

STATE OF ALASKA  
DEPARTMENT OF NATURAL RESOURCES

SUBSURFACE STRUCTURE OF THE COHESIVE FACIES OF THE  
BOOTLEGGER COVE FORMATION, SOUTHWEST ANCHORAGE, ALASKA

By  
Catherine A. Ulery and Randall G. Urdike



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1983

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Cover photograph: *Oblique aerial view of southwest Anchorage, looking south. Knik Arm in foreground, Turnagain Arm in background. See figure 2, page 3, for names of other geographic features.*

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### METRIC CONVERSION FACTORS

To convert meters to feet, multiply by 3.28. To convert centimeters to inches, divide by 2.54.

## SUBSURFACE STRUCTURE OF THE COHESIVE FACIES OF THE BOOTLEGGER COVE FORMATION, SOUTHWEST ANCHORAGE, ALASKA

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### INTRODUCTION AND ACKNOWLEDGMENTS

The Bootlegger Cove Formation directly influences ground- and surface-water resources, construction design, and aggregate resources of the southwest Anchorage area (figs. 1, 2). Detailed subsurface mapping of the formation will enhance future planning efforts and provide a better understanding of Pleistocene events that are largely responsible for the stratigraphy and geomorphology of the area.

The derivative maps (pls. 1-3) in this report are the result of the interpretation and correlation of over 950 geotechnical boreholes, water-well logs, and measured stratigraphic sections. Field work was conducted during the summer of 1981.

Borehole and water-well data were contributed by Anchorage consulting and engineering firms and the U.S. Geological Survey Water Resources Division. Previous studies by Miller and Dobrovolny (1959), Karlstrom (1964), Shannon and Wilson, Inc. (1964), Schmoll and Dobrovolny (1972), Schmoll and others (1972), Updike and Carpenter (1984), and Reger and Updike (1983) were useful in preparing this report. We appreciate the thoughtful reviews of R.D. Reger and R.A. Combellick (DGGs). Plates and illustrations were prepared by A.C. Schell, DGGs cartographer.

### SUMMARY OF THE GEOLOGIC HISTORY

The Bootlegger Cove Formation encompasses a wide variety of sediment textures from numerous depositional regimes in a single glaciomarine-glaciodeltaic system (Updike, 1985). Eight geologic facies, each reflecting subtle variations of a late Pleistocene glaciomarine environment, are defined by their engineering and textural characteristics. These facies include:

Cohesive facies	
Facies F.I	Clay, with very minor silt and sand
Facies F.II	Silty clay, clayey silt, or both
Facies F.III	Silty clay, clayey silt, or both (sensitive)

Facies F.IV Silty clay, clayey silt, or both, with thin silt and sand lenses

Facies F.V Silty clay, clayey silt, or both, with random pebbles, cobbles, and boulders

#### Noncohesive facies

Facies F.VI Silty fine sand, with silt and clay layers

Facies F.VII Fine to medium sand, with traces of silt and gravel

Facies F.VIII Sandy gravel and gravelly sand, with discontinuous layers of silt and fine sand

At the maximum extent of the late Naptowne glacial advance (14,000-18,000 yr B.P.) (table 1), an ice front that entered the Anchorage basin from the northwest terminated in the western part of the map area. The basin was probably bounded to the northeast by the Knik-Matanuska ice lobe and to the south by the Turnagain ice lobe. This environment sometimes limited the influx of marine water from lower Cook Inlet, resulting in fluctuations between marine and brackish waters. Ablation of the terminus of the Knik-Matanuska ice lobe produced a glacial fan delta that prograded eastward into deeper waters of the basin. In the western third of the map area, gravel, sand, and silt (facies F.VI-F.VIII) grade eastward into cohesive silt and clay (facies F.I-F.V). Although interbedding of the facies indicates some fluctuations in fan-delta deposition, the textural sequence of the Bootlegger Cove Formation generally reflects the gradational nature of the depositional system from ice-contact to glacio-deltaic to deep-water regime.

