Lithology and palynology of Tertiary rocks exposed near Capps Glacier and along Chuitna River, Tyonek quadrangle, southern Alaska

by

W. L. Adkison, J. S. Kelley, and K. R. Newman

U.S. Geological Survey open-file report 75-21

1975

Prepared in cooperation with the Division of Geological and Geophysical Surveys, Department of Natural Resources, State of Alaska

Introduction

This report provides detailed lithologic descriptions and lists palynomorph assemblages of the Kenai Group of Tertiary age at selected exposures on the south side of Capps Glacier and at two places along Chuitna River (pl. 1); the exposures lie about 60 miles west of Anchorage, Alaska. A preliminary report on the heavy minerals in Tertiary rocks of the Capps Glacier–Chuitna River area is being prepared by J. S. Kelley. This work is part of a study to provide stratigraphic control to aid in the search for oil and gas in the Cook Inlet basin.

The work was done under a cooperative agreement between the U.S. Geological Survey and the Division of Geological and Geophysical Surveys, Department of Natural Resources, State of Alaska. The writers gratefully acknowledge the assistance of W. C. Fackler, Deputy Commissioner, Department of Natural Resources, and D. C. Hartman, former State Geologist.

Field work for this report was done in July and part of August 1973 by Adkison and Kelley who were assisted by K. T. Biddle. The work was done from four field camps that were supplied and moved by helicopter. The palynomorphs were identified by Newman who was assisted by Linda Lewis.

In the field the rocks in each measured section were described from bottom to top, and this order is used here to summarize the descriptions. The detailed descriptions of the sections, starting on page 16, are in downward order. The section numbers (13-17) are field

numbers and indicate the order in which the sections were measured. The field descriptions commonly included, for each rock type, the color, staining, weathering characteristics, bedding, induration, grain size, accessory particles, fossils, and the nature of the contact with the overlying rock unit. Thicknesses were generally measured with an Abney level and Jacob's staff, but a steel tape and hand level were used for nearly flat-lying beds. Representative lithologic samples of all rock types, except the conglomerates, were taken concurrently with the field descriptions. For the conglomerates, samples of the matrix were collected at irregular stratigraphic intervals of about 50-100 feet. The samples were briefly studied later by Kelley and Biddle, using low-power binocular microscopes, in order to check and amplify the field descriptions.

The Rock Color Chart (Goddard and others, 1948) was used to describe the rock colors, and the Wentworth grade scale was used to describe the grain size. Clastic rocks composed chiefly of particles smaller than coarse silt were generally termed "shale", although the bedding of these rocks is commonly obscure or poorly developed. The term "siltstone" is used for clastic rocks composed of coarse-silt particles. Bedding is classified according to thickness as follows:

fissile, less than 1/16 in.	
platy, 1/16 - 1/2 in.	medium, 4 - 12 in.
very thin, 1/2 - 2 in.	thick, 12 - 36 in.
thin, 2 - 4 in.	massive, more than 36 in.

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The palynological samples were collected mostly from the finer grained clastics (shale, claystone, and siltstone). About half the samples are from close below or within a coal bed. For the lower conglomeratic part of the Tertiary sequence, a few samples of sandy siltstone were taken because there were no finer clastics. Efforts were made to get relatively fresh samples uncontaminated by pollen and spores from modern vegetation. The samples were placed in plastic bags that were closed with tie wires and then placed in tagged cloth bags.

The palynological samples were treated with acids to remove minerals and concentrate acid-resistant organic-walled microfossils (palynomorphs). Most samples had numerous to abundant palynomorphs, chiefly spores and pollen, and these were generally well preserved. Palynomorphs were mostly sparse or absent in samples from the conglomerates. The organic residues from the samples were mounted on slides and examined qualitatively to determine the stratigraphic succession of palynomorphs. The taxa found in this study are listed in Table 1.

Tertiary rocks

As early as 1900 Tertiary rocks on the northwest side of Cook Inlet were referred to the Kenai Formation by Eldridge (1900, p. 21) who briefly described coal-bearing strata along beach bluffs west of Tyonek. He inferred the presence of these rocks to the north on Chulitna (Chuitna?) and Beluga Rivers from reports by prospectors and Indians. The same year Spurr (1900, p. 172, 184) provisionally regarded the Tyonek beds as younger than the Kenai Formation. The

| Palynological sample no. (see Plate 1) 1/ | Palynomorph taxa | | |

most complete study of the Kenai Formation northwest and north of Cook Inlet was made by Barnes (1966). His report was used extensively during field work for the present report. Wolfe, Hopkins, and Leopold (1966) studied plant fossils from the Kenai Formation in the Cook Inlet region, and from this study they proposed three new provincial time-stratigraphic units for the formation, the Seldovian, Homerian, and Clamgulchian Stages.

The Kenai Formation is much thicker in the subsurface of Cook Inlet basin than at any of the surface exposures, as shown by drilling for petroleum since 1957. Calderwood and Fackler (1972, p. 741) pointed out that the name "Kenai Formation" is inadequate to describe the gross sequence of Tertiary rocks and accordingly, they formally proposed: (1) the Kenai Formation be elevated to Kenai Group and (2) this group be divided into five formations named, in upward order, the West Foreland Formation, Hemlock Conglomerate, Tyonek Formation, Beluga Formation, and Sterling Formation. This stratigraphic nomenclature is widely accepted by geologists working with the subsurface stratigraphy in the Cook Inlet basin, and it is used in this report.

All formations of the Kenai Group have subsurface type sections. It is difficult to trace these units to outcrops on the west flank of the basin. Calderwood and Fackler (1972, p. 742, 744, 745) tentatively correlated the West Foreland Formation with scattered but unidentified outcrops on the west flank. They noted that exposures in the Straight Creek-Capps Glacier area may be equivalent to the Hemlock Conglomerate, and that parts of the Tyonek Formation are exposed along the upper part

of Chuitna River. According to Kirschner and Lyon (1973, p. 402, 403, fig. 11), the West Foreland Formation and the Hemlock Conglomerate and Tyonek Formation, undivided, crop out in the general area of this report.

Kenai Group

Rocks of the Kenai Group in the area of this report are tentatively assigned to the West Foreland and Tyonek Formations; the Hemlock Conglomerate seemingly is absent by nondeposition or erosion. This subdivision of the group is based primarily on the palynological determinations (Table 1) and comparison with the palynomorph succession in the Standard Oil Co. of Calif. Deep Creek Unit 1 well located on the Kenai Peninsula (Adkison and Newman, 1973). Strata of the West Foreland Formation and the lower conglomeratic part of the Tyonek Formation (measured sections 13, 14) were called the lower conglomerate member of the Kenai Formation by Barnes (1966).

West Foreland Formation.--The West Foreland Formation consists of conglomerate about 1,200 feet thick (pl. 1) at measured section 13 south of Capps Glacier. At this locality the rocks strike N.60°E., dip about 20° southeast, and according to Barnes (1966, pl. 1), lie unconformably on metamorphic rock of Jurassic and (or) Cretaceous age. The lower 20 feet of the formation is deeply weathered and mostly covered. The basal 2 feet was exposed by digging. In this very limited exposure, the matrix of the conglomerate appeared mottled and streaked -- somewhat suggestive of fault gouge -- but this appearance probably is a

result of ground-water action rather than faulting. Except for the lower 20 feet, the lower 460 feet is well exposed in very steep hillsides where it shows some slight indications of bedding. The overlying part, nearly 700 feet thick, forms more gentle hillsides and, where measured, is generally poorly exposed. The relatively thin cover consists of loose sand and gravel that has washed downhill from overlying beds. The uppermost 40 feet of the West Foreland is well exposed near the top of the ridge.

The conglomerate consists mainly of pebble- and cobble-size clasts in a matrix of clayey silty medium to coarse sand. Rounded boulders, as much as 3 feet long, are numerous in the lower 500 feet and become more scattered upward in the overlying 400 feet. The clasts in the conglomerate include coarse-grained granitic rocks (generally weathered), fine- to medium-grained metamorphic rocks, and volcanic rocks. Zeolite cement is fairly common in much of the conglomerate.

The West Foreland includes a small amount of poorly sorted sandstone that generally occurs in lenses or beds about a foot thick. The sandstone is brownish gray in the lower part of the formation and medium gray to greenish gray in the upper part. The thickest sandstone (14 feet) includes a thin bed or lense of siltstone that contains carbonaceous plant fragments and a palynomorph assemblage (13P-18, table 1). The palynomorphs suggest a possible Eocene age and correlation with the West Foreland Formation in the Deep Creek well on the Kenai Peninsula.

The top of the West Foreland Formation is difficult to determine

in section 13 because the overlying rocks are very similar in lithology and structural attitude. The contact is placed rather arbitrarily at the top of a conglomerate bed and beneath thin beds of sandstone and shale that contain very thin stringers of coal. A palynomorph assemblage in the shale (13P-25) and another assemblage (13P-28), about 50 feet stratigraphically higher, suggest correlation of rocks in the upper part of section 13 with part of the Tyonek Formation in the Deep Creek well. Thus the relationship between the West Foreland and Tyonek Formations is unconformable because the Hemlock Conglomerate is apparently missing. The absence of the Hemlock in section 13 is also interpreted from a preliminary study of the heavy minerals by J. S. Kelley (in preparation). The Hemlock is characterized by abundant garnet in the heavy-mineral suite in the Deep Creek well (Kelley, 1973), but little or no garnet was found in samples from measured sections 13 and 14 and the lower half of section 15.

Tyonek Formation.—The Tyonek Formation consists of interbedded conglomerate and sandstone in the lower part and sandstone, siltstone, and coal in the remainder (pl. 1). The coal-bearing beds, above the lower conglomeratic part of the Tyonek, were included in Barnes' (1966) middle member of the Kenai Formation. Identification of the Tyonek Formation is based on the relative abundance of thick coal beds and on the pollen assemblages (Table 1) which are similar to those in the middle part of the Tyonek in the Deep Creek well (Adkison and Newman, 1973). The total thickness of the formation is unknown, for reasons

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explained below, but it exceeds 2,200 feet.

The lower part of the Tyonek Formation, at least 835 feet thick, is well exposed south of Capps Glacier (measured section 14 and upper part of section 13) where it weathers to very steep hillsides and cliffs that are dominantly brown to brownish gray. The conglomerate is made up of pebble- and cobble-size clasts and is generally similar to that in the West Foreland Formation. A few small boulders are present in the lower part (upper 30 feet of section 13). Zeolite cement seems less common than in the West Foreland Formation. The sandstone is mostly brown, olive gray, and greenish gray, poorly sorted, medium to coarse grained, silty, and clayey. Tuffaceous material is common in much of the sandstone and in the matrix of some conglomerate, and these rocks include interbeds of tuff. A sandstone about 25 feet thick, 270 feet below the top of measured section 14, contains abundant clear vitreous crystal fragments of sodic plagioclase. The fragments, of medium sand size, sparkle conspicuously at exposures in direct sunlight and thus make this sandstone distinctive.

The sequence of conglomerate and sandstone also includes some siltstone and a few thin beds of volcanic ash, bentonite, and shale. One thin lenticular coal bloom lies about 50 feet above the base of the Tyonek Formation (just below sample 13P-28 on measured section 13). Stringers of coal occur in several thin beds of sandstone, siltstone, shale, and tuff; these rock types also contain carbonaceous plant fragments.

Rocks in the upper part of measured section 14 could not be traced

eastward along the south side of Capps Glacier and tied stratigraphically to the overlying coal-bearing rocks in measured section 15; thus the thickness of intervening strata is unknown. The lower conglomeratic part of the Tyonek, described above, is partially exposed at several places on the south side of the glacier eastward from measured section 14 for about 3 miles to sec. 18, T. 14 N., R. 14 W. The top of the conglomeratic sequence, mapped approximately in adjacent section 17 by Barnes (1966, pl. 5), is apparently covered by colluvium, slope wash, and abundant vegetation.

A fault may cut the lower part of the Tyonek, or place it in fault contact with the coal-bearing part to the east, in secs. 18 and 17, T. 14 N., R. 14 W., but no direct evidence was found. These possibilities are suggested by a fault, striking east-northeast, that was mapped in sec. 27-29, T. 14 N., R. 15 W. (pl. 1), during helicopter reconnaissance of the upper Straight Creek area. The north side of the fault is downthrown, and the throw may be about 1,000 feet in the southern part of sec. 29. Eastward projection of the fault from section 27, with slight curvature northward, would pass through secs. 18 and 17, T. 14 N., R. 14 W.

