Changes in Stratigraphic Nomenclature by the U.S. Geological Survey 1967

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CONTRIBUTIONS TO STRATIGRAPHY

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NEW FORMATIONS ON KODIAK AND ADJACENT ISLANDS, ALASKA

By George W. Moore

Formal stratigraphic names have not previously been applied to rocks on Kodiak Island (fig. 2). The island is about 100 km (kilometers) wide and 160 km long and lies south of the center of the Alaskan subcontinent, about 50 km from the mainland. The formations newly named below were studied during the summers of 1962, 1963, and 1965.

UYAK FORMATION

The Uyak Formation is here named for the village of Uyak, which is on the northwest coast of Kodiak Island on the west shore of Uyak Bay (fig. 2). The formation crops out as a belt about 10 km wide along the northwest coast of Kodiak, Uganik, Raspberry, and Afognak Islands. It corresponds to the northwest belt of the greenstone-schist group of Capps (1937).

The type section of the Uyak Formation is designated as the rocks exposed along the west shore of Uyak Bay, from a basal thrust fault 3 km south of Uyak to a point 4 km northwest of Uyak, where the formation goes under a cover of glacial drift. The formation is sheared and cut by faults, but its attitude is fairly uniform; beds strike N. 45° E. and dip 75° NW. The tops of the beds were identified at only a few places, but in each place the beds are upright. If the type section is continuous, a thickness of about 6,000 meters is exposed.

The principal rock types throughout the Uyak Formation are black shale and local schistose green tuff. A few shale and sandstone graded beds also occur. The middle third of the exposed part of the formation contains many beds of pillow basalt and red chert, and the upper third is characterized by thick layers of light-gray chert. Thin limestone lenses occur at two places in the formation: about 700 meters above the base and 400 meters below the top. The chert and basalt underlie ridges, whereas the tuff and shale underlie valleys.

The Uyak Formation is the oldest formation exposed on the Kodiak group of islands. It is thrust over younger rocks to the southeast; elsewhere its relationship to younger sedimentary formations is obscured by the water of Shelikof Strait.

Marine fossils collected from a limestone lens 700 meters above the base of the type section at 57°37.7′ N., 153°59.0′ W., and identified by N.J. Silberling (written commun., 1966) are of Late Triassic age. The Uyak Formation is therefore considered to be Triassic. It has been intruded by penecontemporaneous ultramafic rocks and by a middle Tertiary quartz diorite batholith.

The Uyak Formation correlates with Triassic rocks on the Kenai Peninsula, including chert- and basalt-bearing rocks that extend to Nuka Island Passage (Grant, 1915). It is equivalent to somewhat less deformed and more fossiliferous Triassic rocks directly across Shelikof Strait on Cape Kekurnoi.

KODIAK FORMATION

The Kodiak Formation is here named for Kodiak Island. It crops out along the center of the island in a northeast-trending belt about

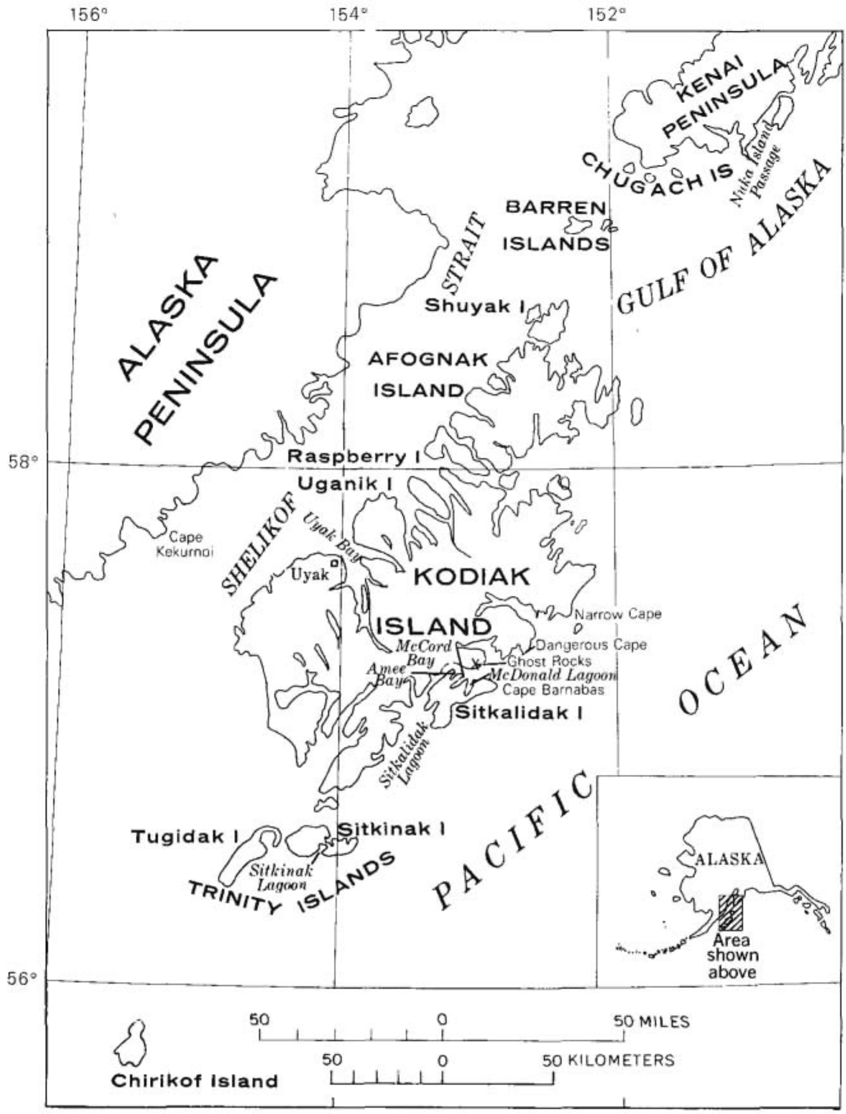

FIGURE 2.—Index map of Kodiak and adjacent islands.

60 km wide that follows an anticlinorium overturned toward the southeast. The Kodiak Formation is the slate-graywacke group of Capps (1937).

The northwest flank of the anticlinorium is a fairly regular homocline in which the attitude of the bedding averages N. 45° E., 45° NW.

