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A Postglacial Pollen Record from Western Kodiak Island, Alaska

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ABSTRACT. Excavation of organic deposits in a seasonally dry depression atop a moraine crest near the village of Karluk, on the west side of Kodiak Island, has provided a more detailed paleoenvironmental record than hitherto available for this part of the island. Radiocarbon dating indicates that the base of the section is approximately 4260 ^{14}C years in age. Seven minor volcanic ashes are recognized prior to the onset of seasonal drying of the basin at about 2330 B.P. A major ash fall (2 cm thick in section) is recorded at about 1625 B.P. The only significant woody taxon indicated in the pollen record is alder (*Alnus*); all other important taxa are herbaceous. This vegetation record indicates alders and ferns dominated the landscape immediately following substrate stabilization, which apparently was delayed in this area until well into the Holocene. Alder became relatively less important as soils matured and other taxa (mostly grasses) invaded. The overall record is one of vegetational and climatic stability since landscape stabilization in this area. Volcanic ashfalls have apparently had no significant long-term impact on the vegetation at the site.

Key words: Alaska, Holocene, Karluk, Kodiak Island, Quaternary, geology, glaciation, paleoenvironments, palynology, radiocarbon dating, tephra

RÉSUMÉ. L'excavation des dépôts organiques dans une dépression ayant été asséchée sur une base saisonnière et située sur le sommet d'une crête morainique, près du village de Karluk, dans la partie ouest de l'île Kodiak, a fourni des données paléoenvironnementales plus détaillées que toutes celles que l'on possédait jusqu'à maintenant sur cette partie de l'île. La datation de la base de la section à l'aide du radiocarbone indique environ 4260 ans ^{14}C. On peut reconnaître 7 cendres volcaniques secondaires avant le début de l'assèchement saisonnier du bassin aux environs de l'an 2330 avant notre ère. On enregistre une retombée importante de cendres (une section de 2 cm d'épaisseur) aux environs de l'an 1625 avant notre ère. Le relevé des pollens indique que le seul taxon ligneux important est l'aulne (*Alnus*); tous les autre taxons importants sont herbacés. Ce relevé de la végétation indique que les aulnes et les fougères ont dominé le paysage dès que le substrat a été stable, ce qui ne s'est produit dans cette région qu'assez tard dans l'holocène. L'aulne est devenu moins important quand les sols ont mûri et ont été envahis par d'autres taxons (surtout des graminées). Dans l'ensemble, les données indiquent que la végétation et le climat de la région ont été constants depuis la stabilisation du paysage. Les retombées de cendres volcaniques n'ont apparemment eu aucun effet à long terme sur la végétation à cet endroit.

Mots clés: Alaska, holocène, Karluk, île Kodiak, quaternaire, géologie, glaciation, paléoenvironnements, palynologie, datation au radiocarbone, cendres volcaniques

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INTRODUCTION

The postglacial vegetation record of western Kodiak Island has previously been known only from the early work of Heusser (1960) and Nybakken (1966), whose studies at Karluk and Three Saints Bay respectively showed highly erratic pollen records dating only from the latter part of the Holocene. The present study was undertaken in 1985 in hopes of providing a more detailed history of vegetation and local environments in the Karluk area, as a backdrop for archeological studies presently under way.

PHYSICAL SETTING

Boundary Creek kettle (informal name) is situated in Boundary Creek valley about 1.5 km south of the present site of the village of Karluk, on the western side of Kodiak Island, Alaska (57°33′08″N, 154°26′05″W; Fig. 1). The kettle itself lies at the base of a steep bedrock ridge at the end of a moraine crest believed to have been formed during the Stintz Bluff Stade of the Akalura Glaciation on Kodiak Island, which Karlstrom (1969) equated with the classical Wisconsin Glaciation of North America. Boundary Creek itself is a major right tributary to the Sturgeon River; it is not labeled on the U.S.G.S. Karluk C-2 topographic quadrangle (scale 1:63 360, 1983), but was identified by Karlstrom (1969) in his discussion of the glacial geology of this area.

