Summary of Cretaceous Stratigraphy in Part of the McCarthy Quadrangle, Alaska

By D. L. JONES *and* E. M. MACKEVETT, JR.

CONTRIBUTIONS TO STRATIGRAPHY

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Marine sedimentary rocks of Cretaceous age are described and named

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SUMMARY OF CRETACEOUS STRATIGRAPHY IN PART OF THE McCARTHY QUADRANGLE, ALASKA

By D. L. JONES and E. M. MACKEVETT, JR.

ABSTRACT

Cretaceous sedimentary rocks in the McCarthy A-4, B-4, B-5, B-6, C-4, C-5, and C-6 quadrangles, Alaska, constitute a complex stratigraphic sequence that is divided into the Kennicott, Moonshine Creek, Schulze, Chititu, and MacColl Ridge Formations. The Kennicott Formation is redefined to include only the lowermost rocks, and a lower sandstone and an upper siltstone member are recognized; the other formations are newly named. The Cretaceous rocks are mainly sandstone and siltstone with subordinate amounts of conglomerate, shale, mudstone, and porcellanite. These rocks were deposited mainly in shallow seas and reflect several marine transgressions and regressions. They have a cumulative thickness of almost 13,000 feet.

The Cretaceous rocks are separated from underlying older rocks by a pronounced angular unconformity and from overlying younger rocks by a slight angular discordance. They are cut by numerous felsic dikes and sills and intruded in several places by plutonic rocks. Because these Cretaceous rocks are locally very fossiliferous, well exposed, and only slightly deformed, they constitute an important biostratigraphic reference section for strata ranging in age from early Albian to late Campanian. No other area in the northeastern Pacific region is known to have such a complete and abundantly fossiliferous record preserved.

INTRODUCTION

PURPOSE AND SCOPE

This report summarizes the Cretaceous stratigraphy of the central part of the McCarthy 1-degree quadrangle. Alaska, an area that includes the McCarthy A-4, B-4, B-5, B-6, C-4, C-5, and C-6 15-minute quadrangles (fig. 1). The geologic mapping was done by MacKevett and his coworkers in the southern Wrangell Mountains during 1961–65, and 1967, and more detailed stratigraphic and paleontologic studies were done by Jones during most of these years. Related laboratory investigations include petrographic and X-ray diffraction studies of the rocks and detailed studies of the fossils. Most of the fieldwork was helicopter-supported with base camps at McCarthy or May Creek. (fig. 2).

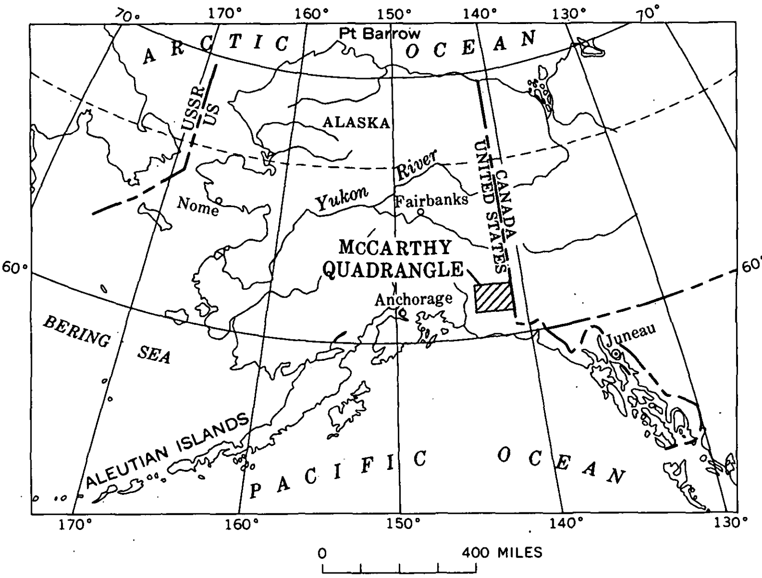


FIGURE 1.—Location of the McCarthy quadrangle.

GEOGRAPHIC SETTING

The Cretaceous rocks described in this report underlie part of the south-central flank of the Wrangell Mountains and part of the contiguous upper Chitina Valley. These rocks crop out along the rugged southern flank of the range up to altitudes of about 6,000 feet, on many of the gently-sloping hills bordering the Chitina Valley, and in cuts along deeply incised rivers throughout the valley (fig. 2). Trees and brush cover much of the lowland and persist on the slopes to altitudes of about 3,000 feet; they are succeeded by grass or flower-covered slopes and sporadic outcrops and ultimately by steep, bare, rocky terrain.

