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QUATERNARY STRATIGRAPHIC SECTIONS WITH RADIOCARBON DATES CHANDALAR QUADRANGLE, ALASKA

by

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INTRODUCTION

Surficial geologic mapping of the Chandalar quadrangle was carried out during 1975 and 1976 as part of the Arctic Environmental Program of the U.S. Geological Survey. Ten organic samples were collected at that time for radiocarbon dating. Six samples have been dated by Stephen W. Robinson at the U.S. Geological Survey Radiocarbon Laboratory in Menlo Park, California, and one additional sample was dated by Isotopes, Inc. (table 1 and plate 1). The three remaining samples will be dated by Isotopes, Inc. during the winter of 1979-1980. The surficial geologic map of the Chandalar quadrangle (Hamilton, 1978a) should be referred to for geologic units and relationships discussed in the following sections.

STRATIGRAPHIC SECTIONS

Exposure 1 (Caro bluff)

Caro bluff extends for about 1 km along the north bank of the Chandalar River immediately downstream from the mouth of Flat Creek and the abandoned mining community of Caro (plate 1). The deposit consists dominantly of outwash (fig. 1), which was generated by meltwater discharging from ice streams of Itkillik I age (Hamilton, 1978a). These glaciers flowed south from source areas deep within the Brooks Range and terminated within and beyond the mouths of valleys tributary to the main valley of the Chandalar River (Williams, 1962). The glacier that occupied the Middle Fork of the Chandalar extended as a bulbous lobe into the main valley and advanced to within 8 km of Caro bluff. A broad outwash apron that extended from the former ice front downvalley past the Caro area is preserved as conspicuous terrace remnants through this stretch of the Chandalar Valley.

Most of the exposed face of Caro bluff exhibits sandy gravel with a thin loess cap. The gravel is considered to be outwash because of its geomorphic relationship with the Itkillik I ice front and because of its coarseness, faceted stones, and abundance of lithologies derived from high-altitude glacier source areas within the Brooks Range. In the central part of the bluff, a lenticular deposit of peat and organic silt above the outwash forms units ℓ^3 and ℓ^4 of figure 1. Unit ℓ^3 probably is a local channel filling, as indicated

Table 1. Radiocarbon dates from the Chandalar quadrangle, Alaska.

Exposure No.	Location	Date and Laboratory No.	Material Dated	Comments
1	Chandalar R. near Caro (67°10.5'N 147°59'W)	>42,000 (USGS-41)	Wood (spruce)	Pollen from associated peat includes spruce, sedge, birch, willow, and aquatic/semiaquatic plants (1). At least 17 beetle taxa present (2).
2	West Fork Chandalar R. (67°11.5'N 148°55'W)	1590 ± 50 (USGS-416)	Charcoal & wood	---
		>42,000 (USGS-415)	Wood	Wood includes spruce (3)
3	Chandalar R. near Funchion Cr. (67°07'N 147°05.5'W)	4170 ± 45 (USGS-374)	Peat	
4	Phoebe Cr. (67°33.5'N 149°12'W)	>42,500 (USGS-167)	Wood	Wood heavily impregnated with iron oxides
5	Lake near Your Cr. (67°52.5'N 148°19'W)	5615 ± 110 (I-10,568)	Wood	Contains 7 ostracod species characteristic of rel. permanent freshwater lake (4). Contains beetle and ant remains (2)
6	Mosquito Fk. (67°03'N 149°55'W)	5370 ± 90 (USGS-376)	Wood	Rich beetle fauna, including carabidae, staphylinidae, and scolytidae (2)

(1) Identified by T. A. Ager, Paleontology Lab, U.S. Geological Survey, Reston, VA.

(2) Preliminary identifications by A. V. and M. A. Morgan, University of Waterloo, Waterloo, Ont.

(3) Identified by Forest Products Laboratory, Madison, WI.

(4) Identified by R. M. Forester, U.S. Geological Survey, Denver, CO.

by its composition and its restriction to a depression in the outwash surface. The overlying peat (unit 4) probably represents a floodplain forest that developed as alluviation slowed and finally ceased. Where thickest, the basal 0.5 m of the peat grades laterally into the highly organic upper beds of unit 2. Sizes of the spruce remains and their annual growth rings suggest favorable growing conditions, as along modern river floodplains where near-surface permafrost is absent. The pollen assemblage (table 1) suggests that spruce formed a gallery forest in which willows may have been abundant as colonizers of newly exposed river bars (T. A. Ager, written communication). The small but varied Coleoptera (beetle) assemblage indicates that wet marsh conditions, characterized by standing water, organic substrates, and sedge-cattail vegetation, also were present (A. V. Morgan, written communication). Unit 5 which caps the section, is loess that may correlate with Itkillik II glacier expansion.