The type section of the Kodiak Formation is designated as the section along the west shore of Uyak Bay, a fiord which nearly bisects Kodiak Island. The base of the section is 4 km south of the head of the bay, where the lower part of the formation is intruded by a quartz diorite stock. The top of the section is 3 km south of the village of Uyak, where Triassic rocks have been thrust over the youngest exposed part of the Kodiak Formation. Faults and dikes cut the unit, but except locally near the base, the beds everywhere in the type section are upright. A calculation based on the average dip indicates that the Kodiak Formation in its type section is 30,000 meters thick.

This exceedingly thick formation consists of a very regular geosynclinal sequence of graded beds that average about 1 meter thick. The fine-grained layer at the top of each graded bed is generally slate, and the coarser layer is medium-grained sandstone. In some places in the lower part of the formation, the fine-grained layers are phyllitic, and in approximately the upper 4,000 meters, they are shaly. The Kodiak Formation is resistant to erosion and provides excellent outcrops.

Along the axis of the anticlinorium, the Kodiak Formation has been intruded by a middle Tertiary quartz diorite batholith, and no stratigraphic units older than the Kodiak occur there. On the southeast side of Kodiak Island, a continuous sequence with younger formations seems to exist, but the rocks are so sheared and deformed that all mapped formation boundaries are faults. The Kodiak Formation is distinguished from the next younger formation there primarily by the Kodiak Formation's lack of basalt and secondarily by its slaty foliation.

No fossils diagnostic of age were found in the formation during the present investigation, but Imlay and Reeside (1954, p. 228) reported that Ulrich (1904, pl. 12–13) described two species of *Inoceramus*—from approximately the middle of the formation—that occur elsewhere in the world in rocks of Late Cretaceous age. The Kodiak Formation is therefore considered here to be Cretaceous on the basis of superposition and this fauna.

The Kodiak Formation also underlies the southeastern part of Afognak Island. It is lithologically correlative on the Kenai Peninsula with the slate and graywacke between Nuka Island Passage and Resurrection Bay (Grant, 1915), and to the southwest on the Shumagin Islands, it is correlative with the Shumagin Formation of Burk (1965). The deep-water sedimentary deposits of the Kodiak Formation correlate on the Alaska Peninsula to the northwest with Cretaceous shallow marine and continental coal-bearing rocks studied by Jones and Detterman (1966) and by Burk (1965).

GHOST ROCKS FORMATION

The Ghost Rocks Formation is named here for Ghost Rocks, which lie on the southeast coast of Kodiak Island directly north of Sitkalidak Island (fig. 2). The unit is equivalent to the southeast belt of the greenstone-schist group of Capps (1937). It crops out in a belt about 10 km wide near the southeast shore of Kodiak Island and through the middle of Sitkalidak Island.

The Ghost Rocks Formation occurs approximately along the axis of an isoclinally folded synclinorium that trends northeast. The synclinorium has been cut by block faults in such a way that wherever the rocks have been carefully studied, older rocks to the northwest and younger rocks to the southeast rest against rocks of the Ghost Rocks Formation in fault contact.

The type section of the Ghost Rocks Formation is designated as the exposures along the north coast of Sitkalidak Island directly opposite Ghost Rocks across Sitkalidak Strait. The type section extends from a major fault on the west side of the head of Amee Bay to a fault on the east side of the mouth of McDonald Lagoon. Specifically, in this isoclinally folded section, the Ghost Rocks Formation includes (1) zeolite-bearing tuffaceous sandstone that crops out at the heads of McCord Bay and Sitkalidak Lagoon, (2) all beds of basalt lying along the synclinorium, and (3) all intervening rocks, consisting of hard claystone, sandstone, tuff, and graded beds, locally in the form of wildflysch. The formation is sheared, faulted, and folded. The internal stratigraphy has not been completely worked out, but the thickness appears to be approximately 5,000 meters. The formation is lithologically distinct, as it is a coherent belt of rocks that contains pillow basalt and tuff, which are not found in either the underlying or the overlying formations.

Capps (1937) correlated this belt of rocks with my Uyak Formation on the northwest side of Kodiak Island, which similarly contains pillow basalt; hence he considered it to be older than my Kodiak Formation. Where the Ghost Rocks Formation rests in fault contact with the Kodiak Formation, however, lithologies that were originally similar in each are more highly metamorphosed in the Kodiak Formation. Moreover, the lack of chert and limestone in the Ghost Rocks Formation makes it different from the Uyak Formation.

No fossils were found in the Ghost Rocks Formation. The similarity in geosynclinal character to formations that are older and younger suggests that the sequence of formations lacks unconformities. Also, an analysis of the thicknesses of similar lithologies in the successive formations and a hypothetical correlation of the volcanic rocks in the Ghost Rocks Formation with nearby intrusive rocks of known age suggest that the formation straddles the boundary between the Paleocene and the Eocene.

To the west, on the Alaska Peninsula, the Ghost Rocks Formation is believed to correlate with the lower part of the basalt-bearing Tolstoi Formation of Burk (1965), which contains fossils of Paleocene age. To the east in Prince William Sound, it correlates with the lower part of the basalt-bearing Orca Group, in which fossils of early Tertiary age have been found (Plafker and MacNeil, 1966, p. B67).

SITKALIDAK FORMATION

The Sitkalidak Formation is named here for Sitkalidak Island; off the southeast coast of Kodiak Island. The formation occurs mainly in a series of patches at the southeastern tips of points on Kodiak, Sitkalidak, and Sitkinak Islands. These points are generally separated by fiords, so the individual patches are about 20 km apart. The formation has been deformed into a series of tight folds that are commonly overturned.

The type section of the Sitkalidak Formation lies along the north coast and near the east end of Sitkalidak Island. It extends in a chiefly overturned section from the axis of an anticline, 3 km northwest of Cape Barnabas, to the base of a 20-meter conglomerate bed, 7 km northwest of Cape Barnabas. The formation consists of a rather uniform sequence of sandstone and siltstone graded beds about 3,000 meters thick that formed under geosynclinal conditions of deposition. A few conglomerate beds also occur in the unit. All mapped contacts with the underlying Ghost Rocks Formation follow faults, and the basal contact of the Sitkalidak Formation has not been reached at the base of the type section. The base is defined to be directly above the uppermost basalt or tuffaceous sandstone bed that marks the top of the Ghost Rocks Formation. The upper contact, except in the type section, where it is deliberately specified, is a transitional zone in which the graded beds of the Sitkalidak Formation (below) alternate with crossbedded sandstone or conglomerate (above) that contains coal fragments.

