

**STATE OF ALASKA**  
**DEPARTMENT OF NATURAL RESOURCES**  
**DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS**

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Report of Investigations 94-6  
SEDIMENTOLOGICAL AND RADIOCARBON-AGE  
DATA FOR TIDAL MARSHES ALONG EASTERN AND  
UPPER COOK INLET, ALASKA

By  
R.A. Combellick and R.D. Reger



**STATE OF ALASKA**  
**Department of Natural Resources**  
**DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS**

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# SEDIMENTOLOGICAL AND RADIOCARBON-AGE DATA FOR TIDAL MARSHES ALONG EASTERN AND UPPER COOK INLET, ALASKA

by  
R.A. Combellick<sup>1</sup> and R.D. Reger<sup>1</sup>

## INTRODUCTION

This report presents the results of field studies we conducted in 1990, 1991, and 1992 to collect evidence of major prehistoric earthquakes in the Cook Inlet region of Alaska. This evidence is preserved as sequences of fresh-water peat layers abruptly overlain by intertidal silt and clay in tidal-marsh deposits (Bartsch-Winkler and Schmoll, 1987, 1992; Combellick, 1986, 1991). We examined and sampled tidal-bank exposures and retrieved drill cores and hand-auger cuttings from six tidal marshes along the shore of eastern and upper Cook Inlet (fig. 1) to document sediment types, stratigraphy, and radiocarbon ages of these deposits. Combellick (1991) described results of similar previous studies of tidal marshes at the heads of Turnagain and Knik Arms in upper Cook Inlet. The purpose of this study was to collect data in four additional marshes along eastern Cook Inlet and to re-examine two marshes in Turnagain and Knik Arms.

During the 1964 great Alaska earthquake, regional tectonic subsidence and local sediment compaction resulted in flooding of tidal marshes at Portage and Girdwood, followed by a rapid influx of tidal mud that buried and preserved the submerged vegetation. By 1980, post-earthquake silt deposition had nearly restored the tidal flats to pre-earthquake levels (Bartsch-Winkler and Garrow, 1982). Now visible in tidal banks at Portage and Girdwood is the peat layer that was buried as a result of this deposition. The peat is composed of fresh- and brackish-water plants and is overlain by a silt and clay layer that is largely devoid of organic material, except for scattered remains of halophytic plants. Rooted in this buried peat layer are the stumps of many

dead cottonwood and spruce trees that are still visible in these marshes. The contact between the peat and overlying mud is sharp and the above-ground portions of many smaller plant fossils extend upward into the mud. The sharp contact, presence of undecayed branches and leaves extending upward into the overlying mud, and abrupt transition from fresh- or brackish-water sediments to marine sediments are results of immediate and rapid burial by tidal mud following submergence of the supratidal flat.

The presence of several similar peat-mud couplets deeper in the tidal-marsh deposits at Girdwood and Portage were recognized as possible evidence of earthquake-related subsidence that may have occurred repeatedly prior to the 1964 event (Combellick, 1986; Bartsch-Winkler and Schmoll, 1987). Radiocarbon dating of plants at each peat-mud contact provides the approximate age of burial and, if these ages correlate closely between widely separated marshes, could provide the approximate ages of prehistoric earthquakes. This information is useful for estimating the long-term recurrence frequency of 1964-style events.

Results of our previous studies indicated that, although there are uncertainties in the radiocarbon-age data and imperfect correlation between marshes, the average recurrence interval of probable earthquake-related subsidence was 590-780 calendar yr during the past 4,700 yr (Combellick, 1991). When these data are combined with some of the results of the current study, they show strong regional evidence that the penultimate, or second to last, great earthquake in the Cook Inlet region occurred about 700-900 yr ago (Combellick, 1993).

<sup>1</sup> Alaska Division of Geological & Geophysical Surveys, 794 University Ave., Suite 200, Fairbanks, AK 99709-3645.

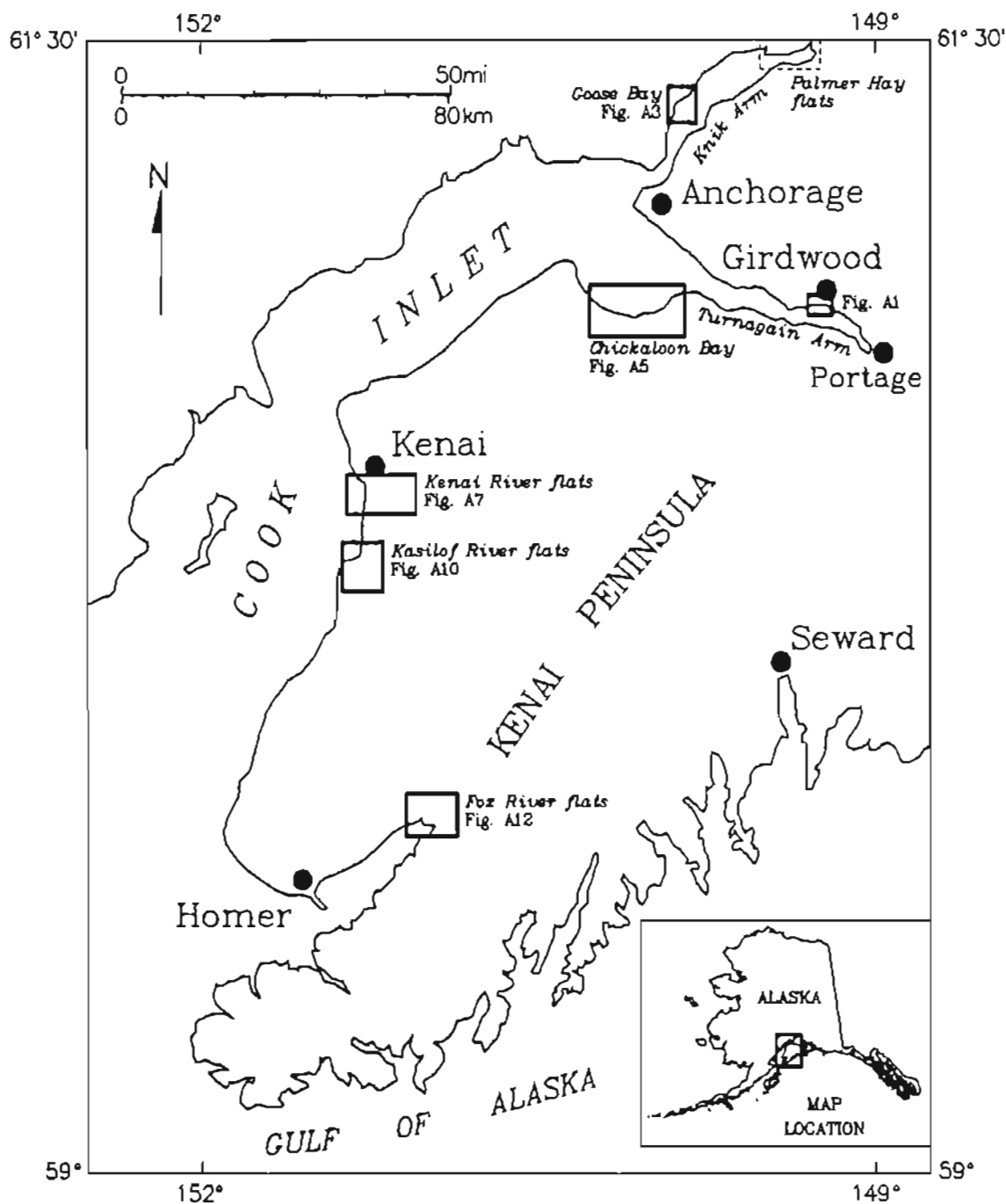


Figure 1. Locations of tidal marshes studied for this report. Sample-locality maps for outlined areas appear in appendix A. See Combellick (1991) for borehole data at Portage and Palmer Hay Flats and for additional data at Girdwood and Goose Bay.

Our approach to this study was to examine and sample tidal-bank exposures and borehole cores in the tidal marshes, carefully sample plant materials at the peat-mud contacts for radiocarbon dating, record the stratigraphy of the deposits, and quantify their granulometric properties. The purpose of this report is to present all of the field and laboratory data that resulted from this study. In addition to their potential for helping to decipher the paleoseismicity of the region, the data may be useful for other studies requiring basic information on the geologic history or sedimentology of these marshes. A separate report (Combellick, 1994) summarizes and interprets these and previously published data for their possible paleoseismic implications.

## FIELD STUDIES

In previous field studies, Combellick (1991) examined bank exposures and drilled boreholes in the tidal marshes of upper Turnagain and Knik Arms, including marshes at Girdwood, Portage, Palmer Hay Flats, and Goose Bay (fig. 1). Our objective in subsequent field studies was to complete similar work in the remaining major tidal marshes along Kenai Peninsula that subsided during the 1964 earthquake. We collected additional data at Girdwood and Goose Bay and conducted new field studies at Chickaloon Bay, Kenai River flats, Kasilof River flats, and Fox River flats. Detailed descriptions of these exposures, hand-auger samples, and borehole cores are presented in appendixes B and C.

## TIDAL-BANK EXPOSURES

We examined a total of 18 natural exposures along tidal channels, coastal banks, and estuaries. Detailed descriptions of these exposures appear in appendix A. Where they are visible, natural exposures provide the best opportunity to record stratigraphy, to observe lateral extent and relations of strata, and to select optimal sites for sampling. Unfortunately, natural tidal-bank

exposures are typically only 3-6 ft (1-2 m) high and rarely exceed 10 ft (3 m) high, even in Turnagain Arm, where the diurnal tidal range is as much as 33 ft (10 m). Except in a few locations where they are kept clean by tidal currents, the lower portions of the banks are covered with modern tidal sediments. The upper parts of many tidal banks are covered with sagged or slumped surficial deposits and vegetation.

Exceptional exposures of interbedded thick tidal sediments and marsh peats spanning the past 3,000 yr or more are visible at Girdwood (fig. A1, location 92-19) and Goose Bay (fig. A3, location 92-20). At most other locations, only the upper portion of the stratigraphic section spanning the past few thousand years is visible. We supplemented our observations and sampling of natural exposures with hand-auger and borehole drilling to extend our data collection to deeper subsurface deposits and to areas where there are few or no natural exposures.

Samples for radiocarbon dating were carefully collected from the thinnest possible upper portion of buried peat layers, normally less than 1 in. (2.5 cm) thick, to obtain a radiocarbon age that closely approximates the age of the surface at the time of burial. We also collected samples of twigs and leaves attached to rooted plants and of the outer 10-25 annual growth rings of rooted stumps.

## HAND-AUGER DRILLING

We drilled shallow reconnaissance holes or extended our observations of bank exposures beneath submerged or covered zones by using one of two types of hand-drilling apparatus. One is a 1½-in.-diameter bit and brace with 1-ft (30-cm) extensions that allow drilling to about 5 ft (1.5 m). Only disturbed cuttings on the bit can be observed or sampled; most details of stratigraphic relations and sediment fabric cannot be determined using this method. Consequently, this method was used only as a reconnaissance tool to determine the sediment type, whether

buried peat layers are present in the shallow subsurface, and whether the ground appeared strong enough to support a heavy drill rig.

The second type of hand-drilling apparatus is a bucket-auger system with interchangeable sampling buckets that range in diameter from 2½ to 4 in. (6-10 cm). With 5-ft (1½-m) drill-rod extensions, drilling depth is limited only by the strength of the operators. The open-ended bucket fills with sediment up to its 8-in. (20-cm) depth as drilling progresses. With the largest-diameter buckets, a more-or-less intact sample can be retrieved that preserves gross stratigraphic relations like contacts between peat and mud, although fine details like the sharpness of the contacts normally cannot be determined.

Samples from both tidal-bank exposures and hand-auger drilling were placed in sealed plastic bags for transportation and storage. No attempt was made to keep these samples stratigraphically intact.

## BOREHOLE DRILLING

In areas where natural exposures are limited or where deeper data were desired, we drilled hollow-stem boreholes and collected sediment cores. A total of 15 boreholes were drilled on vegetated tidal marshes, including 9 sites at Fox River flats in February and March 1991, 4 sites at Kenai River flats in May and June 1991, and 2 sites at Kasilof River flats in June 1991. All boreholes were drilled with a truck- or track-mounted CME-75 drill rig. The 40,000-lb reaction load of this drill rig allowed the sampler to be pushed into the sediment without using a hammer, reducing artificial sample compaction and disturbance. Total drilling depths ranged from 9.5 to 39.5 ft (2.9-12.0 m).

Samples were collected using a continuous-sample-tube system in conjunction with the hollow-stem auger (fig. 2). The sampler consisted of a 5-ft-long (1.5-m), 3.25-in. (8.3-cm) i.d. split steel barrel, which delivered two relatively undisturbed core samples in clear plastic liners, each 2.5 ft

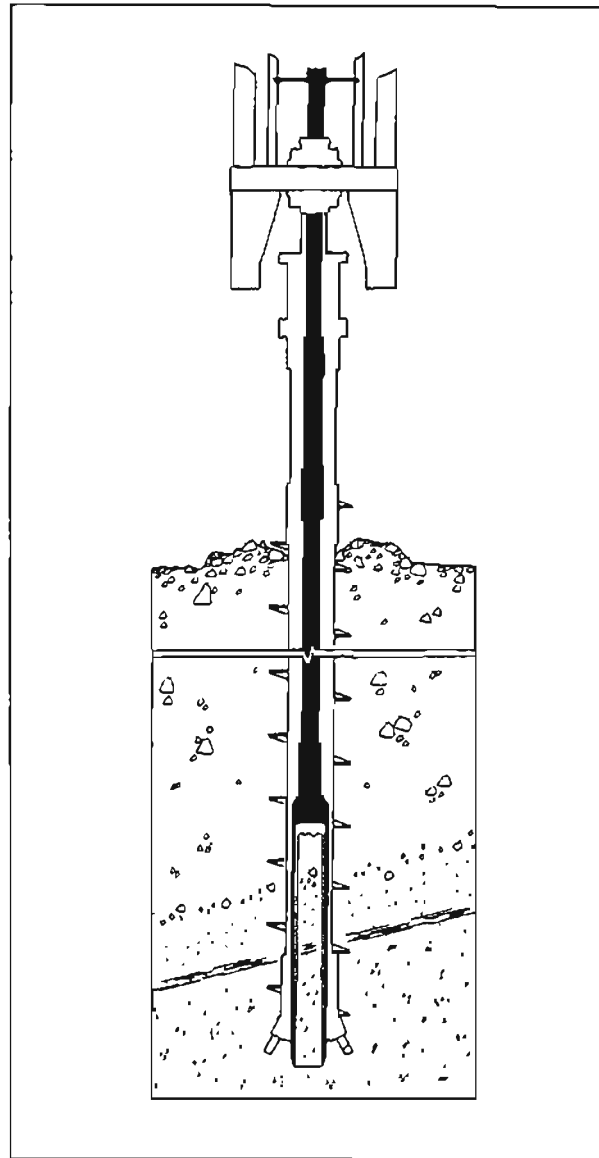


Figure 2. Cross section of hollow-stem auger with continuous-sampling system (solid black). Drilling and sampling occur simultaneously in 5-ft (1.5-m) increments as the nonrotating sample barrel pushes ahead of the auger. Diagram provided by Central Mining Equipment.

(76 cm) long and 2.5 in. (6.4 cm) diam. Drilling and sampling occurred simultaneously in 5-ft (1.5-m) intervals as the auger rotated around the sampler. Samples were retrieved by lifting the sampler to the surface through the hollow-stem auger, disassembling the split barrel, and remov-

ing the filled sample liners. The liners were sealed, placed upright in crates for transportation, and stored in the crates until they were opened in the laboratory.

Sample recovery ranged from 16 to 100 percent. Two circumstances resulted in incomplete sample recovery. First, where very firm material—dense peat, frozen soil, or a large pebble—was underlain by less-firm material, the firm material sometimes plugged the cutting head and forced the softer material to the outside of the sample barrel as the sampler penetrated farther. Second, while retrieving loose, wet sand or silt with no clay for cohesion, part of the sample occasionally flowed out of the sampler.

## LABORATORY ANALYSES

### CORE LOGGING AND SUBSAMPLING

In the laboratory, core samples were split in half lengthwise and retained in their plastic liner halves, which served as trays for handling and storage. After cleaning and smoothing the surface, each sample was described in detail (appendix C) and photographed with high-resolution black-and-white film. A tape measure was registered to the top of the sample according to its depth on the drilling log so that depths to subsamples could be measured accurately.

Subsamples for radiocarbon dating and granulometric analyses were collected from one side of the split samples. Intact (archive) halves and the remainder of the subsampled halves were covered with plastic wrap and stored in core boxes for possible future use.

To obtain sufficient carbon for dating, subsamples of peat layers were normally 0.1 ft (3 cm) thick and were taken from the top of each peat layer. A radiocarbon age at the top of a buried peat layer provides a close maximum age of the ground surface at time of burial, assuming the sample is not contaminated with roots or older organic material. If the peat layer was less than 0.1 ft thick, the entire layer was removed

from the sample half to ensure sufficient quantity for dating.

Some subsamples collected for radiocarbon dating were composed of organic silt or disseminated fine organic matter that may represent relict peat layers or may contain reworked or transported organics. Because the carbon content of these zones is low, subsamples were generally thicker than for peat. We regard radiocarbon ages of these subsamples with some suspicion because the samples contain barely enough carbon for dating and may be contaminated by older detrital organic material, like coal.

A total of 89 subsamples was collected for grain-size analyses as an aid to interpreting depositional processes. These subsamples were also normally 0.1 ft (3 cm) thick except in layers of coarse sand and gravel, which required larger samples.

### RADIOCARBON DATING

Subsamples collected for radiocarbon dating were oven dried, weighed, and examined for contaminants, such as roots of younger plants or transported older organics, both of which were removed. Of 108 organic subsamples collected from bank exposures, cores, and hand-auger holes, 78 were submitted for radiocarbon dating. The remaining samples were not submitted because they were unneeded replicates, were too small, were replaced by better quality samples, or were determined not likely to provide significant age information. Two samples were destroyed in a drying oven that overheated.

Two commercial laboratories performed the radiocarbon dating using standard pretreatment and gas-proportional counting techniques. Their reported radiocarbon ages (table 1) are based on the Libby half-life for  $^{14}\text{C}$  (5,570 yr) and are referenced to A.D. 1950. All ages include a correction for natural  $^{13}\text{C}/^{12}\text{C}$  isotopic fractionation. Calibration to calendar years was based on tree-ring data from sources quoted in table 1 and was



Table 1. Radiocarbon ages of samples collected in this study

[Age in  $^{14}\text{C}$  yr B.P. is conventional radiocarbon age in years before A.D. 1950 with quoted laboratory counting error of one standard deviation. Calibrated ages are the one-sigma limits of age ranges based on published tree-ring corrections<sup>a</sup> and are rounded to the nearest 10 yr. Calibrated ages incorporate an error multiplier of 2 to account for possible noncounting sources of laboratory error. All ages include a correction for natural  $^{13}\text{C}/^{12}\text{C}$  isotopic fractionation. For sample locations and stratigraphic positions, see appendixes A, B, and C]

Location, sample	Depth in section (ft/m)		Material	Age ( <sup>14</sup> C yr B.P.)	Calibrated age (yr B.P.)	Lab number
<u>Girdwood flats (fig. A2)</u>						
91- 1-1	6 <sup>b</sup>	1.83 <sup>b</sup>	Peat	760 ± 70	560-790	Beta-45196
91- 2-1	5 <sup>b</sup>	1.52 <sup>b</sup>	Rooted wood	860 ± 60	670-920	Beta-45197
91- 3-1	11.5	3.51	Peat	2,110 ± 60	1,930-2,310	Beta-45198
91- 4-1	5 <sup>b</sup>	1.52 <sup>b</sup>	Rooted wood	940 ± 60	720-950	Beta-45199
91-20-5.6	5.6	1.71	Peat	1,010 ± 60	780-1,060	Beta-47178
91-31-2.1	2.1	0.64	Peat	600 ± 70	510-670	Beta-50338
91-31-2.5	2.5	0.76	Peat	1,040 ± 60	790-1,060	Beta-50339
91-32-1	4 <sup>b</sup>	1.22 <sup>b</sup>	Rooted wood	830 ± 60	660-910	Beta-59792
92-19-1	9.2	2.79	Peat	1,380 ± 60	1,170-1,360	Beta-54601
92-19-2	11.3	3.45	Rooted wood w/bark	2,000 ± 60	1,820-2,110	Beta-54602
92-19-3	15.7	4.78	Peat	2,600 ± 60	2,490-2,790	Beta-54603
92-19-4	5.6	1.70	Peat	730 ± 50	560-730	Beta-54604
<u>Goose Bay (fig. A4)</u>						
92-20-2	2.0	0.60	Rooted wood	180 ± 50	0-300	Beta-54605
92-20-3	4.3	1.30	Peat w/wood, bark	480 ± 60	330-620	Beta-54606
92-20-4	10.5	3.20	Peat	990 ± 60	750-980	Beta-54607
92-20R-1	14.4	4.40	Peat	1,690 ± 80	1,400-1,800	Beta-65790
92RE20A F-1	22.0	6.70	Shells	3,552 ± 44	3,700-3,960	GX-18226AMS
<u>Chickaloon Bay (fig. A6)</u>						
92-14R-2	3.7	1.12	Peat	260 ± 50	0-440	Beta-54592
92-14R-4	5.9	1.80	Woody peat	930 ± 60	700-950	Beta-54593
92-14R-6	11.8	3.60	Peat	1,960 ± 50	1,810-2,000	Beta-54594
92-14R-7	13.5	4.12	Peat	1,940 ± 70	1,710-2,010	Beta-54595
92-15-2	3.3	1.00	Rooted wood w/bark	0	Modern	Beta-59793
92-16-1	3.8	1.15	Rooted wood w/bark	300 ± 70	0-500	Beta-54596
92-16-3	8.0	2.43	Peat	910 ± 60	680-940	Beta-54597
92-17-1	4.4	1.35	Rooted wood w/bark	20 ± 50	0-250	Beta-54598
92-17-3	3.0	0.90	Triglochin leaf bases	0	Modern	Beta-54599
92-17-4	7.1	2.15	Triglochin(?) -rich peat	1,010 ± 70	750-1,060	Beta-54600
<u>Kenai River flats (fig. A8, A9)</u>						
90- 1-3.5	3.5	1.07	Peat	2,815 ± 230	2,350-3,470	GX-16470
90- 2-3.7	3.7	1.13	Peat	1,265 ± 130	930-1,400	GX-16471
91-30R-1	8.5	2.6	Detrital wood	9,600 ± 50	10,480-10,950	Beta-54590
91-30R-2	7.5	2.3	Herbaceous roots	3,120 ± 130	3,080-3,700	Beta-54591 and CAMS-3226 (AMS)
91-30R-3	8.5	2.6	Detrital wood	9,440 ± 90	10,210-10,890	Beta-59789
91-30R-4	7.5	2.3	Peat	9,260 ± 100	10,010-10,470	Beta-59790
91-30R-5	8.5	2.6	Peat	9,470 ± 90	10,220-10,910	Beta-59791
91RE2C-1	9.5	2.9	Organic silt	11,280 ± 150	12,890-13,520	Beta-47181
91-16-0.7	0.7	0.21	Rooted wood	180 ± 60	0-310	Beta-45208
91-16-2.0	2.0	0.61	Peat	1,350 ± 60	1,160-1,340	Beta-45209
91-16-2.3	2.3	0.70	Rooted wood	1,840 ± 60	1,610-1,880	Beta-50335
91-16-3.0	3.0	0.91	Rooted wood	3,590 ± 70	3,690-4,090	Beta-45210
91-16B-3.35	3.35	1.02	Peat	3,540 ± 70	3,630-3,990	Beta-50336

Table 1 (continued).

Location, sample	Depth in section (ft/m)		Material	Age ( <sup>14</sup> C yr B.P.)	Calibrated age (yr B.P.)	Lab number
91-16-6.5	6.5	1.98	Peat	6,190 ± 80	6,880-7,230	Beta-45211
91-18-3.7	3.7	1.13	Rooted wood	2,640 ± 50	2,720-2,840	Beta-50337
KE1- 4.9	4.9	1.49	Peat	1,590 ± 80	1,310-1,690	Beta-49102
KE1-11.8	11.8	3.60	Peaty silt	6,920 ± 90	7,540-7,910	Beta-50324
KE1-13.9	13.9	4.24	Peat	7,170 ± 120	7,690-8,140	Beta-49103
KE1-14.3	14.3	4.36	Sandy peat	8,080 ± 250	8,360-9,500	Beta-49104
KE2-14.2	14.2	4.33	Silty peat	2,530 ± 80	2,350-2,770	Beta-49105
KE2-15.9	15.9	4.85	Peat	2,780 ± 90	2,750-3,110	Beta-49106
KE2-16.4	16.4	5.00	Peat	2,760 ± 110	2,720-3,200	Beta-49107
<u>Kasilof River flats (fig. A11)</u>						
90- 5-2.7	2.7	0.82	Peat	1,810 ± 80	1,530-1,890	GX-16472
91-15- 2.0	2.0	0.61	Peat	120 ± 60	0-290	Beta-45200
91-15- 3.5	3.5	1.07	Peat	1,270 ± 70	990-1,300	Beta-45201
91-15- 3.9	3.9	1.19	Peat	1,560 ± 50	1,330-1,540	Beta-45202
91-15- 4.0	4.0	1.22	Rooted wood	1,680 ± 50	1,420-1,700	Beta-45203
91-15- 4.8	4.8	1.46	Rooted wood	3,470 ± 70	3,560-3,890	Beta-45204
91-15- 6.6	6.6	2.01	Rooted wood	5,560 ± 60	6,220-6,460	Beta-45205
91-15- 6.8	6.8	2.07	Peat	5,260 ± 70	5,900-6,260	Beta-45206
91-15-10.2	10.2	3.11	Silty peat	7,380 ± 90	7,950-8,340	Beta-45207
91-15B-1	5.3	1.62	Peat	3,310 ± 70	3,370-3,690	Beta-50331
91-15B-3	5.4	1.65	Peat	3,510 ± 60	3,630-3,920	Beta-50332
91-15B-4	5.9	1.80	Peat	4,550 ± 70	4,980-5,450	Beta-50333
91-15B-6	6.0	1.83	Peat	4,970 ± 100	5,480-5,920	Beta-50334
KS1- 2.9	2.9	0.88	Peat	490 ± 90	310-650	Beta-49108
KS1- 3.65	3.65	1.11	Peat	910 ± 80	670-960	Beta-49109
KS1- 5.9	5.9	1.80	Peaty mud	1,280 ± 90	980-1,330	Beta-49110
KS1-21.0	21.0	6.40	Peat	7,740 ± 60	8,370-8,570	Beta-49111
KS1-24.3	24.3	7.41	Peat	10,450 ± 110	12,010-12,610	Beta-49112
<u>Fox River flats (figs. A13, A14)</u>						
91- 5-1	3.4	1.04	Organic silt	6,790 ± 100	7,400-7,770	Beta-50325
91- 6-2	3.5	1.07	Organic silt	6,380 ± 100	7,030-7,400	Beta-50326
91- 6-3	4.2	1.28	Silty peat	5,780 ± 100	6,320-6,850	Beta-50327
91- 8-1	5.0	1.52	Sedge pieces	5,380 ± 90	5,930-6,380	Beta-50328
91-10-1	5.3	1.62	Driftwood	190 ± 60	0-310	Beta-49095
91-11-1	2.0	0.61	<i>Triglochin</i> leaf bases	1,020 ± 90	730-1,080	Beta-50329
91-14-1	8.8	2.68	Detrital wood	800 ± 70	650-900	Beta-50330
FR1- 4.9	4.9	1.49	Organic silt	2,330 ± 110	2,060-2,730	Beta-49096
FR3- 2.4	2.4	0.73	Peaty silt	1,200 ± 110	920-1,300	Beta-49098
FR4- 1.5	1.5	0.46	Silty peat	600 ± 100	480-700	Beta-49099
FR5- 1.6	1.6	0.49	Silty peat	10 ± 100	0-280	Beta-49100

<sup>a</sup>Bard and others (1993), Kromer and Becker (1993), Linick and others (1986), Pearson and Stuiver (1993), Pearson and others (1993), and Stuiver and Pearson (1993).