The radiocarbon date of >42,000 yr B.P. from the Caro bluff provides a crude minimum limit on the age of Itkillik I glaciation. If correct, the date indicates that this ice advance is of early Wisconsin age or older, and did not occur between about 24,000 and 17,000 ^{14}C years ago as inferred by Hamilton and Porter (1975).

Exposure 2 (West Fork bluff)

An unusually high bluff exposure rises 83 m above the West Fork of the Chandalar River 9.5 km upvalley from the mouth of Trail Creek (fig. 2 and plate 1). This locality was covered by ice of the Sagavanirktok River Glaciation, which flowed into the West Fork from source areas to the south as well as from glacial valleys of the Brooks Range (Hamilton, 1978a). The bluff lies 4 km south of the outer limits of Itkillik drift and stands more than 50 m above outwash terraces of Itkillik age. Valley incision below the level of the bluff clearly had taken place prior to the Itkillik Glaciation.

Unit 1, at the base of the bluff, is an arkosic gravel derived mainly from granitic terrane south of the Chandalar Valley; it contains lignitized wood and evidently is of Tertiary age. Unit 2 is till that was derived largely from source areas to the south and is provisionally assigned to the Anaktuvuk River Glaciation. Unit 3, fluvial sand and gravel that coarsens upward, probably into outwash, forms a 54-m deposit that must represent a

long interglacial interval followed by the onset of renewed glaciation. Alluviation possibly was due to tectonic movements along the Kobuk trench (Grantz, 1966, p. 38), but more likely it resulted from either drainage displacements between the Chandalar and Koyukuk River systems or basin-filling following deep scour by glacier ice. Units 4 and 6 are diamictons of a type commonly formed subglacially along the centers of mountain valleys beneath stagnating or weakly active ice streams. These deposits probably represent tills from which fines have been flushed by abundant subglacial meltwater or possibly by stream erosion following deglaciation. The wood-bearing alluvium between units 4 and 6 probably formed during an interstadial interval that separated the two ice advances. Its infinite radiocarbon age is compatible with either a Sagavanirktok River or Itkillik-age interstadial, but regional geologic relations support a Sagavanirktok River age assignment for units 4 through 6. Units 7, 8 and 9, only 60 cm in total thickness, evidently represent the entire post-Sagavanirktok River succession at the West Fork bluff. A radiocarbon age of 1590 $\pm$ 50 yr BP for unit 8 apparently places most of this sequence within the late Holocene. Although unit 8 may have been penetrated by modern rootlets, the radiocarbon sample was hand-picked wood and charcoal that probably contained few contaminants. The weathered and severely deformed silt beneath unit 8 may represent loess influx and frost action during the Itkillik Glaciation; the loess above unit 8 may have formed as a cliff-head deposit after the bluff was eroded back to about its present position.

Exposure 3 (Near Funchion Creek)

A river bluff about 26 m high extends along the north bank of the Chandalar River 2.5 km downstream from the mouth of Funchion Creek (plate 1). It lies within drift correlated with the Sagavanirktok River Glaciation at a position about 5 km west of its downvalley limit (Hamilton, 1978a). The nearest Itkillik-age drift lobe terminates more than 25 km upvalley, and Itkillik-age outwash forms low terraces that could not be distinguished from early Holocene alluvial terraces in the area around Funchion Creek.

Alluvium of probable interglacial age at the base of the exposure (unit 1 of fig. 3) is transitional upward into coarse gravel (unit 2) that appears to be advance outwash from glaciers originating primarily within the Brooks Range. The overlying unit 3 is a typical valley-center till composed

primarily of redeposited advance outwash and other alluvium. Stones are rounded and somewhat sorted, but also are striated and faceted. The upper 2 m of the till may represent ablation deposit. Because of its position near the top of the bluff and its location within the drift sheet, the till almost certainly is of Sagavanirktok River age. Unit 4 is gravel that was deposited during or shortly after glacier recession and prior to the downcutting that occurred between Sagavanirktok River and Itkillik time. Unit 5 represents a post-downcutting interval during which loess accumulated slowly and perhaps intermittently; unit 6 represents a greater rate of loess accretion. The date of 4170 $\pm$ 45 yr BP on unit 5 is considered a minimum age only; it is from peat that was heavily contaminated by younger rootlets and lay close to the burrows of ground squirrels. In addition to burrowing ground squirrels, which probably introduced the scattered stones, unit 6 has been affected by frost action, causing vertical stone orientations, and by gleying, which caused the platy structure.

