Reject [low precision]
16	Turnagain Arm-Girdwood	92-19-4	Down	II	pre	Beta-54604	730	50	peat	Combellick & Reger, 1994	Accept
16	Turnagain Arm-Girdwood	BWS-4-4	Down	II	pre	[4]	730	100	peat	Bartsch-Winkler & Schmoll, 1992	Accept
16	Turnagain Arm-Girdwood	91-1	Down	II	pre	Beta-45196	760	70	peat	Combellick & Reger, 1994	Accept
16	Turnagain Arm-Girdwood	TA1-12.8	Down	II	pre	GX-15210	815	115	peat	Combellick, 1991	Accept
16	Turnagain Arm-Girdwood	91-32-1	Down	II	pre	Beta-59792	830	60	rooted wood	Combellick & Reger, 1994	Accept
16	Turnagain Arm-Girdwood	91-2-1	Down	II	pre	Beta-45197	860	60	rooted wood	Combellick & Reger, 1994	Accept

16	Turnagain Arm-Girdwood	GW-2-G	Down	II	pre	Beta-184321	890	40	peat	Hamilton & Shennan, 2005b	Accept
16	Turnagain Arm-Girdwood	91-4-1	Down	II	pre	Beta-45199	940	60	rooted wood	Combellick & Reger, 1994	Accept
16	Turnagain Arm-Girdwood	GW-1-G	Down	II	pre	CAMS-93958	955	40	peat	Hamilton & Shennan, 2005b	Accept
16	Turnagain Arm-Girdwood	91-20-5.6	Down	II	pre	Beta-47178	1010	60	peat	Combellick & Reger, 1994	Accept
16	Turnagain Arm-Girdwood	92-31-2.5	Down		pre	Beta-50339	1040	60	peat	Combellick & Reger, 1994	Reject [disturbed profile]
16	Turnagain Arm-Girdwood	92-19-1	Down	III	pre	Beta-54601	1380	60	peat	Combellick & Reger, 1994	Accept
16	Turnagain Arm-Girdwood	GW-2-F	Down	III	pre	Beta-184326	1540	40	peat	Hamilton & Shennan, 2005b	Accept
16	Turnagain Arm-Girdwood	BWS-4-5	Down	III?	pre	[5]	1565	45	wood	Bartsch-Winkler & Schmoll, 1992	Accept
16	Turnagain Arm-Girdwood	TA1	Down		pre	GX-15211	1875	125	peat	Combellick, 1991	Reject [age reversal]
16	Turnagain Arm-Girdwood	BWS-5-10	Down		pre	[10]	1910	100	wood	Bartsch-Winkler & Schmoll, 1992	Accept
16	Turnagain Arm-Girdwood	92-19-2	Down	IV	pre	Beta-54602	2000	60	rooted wood	Combellick & Reger, 1994	Accept

16	Turnagain Arm-Girdwood	TA1	Down	IV	pre	GX-15212	2100	75	peat	Combellick, 1991	Accept
16	Turnagain Arm-Girdwood	91-3	Down	IV	pre	Beta-45198	2110	60	peat	Combellick & Reger, 1994	Accept
16	Turnagain Arm-Girdwood	GW-2-E	Down	IV	pre	Beta-184324	2120	50	peat	Hamilton & Shennan, 2005b	Accept
16	Turnagain Arm-Girdwood	BWS-5-17	Down	IV	pre	[17]	2140	35	peat	Bartsch-Winkler & Schmoll, 1992	Reject [age reversal]
16	Turnagain Arm-Girdwood	BWS-5-12	Down	IV	pre	[12]	2290	60	peat	Bartsch-Winkler & Schmoll, 1992	Accept
16	Turnagain Arm-Girdwood	BWS-5-14	Down	V	pre	[14]	2510	35	peat	Bartsch-Winkler & Schmoll, 1992	Reject [age reversal]
16	Turnagain Arm-Girdwood	BWS-5-19	Down	V?	pre	[19]	2510	35	peat	Bartsch-Winkler & Schmoll, 1992	Reject [age reversal]
16	Turnagain Arm-Girdwood	GW-2-C	Down	VI	pre	Beta-184330	2530	40	peat	Hamilton & Shennan, 2005b	Accept
16	Turnagain Arm-Girdwood	GW-2-D	Down	V	pre	Beta-184327	2560	40	peat	Hamilton & Shennan, 2005b	Accept
16	Turnagain Arm-Girdwood	92-19-3	Down	VI	pre	Beta-54603	2600	60	peat	Combellick & Reger, 1994	Accept? [gradational upper contact]
16	Turnagain Arm-Girdwood	BWS-4-8	Down	VII?	pre	[8]	2660	90	wood	Bartsch-Winkler & Schmoll, 1992	Accept

16	Turnagain Arm-Girdwood	GW-2-B	Down	VII?	pre	Beta-184328	2710	40	peat	Hamilton & Shennan, 2005b	Accept
16	Turnagain Arm-Girdwood	TA1	Down	VII?	pre	GX-15213	2755	80	peat	Combellick, 1991	Accept
16	Turnagain Arm-Girdwood	A-1	Down	VII?	pre	W-299	2800	180	rooted stump	Karlstrom, 1964	Reject [low precision]
16	Turnagain Arm-Girdwood	GW-2-A	Down	VIII?	pre	Beta-184329	3040	40	peat	Hamilton & Shennan, 2005b	Accept
16	Turnagain Arm-Girdwood	TA1	Down	IX?	pre	GX-15214	3455	145	peat	Combellick, 1991	Accept
17	Turnagain Arm- Hope	BWS-12-28	Down	?	pre	[28]	2580	80	peat	Bartsch-Winkler & Schmoll, 1992	Accept
18	Turnagain Arm-Ocean View	BWS-15-38	Down		pre	[38]	165	45	wood	Bartsch-Winkler & Schmoll, 1992	Reject [1964 event?]
18	Turnagain Arm-Ocean View	BWS-15-39	Down		pre	[39]	200	40	peat	Bartsch-Winkler & Schmoll, 1992	Reject [1964 event?]
18	Turnagain Arm-Campbell Creek	BWS-16-46	Down		pre	[46]	635	40	wood	Bartsch-Winkler & Schmoll, 1992	Reject [age reversal]
18	Turnagain Arm-Ocean View	BWS-15-41	Down		pre	[41]	680	70	wood	Bartsch-Winkler & Schmoll, 1992	Reject [overlain by thin silt layer]
18	Turnagain Arm-Ocean View	BWS-15-42	Down		pre	[42]	890	60	peat	Bartsch-Winkler & Schmoll, 1992	Accept

18	Turnagain Arm-Ocean View	OV-6-D	Down	II	pre	Beta-184317	940	50	macrofossils	Hamilton et al. 2005	Accept
18	Turnagain Arm-Ocean View	OV-6-D	Down	II	pre	Beta-184315	1070	40	macrofossils	Hamilton et al. 2005	Accept
18	Turnagain Arm-Ocean View	OV-6-D	Down	II	pre	AA-48163	1398	48	peat	Hamilton et al. 2005	Reject [sig. diff. from other ages at this contact]
18	Turnagain Arm-Ocean View	OV-23-C	Down	III	pre	Beta-184311	1500	40	macrofossils	Hamilton et al. 2005	Accept
18	Turnagain Arm-Ocean View	OV-2-C	Down	III	pre	Beta-184318	1530	40	macrofossils	Hamilton et al. 2005	Accept
18	Turnagain Arm-Ocean View	OV-23-B	Down	IV	pre	Beta-184312	2010	50	macrofossils	Hamilton et al. 2005	Accept
18	Turnagain Arm-Ocean View	OV-23-A	Down	V	pre	Beta-184322	2320	40	macrofossils	Hamilton et al. 2005	Accept
19	Turnagain Arm-Chickaloon Bay	92-17-3	Down	I	pre	Beta-54599	modern		Triglochin leaf bases	Combellick & Reger, 1994	Reject [1964 event]
19	Turnagain Arm-Chickaloon Bay	92-14R-2	Down	I	pre	Beta-54793	modern		rooted wood (bark)	Combellick & Reger, 1994	Reject [1964 event]
19	Turnagain Arm-Chickaloon Bay	92-17-1	Down	I	pre	Beta-54598	20	50	rooted wood (bark)	Combellick & Reger, 1994	Reject [1964 event]