Boundary Creek kettle is shown as a small pond on the Karluk C-2 quadrangle. When visited in July 1985, the site was a grassy depression surrounded by willow thickets (*Salix* spp.), and it apparently holds water only on a seasonal basis. Grasses (Poaceae) dominate the vegetation in the depression, but there were also rare sedges (Cyperaceae) and *Rubus chamaemorus* (taxonomy follows Hultén, 1968). Herbaceous understory plants in the surrounding willow thickets are also predominantly grasses but also include ferns, *Geranium erianthum*, *Heracleum lanatum*, *Castilleja unalaschcensis*, *Iris setosa*, *Sanguisorba stipulata*, *Epilobium angustifolium*, *Veratrum viride*, *Valeriana capitata*, *Petasites frigidus*, *Achillea borealis*, and *Angelica lucida*. A matted dry heath community on the tops of nearby earth hummocks included the additional taxa *Empetrum nigrum*, *Vaccinium oxycoccos*, *V. uliginosum*, *Betula nana*, *B. glandulosa*, and *Artemisia* sp. *Alnus sinuata* forms thickets at distances of 200-500 m in the lowlands, as well as on higher, better-drained slopes above the site. These higher slopes also support *Anemone parviflora*, *Dryas octopetala*, *Lupinus nootkatensis*, *Ledum palustre decumbens*, and *Rhododendron camtschaticum*. A single tree of *Betula kenaica* 3 m in height grows about 1 km east of the site; rare *Myrica gale* is also found at this distance.

METHODS

Coring of lakes and bogs in this area proved impossible due to thick deposits of volcanic ash in all depositional basins thus far sampled. A pit 1 m^2 was therefore excavated by hand in the Boundary Creek kettle site, to a depth of slightly over 1.1 m (Fig. 2). Samples for pollen analysis were taken from 1 cm thicknesses at 5 cm intervals through the entire 95 cm of organic silts above the till. Samples for radiocarbon dating were also

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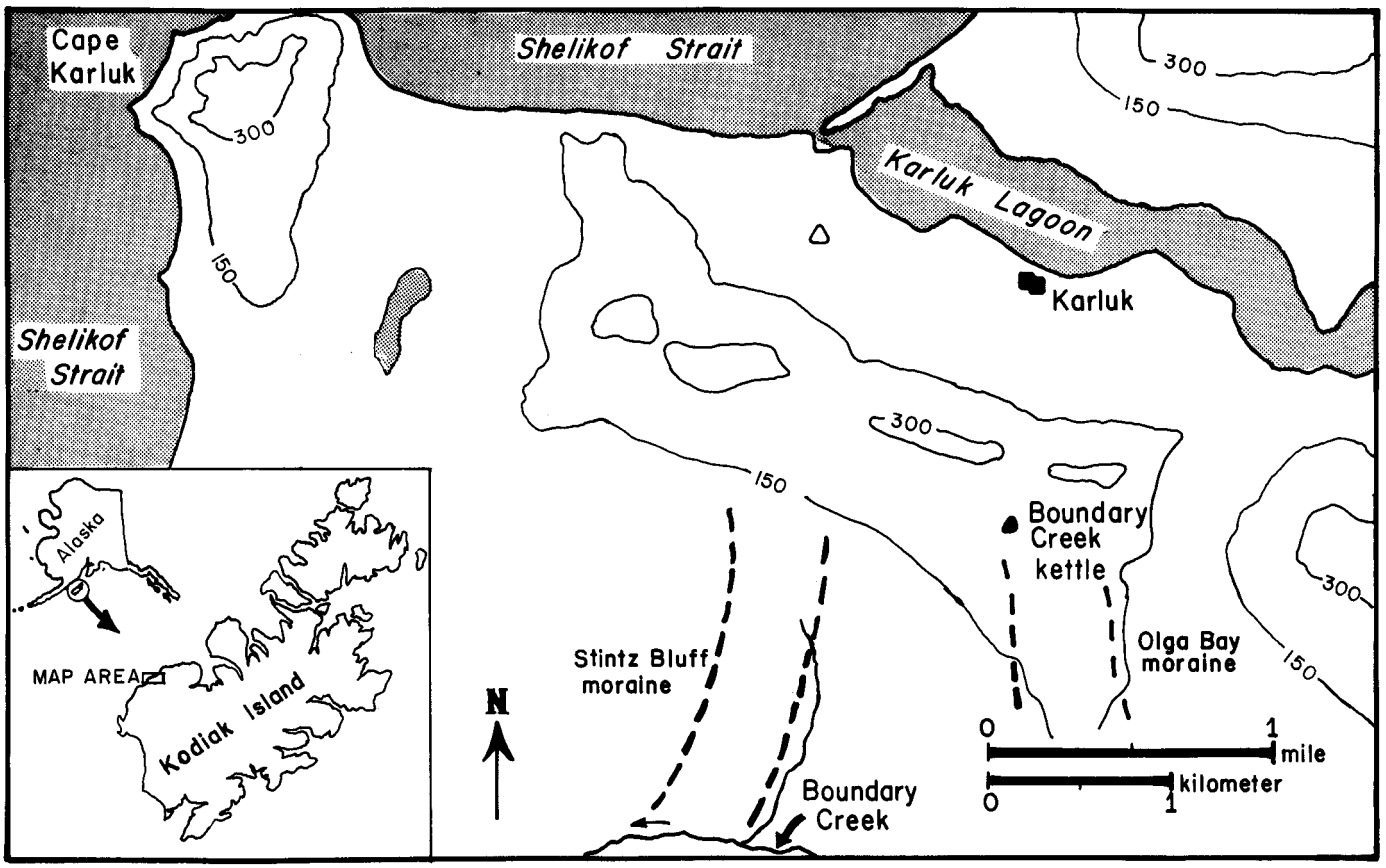