Topography of the region has been strongly modified by glaciation; the high mountainous terrains are characterized by perennial snow and ice fields, arêtes, cirques, and steep-sided ridges. Large valley glaciers extend down the major river drainages and have carved broad steep-walled valleys. Glacial deposits are also abundant throughout the lowland, where they mask much of the underlying Cretaceous rocks.

PREVIOUS WORK AND ACKNOWLEDGMENTS

Cretaceous rocks in the McCarthy quadrangle have been known since the pioneer mapping of Rohn (1900, p. 424, 433), but he and most other early geologists, notably Moffit and Capps (1911, p. 31–43), believed them to be of Jurassic age. Later workers, particularly

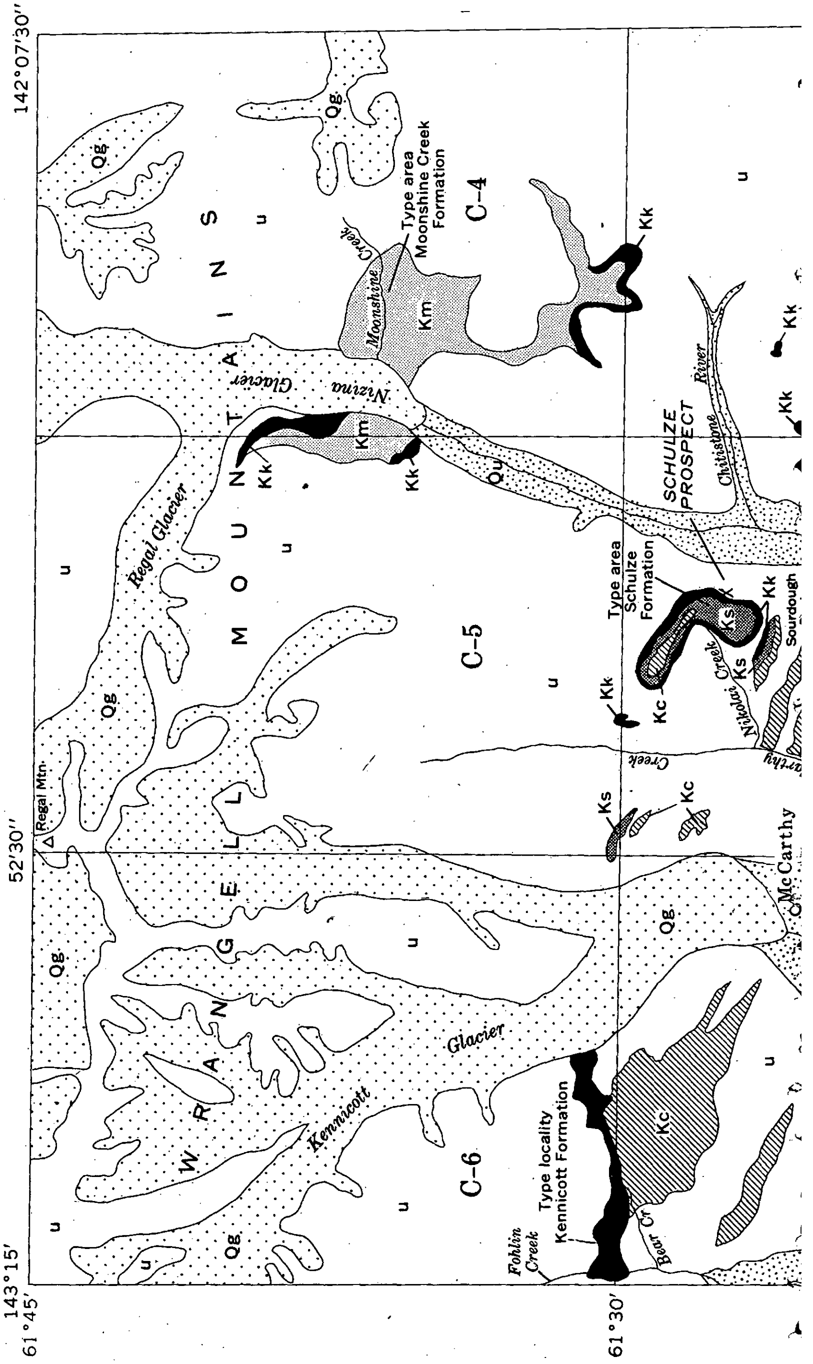
Moffit (1938), who published a comprehensive description of these rocks based on his extensive reconnaissance mapping in the southern Wrangell Mountains and nearby regions, considered them to be mainly Cretaceous; however, Moffit inadvertently included some Jurassic rocks with those he believed to be Cretaceous and considered some Cretaceous rocks to be Jurassic. A more extended summary of early work is given by Jones and Berg (1964). Subsequent efforts to clarify and refine the age and stratigraphic relations of the Cretaceous rocks are founded on detailed geologic mapping of six 15-minute quadrangles by MacKevett and his co-workers, on the mapping of the northern half of the McCarthy A-4 quadrangle by Miller and MacColl (1964), and especially on detailed mapping and stratigraphic and paleontologic studies by Jones. Besides being the basis of this report, this work has provided a description of the Cretaceous rocks in the McCarthy A-4 quadrangle (Jones and Berg, 1964) and in the preliminary geologic maps showing the distribution of Cretaceous rocks in the McCarthy A-4, B-5, C-4, C-5, and C-6 quadrangles (Miller and MacColl, 1964; MacKevett, 1963, 1965a, b; MacKevett and others, 1964).