19	Turnagain Arm-Chickaloon Bay	92-14R-2	Down	I	pre	Beta-54592	260	50	peat	Combellick & Reger, 1995	Reject [1964 event?]
19	Turnagain Arm-Chickaloon Bay	92-16-1	Down	I	pre	Beta-54596	300	70	rooted wood (bark)	Combellick & Reger, 1994	Reject [1964 event?]
19	Turnagain Arm-Chickaloon Bay	92-16-3	Down	II	pre	Beta-54597	910	60	peat	Combellick & Reger, 1994	Accept
19	Turnagain Arm-Chickaloon Bay	92-14R-4	Down	II	pre	Beta-54593	930	60	woody peat	Combellick & Reger, 1994	Accept
19	Turnagain Arm-Chickaloon Bay	BWS-13-31	Down	II	pre	[31]	940	60	peat	Bartsch-Winkler & Schmoll, 1992	Accept (conforms with 92-16-3)
19	Turnagain Arm-Chickaloon Bay	92-17-4	Down	II	pre	Beta-54600	1010	70	peat	Combellick & Reger, 1994	Accept
19	Turnagain Arm-Chickaloon Bay	BWS-13-29	Down		pre	[29]	1420	80	peat	Bartsch-Winkler & Schmoll, 1992	Reject [detrital?]
19	Turnagain Arm-Chickaloon Bay	92-14R-7	Down		pre	Beta-54595	1940	70	peat	Combellick & Reger, 1994	Reject [contact?]

19	Turnagain Arm-Chickaloon Bay	92-14R-6	Down	III	pre	Beta-54594	1960	50	peat	Combellick & Reger, 1994	Accept
20	Knik Arm - Palmer Hay Flats	KA1B	Down	II	pre	GX-15225	470	70	wood-sedge-moss peat	Combellick, 1991	Accept
20	Knik Arm - Palmer Hay Flats	KA7	Down	II	pre	GX-15465	495	120	wood-sedge peat	Combellick, 1991	Accept
20	Knik Arm - Palmer Hay Flats	KA7	Down	II	pre	GX-15466	520	70	wood fragments	Combellick, 1991	Accept
20	Knik Arm - Palmer Hay Flats	KA6	Down	II	pre	GX-15237	560	70	sedge peat	Combellick, 1991	Accept
20	Knik Arm - Palmer Hay Flats	KA6	Down	III	pre	GX-15238	930	115	sedge peat	Combellick, 1991	Accept
20	Knik Arm - Palmer Hay Flats	KA1	Down	III	pre	GX-15226	955	75	sedge peat	Combellick, 1991	Accept
20	Copper R. delta-Alaganic Slough		Up	II	pre	W-6098	960	60	Carex	Plafker et al., 1992; p.c., 2000	Accept
20	Knik Arm - Palmer Hay Flats	KA6	Down	IV	pre	GX-15240	1800	125	woody peat	Combellick, 1991	Reject [age reverssal]
20	Knik Arm - Palmer Hay Flats	KA1	Down	IV	pre	GX-15227	2080	130	sedge peat	Combellick, 1991	Accept
21	Knik Arm - Goose Bay	92-20-2	Down		pre	Beta-54605	180	50	rooted wood	Combellick & Reger, 1994	Reject [1964

											event?]
21	Knik Arm - Goose Bay	92-20-3	Down	II	pre	Beta-54606	480	60	peat	Combellick & Reger, 1994	Accept
21	Knik Arm - Goose Bay	KA4B	Down	II	pre	GX-15233	510	70	sedge peat	Combellick, 1991	Accept
21	Knik Arm - Goose Bay	KA4	Down	II	pre	GX-15231	515	75	wood-sedge peat	Combellick, 1991	Accept
21	Knik Arm - Goose Bay	92-20-4	Down	III	pre	Beta-54607	990	60	peat	Combellick & Reger, 1994	Accept
21	Knik Arm - Goose Bay	92-20R-1	Down	IV	pre	Beta-65790	1690	80	peat	Combellick & Reger, 1994	Reject [three thin peats]
22	Kenai R. flats	91-16-0.7	Down		pre	Beta-45208	180	60	rooted wood	Combellick & Reger, 1994	Reject [1964 event?]
22	Kenai R. flats	90-2-3.7	Down		pre	GX-16471	1265	130	peat	Combellick & Reger, 1994	Reject [sig. diff. from other age at this contact]
22	Kenai R. flats	91-16-2.0	Down	II?	pre	Beta-45209	1350	60	peat	Combellick & Reger, 1994	Reject [sig. diff. from other age at this contact]
22	Kenai R. flats	KE1-4.9	Down	II	pre	Beta-49102	1590	80	peat	Combellick & Reger, 1994	Accept?
22	Kenai R. flats	core 5: 131 cm	Down	II	pre	Beta-184332	1670	40	herbaceous stem	Hamilton & Shennan, 2005a	Accept
22	Kenai R. flats	core 7: 165.5 cm	Down	II	pre	CAMS-93964	1670	45	herbaceous stem	Hamilton & Shennan, 2005a	Accept
22	Kenai R. flats	91-16-2.3	Down		pre	Beta-50335	1840	60	rooted wood	Combellick & Reger, 1994	Reject [no evidence of subsidence into intertidal zone]

22	Kenai R. flats	KE2-14.2	Down	III?	pre	Beta-49105	2530	80	silty peat	Combellick & Reger, 1994	Accept? [gradational contact]
22	Kenai R. flats	91-18-3.7 (=90-2)	Down	IV?	pre	Beta-50337	2640	50	rooted wood	Combellick & Reger, 1994	Accept
22	Kenai R. flats	KE2-15.9	Down	IV?	pre	Beta-49106	2780	90	peat	Combellick & Reger, 1994	Accept
22	Kenai R. flats	KE2-16.4	Down	V?	pre	Beta-49107	2760	110	peat	Combellick & Reger, 1994	Accept
22	Kenai R. flats	90-1-3.5	Down	V?	pre	GX-16470	2815	230	peat	Combellick & Reger, 1994	Reject [low precision]
22	Kenai R. flats	91-30R-1	Down		pre	Beta-54591	3120	130	herbaceou s roots	Combellick & Reger, 1994	Reject [liquefaction feature - confused chronology]
22	Kenai R. flats	91-16-3.0	Down	?	pre	Beta-45210	3590	70	rooted wood	Combellick & Reger, 1994	Reject [no evidence of subsidence into intertidal zone]
23	Kasilof R. flats	91-15-2.0	Down		pre	Beta-45200	120	60	peat	Combellick & Reger, 1994	Reject [1964 event?]
23	Kasilof R. flats	KS1-2.9	Down		pre	Beta-49108	490	90	peat	Combellick & Reger, 1994	Reject [possibly contaminated by modern roots]
23	Kasilof R. flats	KS1-3.65	Down		pre	Beta-49109	910	80	peat	Combellick & Reger, 1994	Reject [gradational contact]