A fossil clam collected from about 300 meters below the top of the Sitkalidak Formation in the type area at 57°11.1′ N., 152°56.5′ W., is a new genus of Vesicomyidae, and a fossil crab, *Callianassa* aff. *C. porterensis*, from the same locality, indicates an Oligocene age (F. S. MacNeil, written commun., 1963). Evidence from superposition suggests that the Sitkalidak Formation is Eocene and Oligocene. To the northeast in Prince William Sound, the formation correlates with the upper part of the Orca Group (Plafker and MacNeil, 1966); on the Alaska Peninsula, it correlates with the upper part of the Tolstoi Formation of Burk (1965).

SITKINAK FORMATION

The Sitkinak Formation is named here for Sitkinak Island, which is about 30 km long and which lies 15 km southwest of Kodiak Island. The formation is in isolated patches along a belt about 250 km long, extending from Chirikof Island at the southwest to Dangerous Cape on Kodiak Island at the northeast. The type section is along the south shore of Sitkinak Island. The basal part includes beach and shallow-marine deposits, but the bulk of the formation is continental and consists of coal-bearing siltstone, sandstone, and conglomerate. In the type section, several half-meter-thick coal beds occur in association with well-preserved fossil leaves.

A complete, though folded, section of the Sitkinak Formation occurs at its type locality, where the formation is about 1,500 meters thick. The basal contact there, which is locally disturbed by faulting, intersects the south shore of Sitkinak Island at a small lagoon 800 meters east of the south entrance to Sitkinak Lagoon at the base of an alternating zone, where graded beds of the underlying Sitkalidak Formation are succeeded by conglomerate and crossbedded sandstone and siltstone that contain coal fragments. At the type section of the Sitkalidak Formation on Sitkalidak Island, the contact is at the stratigraphic base of an overturned 20-meter conglomerate bed 7 km northwest of Cape Barnabas.

At many of its known areas of occurrence, the Sitkinak Formation is the youngest bedrock unit present. In its type section, however, coal-bearing sandstone and siltstone are conformably overlain by marine siltstone containing lower Miocene fossils. The upper contact in the type section is about 200 meters west of the southernmost point of Sitkinak Island.

Identifiable plant fossils are abundant throughout the continental part of the Sitkinak Formation on Sitkinak Island. J. A. Wolfe (written commun., 1968) stated that collections from near the middle and near the top of the section are middle or late Oligocene in age. The Sitkinak Formation is considered here to be Oligocene. It correlates on the Alaska Peninsula with the coal-bearing Stepovak Series of Palache (1904; Stepovak Formation of Burk, 1965). On the east side of the Gulf of Alaska, it correlates with the lower parts of the Poul Creek and Katalla Formations (Plafker, 1967).

NARROW CAPE FORMATION

The Narrow Cape Formation is here named for Narrow Cape, near the east end of Kodiak Island. The type section is along the southwest coast of the cape, from its end northwestward about 1 km to the axis of a syncline where the youngest part of the formation is exposed.

At its type locality, the formation is 700 meters thick. The lower two-thirds consists of sandstone and a few conglomerate beds; the upper third consists of siltstone. On Sitkinak Island, 150 km southwest of the type locality, about 150 meters of siltstone is preserved along a synclinal axis.

At Narrow Cape, the formation rests unconformably on the Sitkalidak Formation of Eocene and Oligocene age. On Sitkinak Island, it rests conformably on the Sitkinak Formation of Oligocene age. The Narrow Cape Formation is the youngest bedrock formation exposed at each of these two areas of outcrop.

The Narrow Cape Formation contains a rich marine fauna. A collection from near the middle of the section at the type locality was determined by F. S. MacNeil (written commun., 1963) to be middle Miocene. A collection from near the base of the formation on Sitkinak Island was determined by MacNeil to be early Miocene. The age of the formation therefore is considered to be Miocene. The Narrow Cape Formation correlates on the Alaska Peninsula with the Bear Lake Formation of Burk (1965). On the east side of the Gulf of Alaska, it correlates with the upper parts of the Poul Creek and Katalla Formation and the lower part of the Yakataga Formation (Plafker, 1967).

TUGIDAK FORMATION

The Tugidak Formation is here named for Tugidak Island, which is about 10 km wide and 20 km long; this island lies approximately 25 km southwest of Kodiak Island. The Tugidak Formation is the only bedrock unit underlying the island, and it occurs there in a homocline dipping approximately 5° NE. The formation also occurs at the north end of Chirikof Island, where it dips about 10° N.

The type section of the Tugidak Formation is designated as the exposures along the west coast of Tugidak Island, from the south tip of the island to the northernmost exposure of bedrock. In its type section, the formation is approximately 1,500 meters thick. It consists of interbedded sandstone and siltstone characterized by randomly distributed pebbles and cobbles. A 1-meter-thick cobble-conglomerate bed occurs about 350 meters above the base. On Chirikof Island, the Tugidak Formation lies in fault contact with older rocks and is overlain with apparent conformity by an unnamed Pleistocene marine formation.

The Tugidak Formation is richly fossiliferous on Tugidak Island. Three collections of marine fossils spaced stratigraphically through the formation were determined to be of Pliocene age by F. S. MacNeil (written commun., 1963). A fossil snail, *Nassarius* cf. *N. Andersoni*, in float from near the base of the formation on Chirikof Island is also considered to be Pliocene by W. O. Addicott (oral commun., 1966). The Tugidak Formation correlates with the Tachilni Formation on the Alaska Peninsula (Burk, 1965). The upper part of it correlates with the "lower" part of the of the Yakataga Formation as exposed on Middleton Island, about 400 km northeast of Kodiak Island (George Plafker and F. S. MacNeil, oral commun., 1963); only the uppermost part of the Yakataga Formation is exposed on Middleton Island.

THREE NEWLY NAMED JURASSIC FORMATIONS IN THE McCARTHY C–5 QUADRANGLE, ALASKA

By E. M. MacKevett, Jr.