Exposure 4 (Phoebe Creek)

Unusually deep incisions along Phoebe Creek and adjacent parts of Bettles River have exposed several thick Pleistocene sections (plate 1). Phoebe Creek bluff appears to contain the longest record, and is the only exposure in this area that yielded datable organic material. Phoebe Creek was glaciated during both Itkillik I and Itkillik II time as well as during earlier glaciations. The Itkillik I ice stream flowed vigorously through the valley of Phoebe Creek and extended beyond the south flank of the Brooks Range (Hamilton, 1978a); the Itkillik II glacier terminated 18 km south of the bluff and appears to have stagnated shortly after its maximum advance.

Four major stratigraphic units are recognized at Phoebe Creek bluff (fig. 4). The basal sediments (unit 1) are strongly oxidized alluvium similar to deposits beneath Itkillik I till near Bettles (Hamilton, 1978b). Unit 2 is a diamicton similar to the probable tills at West Fork bluff and nearly identical to water-washed subglacial deposits along valley centers elsewhere in the Brooks Range. The infinite radiocarbon date on this deposit is considered valid because the wood appears more strongly mineralized than in any known sediment of finite radiocarbon age in the region. The wood is clearly detrital; it probably was eroded and redeposited either by ice or

meltwater and therefore does not necessarily date the till. Unit 3 is a fluvial deposit, but differs from normal to alluvium in this region in its fine grain size and in its continuous near-horizontal bedding. It resembles basin-fill sand deposits mapped farther north in the Itkillik, Atigun, and Sagavanirktok Valleys (Hamilton, 1978c). Unit 4, which caps the section, is a probable till similar to unit 2. Elsewhere in the area, this diamicton is continuous with Itkillik II ground moraine along lower valley walls.

Exposure 5 (Near Your Creek)

Exposure 5 lies on the north shore of a small island in a probable thaw lake on the floor of an unnamed western branch of Your Creek Valley (plate 1). The exposure lies close to glacier source areas within a valley segment that was intensely scoured by Itkillik glaciers and remained glaciated through late Itkillik time (Hamilton, 1978a). The bank stands 7.4 m high and is nearly obscured by slumping. The upper 1.8 m of in situ sediment was exposed by clearing away the slumped material, but permafrost in the debris apron at greater depth prohibited further excavation.

The lowest exposed sediments (unit 1 of fig. 5) consist of sand and sandy peat that apparently was deposited in a marsh or shallow pod. This deposit probably extends down to at least present lake level because the debris apron as well as wave-washed sediments along the water's edge consist entirely of sand. Much of the in situ sediment is rhythmically laminated, and 30 sand-peat couplets occur within a 15-cm interval near the top of the unit. Ostracodes present in the sediments are characteristic of a relatively permanent fresh-water alkaline lake of moderate depth that probably did not freeze down to its bed each winter; they also indicate boreal environments comparable to those of the present (R. M. Forester, written communication). The insect remains indicate that sedge-type vegetation was present (A. V. Morgan, written communication). Alluvial sand and dispersed fine gravel cap the section.

Peat and wood sampled 40-50 cm below the top of unit 1 dates 5615 ± 110 yr BP (I-10,568). This provides a minimum age for deglaciation of the Your Creek area, but probably not a close age limit because five dates ranging from 9080 ± 150 to 10,500 ± 80 yr BP have been obtained from early postglacial sediments in the neighboring Wind River Valley (Hamilton, in preparation).

The radiocarbon date is of greater relevance in providing a limiting maximum age on termination of an earlier lake phase at this locality, which was followed by river downcutting from a level about 7 m above the present.

Exposure 6 (Mosquito Fork bank)

Exposure 6 extends along the south bank of Mosquito Fork immediately upstream from the mouth of Frisky Creek (plate 1). It lies within Holocene alluvial fill that covers the floor of a valley system incised within till of Sagavanirktok River age and outwash of the Itkillik I Glaciation (Hamilton, 1978a). It is associated with a terrace segment that stands about 7 m above the modern floodplain of Mosquito Fork.

Alluvium at the base of the section (unit 1 in fig. 6) is relatively coarse and angular gravel that probably was deposited as part of a fan at the mouth of Frisky Creek. The overlying sand and finer gravel units (2, 4, 5, 7, and 8) consist of alluvium that was deposited primarily by Mosquito Fork. Alluviation was episodic in the Frisky Creek area, causing fining-upward successions (as in unit 7) and two hiatuses marked by growth of floodplain forests (units 3 and 6). The older forest floor dates 5370 $\pm$ 90 yr BP.