The lower part of the coal-bearing strata of the Tyonek Formation is well exposed south of the toe of Capps Glacier (measured section 15). These beds were designated part of the type section of the Seldovian Stage by Wolfe, Hopkins, and Leopold (1966, p. A14). The rocks, 640 feet thick, consist mainly of sandstone, siltstone, and several coal beds including, in the upper part, the thick Capps coal bed. The

upper half includes several beds and lenses of granule to small-pebble conglomerate. The sandstone is mostly light to medium gray or olive gray and very fine to medium grained. Numerous sandstone bodies probably are channel deposits as suggested by sharp basal contacts, cross bedding, and an upward decrease in grain size accompanied by an increase in content of silt and clay. These sandstones and conglomerates appear more quartzose than those in the lower part of the Tyonek. The siltstone is gray to olive gray and obscurely bedded for the most part. Thin beds of gray to black shale make up a small part of the formation. Tuffaceous grains are scattered to abundant in several beds in the lower 45 feet of the exposure. Carbonaceous plant fragments and leaf impressions are abundant in many beds of siltstone, very silty sandstone, and shale. A coalified tree trunk, 6 feet long, extends upward from a thin coal bed that lies about 45 feet above the base of the exposure. Most coal beds are thin and split by partings of siltstone or shale. The cliff-forming Capps coal bed, 63 feet thick, occurs in three main benches. The lower and upper benches include a few partings as much as 0.7 foot thick; the thick middle bench, not closely examined, may include some thin partings.

The stratigraphic relationship between the rocks in measured section 15 at Capps Glacier and those about 11 miles to the southeast, along Chuitna River, in sections 16 and 17 is not determinable in the field. According to Barnes (1966, p. C45, pl. 5), the Capps coal bed rises structurally to the southeast of measured section 15, and less than 3 miles southeast of section 15 the bed is cut off by erosion at

the upland surface. In addition, the Castle Mountain fault, a major structural feature downthrown on the southeast side, strikes southwestward through the area between measured sections 15 and 17 (Barnes, 1966, pl. 5). A strong component of right-lateral movement on this fault is interpreted by Kirschner and Lyon (1973, p. 404, fig. 16).

Rocks in measured sections 16 and 17 probably lie in the upper part of the Tyonek Formation. This position is interpreted from well logs of the Pan American Petroleum Chuitna River State 1 well, located about 4.5 miles east-southeast of measured section 16 in sec. 15, T. 12 N., R. 12 W. Correlation of the electrical log with the measured sections suggests that the exposed rocks are equivalent to the upper 600 feet of strata in the well. The Tyonek Formation in this well extends from the top to a depth of 6,180 feet, according to isopach maps by Hartman, Pessel, and McGee (1972). These writers believe all the other formations of the Kenai Group are missing in the Chuitna River State 1 well. Strata equivalent to those in measured section 15 at Capps Glacier may be present but cannot be identified on the logs for this well.

Rocks of the Tyonek Formation in measured sections 16 and 17 have an aggregate thickness of about 730 feet and consist of sandstone, some siltstone, and several coal beds. These strata were included in the type section of the Seldovian Stage by Wolfe, Hopkins, and Leopold (1966, p. A14). The sections are tentatively correlated on the Chuitna coal bed following Barnes (1966, p. C48). The sandstone is mostly gray and very fine to medium grained. Much of the sandstone probably

occurs as channel fillings as suggested by sharp lower contacts, coarser grained sandstone or thin beds or lenses of conglomerate at the base, cross bedding that commonly changes upward to platy bedding, and scattered coal fragments. Some very fine grained sandstone is very silty and clayey and obscurely bedded. The siltstone is mostly medium to medium dark gray, obscurely bedded, and clayey; some is dark gray and very carbonaceous. Thin beds of gray to black shale make up a small part of the Tyonek Formation at sections 16 and 17. Fossils consist of small carbonaceous plant fragments and large coalified fragments; leaf impressions were found in the roof rock of three coal beds (pl. 1). Major coal beds, about 20 feet thick or more, include the Chuitna and lower Chuitna(?) beds and an unnamed bed at the base of section 17. The latter bed is exposed at the edge of Chuitna River where it was measured by Barnes (1966, pl. 7, loc. 126). The formation also includes several other coals that, with partings, are as much as 10.5 feet thick.

Stratigraphic sections

Detailed descriptions of the Tyonek and West Foreland Formations of the Kenai Group and the uppermost part of the underlying Cretaceous and (or) Jurassic rocks are given starting on page 16. As noted above, these are primarily field descriptions supplemented by brief microscopic study of representative samples. In the descriptions, the palynological sample numbers immediately follow the rock type that was sampled.

References cited

Adkison, W. L., and Newman, K. R., 1973, Lithologic characteristics and palynology of Upper Cretaceous and Tertiary rocks in the Deep Creek Unit well, Kenai Peninsula, Alaska: U.S. Geol. Survey open-file report, 271 p., 1 pl.

Barnes, F. F., 1966, Geology and coal resources of the Beluga-Yentna region, Alaska: U.S. Geol. Survey Bull. 1202-C, 54 p.

Calderwood, K. W., and Fackler, W. C., 1972, Proposed stratigraphic nomenclature for Kenai Group, Cook Inlet basin, Alaska: Am. Assoc. Petroleum Geologists Bull., v. 56, no. 4, p. 739-754.

Eldridge, G. H., 1900, A reconnaissance in the Sushitna basin and adjacent territory, Alaska, in 1898: U.S. Geol. Survey 20th Ann. Rept., pt. 7, p. 1-29.

Goddard, E. N., chm., and others, 1948, Rock-color chart: Washington, D.C., Natl. Research Council, repr. Geol. Soc. America, 1963.

Hartman, D. C., Pessel, G. H., and McGee, D. L., 1972, Preliminary report on stratigraphy of Kenai Group, Upper Cook Inlet, Alaska: Alaska Dept. of Nat. Res., Div. of Geol. Survey, Spec. Rept. 5.

Kelley, J. S., 1973, Preliminary study of the heavy minerals from cores of Tertiary rocks in the Deep Creek Unit well, Kenai Peninsula, Alaska: U.S. Geol. Survey open-file report, 9 p., 1 pl.

Kirschner, C. E., and Lyon, C. A., 1973, Stratigraphic and tectonic development of Cook Inlet petroleum province, in Arctic Geology: Tulsa, Okla., Am. Assoc. Petroleum Geologists Mem. 19, p. 396-407.

Spurr, J. E., 1900, A reconnaissance in southwestern Alaska in 1898: U.S. Geol. Survey 20th Ann. Rept., pt. 7, p. 31-264.

Wolfe, J. A., Hopkins, D. M., and Leopold, E. B., 1966, Tertiary stratigraphy and paleobotany of the Cook Inlet region, Alaska: U.S. Geol. Survey Prof. Paper 398-A, 29 p.

Measured section 13

Location: Gully and hillside exposures, south of big bend in Capps Glacier, from ridge crest (estimated altitude 3050 ft.) in SE corner NE 1/4 NW 1/4 SE 1/4 sec. 21 generally northwestward to SW 1/4 NW 1/4 NE 1/4 sec. 21, T. 14 N., R. 15 W., Tyonek B-6 quadrangle. Most of the section was measured along the north side of a partly snow-filled gully which was very steep sided in the lower part.

	Feet
Tertiary rocks -- Kenai Group, Tyonek Formation	
Conglomerate, gray, strongly iron-stained (lower 2 ft.), mostly pebble and cobble; few small boulders; clasts generally well rounded; much medium to coarse sand matrix; includes at 3 ft. above base a 0.5-ft. bed of olive-gray to light-yellowish-brown stained poorly sorted friable medium- to coarse-grained clayey granular silty sandstone with many granules and small pebbles in lower half; similar lenticular sandstone about 8 ft. above base----------	30.
Sandstone, medium-gray, friable, fine- to medium-grained, subangular, clayey, very silty; conglomeratic and iron-stained in lower 0.5 ft.----------	0.7
Siltstone (13P-28)*, medium-gray, soft, sandy; abundant small brown plant fragments----------	0.15
Coal bloom; includes in middle a 0.05-ft. bed of light-brown to light-gray clay (coal ash?)----------	0.3
Siltstone, medium-gray to brownish-gray, soft, sandy; lower contact probably gradational----------	0.2
Sandstone, olive-gray, fine- to medium-grained, subangular, silty; some coarse grains----------	0.4
Conglomerate, gray, mostly pebble and cobble; much friable light-yellowish-brown-weathering poorly sorted medium- to coarse-grained subangular clayey granular very silty sandstone matrix; lower contact sharp----------	15.
Sandstone, olive-gray, light-yellowish-brown-weathering, obscurely bedded, poorly sorted, medium- to coarse-grained, subangular, clayey, granular, very silty--------	0.7

*Palynological sample

Conglomerate, gray, pebble and cobble; friable light-yellowish-brown-weathering poorly sorted medium- to coarse-grained subangular to subrounded clayey granular very silty sandstone matrix; lower contact sharp----------	25.
Sandstone, medium-gray to greenish-gray, friable, fine-grained, subangular, silty, very clayey----------	0.4
Sandstone, medium-light-gray, iron-stained, friable, medium-grained, subangular, clayey, silty----------	0.1
Shale (13P-25)*, dark-gray to black, carbonaceous, silty, sandy; includes few coal films and partings; lower contact sharp-	0.15
Sandstone, medium-gray, partly green-tinted, friable, fine- to medium-grained, subangular, very clayey, very silty; some coarse grains; few very thin coal stringers----------	0.4
Claystone, greenish-gray to purplish-gray, finely to coarsely sandy, silty, probably bentonitic----------	0.2-0.3
West Foreland Formation	
Conglomerate, gray, pebble and cobble; greenish-gray friable poorly sorted medium- to coarse-grained subangular to subrounded granular very silty sandstone matrix; lower contact sharp----------	5.8
Sandstone, medium-gray to olive-gray, fine- to medium-grained, subangular, silty, very clayey; some coarse and very coarse grains, granules, and pebbles----------	0.7
Conglomerate, similar to above----------	6.2
Sandstone, greenish-gray, friable, poorly sorted, coarse- to very coarse grained, subangular to subrounded, granular, silty; probably lenticular----------	0.8
Conglomerate, similar to above; lower contact sharp----------	5.
Sandstone, medium-gray, partly green-tinted, poorly sorted, fine- to coarse-grained, subangular, very silty, very clayey; lower contact sharp----------	0.9
Bentonite, light-purplish-gray; lower contact sharp----------	0.3
Sandstone, greenish-gray, poorly sorted, medium-grained, subangular, very silty, very clayey; many coarse and very coarse grains, granules, and pebbles----------	0.1

*Palynological sample

Conglomerate, gray, pebble and cobble; greenish-gray friable poorly sorted medium- to coarse-grained subangular clayey granular very silty sandstone matrix---------- 23.

Sandstone, greenish-gray, obscurely bedded, friable, poorly sorted, medium-grained, subangular, clayey, very silty; scattered coarse grains and granules; includes in middle a 1-ft. bed of cobble conglomerate; unit probably lenticular---------- 3.

Conglomerate, gray, pebble and cobble; yellowish-gray to greenish-gray partly iron-stained mostly poorly indurated partly zeolite-cemented poorly sorted medium- to coarse-grained subangular clayey granular very silty sandstone matrix; many cobbles as much as 0.5 ft. long; no boulders seen; poorly exposed in upper 50 ft.; lower contact sharp---------- 58.

Sandstone, medium-gray to light-olive-gray, partly iron-stained, obscurely bedded, very fine to medium-grained, subangular, clayey, silty, partly conglomeratic (pebbly at 6-10 ft. above base); scattered coarse and very coarse grains; includes at about 2 ft. above base a 0.1-ft. bed or lense of light-brown claystone; at about 10 ft. above base a 0.5-ft. bed or lense of light-olive-gray sandy siltstone (13P-18)* with abundant carbonaceous plant fragments; unit poorly exposed; lower contact obscure---------- 14.

Conglomerate, gray, pebble and cobble; yellowish-gray to light-olive-gray slightly iron-stained mostly poorly indurated zeolite-cemented poorly sorted medium- to coarse-grained subangular clayey partly granular very silty sandstone matrix; few or no boulders; may include thin beds or lenses of sandstone; mostly covered by loose sand and gravel---------- 198.