This report names and describes three Jurassic formations in the McCarthy C–5 quadrangle, Alaska: the Lubbe Creek, Nizina Mountain and Root Glacier Formations. Brief descriptions of the stratigraphy of these formations were included in a report by MacKevett and Imlay (1962), and their distributions were shown in a preliminary geologic map of the quadrangle (MacKevett, 1963). Earlier investigators either did not recognize the Jurassic rocks or lumped them with Cretaceous or Triassic rocks. Moffit (1938, pl. 2), however, showed two small patches of undifferentiated Jurassic rocks within the C–5 quadrangle.

The present report supplements previous reports by naming the formations, revising lithologic descriptions and age assignments, and providing additional stratigraphic information. This report is based on field investigations during the summers of 1961 and 1962, on pertinent laboratory studies, and on paleontologic studies by R. W. Imlay. M. C. Blake, Jr., ably assisted in the field during 1961, and the writer is grateful to him and to Imlay for their contributions.

The McCarthy C–5 quadrangle is on the south flank of the rugged and strongly dissected Wrangell Mountains (fig. 3). It is bounded by the 61°30′ and 61°45′ parallels and by the 142°30′ and the 142°52′30″ meridians. Alpine conditions reflected by glaciers, perennial snowfields, diverse surficial deposits related to glacial activity, and several arêtelike ridges characterize a large part of the quadrangle. The quadrangle is uninhabited, although the two largest of the famous Kennecott mines, the Bonanza and the Jumbo, are near its southwestern corner and formerly were thriving mining camps. The most practical mode of travel in the quadrangle is the helicopter.

The Lubbe Creek, Nizina Mountain, and Root Glacier Formations occupy part of a belt of Triassic and Jurassic rocks that trends

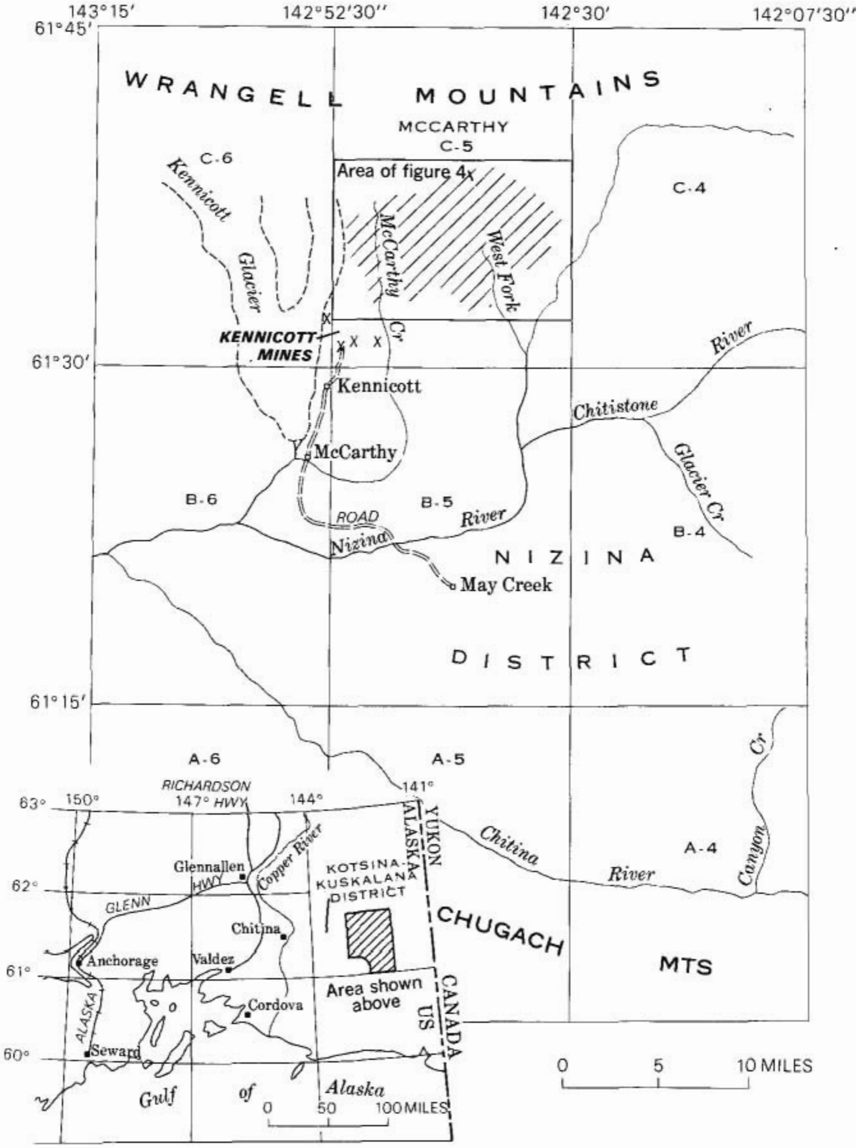

FIGURE 3.—Index map showing the McCarthy C–5 and nearby quadrangles.

northwestward across the middle of the quadrangle (fig. 4). These formations represent the upper part of an essentially concordant stratigraphic sequence whose sediments were deposited from the Late Triassic into the Late Jurassic. The major orogeny in the region was near the end of the Jurassic and (or) in the Early (pre-Albian) Cretaceous; the Jurassic rocks have been folded and faulted and are overlain unconformably by younger deposits. Despite modifications caused by the numerous folds and faults, the Jurassic rocks simulate a gentle northeast-dipping homocline in gross structure. The Lubbe Creek, Nizina Mountain, and Root Glacier Formations consist largely of very fine grained and fine-grained epiclastic rocks.

LUBBE CREEK FORMATION

Name and distribution

The Lubbe Creek Formation is named here from the excellent exposures at its type locality, along Lubbe Creek, a westward-flowing tributary of McCarthy Creek (figs. 4, 5). The formation also crops out on Bonanza Ridge, in the canyon walls that border the upper reaches of McCarthy Creek, and on both sides of the West Fork (fig. 4), all within the McCarthy C–5 quadrangle.

Two small patches of the Lubbe Creek Formation are exposed near the southwest corner of the McCarthy C–4 quadrangle (MacKevett and others, 1964), and the formation also extends into the McCarthy C–6 quadrange (MacKevett, 1965). No similar coeval rocks have been described from other nearby parts of Alaska.

General character, stratigraphic relations, and thickness

The Lubbe Creek Formation consists of impure spiculite and subordinate amounts of coquina. It constitutes an excellent marker horizon, being thin and lithologically distinctive, forming bold outcrops, and containing abundant fossils, including the diagnostic *Weyla*. Strata in the formation commonly are between ½ and 3 feet thick and, exceptionally, as much as 8 feet thick.