<sup>b</sup>Approximate depth.

performed using a computer program by Stuiver and Reimer (1993).

The laboratories did not provide specific error multipliers to account for noncounting analytical errors, so we used a conservative value

of 2 for all calibrated ages. Although this has the effect of doubling the quoted standard deviation, the probability that the true sample age is within the calibrated age range remains at 68 percent. The error multiplier compensates for the fact that

the quoted standard deviation typically is not large enough to account for all sources of laboratory error (Stuiver and Pearson, 1986). We provide the uncalibrated radiocarbon ages so that readers can recalibrate the ages using different standard deviations or error multipliers.

Locations, stratigraphic positions, and calibrated age ranges of the dated samples are shown in the figures in appendix A. At all but one location (91-30 at Kenai River flats; figs. A7, A8), the top of the stratigraphic section is at the surface of a modern tidal marsh. Therefore, radiocarbon ages of organic material at these locations allow approximate dating of stages in marsh development, such as sudden changes from subaerial to submarine conditions resulting from earthquake-related subsidence. At location 91-30, samples were collected from the erosional bank of a late-Wisconsin fluvial terrace. These samples provide bracketing ages for a sand lens that appears to have been injected into a thick peat layer, possibly by earthquake-induced liquefaction. At locations 91-15 (Kasilof River flats; figs. A10, A11), 91-16 (Kenai River flats; figs. A7, A8), and KE2 (Kenai River flats; figs. A7, A9), radiocarbon samples provide bracketing ages for prominent tephra layers.

## GRAIN-SIZE ANALYSES

Samples for grain-size analyses were treated with hydrogen peroxide to remove organic matter then oven dried. Samples with more than 5 percent sand and gravel (24 of the total 89) were first analyzed using conventional 8-in.-diam (20.3-cm) sieves. The fine fractions of samples with more than 10 percent silt and clay (68 samples) were then analyzed using a Micromeritics Sedigraph 5000ET rapid sediment analyzer. This device determines size distribution of fine-grained sediments by using an x-ray beam to measure the mass percent of particles settling past the beam versus time in a liquid of known density and viscosity. The Sedigraph automatically plots the cumulative size distribution on graph paper.

Each sample was analyzed at least twice. If the results differed significantly (more than 5 percent difference between cumulative curves at any grain size), the sample was analyzed a third time. The cumulative size distributions were converted to phi units<sup>2</sup> to allow computation of size statistics. Mean grain size, standard deviation (sorting), and skewness (asymmetry) were computed from the phi size distributions using standard procedures for moment statistics (Friedman and Johnson, 1982) and are reported with percent gravel, sand, silt, and clay in table 2.

## SUMMARY

For this project we examined natural bank exposures, drilled boreholes, and collected samples for radiocarbon dating or grain-size analysis from a total of 55 sites at 6 tidal marshes in eastern and upper Cook Inlet (table 3). Laboratory analyses provided 78 radiocarbon ages and 89 grain-size distributions. The results provide basic data for interpreting the sedimentology and geologic history of these marshes. A separate report (Combellick, 1994) synthesizes these and previously published data and provides possible interpretations regarding the Holocene paleoseismicity of the region.

The results (appendixes A, B, and C) show that these tidal flats have developed during approximately the past 7,000 yr but have undergone episodic alternations between fresh- or brackish-water marsh and sub- or intertidal flat largely devoid of vegetation. Stratigraphy at Kenai River flats (fig. A8) and at Kasilof River flats (fig. A11) indicates that parts of these marshes have alternated between forested and nonforested conditions. Some of these alternations may be a result of coseismic submergence of the marsh followed by

<sup>2</sup> Phi =  $-\log_2(\text{grain diam}_{\text{mm}})$ . Because the natural breakdown of rocks results in a near lognormal distribution of grain diameters in most sedimentary environments, standard moment statistics for normal distributions can be computed for phi (Krumbein, 1936).

Table 2. Grain-size statistics for samples collected in this study

(For sample locations and stratigraphic positions, see appendixes A, B, and C. See Combellick (1991) for grain-size data from Girdwood, Portage, Palmer Hay Flats, and Goose Bay)

Location sample	Mean diam (mm)	Mean diam (phi) <sup>a</sup>	Std. deviation (phi)	Skewness (phi)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
<u>Chickaloon Bay (fig. A6)</u>								
92-14R- 1	0.0115	6.44	2.14	1.55	0.0	0.0	81.0	19.0
92-14R- 3	0.0032	8.29	2.29	0.53	0.0	0.0	54.0	46.0
92-14R- 5	0.0022	8.82	1.99	0.32	0.0	0.0	41.0	59.0
92-15- 1	0.0126	6.31	1.96	1.69	0.0	0.0	84.0	16.0
92-15- 4	0.0039	8.02	2.38	0.61	0.0	0.0	59.0	41.0
92-17- 5	0.0046	7.75	2.46	0.70	0.0	0.0	62.0	38.0
<u>Kenai River flats (fig. A9)</u>								
91-16- 1.0	0.0076	7.04	1.80	0.42	0.0	0.0	69.0	31.0
91-16- 6.6	0.0054	7.53	2.05	0.63	0.0	0.0	66.7	33.3
KE 1- 4.5	0.0038	8.03	2.02	0.50	0.0	0.0	55.0	45.0
KE 1- 7.0	0.0059	7.40	2.30	0.72	0.0	0.0	65.0	35.0
KE 1-13.0	0.0074	7.07	1.99	0.94	0.0	0.0	75.0	25.0
KE 1-15.0	8.0572	-3.01	1.47	1.56	90.2	9.6	0.1	0.0
KE 2- 4.8	0.0037	8.10	2.32	0.45	0.0	0.0	56.0	44.0
KE 2- 7.5	0.0040	7.98	2.55	0.41	0.0	0.0	56.0	44.0
KE 2- 9.4	0.0028	8.47	2.10	0.29	0.0	0.0	46.0	54.0
KE 2-13.8	0.0095	6.72	1.65	1.65	0.0	0.0	85.0	15.0
KE 2-17.6	0.0072	7.12	1.89	0.86	0.0	0.0	73.0	27.0
KE 2-23.0	0.0176	5.83	1.77	1.28	0.0	7.0	80.0	13.0
KE 2-28.1	0.0341	4.87	1.03	-0.10	0.0	18.0	81.2	0.8
KE 3- 1.0	0.0035	8.17	2.31	0.47	0.0	0.0	52.0	48.0
KE 3- 5.0	0.0065	7.27	1.72	0.33	0.0	0.0	66.0	34.0
KE 3-10.0	0.0027	8.55	2.20	0.22	0.0	0.0	46.0	54.0
KE 3-15.2	0.0028	8.46	2.12	0.23	0.0	0.0	44.4	55.6
KE 3-19.8	0.0054	7.54	1.98	0.38	0.0	0.0	59.6	40.4
KE 3-25.0	0.0028	8.49	2.61	0.19	0.0	0.0	47.0	53.0
KE 3-26.0	2.0435	-1.03	2.41	0.42	58.2	38.0	3.9	0.0
KE 4- 4.0	0.0032	8.31	2.34	0.38	0.0	0.0	50.0	50.0
KE 4-10.0	0.0032	8.30	2.28	0.43	0.0	0.0	51.0	49.0
KE 4-14.5	0.0029	8.45	2.36	0.27	0.0	0.0	48.0	52.0
KE 4-19.6	0.0036	8.11	2.63	0.51	0.0	0.0	56.6	43.4
KE 4-23.6	0.0039	8.00	2.26	0.47	0.0	0.0	54.5	45.5
KE 4-27.3	0.0871	3.52	1.78	3.21	0.0	82.9	13.6	3.5
KE 4-30.5	0.1246	3.00	0.59	-1.10	0.0	95.5	4.5	0.0
KE 4-31.0	0.0080	6.97	1.76	0.37	0.0	0.0	69.4	30.6
KE 4-32.4	0.0057	7.44	2.60	0.69	0.0	0.0	63.6	36.4
<u>Kasilof River flats (fig. A11)</u>								
91-15- 1.8	0.0026	8.59	2.42	0.24	0.0	0.0	46.0	54.0
91-15- 7.0	0.0023	8.77	2.53	0.11	0.0	0.0	45.5	54.5
91-15-10.0	0.0043	7.87	1.70	0.55	0.0	0.0	61.0	39.0
91-15-15.4	0.0038	8.03	2.36	0.66	0.0	0.0	60.0	40.0
KS 1- 4.7	0.0039	7.99	2.09	0.64	0.0	0.0	58.0	42.0
KS 1- 7.6	0.0048	7.70	1.93	0.32	0.0	0.0	58.0	42.0
KS 1-13.0	0.0047	7.73	2.24	0.23	0.0	0.0	55.0	45.0
KS 1-17.5	0.0044	7.83	2.22	0.34	0.0	0.0	56.0	44.0

Table 2 (continued)

Location, sample	Mean diam (mm)	Mean diam (phi) <sup>a</sup>	Std. deviation (phi)	Skewness (phi)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
KS 1-20.0	0.0033	8.27	2.43	0.30	0.0	0.0	50.0	50.0
KS 1-25.4	0.2495	2.00	0.96	0.02	0.0	97.5	2.5	0.0
KS 2- 7.5	0.2195	2.19	0.70	-0.46	0.0	98.0	2.0	0.0
KS 2- 8.3	0.0379	4.72	2.96	1.11	0.0	58.0	25.6	16.4
KS 2- 8.7	0.1686	2.57	0.64	0.90	0.0	94.7	5.3	0.0
<u>Fox River flats (figs. A13, A14)</u>								
91- 6- 1	0.3798	1.40	1.06	0.63	0.7	94.7	4.6	0.0
91- 9- 1	0.0038	8.04	1.97	0.57	0.0	0.0	53.0	47.0
FR 1- 3.5	0.0202	5.63	1.43	0.94	0.0	12.0	78.0	10.0
FR 1- 4.0	0.6394	0.65	2.92	0.87	30.4	58.2	9.4	1.9
FR 1- 6.5	0.5056	0.98	1.25	-0.43	9.6	89.3	1.2	0.0
FR 1-15.8	0.0031	8.34	2.12	0.24	0.0	0.0	47.0	53.0
FR 1-17.2	0.3983	1.33	0.58	0.67	0.0	99.6	0.4	0.0
FR 1-17.9	2.8039	-1.49	1.96	0.54	63.2	36.1	0.7	0.0
FR 2- 3.0	0.1184	3.08	0.89	3.20	0.0	93.0	6.4	0.6
FR 2- 4.0	0.0035	8.18	1.52	0.34	0.0	0.0	47.0	53.0
FR 2- 6.0	3.5592	-1.83	2.14	0.61	69.3	30.0	0.7	0.0
FR 2-10.0	2.4051	-1.27	2.03	0.40	58.6	40.3	1.1	0.0
FR 2-18.0	0.0041	7.93	1.94	0.26	0.0	0.0	51.0	49.0
FR 3- 0.5	0.0037	8.09	1.62	0.25	0.0	0.0	47.0	53.0
FR 3- 2.3	0.0022	8.83	1.33	-0.14	0.0	0.0	25.3	74.7
FR 3- 3.6	0.2785	1.84	1.23	-0.52	0.0	96.9	3.1	0.0
FR 3- 4.8	1.2766	-0.35	1.94	0.09	39.0	59.2	1.8	0.0
FR 3- 7.9	1.2036	-0.27	1.72	0.20	34.1	64.3	1.6	0.0
FR 4- 1.0	0.0049	7.68	2.00	0.87	0.0	0.0	64.0	36.0
FR 4- 4.7	0.0086	6.87	2.20	1.27	0.0	0.0	77.0	23.0
FR 4- 6.4	0.0043	7.88	1.70	0.58	0.0	0.0	58.0	42.0
FR 4- 8.4	0.0062	7.33	1.75	0.69	0.0	0.0	70.0	30.0
FR 4-10.5	0.3811	1.39	1.16	0.64	0.0	96.3	3.7	0.0
FR 4-11.4	0.6357	0.65	1.02	0.06	6.6	92.8	0.6	0.0
FR 4-13.6	0.6961	0.52	3.19	0.50	29.6	57.8	10.7	1.9
FR 5- 1.0	0.0036	8.10	1.63	0.68	0.0	0.0	54.0	46.0
FR 5- 2.5	0.0132	6.25	2.00	1.70	0.0	0.0	85.0	15.0
FR 5- 3.1	0.0299	5.06	2.40	1.38	0.0	38.9	51.9	9.2
FR 5- 5.2	0.1306	2.94	0.62	0.51	0.0	91.3	8.7	0.0
FR 5- 9.8	0.4088	1.29	0.96	0.32	0.0	98.4	1.6	0.0
FR 5-10.4	1.5458	-0.63	2.37	0.34	49.4	47.4	3.2	0.0
FR 8- 5.0	0.0155	6.01	2.42	0.15	0.0	24.2	54.4	21.4
FR 8- 7.0	0.0031	8.33	1.90	0.12	0.0	0.0	45.0	55.0
FR 8-11.0	0.0031	8.34	1.86	-0.05	0.0	0.0	45.0	55.0
FR 8-12.5	0.0030	8.38	1.83	0.29	0.0	0.0	45.0	55.0
FR 8-13.7	0.6747	0.57	1.33	0.02	13.0	85.9	1.2	0.0
FR 8-16.0	0.1888	2.41	2.57	0.98	0.0	77.6	17.9	4.5
FR 9- 2.5	0.0079	6.99	2.05	0.52	0.0	0.0	68.0	32.0
FR 9- 6.0	0.0045	7.78	1.81	0.34	0.0	0.0	58.0	42.0
FR 9-10.0	0.0029	8.42	2.13	0.34	0.0	0.0	47.0	53.0
FR 9-19.0	0.0074	7.07	2.12	0.39	0.0	0.0	64.0	36.0

<sup>a</sup>Phi = -log<sub>2</sub>(grain diam<sub>mm</sub>).

Table 3. *Types of data collected at tidal marshes along eastern and upper Cook Inlet*

	Girdwood	Goose Bay	Chickaloon Bay	Kenai River flats	Kasilof River flats	Fox River flats	Total
Bank exposures and hand-auger holes (appendix B)	7	1	5	7	6	14	40
Hollow-stem boreholes (appendix C)	0 <sup>a</sup>	0 <sup>a</sup>	0	4	2	9	15
Radiocarbon-age determinations (table 1)	12 <sup>a</sup>	5 <sup>a</sup>	10	22	18	11	78
Grain-size analyses (table 2)	0 <sup>a</sup>	0 <sup>a</sup>	6	29	13	41	89

<sup>a</sup>See Combellick (1991) for additional data.

aggradation and re-establishment of vegetation, as described by Combellick (1991). Other causes may be nonuniform rise of sea level, local migration of tidal and stream channels, or climatic variation.

The very fine-grained texture of clastic sediments at all marshes except Fox River flats indicates that sediment influx and deposition at these marshes is dominated by marine conditions. The texture of subsurface sediments in these marshes is very similar to the texture of the modern tidal sediments. The coarser-grained texture of sediments and lack of tabular peat layers at most locations on Fox River flats indicate that the sedimentary environment there is dominantly deltaic. Three major streams that empty into Kachemak Bay at Fox River flats deposit large volumes of sand and gravel at their mouths and have probably migrated extensively across the flats, reworking and prograding over pre-existing tidal-flat sediments. Radiocarbon ages of some of the few organic horizons on Fox River flats are anomalously old (fig. A13), possibly a result of contamination by older carbon. A likely contaminant is Tertiary coal, which crops out extensively along Kachemak Bay (Barnes and Cobb, 1959).

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## REFERENCES CITED

- Bard, E., Arnold, M., Fairbanks, R.G., and Hamelin, B., 1993, <sup>230</sup>Th-<sup>234</sup>U and <sup>14</sup>C ages obtained by mass spectrometry on corals: *Radiocarbon*, v. 35, p. 191-199.
- Barnes, F.F., and Cobb, E.H., 1959, *Geology and coal resources of the Homer district, Kenai coal field, Alaska*: U.S. Geological Survey Bulletin 1058F, p. 217-260, 2 sheets, scale 1:63,360.
- Bartsch-Winkler, S.R., and Garrow, H.C., 1982, Depositional system approaching maturity at Portage Flats, in Coonrad, W.L., ed., *The U.S. Geological Survey in Alaska: Accom-*

- plishments during 1980: U.S. Geological Survey Circular 844, p. 115-117.
- Bartsch-Winkler, Susan, and Schmoll, H.R., 1987, Earthquake-caused sedimentary couplets in the upper Cook Inlet region, in Hamilton, T.D., and Galloway, J.P., eds., *Geologic studies in Alaska by the U.S. Geological Survey during 1986: U.S. Geological Survey Circular 998*, p. 92-95.
- Bartsch-Winkler, Susan, and Schmoll, H.R., 1992, Utility of radiocarbon-dated stratigraphy in determining late Holocene earthquake recurrence intervals, upper Cook Inlet region, Alaska: *Geological Society of America Bulletin*, v. 104, no. 6, p. 684-694.
- Combellick, R.A., 1986, Chronology of late-Holocene earthquakes in southcentral Alaska: Evidence from buried organic soils in upper Turnagain Arm [abs.]: *Geological Society of America Abstracts with Programs*, v. 18, no. 6, p. 569.
- \_\_\_\_\_, 1991, Paleoseismicity of the Cook Inlet region, Alaska: Evidence from peat stratigraphy in Turnagain and Knik Arms: Alaska Division of Geological & Geophysical Surveys Professional Report 112, 52 p.
- \_\_\_\_\_, 1993, The penultimate great earthquake in southcentral Alaska: Evidence from a buried forest near Girdwood, in Solie, D.N., and Tannian, Fran, eds., *Short notes on Alaskan geology 1993*: Alaska Division of Geological & Geophysical Surveys Professional Report 113, p. 7-15.
- \_\_\_\_\_, 1994, Investigation of peat stratigraphy in tidal marshes along Cook Inlet, Alaska, to determine the frequency of 1964-style great earthquakes in the Anchorage region: Alaska Division of Geological & Geophysical Surveys Report of Investigations 94-7, 25 p.
- Friedman, G.M., and Johnson, K.G., 1982, *Exercises in sedimentology*: New York, John Wiley & Sons, 208 p.
- Kromer, B., and Becker, B., 1993, German oak and pine <sup>14</sup>C calibration, 7200 BC - 9400 BC: *Radiocarbon*, v. 35, p. 125-135.
- Krumbein, W.C., 1936, Application of logarithmic moments to size frequency distributions of sediments: *Journal of Sedimentary Petrology*, v. 6, p. 35-47.
- Linick, T.W., Long, A., Damon, P.E., and Ferguson, C.W., 1986, High-precision radiocarbon dating of bristlecone pine from 6554 to 5350 BC: *Radiocarbon*, v. 28, p. 943-953.
- Pearson, G.W., Becker, B., and Qua, F., 1993, High-precision <sup>14</sup>C measurement of German and Irish oaks to show the natural <sup>14</sup>C variations from 7890 to 5000 BC: *Radiocarbon*, v. 35, p. 93-104.
- Pearson, G.W., and Stuiver, M., 1993, High-precision bidecadal calibration of the radiocarbon time scale 500-2500 BC: *Radiocarbon*, v. 35, p. 25-33.
- Stuiver, M., and Pearson, G.W., 1986, High-precision calibration of radiocarbon time scale, AD 1950-500 BC: *Radiocarbon*, v. 28, p. 805-838.
- \_\_\_\_\_, 1993, High-precision bidecadal calibration of the radiocarbon time scale, AD 1950-500 BC and 2500-6000 BC: *Radiocarbon*, v. 35, p. 1-23.
- Stuiver, M., and Reimer, P.J., 1993, Extended <sup>14</sup>C database and revised CALIB radiocarbon calibration program: *Radiocarbon*, v. 35, p. 215-230.

## **APPENDIX A**

Station-location maps and stratigraphic diagrams



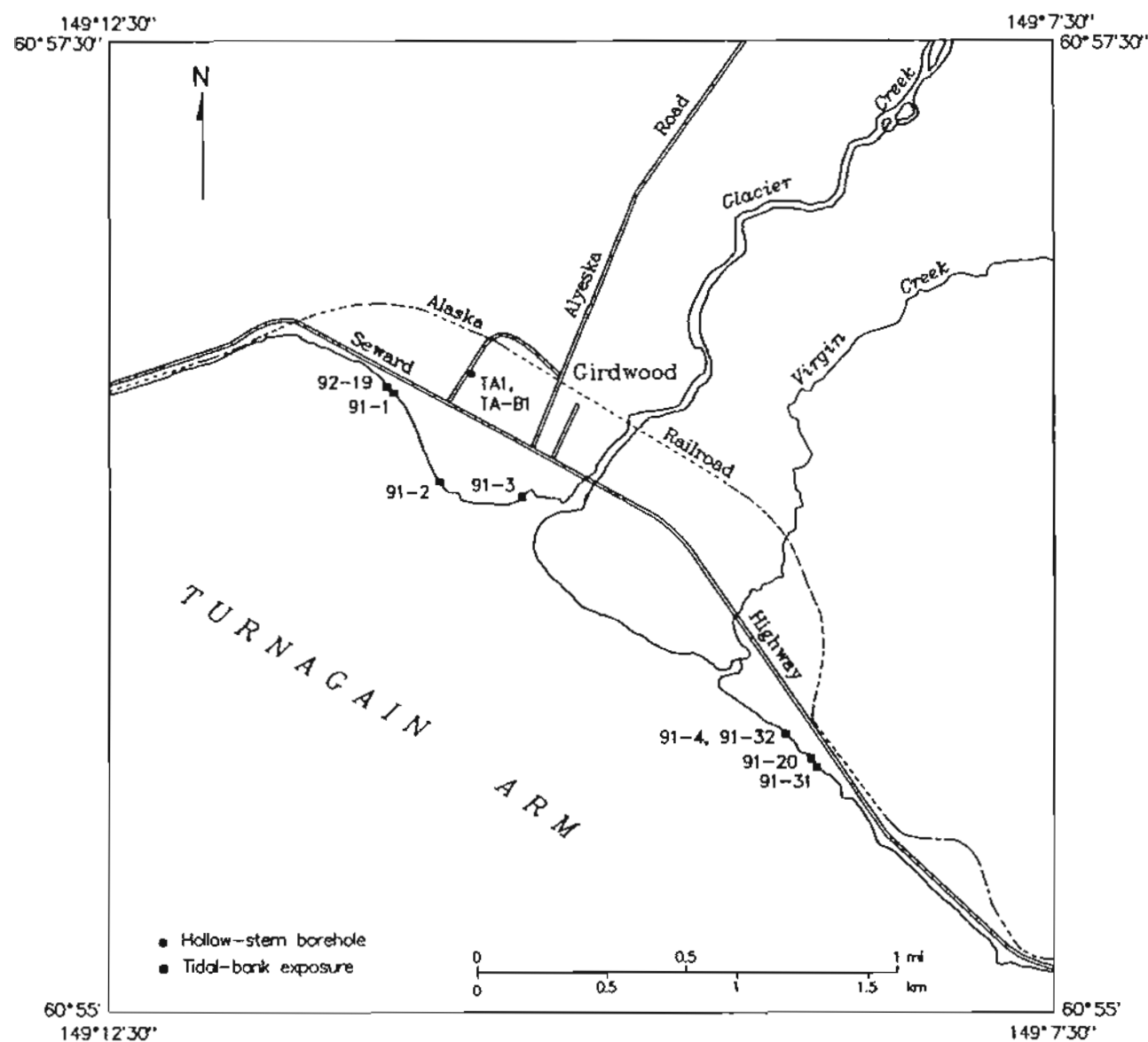


Figure A1. Station locations at a tidal marsh near Girdwood. See figure A2 for stratigraphic diagrams and appendix B for detailed descriptions. Data for boreholes TA1 and TA-B1 are given in Combellick (1991).