23	Kasilof R. flats	91-15-3.5	Down		pre	Beta-45201	1270	70	peat	Combellick & Reger, 1994	Reject [very thin peat]
23	Kasilof R. flats	KS1-5.9	Down		pre	Beta-49110	1280	90	peaty mud	Combellick & Reger, 1994	Reject [gradational contact]
23	Kasilof R. flats	91-15-3.9	Down	?	pre	Beta-45202	1560	50	peat	Combellick & Reger, 1994	Accept
23	Kasilof R. flats	91-15-4.0	Down		pre	Beta-45203	1680	50	rooted wood	Combellick & Reger, 1994	Reject [no evidence of subsidence into intertidal zone]
23	Kasilof R. flats	90-5-2.7	Down		pre	GX-16472	1810	80	peat	Combellick & Reger, 1994	Reject [thick peat sample]
23	Kasilof R. flats	91-15-4.8	Down		pre	Beta-45204	3470	70	rooted wood	Combellick & Reger, 1994	Reject [no evidence of subsidence into intertidal zone]
24	Fox R. flats	FR5-1.6	Down		pre	Beta-49100	10	100	silty peat	Combellick & Reger, 1994	Reject [1964 event]
24	Fox R. flats	91-10-1	Down		u	Beta-50330	190	60	detrital wood	Combellick & Reger, 1994	Reject [flood deposit?]
24	Fox R. flats	FR4-1.5	Down	II?	pre	Beta-49099	600	100	plant fragments, twig and silty peat	Combellick & Reger, 1994	Accept
24	Fox R. flats	91-14-1	Down		u	Beta-50330	800	70	detrital wood	Combellick & Reger, 1994	Reject [flood or tsunami deposit?]

24	Fox R. flats	91-11-1	Down		pre	Beta-50329	1020	90	Triglochin leaf bases	Combellick & Reger, 1994	Reject [weak evidence of subsidence into intertidal zone]
24	Fox R. flats	FR3-2.4	Down	III?	pre	Beta-49098	1200	110	peaty silt	Combellick & Reger, 1994	Reject [v. thin peat]
25	Shuyak Is. - Skiff Passage Marsh	SI-A-4	Down	II	post	QL-4741	260	20	Triglochin peat	Gilpin, 1995	Accept
25	Shuyak Is. - Koniag Marsh	SI-A-2	Down	II	post	QL-4589	310	30	Triglochin peat	Gilpin, 1995	Accept
25	Shuyak Is. - Skiff Passage Marsh	SI-A-4	Down		pre	QL-4742	330	25	sphagnum peat	Gilpin, 1995	Reject [sig. diff from other ages at this contact]
25	Shuyak Is. - Koniag Marsh	SI-A-2	Down	II	pre	QL-4590	330	30	sphagnum peat	Gilpin, 1995	Accept
25	Shuyak Is. - Skiff Passage Marsh	SI-A-4	Down	III	pre	QL-4592	443	14	sphagnum peat	Gilpin, 1995	Accept
25	Shuyak Is. - Deer Marsh	SI-A-5	Down	II	post	QL-4596	447	30	Triglochin? peat	Gilpin, 1995	Accept
25	Shuyak Is. - Bear Trail Marsh	SI-A-7	Down	II	pre	QL-4750	490	20	peat	Gilpin, 1995	Reject [weak strat. correlation]
25	Shuyak Is. - Deer	SI-A-5	Down	II	pre	QL-4597	494	23	Triglochin? peat	Gilpin, 1995	Accept

	Marsh										
25	Shuyak Is. - Skiff Passage Marsh	SI-A-4	Down		post	QL-4591	790	20	Triglochin peat	Gilpin, 1995	Reject [age reversal]
25	Shuyak Is. - Skiff Passage Marsh	SI-A-4	Down	III	post	QL-4593	1248	21	Triglochin peat	Gilpin, 1995	Accept
25	Shuyak Is. - Skiff Passage Marsh	SI-A-4	Down	III	pre	QL-4594	1516	17	sphagnum peat	Gilpin, 1995	Accept
25	Shuyak Is. - Bear Trail Marsh	SI-A-8	Down	IV/V?	pre	QL-4600	2776	16	peat	Gilpin, 1995	Reject [weak strat. correlation]
26	Afognak Is. - Back Bay Marsh	AI-A-1	Down	II	post	Beta-48804	380	60	Triglochin peat	Gilpin, 1995	Accept
26	Afognak Is. - Back Bay Marsh	AI-A-1	Down	II	pre	QL-4667	483	26	sphagnum peat	Gilpin, 1995	Accept
27	Kodiak Is. - Anton Larsen Bay	KI-AL-A-1	Down	III	post	QL-4583	1300	25	Triglochin peat	Gilpin, 1995	Accept
27	Kodiak Is. - Anton Larsen Bay	KI-AL-A-1	Down	III	pre	UA	1430	45	sphagnum peat	Gilpin, 1995	Accept
27	Kodiak Is. - Anton Larsen Bay	KI-AL-A-1	Down		pre	QL-4584	1630	20	sphagnum peat	Gilpin, 1995	Reject [sig. diff from other ages at this contact]

28	Kodiak Is. - Kalsin Bay	KI-KL-3B	Down			Beta-48801	90	60	wood	Gilpin, 1995	Reject [no stratigraphic information]
28	Kodiak Is. - Kalsin Bay	KI-KL-3A	Down			QL-4586	500	20	sphagnum	Gilpin, 1995	Reject [no stratigraphic information]
28	Kodiak Is. - Middle Bay	KI-SC-1	Down		pre	QL-4587	710	30	Triglochin peat	Gilpin, 1995	Reject [uncertain origin]
28	Kodiak Is. - Middle Bay	KI-SC-1	Down		post	QL-4588	800	30	Triglochin peat	Gilpin, 1995	Reject [sig. diff from other ages at this contact]
28	Kodiak Is. - Kalsin Bay	KI-KL-1A	Down	III?	pre	Beta-48800	1020	60	sphagnum	Gilpin, 1995	Accept
28	Kodiak Is. - Middle Bay	KI-SC-1	Down	III?	pre	Beta-48809A	1060	60	sphagnum peat	Gilpin, 1995	Accept
28	Kodiak Is. - Kalsin Bay	KI-KL-1A	Down	III?	pre	QL-4585	1070	30	sphagnum	Gilpin, 1995	Accept
28	Kodiak Is. - Middle Bay	KI-SC-1	Down	III?	post	Beta-48809B	1070	70	Triglochin peat	Gilpin, 1995	Accept
29	Sitkalidak Is. - Tanginak Lagoon	SDI-92-4-45	Up?	II	pre	QL-4672	353	23	sphagnum peat	Gilpin, 1995	Reject [stratigraphy very variable]
29	Sitkalidak Is. - Seal Bay	SDI-92-2-1	Up?	II	post	QL-4745	610	70	Non-Triglochin peat	Gilpin, 1995	Reject [little deformation in 1964]
29	Sitkalidak Is. - Seal Bay	SDI-92-2-1	Up?	II	pre	QL-4671	625	30	Triglochin peat	Gilpin, 1995	Reject [little deformation in 1964]

29	Sitkalidak Is. - Rolling Bay	SDI-92-RB	Down?	?	?	QL-4746	770	25	peat	Gilpin, 1995	Reject [dates marsh initiation]
29	Sitkalidak Is. - Three Sisters	SDI-92-TS	Down?	?	post	QL-4747	1600	25	Triglochin peat	Gilpin, 1995	Reject [little deformation in 1964]
29	Sitkalidak Is. - Tanginak Lagoon	SDI-92-5	Up?	?	pre	QL-4673	1675	25	Triglochin peat	Gilpin, 1995	Reject [stratigraphy very variable]
29	Sitkalidak Is. - Tanginak Lagoon	SDI-92-4-1	Up?	IV?	pre	QL-4748	2530	25	organic silt	Gilpin, 1995	Reject [stratigraphy very variable]
30	Kodiak Is. - Sturgeon Lagoon	KI-KK-A-2	Down	II	pre	QL-4669	330	30	sphagnum peat	Gilpin, 1995	Accept
30	Kodiak Is. - Sturgeon Lagoon	KI-KK-A-2	Down	II	post	Beta-48802	580	60	Triglochin peat	Gilpin, 1995	Reject [out of sequence]
30	Kodiak Is. - Sturgeon Lagoon	KI-KK-A-2	Down	III	pre	QL-4670	1215	30	Triglochin peat	Gilpin, 1995	Accept