FIG. 1. Index map of the region surrounding Karluk on the western side of Kodiak Island, including the position of Boundary Creek kettle. Open triangle marks the approximate site of Heusser's (1960) bog profile from Karluk. Position of the village of Karluk is corrected from the U.S.G.S. Karluk C-2 quadrangle (1952; revised, 1983); the village has been moved inland in recent years in response to increased coastal erosion. Moraine identities are based on field interpretation of the maps of Karlstrom (1969). Contour interval is 150 m.

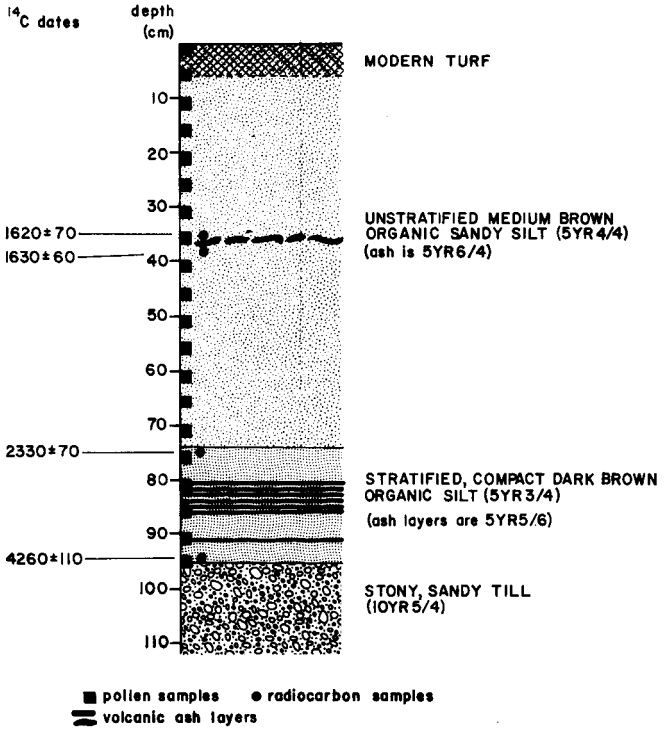

FIG. 2. Stratigraphy of Boundary Creek kettle, showing stratigraphic position of radiocarbon dates and pollen samples.

collected from 1 cm thicknesses of sediment. The exposure face was scraped clean immediately prior to the taking of each sample. All samples were packed in sterile Twirl-Pak® bags and returned to the laboratory.

Pollen samples recovered from the Boundary Creek kettle were subjected to standard treatment procedures (5% KOH, 48% HF, acetic acid washes and acetolysis for 3 min, followed by rinsing over a 10μm mesh sieve to remove fine debris prior to mounting) (Faegri and Iversen, 1975; *cf.* Cwynar *et al.*, 1979). Residues were mounted in silicone oil and counted at 200x. Ideally, at least 400 identifiable Quaternary grains were counted at each level, but this was not always possible because of low pollen concentrations and poor preservation in some samples.

All radiocarbon samples were oven-dried at 40°C and screened through a 1.0 mm sieve to remove identifiable rootlets or other visible contaminants prior to submission for dating.