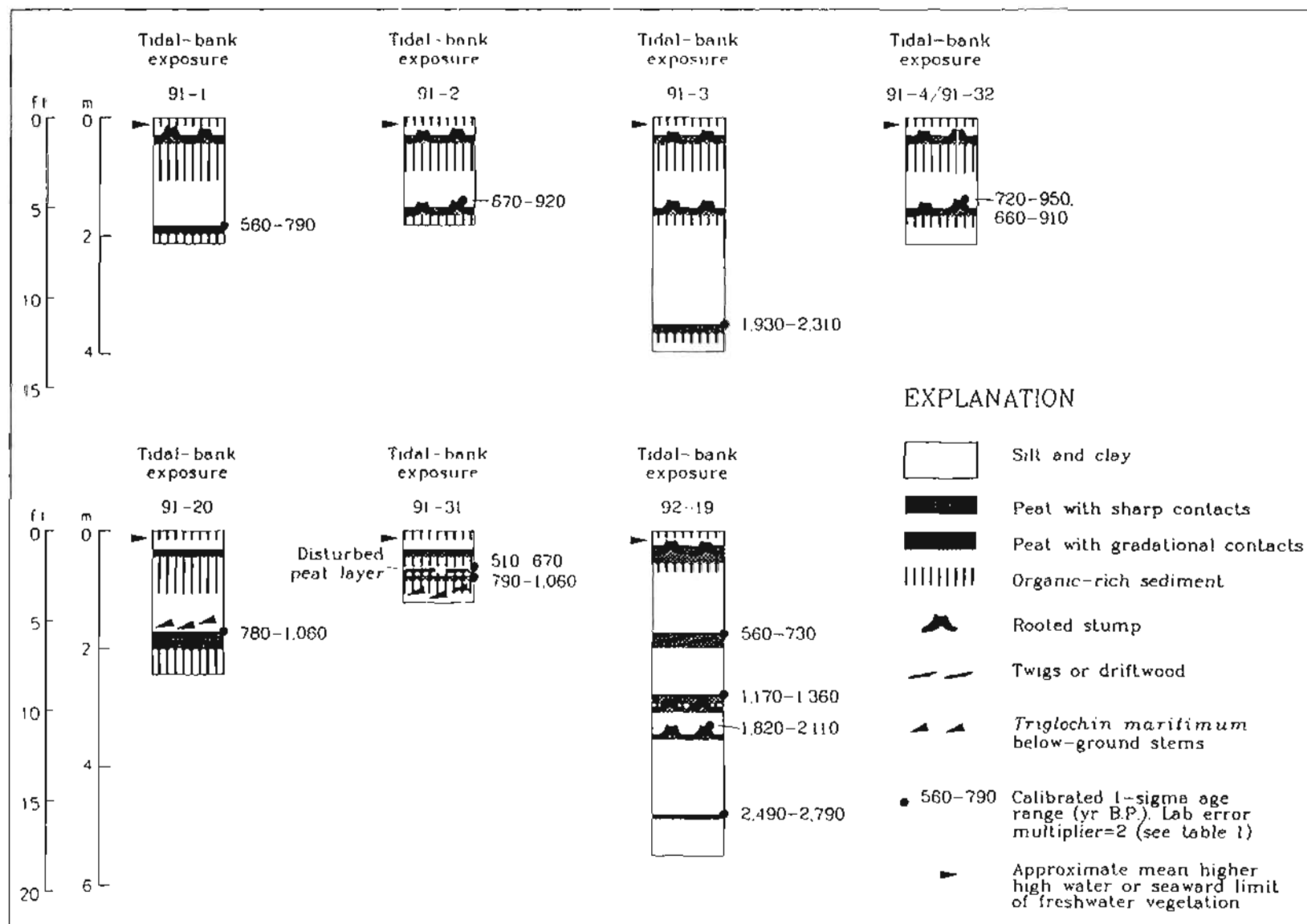


Figure A2. Stratigraphic diagrams for tidal-bank exposures at Girdwood (fig. A1). See appendix B for detailed section descriptions.

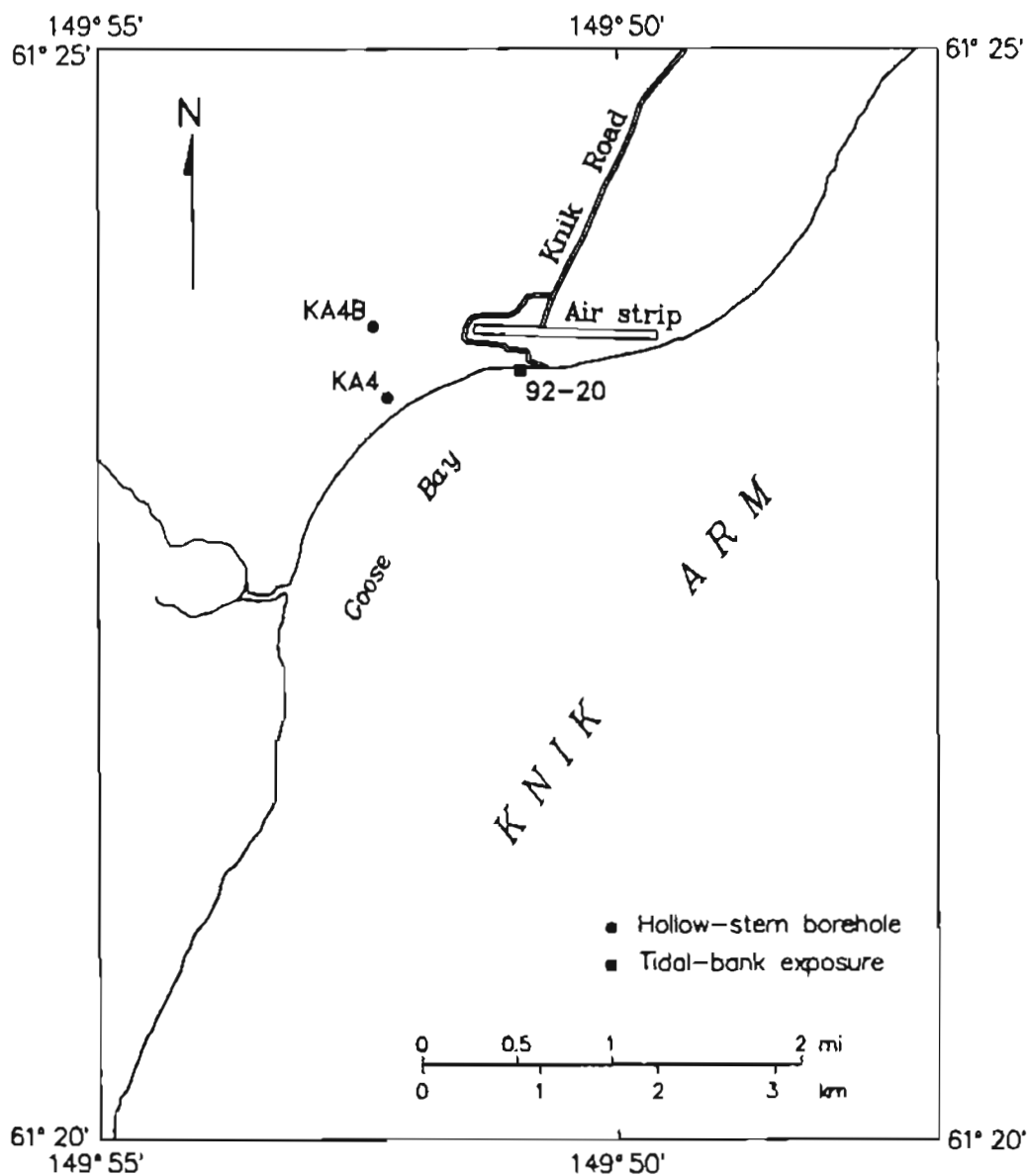


Figure A3. Station locations at Goose Bay. See figure A4 for a stratigraphic diagram of the tidal-bank exposure at 92-20 and appendix B for a detailed description. Data for boreholes KA4 and KA4B are given in Combellick (1991).

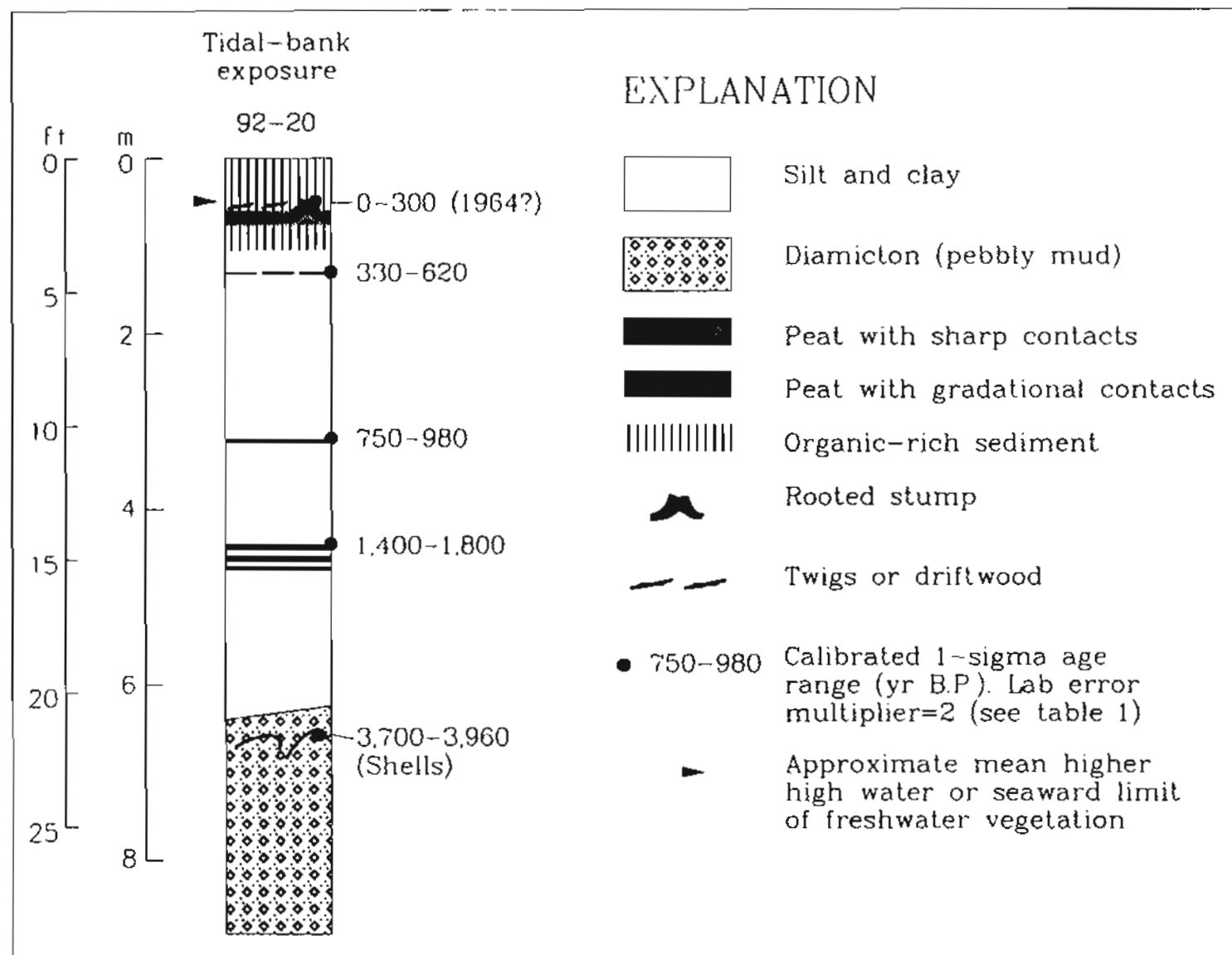


Figure A4. Stratigraphic diagram for tidal-bank exposure 92-20 at Goose Bay (fig. A3). See appendix B for detailed description.

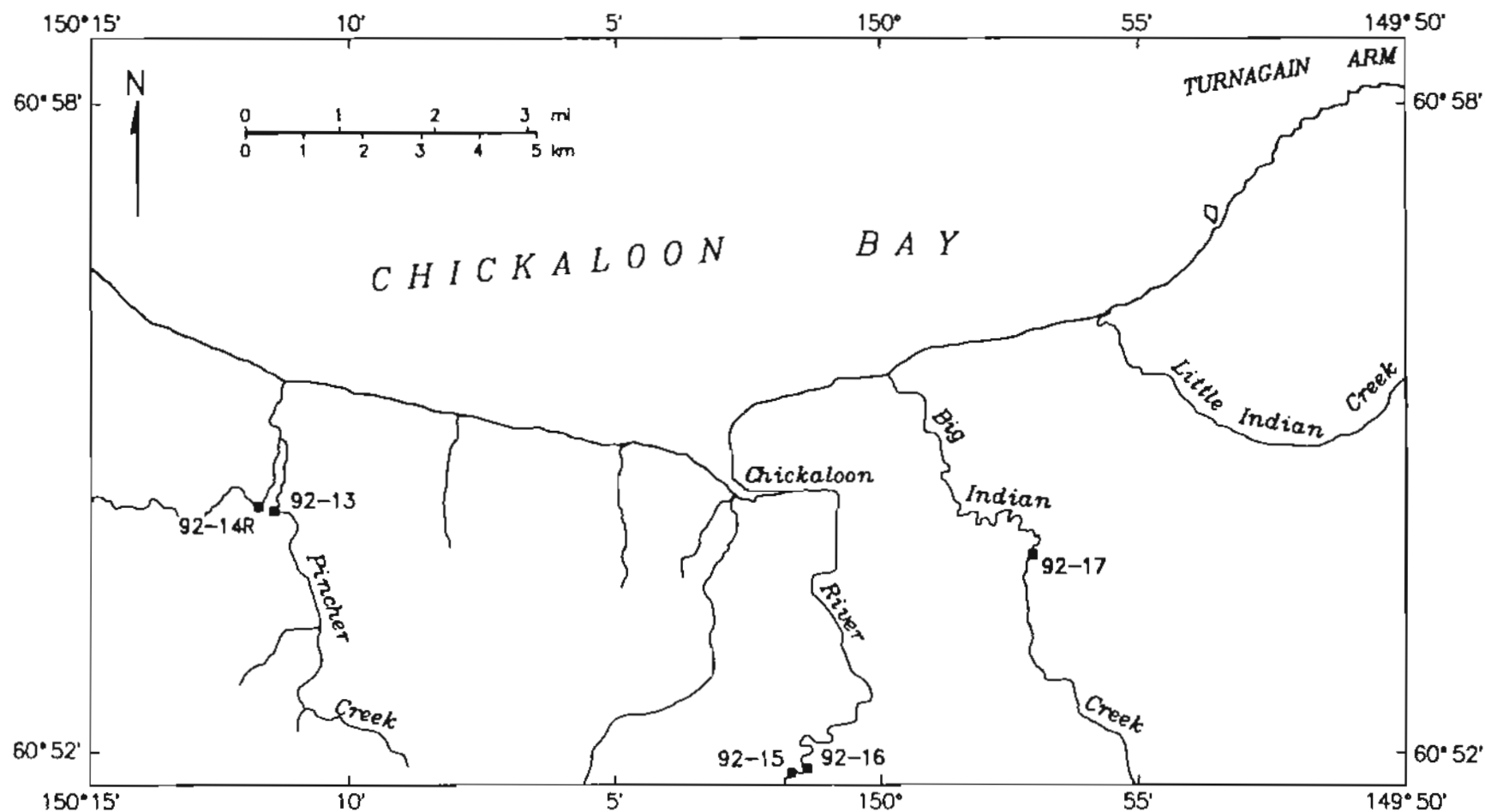


Figure A5. Station locations at Chickaloon Bay. See figure A6 for stratigraphic diagrams and appendix B for detailed descriptions.

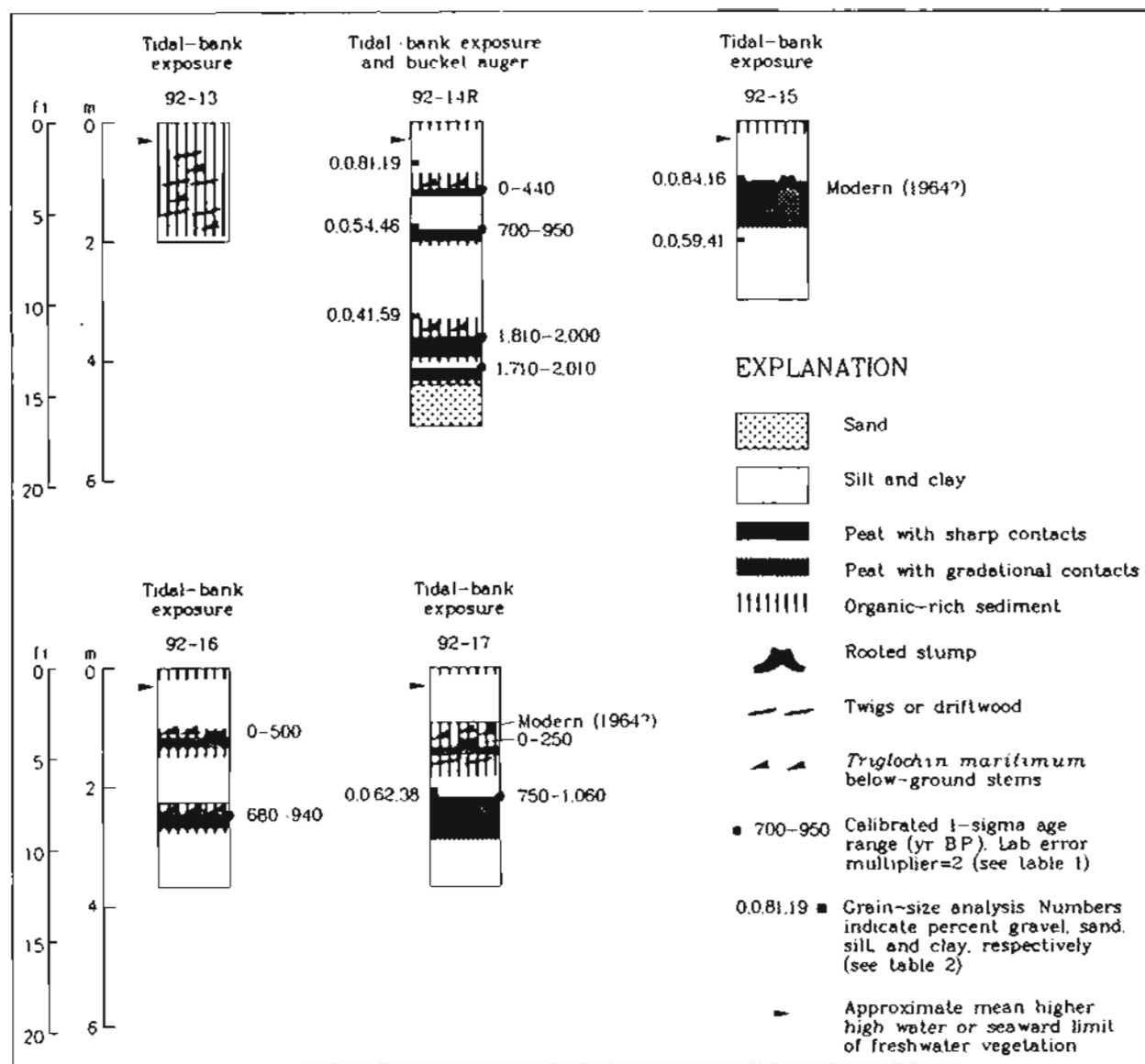


Figure A6. Stratigraphic diagrams for tidal-bank exposures at Chickaloon Bay (fig. A5). See appendix B for detailed descriptions.

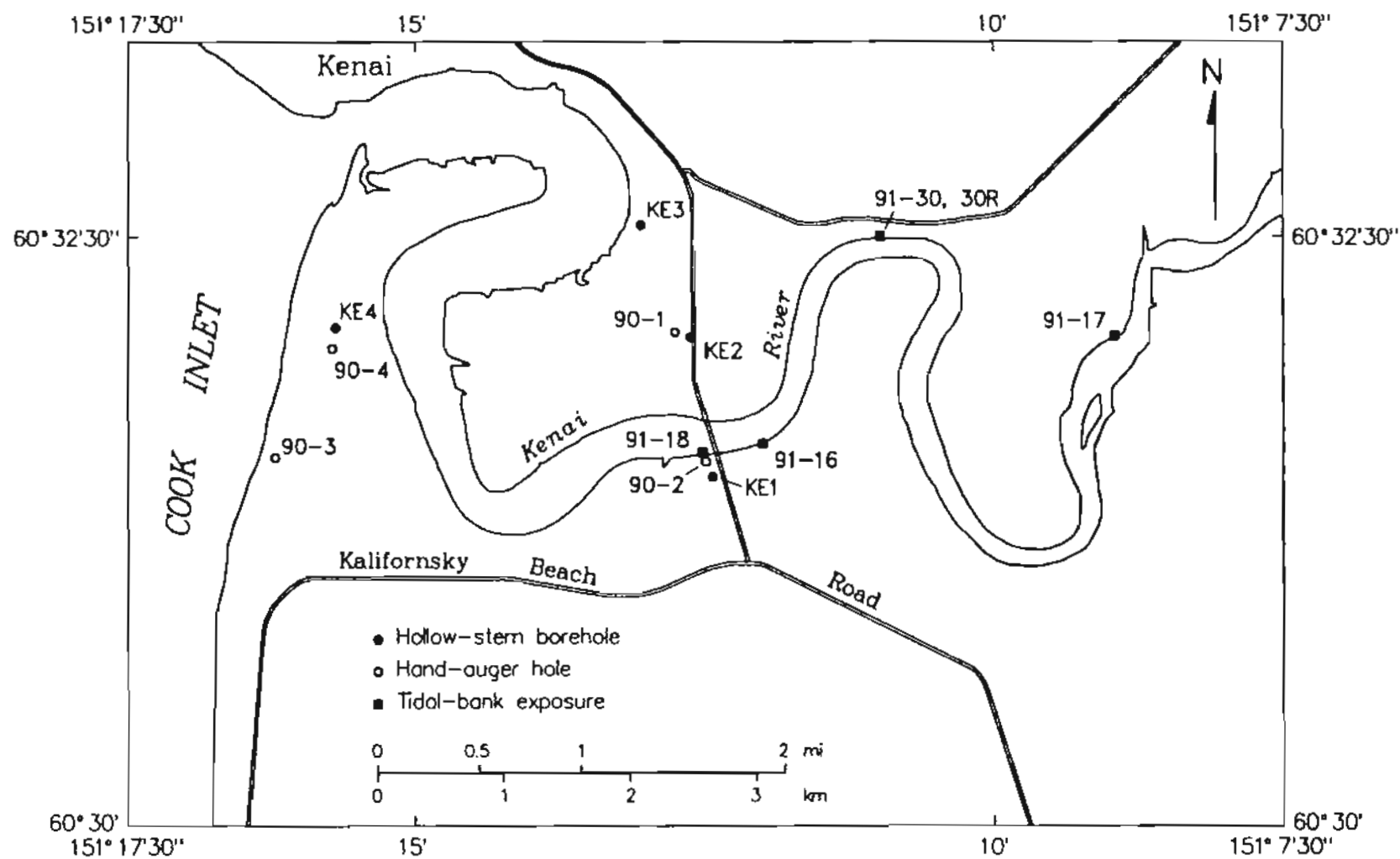


Figure A7. Station locations at Kenai River flats. See figures A8 and A9 for stratigraphic diagrams and appendixes B and C for detailed descriptions.

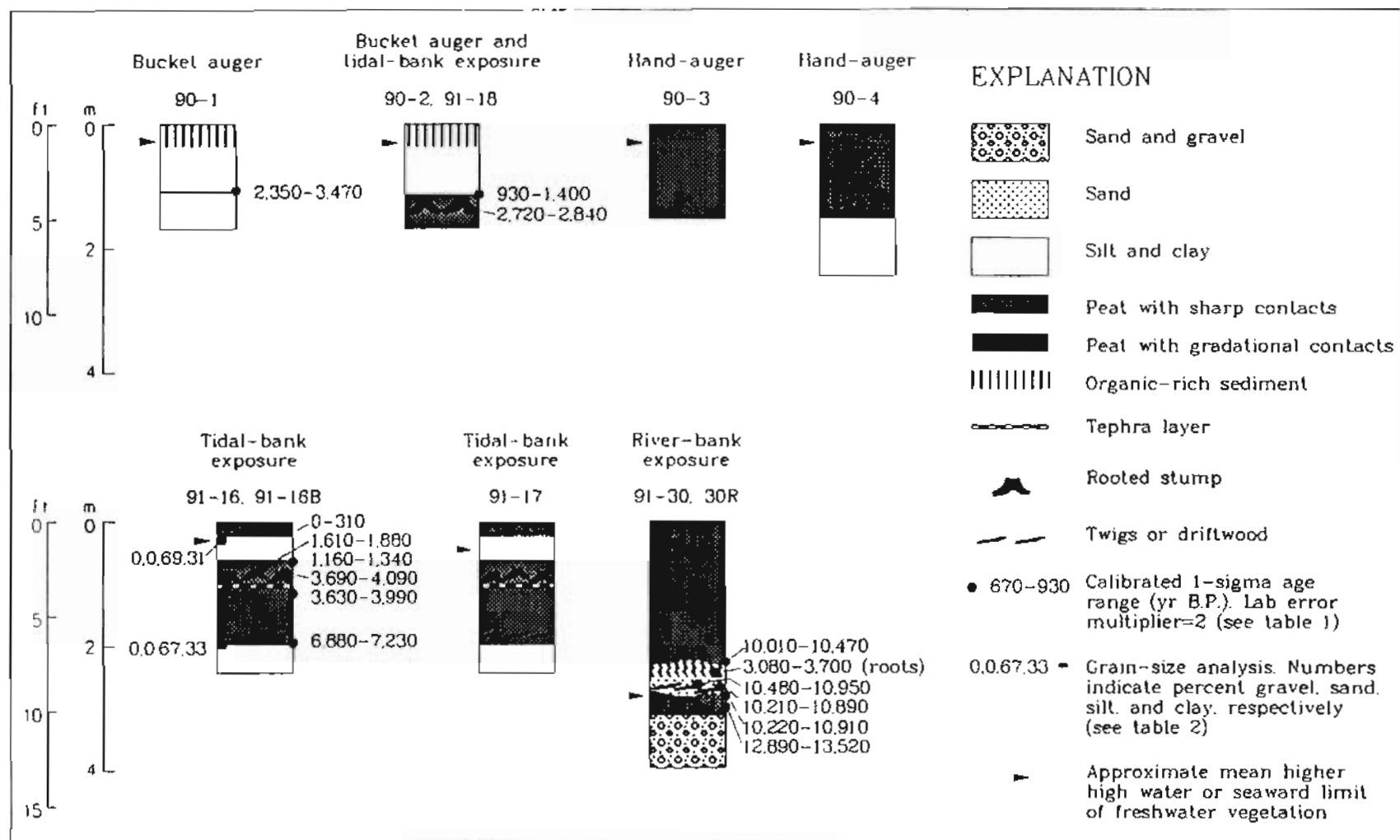


Figure A8. Stratigraphic diagrams for tidal-bank exposures and hand-auger holes at Kenai River flats (fig. A7). See appendix B for detailed descriptions.