The mid-Holocene radiocarbon date may have significance for regional alluvial history and for studies of vegetation response to middle and late Holocene climatic fluctuations. Further assessment of these relationships, however, must be based on additional radiocarbon dates from Holocene terraces and study of associated plant and animal fossils.

DISCUSSION AND SUMMARY

The radiocarbon record from the Chandalar quadrangle is disappointing. Only seven dates are available at present, in contrast to the more than 60 dates being tabulated for the adjoining Philip Smith Mountains quadrangle (Hamilton, in preparation). The age range of the Chandalar dates is also frustrating; three are infinite and the remaining four range only from middle to late Holocene. Despite these limitations, the dates and related bluff stratigraphy are compatible with the stratigraphic sequence defined previously for the Chandalar-Koyukuk region (table 2), and help to validate it.

Table 2. Stratigraphic succession in the Koyukuk and Chandalar drainage systems. Slightly modified from Hamilton (1978b).

Holocene	Postglacial alluviation and downcutting, thaw-lake formation, and peat accumulation in major valleys. Accumulation of basin-fill deposits behind Itkillik end moraines.
Late Pleistocene	ITKILLIK II GLACIATION. Deposition of till, ice-stagnation deposits, outwash, loess, and proglacial lake sediments.
	Interglacial or interstadial unconformity with local peat and forest beds. Dates >42,000 yr BP.
	ITKILLIK I GLACIATION. Deposition of till, outwash, and loess.
Middle(?) Pleistocene	Deposition of interglacial gravel, now heavily oxidized.
	SAGAVANIRKTOK RIVER GLACIATION. Deposition of younger pre-Itkillik drift(s).
Early(?) Pleistocene	Deposition of thick interglacial alluvium.
	ANAKTUVUK RIVER GLACIATION. Deposition of older pre-Itkillik drift(s)
Pliocene(?)	Deposition of preglacial gravel.

The infinite date from rooted stumps at Caro bluff (exposure 1) appears to demonstrate an early Wisconsin or older age for the Itkillik I Glaciation, proving that the Itkillik chronology proposed by Hamilton and Porter (1975) almost certainly is too young. Although the other two infinite dates are on organic materials that are stratigraphically older than the Itkillik I/II interglacial or interstadial, they do help to validate the inferred great antiquity of the West Fork stratigraphic sequence and prove that relict Itkillik I deposits survived overriding by Itkillik II glaciers around Phoebe Creek.

Two of the Holocene dates, obtained from loess caps on bluffs that rise well above postglacial valley floors, contribute little to the general stratigraphic or paleoclimatic record. One, and perhaps both, of these dates seem to be anomalously young owing to contamination by modern rootlets and burrowing ground squirrels. The remaining two finite dates, from exposures 5 and 6, fall within the middle Holocene and represent episodes of alluviation in the Your Creek and Mosquito Fork areas. These events are presently interpreted as local phenomena without general geologic or paleoclimatic significance, but further study and dating of Holocene floodplain deposits may prove that they have greater regional significance.