The Lubbe Creek Formation conformably overlies the upper member of the McCarthy Formation (figs. 5, 6), which is largely or entirely Early Jurassic. Its upper contact is a disconformity that separates it from the Nizina Mountain Formation or, in some places, from the Root Glacier Formation (figs. 5, 6). Locally, the Lubbe Creek is in fault contact with other rocks or is overlain by Quaternary surficial deposits.

The formation is about 300 feet in maximum thickness, but throughout most of its extent it is thinner because of erosion. Southeast of Nizina Mountain, the stratigraphic interval normally occupied by the Lubbe Creek Formation is marked by a hiatus that separates the upper member of the McCarthy Formation from the Nizina Mountain Formation.

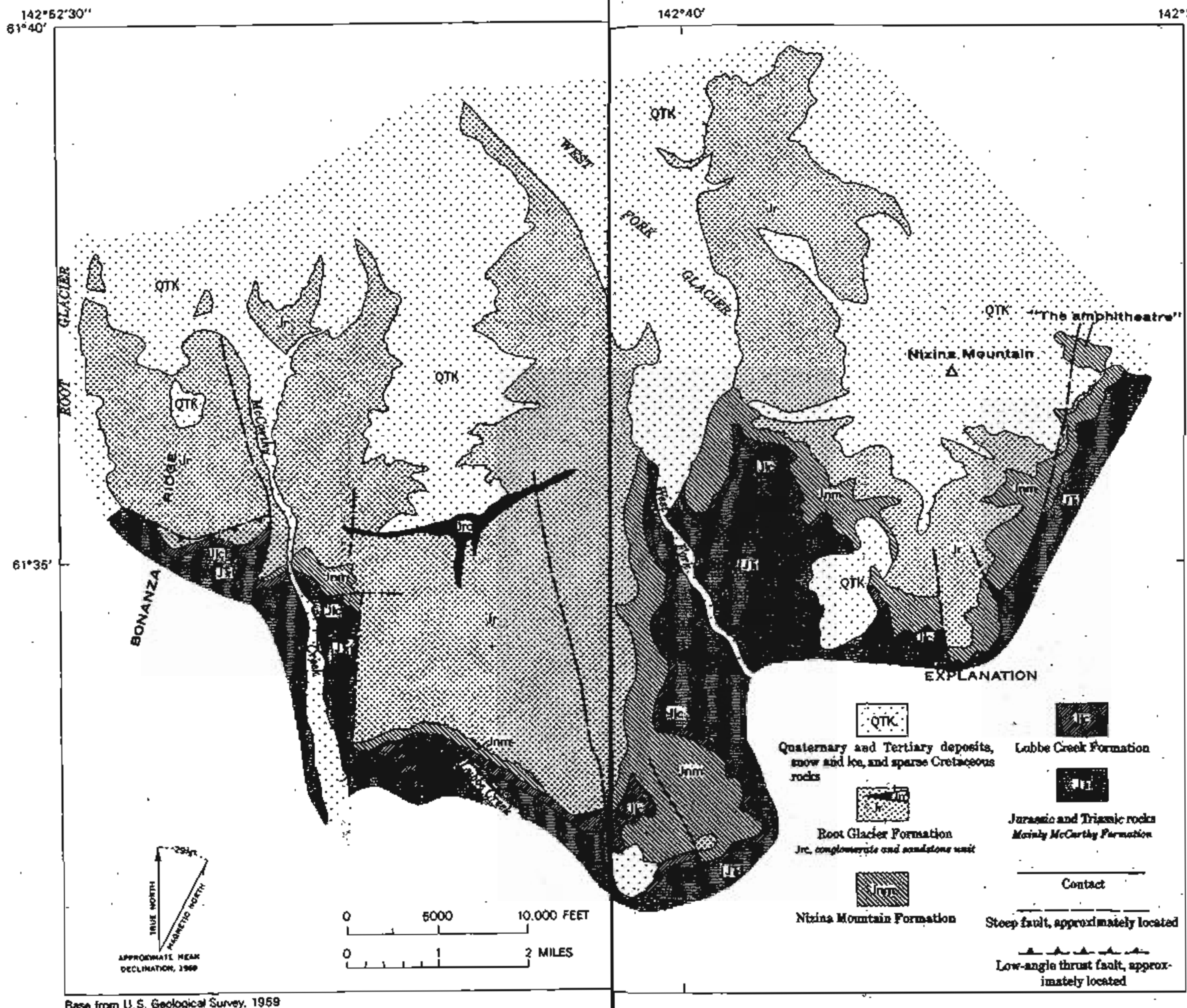

FIGURE 4.—Generalized geologic map of the Lubbe Creek, Nizina Mountain, and Root Glacier Formations in the McCarthy C-5 quadrangle.

FIGURE 5.—Lubbe Creek Formation (Jlc) near the head of Lubbe Creek. The formation conformably overlies the upper member of the McCarthy Formation (JTRmu) and is overlain disconformably by the Nizina Mountain Formation (Jnm) or the Root Glacier Formation (Jr). The Lubbe Creek Formation here is about 150 feet thick.