Conglomerate, gray, pebble and cobble; light-gray to light-olive-gray mostly poorly indurated poorly sorted medium- to coarse-grained subangular clayey granular very silty sandstone matrix with light-gray to pinkish-gray encrusting zeolite cement in part; few rounded boulders; mostly covered as above---------- 150.

*Palynological sample

Conglomerate, gray, pebble and cobble; gray to light-olive-gray partially iron-stained mostly poorly indurated zeolite(?) cemented poorly sorted coarse- to very coarse grained subangular clayey granular pebbly very silty sandstone matrix; few rounded boulders; abundant encrusting zeolite (stilbite) cement and locally much calcite cement about 100 ft. above base; deeply weathered in part; mostly crystal-filled vugs near top; covered as above---------- 180.

Conglomerate, similar to above; few rounded boulders in upper 20 ft. becoming more common downward; mostly poorly exposed except for basal part---------- 100.

Sandstone, brownish-gray, iron-stained, hackly-weathering, hard, well indurated, fine- to medium-grained, very clayey; scattered coarse grains; some slickensides------- 1.

Conglomerate, gray, pebble and cobble; very crudely bedded in part; numerous rounded boulders; coarse sand matrix; weathers to steep hillside---------- 50.

Sandstone, brownish-gray, hard, well indurated, fine- to medium-grained, very clayey, very silty; scattered coarse and very coarse grains---------- 1.

Conglomerate, similar to above; includes at about 45 and 70 ft. above base lenses of brownish-gray medium- to coarse-grained sandstone about 0.5 ft. thick; at about 80 and 115 ft. above base, lenses 1 ft. and 0.3 ft. thick, respectively, of light-brownish-gray to light-olive-gray partly iron-stained moderately to poorly indurated medium- to coarse-grained subangular pebbly clayey very silty sandstone; weathers to steep hillside---------- 170.

Sandstone (lenticular), brownish-gray, hard, well indurated, medium- to coarse-grained, subangular, clayey, very silty; scattered very coarse sand grains and granules; includes sandy siltstone (13P-5)* about 0.1 ft. thick at top---------- 0.5

*Palynological sample

Conglomerate, gray, pebble and cobble; very crudely bedded in part; numerous rounded boulders as much as 3 ft. long; medium-brownish-gray iron-stained poorly indurated poorly sorted medium- to coarse-grained subangular granular pebbly very silty sandstone matrix with interstitial medium-brown waxy clay and little encrusting zeolite cement; includes clasts of coarse-grained granitic rocks (generally weathered), fine- to medium-grained metamorphic rocks (several colors and textures), and volcanic rocks; 0.5-ft. lense of light-yellowish-brown lightly iron-stained moderately indurated coarse-grained subangular clayey very silty sandstone about 190 ft. above base; weathers to very steep hillside---------- 210.

Conglomerate, similar to above; very clayey sandstone matrix; deeply weathered; poorly exposed; matrix in basal 2 ft. mottled and streaked medium gray, light olive gray, and brown and resembles fault gouge to some extent; lower contact sharp---------- 20.

Unconformity

Jurassic and (or) Cretaceous rocks

Metamorphic rock, greenish-gray, reddish-brown, purplish-gray (in part at top); upper 2 ft. deeply weathered; includes at top 0.05-ft. bed of brown weathered clay; underlying rocks not studied---------- 10.+

Measured section 14

Location: Gully and hillside exposures, south of big bend in Capps Glacier, in southern part of SW 1/4 NE 1/4 and generally along the east line of NE 1/4 NW 1/4 SE 1/4 sec. 22, T. 14 N., R. 15 W., Tyonek B-6 quadrangle. This location is approximately the same as locality 57 of Barnes (1966, pl. 1).

	Feet
Pleistocene gravel and boulders, slumpy; not studied; base approximately marked by pronounced change in hillside slope	
Unconformity	
Tertiary rocks -- Kenai Group, Tyonek Formation	
Siltstone (14P-72)*, yellowish-gray to light-olive-gray, hackly- to poor platy-weathering, obscurely bedded, very clayey, tuffaceous; few carbonaceous plant fragments; may be a tuff; lower contact sharp----------	3.2+
Conglomerate, gray, pebble; few cobbles; light-yellowish-brown iron-stained friable poorly sorted medium- to coarse-grained subangular clayey very silty sandstone matrix principally made up of very light-gray and clear grains of quartz and feldspar; includes at 23 ft. above base a lenticular bed of coarse-grained sandstone (similar to the matrix sandstone) about 1.5 ft. thick and similar lenses of sandstone about 0.5 ft. thick at 30, 40, 45, and 70 ft. above base; unit forms very steep rounded slopes; basal part of unit interfingers with underlying rocks----------	84.
Sandstone, medium-light-gray to pale-yellowish-brown, iron-stained, friable, very poorly sorted, coarse-grained, subangular, clayey, very silty; scattered small pebbles; includes 2 lenses of pebble conglomerate, each about 1 ft. thick, at 2.5 and 0.3 ft. below top; lower contact sharp----------	8.5
Volcanic ash, olive-gray to light-bluish-gray, hackly-weathering and sandy in lower 0.3 ft., weathered; hard and dark bluish gray in basal 0.1 ft.; includes small white spherical grains in lower 0.3 ft.; plastic in upper part; 0.1-ft. bed of light-brownish-yellow clay at top; lower contact sharp----------	1.5

*Palynological sample

Sandstone, light- to medium-olive-gray, friable (lower part), medium-grained grading upward to very fine to fine-grained, subangular, clayey, very silty; upper 1 ft. grades to hackly-weathering locally ledge-forming siltstone; includes at top 0.05-ft. bed of carbonaceous siltstone (14P-68)* with some coal films; lower contact sharp---------- 5.9

Sandstone, olive-gray, friable, poorly sorted, medium-grained, partly coarse-grained, partly conglomeratic (pebble and granule), subangular, very clayey, very silty; much grayish-green interstitial clay; includes 2 beds of pebble conglomerate, each about 0.5 ft. thick, near base and top; lower contact sharp---------- 5.3

Siltstone, olive-gray, hackly- to poor conchoidal-weathering, very finely sandy, very clayey; includes in middle a 0.5-ft. bed of light-olive-gray friable medium-grained silty sandstone with grayish-green interstitial clay; possibly tuffaceous ; lower contact sharp---------- 1.3

Conglomerate and interbedded sandstone; conglomerate, medium-light-gray-weathering, partly iron-stained, pebble; some cobbles; forms beds as much as 5 ft. thick; sandstone, moderate-olive-brown, mostly obscurely bedded, partly cross-bedded, friable, medium- to coarse-grained, subangular, mostly conglomeratic, silty; much dusky-yellow-weathering clay; sandstone forms beds generally 1-3 ft. thick, makes up about one-third of unit, and interfingers with conglomerate; unit weathered and poorly exposed; lower contact sharp---------- 58.5

Volcanic ash, light-brownish-gray, hackly-weathering; scattered sand grains and small pebbles; locally cut out by overlying unit; lower contact sharp---------- 1.

Conglomerate, probably medium-light-gray, mostly iron-stained, pebble; few cobbles; friable medium-light-gray poorly sorted medium- to coarse-grained subangular granular silty clayey sandstone matrix; includes at 0.2 ft. below top a 0.7-ft. bed of medium-light-gray friable medium-grained sandstone; deeply weathered and poorly exposed---------- 23.

Sandstone, dusky-yellow, iron-stained, friable, fine- to medium-grained, subangular, clayey, very silty; becomes finer upward; probably lenticular; lower contact sharp---------- 1.6

*Palynological sample

Conglomerate, pebble and cobble; light-gray friable poorly sorted medium- to coarse-grained subangular granular clayey silty sandstone matrix; poorly exposed; lower contact sharp---------- 28.

Conglomerate and some interbedded sandstone; conglomerate, similar to above; much light- to medium-light-gray friable poorly sorted medium- to coarse-grained subangular granular clayey silty sandstone matrix; sandstone, light- to medium-gray, friable, medium- to coarse-grained, subangular; forms beds 0.5-0.7 ft. thick at base, middle, and top of unit; upper bed medium-grained and fairly well sorted; unit locally includes near base a 0.5-ft. lense of medium-gray iron-stained very fine grained clayey sandstone; lower contact sharp---------- 5.4

Conglomerate, pebble and cobble; light-olive-brown friable poorly sorted medium- to coarse-grained subangular clayey granular silty sandstone matrix; poorly exposed; lower contact sharp---------- 40.

Sandstone, olive-gray, olive-green, and olive-brown, obscurely bedded, friable, poorly sorted, mostly medium- to coarse-grained, subangular, granular, silty, clayey; partly fine- to medium-grained in middle; many coarse grains and granules of dark-gray platy rock fragments; abundant medium-sand-sized clear vitreous crystal fragments of sodic plagioclase -- probably oligoclase---- 18.5

Sandstone, light-olive-gray, obscurely bedded, friable, poorly sorted, coarse-grained (lower part) grading upward to fine- to medium-grained (upper 2 ft.), subangular, granular, silty, very clayey; many very coarse grains and some granules in lower part; includes at 2 ft. above base a 0.3-ft. lense of bluish-green medium- to very coarse grained sandstone with abundant rounded black rock fragments; abundant crystal fragments of plagioclase as above; upper 1 ft. of unit tuffaceous and poor platy bedded; lower contact sharp---- 6.7

Tuff and interlensing sandstone and siltstone; tuff, light-yellowish-gray to light-yellowish-brown, mostly platy-weathering, ash, silty, sandy, some pumice lapilli; sandstone, olive-gray, friable, medium- to coarse-grained, tuffaceous; forms lenses as much as 3.8 ft. thick in lower two-thirds of unit; siltstone, yellowish-gray, light-gray-weathering, probably platy-bedded, tuffaceous; present in minor amount in upper half; unit fairly good cliff former locally; lower contact sharp---------- 13.5

Sandstone, medium-gray, olive-gray, and greenish-gray, mostly hackly-weathering, obscurely bedded, mostly very fine grained and very clayey, partly fine- to medium-grained and friable, subangular, tuffaceous; near middle includes rounded pebbles at base of 0.4-ft. bed of friable medium-grained sandstone; upper 0.4 ft. hard ledge former; abundant carbonaceous plant fragments and coal stringers at 0.2 ft. below top-------- 6.4

Conglomerate, pebble and cobble; medium-greenish-gray friable poorly sorted medium- to coarse-grained subangular clayey silty sandstone matrix; includes at 6 ft. above base 1-ft. bed or lense of medium-gray partly iron-stained friable medium- to coarse-grained clayey silty sandstone; lower contact sharp---------- 17.4

Sandstone, olive-gray to medium-gray, partly light-yellowish-brown, hackly-weathering (upper part), friable (lower half), poorly sorted, medium- to very coarse grained (lower third), mostly fine- to medium-grained (remainder); very clayey in upper part; lower 1.5 ft. includes pebble-cobble conglomerate lenses as much as 0.3 ft. thick; thin beds of sandy siltstone in upper 2.3 ft.; at top 0.1-ft. bed of medium- to dark-gray siltstone (14P-54)* with abundant carbonaceous plant fragments; lower contact sharp---------- 4.5

Conglomerate, pebble and cobble; light-olive-gray friable medium- to coarse-grained subangular granular clayey silty sandstone matrix; lower contact sharp---------- 20.5

Sandstone, light-olive-gray, obscure platy-bedded, mostly very fine grained, partly fine-grained (in upper 1 ft.), very silty, clayey; scattered very coarse sand grains; numerous carbonaceous plant fragments on bedding; pinches out laterally---------- 2.6

*Palynological sample

Conglomerate, pebble and cobble (lower half) to mainly pebble; pale-yellowish-brown partly iron-stained friable poorly sorted fine- to very coarse grained subangular clayey granular very silty sandstone matrix (color principally the result of abundant light-brown interstitial silt and clay); no bedding seen in lower half; upper half includes few 0.5-1.-ft. beds (probably lenticular) of medium- to coarse-grained conglomeratic sandstone; unit interfingers with underlying rocks------- 15.