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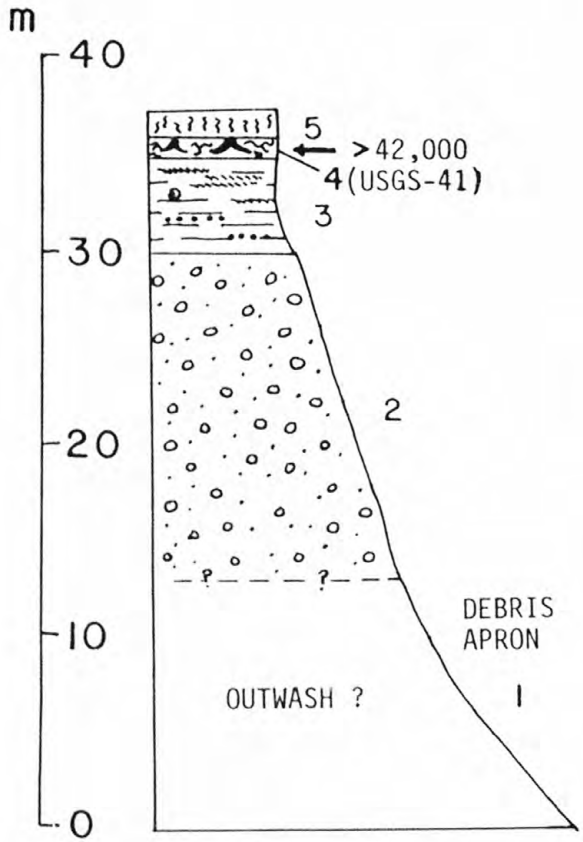
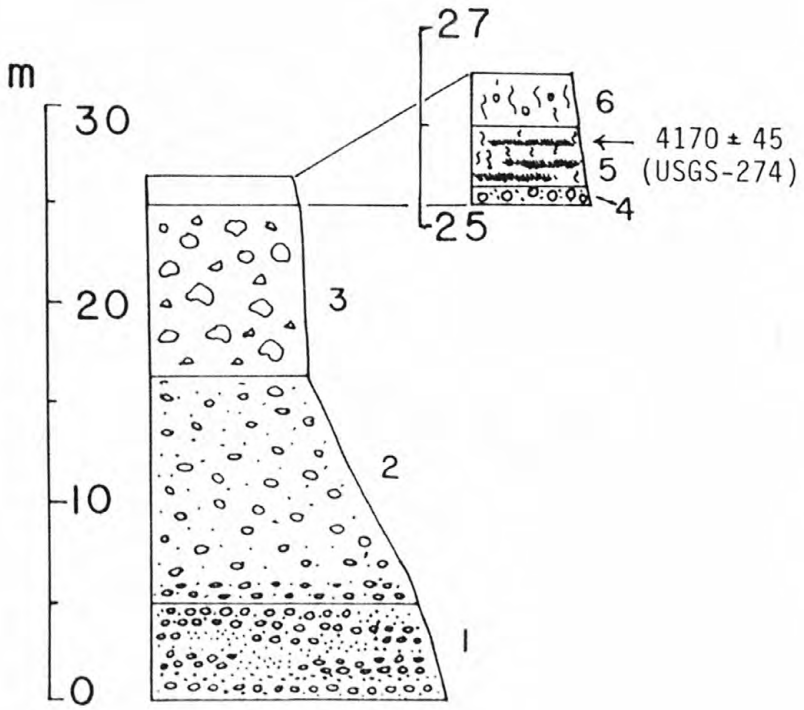


UNIT	THICKNESS (m)	DESCRIPTION
5	1.2	Silt; nonbedded and well sorted, with local columnar jointing. Light brownish grey (10 YR 6/2) when moist; very pale brown (10 YR 7/4) when dry. Upper 80 cm has platy structure; basal 40 cm is massive. Probable loess.
4	0.5-1.0	Bryophytic peat containing large spruce fragments, some rooted, with ring widths up to 0.4 cm. Roots show slight oxide staining. Locally interbedded with peaty silt containing gastropod remains. Probable floodplain-forest floor.
3	5	Dark greyish brown (2.5 Y 4/2) organic silt, faintly bedded. Contains twigs, peat lenses, gastropod shells, and some pebbles. Probable channel fill or floodplain deposit.
2	17	Sandy gravel. Unweathered subrounded stones up to very small boulder size; some faceted, many of Kanayut conglomerate and quartzite. Coarsens upward from very sandy pebble gravel near base through sandy pebble-cobble gravel to cobble-small boulder gravel with relatively little sand near top. Probable outwash.
1	13	Covered. Debris apron at base of bluff.

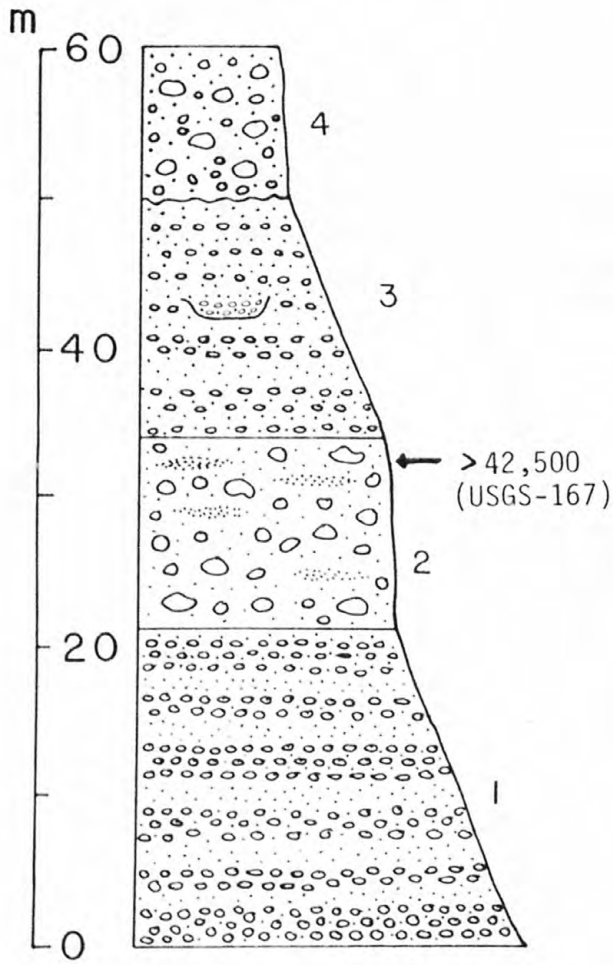
Figure 1. Exposure 1 (Caro bluff). North side Chandalar River 1.5 km downstream from Caro. Height of exposed face 37 m.