The Bootlegger Cove Formation overlies varying thicknesses of glaciofluvial silt, sand, and gravel associated with an earlier glacial episode. The upper surface of the underlying unit (pl. 2) exhibits considerable relief, which suggests that an erosional period preceded deposition of the Bootlegger Cove Formation. The underlying stratified sediments overlie a subsurface till that was observed throughout the map area and is probably of early Naptowne (>35,000 yr B.P.) or late

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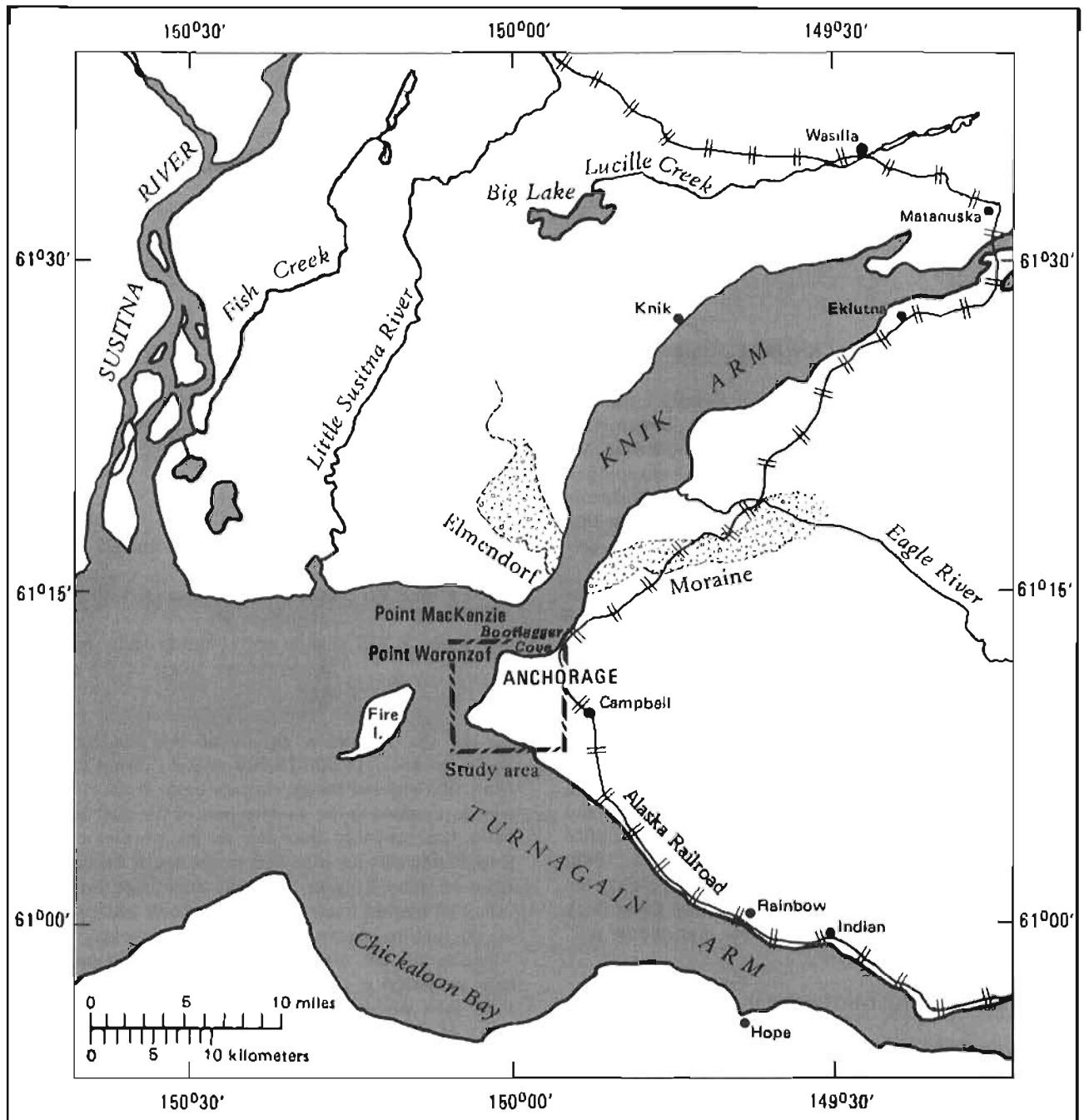


Figure 1. Location map of Anchorage lowland showing study area.