STRATIGRAPHY AND DATING

The stratigraphy of the Boundary Creek kettle is shown in Figure 2. The basal part of the section is well stratified, with seven identifiable ash layers; the upper portion is not visibly stratified. A single major ash layer, discontinuous but up to 2 cm thick, is identifiable in this upper part of the section. Ash from the 1912 Katmai eruption was originally one foot (30 cm) deep at Kodiak (Griggs, 1918), but today it is about 15 cm thick in bogs in that area (personal observation of R.E.N.). Assuming a

similar 50% compaction rate, this ash at Boundary Creek probably represents an original ash fall of at least 4 cm thickness. The 1912 Katmai eruption left only a trace of ash at Karluk (Griggs, 1918), not detectable in the geologic record there today.

Four radiocarbon dates provide a chronology for deposition at this site (Table 1). The basal radiocarbon date indicates organic deposition in this basin began only 4260 ± 110 ^{14}C years ago. The top of the well-stratified part of the record is dated at 2330 ± 70 B.P., and the major volcanic ash unit in the upper part of the section occurs between dates of 1620 ± 70 B.P. and 1630 ± 60 B.P. (Fig. 2, Table 1).

TABLE 1. Radiocarbon dates from Boundary Creek kettle

Depth (cm)	Age	Laboratory id.
34-35	1620 ± 70	Beta-19430
36-37	1630 ± 60	Beta-19429
74-75	2330 ± 70	Beta-19428
95-96	4260 ± 110	Beta-19427

PALYNOLOGY

A pollen percentage diagram (Fig. 3) was produced using a sum of identified pollen grains and those that were in good condition but could not be identified. Spores and pollen grains too degraded to be identifiable were excluded from the basic sum. The diagram has been subdivided into two zones, one of which has itself been subdivided into two subzones.

Zone I, the base of the Boundary Creek diagram, shows high concentrations (53% of the total) of alder pollen as well as of spores of monolete ferns within the basal 1 cm. Alder decreases to 30% of the total in the next 10 cm, while monolete fern spores increase from a basal abundance of about 27% to about 50% of the pollen sum. The decrease in relative abundance of alder is caused mostly by an increase of grass from less than 20% to nearly 40% of all pollen present. Fern spore abundance is independent of pollen abundance, since fern spores were not included in the basic pollen sum.

In Zone II, alder abundance falls to about 15% of the pollen total, grass rises to 40-50%, and sedge pollen generally constitutes 20-30% of the pollen sum. In the basal part of this zone, subzone IIa, monolete fern spores are present at an abundance of about 20% of the pollen sum. These become less important, typically 10% or less, in subsequent subzone IIb. This is the only significant difference between the spectra of the two subzones.

Heaths constitute an average of about 5% of the total pollen identified throughout both Zones I and II. The remainder of the taxa represented in the pollen record represent herbaceous plants and show only minor fluctuations following the initial alder decline.