UNIT	THICKNESS (m)	DESCRIPTION
6	0.45	Slightly stony buff silt with platy structure. Stones of pebble to granule size; many with vertical orientation.
5	0.60	Black silty peat interbedded with buff to grey loess.
4	0.20	Gravel. Subrounded stones up to cobble size in coarse sandy matrix.
3	8.7	Till. Generally subrounded stones up to 1 m diameter in compact, unsorted, dark grey (5 Y 4/1) muddy matrix. Pebbles and small cobbles predominant; many stones striated. No obvious fabric. Upper 2 m slightly sandier and less compact, with local sandy interbeds.
2	11.5	Outwash. Subrounded pebbles and cobbles in coarse sandy matrix. Abundant large cobbles of Kanayut lithologies. Basal 2 m is sandy fine gravel transitional to unit 1.
1	5.0	Bedded sand and gravel. Gravel beds range from cobble gravel in coarse sandy matrix to well sorted small-pebble gravel in silty sandy matrix. Contains lenses of cross-bedded medium sand up to 50 cm thick and lenses of grey silt and black organic silt up to 12 cm thick. Upper 50 cm of unit has reddish brown oxide staining. Possible unconformity 1 m below upper contact is marked by vertical stone fabric and involuted sand lens.

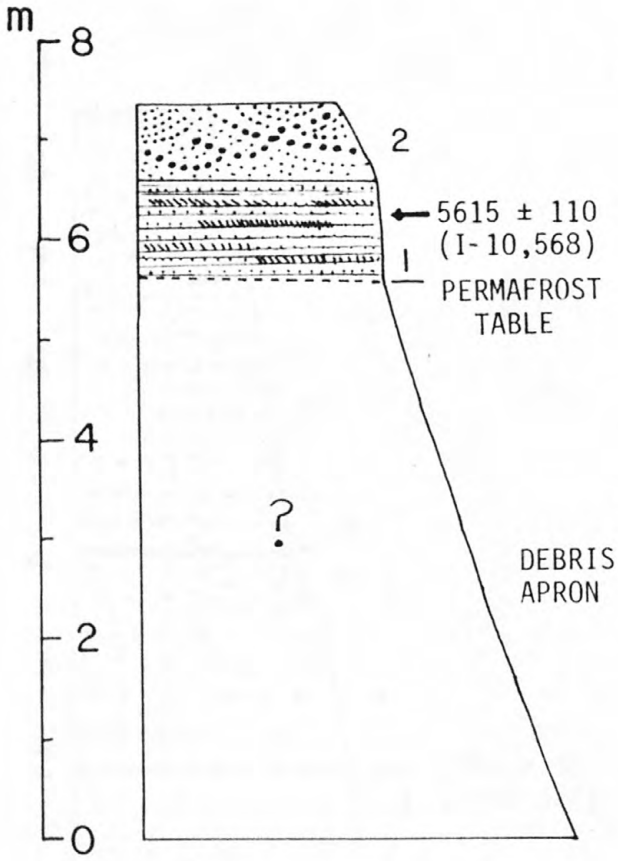
LAG DEPOSIT AT RIVER EDGE: Subrounded cobbles and small boulders; many faceted; some striated. Average maximum diameter 25-35 cm; largest stones up to 80 cm. Lithologies include Kanayut quartzite and conglomerate, gneiss, granite, quartz, schist, and green dike rock.

Figure 3. Exposure 3 (bluff near Funchion Creek). North side Chandalar River 2.5 km downstream from mouth of Funchion Creek. Total height 26.5 m.