Grateful acknowledgment is made to several members of the southern Wrangell Mountains project who participated in mapping the Cretaceous rocks and collected fossils from them. These geologists include M. C. Blake, Jr., H. C. Berg, George Plafker, J. H. Stout, R. L. Applegate, G. R. Winkler, and J. G. Smith.

GEOLOGY

GEOLOGIC SETTING

The southern Wrangell Mountains contain diverse sedimentary and igneous rocks that range in age from Mississippian to Quaternary (fig. 2). Pre-Cretaceous rocks occupy a broad northwest-trending belt along the southern flank of the range. Cretaceous rocks overlie the older rocks with strong angular unconformity that reflects the major orogeny of the region that occurred near the close of the Jurassic or in the Early Cretaceous. The Cretaceous rocks are cut by Tertiary intrusive rocks, chiefly altered felsic varieties, that form numerous sills, dikes, and small plutons, and to a lesser extent, by small plutons of granodiorite and by mafic dikes. Locally the Cretaceous rocks are overlain with slight angular unconformity by Tertiary continental sedimentary rocks that are intercalated with the basal flows of the Wrangell Lava. More commonly they are unconformably overlain by unconsolidated Quaternary surficial deposits, particularly the extensive fluvioglacial deposits that cover most lowland regions. The Cretaceous rocks generally have been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W R A N G E L L M O U N T A I N S
Type area Moonshine Creek Formation
Moonshine Creek
Nizina Glacier
Regal Glacier
Regal Mtn.
SCHULZE PROSPECT
Type area Schulze Formation
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Nikolai Creek
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McCarthy Creek
McCarthy
Kennicott Glacier
Type locality Kennicott Formation
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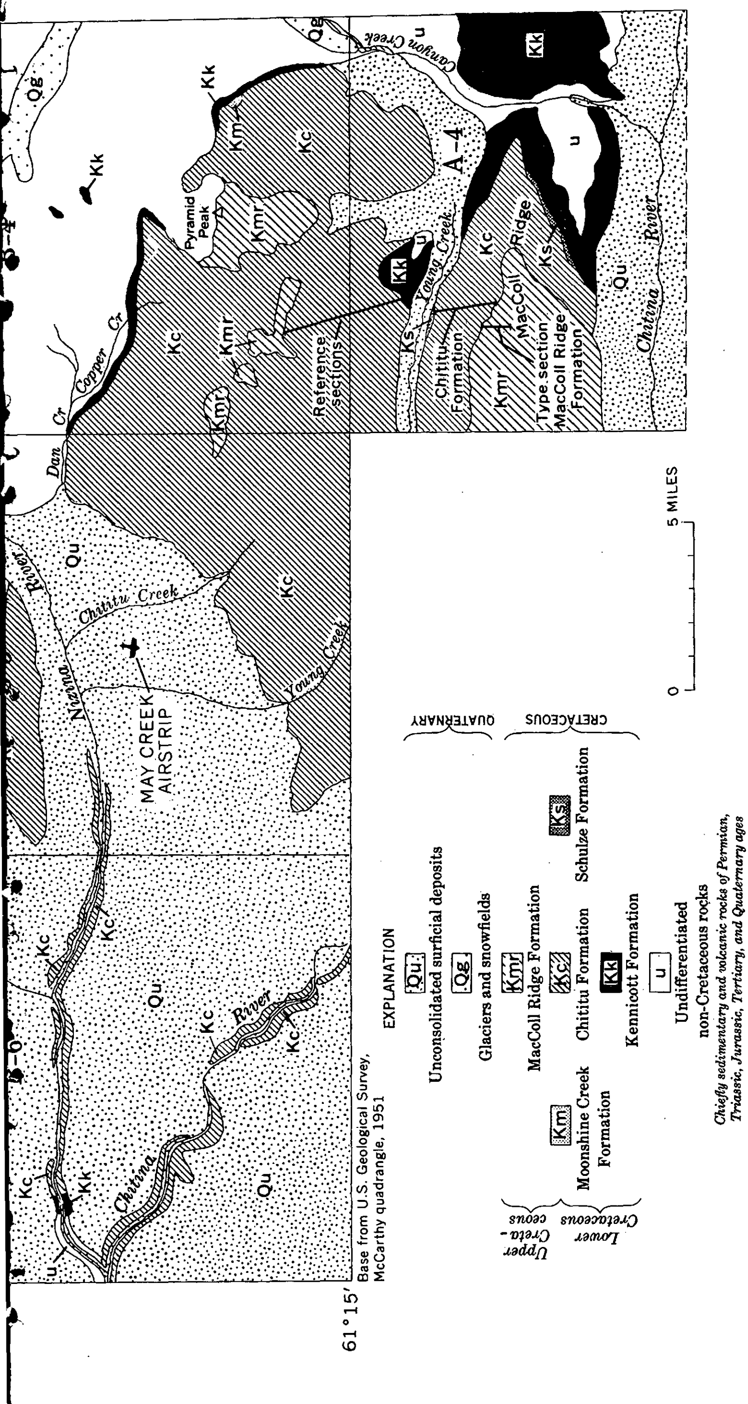