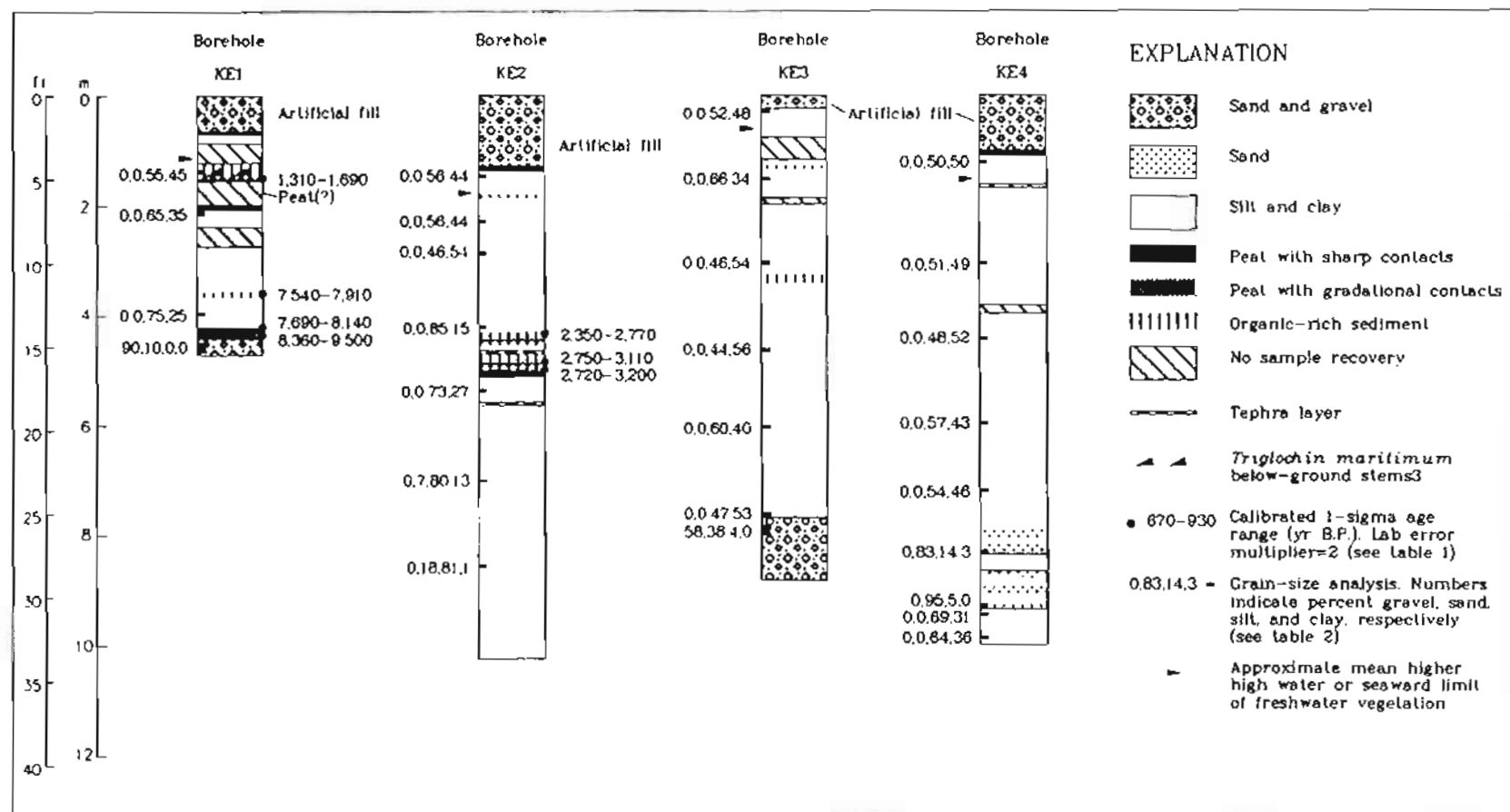


Figure A9. Stratigraphic diagrams for boreholes at Kenai River flats (fig. A7). See appendix C for detailed descriptions.

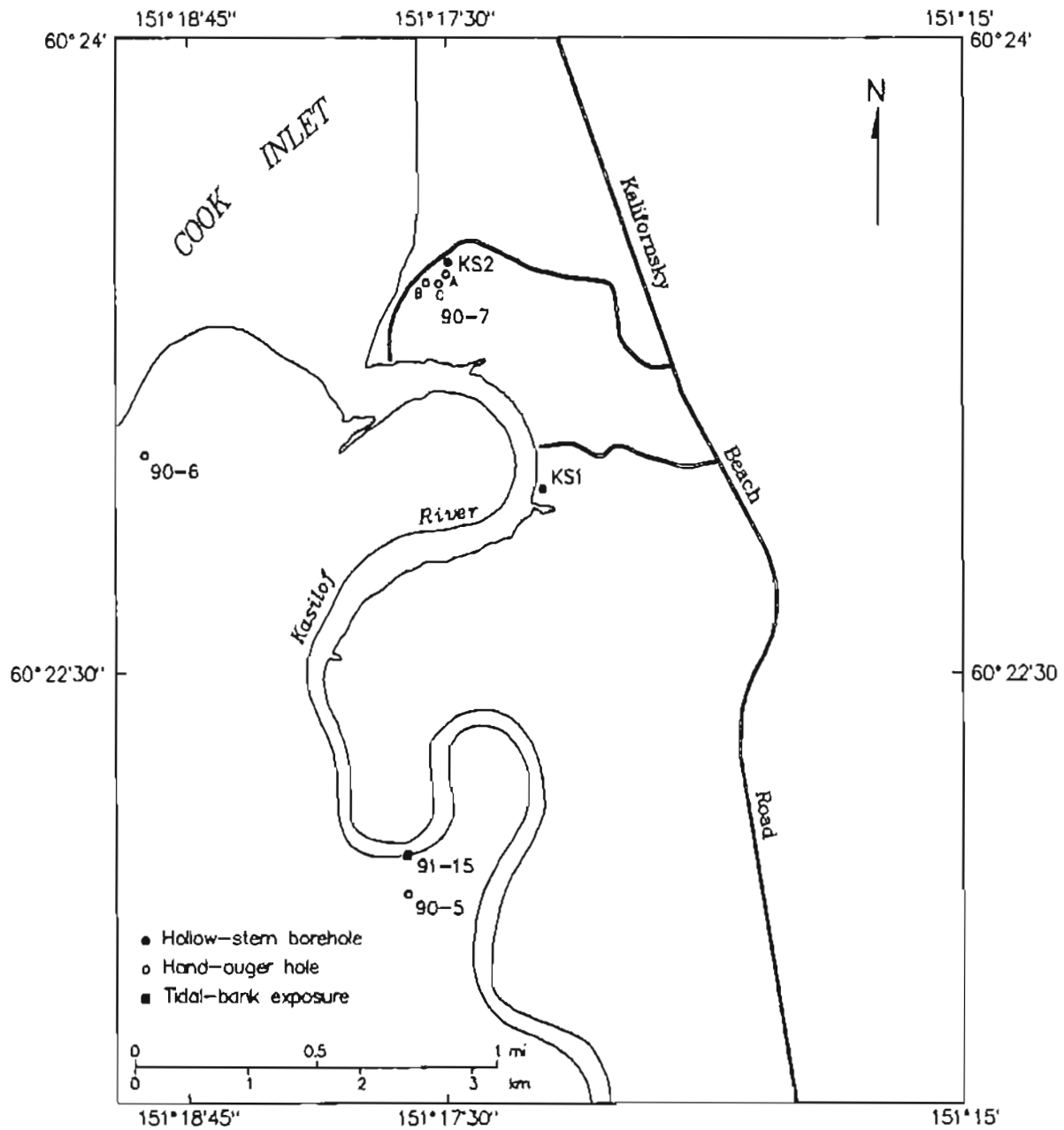


Figure A10. Station locations at Kasilof River flats. See figure A11 for stratigraphic diagrams and appendixes B and C for detailed descriptions.

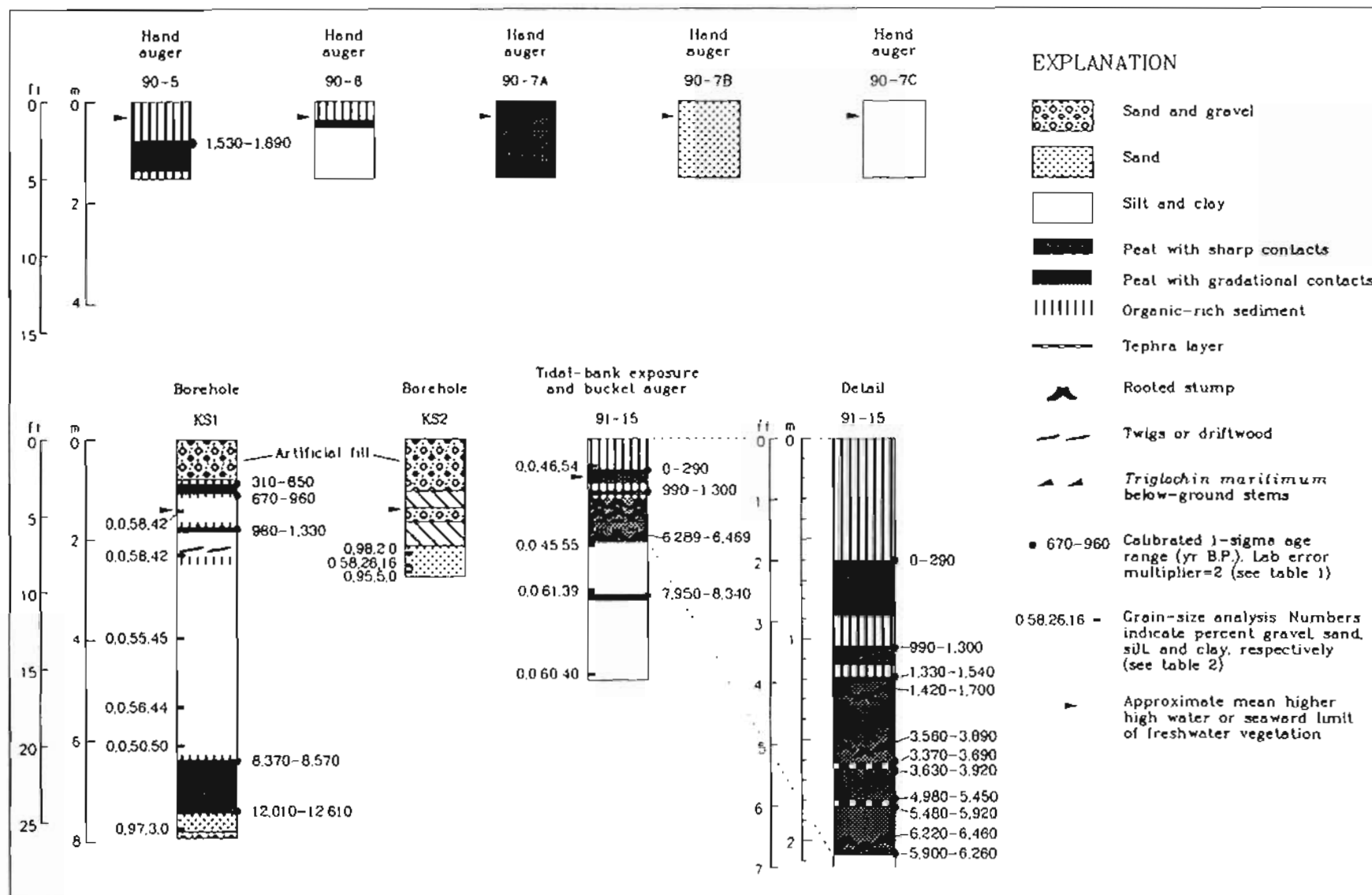


Figure A11. Stratigraphic diagrams for tidal-bank exposures, hand-auger holes, and boreholes at Kasilof River flats (fig. A10). See appendixes B and C for detailed descriptions.

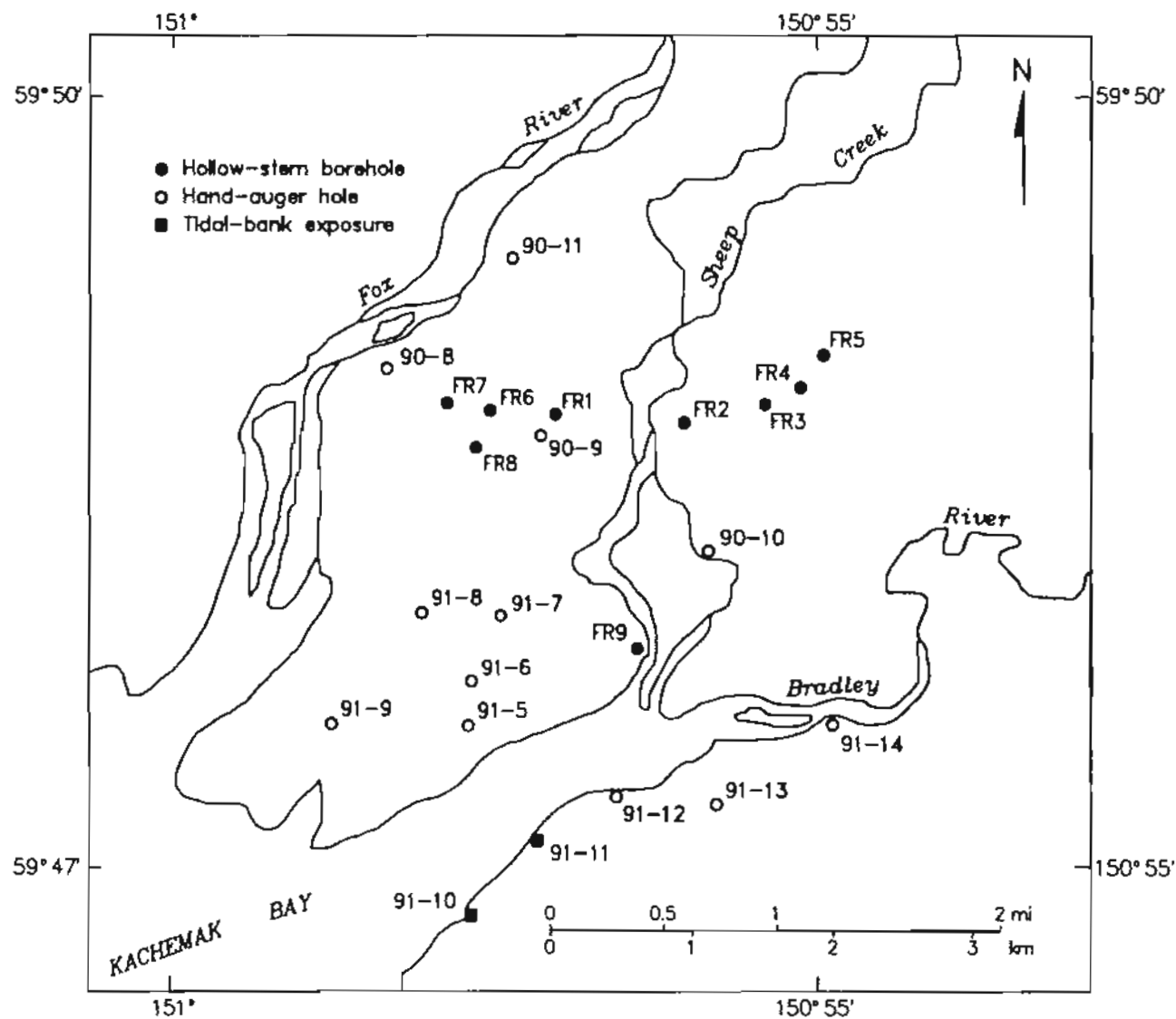


Figure A12. Station locations at Fox River flats. See figures A13 and A14 for stratigraphic diagrams and appendixes B and C for detailed descriptions.

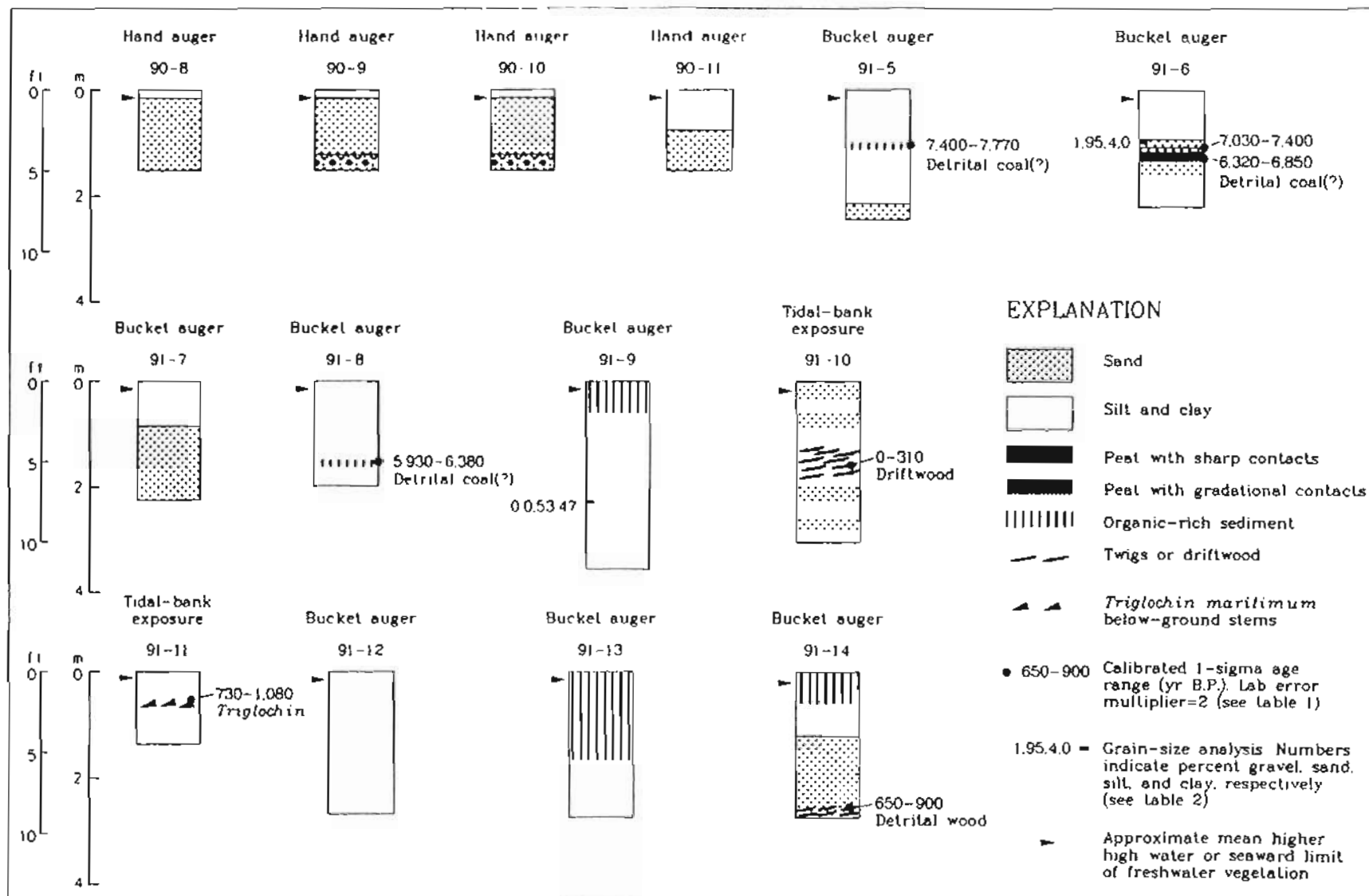


Figure A13. Stratigraphic diagrams for hand-auger holes and tidal-bank exposures at Fox River flats (fig. A12). See appendix B for detailed descriptions.

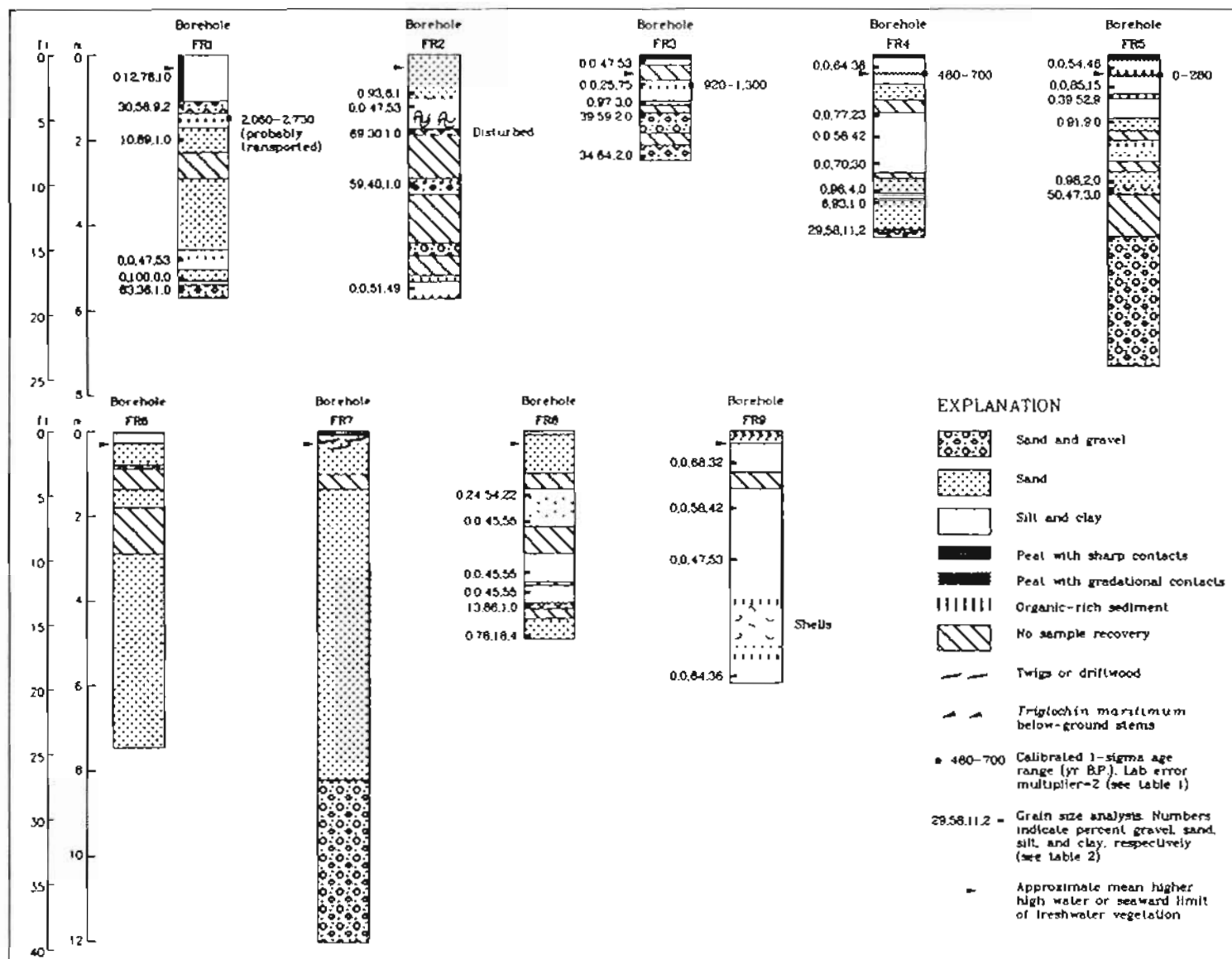


Figure A14. Stratigraphic diagrams for boreholes at Fox River flats (fig. A12). See appendix C for detailed descriptions.

## APPENDIX B

## DESCRIPTIONS OF TIDAL-BANK EXPOSURES AND HAND-AUGER SAMPLES

See appendix A for location maps and stratigraphic diagrams, appendix C for borehole-sample descriptions.

Unless otherwise indicated, datum for depth is the modern tidal-marsh surface.

Codes for intended sample analyses:

C14—radiocarbon age; GS—grain-size analysis; MP—micropaleontology; EM—electron microprobe (tephra).

See tables 1 and 2 in the text for radiocarbon ages and grain-size statistics, respectively.

Micropaleontology and tephra studies will be reported separately.

1990 PRE-DRILLING RECONNAISSANCE STATIONS

All locations determined from 1:25,000- or 1:63,360-scale topographic maps.

**90-1, KENAI RIVER FLATS - 60°32'6"N, 151°12'43"W - 3-in. bucket-auger hole - 10/18/90**

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-1.25	0-0.38	Surface vegetation, silt, and peat. <u>Spl 90-1-1</u> at 1.25 ft (0.38 m)(C14), basal peat with some underlying silt; max. age of surface vegetation.
1.25-5.5	0.37-1.68	Sticky, clayey silt with some plant remains. <u>Spl 90-1-3.5</u> at 3.5 ft (1.07 m)(C14), thin (½-in.) grassy peat layer with some surrounding silt.

**90-2, KENAI RIVER FLATS - 60°31'34"N, 151°12'28"W - 1½-in. hand-auger hole - 10/18/90**

**91-18**, adjacent tidal-bank exposure - 5/15/91.

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-1.2	0-0.37	Surface organics and peat.
1.2-3.7	0.37-1.13	Sticky gray clayey silt with scattered organics.
3.7-5.0	1.13-1.52	Peat (base not encountered). <u>Spl 90-2-3.7</u> at 3.7 ft (1.13 m)(C14), peat at top surface of layer plus some overlying silt. <u>Spl 91-18-3.7</u> at 3.7 ft (1.13 m), branch of stump rooted near top of peat (C14). <u>Spl 90-2-4.0</u> at 4.0-4.5 ft (1.22-1.37 m)(C14), peat with minor silt.