UNIT	THICKNESS (m)	DESCRIPTION
4	10	Diamicton. Nonsorted, nonstratified faceted stones up to 1 m diameter in well sorted fine sand matrix. Unconformably overlies unit 3.
3	13	Bedded sand and fine gravel. Rounded to subrounded stones in well sorted sand matrix. Beds of fine to very fine sand alternate with beds of coarse sand and granules through much of unit. Contacts sharp, continuous, and near horizontal. Lenticular channel fill of pebbles and small cobbles in sandy matrix present. Some stones near upper contact are weathered.
2	16	Diamicton. Nonbedded to very crudely bedded, nonstratified, subangular to subrounded stones up to small boulder size (50 cm diam) in nonsorted sand-granule-pebble matrix. Contains lenses 20-60 cm thick of cross-bedded, stratified sand and sandy fine gravel. Sand lens 2 m from upper contact contains wood.
1	21	Oxidized gravel. Subrounded stones in coarse sand-to-granule matrix. Pebble-cobble beds alternate with pebble-granule beds. Slightly cemented by carbonate and oxides, with oxide colors ranging up to strong brown (7.5 YR 5/6).

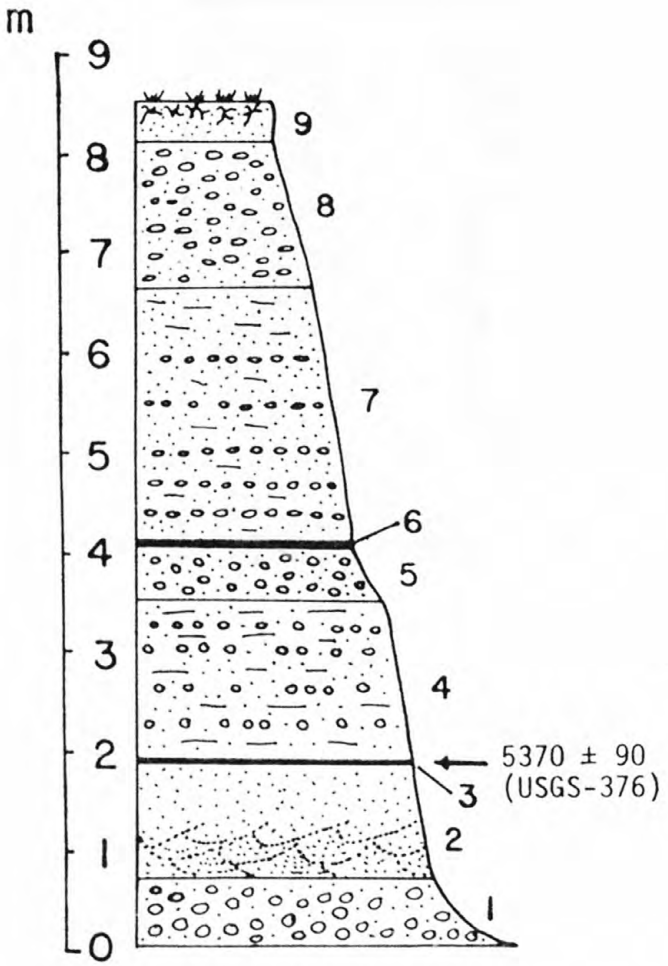
Figure 4. Exposure 4 (Phoebe Creek bluff). South side Phoebe Creek Valley 1.5 km above its mouth. Total height 60 m.



UNIT	THICKNESS (m)	DESCRIPTION
2	0.8	Yellowish brown (10 YR 5/4) fine sand and pebbly fine sand, locally cross bedded.
1	>1.0	Interbedded olive grey (5 Y 5/2) to light olive grey (5 Y 6/2) fine sand and black (10 YR 2/1) sandy peat, forming horizontal laminae 0.2 to 5.0 cm thick. Rhythmic couplets of 0.5 cm average thickness occur near upper contact