Knik (>45,000 yr B.P.) age (table 1).

The topography of the top of the cohesive facies (facies F.I-F.V) of the Bootlegger Cove Formation is shown on plate 1. The overlying sediments are composed of facies F.VI-F.VIII, or of retransported, post-Bootlegger Cove Formation silt, sand, and gravel. In the northeast corner of the map area, the cohesive facies are overlain by post-Bootlegger Cove Formation glaciofluvial sediments associated with a very late Naptowne glacial

advance (10,000-12,000 yr B.P.) (table 1). These sediments consist of stratified sand and gravel that grade into sand and silt to the west and south.

#### COHESIVE FACIES

The cohesive facies (F.I-F.V) were previously referred to as the Bootlegger Cove Clay (Miller and Dobrovlny, 1959) and defined as a light-gray silty clay,

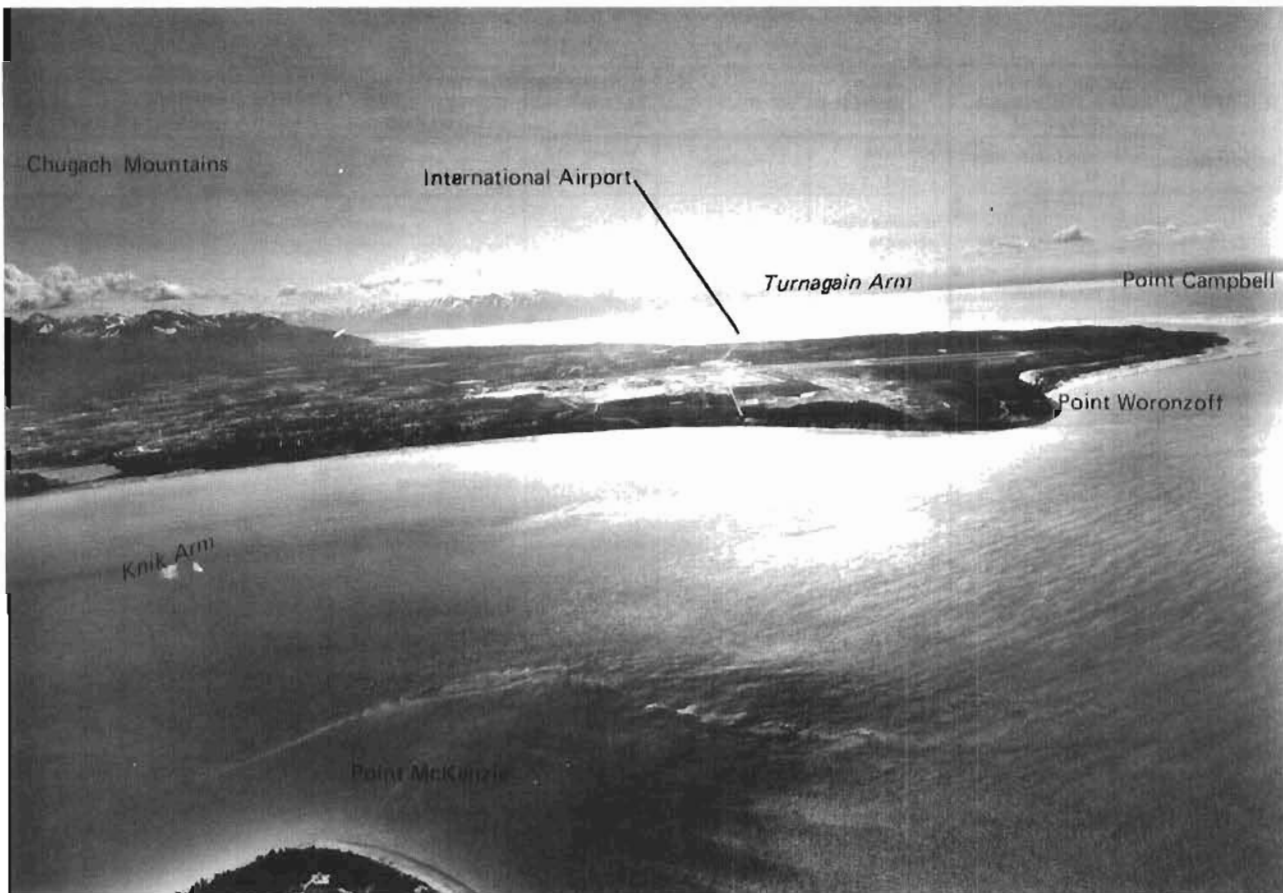


Figure 2. Oblique aerial view of southwest Anchorage, looking south, June 14, 1979. Photograph by North Pacific Aerial Surveys, Anchorage.

locally called the 'blue clay.' The type locality for this unit is Bootlegger Cove (pl. 1), and the 'clay' is almost continuously exposed westward along Knik Arm. The noncohesive facies (F.VI-F.VIII) extend eastward from the Point Woronzoff and Point Campbell highlands.