Siltstone (14P-50 -- lower 3 ft.)*, light-olive-gray to olive-gray, hackly-weathering, obscurely bedded, sandy, very tuffaceous; carbonaceous plant fragments abundant in part; includes at base 0.7-ft. bed of medium-gray very fine to fine-grained silty clayey tuffaceous sandstone; at 1.1 ft. below top a 0.5-ft. bed of brownish-yellow silty tuff; lower contact sharp---------- 10.2

Sandstone, medium-gray, iron-stained, friable, medium- to coarse-grained, clayey, very silty, tuffaceous; numerous very coarse grains---------- 0.5

Tuff, medium-gray, brownish-yellow, and brownish-gray, soft, plastic, very thin bedded, sandy; includes carbonaceous shale stringers and several coal stringers as much as 0.05 ft. thick; lower contact sharp---------- 0.8

Sandstone, medium-light-gray to light-olive-gray, hard, medium-grained grading to very fine grained (upper 1 ft.), subangular, clayey, very silty; scattered granules in lower part; carbonaceous films in upper 1 ft.---------- 1.4

Volcanic ash, light-brownish-yellow, soft---------- 0.4

Sandstone, medium-gray to olive-gray, hackly-weathering (lower 1.3 ft.), obscurely bedded, soft and friable (upper 0.6 ft.), very fine grained, subangular, clayey, very silty; lower contact fairly sharp---------- 3.1

Tuff, light-brown, hackly-weathering, obscurely bedded, soft, sandy, ash; lower contact sharp---------- 0.8

*Palynological sample

Sandstone, olive-gray to greenish-gray, poor platy-weathering and hard (upper half), obscurely bedded, friable (lower half), very fine grained, clayey, very silty; includes at base 0.5-ft. bed of hackly-weathering sandy tuffaceous siltstone; at 0.9 ft. above base a 0.4-ft. bed of iron-stained small-pebble conglomerate with medium-grained sandstone matrix; lower contact sharp----- 3.3

Conglomerate, light-olive-gray to greenish-gray, iron-stained (basal part), pebble and cobble; greenish-gray friable poorly sorted medium- to coarse-grained subangular clayey very silty sandstone matrix with many dark rock fragment granules; locally includes at about 0.2 ft. above base a 0.5-ft. lense of silty sandstone and sandy siltstone; lower contact sharp------- 23.5

Sandstone, olive-gray, obscurely bedded, friable, coarse- to very coarse grained, very silty; includes in upper 8 ft. abundant granules and small pebbles of devitrified tuff and pumice; abundant black rock fragment granules; lower contact sharp---------- 10.

Siltstone, olive-gray, hackly-weathering, very clayey, tuffaceous(?), sandy; many dark-gray sand grains; lower contact sharp---------- 0.6

Sandstone, light-olive-gray to light-olive-brown (greenish color due to moderate-olive interstitial clay and silt), poor platy- to hackly-weathering (lower half), friable (upper half), medium-grained, subangular, clayey, very silty; abundant dark-gray rock fragments; includes 0.1-ft. lense of bluish-gray clay about 4 ft. above base (probably weathered volcanic ash)---------- 6.2

Note: The rocks described above form a generally steep hillside along the east line of NE 1/4 NW 1/4 SE 1/4 sec. 22 and lie above a thick sequence of dominantly brown cliff-forming conglomerate and sandstone. The remainder of the section is in the large gully in the southern half of SW 1/4 NE 1/4 sec. 22.

Siltstone, pale-yellowish-brown, hackly-weathering, obscurely bedded, very sandy, tuffaceous; scattered granules; lower contact sharp; this unit used as a marker bed to connect section described above, where it is 1 ft. thick, with that described below; locally overlain by slumpy Pleistocene strata---------- 1.+

Conglomerate, medium-brown-weathering, obscurely cross-bedded, granule and small-pebble; medium-brown friable clayey sandy matrix with abundant dark-gray rock fragments; grades upward into very coarse grained very silty sandstone in upper 3 ft.; lower contact sharp------ 18.5

Sandstone, medium-brown-weathering, locally cliff- or ledge-forming, partly slabby-weathering, obscurely bedded, poorly indurated, poorly sorted, coarse- to very coarse grained, clayey, very silty to tuffaceous; mostly dark-gray rock fragments; few rounded pebbles, cobbles, and one boulder in lower part; abundant granules about 18 ft. above base; includes 0.3-ft. bed of pebbly sandstone about 2 ft. below top and scattered pebbles above; commonly forms massive rounded steep slopes; lower contact sharp---------- 29.

Sandstone and interbedded siltstone; sandstone, medium-brown, yellowish-brown-weathering, obscurely bedded, medium- to coarse-grained, subangular, very silty, tuffaceous; some granules; includes devitrified pumice fragments; siltstone, medium-brown, yellowish-brown-weathering, medium to coarsely sandy, tuffaceous; some granules; includes devitrified pumice fragments; unit locally includes large carbonaceous wood fragments about 1 ft. below top; unit includes scattered pigeonite(?) crystals; lower contact sharp---------- 5.4

Siltstone (14P-36)*, brownish-gray, hackly-weathering, obscurely bedded, sandy, probably tuffaceous; few small carbonaceous plant fragments; lower contact sharp---------- 0.6

Sandstone, light-brownish-gray, partly laminated to platy-bedded, fairly hard, tight, fine- to medium-grained, silty, tuffaceous; includes small devitrified pumice fragments; lower contact sharp---------- 0.6

*Palynological sample

Conglomerate and interbedded sandstone; conglomerate, brownish-gray, pebble and cobble; brownish-gray poorly sorted medium- to coarse-grained subangular granular very silty tuffaceous sandstone matrix with some encrusting zeolite cement; black iridescent manganese oxide(?) coating on some pebbles and cobbles; few pigeonite(?) crystals; sandstone, brownish-gray, poor slabby-weathering, cross-bedded, poorly sorted, coarse-grained, subangular, pebbly, silty, clayey, tuffaceous; few cobbles; abundant gray rock fragments; few devitrified pumice fragments; forms beds as much as 5 ft. thick (many vary to sandy tuffaceous siltstone); interfingers with conglomerate; poor cliff former---------- 17.5

Conglomerate, as above; cliff former; lower contact sharp---------- 20.

Sandstone, olive-gray, partly platy- to very thin bedded, partly friable, medium- to coarse-grained, sub-rounded to subangular, very silty, clayey, tuffaceous(?); many dark-gray rock fragments in part; includes at 5 ft. above base a 0.2-ft. lenticular bed of medium-dark-gray siltstone; at 6 ft. above base a 0.5-ft. lense of pebble-cobble conglomerate with few hard tuff clasts; lower contact sharp---------- 7.8

Sandstone, yellowish-gray, fine-grained, very silty, clayey, tuffaceous; many devitrified tuff grains mostly of very coarse sand size; lower contact gradational---------- 1.3

Siltstone, yellowish-gray, chunky- to poor platy-weathering, poor platy-bedded, tuffaceous; sandy in upper part; includes many courses, as much as 0.4 ft. thick of devitrified tuff granules and small pebbles; locally poor cliff former; lower contact probably gradational---------- 7.5

Siltstone, olive-gray, obscurely bedded; some small yellowish-gray tuff pebbles in upper 0.2 ft.; few carbonaceous plant fragments; lower contact sharp-------- 2.4

Sandstone, light-gray, mostly obscurely bedded, poor laminated to platy-bedded (lower 1 ft.), hard, very fine grained, very silty, tuffaceous(?); some fine- to medium-grained lenses in basal 0.2 ft.; abundant carbonaceous plant fragments, randomly oriented in part, mostly at 2-3 ft. above base and in upper 0.5 ft.; lower contact sharp---------- 6.4

Sandstone, grayish-orange, obscurely bedded, friable, medium- to coarse-grained, subangular, very silty, tuffaceous; includes at base 1.2-ft. bed of pebble-cobble conglomerate and similar bed 0.7 ft. thick about 1 ft. below top; many granules in upper 0.5 ft.; lower contact sharp---------- 3.5

Siltstone and bentonite; siltstone, medium-light-gray to olive-gray, obscurely bedded, very clayey, bentonitic; few carbonaceous plant fragments; bentonite, light-bluish-gray, silty; unit includes near middle a 0.2-ft. bed of medium-light-gray very fine grained sandstone with scattered tuff clasts and a 0.5-ft. bed of soft very fine grained clayey sandstone at top; lower contact gradational------- 2.2

Sandstone, medium-light-gray to yellowish-brown, iron-stained, obscurely bedded, fine-grained (lower half) to very fine grained, clayey, very silty, tuffaceous; many yellowish-gray devitrified tuff fragments; includes at about 0.5 ft. below top a 0.3-ft. bed of medium-gray siltstone with randomly oriented carbonaceous plant fragments; lower contact sharp---------- 2.3

Conglomerate, manganese oxide(?) stained, pebble and cobble; light-olive-gray to yellowish-gray friable poorly sorted fine- to coarse-grained subangular very silty tuffaceous sandstone matrix with common dark-gray rock fragments; scattered boulders at base; size of cobbles generally decreases upward; includes lenses of brown medium- to coarse-grained sandstone as much as 0.5 ft. thick; unit locally thins to about 6 ft.; lower contact sharp and undulatory---------- 20.5

Tuff and interbedded sandstone and siltstone (mostly not closely examined); blocky- to platy-weathering, cliff-forming, platy- to very thin bedded, partly laminated, closely jointed; carbonaceous films and plant fragments; tuff, yellowish-brown, hard, very fine grained, well indurated, partly granular, partly sandy; devitrified tuff clasts in part; sandstone, very fine to fine-grained, hard, very tuffaceous, clayey; devitrified tuff fragments; siltstone, medium-light-gray to yellowish-gray, hard, very tuffaceous, slightly sandy; basal 0.2-ft. siltstone includes accretionary lapilli; lower contact sharp---------- 10.5

Shale (14P-25)*, olive-gray-weathering, obscurely bedded, very silty, tuffaceous(?); many carbonaceous plant fragments; lower contact fairly sharp---------- 0.6

Sandstone, olive-gray, orange-gray-weathering, poor blocky-weathering, irregular laminated to platy-bedded, mostly hard, coarse-grained (base) grading upward to fine-grained (top), subangular, clayey, very silty, tuffaceous; many coaly stringers and fragments near base and top; includes scattered devitrified tuff fragments as much as 0.1 ft. long in upper part; lower contact sharp---------- 4.7

Conglomerate, obscurely bedded, rounded pebble and cobble; yellowish-gray partly iron-stained mostly friable poorly sorted medium- to coarse-grained sub-angular granular very silty tuffaceous sandstone matrix with abundant dark rock fragments; locally includes near middle lenses, as much as 2 ft. thick, of iron-stained cross-bedded sandstone (beds convex upward); lower contact mostly sharp and fairly even; unit locally interfingers with underlying rocks---------- 20.5

Sandstone, yellowish-gray to light-olive-gray, poor cliff-forming, platy- to very thin bedded, partly cross-bedded, medium- to very coarse grained, mostly conglomeratic, tuffaceous; common devitrified pumice fragments; abundant granules and small pebbles in large part; scattered cobbles about 1 ft. below top; many lenticular beds; includes tuffaceous(?) siltstone beds (similar to below), locally as much as 2 ft. thick, with many devitrified pumice fragments; many thin beds (about 0.2 ft.) of very tuffaceous sandstone; few small carbonaceous plant fragments in lower one-third; lower contact gradational---------- 6.5

*Palynological sample

Bentonite, olive-gray, chunky-weathering, obscurely bedded, finely to coarsely sandy, very silty, very impure; lower contact sharp---------- 2.

Tuff, light-gray, poor ledge-forming, obscurely bedded, hard, well indurated, vitric(?); abundant carbonaceous plant fragments mostly subparallel to bedding; includes at base 0.3-ft. bed of very fine to fine-grained sandstone with abundant plant fragments; lower contact sharp---------- 1.3

Sandstone, light-olive-gray, obscurely bedded, mostly friable, coarse-grained, subangular, very silty; devitrified tuff fragments; includes 0.1-ft. bed of granule to pebble conglomerate at top; lower contact fairly sharp---------- 1.4

Conglomerate, medium-brown, obscurely bedded, pebble; grayish-orange friable poorly sorted medium-grained very silty tuffaceous sandstone matrix; few small cobbles; lower contact sharp---------- 3.

Sandstone, grayish-green, olive-green (upper two-thirds), poor slabby-weathering, obscurely bedded, friable, medium- to coarse-grained, subangular; much grayish-green silty clay matrix; abundant dark-gray rock fragments; several courses of abundant pebbles; lower contact gradational---------- 15.

Sandstone, medium-gray, light-brownish-gray-weathering, poor slabby-weathering, obscurely bedded, mostly friable, poorly sorted, coarse-grained, subangular, very silty, tuffaceous; abundant very coarse grains; scattered granules and pebbles; includes at base 0.3-ft. bed of pebble conglomerate; several courses of abundant pebbles mostly in upper part; lower contact sharp---------- 6.