Appendix B: Late Holocene radiocarbon ages from prehistoric coastal archaeological sites

AHRS No. (49-)	Site Name	Lab no.	14C age	1-sigma error	Material dated[2]	Context	Reference
Region 1: Prince William Sound							
ANC 589	College Fjord ("A")	Beta 18573	460	70	?	hearth in intertidal test pit; charcoal interlayered with fine sand	Dotter 1988
COR 001	Palugvik	P 192	1727	105	WD	house post? (inner wood)	D Clark 1984
COR 001	Palugvik	P 173	2265	112	WD	shovel (paraffin treated)	D Clark 1984
COR 038	Hawkins Is ("Tauxtvik") ("C")	Beta 23369	570	120	?		Dotter 1988
COR 038	Hawkins Is ("Tauxtvik") ("C")	Beta 23370	610	70	?		Dotter 1988
COR 080	Hawkins Island	WSU 2240	385	100	?		Dotter 1988
COR 081	Little Nuchek	WSU 2239	460	90	?	Intertidal test pit	Dotter 1988
COR 318?	Orca Inlet ("B")	Beta 23380	350	60	?		Dotter 1988
SEW 056	Uqciuvit	WSU 3938	110	90	W	cultural; questionable age	Yarborough and Yarborough 1991

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SEW 056	Uqciuvit	WSU 3914	200	90	?	burial from final stage of occupation	Yarborough and Yarborough 1991
SEW 056	Uqciuvit	WSU 3913	295	90	W	house "floor"?	Yarborough and Yarborough 1991
SEW 056	Uqciuvit	Beta 30558	590	60	?	house pit	Yarborough and Yarborough 1991
SEW 056	Uqciuvit	WSU 3940	830	65	?	house "floor"?	Yarborough and Yarborough 1991
SEW 056	Uqciuvit	WSU 3915	960	60	CH?	cultural	Yarborough and Yarborough 1991
SEW 056	Uqciuvit	WSU 3911	1020	60	CH?	cultural	Yarborough and Yarborough 1991
SEW 056	Uqciuvit	WSU 3937	1400	70	CH?	cultural from upper EPA strat. level in higher part of site	Yarborough and Yarborough 1991
SEW 056	Uqciuvit	WSU 3941	1510	120	CH?	cultural; above gravel	Yarborough and Yarborough 1991
SEW 056	Uqciuvit	Beta 28804	2000	110	CH?	cultural; below gravel	Yarborough and Yarborough 1991
SEW 056	Uqciuvit	WSU 3939	2310	60	CH?	cultural; below gravel	Yarborough and Yarborough 1991
SEW 056	Uqciuvit	WSU 3916	2370	70	CH?	cultural; below gravel	Yarborough and Yarborough 1991
SEW 056	Uqciuvit	WSU 3936	3380	100	CH?	In oldest stratum just above grey silt loam	Yarborough and Yarborough 1991
SEW 056	Uqciuvit	WSU 3912	3810	90	CH?	In oldest stratum at base of pit; few artifacts	Yarborough and Yarborough 1991

SEW 068	Kake Cove, Chenega I.	GX 17343	1665	65	WD	wooden artifacts in peat just below present sandy cobble beach	Reger et al. 1992
SEW 068	Kake Cove, Chenega I.	GX 17342	1985	65	WD	wooden artifacts just below present sandy cobble beach	Reger et al. 1992
SEW 080/081/082	Montague Island ("L")	Beta 23372	190	70	CH		Dotter 1988
SEW 080/081/082	Montague Island ("L")	Beta 23378	310	50	CH		Dotter 1988
SEW 080/081/082	Montague Island ("L")	Beta 23371	340	80	CH		Dotter 1988
SEW 080/081/082	Montague Island ("L")	Beta 23373	550	80	CH		Dotter 1988
SEW 234		WSU 2913	95	65	CH		Dotter 1988
SEW 234		WSU 2911	315	65	CH		Dotter 1988
SEW 234		WSU 2910	695	40	CH		Dotter 1988
SEW 349/553/554/555	Unakwik Inlet ("F")	Beta 23381	530	80	CH		Dotter 1988
SEW 349/553/554/555	Unakwik Inlet ("F")	Beta 23366	1090	70	CH		Dotter 1988
SEW 430		Beta 42077	660	80	CH	rockshelter	Haggarty et al. 1991

SEW 440	Eleanor I.	Beta 78756	280	60	CH	cultural; coincides stratigraphically with patchy tephra in northern part of site (= Valdez ash?)	L.F. Yarborough 1997
SEW 440	Eleanor I.	Beta 78760	380	60	CH	cultural	L.F. Yarborough 1997
SEW 440	Eleanor I.	Beta 78759	400	50	CH	cultural	L.F. Yarborough 1997
SEW 440	Eleanor I.	Beta 97208	530	60	CH	cultural; overlies bedrock and predates heavy FCR deposition at eastern edge of site.	L.F. Yarborough 1997
SEW 440	Eleanor I.	Beta 97209	1030	100	CH	cultural	L.F. Yarborough 1997
SEW 440	Eleanor I.	Beta 78758	1820	60	CH	cultural, in gravel layer at 64 cm? (N16E27); also dates underlying tephra (White River north lobe= 1885 BP)	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 89039	250	50	CH	cultural	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 78764	300	50	CH	cultural	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 78761	350	50	CH	cultural	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 89040	360	60	CH	cultural	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 78768	380	50	CH	cultural	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 89043	430	50	CH	cultural	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 89044	430	50	CH	cultural	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 78767	460	60	CH	cultural	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 89046	520	50	CH	cultural	L.F. Yarborough 1997

SEW 488	Knight I.	Beta 89045	560	60	CH	cultural	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 89047	560	70	CH	cultural	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 89055	570	70	CH	cultural	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 89052	590	60	CH	cultural	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 78763	600	60	CH	cultural	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 89038	600	60	CH	cultural	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 78762	610	60	CH	cultural	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 89054	620	80	CH	cultural	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 89051	700	60	CH	cultural	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 78766	810	50	CH	cultural	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 89048	820	60	CH	cultural	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 78765	900	70	CH	cultural	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 89049	910	90	CH	cultural	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 89050	990	60	CH	cultural	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 89056	1130	80	CH	cultural; dates pumice (varies from 90-140 cm depth)	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 89057	1290	50	CH	cultural	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 89042	1680	50	CH	from peat; occupation of site uncertain	L.F. Yarborough 1997
SEW 488	Knight I.	Beta 89058	2680	60	CH	occupational extent unknown	L.F. Yarborough 1997
SEW 548	Icy Bay islet ("I")	Beta 23376	440	80	CH		Dotter 1988
SEW 548	Icy Bay islet ("I")	Beta 97210	990	80	CH	non-cultural layer? (70-90 cm in N25E33)	L.F. Yarborough 1997
Region 2: Kenai Fjords							
SEL 188	MacArthur Pass	Beta 39475	620	50	CH		Schaaf and Johnson 1990; Betts et al. 1991;