FIGURE 2.—Generalized distribution of Cretaceous rocks in part of the McCarthy quadrangle.

folded into series of broad, gentle folds that commonly trend northwestward, and they are slightly offset by a few faults.

STRATIGRAPHY

Cretaceous sedimentary rocks form a complex stratigraphic sequence and are widely distributed throughout the McCarthy quadrangle (figs. 2, 3). The name Kennicott Formation generally has been applied to all or parts of this sequence, but as Jones and Berg (1964, p. A5) point out, numerous discrepancies in usage render the name impractical without redefinition. The Cretaceous rocks are dominantly shallow-water marine deposits that are separated by several disconformities. The oldest Cretaceous deposits in the area studied are basal sandstones and conglomerates of Albian age that are separated from older rocks by a pronounced angular unconformity. These basal deposits are older in the southern part of the study area than in the northern part; this distribution indicates that the ancestral Cretaceous seas transgressed from the south or southwest (fig. 3). These basal deposits are overlain by rocks that were formed and modified during several marine transgressions and regressions that included some stages of widespread uniform sedimentation and others of local sedimentation in isolated or restricted basins. The sedimentary record, although disrupted by numerous hiatuses, extends from the Albian into the upper Campanian or Maestrichtian (fig. 3).

The Cretaceous rocks are herein divided into the Kennicott, Moonshine Creek, Schulze, Chititu, and MacColl Ridge Formations (figs. 2, 3), all of which, except for the Kennicott, are new names. Most of these formations contain abundant marine invertebrate fossils, but only those fossils that provide significant age data are discussed in this report.

Kennicott Formation

NAME AND DISTRIBUTION

The name Kennicott was originally applied by Rohn (1900, p. 433), who used "Kennicott Series" to designate sedimentary rocks in the vicinity of Fohlin and Bear Creeks (fig. 2) that were believed to be Jurassic in age. The name "Kennicott Formation" was introduced by Schrader and Spencer (1901, p. 33, 48–50, pl. 4), and subsequently, this name has been used several times with different implications and denotations. Commonly, these various usages have included some Jurassic rocks and some Cretaceous rocks different from those at Rohn's type area. Summaries of the early evolution of the name Kennicott Formation are given by Martin (1926, p. 330–349) and Jones and Berg (1964).