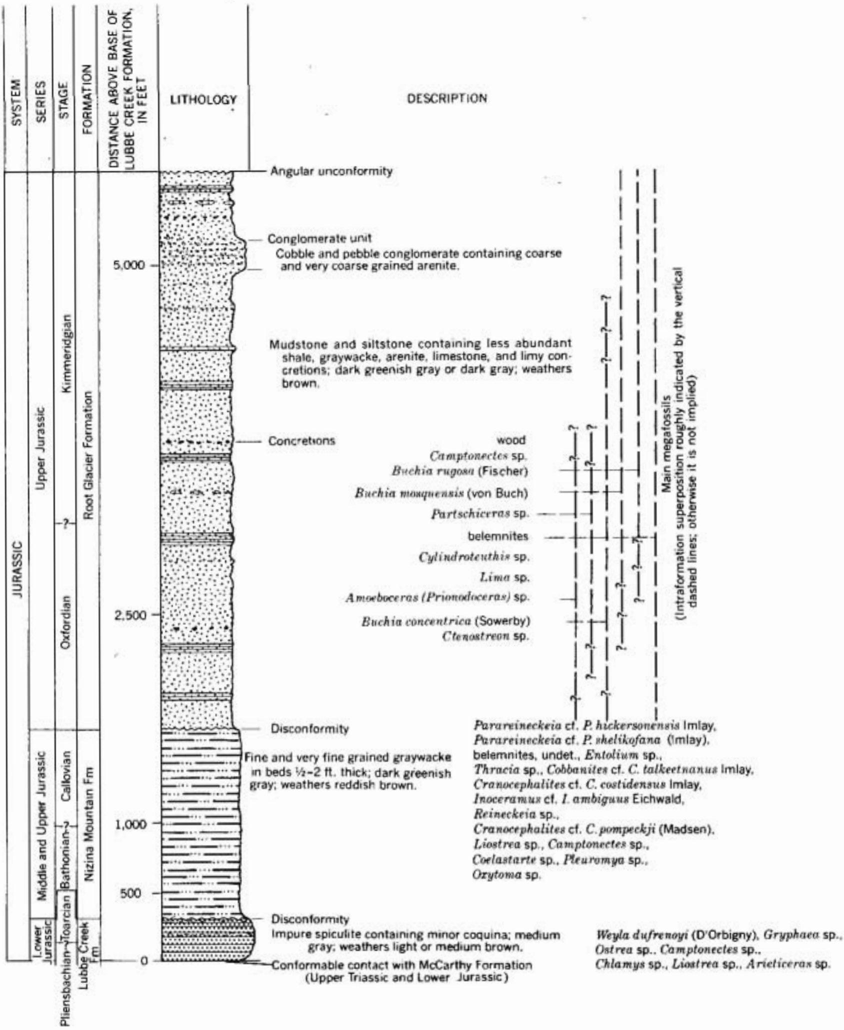

FIGURE 6.—Composite columnar section showing the Lubbe Creek, Nizina Mountain, and Root Glacier Formations.

Petrology and petrography

The Lubbe Creek Formation consists of impure spiculite and minor amounts of coquina; the rocks are medium gray where fresh and light or medium brown where weathered. Chert lenses as much as 10 feet long and 6 inches thick occur in some of the spiculites. The impure spiculites are fine-grained silica-rich rocks that contain organic and inorganic clasts in a chalcedony matrix. The clasts include spicules, Radiolaria, fragments of pelecypods and belemnites, calcite, quartz, dolomite, and plagioclase. Calcite is the dominant mineral of the clastic grains and of most shell fragments. The spiculites also contain minor amounts of chlorite, hematite, pyrite, carbonaceous material, ilemnite, biotite, and apatite. Most of the clasts are ragged to subangular and less than 0.2 millimeter in maximum dimension. The spicules are generally less than 0.3 mm long; commonly they are chalcedonic, and uncommonly, calcareous. A few have chloritic cores.

The coquina contains abundant poorly sorted bioclastic material, chiefly shells and shell fragments of megafossils, in a chalcedony matrix. Its subordinate clastic constituents are similar to those of the impure spiculites.

Age

The Lubbe Creek Formation is late Early Jurassic in age. The ammonite *Arieticeras* (USGS Mesozoic loc. 28531) provides excellent evidence for a late Pliensbachian age. The early Pliensbachian ammonite *Uptonia* (Mesozoic loc. 28675), less than 100 feet below the base of the Lubbe Creek Formation in the C–4 quadrangle, shows that no part of the formation is older than Pliensbachian. That the age is no younger than Toarcian is shown by an abundance of the Early Jurassic pelecypod *Weyla* in the upper part of the formation. Identification of this pelecypod as *Weyla dufrenoyi* (D'Orbigny) (Prof. S. W. Muller, oral commun., 1964) suggests a Toarcian age for the upper part of the formation.

In addition to *Weyla*, the fauna of the Lubbe Creek Formation, as identified by R. W. Imlay of the U.S. Geological Survey (written commun., 1963), includes: *Prodactylioceras*? sp., *Arieticeras*? sp., *Arieticeras* sp., *Gryphaea* sp., *Ostrea* sp., *Camptonectes* sp., *Astarte* sp., *Eopecten* sp., *Chlamys* sp., *Liostrea* sp., and brachiopods.

NIZINA MOUNTAIN FORMATION

Name and distribution

The Nizina Mountain Formation is named here for its type locality outcrops that partly girdle the ridge that extends southward from Nizina Mountain (fig. 4). The formation is well exposed on canyon walls of the West Fork. From these exposures it extends eastward around the nose of the ridge south of Nizina Mountain. Northeastward from there, it crops out almost continously along the east side of the ridge and extends to near "the amphitheatre," where it is overlapped by younger rocks (figs. 4, 7). The formation is intermittently exposed along the north side of Lubbe Creek and near the head of McCarthy Creek.