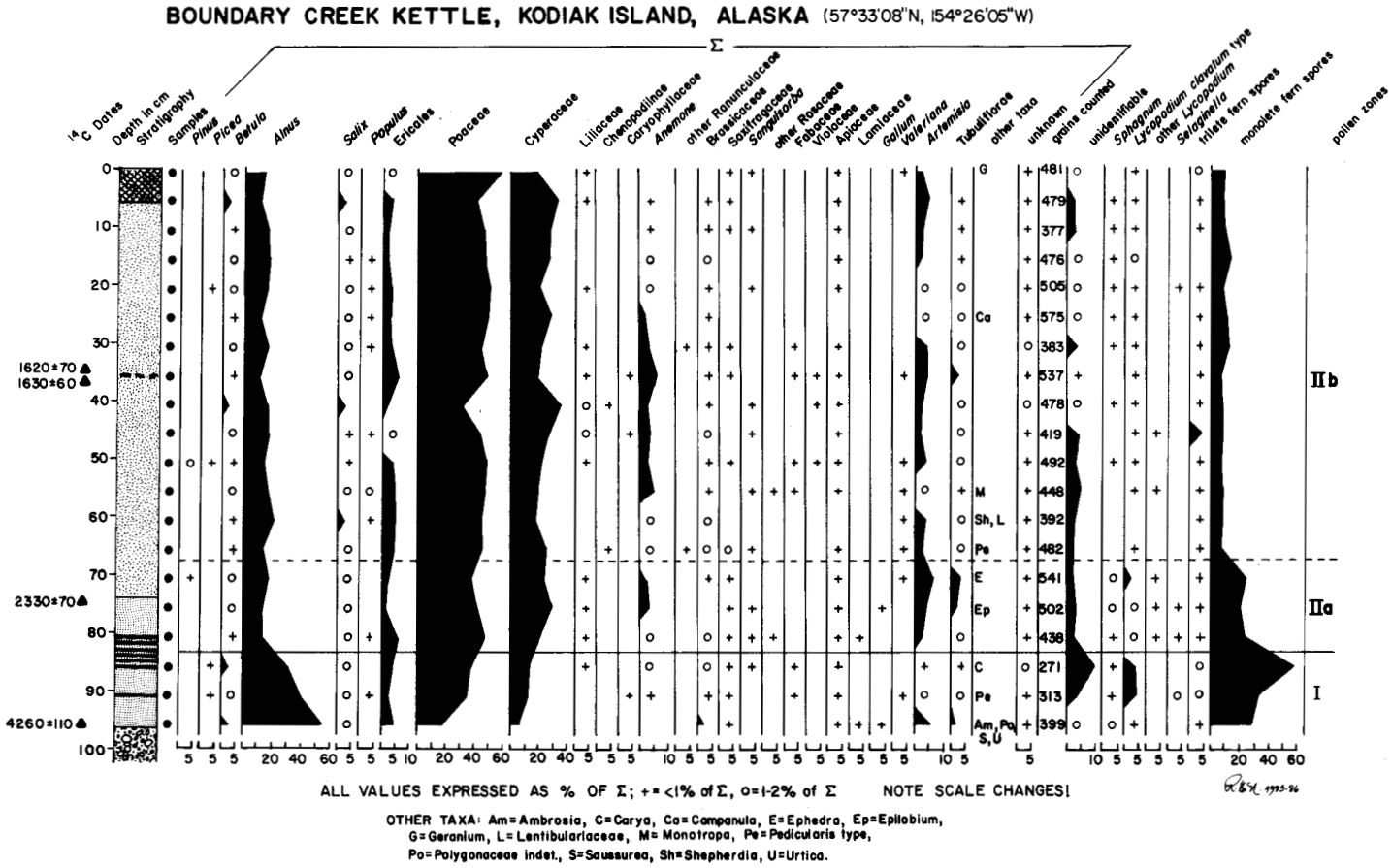

FIG. 3. Percentage pollen diagram from Boundary Creek kettle. Lithostratigraphy as in Figure 2.

DISCUSSION AND PALEOENVIRONMENTAL INTERPRETATION

Dating

Karlstrom (1969), basing his assignments on correlations to better-dated sequences elsewhere, tentatively estimated that the Stintz Bluff Stade of his Akalura Glaciation occurred about 9000 B.P. and his next older Olga Bay Stade at 12 500 B.P. Our basal radiocarbon age on this section, however, indicates that organic deposition at this site only began in the late Holocene, probably after 4400 B.P. The pollen record (discussed below) suggests that this minimum age nevertheless is a close approximation to the actual timing of ground stabilization at the Stintz Bluff moraine position in this area.

Heusser (1985) noted that deglaciation had begun on Kodiak Island by 12 200 B.P. and on the Trinity Islands to the south by 13 800 B.P. The basal radiocarbon ages on his sections at Kodiak (8870 ± 300) and Afognak (9350 ± 320) (Heusser, 1960) indicate that deglaciation was somewhat delayed in the more northern part of the island. This is in agreement with a basal radiocarbon date of 9250 ± 150 (I-14 817) from a bog in the village of Ouzinkie, on Spruce Island, to the north of Kodiak (R.E. Nelson, unpubl. data).

The oldest radiocarbon age from archeological excavations at the mouth of the Karluk River, however, is 4900 ± 100 B.P. (Jordan and Knecht, 1987). Heusser (1960) also recorded a relatively young age (3470 ± 180 B.P.) for the base of his bog section at Karluk. These dates and the one from Boundary Creek kettle suggest that landscape stabilization on this particular portion of Kodiak Island may have been delayed significantly longer than recognized elsewhere.