Transitions from the coarser deltaic regime to the finer deep-water regime are represented by gradations and interbedding of these two facies groups. As indicated on plates 1 and 2, a transition zone occurs at the topographic rise to the Point Woronzoff highlands. A similar relationship between the cohesive and non-cohesive facies is evident in sporadic exposures along Turnagain Arm from Campbell Lake to the Point Campbell highlands and is confirmed by borehole data.<sup>2</sup> The transition is less clearly observed in the International Airport area, where most boreholes are shallow. Interbedding of the two facies groups in this area may extend farther eastward to Hood Lake and Lake Spenard. The cohesive facies occur northeast of the map area beneath downtown Anchorage, further north beneath

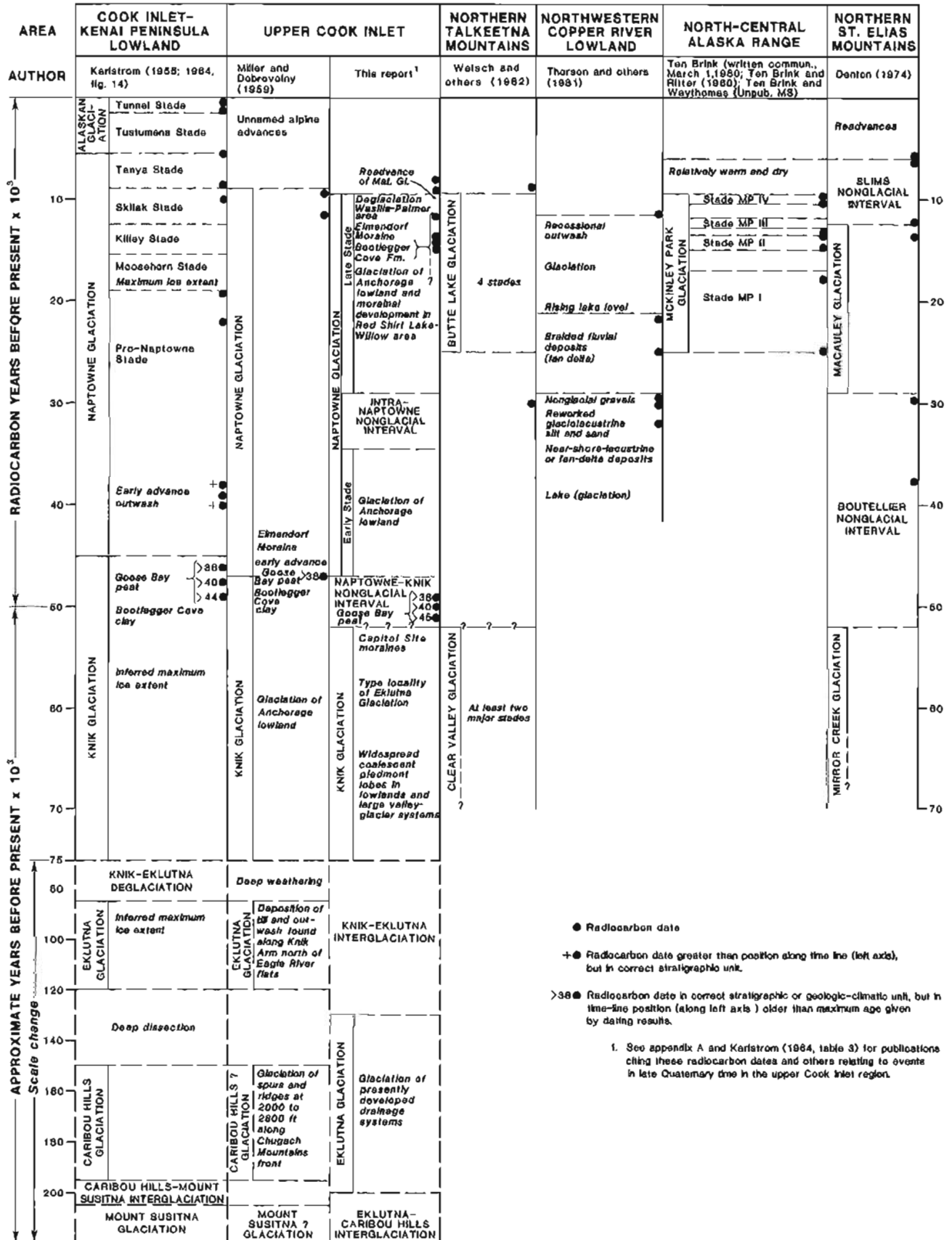
the Elmendorf moraine [Late Naptowne (10,000-12,000 yr B.P., table 1)], and in bluffs near Point McKenzie (across Knik Arm to the north).