**90-3, MARSH BEHIND KALIFORNSKY BEACH - 60°31'35"N, 151°16'13"W - 1½-in. hand-auger hole - 10/18/90**

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-5.0	0-1.52	Soft, wet peat. Base not encountered.

**90-4, KENAI RIVER FLATS - 60°32'1"N, 151°15'40"W - 1½-in. auger hole - 10/18/90**

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-5.0	0-1.52	Peat.
5.0-8.0	1.52-2.44	Gray clayey silt with minor organics.

**90-5, KASILOF RIVER FLATS - 60°21'58"N, 151°17'40"W - 1½-in. hand-auger hole - 10/18/90**

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-2.5	0-0.76	Organic-rich silt.
2.5-4.5	0.76-1.37	Reddish-brown fibrous peat with some sandy zones. <u>Spl 90-5-2.7</u> at 2.5-2.8 ft (0.76-0.85 m)(C14), from top of peat layer; includes minor overlying silt. <u>Spl 90-5-3.6</u> at 3.6 ft (1.10 m)(C14), organic-rich silt; not submitted for dating because sample is not at base or top of organic-rich layer.
4.5-5.0	1.37-1.52	Sandy organic-rich silt; lost most of sample.

**90-6, KASILOF RIVER FLATS - 60°23'1"N, 151°18'56"W - 1½-in. hand-auger sample - 10/18/90**

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-1.2	0-0.37	Organic-rich silt.
1.2-1.7	0.37-0.52	Peat. <u>Spl 90-6-1.2</u> at 1.2-1.5 ft (0.37-0.46 m)(C14).
1.7-5.0	0.52-1.52	Sticky, gray clayey silt with scattered organics. Small pod of peat at 5.0 ft (1.52 m); may be near top of an underlying peat layer.

**90-7A, KASILOF RIVER FLATS - 60°23'28"N, 151°17'29"W - 1½-in. hand-auger hole - 10/18/90**

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-5.0	0-1.52	Peat.

**90-7B, KASILOF RIVER FLATS - 60°23'25"N, 151°17'31"W - 1½-in. hand-auger hole - 10/18/90**

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-5.0	0-1.52	Fine to medium, clean sand, probably part of nearby beach deposit.

**90-7C, KASILOF RIVER FLATS - 60°23'25"N, 151°17'29"W - 1½-in. hand-auger hole - 10/18/90**

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-5.0	0-1.52	Gray silty clay with negligible organics.

**90-8, FOX RIVER FLATS - 59°48'55"N, 150°58'18"W - 1½-in. hand-auger hole - 10/19/90**

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-0.5	0-0.15	Clayey silt with minor sand.
0.5-5.0	0.15-1.52	Clean fine to medium sand, coarsening downward.

**90-9, FOX RIVER FLATS - 59°48'42"N, 150°57'2"W - 1½-in. hand-auger hole - 10/19/90**

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-0.5	0-0.15	Clayey silt with minor sand.
0.5-4.0	0.15-1.22	Clean fine to medium sand, coarsening downward.
4.0-5.0	1.22-1.52	Pebbly coarse sand.



**90-10, FOX RIVER FLATS - 59°48'15"N, 150°55'47"W - 1½-in. hand-auger hole - 10/19/90**

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-0.5	0-0.15	Clayey silt with minor sand.
0.5-4.0	0.15-1.22	Clean fine to medium sand, coarsening downward.
4.0-5.0	1.22-1.52	Pebbly coarse sand.

**90-11, FOX RIVER FLATS - 59°49'22"N, 150°57'17"W - 1½-in. hand-auger hole - 10/19/90**

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-2.5	0-0.76	Gray clayey silt.
2.5-5.0	0.76-1.52	Fine sand.

**1991 BANK EXPOSURES AND BUCKET-AUGER STATIONS**

All locations determined from 1:25,000- or 1:63,360-scale topographic maps.

**91-1, GIRDWOOD - 60°56'35"N, 149°11'0"W - Tidal-bank exposure - 5/8/91**

Depths are approximate.

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-1	0-0.30	Surface vegetation and silt.
1-1.5	0.30-0.46	Fibrous peat with rooted stumps.
1.5-6	0.46-1.83	Gray clayey silt with abundant organics, decreasing downward.
6-6.5	1.83-1.98	Grassy peat; sharp upper contact, gradational lower contact. <u>Spl 91-1-1</u> at 6-6.1 ft (1.83-1.86 m), top of peat layer (C14).

**91-2, GIRDWOOD - 60°56'22"N, 149°10'45"W - Tidal-bank exposure - 5/8/91**

Depths are approximate.

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-1	0-0.30	Surface vegetation and silt.
1-1.5	0.30-0.46	Fibrous peat with rooted stumps.
1.5-5	0.46-1.52	Gray clayey silt with abundant organics.
5-5.5	1.52-1.68	Peat with rooted stumps. <u>Spl 91-2-1</u> at 5 ft (1.52 m), wood from rooted stump (C14).

**91-3, GIRDWOOD - 60°56'20"N, 149°10'20"W - Tidal-bank exposure - 5/8/91**

Depths are approximate.

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-1	0-0.30	Surface vegetation and silt.
1-1.5	0.30-0.46	Fibrous peat with rooted stumps.
1.5-5	0.46-1.52	Gray clayey silt with abundant organics, decreasing downward.
5-5.5	1.52-1.68	Peat with rooted stumps.
5.5-11.5	1.68-3.51	Gray clayey silt.

11.5-12.0      3.51-3.66      Peat with some embedded small logs. Upper contact sharp. Abrasion on logs suggest that they may have been rammed into the peat and underlying mud. Spl 91-3-1 at 11.5-11.6 ft (3.51-3.54 m), peat at top of layer (C14).

91-4 and 91-32, GIRDWOOD - 60°55'42"N, 149°8'55"W - Tidal-bank exposure - 5/8/91

Depths are approximate.

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-1	0-0.30	Surface vegetation and silt.
1-1.5	0.30-0.46	Fibrous peat with rooted stumps.
1.5-5	0.46-1.52	Gray clayey silt with abundant organics, decreasing downward.
5-5.5	1.52-1.68	Peat with rooted stumps. Sharp upper contact, gradational lower contact. <u>Spl 91-4-1</u> at 5 ft (1.52 m), outer rings of rooted stump (C14). <u>Spl 91-32-1</u> at 5 ft (1.52 m), outer 15 rings of same rooted stump (C14); sampled 10/3/91. <u>Spl 91-32-2</u> at 5 ft (1.52 m), sections of roots from same stump (C14); sampled 10/3/91.

91-5, FOX RIVER FLATS - 59°47'34"N, 155°57'40"W - 3-in. bucket-auger hole - 5/9/91

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-7.0	0-2.13	Gray clayey silt with scattered organics. <u>Spl 91-5-1</u> at 3.4 ft, gray clayey silt with dark gray organic smear (C14).
7.0-8.0	2.13-2.44	Clean medium to coarse gray sand, saturated, flowing.

91-6, FOX RIVER FLATS - 59°47'45"N, 150°57'40"W - 3-in. bucket-auger hole - 5/9/91

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-3.0	0-0.91	Gray clayey silt with scattered organics.
3.0-3.5	0.91-1.07	Gray to brown fine to medium sand with minor silt. Tsunami deposit? <u>Spl 91-6-1</u> at 3.2 ft (0.98 m), sand (GS).
3.5-3.8	1.07-1.16	Dark gray organic smear in gray silt. <u>Spl 91-6-2</u> at 3.5 ft (1.07 m)(C14).
3.8-4.4	1.16-1.34	Grassy peat with gray silt. <u>Spl 91-6-3</u> at 4.2 ft (1.28 m)(C14).
4.4-7.2	1.34-2.20	Gray clayey silt with some sand near top.

91-7, FOX RIVER FLATS - 59°47'57"N, 150°57'25"W - 3-in. bucket-auger hole - 5/9/91

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-2.8	0-0.85	Gray clayey silt with some organics.
2.8-7.4	0.85-2.26	Clean sand with some gravel near bottom. Coarsens downward from fine to medium sand at top to coarse pebbly sand at base. Maximum pebble size 2 cm.

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91-8, FOX RIVER FLATS - 59°47'57"N, 150°58'0"W - 3-in. bucket-auger hole - 5/9/91

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-6.5	0-1.98	Sticky gray clayey silt with scattered organics. Organic-rich layer with abundant sedge blades at 5 ft (1.52 m). Very sticky and dense at base. <u>Spl 91-8-1</u> at 5.0 ft (1.52 m)(C14).

91-9, FOX RIVER FLATS - 59°47'33"N, 150°58'40"W - 3-in. bucket-auger hole - 5/11/91

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-11.7	0-3.57	Entire section gray clayey silt. Mostly dry and friable. Some <i>Carex</i> blades and roots in upper 2 ft (0.61 m). Some dark gray organic smears at 10.5 ft (3.20 m) to bottom. <u>Spl 91-9-1</u> at 7.5 ft (2.29 m)(GS). <u>Spl 91-9-2</u> at 10.0 ft (3.05 m), disseminated fine organics; fragments of small shell (gastropod or pelecypod) at 10.5 ft (3.20 m)(C14).

91-10, FOX RIVER FLATS - 59°46'50"N, 150°57'40"W - Tidal-bank exposure - 5/11/91

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-2.0	0-0.61	Layered silty fine sand and clayey silt. Forms upper bench covered by <i>Carex</i> . Slightly sandier than underlying deposits.
2.0-10.0	0.61-3.05	Layered silty fine sand and clayey silt. Clayey silt dominates. Layers up to 2.5 cm thick. Scattered grass blades and roots throughout. No current structures in laminae (flat-lying). Discontinuous layer of driftwood at 4-6 ft (1.22-1.83 m). <u>Spl 91-10-1</u> at 5.3 ft, driftwood for maximum age (C14).

91-11, FOX RIVER FLATS - 59°47'10"N, 150°57'10"W - Tidal-bank exposure - 5/11/91

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-2.5	0-0.76	Gray clayey silt with faint horizontal layering and abundant grass and roots. Oxidized horizon with abundant <i>Triglochin maritimum</i> bases in growth position at 1.7-2.2 ft (0.52-0.67 m). <u>Spl 91-11-1</u> at 2.0 ft (0.61 m), leaf bases (C14). <u>Spl 91-11-2</u> at same depth, leaf bases for identification ( <i>T. maritimum</i> confirmed).

91-12, FOX RIVER FLATS - 59°47'18"N, 150°56'5"W - 3-in. bucket-auger hole - 5/11/91

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-8.8	0-2.68	Steel-gray clayey silt. Minor scattered organics in upper 2 ft (0.61 m). Remainder nearly free of organics. No peats or organic smears.

91-13, FOX RIVER FLATS - 59°47'15"N, 150°55'45"W - 3-in. bucket-auger hole - 5/11/91

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-5.5	0-1.68	Gray to slightly brownish-gray clayey silt with scattered organics (grass blades, roots). Strongly oxidized at base.
5.5-9.0	1.68-2.74	Steel-gray clayey silt with negligible organics. Uniform except less clay toward base (cohesiveness decreases downward).

## 91-14, FOX RIVER FLATS - 59°47'35"N, 150°54'55"W - 3-in. bucket-auger hole - 5/11/91

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-4.0	0-1.22	Gray clayey silt with abundant roots and sedge blades in upper 2.0 ft (0.61 m).
4.0-9.0	1.22-2.74	Clean fine to medium sand with negligible organics, except abundant wood fragments at 8.6-9.0 ft (2.62-2.74 m). <u>Spl 91-14-1</u> at 8.8 ft (2.68 m), medium-grained clean sand with abundant wood (C14).

## 91-15, KASILOF RIVER FLATS - 60°22'4"N, 151°17'40"W - Tidal-bank exposure - 5/12/91

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-0.6	0-0.18	Vegetation and root mat with gray silt.
0.6-2.0	0.18-0.61	Gray clayey silt with abundant roots. <u>Spl 91-15-1.8</u> at 1.8 ft (0.55 m)(GS).
2.0-2.9	0.61-0.88	Brown to reddish-brown grassy peat. Thin (<1 cm) tephra(?) at 2.4 ft (0.73 m). Sharp upper contact. <u>Spl 91-15-2.0</u> at 2.0 ft (0.61 m), top 2 cm of peat layer (C14).
2.9-3.4	0.88-1.04	Gray to brownish-gray clayey silt with abundant roots and sedge blades. <u>Spl 91-15-3.0</u> at 2.9-3.1 ft (0.88-0.95 m)(MP).
3.4-3.7	1.04-1.13	Dark brown grassy peat with scattered small twigs. Moderately sharp upper contact. <u>Spl 91-15-3.5</u> at 3.5-3.6 ft (1.07-1.10 m)(C14).
3.7-3.9	1.13-1.19	Gray clayey silt with abundant plant fragments. <u>Spl 91-15-3.8</u> at 3.8 ft (1.16 m)(MP).
3.9-5.9	1.19-1.80	Dark brown sedge and woody peat with two zones of rooted tree stumps, one near the top and one near the bottom. Sharp upper contact. Upper zone of rooted stumps is at 4.0-4.5 ft (1.22-1.37 m). Lower zone is at 4.8-5.6 ft (1.46-1.71 m). Tephra layer at 5.3-5.4 ft (1.62-1.65 m) overlies some stumps in lower layer and underlies others. Otherwise no apparent clastic estuarine sediments overlie lower zone of stumps (no evidence of submergence into intertidal zone). <u>Spl 91-15-3.9</u> at 3.9-4.0 ft (1.19-1.22 m), peat at top of layer (C14). <u>Spl 91-15-4.0</u> , outer growth rings from stump rooted at 4.0 ft (1.22 m)(C14). <u>Spl 91-15-4.8</u> , outer growth rings from stump rooted at 4.8 ft (1.46 m)(C14). <u>Spl 91-15B-1</u> at 5.2-5.3 ft (1.59-1.62 m), peat in contact with underlying tephra (C14; minimum age of tephra). Collected 10/1/91. <u>Spl 91-15B-2</u> at 5.3-5.4 ft (1.62-1.65 m), tephra (EM). Collected 10/1/91. <u>Spl 91-15B-3</u> at 5.4-5.5 ft (1.65-1.68 m), peat in contact with overlying tephra (C14; maximum age of tephra). Collected 10/1/91. <u>Spl 91-15B-4</u> at 5.8-5.9 ft (1.77-1.80 m), peat at base of layer in contact with underlying tephra (C14; minimum age of underlying tephra). Collected 10/1/91.
5.9-6.0	1.80-1.83	Reddish-tan tephra with texture of fine- to medium-grained sand. <u>Spl 91-15B-5</u> at 5.9-6.0 ft (1.80-1.83 m), tephra (EM). Collected 10/1/91.

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6.0-6.8	1.83-2.07	<p>Dark reddish-brown <i>Sphagnum</i> peat. Zone of buried spruce stumps at base. Very sharp lower contact.</p> <p><u>Spl 91-15-6.0</u> at 6.0-6.1 ft (1.83-1.86 m), peat at top of layer (C14; maximum age of overlying tephra).</p> <p><u>Spl 91-15B-6</u> at 6.0-6.1 ft (1.83-1.86 m), peat at top of layer (C14; maximum age of overlying tephra). Collected 10/1/91.</p> <p><u>Spl 91-15-6.6</u>, outer growth rings from stump rooted at 6.6 ft (2.01 m)(C14).</p> <p><u>Spl 91-15-6.8</u> at 6.7-6.8 ft (2.04-2.07 m), basal peat (C14).</p>
6.8-15.8	2.07-4.82	<p>[Base of exposure is at 7.0 ft (2.13 m); drilled with 3-in. bucket auger to 15.8 ft (4.82 m).]</p> <p>Steel gray clayey silt with scattered roots and rhizomes. No visible bedding. Scattered rounded pebbles to about 8-cm diameter, possibly ice rafted to tidal flat. Peaty layer at 10.2-10.6 ft (3.11-3.23 m). Below peaty layer, gray clayey silt has abundant roots and grass blades.</p> <p><u>Spl 91-15-7.0</u> at 6.8-7.1 ft (2.07-2.16 m)(GS, MP).</p> <p><u>Spl 91-15-10.0</u> at 9.8-10.2 ft (2.99-3.11 m)(GS, MP).</p> <p><u>Spl 91-15-10.2</u> at 10.2-10.6 ft (3.11-3.23 m), peaty clayey silt (C14).</p> <p><u>Spl 91-15-15.4</u> at 15.4 ft (4.70 m)(GS, MP).</p> <p><u>Spl 91-15-15.7</u> at 15.7 ft (4.79 m), organic-rich clayey silt (C14).</p>

#### 91-16, KENAI RIVER FLATS - 60°31'37"N, 151°12'0"W - Tidal-bank exposure - 5/14/91

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-0.8 ft	0-0.24	<p>Vegetation and dark brown peat. Woody layer at 0.7 ft (0.21 m).</p> <p><u>Spl 91-16-0.7</u>, 2.5-cm-diameter branch at 0.7 ft (0.21 m)(C14).</p>
0.8-2.0	0.24-0.61	<p>Gray clayey silt with abundant sedge blades and roots.</p> <p><u>Spl 91-16-1.0</u> at 0.8-1.2 ft (0.24-0.37 m)(GS, MP).</p>
2.0-6.5	0.61-1.98	<p>Dark brown to brownish-red peat. Gradational from sedge-woody peat at top to reddish <i>Sphagnum</i> peat in middle to sedge-<i>Sphagnum</i> peat at base. Widespread layer of tree branches and roots at 3.0 ft (0.91 m). Many rooted stumps at this level. Extensive 3-cm-thick shrub-wood layer at 6.0 ft (1.83 m). Peat layer contains at least six tephra layers. Most prominent is at 3.3-3.4 ft (1.01-1.04 m), immediately below the layer of rooted tree stumps. Peat layer has a sharp lower contact.</p> <p><u>Spl 91-16-2.0</u> at 2.0 ft (0.61 m), top 2 cm of peat layer (C14).</p> <p><u>Spl 91-16-2.3</u>, wood from stump rooted at 2.3 ft (0.70 m)(C14).</p> <p><u>Spl 91-16-3.0</u>, 4-cm-diameter branch of stump rooted at 3.0 ft (0.91 m)(C14).</p> <p><u>Spl 91-16-3.3</u> and <u>91-16B-3.3</u> (collected 10/2/91), thin tephra at 3.3 ft (1.01 m) for microscopic examination and EM. [Tephra confirmed]</p> <p><u>Spl 91-16B-3.35</u> at 3.35 ft (1.02 m), peat underlying tephra (C14).</p> <p><u>Spl 91-16-6.5</u>, basal peat at 6.4-6.5 ft (1.95-1.98 m)(C14).</p>
6.5-7.0	1.98-2.13	<p>Gray clayey silt with abundant sedge blades and rhizomes.</p> <p><u>Spl 91-16-6.6</u> at 6.5-6.7 (GS, MP).</p>

**91-17, KENAI RIVER FLATS - 60°32'6"N, 151°8'55"W - Tidal-bank exposure - 5/15/91**

Exposure is about 3 km upstream from 91-16 on opposite (north) side of tidally influenced lower Kenai River. Section is nearly identical to 91-16. Peats are similar thickness and the woody layers and tephra are in the same relative positions. Section not measured, no samples taken.

**91-18** (see 90-2).

**91-19** - Number not used.

**91-20, GIRDWOOD - 60°55'39"N, 149°8'48"W - Tidal-bank exposure - 7/16/91**

Depths are approximate except for sample depth.

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-1	0-0.30	Surface vegetation and silt.
1-1.5	0.30-0.46	Fibrous peat. No rooted stumps at this location.
1.5-5.6	0.46-1.71	Gray clayey silt with abundant organics. Scattered leaf bases of <i>Triglochin maritimum</i> in growth position near base of layer.
5.6-6.6	1.71-2.01	Dark brown fibrous peat. Sharp upper contact, gradational lower contact. <u>Spl 91-20-5.6</u> at 5.6 ft (1.71 m), peat from top 1 cm of layer (C14).
6.6-8	2.01-2.44	Gray clayey silt with abundant organics.

**91-21 to 91-29** - Numbers not used.

**91-30, KENAI/CUNNINGHAM PARK - 60°32'30"N, 151°10'55"W - River-bank exposure - 10/2/91**

Datum is top of peat section at terrace surface about 10 ft (3 m) above modern tidal flat.

Depths are approximate.

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-7.5	0-2.3	Dark brown fibrous peat with abundant twigs, roots, and seeds. <u>Spl 91-30-1</u> at 7.5 ft (2.3 m), grass roots in growth position extending vertically downward into underlying injected(?) sand (C14); provides minimum age for sand body. <u>Spl 91-30R-2</u> at 7.5 ft (2.3 m), similar grass roots (C14); collected 6/24/92. <u>Spl 91-30R-4</u> at 7.5 ft (2.3 m), bottom 1 cm of peat in contact with top of injected(?) sand (C14); should correlate with 91-30R-5, providing maximum age for sand body if sand was injected. Collected 9/22/92.

7.5-8.5	2.3-2.6	<p>Irregular lens of medium to coarse sand with contorted layering and floating broken pieces of peat. Ragged margin and peat partially ripped from lens margins indicate possible injection as a sill within larger peat layer, possibly as a result of liquefaction. Source may be alluvium underlying peat, but feeder dike is not visible. Some crossbedding within sand body may indicate normal accretionary deposition rather than injection.</p> <p><u>Spl 91-30-2</u> at 8.5 ft (2.6 m), wood branch lying horizontal at base of sand body with layering folded around it (C14); provides maximum age for sand body (allochthonous).</p> <p><u>Spl 91-30-3</u> at 8.5 ft (2.6 m), twigs in lying horizontal within sand body (C14); provides maximum age for sand body (allochthonous).</p> <p><u>Spl 91-30R-1</u> at 8.5 ft (2.6 m), twigs 0.5-2 cm diameter lying subhorizontal and subparallel within sand body (C14); provides maximum age for sand body (allochthonous). Apparently derived from underlying woody peat and incorporated into sand during injection. Collected 6/24/92.</p> <p><u>Spl 91-30R-3</u> at 8.5 ft (2.6 m), single branch, about 5 cm diameter, lying subhorizontal and incorporated into thin (10 cm) margin of sand lens about 10 ft (3 m) west of 91-30R-1 (C14). Should correlate with 91-30R-1, giving maximum age of sand sill. Collected 6/24/92.</p>
8.6-9.8	2.6-3.0	<p>Dark brown fibrous peat with abundant twigs, roots, and seeds.</p> <p><u>Spl 91-30R-5</u> at 8.5 ft (2.6 m), top 1 cm of peat in contact with base of sand lens (C14); should correlate with 91-30R-4, providing maximum age for sand body if sand was injected. Collected 9/22/92.</p> <p><u>Spl 91RE2C-1</u> at 9.5 ft (2.9 m), organic silt (C14).</p>
9.8-13.1	3.0-4.0	<p>Reddish-brown oxidized pebbly fine sand. Sharp upper contact. Base covered by modern beach deposits; thickness unknown. Reddish-brown color fades downward and disappears at 10 cm.</p>

## 91-31, GIRDWOOD - 60°55'38"N, 149°8'48"W - Tidal-bank exposure - 10/3/91

Depths are approximate except for sample depths.

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-1	0-0.30	Surface vegetation and silt.
1-1.5	0.30-0.46	Fibrous peat. No rooted stumps at this location.
1.5-2.1	0.46-0.64	Gray clayey silt with abundant plant fragments.
2.1-2.4	0.64-0.73	<p>Medium brown, discontinuous fibrous peat with sedge blades and roots. Sharp but irregular upper and lower contacts. May be allochthonous or disturbed.</p> <p><u>Spl 91-31-2.1</u> at 2.1 ft (0.64 m), peat from top 2 cm of layer (C14).</p>
2.4-2.5	0.73-0.76	Gray clayey silt with abundant roots.
2.5-2.8	0.76-0.85	<p>Dark brown, continuous peat with sedge blades, roots, and twigs. Sharp upper contact, gradational lower contact. More likely than upper peat layer to have been buried as a result of coseismic subsidence.</p> <p><u>Spl 91-31-2.5</u> at 2.5 ft (0.76 m), peat from top 2 cm of layer (C14).</p>
2.8-5	0.85-1.52	Gray clayey silt with abundant roots and below-ground stems of <i>Triglochin maritimum</i> .

91-31 - see 91-4.

**1992 TIDAL-BANK EXPOSURES**

All locations determined by Global Positioning System (GPS), corrected where necessary by reference to 1:12,000 to 1:25,000 aerial photographs.

92-1 to 92-12, numbers not used.

92-13, CHICKALOON FLATS - 60°54'15"N, 150°11'29.0"W - Tidal-channel exposure - 6/28/92

Depths are approximate.

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-6.6	0-2.0	Gray mud with variable peat and wood; grass blades, roots, and <i>Triglochin</i> leaf bases scattered throughout. No evidence of rooted stumps. All wood appears to be driftwood (transported); no evidence of rooted stumps and no distinct peat-mud couplets to indicate earthquake-related submergence. Driftwood is most abundant in layers at about 3.3 and 4.9 ft (1.0 and 1.5 m). Organic-free mud underlies basal peat at about 6.6 ft (2.0 m).

92-14R, CHICKALOON FLATS - 60°54'17"N, 150°11'49"W - Tidal-bank exposure - 7/1/92

Drilled with bucket auger from 6.6 to 16.7 ft (2.02-5.10 m).