							Erlandson et al. 1992
SEL 188	MacArthur Pass	Beta 39476	560	50	CH		Schaaf and Johnson 1990; Betts et al. 1991;
SEL 188	MacArthur Pass	Beta 39477	710	50	CH		Schaaf and Johnson 1990; Betts et al. 1991;
SEL 188	MacArthur Pass	Beta 39478	700	90	CH		Schaaf and Johnson 1990; Betts et al. 1991;
SEL 188	MacArthur Pass	GX 17226	825	65	CH	split w GX-17227	Dekin et al. 1993; Crowell and Mann 1996
SEL 188	MacArthur Pass	GX 17227	660	60	CH	split w GX-17226	Dekin et al. 1993; Crowell and Mann 1996
		wt. mean & sd	736	88			
SEL 188	MacArthur Pass	GX 17232	855	115	CH	split w GX-17233	Dekin et al. 1993; Crowell and Mann 1996
SEL 188	MacArthur Pass	GX 17234	1005	65	WD	split w GX-17235	Dekin et al. 1993; Crowell and Mann 1996
SEL 188	MacArthur Pass	GX 17235	1210	65	WD	split w GX-17234	Dekin et al. 1993; Crowell and Mann 1996
		wt. mean & sd	1108	44			
SEL 188	MacArthur Pass	GX 17236	585	105	CH	split w GX-17237	Dekin et al. 1993; Crowell and Mann 1996
SEL 188	MacArthur Pass	GX 17237	670	105	CH	split w GX-17236	Dekin et al. 1993; Crowell and Mann 1996
		wt. mean & sd	628	74			
SEL 188	MacArthur Pass	GX 17238	770	65	CH	split w GX-17239	Dekin et al. 1993; Crowell and Mann 1996
SEL 188	MacArthur Pass	GX 17239	925	105	CH	split w GX-17238	Dekin et al. 1993; Crowell and Mann 1996
		wt. mean & sd	813	55			
SEL 188	MacArthur Pass	Beta 39479	1350	70	CH		Schaaf and Johnson 1990; Betts et al. 1991;
SEL 188	MacArthur Pass	GX 17228	1690	140	CH	split w GX-17229	Dekin et al. 1993;

							Crowell and Mann 1996
SEL 188	MacArthur Pass	GX 17229	1710	120	CH	split w GX-17228	Dekin et al. 1993; Crowell and Mann 1996
		wt. mean & sd	1700	90			
SEL 215	Berger Bay, Nuka I.	GX 17335	670	60	CH	from artifact-bearing upper peat	Reger et al. 1992
SEL 215	Berger Bay, Nuka I.	GX 17336	665	105	CH	from artifact-bearing upper peat	Reger et al. 1992
SEL 215	Berger Bay, Nuka I.	GX 17337	840	60	CH	from artifact-bearing upper peat	Reger et al. 1992
SEL 215	Berger Bay, Nuka I.	GX 17338	655	100	WD	from artifact-bearing upper peat	Reger et al. 1992
SEL 215	Berger Bay, Nuka I.	GX 17339	920	60	WD	from artifact-bearing upper peat	Reger et al. 1992
SEL 215	Berger Bay, Nuka I.	GX 17340	425	105	WD	from artifact-bearing upper peat	Reger et al. 1992
SEL 215	Berger Bay, Nuka I.	GX 17341	635	60	WD	from artifact-bearing upper peat	Reger et al. 1992
XBS 020	Northwest Lagoon	Beta 23383	140	60	CH		Dotter 1988; Kent and McCallum 1991;
XBS 020	Northwest Lagoon	Beta 67272	240	70	CH		Crowell and Mann 1996
XBS 020	Northwest Lagoon	Beta 23382	320	50	CH		Dotter 1988; Kent and McCallum 1991;
XBS 020	Northwest Lagoon	Beta 67267	580	80	CH		Crowell and Mann 1996

XBS 020	Northwest Lagoon	Beta 67271	610	90	CH		Crowell and Mann 1996
XBS 020	Northwest Lagoon	Beta 67269	660	90	CH		Crowell and Mann 1996
XBS 020	Northwest Lagoon	Beta 67270	690	90	CH		Crowell and Mann 1996
XBS 020	Northwest Lagoon	Beta 67268	830	70	CH		Crowell and Mann 1996
XBS 030	Bear Cove Village	Beta 67273	590	50	CH		Crowell and Mann 1996
XBS 030	Bear Cove Village	Beta 67274	640	110	CH		Crowell and Mann 1996
XBS 030	Bear Cove Village	Beta 170800	710	60	CM	lowest charcoal lens in stratum 5 in structure 7	Crowell 2003
XBS 030	Bear Cove Village	Beta 170803	720	70	CM	bottom of feature B, stratum 3 in structure 7	Crowell 2003
XBS 030	Bear Cove Village	Beta 170797	860	70	CM	top of stratum 5 in structure 7	Crowell 2003
XBS 030	Bear Cove Village	Beta 170804	960	80	CM	upper charcoal lens below structure 8 house floor	Crowell 2003
XBS 030	Bear Cove Village	Beta 170805	1010	110	CM	lower charcoal lens below structure 8 house floor	Crowell 2003
XBS 031	Verdant Cove South Midden	Beta 67277	570	50	CH		Crowell and Mann 1996
Region 3: Kenai Peninsula							
KEN 045	Clam Gulch	I 12161	190	80	CH		Reger 1987

KEN 045	Clam Gulch	I 12166	240	70	CH		Reger 1987
KEN 045	Clam Gulch	I 12167	200	70	CH		Reger 1987
KEN 045	Clam Gulch	Beta 6686	340	50	CH		Reger 1987
KEN 045	Clam Gulch	I 12168	360	80	CH		Reger 1987
KEN 230	?	WSU 4142	350	90			Reger and Boraas 1996
KEN 230	?	WSU 4143	220	120			Reger and Boraas 1996
KEN 230	?	WSU 4144	310	90			Reger and Boraas 1996
KEN 232	Nelson	WSU 4148	380	90			Reger and Boraas 1996
KEN 233	Pelch	WSU 4147	540	90			Reger and Boraas 1996
KEN 233	Pelch	WSU 4149	645	60			Reger and Boraas 1996
Region 4: Kachemak Bay							
SEL 010	Halibut Cove 1 (Pt. West)	WSU 3812	510	60	CH	House (hearth) - above midden	Mills 1994, Reger and Boraas 1996
SEL 010	Halibut Cove 1 (Pt. West)	WSU 3810	775	60	CH	House (hearth) - above midden	Mills 1994, Reger and Boraas 1996
SEL 010	Halibut Cove 1 (Pt. West)	WSU 3859	1100	60	CW	near top of midden	Mills 1994, Reger and Boraas 1996
SEL 010	Halibut Cove 1 (Pt. West)	WSU 3811	1940	70	CH	base of midden	Mills 1994, Reger and Boraas 1996
SEL 027	Port Graham	Beta 99311	500	60	CH	post-dates site occupation	Workman and Workman 1997
SEL 027	Port Graham	Beta 99312	570	80	CH	cultural deposits	Workman and Workman 1997
SEL 027	Port Graham	Beta 99310	610	60	CH	cultural deposits	Workman and Workman 1997
SEL 030	Cottonwood Creek	S 1054	1555	75	CH	midden	# Mills 1994
SEL 030	Cottonwood Creek	S 1042	1745	65	CW	floor plank	# Mills 1994
SEL 030	Cottonwood Creek	S 1043	1750	125	CW	floor plank	# Mills 1994

SEL 033	Chugachik Island	UGa 2344	1475	70	CH	midden	# Mills 1994
SEL 033	Chugachik Island	S 1063	1705	65	CH	midden	Mills, 1994, Reger and Boraas 1996
SEL 033	Chugachik Island	UGa 2342	1940	90	CH	midden	# Mills 1994
SEL 033	Chugachik Island	S 1062	2310	65	BB	midden	# Mills 1994
SEL 033	Chugachik Island	UGa 2343	2740	75	WD	midden	# Mills 1994
SEL 041	Fox Farm and Bluff	UGa 2339	1090	195	CH	midden	# Mills 1994
SEL 041	Fox Farm and Bluff	UGa 2340	1130	120	CH	occupation layer	# Mills 1994
SEL 041	Fox Farm and Bluff	UGa 2341	1315	250	CH	midden	# Mills 1994
SEL 079	Seal Beach	UGa 3635	1685	100	CH	midden	# Mills 1994
SEL 079	Seal Beach	UGa 3636	2050	60	CH	lower component	# Mills 1994
SEL 245	Sylva	Beta 58167	1020	60	CH	unknown cultural affinity	# Mills 1994
Region 5: Eastern Kodiak							
AFG 004	Aleut Town	Beta 150810	920	50	CM	90cm b.s.	D. Clark, p.c. 2002
AFG 004	Aleut Town	Beta 150811	1090	80	CM	hearth at south end of excavation	D. Clark,p.c. 2002
AFG 005	Malina Creek	?	500	50	?		Knecht 1995
AFG 005	Malina Creek	Beta 42073	620	70	?		Haggarty et al. 1991; Mills 1994
AFG 010	Salmon Bend	Beta 170061	1330	60	CM	Top of fill in main room, immediately before tsunami	D. Clark, p.c. 2002