The cohesive facies are composed predominantly of relatively impermeable blue-gray silty clay or clayey silt, with thin silt and sand lenses (facies F.IV). Thicknesses range from less than 5 m near Lake Spenard to over 60 m to the northeast and southeast (pl. 3). Facies F.III, which was probably responsible for the ground failures during the March 1964 Prince William Sound Earthquake, is traceable in boreholes in the northern map area between sea level and 15 m above sea level and pinches out to the west and presumably to the south. Although facies F.I and F.II are less common and can be found at any elevation, they most often occur above sea level. Facies F.V, which is generally found in the lower part of the formation, represents episodes of ice rafting of coarse clasts from the calving terminus of an adjacent glacier. The clasts were subsequently incorporated in a clayey silt matrix.

The top of the cohesive facies commonly grades upward into silt and sand of facies F.VI and F.VII. This

<sup>2</sup>See Updike and Ulery (1984) for cross sections of southwest Anchorage.

Table 1. Tentative comparison of late Quaternary glacial chronologies in the upper Cook Inlet region with other areas in southern Alaska (from Reger and Updike, 1983, p. 193).





relationship is most consistently observed in the transition zone and sporadically occurs throughout the map area. Silt, sand, and gravel of the noncohesive facies are interbedded with the cohesive facies in the lower part of the formation, which suggests fluctuations in the ice-front position during the initial stages of delta development.

### SUMMARY

The variety of sediment textures that define the eight facies of the Bootlegger Cove Formation reflect depositional variations within the Late Pleistocene glaciomarine environment of upper Cook Inlet. Two depositional regimes have been defined on the basis of textural variations that are subtle within both the finer cohesive facies and the coarser noncohesive facies. Interbedding between the two regimes in the transition zone negates definition of the western boundary of the cohesive facies. With the exception of the transition into the coarser glacio-deltaic regime, the cohesive facies is a mappable unit that can be utilized by planners to evaluate subsurface conditions.

Although the contour map of the bottom of the cohesive facies may not be as readily interesting to planners, it sheds some light on the complex glacial history of the Anchorage lowland. The erosional surface on which the cohesive facies were deposited suggests that an interglacial event separates the Bootlegger Cove Formation from the underlying glaciofluvial deposits.

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