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-2.8	0-0.85	Gray very fine sand or coarse silt with scattered grassy roots, most numerous in upper 20 cm. Very faint layering to 1 cm thick. <u>Spl 92-14R-1</u> at 2.1-2.3 ft (0.65-0.70 m)(GS, MP).
2.8-3.4	0.85-1.05	Brownish-gray, peaty, clayey silt with abundant <i>Triglochin</i> . Gradational upper contact.
3.4-3.7	1.05-1.12	Wood lying horizontal on top of underlying peat; probably driftwood.
3.7-4.1	1.12-1.25	Very dark brown peat with common woody roots. Very sharp upper contact, slightly less sharp lower contact. <u>Spl 92-14R-2</u> at 3.7 ft (1.12 m), top 1 cm of peat layer (C14).
4.1-5.9	1.25-1.80	Gray silty clay with no visible layering. Sharp upper and lower contacts. Scattered vertical grass roots but no <i>Triglochin</i> . <u>Spl 92-14R-3</u> at 5.6-5.9 ft (1.70-1.80 m)(GS,MP).
5.9-6.6	1.80-2.02	Brown mossy peat with abundant twigs and roots. Sharp to slightly gradational (0.5-2.0 cm) upper contact, gradational (5 cm) lower contact. <u>Spl 92-14R-4</u> at 5.9 ft (1.8 m), woody peat and moss from upper 1 cm of peat layer (C14). Twigs all have bark.
6.6-10.8	2.02-3.30	Gray organic-poor plastic clayey silt.
10.8-11.8	3.30-3.60	Brownish-gray peaty mud with abundant sedge(?) and possible <i>Triglochin</i> leaf-base fragments. <u>Spl 92-14R-5</u> at 10.8 ft (3.30 m)(GS, MP).
11.8-12.9	3.60-3.93	Brown grassy peat. Very sharp (<2 mm) upper contact, gradational lower contact. <u>Spl 92-14R-6</u> at 11.8 ft (3.60 m)(C14).
12.9-13.5	3.93-4.12	Brownish-gray peaty, clayey silt with abundant grass blades. Grades downward to gray clayey silt with minor organics.
13.5-14.2	4.12-4.32	Brown grassy peat with scattered twigs and other wood fragments. Gradational lower contact; upper contact disturbed by drilling. <u>Spl 92-14R-7</u> at 13.5 ft (4.12 m), top 5 cm of peat layer with bark-covered twigs (C14).



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14.2-14.4	4.32-4.40	Gray clayey silt with minor organics.
14.4-16.7	4.40-5.10	Gray clean medium to coarse sand with sandy gravel at base.

## 92-15, CHICKALOON FLATS - 60°51'48"N, 150°1'34"W - Tidal-bank exposure - 6/30/92

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-3.3	0-1.0	Brownish-gray coarse silt. Abundant grass and shrub roots in upper 20 cm. Remainder is organic-poor except for scattered small woody roots. Faint layering about 1 cm thick in fining upward layers. Could be coarse intertidal or fluvial overbank deposits. Sharp to slightly diffuse lower contact (2-10 mm). <u>Spl 92-15-1</u> at 3.0-3.3 ft (0.9-1.0 m)(GS, MP).
3.3-5.9	1.0-1.8	Peat to muddy peat. Relatively sharp (1-10 mm) upper contact. Upper 8 cm is oxidized and woody with willow(?) roots. One rooted shrub has branches extending vertically into overlying sand. Lower half of layer contains numerous <i>Triglochin</i> bases. Lower contact is gradational with underlying gray clayey silt. Peat layer appears to show a transition from <i>Triglochin</i> -dominated low marsh in lower half to willow- and grass-dominated high marsh in upper half, then rapid burial. <u>Spl 92-15-2</u> at 3.3 ft (1.0 m), willow branches from rooted shrub with branches extending upward into overlying silt (C14). <u>Spl 92-15-3</u> at 3.3 ft (1.0 m), grass and leaf mat from top 1 cm of peat layer (C14).
5.9-9.8	1.8-3.0	Steel gray organic-poor clayey silt with scattered small roots. <u>Spl 92-15-4</u> at 6.6 ft (2.0 m)(GS, MP).

## 92-16, CHICKALOON FLATS - 60°51'48"N, 150°1'17"W - Tidal-bank exposure - 6/30/92

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-3.3	0-1.0	Very fine sand or coarse silt. Organic poor except for roots in upper 30 cm.
3.3-3.8	1.0-1.15	Peaty mud with abundant <i>Triglochin</i> leaf bases, sedge fragments, and some driftwood.
3.8-4.4	1.15-1.35	Peat containing abundant rooted shrub wood with bark. Sharp upper and lower contacts. Basal portion is grass and moss. <u>Spl 92-16-1</u> at 3.8 ft (1.15 m), rooted wood at peat surface (C14).
4.4-7.4	1.35-2.25	Gray mud with abundant rootlets in upper 1 cm and organic-poor lower portion. Thin (2-5 mm) tephra 15 cm below peat contact. <u>Spl 92-16-2</u> at 4.9 ft (1.50 m), tephra for microscopic examination.
7.4-8.0	2.25-2.43	Peaty mud with abundant <i>Triglochin</i> leaf bases. Sharp upper contact.
8.0-8.8	2.43-2.68	Grassy peat with sharp to diffuse upper contact. Gradational lower contact. <u>Spl 92-16-3</u> at 8.0 ft (2.44 m), upper 2 cm of peat layer (C14).

## 92-17, CHICKALOON FLATS - 60°53'50"N, 149°57'2"W - Tidal-bank exposure - 6/30/92

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-3.0	0-0.9	Brownish-gray coarse silt or very fine sand. Abundant roots in upper 10 cm; scattered roots in remainder of layer.
3.0-4.4	0.9-1.35	<i>Triglochin</i> -rich, brownish-gray, peaty clayey silt. Sharp upper contact. May be the low-marsh surface submerged and buried during the 1964 earthquake. <u>Spl 92-17-3</u> at 3.3 ft (1.0 m), upper 2 cm of <i>Triglochin</i> layer (C14).

4.4-4.8	1.35-1.45	Grassy and woody peat of variable thickness. Irregular upper and lower contacts. Upper contact is sharp in some places, diffuse in others. branches with bark appear to be rooted shrubs. <u>Spl 92-17-1</u> at 4.4 ft (1.35 m), wood with bark, rooted in peat (C14). <u>Spl 92-17-2</u> at 4.4 ft (1.35 m), upper 2 cm of peat (C14).
4.8-5.6	1.45-1.70	Grayish-brown oxidized clayey silt with abundant roots and wood fragments, probably transported.
5.6-7.1	1.70-2.15	Gray clayey silt with abundant small roots, decreasing downward to organic-poor mud. Laminations up to 1 cm thick. <u>Spl 92-17-5</u> at 6.7-7.1 ft (2.05-2.15 m)(GS).
7.1-9.5	2.15-2.90	Grassy and <i>Triglochin</i> -rich peat alternating with organic-rich mud. Sharp upper contact. <u>Spl 92-17-4</u> at 7.1 ft (2.16 m), upper 2 cm of <i>Triglochin</i> -rich peat (C14).
9.5-9.8	2.90-3.00	Organic-poor mud. Submerged below water level at 9.8 ft (3.0 m).

92-18, superseded by 92-19.

92-19, GIRDWOOD - 60°56'35"N, 149°11'1"W - Tidal-bank exposure - 7/1/92

Depths are approximate.

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-0.7	0-0.2 m	Surface vegetation and silt.
0.7-1.0	0.2-0.3	Peat with rooted stumps (submerged during the 1964 earthquake).
1.0-5.6	0.3-1.7	Gray clayey silt with scattered plant fragments.
5.6-5.9	1.7-1.8	Grassy peat with twigs. Sharp upper contact. <u>Spl 92-19-4</u> at 5.6 ft (1.7 m), top 2 cm of peat, including grass blades extending vertically into overlying mud (C14).
5.9-9.2	1.8-2.8	Gray clayey silt with scattered plant fragments.
9.2-9.8	2.8-3.0	Two peat layers separated by a 7-cm layer of mud. Contains stumps rooted at base of lower peat layer. Top of upper peat layer is grass, with some blades extending vertically into overlying mud. <u>Spl 92-19-1</u> at 9.2 ft (2.8 m), top 1 cm of grassy peat from upper layer (C14).
9.8-11.5	3.0-3.5	Gray clayey silt with scattered plant fragments.
11.5-11.8	3.5-3.6	Peat with rooted stumps. Sharp upper contact. <u>Spl 92-19-2</u> at 11.5 ft (3.5 m), rooted stump with papery bark (C14). Root contains about 18 total growth rings.
11.8-15.7	3.6-4.8	Gray clayey silt with scattered plant fragments.
15.7-16.1	4.8-4.9	Peat with gradational upper contact. <u>Spl 92-19-3</u> at 15.7 ft (4.8 m), top 3 cm of peat layer (C14).
16.1-16.4	4.9-5.0	Gray clayey silt with scattered plant fragments. Low tide level at about 16.4 ft (5.0 m).

92-20, GOOSE BAY - 61°23'33"N, 149°50'56"W - Tidal-bank exposure - 7/2/92

<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
0-2.0	0-0.60	Organic-rich clayey silt. Organics increase downward; woody in bottom 10 cm.

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2.0-2.5	0.60-0.77	Dark brown mossy, woody peat with many shrub roots. Rooted stump near top. Sharp (<5 mm) upper contact with overlying peaty mud. Gradational lower contact. <u>Spl 92-20-1</u> at 2.0 ft (0.60 m), top 1 cm of peat layer (C14).
2.5-3.4	0.77-1.05	Organic-rich clayey silt with large wood pieces, possibly driftwood, to 10 cm diameter. Organic content decreases downward.
3.4-4.3	1.05-1.30	Gray clayey silt with minor organics.
4.3-4.3	1.30-1.32	Thin, discontinuous grassy peat with wood fragments and bark. <u>Spl 92-20-3</u> at 4.3 ft (1.30 m), top 2 mm seam of peat layer with bark and twigs (C14).
4.3-10.5	1.32-3.20	Gray clayey silt.
10.5-10.7	3.20-3.25	Thick (2-5 cm) peat with driftwood. Peat layer splits into two seams in some places. Very sharp upper and lower contacts. No visible organics in mud above or below. <u>Spl 92-20-4</u> at 10.5 ft (3.20 m), top 1 cm of peat layer (C14).
10.7-14.4	3.25-4.40	Gray clayey silt with layering 1-10 cm thick toward base and some contorted zones. Scattered flattened driftwood, otherwise negligible organics.
14.4-15.4	4.40-4.70	Up to three discontinuous peat layers up to 7 cm thick with interlayered mud up to 3 cm thick. Contains numerous abraded wood fragments that may be allochthonous. <u>Spl 92-20-5</u> at 14.4 ft (4.40 m), top 1 cm of uppermost peat layer where 7 cm thick (C14). Sample includes some twigs with bark. <u>Spl 92-20R-1</u> at 14.4 ft (4.40 m), top 2 cm of grassy peat (C14), collected 8/18/93 to replicate 92-20-5. Wood fragments omitted.
15.4-21.0	4.70-6.40	Gray clayey silt with laminae in upper part. Some highly contorted zones near top. Sharp unconformity at contact with underlying diamicton.
21.0-26.2	6.40-8.00	Hard gray mud with abundant angular pebbles (dropstones?). Matrix consists of dark medium gray to dark gray silt with some fine sand, trace clay, and scattered pelecypod shells. <u>Spl 92RE20A F-1</u> at 22.0 ft (6.70 m), shell fragments of the pelecypod <i>Macoma balthica</i> (C14).

END

## APPENDIX C

## DESCRIPTIONS OF BOREHOLE SAMPLES

See appendix A for location maps and graphic logs,  
 appendix B for descriptions of tidal-bank exposures and hand-auger samples.  
 Unless otherwise indicated, datum for depth is the modern tidal-marsh surface.  
 All locations determined from 1:25,000- or 1:63,360-scale topographic maps.

Photographs are available for all core samples on request.

Codes for intended sample analyses:

C14—radiocarbon age; GS—grain-size analysis; MP—micropaleontology; EM—electron microprobe (tephra).

See tables 1 and 2 in the text for radiocarbon ages and grain-size statistics, respectively.

Micropaleontology and tephra studies will be reported separately.

## BOREHOLE FR1, FOX RIVER FLATS - 59°48'46"N, 150°56'58"W. Drilled 2/26/91.

<u>Core</u>	<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
FR1-1	0.0-3.5 ft	0-1.07	Gray silt with scattered organics and minor clay (bagged; originally frozen and could not be sampled with continuous sampler. Taken from hollow-stem auger after drilling to 3.5 ft (1.07 m) <u>Spl FR1-3.5</u> , bulk sample (GS).
FR1-2	3.5-4.5	1.07-1.37	Thin (<2 cm) layer of gray silt with some roots overlying clean medium to coarse sand and gravel with subrounded to rounded pebbles up to 2 cm long (bagged). <u>Spl FR1-4.0</u> , at 3.95-4.05 ft (1.20-1.23 m)(GS).
FR1-3	4.5-5.0	1.37-1.52	Faintly layered gray silt with minor clay and organics. Small pod of dark gray organics at 4.9-4.95 ft (1.49-1.51 m). <u>Spl FR1-4.9</u> at 4.85-4.95 ft (1.48-1.51 m)(C14).
FR1-4	5.0-5.6	1.52-1.71	Gray silt or clayey silt with interbeds of clean, fine to medium sand. Trace very fine fibrous organics. Layer of clean fine to medium sand at 5.3-5.4 ft (1.62-1.65 m).
	5.6-7.2	1.71-2.20	Gray clean medium to coarse sand with minor angular to subangular pebbles to 1 cm. Lens of gray clayey silt at 6.0 ft (1.83 m). Faint layering. <u>Spl FR1-6.5</u> at 6.4-6.6 ft (1.95-2.01 m)(GS).
FR1-4C	7.2-7.5	2.20-2.29	Medium sand (catcher sample; bagged).
	7.5-9.5	2.29-2.90	Not recovered.
FR1-5	9.5-14.5	2.90-4.42	Heaving medium to coarse sand (bag sample); coring not attempted.
FR1-6	14.5-15.0	4.42-4.57	Gray, clean, moderately sorted medium to coarse sand, larger clasts subangular to very angular. No bedding; probably disturbed. Some clayey silt inclusions, probably ripped up from below during sampling.
	15.0-16.5	4.57-5.03	Gray, faintly laminated clayey silt. Possible organic-rich zone 15.5-15.7 ft (4.73-4.79 m)(disseminated organics in dark gray smear). Otherwise no visible organics. <u>Spl FR1-15.6</u> at 15.5-15.7 ft (4.73-4.79 m)(C14). <u>Spl FR1-15.8</u> at 15.75-15.9 ft (4.80-4.85 m)(GS). <u>Spl FR1-16.0</u> at 15.9-16.1 ft (4.85-4.91 m)(MP).
	16.5-16.6	5.03-5.06	Gray medium to coarse sand.

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	16.6-17.0	5.06-5.18	Not recovered.
FR1-7	17.0-17.4	5.18-5.30	Dark gray, clean fine to medium sand. Grains angular. 2-cm-diam pocket of gray clayey silt at 17.3 ft (5.27 m), probably rip-up clast from disturbed section below. No visible bedding. <u>Spl FR1-17.2</u> at 17.1-17.25 ft (5.21-5.26 m)(GS).
	17.4-17.7	5.30-5.40	Disturbed mixture of gray clayey silt and medium to coarse sand. Probably disturbed during sampling. Probably originally a clayey-silt layer overlying gravel.
	17.7-18.65	5.40-5.69	Brownish gray to dark gray sand and pebble gravel. Oxidized in upper 0.3 ft (0.09 m). Max. grain diameter 2 cm. Clasts very angular in sand and small gravel; rounded in larger sizes. No visible bedding or organics. <u>Spl FR1-17.9</u> at 17.75-18.1 ft (5.41-5.52 m)(GS).
FR1-7C	18.65-18.95	5.69-5.78	Medium to coarse sand (catcher sample; bagged).

**BOREHOLE FR2, FOX RIVER FLATS - 59°48'43"N, 150°56'2"W, Drilled 2/27/91.**

<u>Core</u>	<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
FR2-1	0-2.5	0-0.76	Gray silt or very fine sand with minor plant material (small bagged sample; frozen when drilled).
FR2-2	2.3-2.5	0.70-0.76	Slough from open hole above; disregard.
	2.5-3.4	0.76-1.04	Brownish gray fine sand with minor silt and minor small rootlets. Gray silt layer at 2.70-2.75 ft (0.82-0.84 m). Lower contact disturbed. Entire core slightly oxidized. No visible layering other than silt bed. <u>Spl FR2-3.0</u> at 2.9-3.1 ft (0.88-0.95 m)(GS).
	3.4-4.4	1.04-1.34	Disturbed gray silt with no visible bedding. Scattered small roots and minor oxide mottling. Grades to clayey silt at base. <u>Spl FR2-4.0</u> at 3.95-4.05 ft (1.20-1.23 m)(GS).
	4.4-4.5	1.34-1.37	Fine sand and silt (catcher sample; bagged).
FR2-3	4.5-4.65	1.37-1.42	Faintly laminated gray silt and clayey silt. Laminæ 2-5 mm thick. Lower contact sharp.
	4.65-5.65	1.42-1.72	Disturbed, mixed brownish-gray fine sand, gray silt, and gray clayey silt. Faint disturbed bedding and minor small plant fragments. Lower contact sharp.
	5.65-6.15	1.72-1.88	Brownish-gray medium to coarse sand and pebble gravel. Pebbles to 2.5 cm, angular to subrounded. No visible bedding or organics. <u>Spl FR2-6.0</u> at 5.9-6.15 ft (1.80-1.88 m)(GS).
	6.15-9.5	1.88-2.90	Not recovered.
FR2-4	9.5-9.8	2.90-2.99	Gray medium to coarse sand, coarsening downward. No visible grading or organics. Gradational lower contact.
	9.8-10.6	2.99-3.23	Gray medium to coarse sand and pebble gravel. Angular to subrounded pebbles to 3 cm. <u>Spl FR2-10.0</u> at 9.8-10.2 ft (2.99-3.11 m) (GS).
FR2-4C	10.6-10.8	3.23-3.29	Wet sand and gravel (catcher sample; bagged).

	10.8-14.5	3.29-4.42	Not recovered.
FR2-5	14.5-15.5	4.42-4.73	Clean sand and gravel, probably flow-in; bagged.
	15.5-17.0	4.73-5.18	Not recovered.
FR2-6	17.0-17.5	5.18-5.34	Gray clean fine sand grading downward to gravely coarse sand with angular to rounded pebbles to 2 cm. Rip-up clast(?) of clayey silt 4 cm long at 17.1-17.25 ft (5.21-5.26 m). Sharp base.
	17.5-18.75	5.34-5.72	Gray clayey silt with very faint bedding. No visible organics, except dark gray disseminated carbon in lower 0.15 ft (0.05 m). <u>Spl FR2-18.0</u> at 17.95-18.05 ft (5.47-5.50) (GS). <u>Spl FR2-18.3</u> at 18.2-18.4 ft (5.55-5.61) (MP). <u>Spl FR2-18.7</u> at 18.6-18.75 ft (5.67-5.72) (C14).

## BOREHOLE FR3, FOX RIVER FLATS - 59°48'46"N, 150°55'25"W. Drilled 2/27/91.

Core	Depth (ft)	Depth (m)	Description
FR3-1			Core was originally frozen; thaw resulted in 0.3 ft (0.09 m) thaw consolidation (33%).
	0-0.35	0-0.11	Woody peat and organic matter with abundant gray clayey silt.
	0.35-0.6	0.11-0.18	Gray clayey silt with minor organic matter. <u>Spl FR3-0.5</u> at 0.5-0.6 ft (0.15-0.18 m)(GS).
FR3-1C	0.6-0.8	0.18-0.24	Silt, originally frozen (catcher sample; bagged).
	0.8-2.0	0.24-0.61	Not recovered.
FR3-2			Entire core underwent about 0.3 ft (0.09 m) thaw consolidation (15%).
	2.0-3.55	0.61-1.08	Gray to brownish gray silt and clayey silt with faintly bedded fine sandy lenses at 2.8-3.0 ft (0.85-0.91 m) and 3.2-3.3 ft (0.98-1.01 m). Slight iron oxide mottling. Peaty interval at 2.4-2.5 ft (0.73-0.76 m) with irregular upper and lower contacts and no identifiable plant fossils. <u>Spl FR3-2.2</u> at 2.2-2.3 ft (0.67-0.70 m)(MP) <u>Spl FR3-2.3</u> at 2.3-2.4 ft (0.70-0.73 m)(GS). <u>Spl FR3-2.4</u> at 2.4-2.5 ft (0.73-0.76 m)(C14); peaty clayey silt.
	3.55-3.7	1.08-1.13	Gray clean, moderately sorted medium sand with a few small pebbles. Very sharp upper contact with overlying gray silt. <u>Spl FR3-3.6</u> at 3.55-3.7 ft (1.08-1.13 m)(GS).
FR3-2C	3.7-3.9	1.13-1.19	Clean fine to medium sand (catcher sample; bagged).
	3.9-4.5	1.19-1.37	Not recovered.
FR3-3	4.5-5.9	1.37-1.80	Dark brownish gray clean fine to medium sand at top, grading to gravely coarse sand at bottom. Sandy upper 0.6 ft (0.18 m) may be flow-in. <u>Spl FR3-4.8</u> at 4.6-4.9 ft (1.40-1.49 m)(GS).
FR3-3C	5.9-6.1	1.80-1.86	Gravely coarse sand (catcher sample; bagged).

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	6.1-7.0	1.86-2.13	Not recovered.
FR3-4	7.0-8.0	2.13-2.44	Dark gray gravelly coarse sand with small subangular pebbles to 1 cm. Faint bedding with fine-sand layer at 7.45-7.55 ft (2.27-2.30 m). <u>Spl FR3-7.9</u> at 7.7-8.0 ft (2.35-2.44 m)(GS).
FR3-4C	8.0-8.2	2.44-2.50	Wet coarse sand and pebble gravel (catcher sample; bagged).

#### BOREHOLE FR4, FOX RIVER FLATS - 59°48'50"N, 150°55'5"W. Drilled 2/28/91.

<u>Core</u>	<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
FR4-1			Core was frozen when retrieved. Thaw consolidation about 0.5 ft (0.15 m), or 29%.
	0-0.3	0-0.09	Surface organics (grass) and dark brown fibric peat. Gray silt layer at 0.1-0.15 ft (0.03-0.05 m). Sharp base.
	0.3-1.2	0.09-0.37	Wet gray clayey silt with no visible bedding. Scattered plant fragments at 0.3-0.4 ft (0.09-0.12 m), finely disseminated organics in remainder of core. Appears intertidal or subtidal. <u>Spl FR4-1.0</u> at 0.95-1.05 ft (0.29-0.32 m)(GS). <u>Spl FR4-1.1</u> at 1.05-1.2 ft (0.32-0.37 m)(MP).
FR4-2	1.2-2.3	0.37-0.70	Gray to brownish gray, moist, disturbed clayey silt. flattened plant fragments and twig (1 cm diam) in silty peat layer at 1.4-1.55 ft (0.43-0.47 m). Deformed peaty layer at 1.65-1.8 ft (0.50-0.55 m). Sharp base. <u>Spl FR4-1.5</u> at 1.4-1.55 ft (0.43-0.47 m)(C14), silty peat, twig, and scattered plant fragments in silt above peat.
	2.3-3.5	0.70-1.07	Interbedded gray silt, clayey silt, and fine sand. Slight oxidation. Dark gray decomposed organics at 2.8-2.9 ft (0.85-0.88 m). Plant stem at 2.35 ft (0.72 m); otherwise devoid of visible organics. Fine-sand layers are well sorted and silt free.
	3.5-4.5	1.07-1.37	Not recovered.
FR4-3	4.5-6.65	1.37-2.03	Dark gray clayey silt with scattered small plant fragments and fine-sandy zones (minor). Distinct thin bedding at 5.9-6.65 ft (1.80-2.03 m). Possible below-ground stem of <i>Triglochin</i> sp. at 6.1 ft (1.86 m). Increasing clay content toward base. <u>Spl FR4-4.7</u> at 4.65-4.75 ft (1.42-1.45 m)(GS). <u>Spl FR4-6.4</u> at 6.35-6.45 ft (1.94-1.97 m)(GS).
	6.65-7.0	2.03-2.13	Shrinkage gap.
FR4-4	7.0-9.05	2.13-2.76	Gray silt or slightly clayey silt. Scattered plant fragments (decomposed stems, grass blades) at 7.0-7.3 ft (2.13-2.23 m). Light brown silt layer with minor organics at 7.3-7.35 ft (2.23-2.24 m), possibly tephra. Distinct thin bedding at 7.8-8.2 ft (2.38-2.50 m). Lens of gray fine sand at 8.55-8.7 ft (2.61-2.65 m). <u>Spl FR4-7.35</u> at 7.3-7.35 ft (2.23-2.24 m)(possible tephra; EM). <u>Spl FR4-8.4</u> at 8.35-8.45 ft (2.55-2.58 m)(GS).
	9.05-9.5	2.76-2.90	Not recovered.

FR4-5	9.5-10.7	2.90-3.26	Dark gray (when moist), clean, fine to coarse sand. Upper 0.3-0.4 ft (0.09-0.12 m) could be flow-in. Grades fine to coarse downward. No visible bedding or organics. Negligible silt. Sharp but slightly distorted lower contact (disturbed during sampling?). <u>Spl FR4-10.5</u> at 10.4-10.6 ft (3.17-3.23 m)(GS).
	10.7-11.1	3.26-3.38	Disturbed gray, clayey silt with disturbed zones of fine to medium sand. No organics.
	11.1-11.7	3.38-3.57	Gray clean medium to coarse sand with minor angular to rounded pebbles to 1 cm. No bedding or organics. <u>Spl FR4-11.4</u> at 11.3-11.5 ft (3.45-3.51 m)(GS).
FR4-5C	11.7-12.0	3.57-3.66	Medium to coarse sand with minor silt and minor small pebbles (catcher sample; bagged).
FR4-6	12.0-13.5	3.66-4.12	Gray medium to coarse sand with minor small pebbles and negligible silt. Coarsens downward. Fine sand in upper 0.2 ft (0.06 m) may be flow-in. Base fairly sharp. No bedding or organics.
	13.5-13.82	4.12-4.21	Gray, poorly sorted pebbly sand with some silt. Numerous broken wood fragments in bottom 0.5 ft (0.15 m). No visible bedding or organics other than wood fragments. <u>Spl FR4-13.6</u> at 13.5-13.7 ft (4.12-4.18 m)(GS). <u>Spl FR4-13.8</u> at 13.75-13.82 ft (4.19-4.21 m)(C14), very small sample of wood fragments.
FR4-6C	13.82-14.1	4.21-4.30	Poorly sorted pebbly sand with some silt and a few small plant fragments (catcher sample; bagged).