Sandstone, olive-gray, friable, fine-grained, subangular, partly clayey, very silty, tuffaceous(?); abundant light-yellowish-brown tuff clasts of coarse sand to pebble size; includes near middle a 0.3-ft. lense of grayish-orange ash tuff with scattered clear plagioclase crystals; lower contact sharp---------- 1.9

Sandstone, medium-gray, obscure platy- to thin-bedded, mostly friable, coarse-grained, subangular, very silty, clayey, tuffaceous(?); abundant black rock fragments; medium grained in 2-ft. zone near middle; lower contact fairly sharp---------- 11.

Conglomerate and some interbedded sandstone and siltstone; cliff-forming; conglomerate, brown- to yellowish-brown-weathering, mostly hard, indurated; tabular and subtabular granules and small pebbles of grayish-orange devitrified fibrous tuff in poorly sorted medium-grained very silty clayey tuffaceous sandstone matrix; siltstone, yellowish-brown, mostly hard, indurated, even-textured, sandy, tuffaceous; conglomerate makes up about three-fourths of unit; probably includes petrified logs locally (not seen in place); lower contact fairly sharp---------- 6.

Sandstone, medium-brownish-gray, light-brownish-gray-weathering, obscure platy-bedded, mostly friable, poorly sorted, coarse-grained, subangular, very silty, clayey, tuffaceous(?); abundant dark-gray rock fragments; some very coarse grains of devitrified pumice or ash tuff; lower contact gradational---------- 11.2

Tuff, olive-gray to pale-greenish-gray, obscurely bedded, soft, silty, sandy, clayey; probably includes much intermixed bentonite, especially in lower two-thirds; many very coarse sand-sized clasts of devitrified pumice; large carbonaceous wood fragments at base and about 2 ft. below top; includes 0.3-ft. bed of bentonite (similar to below) about 2 ft. above base; upper 1 ft. becomes very coarsely sandy; lower contact fairly sharp---------- 7.8

Bentonite, grayish-yellow to grayish-orange; includes a cobble of medium-gray pre-Tertiary(?) meta-sandstone; lower contact sharp---------- 0.8

Sandstone, yellowish-gray, obscurely bedded, mostly friable, poorly sorted, coarse-grained (base) grading upward to very fine grained (top), subangular, very silty, clayey, tuffaceous(?); grayish-orange-weathering silt and clay; many pebbles at base; includes granule bed about 0.1 ft. thick near middle; carbonaceous stringers in upper 0.2 ft.; lower contact sharp---------- 4.1

Siltstone, olive-gray, hackly-weathering, obscurely bedded, clayey; iron-stained and few carbonaceous plant fragments in upper 0.4 ft. (14P-9)*; lower contact gradational---------- 5.

*Palynological sample

Sandstone, medium-light-gray, brownish-gray-weathering (lower part), soft and friable (upper part), even-textured, very fine grained, silty; includes at base 0.1-ft. lenticular bed of dark-gray carbonaceous siltstone with coal stringers; lower contact sharp---------- 5.

Sandstone, light-brown-weathering, obscure platy- to thin-bedded, probably cross-bedded, poorly sorted, coarse- to very coarse grained, very silty, tuffaceous; scattered granules; one cobble of olive-gray hackly-fracturing soft Tertiary(?) siltstone near top; interfingers with underlying rocks---------- 7.3

Conglomerate, brown, pebble; abundant cobbles and granules; pale-yellowish-brown-weathering poorly sorted coarse- to very coarse grained subangular very silty sandstone matrix; includes lenses and thin beds of very coarse grained sandstone similar to matrix sandstone; lower contact sharp---------- 5.5

Sandstone, medium-brown, iron-stained, friable, poorly sorted, coarse-grained, subangular, very silty; lower 3 ft. mostly very coarse grained; includes beds of pebble conglomerate at base (0.2 ft.) and at 4 ft. above base (0.5 ft.); latter bed includes one cobble of dark-gray hackly-weathering Tertiary(?) siltstone; unit becomes conglomeratic in upper part with lenses of pebble conglomerate; lower contact sharp---------- 12.3

Sandstone, brown-weathering, iron-stained, partly irregular laminated, even textured, very fine grained, silty; lower contact sharp---------- 2.9

Sandstone, light-olive-gray, laminated to platy-bedded, mostly fine-grained, partly very fine grained, very silty, clayey; some carbonaceous laminae; includes 4 beds of friable sandstone as much as 0.4 ft. thick; lower contact fairly sharp---------- 5.9

Sandstone, medium-brown, obscurely bedded, friable, poorly sorted, coarse-grained, subangular, very silty, clayey, tuffaceous(?); becomes somewhat finer grained toward top; few large carbonaceous wood fragments parallel to bedding; lower contact sharp---------- 3.4

Conglomerate, brown, pebble; abundant cobbles and granules; moderate-yellow-brown-weathering friable poorly sorted coarse-grained subangular very silty clayey tuffaceous sandstone matrix; includes beds and lenses, as much as 0.5 ft. thick, of cross-bedded very coarse grained conglomeratic sandstone; lower half not examined ---------- about 41.

Tuff(?), lenticular, not examined---------- about 0-3.

Lower part of exposed rocks not examined

Measured section 15

Location: Hillside exposures, south of toe of Capps Glacier, from near center of east line SW 1/4 SE 1/4 sec. 10 generally northward and eastward to SE 1/4 SW 1/4 NW 1/4 sec. 11, T. 14 N., R. 14 W., Tyonek B-5 quadrangle. This location includes locality 60 of Barnes (1966, pl. 5, fig. 2).

	Feet
Tertiary rocks -- Kenai Group, Tyonek Formation	
Sandstone, not examined; locally poor cliff-forming; appears similar to underlying unit except conglomerate beds largely confined to about the lower 15 ft.------estimated	45.
Sandstone, medium-light-gray, partly iron-stained, obscurely bedded, probably partly cross-bedded, friable, poorly sorted, mostly medium-grained, subangular to subrounded; common black rock fragments; some coarse-grained with scattered rounded white quartz granules; includes 2-ft. lense of quartz-rich small-pebble conglomerate at base and many similar lenses and beds (average thickness about 0.5 ft.) of conglomerate in remainder; 1.2-ft. bed of friable fine- to medium-grained sandstone at 15.5 ft. above base; lower contact sharp, undulating, and disconformable----------	33.
Sandstone, medium-light-gray, partly heavily iron-stained, obscurely bedded, probably partly cross-bedded, friable, mostly medium-grained, subangular to subrounded; common dark-gray rock fragments; some coarse-grained with scattered granules of dark- to medium-gray microcrystalline siliceous rock and white quartz; upper 3 ft. includes lenses of small-pebble conglomerate as much as 0.3 ft. thick; lower contact sharp----------	18.
Coal, Capps bed (upper bench), mostly platy-weathering, partly blocky, cliff-forming; lower half appears more impure than upper half; includes lenticular partings of deeply weathered medium-gray silty shale as much as 0.4 ft. thick at 2, 2.5, and 4 ft. above base----------	12.

Siltstone, medium-gray, partly iron-stained, hackly-weathering, obscurely bedded; many carbonaceous plant fragments; some leaf impressions in part; includes at 2.3 ft. above base a 1.6-ft. zone consisting mostly of medium-gray partly friable very fine to fine-grained very silty sandstone; at 0.2 ft. below top a 0.2-ft. bed of medium-gray shale with abundant plant fragments; 0.2-ft. bed of dark-brown carbonaceous siltstone (15P-46)* at top----------	4.3
Coal, Capps bed (middle bench), blocky, cliff-forming; not examined in detail but generally appears more pure than upper bench----------	27.6
Siltstone, medium-dark-gray, obscurely bedded, soft, clayey; abundant carbonaceous plant fragments in part; poorly observed----------	8.
Coal and interbedded dark-gray to black carbonaceous shale; deeply weathered; thickest coal (0.5 ft.) in lower part----------	2.
Shale, medium-dark-gray, obscurely bedded, soft, clayey; abundant carbonaceous plant fragments; few very thin coal stringers; includes 0.2-ft. bed of dark-gray to black carbonaceous shale at base----------	1.5
Coal, Capps bed (lower bench), fairly blocky, cliff-forming; includes at 1.5 ft. above base a 0.7-ft. bed of dark-gray very carbonaceous shale and medium-gray shale; at 2.9 ft. above base a 0.5-ft. bed of medium-gray shale; at 5.9 ft. above base 0.4-ft. bed of dark-gray carbonaceous shale and interbedded coal; lower contact sharp----------	7.7
Siltstone (15P-43 -- upper one-third)*, medium-dark-gray, hackly-weathering, obscurely bedded, sandy to clayey; abundant carbonaceous plant fragments; includes 0.8-ft. bed of medium-gray very fine grained very silty sandstone near middle; lower contact sharp----------	1.6
Coal, platy-weathering----------	0.1
Siltstone, medium-gray, partly iron-stained, hackly-weathering, obscurely bedded, clayey to finely sandy; carbonaceous plant fragments; includes in lower-middle part about 0.3-ft. bed of platy-weathering coal and interbedded carbonaceous shale; bed of medium-gray very fine grained sandstone about 1 ft. thick at 0.4 ft. below top-	5.1

*Palynological sample

Sandstone, medium-gray, soft, friable, very fine grained, subangular, silty; carbonaceous stringers and films------	1.
Siltstone, medium-gray, partly iron-stained, hackly-weathering, obscurely bedded; scattered fine angular sand grains in lower 1.5 ft.; abundant carbonaceous plant fragments and leaf impressions in part; includes thin zones of interbedded carbonaceous shale and platy-weathering impure coal at base (0.1 ft. thick), at 1.5 ft. above base (0.4 ft.), and at 4 ft. above base (0.8 ft.); upper 3 ft. includes very fine grained silty sandstone in several beds as much as 0.5 ft. thick; lower contact sharp----------	13.
Sandstone, medium-gray, partly iron-stained, obscurely bedded, partly friable, very fine to fine-grained, subangular, silty, clayey; forms beds about 1.5 ft. thick; includes medium-dark-gray obscurely bedded siltstone in several beds as much as 0.5 ft. thick; carbonaceous plant fragments and leaf impressions in some of the siltstone; 0.1-ft. bed of medium-dark-gray platy-weathering carbonaceous clayey siltstone about 2 ft. below top; lower contact sharp----------	9.1
Siltstone, medium- to medium-dark-gray, iron-stained, hackly-weathering, obscurely bedded, very clayey in part; ironstone nodules as much as 0.1 ft. thick; leaf impressions at top; lower contact sharp----------	4.9
Siltstone, medium-gray, hackly-weathering, obscurely bedded, very clayey in part; scattered fine angular sand grains; abundant carbonaceous plant fragments in part; includes at top 0.1-ft. bed of platy-weathering soft siltstone with abundant plant fragments and leaf impressions; lower contact sharp----------	1.3
Coal, blocky; lower contact sharp----------	1.9
Siltstone, medium- to medium-dark-gray, hackly-weathering, obscurely bedded, soft, sandy to very clayey; abundant plant fragments in part; several coaly lenses as much as 0.1 ft. thick; bed of brownish-gray siltstone (15P-37)* about 0.5 ft. thick at top----------	6.1
Siltstone, medium-gray, hackly-weathering, obscurely bedded, clayey to very sandy; soft, friable, and micaceous (muscovite) in basal 0.3 ft. and upper 1 ft; lower contact sharp----------	6.

*Palynological sample

Sandstone, light-gray, massive-weathering, obscurely bedded, friable, moderately sorted, medium-grained (base) grading upward to fine-grained (about 12 ft. above base), subrounded to subangular; common black rock fragments; generally small amount of matrix; silty in upper 2.3 ft.; includes 0.2-ft. bed of very sandy micaceous (muscovite) siltstone 18 ft. above base; lower contact sharp---------- 19.3

Conglomerate, medium-light-gray, partly iron-stained, obscurely bedded, friable, granule and small-pebble (well rounded); white quartz, black rock fragments, and scattered grayish-orange-pink sandy ash tuff; light-gray friable poorly sorted medium-grained subangular micaceous (muscovite) sandstone matrix with abundant black rock fragments; includes at base a 4-ft. bed of medium-light-gray friable medium-grained conglomeratic sandstone and a similar bed, 5 ft. thick, at 15 ft. above base; lower contact sharp and probably disconformable---------- 31.