Whether this apparent long delay of stabilization of the ground surface in this area is real or an artifact of our data is certainly a question worthy of further study, but the issue cannot be resolved by the information in hand at the present time. Certainly, a proposal that deglaciation of this part of Kodiak may have been delayed as long as the mid-Holocene is unrealistic in light of what is known of the general glacial history of this region (Porter *et al.*, 1983).

Stratigraphy

The change from a compact, stratified record in the basal 25 cm of the Boundary Creek kettle section to one that is unstratified likely reflects the onset of seasonal drying of the basin itself. Development of rooted vegetation and seasonal wet-dry cycles would be expected to disturb the fine-scale stratigraphy in such a situation. This seasonal drying may indicate a slight decrease in available moisture but is more likely the result of shallowing of the basin via sediment infilling and erosion of the surrounding terrain. Maximum spillover depth of the basin at present is only about 1 m.

The numerous volcanic ashes recorded in the Boundary Creek section almost certainly correlate in part to those discussed earlier by Clark (1979) in other areas on Kodiak Island and the adjacent mainland, but direct correlations are not possible without better dating control on our sequence. The ash in our section bracketed by radiocarbon dates of 1620 and 1630 B.P. is undoubtedly that to which he refers as the 300 A.D. ash from Uyak (Clark, 1979).

Vegetation and Climatic Changes

The vegetation record from Boundary Creek kettle is apparently one of vegetational succession accompanying climatic stability following the stabilization of the ground surface in the area. Willows and possibly poplar (*Populus*) were likely the first pioneer taxa to invade (Lawrence, 1958; Viereck, 1970), but they probably suffered from nitrogen deficiencies in the soil (Lawrence, 1958) and thus have left no significant pollen record. Alders, already present in the region by this time (Ager and Brubaker, 1985) very likely were the dominant pioneer species to first become established and reach reproductive maturity, due to their ability to utilize atmospheric nitrogen via root symbionts. Once established, *Alnus sinuata* is capable of producing abundant seed within seven years (Lawrence, 1958).

We believe that Pollen Zone I at Boundary Creek kettle, which is dominated by pollen of alder, represents that initial vegetation of recently stabilized terrain. The relative agreement of the three available dates from this area (see above) also independently suggests that substrate stabilization was delayed here until the early part of the latter half of the Holocene.

The rapid decrease in the relative abundance of alder pollen in Zone I and its continued low relative abundance in Zone II is precisely what would be expected if indeed the alder was the pioneer species on the site. The addition of nitrogen to the soil through loss of the annual crop of leaves, as well as by direct leaching from the root nodules (Lawrence, 1958), increases the fertility of the young soils and allows the establishment of other plant taxa that are incapable of nitrogen fixation. Ferns were apparently the first taxa to reap the benefits of this process and initially increased in relative abundance. As grasses and other taxa became more important in the vegetation, the ferns decreased in abundance in response to the pressures of competition for space. The decrease in fern spore abundance that delineates subzone IIa from subzone IIb reflects this loss of growing space.

The fact that the remainder of the pollen record shows no significant changes to the present day indicates that climatic conditions at this site have remained unchanged since at least the beginning of subzone IIb, and very likely since substrates became stable. There is also no evident effect on the vegetation from the ash falls that are recorded in the section, including the thick ash that fell about 1625 B.P. Prehistoric cultures in this area apparently lived in a relatively stable vegetational and climatic environment. Whether the numerous volcanic ash falls had direct adverse effects on prehistoric populations in this area must await analysis of the archeological data now accumulating.

Our paleovegetational record differs somewhat from that of Heusser (1960) from Karluk. Heusser showed a gradual though erratic decrease in alder percentages, from over 50% to less than 25% of his total, continuing through his section. His pollen diagram also showed a major abundance of birch pollen, which is all but absent from the Boundary Creek kettle section. Heusser's vegetation record may thus record evidence of different microclimatic effects on vegetation in the immediate Karluk area.

The lack of evidence for vegetational or climatic change in at least the past 4400 years at Boundary Creek kettle is consistent with interpretations from other coastal sites in southwestern and south-central Alaska, from the Yukon Delta to the Kenai Peninsula (Ager, 1982, 1983; Ager and Sims, 1982; Ager and Brubaker, 1985; Heusser, 1960, 1983, 1985; Nybakken, 1966).

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