**BOREHOLE FRS, FOX RIVER FLATS - 59°48'59"N, 150°54'58"W. Drilled 2/28/91.**

<u>Core</u>	<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
FRS-1	0-0.5	0-0.15	Modern vegetation and dark brown fibric peat (grass and moss).
	0.5-1.2	0.15-0.37	Wet gray clayey silt with no visible bedding. Some modern roots and minor small plant fragments. <u>Spl FRS-1.0</u> at 0.95-1.05 ft (0.29-0.32 m)(GS). <u>Spl FRS-1.1</u> at 1.05-1.2 ft (0.32-0.37 m)(MP).
FRS-2	1.2-1.55	0.37-0.47	Wet gray silt or clayey silt with abundant plant fragments, most numerous at 1.35-1.45 ft (0.41-0.44 m). Gradational base. No visible bedding. Low clay content(?).
	1.55-1.65	0.47-0.50	Grayish brown silty peat containing small (<1 cm) fragments of grass, moss(?), twigs, and roots. Gradational base. Probably former ground surface, but sudden burial not evident. <u>Spl FRS-1.6</u> at 1.55-1.65 ft (0.47-0.50 m)(C14).
	1.65-3.0	0.50-0.91	Moist, gray silt or clayey silt with no visible bedding and minor organics. Sharp base. Clay content increases slightly downward. <u>Spl FRS-2.5</u> at 2.45-2.55 ft (0.75-0.78 m)(GS).
	3.0-3.15	0.91-0.96	Moist, gray clean fine sand with minor silt. Very faint bedding, no organics. <u>Spl FRS-3.1</u> at 3.05-3.15 ft (0.93-0.96 m)(GS).



FR5-2C	3.15-3.35	0.96-1.02	Silty fine sand grading downward to silt (catcher sample; bagged).
	3.35-4.0	1.02-1.22	Shrinkage gap.
FR5-3	4.0-4.4	1.22-1.34	Gray clayey silt with very faint layering; no visible organics. Base sharp but irregular.
	4.4-4.85	1.34-1.48	Clean, gray, very fine sand grading downward to clayey silt. 4-mm-thick lamina of coarser fine sand at top. Very faintly layered. Negligible organics. Base sharp and horizontal.
	4.85-5.65	1.48-1.72	Clean, uniform dark gray fine sand with trace silt. No visible bedding or organics. <u>Spl FR5-5.2</u> at 5.1-5.3 ft (1.55-1.62 m)(GS).
FR5-3C	5.65-5.85	1.72-1.78	Wet, clean fine sand.
	5.85-6.5	1.78-1.98	Not recovered.
FR5-4	6.5-6.6	1.98-2.01	Gray, clean, very fine sand.
	6.6-8.2	2.01-2.50	Gray, interbedded silt, clayey silt, and very fine sand. Layers are 3-20 mm thick. Abundant flattened grass blades at 6.8-6.85 ft (2.07-2.09 m). Oxidized layer (slightly brownish) at 8.07-8.13 ft (2.46-2.48 m). Slightly organic rich (fine plant matter) at 7.2-7.3 ft (2.20-2.23 m), otherwise negligible organics. <u>Spl FR5-6.7</u> at 6.65-6.75 ft (2.03-2.06 m)(MP). <u>Spl FR5-6.8</u> at 6.8-6.85 ft (2.07-2.09 m)(C14), grass blades in flattened layers.
	8.2-9.0	2.50-2.74	Not recovered.
FR5-5	9.0-10.2	2.74-3.11	Dark gray, clean sand, grading from fine at top to coarse with a few small pebbles at base. Clasts very angular to subrounded. No bedding or organics. <u>Spl FR5-9.8</u> at 9.7-9.9 ft (2.96-3.02 m)(GS).
	10.2-10.6	3.11-3.23	Gray coarse sand and pebble gravel with minor silt. No bedding or organics. <u>Spl FR5-10.4</u> at 10.2-10.8 ft (3.11-3.29 m)(GS).
FR5-5C	10.6-10.8	3.23-3.29	Wet sand and gravel (catcher sample; bagged).
	10.8-14.0	3.29-4.27	Not recovered.
FR5-6	14.0-15.75	4.27-4.80	Dark gray (when moist) clean medium to coarse sand with abundant gravel at 14.8-15.75 ft (4.51-4.80 m). Gravel clasts subangular to rounded, maximum size 2.5x1.5x4.0 cm (quartz) at 15.5 ft (4.73 m). No visible bedding or organics. Top 1 ft (0.30 m) probably flow-in of saturated sand.
FR5-6C	15.75-16.0	4.80-4.88	Wet sand and gravel (catcher sample; bagged).
	16.0-24.0	4.88-7.32	Drilled through but not recovered. Saturated sand and gravel.

**BOREHOLE FR6, FOX RIVER FLATS - 59°48'46"N, 150°57'30"W. Drilled 3/1/91.**

<u>Core</u>	<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
FR6-1	0-0.6	0-0.18	Wet gray silt or clayey silt with very faint layering and minor organics. Peat at 0.1-0.15 ft (0.03-0.05 m), probably surface vegetation, covered by silt; probably disturbed. Core originally 1.1 ft (0.34 m) long and frozen (54% thaw consolidation).
FR6-2	0.6-0.9	0.18-0.27	Gray silt with no visible bedding, negligible clay, and trace organics. Sharp base.
	0.9-2.65	0.27-0.81	Interbedded clean fine sand, silty fine sand, and medium to coarse sand with some pebbles. Flat piece of wood, 3 mm thick, at 1.52 ft (0.46 m). large broken phyllite clast at 2.60-2.65 ft (0.79-0.81 m) (base of core). Subangular to subrounded pebbles to 3 cm.
FR6-2C	2.65-2.85	0.81-0.87	Clean coarse sand and pebble gravel.
	2.85-4.5	0.87-1.37	Not recovered.
FR6-3	4.5-5.65	1.37-1.72	Dark gray (when moist), clean, medium to coarse sand and gravelly sand. Pebble gravel at 4.7-5.0 ft (1.43-1.52 m), with subangular to subrounded pebbles to 1.5 cm.
FR6-3C	5.65-5.85	1.72-1.78	Wet clean sand with a few pebbles (catcher sample; bagged).
	5.85-9.5	1.78-2.90	Not recovered.
FR6-4	9.5-11.85	2.90-3.61	Dark gray (when moist), clean, medium to coarse sand with minor subrounded pebbles to 1 cm. No visible bedding or organics. Thin silt layer at 11.7-11.75 ft (3.57-3.58 m). Much of core may be flow-in.
FR6-4C	11.85-12.0	3.61-3.66	Clean medium to coarse sand; probably flow-in.
	12.0-24.5	3.66-7.47	Drilled through but not recovered. Saturated sand.

**BOREHOLE FR7, FOX RIVER FLATS - 59°48'47"N, 150°57'45"W. Drilled 3/1/91.**

<u>Core</u>	<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
FR7-1	0-0.15	0-0.05	Gray clayey silt at ground surface. Probably modern high-tidal deposition.
	0.15-0.2	0.05-0.06	Brown peat composed of fine plant fragments.
	0.2-0.9	0.06-0.27	Dark gray clean medium sand with no visible bedding and trace plant fragments.
	0.9-1.05	0.27-0.32	Dark gray silty fine sand. Several broken wood fragments at 1.0 ft (0.30 m). Sharp base.
	1.05-1.3	0.32-0.40	Dark gray silty fine sand with faint bedding and no visible organics.
FR7-2	1.3-1.6	0.40-0.49	Gray silty fine to medium sand with trace small pebbles. Coarsens downward. 3-mm-diam twigs at 1.32 ft (0.40 m) and 1.58 ft (0.48 m). Sharp base.

	1.6-1.75	0.49-0.53	Gray layered silt and silty fine sand with minor plant fragments. Sharp base.
	1.75-3.35	0.53-1.02	Dark gray clean medium to coarse sand; coarsens downward. Trace pebbles and clay balls at 1.9 ft (0.58 m).
	3.35-4.5	1.02-1.37	Not recovered.
FR7-3	4.5-6.65	1.37-2.03	Dark gray, clean, fine to coarse sand with trace small pebbles. Faint bedding; no visible organics.
FR7-3C	6.65-6.9	2.03-2.10	Pebbly coarse sand; rounded pebbles to 3 cm (catcher sample; bagged).
	6.9-27.0	2.10-8.23	Drilled through but not recovered. Wet sand.
	27.0-39.5	8.23-12.04	Drilled through but not recovered. Wet sand and gravel.

**BOREHOLE FR8, FOX RIVER FLATS - 59°48'40"N, 150°57'35"W. Drilled 3/2/91.**

<u>Core</u>	<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
FR8-1			Core originally frozen; 0.4 ft (0.12 m) thaw consolidation (23%).
	0-0.25	0-0.08	Gray silt with minor surface vegetation and some embedded plant fragments in 0-0.1 ft (0-0.03 m). Organics decrease downward. Base very sharp. <u>Spl FR8-0.2</u> at 0.15-0.25 ft (0.05-0.08 m)(MP). <u>Spl FR8-0.3</u> at 0.25-0.3 ft (0.08-0.09 m)(C14); although shallow, contamination by surface roots appears absent.
	0.3-1.35	0.09-0.41	Interbedded dark gray, clean, fine sand, medium sand, and silty fine sand with numerous grass and wood fragments.
FR8-2	1.35-3.3	0.41-1.01	Interbedded gray to brownish gray, clean, fine sand, medium sand, fine sandy silt, and silt. Minor lenses of coarse sand. Beds 1-4 cm thick. Scattered minor plant fragments.
	3.3-4.5	1.01-1.37	Not recovered.
FR8-3	4.5-5.85	1.37-1.78	Disturbed gray silt, fine sandy silt, and silty fine sand. Mottled with dark gray disseminated carbon. Otherwise no visible organics. <u>Spl FR8-5.0</u> at 4.9-5.1 ft (1.49-1.55 m)(GS). <u>Spl FR8-5.1</u> at 5.1-5.2 ft (1.55-1.59 m)(MP).
FR8-4	5.85-7.35	1.78-2.24	Gray silt with minor clay, no visible bedding, and no visible organics. Disturbed lens of fine to medium sand 5 mm thick at 6.42 ft (1.96 m). <u>Spl FR8-7.0</u> at 6.95-7.05 ft (2.12-2.15 m)(GS).
	7.35-9.5	2.24-2.90	Not recovered.
FR8-5	9.5-11.65	2.90-3.55	Dry, light gray to gray, very compact, uniform silt with no visible bedding or organics. Highly fractured when split. <u>Spl FR8-11.0</u> at 10.95-11.05 ft (3.34-3.37 m)(GS).
	11.65-12.0	3.55-3.66	Not recovered.
FR8-6	12.0-13.3	3.66-4.05	Uniform gray silt grading downward to sandy silt. No visible bedding or organics. Base sharp but irregular. <u>Spl FR8-12.5</u> at 12.4-12.6 ft (3.78-3.84 m)(GS).

	13.3-13.65	4.05-4.16	Dark gray, clean, medium to coarse sand with some angular to rounded pebbles to 1 cm. No bedding or organics.
FR8-6C	13.65-13.75	4.16-4.19	Clean medium to coarse sand with pebbles (catcher sample; bagged). <u>Spl FR8-13.7</u> (entire core)(GS).
	13.75-14.5	4.19-4.42	Not recovered.
FR8-7	14.5-15.4	4.42-4.70	Dark gray, clean, well-sorted medium to coarse sand, coarsening downward. May be flow-in. 1.5-cm pocket of clayey silt at 14.9 ft (4.54 m). No visible bedding or organics. Sharp base.
	15.4-15.75	4.70-4.80	Gray, gravelly medium to coarse sand with minor silt. No bedding or organics.
FR8-7C	15.75-16.1	4.80-4.91	Medium to coarse sand with minor gravel and silt. Coarse clasts are angular. <u>Spl FR8-16.0</u> (entire core)(GS).

**BOREHOLE FR9, FOX RIVER FLATS - 59°47'50"N, 150°56'25"W. Drilled 3/2/91.**

<u>Core</u>	<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
FR9-1	0-0.3	0-0.09	Brownish gray, medium to coarse sand and minor silt with roots and below-ground stems of surface grasses.
	0.3-0.95	0.09-0.29	Interbedded gray fine sand, medium sand, sandy silt, and dark gray medium to coarse sand with scattered plant fragments. Beds 3-25 mm thick. Coarse clasts are angular.
FR9-2	0.95-2.9	0.29-0.88	Finely layered, gray, fine sandy silt with scattered small plant fragments. Layers 1-3 mm thick over most of core from 1.25 ft (0.38 m) to base; thicker layers to 30-50 mm. 5-mm-thick layer of slightly oxidized, clean, medium sand. <u>Spl FR9-2.5</u> at 2.45-2.55 ft (0.75-0.78 m)(GS). <u>Spl FR9-2.6</u> at 2.55-2.65 ft (0.78-0.81 m)(MP).
	2.9-3.2	0.88-0.98	Silt or fine sand (catcher sample; bagged).
	3.2-4.5	0.98-1.37	Not recovered.
	4.5-5.55	1.37-1.69	Laminated, gray, light gray, and brownish-gray silt, fine sandy silt, and minor fine sand. Laminae 1-15 mm thick. Negligible organics (fine rootlets). Gradational base.
FR9-3	5.55-6.95	1.69-2.12	Uniform gray silt or clayey silt. No visible bedding or organics. Slight oxide mottling. <u>Spl FR9-6.0</u> at 5.95-6.05 ft (1.81-1.84 m)(GS). <u>Spl FR9-6.1</u> at 6.05-6.15 ft (1.84-1.88 m)(MP).
	6.95-7.0	2.12-2.13	Shrinkage gap.
FR9-4	7.0-9.2	2.13-2.80	Gray to light gray (when dry), very compact silt with no visible organics. Nearly uniform, except for some 1-3-mm-thick laminations of light gray silt at 7.2-7.3 ft (2.20-2.23 m). Highly fractured during splitting.

FR9-5	9.2-12.0	2.80-3.66	Gray, uniform, very compact silt or clayey silt. Severely fractured during splitting. No visible bedding or organics. Slight iron-stain mottling. <u>Spl FR9-10.0</u> at 9.95-10.05 ft (3.03-3.06 m)(GS). <u>Spl FR9-10.1</u> at 10.05-10.15 ft (3.06-3.09 m)(MP). <u>Spl FR9-10.3</u> at 10.15-10.5 ft (3.09-3.20 m)(specific gravity for grain-size analyses).
FR9-6	12.0-13.1	3.66-3.99	Gray, compact, uniform silt with no visible bedding or organics. Fractured during splitting. Gradational lower contact.
	13.1-14.2	3.99-4.33	Gray to dark gray compact silt with faint bedding and dark gray organic mottling; darkest at 13.15-13.25 ft (4.01-4.04 m). Scattered small pelecypod valves in random orientations at 13.55-13.85 ft (4.13-4.22 m). <u>Spl FR9-13.2</u> at 13.15-13.25 ft (4.01-4.04 m)(C14).
FR9-7	14.5-16.5	4.42-5.03	Gray to dark gray silt with dark gray organic partings and scattered small pelecypod shells. Examples at 14.65 ft (4.47 m) and 15.6 ft (4.76 m). Angular pebble 5 cm long at 16.1 ft (4.91 m) with small shell fragments underneath. Lower contact sharp but shows penetration of clayey silt into underlying fine sand, like load injection. Unit becomes clayey toward base.
	16.5-16.9	5.03-5.15	Laminated, gray, light gray, and dark gray silt, fine sand, and sandy silt. Layers 1-10 mm thick. Small broken shell fragments at 16.8-16.9 ft (5.12-5.15 m).
	16.9-17.0	5.15-5.18	Shrinkage gap.
FR9-8	17.0-19.45	5.18-5.93	Layered gray silt or clayey silt with minor light gray laminae of fine-sandy silt, minor dark gray organic mottling, and trace scattered small shell fragments. Dark gray layer with disseminated organics and single shell fragment at 17.3-17.45 ft (5.27-5.32 m). <u>Spl FR9-17.4</u> at 17.3-17.45 ft (5.27-5.32 m)(C14). <u>Spl FR9-19.0</u> at 18.95-19.05 ft (5.78-5.81 m)(GS).

**BOREHOLE KE1, KENAI RIVER FLATS - 60°31'29"N, 151°12'22"W. Drilled 5/14/91**

Datum for depth is the surface of artificial fill overlying the modern tidal-marsh surface.

<u>Core</u>	<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
	0-1.5	0-0.46	Artificial fill (sand and gravel); no sample.
KE1-1	1.5-2.15	0.46-0.66	Artificial fill (pebbly coarse sand).
	2.15-2.2	0.66-0.67	Dark brown fine fibrous peat; ground surface at time of fill emplacement.
	2.2-2.8	0.67-0.85	Gray to slightly brownish gray uniform clayey silt with scattered plant fragments and peat partings. Brownish at top near peat.
	2.8-4.0	0.85-1.22	Not recovered.
KE1-2	4.0-4.9	1.22-1.49	Gray to brownish gray uniform clayey silt with abundant plant fragments. Gradationally peaty toward base. Three possible below-ground stems of <i>Triglochin</i> sp. at 4.3-4.4 ft (1.31-1.34 m). Gradational lower contact. <u>Spl KE1-4.5</u> at 4.45-4.55 ft (1.36-1.39 m)(GS). <u>Spl KE1-4.6</u> at 4.55-4.65 ft (1.39-1.42 m)(MP).

	4.9-5.05	1.49-1.54	Dark brown fibric peat with minor silt. Woody at 5.0-5.05 ft (1.52-1.54 m). Gradational upper contact. <u>Spl KE1-4.9</u> at 4.9-5.0 ft (1.49-1.52 m)(C14).
	5.05-6.5	1.54-1.98	Not recovered (peat?).
KE1-3	6.5-6.8	1.98-2.07	Dark brown fibric grass and woody peat. Sharp but irregular basal contact. Upper contact not recovered. Sampled peat is probably base of unit in KE1-2. Two large (3-cm-diam) roots embedded in peat at 6.6-6.8 (2.01-2.07 m). <u>Spl KE1-6.7</u> at 6.65-6.8 ft (2.03-2.07 m)(C14).
	6.8-7.8	2.07-2.38	Uniform gray silt with minor scattered plant fragments. No visible bedding. Sharp, irregular top. <u>Spl KE1-7.0</u> at 6.96-7.05 ft (2.12-2.15 m)(GS). <u>Spl KE1-7.1</u> at 7.05-7.15 ft (2.15-2.18 m)(MP).
	7.8-9.0	2.38-2.74	Not recovered.
KE1-4	9.0-11.45	2.74-3.49	Gray to brownish gray silt with numerous scattered plant fragments. Very faint lamination, slightly disturbed (or rippled).
	11.45-11.5	3.49-3.51	Shrinkage gap.
KE1-5	11.5-13.85	3.51-4.22	Gray to brownish gray silt with very faint lamination, scattered plant fragments, and scattered dark gray organic mottling. Organic-rich laminated silt at 11.7-12.0 ft (3.57-3.66 m), with most concentrated grass stems and roots at 11.8-11.85 ft (3.60-3.61 m). Peaty zone has gradational top and bottom. base of unit sharp but irregular over thin peat. <u>Spl KE1-11.8</u> at 11.75-11.85 ft (3.58-3.61 m), peaty silt (C14). <u>Spl KE1-12.8</u> at 12.6-12.95 ft (3.84-3.95 m)(specific gravity for grain-size analyses). <u>Spl KE1-13.0</u> at 12.95-13.05 ft (3.95-3.98 m)(GS). <u>Spl KE1-13.5</u> at 13.45-13.55 ft (4.10-4.13 m)(MP).
	13.85-13.9	4.22-4.24	Dark brown fibric woody peat. Fairly sharp but irregular top and base, and no significant organics above or below (possibly a former ground surface). <u>Spl KE1-13.9</u> at 13.85-13.9 ft (4.22-4.24 m)(C14).
	13.9-13.95	4.24-4.25	Light brownish gray clean fine sand. Sharp contacts. No visible bedding or organics.
	13.95-14.0	4.25-4.27	Gray silt with no visible bedding or organics.
KE1-6	14.0-14.12	4.27-4.30	Dark grayish brown, clean fine to medium sand with no visible bedding or organics. Could be flow-in. Sharp basal contact.
	14.12-14.45	4.30-4.41	Dark brown sandy peat or highly organic sandy silt. Organic material is very fine and unidentifiable, except it appears to be plant matter. 2-cm pebble embedded at 14.4 ft (4.39 m). Basal contact is sharp but irregular over underlying gravelly sand. <u>Spl KE1-14.3</u> at 14.25-14.45 ft (4.34-4.41 m)(C14).
	14.45-15.5	4.41-4.73	Medium to coarse sand and pebble gravel with no visible bedding or organics. Angular to well-rounded pebbles to 4.5-cm length. Negligible silt. Approx. 60% gravel, 40% sand. <u>Spl KE1-15.0</u> at 14.7-15.3 ft (4.48-4.66 m)(GS).

**BOREHOLE KE2, KENAI RIVER FLATS - 60°32'5"N, 151°12'33"W. Drilled 6/3/91.**

Datum for depth is the surface of artificial fill overlying the modern tidal-marsh surface.

<u>Core</u>	<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
	0-3.5	0-1.07	Artificial sand-and-gravel fill; no sample.
KE2-1	3.5-4.25	1.07-1.30	Sand and gravel (artificial fill).
	4.25-4.5	1.30-1.37	Dark brown grassy peat with twigs or roots to 1.5-cm diam at 4.4-4.5 ft (1.34-1.37 m). Sharp but irregular top is probably ground surface at time of fill emplacement. Base sharp and horizontal.
	4.5-5.4	1.37-1.65	Gray silt with scattered small dark gray organic patches at 4.5-4.8 ft (1.37-1.46 m) and abundant small plant fragments with associated oxide mottling at 5.0-5.3 ft (1.52-1.62 m). No visible bedding. <u>Spl KE2-5.8</u> at 4.75-4.85 ft (1.45-1.48 m)(GS). <u>Spl KE2-4.9</u> at 4.85-4.95 ft (1.48-1.51 m)(MP).
KE2-2	5.4-6.05	1.65-1.84	Gray to brownish gray silt with numerous small plant fragments and associated oxide mottling. Plant fragments and oxide stains are most abundant near base at 5.9-6.05 ft (1.80-1.84 m).
	6.05-6.2	1.84-1.89	Shrinkage gap.
KE2-3	6.2-8.5	1.89-2.59	Gray to brownish gray silt with minor plant fragments and iron oxide mottling. Fine-sand parting with associated iron oxide at 6.45 ft (1.97 m). Very faint, disturbed laminae most visible at 7.0-7.6 ft (2.13-2.32 m). Clay content increases toward base. Gradational basal contact. <u>Spl KE2-7.5</u> at 7.45-7.55 ft (2.27-2.30 m)(GS).
	8.5-8.7	2.59-2.65	Shrinkage gap.
KE2-4	8.7-11.05	2.65-3.37	Gray clayey silt with scattered very small plant fragments and dark gray organic mottles. Organic mottling is scattered at 8.7-10.4 ft (2.65-3.17 m), abundant at 10.4-11.05 ft (3.17-3.37 m). A few very small shell(?) fragments at 9.8-10.2 ft (2.99-3.11 m). <u>Spl KE2-9.4</u> at 9.35-9.45 ft (2.85-2.88 m)(GS). <u>Spl KE2-9.5</u> at 9.45-9.55 ft (2.88-2.91 m)(MP).
	11.05-11.2	3.37-3.41	Shrinkage gap.
KE2-5	11.2-13.6	3.41-4.15	Gray silt or clayey silt with dark gray organic mottles at 11.2-12.0 ft (3.41-3.66 m). Some small plant fragments associated with dark gray mottles. No visible bedding.
	13.6-13.7	4.15-4.18	Shrinkage gap.
KE2-6	13.7-14.05	4.18-4.28	Gray silt or clayey silt with no visible bedding or organics. Gradational base. <u>Spl KE2-13.8</u> at 13.75-13.85 ft (4.19-4.22 m)(GS). <u>Spl KE2-13.9</u> at 13.85-13.95 ft (4.22-4.25 m)(MP).
	14.05-14.9	4.28-4.54	Gray to brown organic silt and peat. Scattered plant fragments at top, increasing gradually to fibric peat with negligible silt at 14.5-14.6 ft (4.45-4.45 m). Silt content increases gradually in interval 14.6-14.9 ft (4.45-4.54 m) to >50%. Several broken twigs or roots in cross section at 14.05-14.3 ft (4.28-4.36 m). Gradational top and base. <u>Spl KE2-14.2</u> at 14.15-14.3 ft (4.31-4.36 m)(C14).