Coal, slumpy, partly platy-weathering, blocky; poorly observed; probably rather impure for most part; includes at 0.5 ft. above base a 0.2-ft. bed of brownish-gray platy-weathering clayey carbonaceous siltstone overlain by a 0.7-ft. bed of medium-gray poor platy-weathering siltstone with abundant carbonaceous plant fragments and leaf impressions; at 1.7 ft. below top a 0.2-ft. bed of medium-dark-gray irregular platy-weathering siltstone with abundant coal films and plant fragments; lower contact sharp; thickness decreases to 3.5 ft. about one-fourth mile to north------ 7.4

Note: Palynological sample 15P-32 taken from 0.5-ft. siltstone directly below 7.4-ft. coal described above. Upper part of section described below is from very steep hillside and cliff about one-fourth mile north of preceding section.

Siltstone (15aP-9)*, medium- to medium-dark-gray, hackly-weathering, obscurely bedded, clayey; abundant carbonaceous plant fragments; includes 0.3-ft. bed of platy-weathering impure coal at 0.3 ft. above base------- 2.

Coal---------- 0.2

Sandstone, medium-brownish-gray, obscurely bedded, friable, poorly sorted, fine- to medium-grained, subangular, micaceous, silty, very clayey; lower contact sharp------- 2.3

*Palynological sample

Siltstone, medium- to medium-dark-gray, partly poor hackly-weathering, partly laminated to platy-bedded, mostly very clayey; many carbonaceous plant fragments and partings; includes some platy-weathering carbonaceous siltstone----------	5.8
Siltstone, greenish-gray, hackly-weathering, obscurely bedded, clayey; abundant carbonaceous plant fragments and leaf impressions; includes a few beds of friable very fine grained silty sandstone as much as 1 ft. thick; 1-ft. bed of fine-grained sandstone at top; lower contact fairly sharp----------	14.5
Sandstone, medium-gray, poor slabby-weathering and cliff-forming, partly platy-weathering (upper 7 ft.), obscurely bedded, probably cross-bedded, friable, moderately sorted, medium-grained (lower part) grading upward to fine-grained (5 ft. above base) and very fine grained and silty (upper 7 ft.), subangular; includes many lenses and beds of very fine grained laminated to platy-bedded sandstone; lower contact sharp and disconformable----------	22.
Siltstone, medium-gray, hackly- to poor platy-weathering; upper half partly medium-dark-gray and very carbonaceous; abundant carbonaceous plant fragments and leaf impressions in part; many films and lenses of impure coal as much as 0.2 ft. thick in upper half; includes interbeds of medium-gray poor platy-weathering friable very fine grained very silty sandstone as much as 1 ft. thick; lower contact sharp----------	7.8
Coal, blocky, platy-weathering----------	1.
Siltstone, medium-gray, poor hackly-weathering, obscurely bedded, sandy; abundant carbonaceous plant fragments and leaf impressions in part; forms beds as much as 3.5 ft. thick; includes interbeds of medium-gray friable very fine grained very silty sandstone as much as 1 ft. thick; lower contact fairly sharp----------	12.2

Sandstone, medium-gray to brownish-gray, iron-stained, poor cliff-forming, mostly obscurely bedded, partly platy-bedded and cross-bedded, friable, moderately sorted, medium-grained, subangular, silty; many coarse grains in part; many dark-gray rock fragments; includes a 0.2-ft. lense of medium-gray hackly-weathering siltstone with abundant carbonaceous plant fragments at about 2.5 ft. above base; few lenses of iron-cemented fine- to medium-grained sandstone as much as 0.2 ft. thick about 15 ft. above base; lower contact sharp disconformable channel base that locally extends downward into covered interval---------- 23.5

Sandstone, medium-gray, partly iron-stained, mostly poor hackly-weathering, laminated, partly friable, very fine grained, silty, partly very silty and clayey with many carbonaceous partings; locally cut out by overlying unit---------- 3.

Covered interval---------- 8.

Siltstone, inaccessable----------estimated 5.

Coal, inaccessable, blocky; probably includes a parting about 0.3 ft. thick about 0.5 ft. above base-----estimated 3.

Siltstone, inaccessable (described from below, using binoculars), mostly medium-gray, hackly-weathering; includes about 25 percent platy-weathering carbonaceous siltstone, shale, and coal lenses (about 0.2 ft. thick) in zones about 1 ft. thick----------estimated 10.

Sandstone, inaccessable, massive, cliff-forming; appears homogeneous; lower contact locally disconformable channel base that extends downward into underlying cliff-forming sandstone----------estimated 25-30.

Siltstone or very fine grained sandstone, inaccessable; forms slight reentrant in cliff face; locally cut out by overlying unit----------estimated 2.

Sandstone, mostly inaccessable (lower 8 ft. sampled), medium-light-gray, cliff-forming, slabby-weathering, platy- to thin-bedded, cross-bedded, friable in part, very fine to medium-grained, subangular, very silty; scattered grains of light-gray tuff(?); includes thin beds (about 0.5-1 ft.) of siltstone or very fine grained sandstone; concretionary sandstone bodies about 2 ft. thick locally in lower and upper parts; some large carbonaceous or coalified wood fragments; lower contact sharp and probably disconformable--about 33-35.

Sandstone, medium-gray, poor platy-weathering, poor irregular platy-bedded, very fine grained, clayey, very silty; abundant leaf impressions; large coalified wood fragments as much as 0.05 ft. thick in lower part; includes near middle about 0.5-ft. bed of medium-dark-gray platy-bedded very clayey siltstone with abundant leaf impressions; lower contact sharp---------- 2.5

Shale, dark-gray to black, very carbonaceous, very clayey; many coal stringers; lower contact fairly sharp---------- 0.2

Siltstone, medium-gray, obscurely bedded; some randomly oriented carbonaceous plant fragments; lower contact fairly sharp---------- 1.

Shale, medium- to medium-dark-gray, obscurely bedded, very clayey; abundant carbonaceous plant fragments---------- 0.7

Coal, probably blocky (dug out); lower contact sharp---------- 2.1

Shale (15P-28)*, brownish-gray, obscurely bedded, silty; abundant carbonaceous plant fragments---------- 0.9

Covered interval---------- 4.2

Sandstone, medium-gray, deeply iron-stained (about 1.5 ft. below top), mostly slabby-weathering, mostly laminated to platy-bedded, partly friable, very fine grained, very silty, mostly clayey; includes 3 beds of medium-dark-gray clayey siltstone 0.3-0.6 ft. thick; lower contact sharp---------- 5.

*Palynological sample

Siltstone and interbedded sandstone; medium-dark-gray to greenish-gray, hackly- to poor slabby-weathering, obscurely bedded, clayey; siltstone, some carbonaceous plant fragments, clayey, sandy in part; forms beds about 2-3 ft. thick; sandstone, very fine grained, very silty, clayey; forms beds about 1.5-3 ft. thick; unit probably includes ironstone-nodule zone about 8 ft. above base; includes at top 0.5-ft. bed of medium-dark-gray fissile-bedded carbonaceous clayey shale with abundant plant fragments; lower contact fairly sharp---------- 10.2

Sandstone, medium-light-gray, partly laminated to platy-bedded, very fine grained, very silty, clayey; includes some siltstone similar to above; top marked by 0.3-ft. bed of medium-dark-gray fissile-bedded shale with abundant carbonaceous plant fragments and coal films---------- 4.5

Siltstone, medium-gray, slightly iron-stained in part, hackly-weathering, obscurely bedded, mostly very clayey; abundant carbonaceous plant fragments in part; many leaf impressions at about 2 ft. above base; lower contact fairly sharp---------- 6.

Shale, dark-gray to black, very carbonaceous, clayey; varies to bone coal; abundant thin coal stringers-------- 0.6

Shale, dark-brownish-gray, iron-stained in part, blocky-weathering; abundant coal stringers; lower contact sharp---------- 0.6

Sandstone and interbedded siltstone; obscurely bedded; sandstone, medium-gray, partly hackly-weathering (upper 4 ft.), mostly friable, fine-grained, partly medium-grained (in lower 3-ft. bed), subangular, very silty; some very fine grained clayey sandstone; concretionary bodies as much as 1 ft. thick in lower 3 ft.; forms beds generally about 1 ft. thick; siltstone, medium-gray, hackly-weathering, sandy; abundant carbonaceous plant fragments in part; forms beds about 1-2 ft. thick; lower contact sharp---------- 15.6

Siltstone, medium- to medium-dark-gray, clayey, finely sandy; abundant carbonaceous plant fragments and leaf impressions in part---------- 0.8

Siltstone and interbedded sandstone; light-olive-gray, medium-brown, hackly-weathering, obscurely bedded; siltstone, mostly sandy; few carbonaceous plant fragments; forms beds about 1-1.5 ft. thick; sandstone, very fine grained, subangular, silty, clayey; forms beds commonly about 1 ft. thick; unit includes at 2.7 ft. above base a 1-ft. bed of medium-brown sandy shale; 2 beds about 0.5 ft. thick of deeply iron-stained hard ledge-forming sandstone in upper half; lower contact sharp---------- 6.6

Shale (15P-22)*, medium-dark-gray, hackly-weathering, obscurely bedded, clayey to finely sandy; abundant carbonaceous plant fragments; leaf impressions in part; includes at base and top beds of platy-weathering impure coal 0.1-0.2 ft. thick; near middle an 0.8-ft. bed of medium-dark-gray siltstone with a 0.1-ft. bed of brownish-gray friable fine- to medium-grained sandstone in the middle; lower contact sharp---------- 2.2

Sandstone, medium- to medium-light-gray, partly iron-stained, slabby-weathering (upper half), mostly cross-bedded (in lower half) and laminated to platy-bedded, friable, moderately sorted, mostly medium-grained (lower half) to fine-grained, subangular, very silty (upper half), clayey; some lenses of coarse-grained sandstone with abundant granules and small pebbles; includes near middle concretionary lenses of hard iron-cemented sandstone; scattered concretionary sandstone bodies about 1 ft. thick in upper half; locally many large coalified plant fragments about 4-8 ft. above base; scattered coal lenses as much as 0.3 ft. thick in upper 2 ft.; abundant carbonaceous plant fragments in very clayey upper 1 ft.; lower contact sharp and probably disconformable---------- 24.

Carbonaceous shale and interbedded coal; includes at top 0.1-ft. lense of brownish-gray siltstone; lower contact sharp---------- 0.4

Siltstone, medium-dark-gray, hackly-weathering, obscurely bedded, very clayey; abundant carbonaceous plant fragments; lower contact fairly sharp---------- 0.8

Shale, dark-gray, poor fissile-bedded, carbonaceous, clayey; abundant plant fragments and bony coal partings---------- 0.6

*Palynological sample

1	Coal, platy-weathering; includes 0.1-ft. parting of fissile carbonaceous shale about 1 ft. above base--------	1.4
2	Covered interval; laterally consists of interbedded coal and siltstone or shale----------	7.2
3	Coal, bright, blocky; lower contact sharp----------	0.2
4	Sandstone, medium-gray, partly iron-stained, partly friable, very fine grained, subangular, mostly very silty, clayey----------	3.
5	Siltstone, medium- to medium-dark-gray, hackly-weathering (upper half), poor irregular platy-bedded (lower half), sandy and carbonaceous (lower half), clayey in part; abundant carbonaceous plant fragments; thin bone-coal partings; lower contact fairly sharp----------	2.
6	Sandstone, medium-gray, poor slabby-weathering, obscurely bedded, partly friable, very fine grained, subangular, silty, clayey; includes in lower-middle part a 0.2-ft. bed of medium-dark-gray sandy carbonaceous siltstone with abundant plant fragments; at top a 0.2-ft. bed of light-grayish-brown hackly-weathering siltstone-------	4.
7	Siltstone, medium-dark-gray, poor irregular platy-bedded, clayey, carbonaceous; abundant plant fragments and leaf impressions in lower part; thin bone-coal partings; lower contact fairly sharp----------	1.
8	Sandstone, medium-gray, probably poor slabby-weathering, obscurely bedded, friable, very fine grained, subangular, very silty, clayey; includes at base 0.8-ft. bed of medium-dark-gray irregular platy-bedded partly sandy carbonaceous siltstone (15P-16 -- upper 0.5 ft.)* with abundant plant fragments in lower part; upper 0.2 ft. of unit grades to hackly-weathering siltstone; lower contact fairly sharp---------	3.7
9	Sandstone, medium-gray, obscurely bedded, friable, very fine to fine-grained, silty, clayey; includes in middle 0.8-ft. bed of medium-dark-gray very fine grained silty clayey carbonaceous sandstone with abundant leaf impressions; lower contact sharp----------	2.4