- - - - - Permafrost table at 1.80 m depth - - - - - - -

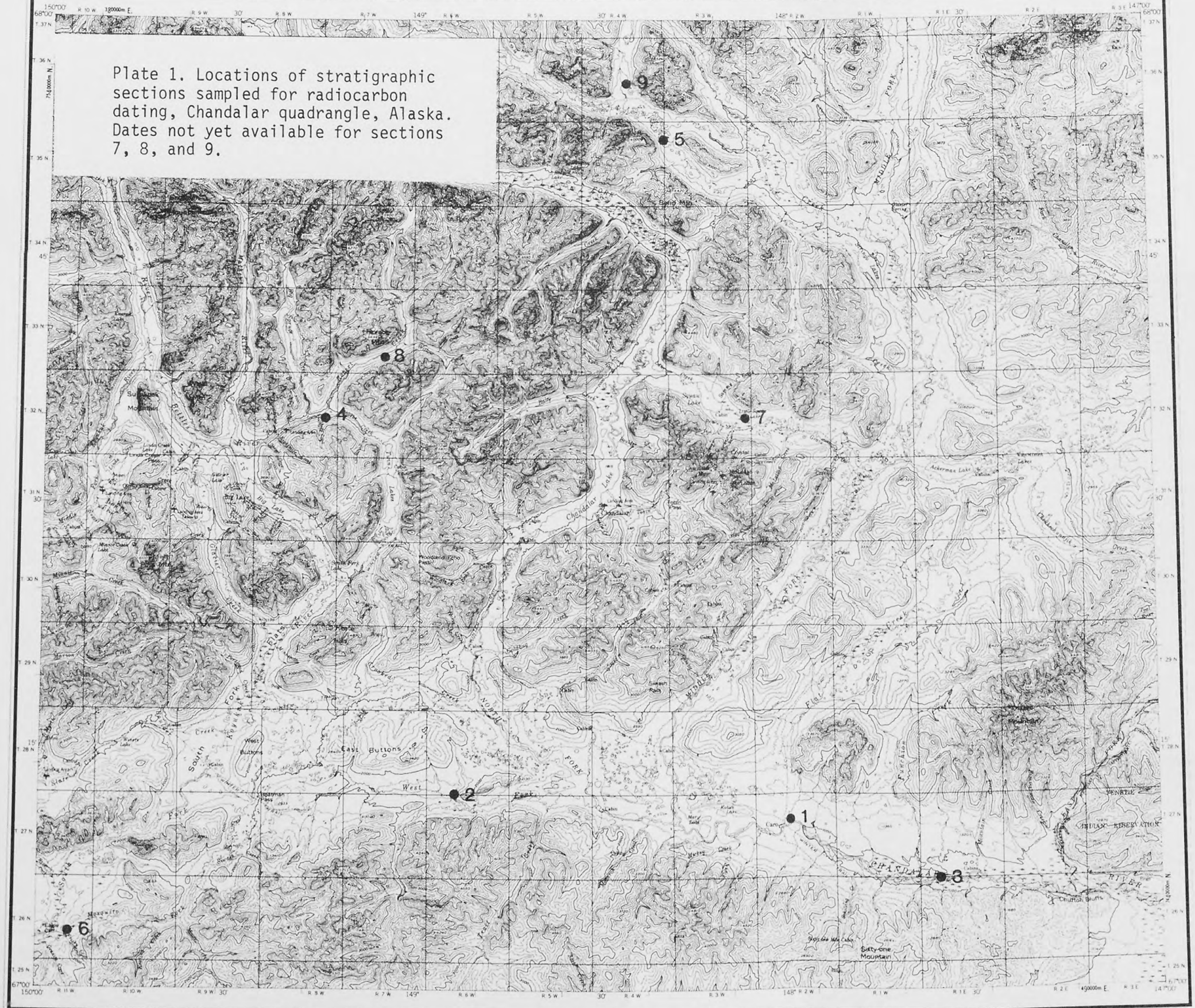
Figure 5. Exposure 5 (bank deposit near Your Creek). North shore of island in unnamed lake 7 km north of Bend Mountain. Total height 7.4 m.



UNIT	THICKNESS (m)	DESCRIPTION
9	0.4	Modern organic mat above greenish grey frost-churned sandy silt.
8	1.5	Gravel. Subrounded pebbles and small cobbles in matrix of medium sand.
7	2.5	Organic fine sand alternating with granule-fine pebble gravel in beds 2-10 cm thick. Fines upward into 0.5 m of grey organic silty fine sand.
6	0.3	Grey organic silty fine sand overlain by organic litter horizon consisting of matted wood, leaves, stems, and other plant parts with abundant insect fauna. Former forest floor.
5	0.5	Oxidized gravel. Large pebbles and some small cobbles in coarse sand matrix.
4	1.6	Grey fine sand and very dark grey silty fine sand alternating with oxidized coarse sandy granules and fine pebbles in beds 2-10 cm thick.
3	0.2	Wood fragments in grey silty fine sand matrix. Former forest floor.
2	1.0	Grey silty fine sand above cross-bedded, strongly oxidized, dark red (10 R 3/6) coarse sand.
1	0.5	Gravel. Angular to subangular stones up to cobble size. Probable fan deposit.

Figure 6. Exposure 6 (Mosquito Fork bank). South side Mosquito Fork 0.5 km above mouth of Frisky Creek. Total height 8.5 m.

Plate 1. Locations of stratigraphic sections sampled for radiocarbon dating, Chandalar quadrangle, Alaska. Dates not yet available for sections 7, 8, and 9.



CONTOUR INTERVAL 200 FEET
DATUM IS MEAN SEA LEVEL

LOCATION INDEX

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