AFG 010	Salmon Bend	Beta 170060	1400	80	CM	Annex room, well above floor, but well below top	D. Clark, p.c. 2002
AFG 011		GaK 3803	3890	110	?		D. Clark 1979; Mills 1994
AFG 012		Beta 101917	280	60	CM	Sq. 4 Midden	Partlow 2000
AFG 012		Beta 101914	310	40	CM	Sq. 2 House hearth	Partlow 2000
AFG 012		Beta 101915	420	60	CM	Sq. 1	Partlow 2000
AFG 012		Beta 101916	450	60	CM	Sq. 2. Sub housefloor pit	Partlow 2000
AFG 015	Settlement Point	Beta 101552	300	50	CH	House 2 hearth	Saltonstall and Carver 2002
AFG 015	Settlement Point	Beta 114205	300	50	CH	House 6 hearth	Saltonstall and Carver 2002
AFG 015	Settlement Point	Beta 114203	330	60	CH	House 4 hearth	Saltonstall and Carver 2002
AFG 015	Settlement Point	Beta 114098	340	60	CH	Midden L2G	Saltonstall and Carver 2002
AFG 015	Settlement Point	Beta 114097	350	70	CH	House 3 hearth	Saltonstall and Carver 2002
AFG 015	Settlement Point	Beta 114096	370	80	CH	Midden L1	Saltonstall and Carver 2002
AFG 015	Settlement Point	Beta 101913	390	50	CH	Midden L2D/L2E contact	Saltonstall and Carver 2002
AFG 015	Settlement Point	Beta 101912	440	50	CH	Midden bottom L2	Saltonstall and Carver 2002
AFG 015	Settlement Point	Beta 114202	440	60	CH	House 5 hearth	Saltonstall and Carver 2002
AFG 015	Settlement Point	Beta 114204	450	50	CH	House 7 hearth	Saltonstall and Carver 2002
AFG 015	Settlement Point	Beta 118300	570	60	CH	House 1 floor	Saltonstall and Carver 2002

AFG 015	Settlement Point	Beta 101551	620	50	CH	House 1 hearth	Saltonstall and Carver 2002
AFG 082	Shuyak I.	GX 17333	1730	65	CH	lower midden	Reger et al. 1992
AFG 082	Shuyak I.	GX 17334	1840	65	CH	lower midden	Reger et al. 1992
AFG 088	Afognak River	Beta 88720	2780	110	CH	intrusive feature, base of site	D. Clark 1997
AFG 088	Afognak River	Beta 88719	3490	90	CH	base of site	D. Clark 1997
AFG 088	Afognak River	Beta 77807	3530	80	CH	base of site	D. Clark 1997
AFG 098	Neketa Bay, Shuyak I.	GX 17332	360	125	spruce bark	upper component	Reger et al. 1992
AFG 098	Neketa Bay, Shuyak I.	GX 17323	500	60	bark (spruce?)	upper component	Reger et al. 1992
AFG 098	Neketa Bay, Shuyak I.	GX 17326	500	100	CH	upper component	Reger et al. 1992
AFG 098	Neketa Bay, Shuyak I.	GX 17325	500	105	CH	upper component	Reger et al. 1992
AFG 098	Neketa Bay, Shuyak I.	GX 17331	570	60	CH	upper component	Reger et al. 1992
AFG 098	Neketa Bay, Shuyak I.	GX 17328	625	60	CH	upper component	Reger et al. 1992
AFG 098	Neketa Bay, Shuyak I.	GX 17327	950	65	grass, needles	lower component	Reger et al. 1992
AFG 098	Neketa Bay, Shuyak I.	GX 17329	1040	105	CH	lower component	Reger et al. 1992
AFG 098	Neketa Bay, Shuyak I.	GX 17324	1055	105	CH	lower component	Reger et al. 1992
AFG 098	Neketa Bay, Shuyak I.	GX 17330	1175	110	CH	lower component	Reger et al. 1992
AFG 119		Beta 42074	1000	80	?		Haggarty et al. 1991; Mills 1994
AFG 215	Tsunami	Beta 165141	880	40	CM	above tsunami deposit in cultural material	Clark, p.c. to Fitzhugh 2002

AFG 215	Tsunami	Beta 165139	1320	80	CM	termination of main house just below tsunami deposit	Clark, p.c. to Fitzhugh 2002
AFG 215	Tsunami	Beta 165140	1750	60	CM	from orange clay floor of house. should just postdate beginning of occupation	Clark, p.c. to Fitzhugh 2002
KOD 026	Monashka Bay	P 1049	298	44	CH	riverine site	D. Clark 1966; Mills 1994;
KOD 026	Monashka Bay	Beta 33545	1570	60	CH lens	from firepit	C. Donta p.c. 1992 to Mills 1994
KOD 026	Monashka Bay	Beta 34832	1680	50	CH lens	midden sample	C. Donta p.c. 1992 to Mills 1994
KOD 043	Kizhuyak	B 836	600	100	CH		D. Clark 1984; Mills 1994;
KOD 044	Crag Pt.	Beta 20122	910	60	CH		Haggarty et al. 1991; Mills 1994
KOD 044	Crag Pt.	Beta 45944	910	70	CH		Mills 1994
KOD 044	Crag Pt.	Beta 20533	1890	90	CH		Haggarty et al. 1991; Mills 1994
KOD 044	Crag Pt.	Beta 92094	1940	60	WD		Clark, p.c. 2002
KOD 044	Crag Pt.	Beta 48044	2000	70	CH		Mills 1994
KOD 044	Crag Pt.	P 1057	2033	52	CH	appx. basal date from main component	Clark p.c. 2002
KOD 044	Crag Pt.	Beta 48043	2190	90	?		Mills 1994
KOD 044	Crag Pt.	Beta 45943	2380	70	CH		Mills 1994
KOD 044	Crag Pt.	Beta 94894	3150	80	BO	dark thick lower stony black Kachemak layer	Clark, p.c. 2002

KOD 044	Crag Pt.	Beta 45942	3160	70	CH		Mills 1994
KOD 044	Crag Pt.	Beta 66656	3190	50	CH		Mills 1994
KOD 044	Crag Pt.	Beta 66655	3290	50	CH		Mills 1994
KOD 044	Crag Pt.	Beta 45945	3340	60	CH		Mills 1994
KOD 210	Blisky	Beta 77806	340	70	WD/CH	Fire pit, burned log, may be part of sweat bath feature; should be older than sweat bath due to old wood problem	Clark, p.c. 2002
KOD 210	Blisky	Beta 77805	410	80	GR	in sweat bath feature; should be accurate age of bath	Clark, p.c. 2002
KOD 210	Blisky	Beta 77804	2010	80		Hearth, base of site, test pit	Clark, p.c. 2002
KOD 210	Blisky	Beta 113164	2880	120	CH	from discrete lens in house floor	Steffian p.c. 2002
KOD 210	Blisky	Beta 113163	3050	60	CH	from FCR dump	Steffian p.c. 2002
KOD 324	Kizhuyak Bay	Beta 14497	2700	90	CH	charcoal lens in midden	Crozier 1986, 1987; Mills 1994
KOD 324	Kizhuyak Bay	Beta 8186	3520	60	CH	from erosion profile	Mills 1994
KOD 324	Kizhuyak Bay	Beta 14500	3630	80	CH	from test pit-no other info	Mills 1994
KOD 415	Horseshoe Cove	Beta 180510	640	50	?	Profile 4, 75cm bs	Saltonstall and Steffian 2005
KOD 415	Horseshoe Cove	Beta 194351	750	60	?	TP1, Pit 17, Level B,	Saltonstall and Steffian 2005
KOD 415	Horseshoe Cove	Beta 194349	790	60	?	TP2, Pit 11, Level B,	Saltonstall and Steffian 2005