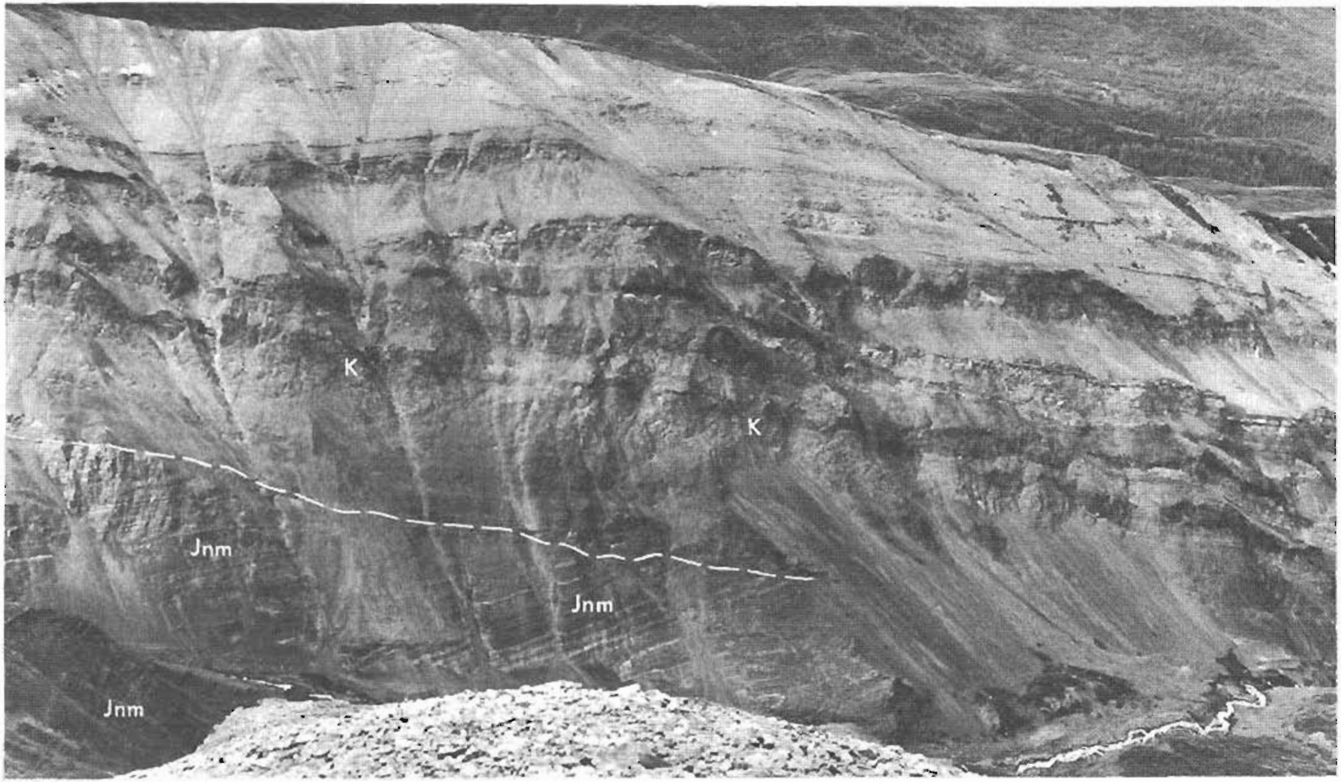

FIGURE 7.—Nizina Mountain Formation (Jnm) unconformably overlain by Cretaceous marine sedimentary rocks (K) at "the amphitheatre." The relief in the photograph is about 600 feet.

Except for one isolated outcrop in the McCarthy C–6 quadrangle (MacKevett, 1965), the Nizina Mountain Formation has been recognized only in the McCarthy C–5 quadrangle.

General character, stratigraphic relations, and thickness

The Nizina Mountain Formation consists dominantly of fine-grained to very fine grained graywacke[1] in distinct beds ½–2 feet thick. Most outcrops of the formation underlie moderate slopes that have reddish-brown weathered surfaces. The formation's upper and lower contacts are unconformities, commonly disconformities, but east of Nizina Mountain its upper contact is an angular unconformity with post-Jurassic rocks (fig. 7). In most places, the Nizina Mountain Formation disconformably overlies the Lubbe Creek Formation (figs. 4, 5, 6), but southeast of Nizina Mountain it disconformably overlies the upper member of the McCarthy Formation. At most places, the Nizina Mountain Formation is overlain disconformably by the Root Glacier Formation (figs. 5, 6). In a few places, it is separated by an angular unconformity from overlying Cretaceous (Albian) sedimentary rocks or from Tertiary rocks that are part of the Wrangell Lava (fig. 7). Quaternary surficial deposits locally cover the Nizina Mountain Formation.

The Nizina Mountain Formation is about 1,350 feet in maximum thickness at its type locality. Elsewhere, because of extensive erosion, it is thinner, and many of its outcrops are only a few tens of a few hundreds of feet thick.

Petrology and petrography

The dominant fine-grained to very fine grained graywackes of the formation are associated with sparsely distributed shaly partings and a few limy lenses and concretions. The graywackes are mainly dark greenish gray and weather reddish brown. They consist of poorly sorted subangular to subrounded clasts in extremely fine-grained chalcedony-rich matrices. The clasts range from 0.05 to 0.5 mm in maximum dimension. They are composed of plagioclase, generally sodic labradorite, and quartz, along with less abundant cherty lithic fragments, calcite, opaque minerals, and rare biotite and chlorite; they also contain clay minerals, opaque dust, and sparse laumontite (leonhardite), epidote, prehnite, and calcite. Opaque minerals in the Nizina Mountain Formation include pyrite, hematite, ilmenite, and magnetite.

[1] Nomenclature of the sandstones in this report follows the usage of Williams, Turner, and Gilbert (1954, p. 289–321).

Age

The Nizina Mountain Formation is Middle and Late Jurassic and probably includes strata representative of both the Bathonian and Callovian stages. Its large fauna chiefly consists of belemnites that are as much as 5 centimeters long and 0.5 cm wide and of poorly preserved ammonites. Fossils from the formation that were identified by R. W. Imlay (written commun., 1963) include the following: *Parareineckeia* cf. *P. hickersonensis* Imlay, *P.* cf. *P. shelikofana* (Imlay), *P.* sp., *Entolium* sp., *Thracia* sp., *Cobbanites* cf. *C. talkeetnanus* Imlay, *Cranocephalites* cf. *C. costidensus* Imlay, *C.* cf. *C. pompeckji* (Madsen), *Arctocephalites*? sp., *Inoceramus* cf. *I. ambiguus* Eichwald, *Plesiopecten*? sp., *Coelastarte* sp., *Pleuromya* sp., *Liostrea* sp., *Camptonectes* sp., *Oxytoma* sp., *Quenstedtia*? sp., and undetermined belemnites, aptychus, fish scales, and a crustacean appendage.

ROOT GLACIER FORMATION

Name and distribution

The Root Glacier Formation is applied here to the thick dominantly very fine grained and clastic marine sedimentary rocks that are well exposed on the arêtelike ridges that border Root Glacier (Bonanza Ridge in the McCarthy C–5 quadrangle and the ridge that extends northward from Donoho Peak in the McCarthy C–6 quadrangle). Because of structural complications on these ridges, including a thrust fault, the type locality of the Root Glacier Formation is designated as the hillside east of the upper part of McCarthy Creek (fig. 4), where the Root Glacier rocks are also fairly well exposed but less deformed. The formation also includes a facies conglomerate and very coarse grained sandstone.

The Root Glacier Formation extends eastward from the margins of Root Glacier to the slopes southeast of Nizina Mountain (fig. 4). It is well exposed on Bonanza Ridge, the environs of upper McCarthy Creek, the ridge between McCarthy Creek and the West Fork, and near the West Fork Glacier (figs. 4, 5, 8). The conglomerate crops out on the ridge between McCarthy Creek and the West Fork and forms strike-controlled spurs that extend laterally from the main ridge (figs. 4, 8).