*Palynological sample

Siltstone, medium- to medium-dark-gray, mostly obscurely bedded, mostly very sandy; many carbonaceous plant fragments and leaf impressions in lower 3 ft. and upper 1 ft.; few iron-rich lenses as much as 0.3 ft. thick at 3-4.5 ft. above base; includes beds of medium-gray mostly friable very fine to fine-grained very silty sandstone 1.5 and 2.5 ft. thick at 4.5 and 10.5 ft. above base, respectively; ironstone nodules as much as 0.3 ft. thick at 8.3 ft. above base; lower contact sharp---------- 14.4

Siltstone, medium- to medium-dark-gray, hackly- to poor platy-weathering, partly laminated, clayey; abundant carbonaceous plant fragments and leaf impressions in lower 2.5 ft.; scattered ironstone nodules 0.2 ft. thick at 1.2 ft. above base; includes at 3.2 ft. above base a 1.3-ft. zone of interbedded friable medium- to coarse-grained sandstone (with abundant very coarse grains of white quartz and granitic rock fragments) and medium- to dark-gray carbonaceous sandy siltstone; upper 2 ft. interbedded with medium-light-gray very fine grained quartz-rich sandstone; lower contact gradational---------- 9.3

Sandstone, medium-gray, partly iron-stained, hackly- to poor slabby-weathering, mostly friable, obscure platy- to very thin bedded, partly laminated, very fine grained, subangular, very silty, clayey; includes at base 0.4-ft. bed of medium-gray siltstone with abundant carbonaceous plant fragments; a coalified tree trunk, 6 ft. long and in growth position, extends from the underlying coal through this sandstone unit into the overlying unit---------- 4.6

Coal, mostly bright and blocky; many fragments of amber in basal 0.1 ft.---------- 0.7

Shale, brownish-gray, obscurely bedded, mostly clayey; scattered sand grains (quartz, feldspar, and very light gray ash tuff); many carbonaceous plant fragments; lower contact gradational---------- 0.7

Siltstone, olive-gray, obscurely bedded, finely to medium sandy; scattered grains of very light gray ash tuff; some large randomly oriented coalified wood fragments; upper 0.6 ft. becomes olive-gray fine- to coarse-grained silty very clayey sandstone; lower contact sharp---------- 1.6

Sandstone, medium-light-gray, friable, poorly sorted, fine- to medium-grained, subangular, very silty, clayey; includes 3 carbonaceous siltstone stringers; lower contact sharp----------	1.3
Siltstone, mostly olive-gray, brownish-gray (lower 0.5 ft.), medium-dark-gray (upper 0.5 ft.), hackly-weathering, obscurely bedded, mostly clayey; carbonaceous plant fragments scattered in lower half and abundant in upper half; unit absent laterally (probably cut out by channeling)----------	3.5
Coal, mostly blocky, bright; locally overlain by sandstone----------	1.7
Shale, medium-gray to brownish-gray, obscurely bedded, clayey, partly sandy; abundant carbonaceous plant fragments----------	0.5
Coal; lower contact sharp----------	0.1-0.3
Sandstone, medium-gray to light-olive-gray, slabby-weathering, obscurely bedded, partly friable, poorly sorted, medium- to coarse-grained (basal 0.1-0.5 ft.) becoming finer grained upward, very silty, clayey; scattered grains of light-gray ash tuff; many carbonaceous plant fragments; some large coalified wood fragments----------	1.8
Shale, dark-gray to black, carbonaceous, very silty, partly sandy; many plant fragments; upper 0.1 ft. includes irregular lenses and pods of brownish-gray sandy siltstone with abundant light-gray ash tuff grains----------	0.8
Coal, mostly bright and blocky; includes few bone-coal or black carbonaceous shale partings less than 0.1 ft. thick; lower contact sharp----------	1.5
Sandstone, light-olive-gray, slabby-weathering, obscurely bedded, mostly fine- to medium-grained, very silty, very clayey; many carbonaceous laminations in lower 0.3 ft.; many carbonaceous plant fragments; some coalified wood fragments; lower part includes some friable coarse-grained sandstone lenses as much as 0.6 ft. thick; abundant grains of light-gray tuff in upper 0.2 ft.----------	1.3

Shale, dark-gray, fissile, clayey, carbonaceous; interbedded medium-gray shale; includes coal stringers; 0.1-ft. bed of bone coal at top; lower contact sharp---------- 0.6

Siltstone, medium-gray to light-olive-gray, partly iron-stained, hackly-weathering, obscurely bedded, very sandy; some carbonaceous plant fragments and randomly oriented coalified wood fragments; abundant plant fragments in 0.2-ft. brownish-gray bed at base; scattered grains of amber near middle; abundant tuffaceous grains in upper 0.3 ft.; lower contact sharp---------- 2.1

Bone coal interbedded with dark-gray to black clayey carbonaceous shale; lower contact fairly sharp---------- 1.2

Sandstone, medium-gray, light-olive-gray, and brownish-gray (upper 0.5 ft.), obscurely bedded, friable (lower 2 ft.), poorly sorted, fine- to coarse-grained, subangular, very silty; very clayey in upper 1 ft. and decreasingly clayey downward; abundant light-gray tuffaceous grains; abundant randomly oriented carbonaceous plant fragments in upper 1 ft.; lower contact sharp---------- 3.1

Siltstone, medium-gray, partly olive-gray tinted, obscurely bedded, partly sandy; some randomly oriented carbonaceous plant fragments; brownish-gray to medium-dark-gray with abundant plant fragments in upper 0.2 ft.; lower contact gradational---------- 2.

Sandstone, light-olive-gray, slabby-weathering, mostly obscurely bedded, partly laminated to platy-bedded (in lower half), partly friable, poorly sorted, very fine to fine-grained, subangular, very silty, clayey; some carbonaceous plant fragments mostly randomly oriented; few large coalified wood fragments; lower contact fairly sharp---------- 3.1

Sandstone, probably lenticular, light-olive-gray, obscurely bedded, friable, poorly sorted, mostly medium-grained, lower part medium- to coarse-grained, subangular, silty, clayey; many large randomly oriented coalified wood fragments in lower 1 ft.; includes at 1 ft. above base 0.3-ft. lense of medium-dark-gray very fine grained clayey sandstone; at 1.4 ft. below top a 0.2-ft. bed or lense of very fine to fine-grained sandstone with abundant carbonaceous films and laminations; lower contact sharp---------- 4.3

Coal, fairly bright, blocky---------- 1.3

Siltstone (15P-2)*, brownish-gray, hackly-weathering, obscurely bedded, sandy; abundant carbonaceous plant fragments; many large randomly oriented coalified wood fragments; includes 0.15-ft. lense of light-olive-gray friable medium- to coarse-grained sandstone (many tuffaceous fragments) at 0.3 ft. above base---------- 1.1

Coal, fairly bright, blocky---------- 0.7

Shale (15P-2)*, brownish-gray to dark-gray, hackly-weathering; abundant carbonaceous plant fragments; includes coal stringers and coaly shale---------- 1.1

Coal, similar to above; includes at 0.4 ft. above base a 0.1-ft. bed of shale (15P-2)* similar to above; lower contact sharp---------- 1.2

Siltstone, medium-gray to olive-gray, hackly-weathering, mostly obscurely bedded, some platy-bedded (about 5 ft. above base), mostly clayey, lower 4 ft. mostly sandy; carbonaceous plant fragments scattered in lower half and generally abundant in upper half; few large randomly oriented coalified wood fragments in upper 3 ft.; includes at 2 ft. above base 0.5-ft. bed of hard limy siltstone; 1.5-ft. bed of medium-gray very fine to fine-grained silty clayey sandstone 0.2 ft. below top; at top 0.2-ft. bed of brownish-gray to dark-gray sandy siltstone with abundant pyroclastic(?) grains; lower contact concealed---------- 10.

Covered interval to creek level---------- 15.

*Palynological sample

Measured section 16

Location: Hillside exposure about 200-300 yd. south of confluence of Chuit Creek and Chuitna River in SE corner SW 1/4 sec. 1, T. 12 N., R. 13 W., Tyonek A-5 quadrangle. This location is the same as locality 152 of Barnes (1966, pl. 5).

	Feet
Tertiary rocks -- Kenai Group, Tyonek Formation	
Possible coal bed; suggested by scattered fragments of coal about 0.5 ft. long----------thickness unknown	
Covered interval----------estimated	50.
Sandstone, medium-gray, iron-stained, locally cliff-forming, platy- to very thin bedded, cross-bedded, friable, moderately sorted, fine- to medium-grained; subrounded to subangular; some coalified wood fragments; abundant black rock fragments; includes at base 0.3-ft. bed of pebble-granule conglomerate with coarse to very coarse sand matrix; few lenses of granule- and small-pebble conglomerate about 0.3 ft. thick; 1-ft. lense of granules about 10 ft. above base; 1-ft. lense of medium-gray siltstone at 38 ft. above base; lower contact sharp and probably disconformable----------	48.
Coal; mostly impure in upper 1.5-2 ft.; lower contact sharp----------	5.
Siltstone (16P-17 -- upper 1 ft.)*, medium-gray, poor platy- (lower part) to hackly-weathering, obscurely bedded, sandy, increasingly clayey upward; some carbonaceous plant fragments; includes in lower 2 ft. few beds of friable very fine grained silty micaceous sandstone as much as 0.5 ft. thick; 0.3-ft. bed of dark-gray sandy carbonaceous siltstone at top; lower contact sharp----------	9.3
Sandstone and interbedded siltstone, medium-gray, beds about 1 ft. thick; sandstone, poor platy-weathering, very fine grained, subangular, very silty, partly clayey, micaceous, partly carbonaceous; siltstone, very sandy, partly clayey, few carbonaceous laminations; few carbonaceous plant fragments in unit; lower contact sharp----------	10.8

*Palynological sample

Sandstone, medium-gray, slightly iron-stained (lower half), very friable (upper half), moderately sorted, fine-grained, subangular to subrounded, micaceous; scattered black rock fragments; many hard clasts of sandstone in 0.3-ft. zone near middle; lower contact sharp---------- 6.7

Sandstone, medium- to medium-dark-gray, partly iron-stained, platy-weathering, laminated to platy-bedded, moderately sorted, very fine grained, subangular, micaceous; abundant carbonaceous laminations---------- 2.8

Sandstone, medium-gray, iron-stained (lower half), cliff-forming, laminated to platy-bedded, cross-bedded (sets as much as 4 ft. thick), friable, moderately sorted, medium-grained, subangular; scattered black rock fragments; few carbonaceous wood fragments; 1 piece of partly decomposed wood (0.1 ft. diameter and more than 1 ft. long) near middle; few pebbles at base; includes few pebble-granule conglomeratic lenses as much as 0.3 ft. thick; lense of medium-gray partly hard siltstone as much as 2.5 ft. thick at 5 ft. above base; few cobble- and boulder-size rounded siltstone clasts (commonly iron-rich centers) in lower half of unit; lower contact sharp and disconformable---------- 75.

Siltstone, medium-dark-gray, iron-stained, hackly-weathering, mostly obscurely bedded, partly clayey; abundant leaf impressions in part; lower contact sharp---------- 3.

Shale and interbedded coal, platy-weathering; shale, dark-gray to black, poor fissile to platy-bedded, mostly clayey, carbonaceous; coal, very impure; composed mostly of large coalified wood fragments; lower contact sharp---------- 6.9

Siltstone, medium-dark-gray to dark-greenish-gray, partly iron-stained, hackly-weathering, obscurely bedded, sandy and micaceous (lower part), mostly clayey; upper 2 ft. grades into claystone (16P-11)* that contains some carbonaceous plant fragments; includes at top 0.2-ft. bed of plastic (wet) sandy claystone; lower contact sharp---------- 8.5

*Palynological sample

Sandstone, medium-gray, partly iron-stained, mostly poor slabby-weathering, obscurely bedded; consists of friable very fine to fine-grained subangular silty sandstone (about 75 percent) in beds about 1 ft. thick interbedded with poor platy-weathering very fine grained subangular very silty sandstone in beds about 0.3 ft. thick; lower contact fairly sharp---------- 13.5

Sandstone, medium-gray, partly iron-stained, locally poor cliff-forming, partly platy- to very thin bedded, cross-bedded (more prominent in upper half), locally disrupted bedding (upper half), friable, moderately sorted, mostly fine- to medium-grained, subangular, upper 8 ft. fine-grained; abundant black rock fragments; includes at base 0.3-ft. bed of granule- and small-pebble conglomerate (1 cobble of granitic rock 0.5 ft. long); similar beds and lenses of conglomerate mostly in lower half; some concretionary (limy?) sandstone bodies (about 2 ft. thick and 6 ft. long) in lower half; few lenticular iron-cemented sandstone lenses as much as 0.2 ft. thick; scattered coalified wood fragments; lower contact sharp and locally channelled---------- 63.