KOD 415	Horseshoe Cove	Beta 194347	850	50	?	Sub Datum 3, Pit 26, hearth	Saltonstall and Steffian 2005
KOD 415	Horseshoe Cove	Beta 194348	870	50	?	Sub Datum 4, Pit 23, hearth	Saltonstall and Steffian 2005
KOD 415	Horseshoe Cove	Beta 180512	880	40	?	Profile 1, ca 50cm bs	Saltonstall and Steffian 2005
KOD 415	Horseshoe Cove	Beta 194350	900	60	?	TP3, Pit 12, Level B,	Saltonstall and Steffian 2005
KOD 415	Horseshoe Cove	Beta 194352	960	70	?	TP5, Pit 14, Level B, roof	Saltonstall and Steffian 2005
KOD 415	Horseshoe Cove	Beta 180511	3070	70	?	Profile 2, 75-85cm bs	Saltonstall and Steffian 2005
KOD 415	Horseshoe Cove	Beta 180508	3100	60	?	Profile 2, 125-135cm bs	Saltonstall and Steffian 2005
KOD 415	Horseshoe Cove	Beta 180509	3110	60	?	Profile 2, 105-115cm bs	Saltonstall and Steffian 2005
KOD 415	Horseshoe Cove	Beta 194345	3290	70	?	Sub Datum 2, Level 1C3	Saltonstall and Steffian 2005
KOD 415	Horseshoe Cove	Beta 194346	3290	70	?	Sub Datum 2, Level 1C4	Saltonstall and Steffian 2005
KOD 415	Horseshoe Cove	Beta 194344	3380	70	?	Sub Datum 2, Level 1C2	Saltonstall and Steffian 2005
KOD 415	Horseshoe Cove	Beta 194343	3460	60	?	Sub Datum 2, Level 1C1	Saltonstall and Steffian 2005
KOD 415	Horseshoe Cove	Beta 194342	3770	40	?	Sub Datum 2, Level 1C5	Saltonstall and Steffian 2005
Region 6: Southwestern Kodiak							
KOD 083	Three Saints	P 1042	2028	55	CH	associated with hearth and clay-lined basin	D. Clark 1966a; Mills 1994

KOD 099	Kiavak (Naumliak, Nayumlyak, Kiyaik)	P 1044	280	44	CH	basal level in rubble lens	D. Clark 1966a; Mills 1994
KOD 099	Kiavak (Naumliak, Nayumlyak, Kiyaik)	P 1045	391	48	CH	refuse lens	D. Clark 1966a; Mills 1994
KOD 100	Kiavak	S 2996	1960	75	CH	housepit, penetrates to near base	D. Clark 1997
KOD 100	Kiavak	S 3488	2750	130	CH	bulk sample collected from over 40 vertical cm; may mix charcoal, shell, bone and oil	D. Clark 1997
KOD 100	Kiavak	P 1039	3263	71	CH	midden, middle component	D. Clark 1974
KOD 101	Rolling Bay	P 1048	353	44	CH	exterior hearth; base of deposit	D. Clark 1966b; Mills 1994
KOD 101	Rolling Bay	P 1047	393	40	CH	exterior hearth; base of deposit	D. Clark 1966b; Mills 1994
KOD 106	SAS 126	Beta 78518	930	70	CH		Fitzhugh 2003
KOD 110	SAS 25	Beta 78502	480	60	CH		Fitzhugh 2003
KOD 504	SAS 48	Beta 78503	360	60	CH		Fitzhugh 2003
KOD 509	SAS 54	Beta 78505	820	90	CH		Fitzhugh 2003
KOD 510	SAS 55	Beta 78521	400	50	CH		Fitzhugh 2003
KOD 516	SAS 62	Beta 78506	1720	60	CH		Fitzhugh 2003
KOD 540	SAS 100	Beta 78511	1500	60	CH		Fitzhugh 2003
KOD 541	SAS 101	Beta 78512	1530	60	CH		Fitzhugh 2003
KOD 552	SAS 117	Beta 78514	1090	60	CH		Fitzhugh 2003
KOD 564	SAS 49	Beta 71092	1750	60	CH		Fitzhugh 2003

KOD 564	SAS 49	Beta 91316	1890	70	CH		Fitzhugh 2003
KOD 566	SAS 86	Beta 78510	1610	60	CH		Fitzhugh 2003
KOD 578	SAS 143	Beta 91318	2110	50	CH		Fitzhugh 2003
XTI 052	Sitkinak	Beta 7325	200	50	?	?	Haggarty et al. 1991; Mills 1994
XTI 052	Sitkinak	Beta 7326	750	80	?	?	Haggarty et al. 1991; Mills 1994
Region 7: Northwestern Kodiak							
KAR 001	New Karluk	Beta 15014	290	60	WD	HF 6 (floorplank)	Jordan and Knecht 1988; Mills 1994
KAR 001	New Karluk	Beta 8942	370	50	CH	from erosion profile/ TP	Mills 1994
KAR 001	New Karluk	Beta 15015	480	80	WD	HF 8 (floorplank)	Jordan and Knecht 1988; Mills 1994
KAR 001	New Karluk	Beta 25599	630	50	WD	HF 9A (floorplank)	
KAR 001	New Karluk	Beta 15016	740	80	WD	HF 10 (floorplank)	Jordan and Knecht 1988; Mills 1994
KAR 001	New Karluk	Beta 25600	780	60	WD	?	Mills 1994
KAR 029	Larsen Bay	Beta 23767	450	70	carbon	structural depression	Crozier 1989; Mills 1994
KAR 029	Larsen Bay	Beta 23769	620	50	carbon	housefloor	Crozier 1989; Mills 1994
KAR 029	Larsen Bay	Beta 23768	870	70	CH	hearth	Crozier 1989; Mills 1994
KAR 029	Larsen Bay	Beta 23765	990	60	CH	firepit assoc. w housefloor	Crozier 1989; Mills 1994
KAR 029	Larsen Bay	Beta 23766	1000	110	CH	firepit assoc. w housefloor	Crozier 1989; Mills 1994
KAR 029	Larsen Bay	Beta 23771	1290	80	CH	hearth in housefloor	Crozier 1989; Mills 1994
KAR 029	Larsen Bay	Beta 23770	1310	70	carbon	housefloor	Crozier 1989; Mills 1994
KAR 031	Old Karluk	Beta 15017	320	60	CH	exterior hearth; Level 3, midden	Mills 1994; rejected by Jordan, accepted by Mills