	14.9-15.4	4.54-4.70	Gray silt or clayey silt with minor brown and dark gray organic mottling. Little or no visible plant material. Diagonal parting along white zone of very fine sand at 15.2-15.3 ft (4.63-4.66 m). Gradational top and base. <u>Spl KE2-15.1</u> at 15.05-15.15 ft (4.59-4.62 m)(MP). <u>Spl KE2-15.25</u> at 15.2-15.3 ft (4.63-4.66 m)(check for possible volcanic ash). [Tephra confirmed]
	15.4-15.9	4.70-4.85	Gray to brownish gray organic silt or clayey silt. Abundant small plant fragments, mostly grass blades and roots. Gradational contacts.
	15.9-16.1	4.85-4.91	Dark brown fibrous and woody peat. Flattened horizontal grass fragments near top, wood fragments at bottom. Gradational top. <u>Spl KE2-15.9</u> at 15.9-16.0 ft (4.85-4.88 m)(C14).
	16.1-16.2	4.91-4.94	Shrinkage gap.
KE2-7	16.2-16.35	4.94-4.98	Gray to brownish gray clayey silt with abundant plant material. Could be disturbed or flow-in silt in otherwise continuous peat layer, or could be intervening silt between separate peats. Base fairly sharp.
	16.35-16.8	4.98-5.12	Dark brown fibrous and woody peat. Broken twigs to 1.5 cm diam. Sharp base and relatively sharp top. <u>Spl KE2-16.4</u> at 16.35-16.45 ft (4.98-5.02 m)(C14).
	16.8-18.6	5.12-5.67	Gray uniform silt to clayey silt. Minor organics at top near overlying peat and trace organics scattered throughout. Very light gray very fine disturbed sand or silt layers at 18.3-18.45 ft (5.58-5.61 m) may be tephra. Otherwise no visible bedding. <u>Spl KE2-17.5</u> at 17.45-17.55 ft (5.32-5.35 m)(MP). <u>Spl KE2-17.6</u> at 17.55-17.65 ft (5.35-5.38 m)(GS). <u>Spl KE2-18.4</u> at 18.4-18.45 ft (5.61-5.63 m)(check for volcanic ash). [Tephra confirmed]
	18.6-18.7	5.67-5.70	Shrinkage gap.
KE2-8	18.7-21.05	5.70-6.42	Gray to brownish gray silt or clayey silt with scattered plant fragments. Organics are most numerous at 19.1-19.4 ft (5.82-5.91 m), with 3 mm twig at 19.2 ft (5.85 m). Distinct laminations 1-3 mm thick, horizontal and undisturbed, at 20.5-21.0 ft (6.25-6.40 m). Zone at 19.4-19.5 ft (5.91-5.95 m) shows high magnetic-susceptibility peak but no visible tephra. <u>Spl KE2-19.5</u> at 19.4-19.5 ft (5.91-5.95 m)(check for volcanic ash).
	21.05-21.2	6.42-6.46	Shrinkage gap.
KE2-9	21.2-23.6	6.46-7.20	Gray laminated silt and fine sandy silt with minor scattered plant fragments. Broken wood fragment and peat parting at 21.3 ft (6.49 m). Laminations faint and mildly to moderately distorted. Dark gray organic mottles at 23.2-23.5 ft (7.07-7.16 m). Magnetic susceptibility very high at 22.85-22.95 ft (6.97-7.00 m), but no visible sign of tephra. <u>Spl KE2-22.9</u> at 22.85-22.95 ft (6.97-7.00 m)(check for volcanic ash). <u>Spl KE2-23.0</u> at 22.95-23.05 ft (7.00-7.03 m)(GS). <u>Spl KE2-21.75</u> at 21.7-21.8 ft (6.62-6.65 m)(control sample for ash content in zone of low magnetic susceptibility).
	23.6-23.7	7.20-7.23	Shrinkage gap.



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KE2-10	23.7-26.1	7.23-7.96	Gray silt, fine sandy silt, and clayey silt with faint bedding and dark gray organic mottling. Single rounded pebbles, 2 cm long, embedded at 25.8 ft (7.87 m).
	26.1-26.2	7.96-7.99	Shrinkage gap.
KE2-11	26.2-28.5	7.99-8.69	Gray and minor light gray and brownish-gray silt and fine sandy silt with scattered dark gray organic mottles. Distinct and slightly disturbed bedding at 26.8-28.5 ft (8.17-8.69 m). Fine sandy laminae up to 2 mm thick. Subrounded quartz pebble 1 cm long at 28.2 ft (8.60 m). <u>Spl KE2-28.1</u> at 28.05-28.15 ft (8.55-8.58 m)(GS). <u>Spl KE2-28.65</u> at 28.6-28.7 ft (8.72-8.75 m)(control sample for volcanic-ash content collected in zone of low ambient magnetic susceptibility).
	28.5-28.7	8.69-8.75	Shrinkage gap.
KE2-12	28.7-31.1	8.75-9.48	Gray silt with scattered dark gray organic mottles and several small rounded pebbles. Light gray laminae of very fine sand at 29.95-30.1 ft (9.13-9.18 m) and dark bands of disseminated organics at 28.80-28.85 ft (8.78-8.80 m) and 29.6-29.7 ft (9.02-9.05 m).
	31.1-31.2	9.48-9.51	Shrinkage gap.
KE2-13	31.2-33.6	9.51-10.24	Gray silt with a few distorted lenses of silty very fine sand or sandy silt and numerous isolated angular to rounded pebbles to 5 cm long. Minor scattered dark gray organic smears. Pebbles appear to be in random orientations to sub-horizontal. Trace detrital coal fragments.

#### BOREHOLE KE3, KENAI RIVER FLATS - 60°32'33"N, 151°13'3"W. Drilled 6/4/91.

Datum for depth is the surface of artificial fill overlying the modern tidal-marsh surface.

<u>Core</u>	<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
KE3-1	0-0.8	0-0.24	Brown sand and gravel; artificial fill.
	0.8-2.5	0.24-0.76	Gray to brownish gray silt with scattered plant fragments at 1.4-2.5 ft (0.43-0.76 m). Gradually browner toward base (2.1-2.5 ft or 0.64-0.76 m), apparently due to iron-oxide staining. <u>Spl KE3-1.0</u> at 0.9-1.05 ft (0.27-0.32 m)(GS).
	2.5-3.8	0.76-1.16	Not recovered.
KE3-2	3.8-6.1	1.16-1.86	Gray to brownish-gray silt to clayey silt with minor scattered plant fragments and no visible bedding. Nearly uniform, with iron-oxide mottling. Slightly organic-rich zone at 4.25-4.4 ft (1.30-1.34 m). <u>Spl KE3-4.3</u> at 4.25-4.4 ft (1.30-1.34 m)(C14; for max. age of sediment). <u>Spl KE3-5.0</u> at 4.95-5.05 ft (1.51-1.54 m)(GS).
	6.1-6.5	1.86-1.98	Not recovered.
KE3-3	6.5-8.85	1.98-2.70	Gray to brownish gray silt to clayey silt with no visible bedding and minor scattered small plant fragments. Minor oxide mottling, apparently associated with small plant fragments. Fine-sandy layer at 6.8-6.85 ft (2.07-2.09 m), possibly tephra. <u>Spl KE3-6.8</u> at 6.8-6.85 ft (2.07-2.09 m)(check for possible ash content). [Tephra not present].

	8.85-9.0	2.70-2.74	Shrinkage gap.
KE3-4	9.0-11.5	2.74-3.51	Gray clayey silt with dark gray organic mottling and layering. Layered dark gray organic smears most prominent at 10.7-11.2 ft (3.26-3.41 m). Otherwise no visible layering or organic fragments. <u>Spl KE3-10.0</u> at 9.95-10.05 ft (3.03-3.06 m)(GS). <u>Spl KE3-11.2</u> at 11.1-11.25 ft (3.38-3.43 m)(C14; dark gray disseminated organics; may be transported).
KE3-5	11.5-13.9	3.51-4.24	Gray clayey silt with interlayers of light brownish-gray silt or silty very fine sand, 1-35 mm thick. Examples are at 12.35-12.5 ft (3.77-3.81 m), 13.05-13.1 ft (3.98-3.99 m), and 13.65 ft (4.16 m). Dark gray organic motiles and bands at 11.5-11.8 ft (3.51-3.60 m), 12.8-13.0 ft (3.90-3.96 m), and 13.5-13.6 ft (4.12-4.15 m). Laminated at 13.7-13.8 ft (4.18-4.21 m).
	13.9-14.0	4.24-4.27	Shrinkage gap.
KE3-6	14.0-16.35	4.27-4.98	Gray clayey silt with minor laminae and zones of light brownish gray silt (tephra?). Faint layering throughout and distinctly laminated (3-6-mm layers) at 15.75-15.9 ft (4.80-4.85 m). Zone of scattered rounded pebbles to 1.5 mm at 14.4-14.55 ft (4.39-4.44 m), probably ice-raftered dropstones. <u>Spl KE3-15.2</u> at 15.15-15.25 ft (4.62-4.65 m)(GS).
KE3-7	16.35-18.8	4.98-5.73	Layered and laminated gray clayey silt with thin layers and partings of light brownish-gray silt or silty very fine sand (tephra?). <u>Spl KE3-16.5</u> at 16.5-16.55 ft (5.03-5.05 m)(check for tephra). [Tephra not present].
	18.8-19.0	5.73-5.79	Not recovered.
KE3-8	19.0-21.4	5.79-6.52	Faintly layered gray clayey silt with distinct scattered laminae of light brownish-gray silt. Minor dark gray organic motiles at 19.6-19.7 ft (5.98-6.01 m). Pair of subrounded, elongated pebbles to 35 mm length at 20.9-21.0 ft (6.37-6.40 m). <u>Spl KE3-19.8</u> at 19.75-19.85 ft (6.02-6.05 m)(GS).
	21.4-21.5	6.52-6.55	Shrinkage gap.
KE3-9	21.5-24.0	6.55-7.32	Gray silt to clayey silt with scattered laminae of light brown to brownish-gray silt and very fine sand. Trace dark gray organic mottling.
KE3-10	24.0-25.25	7.32-7.70	Gray silt to clayey silt with faint layering, minor dark gray organic mottling, and scattered small rounded pebbles to 1 cm. Clay content increases downward. Sharp basal contact. <u>Spl KE3-25.0</u> at 24.95-25.05 ft (7.61-7.64 m)(GS).
	25.25-26.45	7.70-8.06	Dark gray (when moist) medium to coarse sand and pebble gravel. Silty in upper and lower 0.4 ft (0.12 m); clean between. No visible layering or organics. Subangular to subrounded pebbles to 6 cm long. <u>Spl KE3-26.0</u> at 25.7-26.3 ft (7.84-8.02 m)(GS).
	26.45-29.0	8.06-8.84	Sand and gravel; drilled but not recovered.

**BOREHOLE KE4, KENAI RIVER FLATS - 60°32'8"N, 151°15'41"W. Drilled 6/4/91.**

Datum for depth is the surface of artificial fill overlying the modern tidal-marsh surface.

<u>Core</u>	<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
	0-3.0	0-0.91	Artificial sand-and-gravel fill; not recovered.
KE4-1	3.0-3.3	0.91-1.01	Light brown sand-and-gravel road fill (artificial).
	3.3-3.55	1.01-1.08	Dark brown, fibric, grassy and woody peat on buried surface of tidal flat beneath road fill. Sharp basal contact. <u>Spl KE4-3.5</u> at 3.5-3.55 (1.07-1.08 m)(C14; basal age of surface vegetation).
	3.55-5.3	1.08-1.62	Gray silt to clayey silt with minor dark gray organic mottling in top 0.2 ft (0.06 m) and slight iron-oxide staining increasing toward base in interval 4.3-5.3 ft (1.31-1.62 m). <u>Spl KE4-4.0</u> at 3.95-4.05 (1.20-1.23 m)(GS).
	5.3-5.5	1.62-1.68	Not recovered.
KE4-2	5.5-7.95	1.68-2.42	Uniform gray to brownish-gray clayey silt with minor iron-oxide mottling and no visible organics. Faint layering at 5.8-6.0 ft (1.77-1.83 m), otherwise no visible layering.
	7.95-8.0	2.42-2.44	Shrinkage gap.
KE4-3	8.0-10.4	2.44-3.17	Uniform gray to brownish-gray clayey silt with minor iron-oxide mottling and no visible organics. Minor sandy zones. Single small (<1 cm diam) rounded pebble at 9.9 ft (3.02 m). <u>Spl KE4-10.0</u> at 9.95-10.05 ft (3.03-3.06 m)(GS).
	10.4-10.5	3.17-3.20	Shrinkage gap.
KE4-4	10.5-12.45	3.20-3.80	Gray to brownish-gray clayey silt with faint, slightly disturbed layering. Brownish iron-oxide mottling decreases downward and disappears at 11.7 ft (3.57 m). Clay content appears to increase gradually downward. Dark gray organic mottling increases downward beginning at 10.7 ft (3.26 m). Disturbed dark gray organic-rich layer at 12.2-12.4 ft (3.72-3.78 m) (disseminated charcoal?).
	12.45-13.0	3.80-3.96	Not recovered.
KE4-5	13.0-15.4	3.96-4.70	Gray to dark gray layered clayey silt. Abundant dark gray organic mottles and layers, but no other visible organics, such as plant fragments. Very thin fine-sand partings at 13.35-13.4 ft (4.07-4.09 m), 15.0 ft (4.57 m), and 15.35 ft (4.68 m), possibly tephra. Possible vertical burrow fillings at 13.3-13.5 ft (4.05-4.12 m) and 13.85-14.0 ft (4.22-4.27 m). <u>Spl KE4-14.5</u> at 14.45-14.55 ft (4.41-4.44 m)(GS). <u>Spl KE4-14.8</u> at 14.7-14.9 ft (4.48-4.54 m)(C14; disseminated dark gray organics in layered silt; transported?).
	15.4-15.5	4.70-4.73	Shrinkage gap.
	15.5-17.85	4.73-5.44	Gray laminated clayey silt with dark gray mottles and laminae of organic silty clay. Mostly undisturbed. Thin (4-mm) layer of light brownish-gray very fine sand at 16.5 ft (5.03 m)(tephra?). Distinct dark gray organic-rich layer at 16.9-17.0 ft (5.15-5.18 m).

	17.85-18.0	5.44-5.49	Shrinkage gap.
KE4-7	18.0-20.4	5.49-6.22	Gray laminated clayey silt with some dark gray organic mottling and layering, and laminae and partings of light brownish-gray very fine sand. Concentrated sandy laminae at 19.75-19.9 ft (6.02-6.07 m), coinciding with major magnetic-susceptibility peak at 19.9 ft (6.07 m). <u>Spl KE4-19.6</u> at 19.55-19.65 ft (5.96-5.99 m)(GS). <u>Spl KE4-19.9</u> at 19.85-19.95 ft (6.05-6.08 m); light gray lamina of very fine sand at magnetic-susceptibility peak, possibly tephra. [Tephra not present].
	20.4-20.5	6.22-6.25	Shrinkage gap.
KE4-8	20.5-22.9	6.25-6.98	Gray laminated clayey silt with a few partings and laminae of light brownish gray silt or very fine sand. No appreciable organics. Mostly undisturbed, with slightly inclined laminae. Slightly disturbed interbeds of gray clayey silt and light brownish gray silt or very fine sand at 22.75-22.9 ft (6.94-6.98 m).
	22.9-23.0	6.98-7.01	Shrinkage gap.
KE4-9	23.0-25.45	7.01-7.76	Gray clayey silt with minor laminae of light brownish-gray silt and very fine sand. Minor organic mottling. Disturbed layering at 23.2-24.3 ft (7.07-7.41 m). Undisturbed or slightly disturbed laminae 1-6 mm thick elsewhere. <u>Spl KE4-23.6</u> at 23.55-23.65 ft (7.18-7.21 m)(GS).
	25.45-25.5	7.76-7.77	Shrinkage gap.
KE4-10	25.5-26.6	7.77-8.11	Gray clayey silt with minor partings of silt or very fine sand and trace of organic mottling. Faint laminations. Gradational basal contact.
	26.6-27.35	8.11-8.34	Interbedded gray clayey silt and light gray to brownish-gray very fine sand. Sand layers < 1 mm to 30 mm thick. Slightly disturbed layering at 27.2-27.3 ft (8.29-8.32 m). Sand layers at 27.0-27.1 ft (8.23-8.26 m). Sharp basal contact. <u>Spl KE4-27.1</u> at 27.05-27.12 ft (8.25-8.27 m)(tephra?; corresponds to high magnetic-susceptibility peak). [Tephra not present]. <u>Spl KE4-27.3</u> at 27.25-27.35 ft (8.31-8.34 m)(GS).
	27.35-27.9	8.34-8.51	Nearly uniform gray clayey silt. Very faint layering and dark gray organic mottling. Sharp upper contact.
		27.9-28.0	8.51-8.54 Shrinkage gap.
KE4-11	28.0-28.45	8.54-8.67	Gray, faintly layered clayey silt. No visible organics. Sharp but irregular lower contact.
	28.45-30.35	8.67-9.25	Interbedded gray clayey silt, light gray silt, and light gray fine to very fine sand. Silt and sand layers are 1-5 mm thick and moderately disturbed. Possible current ripples at 29.7-29.9 ft (9.05-9.12 m). No visible organics except minor dark gray mottling at 29.4-29.5 ft (8.96-8.99 m) and 29.8-29.85 ft (9.09-9.10 m). Core is approximately 80 percent clayey silt.
KE4-12	30.35-30.7	9.25-9.36	Interbedded gray clayey silt and light gray clean very fine sand. Layers 1-25 mm thick. Trace dark gray organic mottling in clayey silt. Layers slightly curved downward at edges, probably due to disturbance during coring. Sharp lower contact. Approximately 70 percent very fine sand.

30.7-32.55	9.36-9.92	Faintly laminated gray silt and clayey silt with trace dark gray organic mottling. Minor thin (<5 mm) interbeds of light gray very fine sand. More clay-rich and uniform at 32.2-32.55 ft (9.82-9.92 m). Sharp lower contact. <u>Spl KE4-30.5</u> at 30.45-30.55 ft (9.28-9.31 m)(GS; fine sand). <u>Spl KE4-31.0</u> at 30.95-31.05 ft (9.44-9.47 m)(GS; silt and clay). <u>Spl KE4-32.4</u> at 32.35-32.45 ft (9.86-9.89 m)(GS; clay).
32.55-32.8	9.92-10.00	Interbedded light gray clean fine to medium sand and gray clayey silt. Sand layer is 0.1 ft (0.03 m) thick and contains single subrounded pebble 2 mm long.

**BOREHOLE KS1, KASILOF RIVER FLATS - 60°22'56"N, 151°17'4"W. Drilled 6/5/91.**

Datum for depth is the surface of artificial fill overlying the modern tidal-marsh surface.

<u>Core</u>	<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
KS1-1	0-0.9	0-0.27	Artificial fill; reddish-brown to brownish-gray, structureless sand and pebble-gravel with surface roots in upper 0.5 ft (0.15 m).
	0.9-2.0	0.27-0.61	Artificial fill; not recovered (sampler plugged with gravel).
KS1-2	2.0-2.6	0.61-0.79	Artificial fill; brownish-gray, structureless sand and pebble gravel. Lower contact sharp but irregular.
	2.6-2.85	0.79-0.87	Gray to brownish-gray organic clayey silt with abundant fibric root material. A few hairs(?) at upper contact with fill. Possibly disturbed by fill emplacement. Lower contact sharp (<1 cm).
	2.85-3.7	0.87-1.13	Dark brown, reddish-brown, and light brown fibric grassy and woody peat. A few twigs. Disseminated light brown to white medium sand grains (tephra?) at 3.3-3.35 ft (1.01-1.02 m). Gradational lower contact (2 cm). <u>Spl KS1-2.9</u> at 2.85-2.95 ft (0.87-0.90 m)(C14; age at top of peat layer). Sample possibly contaminated by roots from overlying organic mud. Probably modern. <u>Spl KS1-3.65</u> at 3.6-3.7 ft (1.10-1.13 m)(C14; for basal peat age).
	3.7-3.8	1.13-1.16	Gray clayey silt with some plant fragments.
	3.8-4.5	1.16-1.37	Not recovered.
KS1-3	4.5-5.7	1.37-1.74	Gray, faintly layered clayey silt with scattered plant fragments. Increasing brown plant material at 5.4-5.7 ft (1.65-1.74 m). very gradational lower contact (12 cm). <u>Spl KS1-4.7</u> at 4.65-4.75 ft (1.42-1.45 m)(GS). <u>Spl KS1-5.6</u> at 5.55-5.65 ft (1.69-1.72 m)(MP).
	5.7-6.1	1.74-1.86	Brownish-gray to brown interlayered peaty mud and muddy peat with gradational upper (12 cm) and lower (3 cm) contacts. Three probable leaf bases of <i>Triglochin maritimum</i> at 5.75-5.95 ft (1.75-1.81 m). Probable low-marsh peat, but not necessarily buried as a result of coseismic subsidence (apparent gradual return to subtidal conditions). <u>Spl KS1-5.9</u> at 5.85-6.0 ft (1.78-1.83 m)(C14; age of peat mud, not necessarily age of coseismic subsidence).
	6.1-6.8	1.86-2.07	Gray clayey silt with very faint layering and scattered dark gray organic mottling. One small plant fragment at 6.1 ft (1.86 m).

	6.8-7.0	2.07-2.13	Shrinkage gap.
KS1-4	7.0-9.3	2.13-2.84	Gray clayey silt or silty clay with very faint horizontal layering and numerous scattered plant fragments. Plant fragments include small (<3 mm diam) twigs at 7.2 ft (2.20 m) and 7.8 ft (2.38 m) and grass stems. Plant fragments most numerous at 7.7-8.2 ft (2.35-2.50 m). <u>Spl KS1-7.6</u> at 7.55-7.65 ft (2.30-2.33 m)(GS).
	9.3-9.5	2.84-2.90	Shrinkage gap.
KS1-5	9.5-11.95	2.90-3.64	Gray clayey silt or silty clay with faint laminations and trace to abundant dark gray organic mottling, increasing toward base. Minor scattered plant fragments. Dark gray organic mottling prevalent at 11.5-11.95 ft (3.51-3.64 m).
	11.95-12.0	3.64-3.66	Shrinkage gap.
KS1-6	12.0-14.3	3.66-4.36	Uniform gray clayey silt with trace dark gray organic mottling. <u>Spl KS1-13.0</u> at 12.95-13.05 ft (3.95-3.98 m)(GS). <u>Spl KS1-13.3</u> at 13.1-13.5 ft (3.99-4.12 m)(specific gravity for grain-size analyses).
	14.4-14.5	4.39-4.42	Not recovered.
KS1-7	14.5-16.8	4.42-5.12	Gray clayey silt with abundant dark gray, slightly layered, organic mottling at 14.5-15.4 ft (4.42-4.70 m). Trace scattered organic mottling in remainder. Uniform texture and no layering except for mottling. Trace small (<5 mm) rounded pebbles.
	16.8-17.0	5.12-5.18	Not recovered.
KS1-8	17.0-19.45	5.18-5.93	Uniform gray silt or clayey silt, grading downward to dark gray mottled silt or clayey silt. Partial recovery 17.5-18.6 ft (5.34-5.67 m). Scattered small (<1 mm) rounded pebbles at 18.4-18.8 ft (5.61-5.73 m). <u>Spl KS1-17.5</u> at 17.45-17.55 ft (5.32-5.35 m)(GS).
	19.45-19.5	5.93-5.95	Shrinkage gap.
KS1-9	19.5-20.9	5.95-6.37	Gray silt or clayey silt with numerous rounded to well-rounded pebbles to 2 cm. Layer of medium to coarse pebbly sand at 20.32-20.38 ft (6.20-6.21 m). Faint layering with thin (<2 mm) peaty layers at 20.5-20.9 ft (6.25-6.37 m). Lower contact with underlying peat is gradational (5 cm) and possibly disturbed. <u>Spl KS1-20.0</u> at 19.9-20.1 ft (6.07-6.13 m)(GS).
	20.9-22.0	6.37-6.71	Dark brown to reddish-brown fibric moss and woody peat with some layers of light brown wood fragments. Dominantly woody layer at 21.25-21.4 ft. Possible thin (5 mm) tephra at 21.25-21.4 ft (6.48-6.52 m). Remaining peat mostly moss ( <i>Sphagnum</i> ?). <u>Spl KS1-21.0</u> at 20.85-21.05 ft (6.36-6.42 m)(C14; peat at top of layer).
KS1-10	22.0-23.42	6.71-7.14	Dark reddish brown to light brown moss ( <i>Sphagnum</i> ?) and sedge peat. Trace to abundant sedge seeds, increasing downward, at 22.6-23.42 ft (6.89-7.14 m). Layering dips about 20° but is undisturbed. Trace silt at top, probably from sampler.

KS1-11	23.42-24.02	7.14-7.32	Light brown to dark reddish-brown fibric peat. Numerous sedge seeds at top, decreasing downward to none at base. Very sharp (<1 mm) basal contact with slight dip.
	24.02-24.08	7.32-7.34	Gray, well-sorted, clean very fine sand with finely disseminated peat. Possibly beach sand(?).
	24.08-24.4	7.34-7.44	Brown to dark brown very fine fibric peat with a few sedge seeds. Silty in lower, lighter colored half (24.25-24.4 ft or 7.39-7.44 m). Lower contact very sharp (<1 mm) and slightly curved. <u>Spl KS1-24.3</u> at 24.15-24.4 ft (7.36-7.44 m)(C14; fine fibric peat for basal age).
	24.4-25.9	7.44-7.90	Light to dark gray layered clean, moderately well-sorted silt and fine, medium, and coarse sand. Dark gray, very fine organic-rich layer at 24.75-24.9 ft (7.55-7.59 m). Clean, very coarse pebbly sand at 25.65-25.9 ft (7.82-7.90 m). <u>Spl KS1-25.4</u> at 25.3-25.45 ft (7.71-7.76 m)(GS).

**BOREHOLE KS2, KASLOF RIVER FLATS - 60°23'28"N, 151°17'29"W. Drilled 6/5/91.**

Datum for depth is the surface of artificial fill overlying the modern tidal-marsh surface.

<u>Core</u>	<u>Depth (ft)</u>	<u>Depth (m)</u>	<u>Description</u>
	0-1.0	0.30	Surface vegetation and artificial fill; core not retained.
	1.0-2.0	0.30-0.61	Tidal mud beneath fill; core not retained because gravel plugged sampler.
KS2-1	2.0-3.4	0.61-1.04	Artificial fill; sand and crushed gravel.
	3.4-4.5	1.04-1.37	Not recovered.
KS2-2	4.5-5.4	1.37-1.65	Artificial fill; sand and crushed gravel. Contact with underlying fine sand is somewhere in unsampled interval below.
	5.4-7.0	1.65-2.13	Not recovered.
KS2-3	7.0-8.1	2.13-2.47	Brownish-gray, clean, well-sorted, medium sand with no visible bedding or organics. Possibly disturbed or flowed in. Probably beach or dune sand. Single rounded pebble, 1 cm long, at 8.0 ft (2.44 m). Sharp (<1 mm) contact basal contact. <u>Spl KS2-7.5</u> at 7.4-7.6 ft (2.26-2.32 m)(GS).
	8.1-8.35	2.47-2.55	Gray laminated fine-sandy silt with minor interlaminae of fine sand. Undisturbed horizontal laminae. <u>Spl KS2-8.3</u> at 8.25-8.35 ft (2.52-2.55 m)(GS).
	8.35-9.0	2.55-2.74	Gray, clean, well-sorted fine to medium sand. Grain size decreases downward. No visible bedding or organics. Probably beach or dune sand. <u>Spl KS2-8.7</u> at 8.6-8.8 ft (2.62-2.68 m)(GS).

END