Sandstone, similar to above, much iron-stained; cross-bed sets about 3 ft. thick; coarse- to very coarse grained in lower 1 ft.; many granules and small pebbles in basal 0.2 ft.; includes 0.3-ft. lenses of pebble conglomerate mostly in lower two-thirds; concretionary sandstone bodies (less than 1 ft. thick and about 2 ft. long) near middle; lower contact sharp and probably disconformable---------- 30.

Siltstone, medium-dark-gray, slightly iron-stained, hackly-weathering, obscurely bedded, mostly very finely sandy; includes 3.5-ft. bed of medium-gray soft very fine grained very silty sandstone at 9.5 ft. above base; upper 8 ft. dominantly sandstone as below with interbeds of siltstone about 0.5 ft. thick; unit poorly exposed (dug out)---------- 23.

Covered interval---------- 10.

Clinker, slumpy, reddish-brown; leaf impressions common in part---------- 22.2

Coal ash, yellowish-orange, reddish-orange, reddish-brown, light-yellowish-gray, flaky-weathering; may include burned shale partings	5.8
Coal, lower part of Chuitna bed, fairly blocky; mostly dull luster	2.8
Shale (16P-5)*, medium-dark-gray, hackly-weathering, silty, partly clayey; abundant randomly oriented carbonaceous plant fragments; upper 0.2 ft. dark-gray, clayey, and very carbonaceous	1.
Sandstone, light-gray to light-olive-gray, mostly obscurely bedded, partly cross-bedded (in lower 1.5 ft.), very fine grained, very silty, micaceous; abundant randomly oriented carbonaceous plant fragments; includes at top 1-ft. bed of hackly-weathering siltstone; lower contact sharp	4.7
Sandstone, medium-gray, obscurely bedded, friable, moderately sorted, fine-grained, subangular, silty, micaceous; scattered black rock fragments; scattered medium and coarse grains in lower two-thirds and very fine grained in upper 0.5 ft.; large coalified wood fragments about 0.3 ft. above base and in upper 3.7 ft.; includes at 4.5 ft. above base about 0.1-ft. bed of interlaminated very impure coal and very fine grained silty micaceous sandstone; very thin coal stringers in upper 3.7 ft.	8.7
Sandstone, medium-gray to light-olive-gray, mostly obscurely bedded, partly laminated to platy-bedded (near top), friable, very fine grained, subangular, silty; includes at base 0.5-ft. bed of medium-dark-gray sandy siltstone; at about 3.5 ft. above base a 3-ft. bed of medium-dark-gray obscurely bedded clayey siltstone	8.8
Sandstone, medium-gray to light-olive-gray, moderately sorted, very fine grained, subangular, micaceous, very clayey (lower 5 ft.); includes at top 0.3-ft. bed of dark-gray clayey carbonaceous siltstone	7.3
Siltstone, medium-dark-gray, obscurely bedded; many carbonaceous plant fragments; abundant large coalified wood fragments in upper 0.2 ft.; lower contact fairly sharp	1.3

*Palynological sample

	Siltstone, medium-dark-gray, clayey, carbonaceous; many large coalified wood fragments; some very thin coal stringers; includes few beds, less than 0.1 ft. thick, of medium-gray siltstone; lower contact sharp----------	1.
	Siltstone (16P-1 -- near middle)* and interbedded coal stringers and lenses; platy-weathering; siltstone, partly dark-gray and carbonaceous; partly medium-gray with abundant carbonaceous plant fragments; leaf impressions in part; many flattened coalified logs----------	3.6
	Coal; probably includes thin shale partings; poorly observed; under water (Chuitna River)----------estimated	2.+

*Palynological sample

Measured section 17

Location: Hillside and gully exposures on south side of Chuitna River in SE corner NE 1/4 NE 1/4 and in E 1/2 SE 1/4 NE 1/4 sec. 34, T. 13 N., R. 13 W., Tyonek A-5 quadrangle. This location is approximately the same as localities 123-126 of Barnes (1966, pl. 5).

	Feet
Tertiary rocks -- Kenai Group, Tyonek Formation	
Coal, Chuitna(?) bed, blocky, locally cliff-forming, locally burned; middle part includes 2 lenticular beds of brown clayey siltstone (scattered pyroclastic grains) each 0.1 ft. thick and about 1 ft. apart vertically; top weathered and covered by soil----------	20.+
Siltstone (17P-17-upper 0.2 ft.)*, medium-gray, brownish-gray (upper 0.3 ft.), hackly-weathering, obscurely bedded, soft, clayey, slightly micaceous; carbonaceous plant fragments generally scattered but abundant at top; includes at 2 ft. below top a 0.5-ft. bed of medium-gray friable very fine grained sandstone----------	5.
Sandstone, medium-gray, friable, very fine grained, subangular to subrounded, clayey, micaceous; lower contact fairly sharp----------	2.
Siltstone, medium-gray, iron-stained (lower half), hackly-weathering, obscurely bedded, soft (upper half), clayey; finely sandy in lower half----------	3.
Sandstone, medium-gray, partly iron-stained, locally cliff-forming, mostly obscurely bedded, some platy-bedded and cross-bedded, friable, mostly medium-grained grading upward to fine-grained (upper 3 ft.), subangular to subrounded; scattered coal fragments; includes in lower 17 ft. lenses and beds of granule- and small-pebble conglomerate as much as 1 ft. thick; lower contact sharp----------	26.5

*Palynological sample

Sandstone, medium-gray, deeply iron-stained (lower 4 ft.), obscure platy-bedded, cross-bedded, friable, mostly medium-grained, partly coarse-grained (in lower 4 ft.), subangular to subrounded; granules numerous in lower 4 ft. and generally abundant in upper 22 ft.; scattered small pebbles; upper 12 ft. includes several lenses, as much as 0.5 ft. thick, of pebble conglomerate with scattered rounded cobbles---------- 37.

Covered interval, probably sandstone---------- 15.5

Sandstone, medium-gray, partly iron-stained, chunky-weathering, very fine grained, subangular to subrounded, silty, clayey, micaceous; lower half includes several beds, as much as 0.2 ft. thick, of medium-gray iron-stained hackly- to chunky-weathering clayey siltstone; few beds, about 0.1 ft. thick, of friable very fine grained sandstone in middle and near top---------- 11.

Covered interval, probably siltstone and sandstone---------- 32.5

Coal, Lower Chuitna(?) bed, locally cliff-forming, partly platy-weathering, fairly blocky; includes several partings, about 0.4 ft. thick, of interbedded carbonaceous shale and coal; upper 1.5 ft. mostly deeply weathered carbonaceous shale (poorly observed); top slumpy---------- 21.4

Shale, medium-dark-gray to grayish-brown, carbonaceous, micaceous; interbedded coal; lower contact sharp--------- 1.5

Siltstone (17P-11-upper 1 ft.)*, medium- to medium-dark-gray, partly iron-stained, obscurely bedded, soft, clayey; micaceous in lower 2.3 ft.; upper 0.2 ft. poor platy-bedded and carbonaceous; lower contact fairly sharp---------- 2.5

Sandstone, medium-gray, obscurely bedded, friable, very fine grained, subangular to subrounded, clayey, micaceous; lower contact fairly sharp---------- 2.1

Siltstone, medium-gray, partly slightly iron-stained, poor hackly-weathering, obscurely bedded, soft, clayey, micaceous; lower contact gradational---------- 2.3

Sandstone, medium-gray, poor platy-weathering, obscurely bedded, slightly friable, very fine grained, angular to subangular, micaceous, slightly clayey---------- 1.2

*Palynological sample

Covered interval, probably sandstone---------- 5.

Sandstone, medium-light-gray, friable, fine- to medium-grained, partly very fine grained (several beds 0.5-1 ft. thick), subangular to subrounded, micaceous; few thin conglomeratic lenses and beds; includes large woody plant fragments; lower 6-8 ft. deeply weathered and slumpy---------- 34.

Sandstone, medium-light-gray, slightly iron-stained, partly cross-bedded (in upper half), friable, mostly medium-grained, partly fine-grained, subrounded to subangular; includes at about 10 ft. above base a 0.4-ft. bed of granule- and small-pebble conglomerate; several lenses or courses of pebbles mostly in upper half; many granules and small pebbles in upper 2 ft.; lower contact sharp and probably disconformable---------- 21.

Coal and interbedded shale; shale, dark-gray to black and brownish-gray, soft, carbonaceous; includes at 1.6 ft. above base a 1.2-ft. bed of shale with abundant coal stringers---------- 10.5

Siltstone (17P-6 -- upper 1 ft.)*, medium-gray, hackly-weathering, obscurely bedded, soft, clayey, sandy in basal part; becomes more clayey upward and upper half grades into shale; carbonaceous plant fragments common in upper 1 ft.; includes ironstone nodules as much as 0.5 ft. thick and 2 ft. long at 0.6 ft. below top; lower contact gradational---------- 4.

Sandstone, medium-gray, partly iron-stained, possibly laminated to platy-bedded, very fine grained, subangular, clayey; abundant carbonaceous plant fragments in basal 0.2 ft.; includes 0.7-ft. bed of friable fine- to medium-grained subangular to subrounded sandstone at 0.2 ft. above base---------- 3.1

Covered interval---------- 9.5

Siltstone, medium-gray, obscurely bedded, very clayey; scattered carbonaceous plant fragments---------- 1.8

Siltstone, dark-gray, fissile to platy-bedded, very clayey; abundant carbonaceous plant fragments and coal films; some large coalified plant fragments---------- 1.2

Covered interval---------- 14.

*Palynological sample

Siltstone, medium-gray, partly iron-stained, hackly-weathering, obscurely bedded, soft, very clayey; partly sandy in upper 4 ft.; abundant carbonaceous plant fragments about 1 ft. above base; includes ironstone nodules, 0.1-0.2 ft. thick, at 4.5 ft. above base and 1 ft. below top---------- 12.5

Covered interval---------- 25.

Sandstone, medium-gray, partly iron-stained, obscurely bedded, very fine grained, subangular to subrounded, mostly clayey; some friable very fine to fine-grained sandstone in lower 2 ft.; upper half includes few beds, about 0.5 ft. thick, of medium-gray obscurely bedded soft clayey siltstone; lower contact sharp---------- 6.

Shale, medium- to medium-dark-gray, obscurely bedded, silty; includes at top 0.2-ft. bed of dark-gray to black coaly shale (17P-2)*---------- 0.7

Sandstone and interbedded siltstone; sandstone, medium-gray, partly iron-stained, obscurely bedded, mostly friable, very fine to fine-grained, subangular to subrounded, silty, partly very clayey; forms beds commonly about 1-2 ft. thick (one 3.5-ft. bed 2.5 ft. below top) and makes up about three-fourths of unit; siltstone, medium-gray, partly iron-stained, obscurely bedded, clayey; generally abundant carbonaceous plant fragments; includes scattered ironstones 0.1-0.2 ft. thick; forms beds commonly less than 1 ft. thick; lower contact sharp---------- 18.3

Sandstone, medium-gray, ledge-forming, locally concretionary (bodies as much as 10 ft. long), hard, fine-grained, angular to subangular, limy; few coalified plant fragments; includes at base 0.1-ft. bed of medium-dark-gray hard limy siltstone; lower contact fairly sharp---------- 1.8

Sandstone, medium-gray, iron-stained, obscurely bedded, mostly friable, mostly fine-grained, partly medium-grained (in lower 3 ft.), subrounded to subangular; includes in lower 14.7 ft. few beds, about 0.5 ft. thick, of medium-gray partly iron-stained laminated to platy-bedded soft sandy clayey siltstone with scattered carbonaceous plant fragments; upper 4.3 ft. dominantly siltstone similar to below with several thin beds of very fine grained clayey sandstone---------- 19.

*Palynological sample

Covered interval; measured mostly across floodplain of river; may be thicker than indicated----------	23.
Coal; under water (Chuitna River); equivalent to upper(?) part of coal bed (more than 20 ft. thick) at locality 126 of Barnes (1966, pls. 5, 7)----------	2.+