							1994;
KAR 031	Old Karluk	Beta 15690	430	60	CH	midden, L-3, Feature B	Mills 1994; rejected by Jordan, accepted by Mills 1994
KAR 031	Old Karluk	Beta 15691	980	60	WD	L-7, house floor plank	Jordan 1992; Mills 1994
KAR 031	Old Karluk	Beta 8946	2010	70	WD	post from L-7 house floor	Jordan and Knecht 1988; Mills 1994
KAR 031	Old Karluk	Beta 8945	2540	60	CH	L-9	Jordan and Knecht 1988; Mills 1994
KAR 039		Beta 8943	2650	60	CH	TP	Haggarty et al. 1991; Mills 1994
KAR 048		Beta 8944	3050	70	CH	pit feature?	Mills 1994
KOD 145	Uyak	Beta 34281	1130	70	CH	hearth in House 2	Steffian 1992b; Mills 1994
KOD 145	Uyak	Beta 25603	1140	90	WD	House 13 floorplank	Steffian 1992b; Mills 1994
KOD 145	Uyak	Beta 34283	1270	100	CH	hearth in House 1	Steffian 1992b; Mills 1994
KOD 145	Uyak	Beta 25602	1310	70	CH	hearth in House 8	Steffian 1992b; Mills 1994
KOD 145	Uyak	Beta 34282	1320	70	WD	outer rings from post in House 1	Steffian 1992b; Mills 1994
KOD 224	Uganik I.	UGa 2823	1080	90	?	?	Haggarty et al. 1991; Mills 1994
KOD 224	Uganik I.	UGa 2820	3130	85	?	?	D. Clark 1984; Mills 1994
KOD 224	Uganik I.	UGa 2822	3365	70	?	?	D. Clark 1984; Mills 1994
Region 8: Katmai							
AFG 207	Sukoi Bay terrace	Beta 74849	2020	80	CH	upper component	Crowell and Mann 1996
AFG 207	Sukoi Bay terrace	Beta 74850	3570	60	CH	lower component	Crowell and Mann 1996

XMK 006	Kukak	Beta 97002	720	70	CH	House 3	D. Dumond, p.c. 2002
XMK 006	Kukak	I-1636	775	110	CH	House	Clark 1977; Mills 1994; Crowell and Mann 1996
XMK 006	Kukak	I-505	775	95	CH		Mills 1994; Crowell and Mann 1996
XMK 006	Kukak	I-1638	1075	100	CH	floor	Clark 1977; Mills 1994; Crowell and Mann 1996
XMK 006	Kukak	I-1637	1450	130	CH	floor	Clark 1977; Mills 1994; Crowell and Mann 1996
XMK 006	Kukak	I-1944	1460	95	CH	floor	Clark 1977; Mills 1994; Crowell and Mann 1996
XMK 018	Takli	I-3733	2810	100	CH		Clark 1977; Mills 1994; Crowell and Mann 1996
XMK 018	Takli	I-1941	2910	105	CH		Clark 1977; Mills 1994; Crowell and Mann 1998
XMK 020	Hook Point	I-1942	1680	100	CH	floor	Clark 1977; Mills 1994; Crowell and Mann 1996
XMK 020	Hook Point	I-1943	3470	110	CH	hearth	Clark 1977; Mills 1994; Crowell and Mann 1997
XMK 030	Mink Island	Beta 122729	370	40	CH	upper midden	
XMK 030	Mink Island	Beta 130090	400	60	CH	upper midden	
XMK 030	Mink Island	Beta 149293	520	80	CH	upper midden	
XMK 030	Mink Island	Beta 109926	540	60	CH	upper midden	
XMK 030	Mink Island	Beta 130091	720	60	CH	upper midden	
XMK 030	Mink Island	Beta 109929	850	60	CH	upper midden	
XMK 030	Mink Island	Beta 109927	860	50	CH	upper midden	
XMK 030	Mink Island	Beta 109928	860	140	CH	upper midden	
XMK 030	Mink Island	Beta 114541	950	60	CH	upper midden	
XMK 030	Mink Island	Beta 115542	970	50	CH	upper midden	
XMK 030	Mink Island	Beta 109930	970	60	CH	upper midden	
XMK 030	Mink Island	Beta 114544	1510	90	CH	upper midden	
XMK 030	Mink Island	Beta 147721	1590	40	CH	upper midden	
XMK 030	Mink Island	Beta 109931	1620	60	CH	upper midden	

XMK 030	Mink Island	Beta 130085	1650	70	CH	upper midden	
XMK 030	Mink Island	Beta 114545	1710	50	CH	upper midden	
XMK 030	Mink Island	Beta 114543	1920	120	CH	upper midden	
XMK 030	Mink Island	WSU 5044	1925	50	CH	upper midden	
XMK 030	Mink Island	Beta 130086	2010	60	CH	upper midden	
XMK 030	Mink Island	Beta 130102	3690	130	CH	lower midden	
XMK 047		Beta 75314	640	90	CH		Crowell and Mann 1996
XMK 056	Russian Anchorage	Beta 74853	690	60	CH		Crowell and Mann 1996
XMK 056	Russian Anchorage	Beta 75318	1890	70	CH		Crowell and Mann 1996
XMK 058	Cape Gull	GX 17004	750	110	CH	split w GX-17005	Haggarty et al. 1991; Dekin et al. 1993; Crowell and Mann 2001
XMK 058	Cape Gull	GX 17005	730	120	CH	split w GX-17004	Haggarty et al. 1991; Dekin et al. 1993; Crowell and Mann in prep.
		wt. mean & sd	741	81			
XMK 058	Cape Gull	GX 17006	525	60	CH	split w GX-17007	Haggarty et al. 1991; Dekin et al. 1993; Crowell and Mann in prep.
XMK 058	Cape Gull	GX 17007	590	105	CH	split w GX-17006	Haggarty et al. 1991; Dekin et al. 1993; Crowell and Mann in prep.
		wt. mean & sd	541	52			
XMK 058	Cape Gull	GX 17008	510	105	CH	split w GX-17009	Haggarty et al. 1991; Dekin et al. 1993; Crowell and Mann in prep.

XMK 058	Cape Gull	GX 17009	550	85	CH	split w GX-17008	Haggarty et al. 1991; Dekin et al. 1993; Crowell and Mann in prep.
		wt. mean & sd	534	66			
XMK 059	Kukak Bay Refuge Rock	Beta 74856	360	60	CH	midden	Crowell and Mann 1996
XMK 075	Takli Island	GX 17212	2175	205	CH	split w GX-17213	Dekin et al. 1993; Crowell and Mann 1996
XMK 075	Takli Island	GX 17213	2020	180	CH	split w GX-17212	Dekin et al. 1993; Crowell and Mann 1996
		wt. mean & sd	2087	135			
XMK 072	Takli Islet	GX 17214	3605	150	CH	split w GX-17215; midden	Dekin et al. 1993; Crowell and Mann 1996
XMK 072	Takli Islet	GX 17215	3875	175	CH	split w GX-17214; midden	Dekin et al. 1993; Crowell and Mann 1996
		wt. mean & sd	3719	113			
XMK 106	Tiny Island Village	Beta 74857	1530	80	CH		Crowell and Mann 1996
XMK 107	Tiny Island II	Beta 83699	620	60	CH		Crowell and Mann 1996
XMK 111	Tiny Island Passage	Beta 75315	3270	70	CH		Crowell and Mann 1996
XMK-113	Kinak River Wet Site	Beta-74851	210	60	CH		Crowell and Mann, in prep.
XMK-113	Kinak River Wet Site	Beta-74852	960	60	CH		Crowell and Mann, in prep.
XMK 115	Aguchik Island Cove	Beta 74664	3560	80	CH	non-cultural (RSL estimate @ 0.6 m ASL)	Crowell and Mann 1996
XMK 116	Aguchik Island Tombolo	Beta 74673	2970	60	CH	non-cultural (RSL estimate @ 1.8 m ASL)	Crowell and Mann 1996

XMK 118	Kukak Point Village	Beta 75319	900	60	CH	midden	Crowell and Mann 1996
XMK 119	Kaflia River mouth	Beta 75320	3350	90	CH	midden	Crowell and Mann 1996
XMK 120	Kaflia River mouth	Beta 75321	460	70	CH	midden	Crowell and Mann 1996

[1]**Materials dated:**
CH=charcoal (wood?); CM=charred material; BO=bulk organic; GR= grass; ANT=antler; CW=charred wood; BB=birch bark: WD =wood

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