The Root Glacier Formation extends northwestward across the McCarthy C–6 quadrangle (MacKevett, 1965) toward the northeast corner of the C–7 quadrangle. The formation has not been recognized in other nearby quadrangles, but it may correlate with some of the Jurassic or Cretaceous rocks of Moffit (1938, p. 66–68) from the Kotsina-Kuskalana region.

General character, stratigraphic relations, and thickness

The formation mainly consists of poorly sorted and poorly bedded pelitic and fine psammitic rocks. Characteristically these rocks form moderately smooth slopes (figs. 5, 8) that locally are breached by a few resistant limy beds and lenses and by outcrops of coarse clastic rocks. The conglomerate forms bold outcrops that protrude from the surrounding rocks (fig. 8). The formation is cut by andesitic dikes that locally are sufficiently numerous to constitute dike swarms and by a few sandstone dikes. Parts of the formation are a series of open folds that commonly plunge gently northwestward.

The Root Glacier Formation disconformably overlies the Nizina Mountain Formation or, locally, the Lubbe Creek Formation (figs. 4, 5, 6). It is overlain unconformably by the Wrangell Lava and in some places is mantled by Quaternary surficial deposits. The conglomerate forms an intraformational lens stratigraphically high in the formation (figs. 4, 5, 8). Both of its contacts are broadly gradational from conglomerate through sandstone to dominantly pelitic rocks. Snow and ice cover parts of the conglomerate.

Accurate estimates of the thickness of the formation are precluded because of the angular unconformity that marks the upper contact, because of the lack of persistent marker beds, and because of numerous folds and faults. The large disparities in estimated thicknesses probably reflect fairly abrupt changes in thickness attributable to such factors as unequal erosion and differences in original thickness. The estimated thicknesses are probably reasonable minimum values. They range from 1,300 to about 4,000 feet. The conglomerate lens is about 200 feet in maximum thickness.

Petrology and petrography

The formation consists mainly of diverse clastic rocks, chiefly mudstone and siltstone and less abundant graywacke, arenite, and shale. It also contains some limy beds, lenses, and concretions. The conglomerate unit comprises well-indurated pebble and cobble conglomerate and coarse-grained and very coarse grained arenite. Reworked shaly chips are constituents of a few of the dominantly pelitic rocks. Most rocks of the formation are dark greenish gray or dark gray where fresh and diverse shades of brown where weathered.

The mudstone, siltstone, and shale contain similar mineral assemblages. They are closely related rocks and are distinguished by the sizes of their clasts or, in the case of the shale, by the development of fissility and pencil structure. Some of the very fine grained rocks contain carbonaceous trash, fossil wood, minute calcitic or chalcedonic spherical remnants of microfossils, and calcite veinlets. The shales and some of the siltstones are finely laminated because of the preferred

FIGURE 8.—Conglomerate (Jrc) of the Root Glacier Formation east of McCarthy Creek. The conglomerate is about 200 feet in maximum thickness. A downfaulted segment of conglomerate is in the left foreground. The Root Glacier Formation (Jr) is cut by several dikes. The Wrangell Lava (QTw) dominates the high terrain in the background.

orientation of their platy minerals or because of the parallelism of trains of carbonaceous material or other rock-forming elements. The mudstone, siltstone, and shale consist of clasts of very fine grained quartz, calcite, and plagioclase, cemented by calcite, along with chlorite and clay minerals. Less common minerals in these rocks are chalcedony, sericite, biotite, illite, and opaque minerals, chiefly pyrite and secondary hydrous iron oxides. The rare detrital constituents are apatite, zircon, and epidote. A few of the mudstones contain moderate quantities of the zeolite, laumontite (leonhardite).

The graywacke and arenite commonly are very fine grained to medium-grained rocks. The graywacke is feldspathic. It characteristically is poorly sorted and is composed of subangular clasts in a calcite-chlorite-clay matrix that constitutes 10–30 percent of the rock. The clasts include quartz and plagioclase and less commonly clinopyroxene, lithic fragments, biotite, hornblende, calcite, K-feldspar, and opaque minerals. The matrix consists chiefly of calcite and chlorite and subordinate amounts of sericite, chalcedony, and clay minerals. The arenite resembles the graywacke, but it either is cemented by calcite or contains less than 10 percent matrix.

The few limy rocks in the formation are chiefly impure calcarenites and represent a phase of sedimentation marked by the dominance of calcite, both in the detrital fraction and in the matrix or cementing material. The concretions form spherical masses ½–1½ feet in diameter that are composed of dense, very fine grained calcite.

The conglomerates contain well-rounded pebbles, cobbles as much as 6 inches in diameter, and a few blocky intraformational fragments of mudstone and siltstone, all in a sandy matrix. About two-thirds of the cobbles and pebbles are limestone, probably derived from the Chitistone and Nizina Limestones. The other cobbles and pebbles include medium-grained granite that is rich in pink K-feldspar, chert, altered basalt derived from the Nikolai Greenstone, and quartz.

Except for a few extraneous lithic pebbles and granules, the very coarse grained and coarse-grained arenite consists of subangular clasts of quartz and plagioclase that are cemented by calcite, along with minor chlorite and clay minerals. It also carries minor amounts of opaque iron minerals and their alteration products. Fragments of wood are widely scattered in some of the sandstone.

Age

Paleontologic studies by R. W. Imlay indicate that the Root Glacier Formation is Late Jurassic or, more specifically, late Oxfordian and Kimmeridgian in age. Its main fossils include pelecypods of the genus *Buchia* [formerly *Aucella*], belemnites as much as 12 cm long, ammonites, and wood fragments. Fossils identified by Imlay include:

Lima sp., *Camptonectes* sp., *Ctenostreon* sp., *Buchia rugosa* (Fischer), *B. concentrica* (Sowerby), *B. mosquensis* (von Buch), *Partschiceras* sp., *Amoeboceras* (*Prionodoceras*) sp., "*Turbo*" sp., and *Cylindroteuthis* sp. This assemblage is similar to that of the Naknek Formation, a widely distributed Upper Jurassic unit of the Alaska Peninsula, Cook Inlet region, and Talkeetna Mountains (Martin, 1926, p. 132, 133, 168–180, 203–218; Grantz, 1960a, b).

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