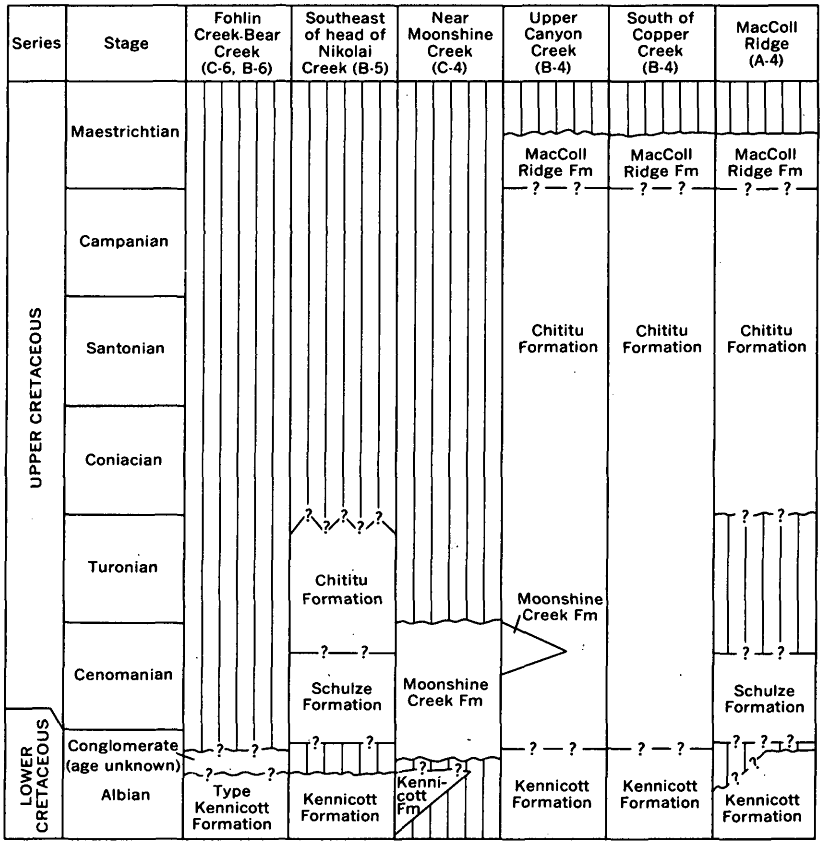

FIGURE 3.—Generalized correlation chart showing relation of Cretaceous rocks in parts of the McCarthy quadrangle.

In view of the diverse previous usage of the name Kennicott Formation, and because none of the previous definitions are entirely compatible with the results of our more detailed studies, it is necessary to define the formation more precisely. The Kennicott Formation is here redefined to include the conglomerate, sandstone, siltstone, and shale that constitute the lowermost sequence of sedimentary rocks that unconformably overlies Triassic rocks in the McCarthy B-6 and C-6 quadrangles (fig. 2). The type locality is designated as the hillsides east of Fohlin Creek and north of Bear Creek mainly in the southwestern part of the McCarthy C-6 quadrangle, but to a lesser extent in the northwestern part of the adjoining McCarthy B-6 quadrangle (fig. 2). The type locality is within Rohn's (1900, p. 424) loosely defined type area for his Kennicott Series.

The Kennicott Formation is widely distributed throughout the McCarthy quadrangle (fig. 2). It is well exposed at its type locality and elsewhere in the southern part of the C-6 quadrangle and in the A-4 quadrangle north of the Chitina River. Other good exposures of the formation are in the C-5 and C-4 quadrangles west of the Nizina River and south of Regal Glacier. It is exposed in parts of the B-5, B-6, C-4, and B-4 quadrangles as a basal unit underlying younger Cretaceous rocks or less commonly as isolated erosional remnants.

THICKNESS AND STRATIGRAPHIC RELATIONS

The Kennicott Formation ranges from a few tens of feet to almost 500 feet in thickness. Generally the formation is bipartite and consists of a basal unit of sandstone and conglomerate as much as 100 feet thick and an overlying unit of fine siltstone, shale, and sandstone as much as 375 feet thick. Differences in thickness characterize much of the formation, particularly its transgressive basal unit, which in several exposures is only a few feet or a few tens of feet thick. At the type locality the basal unit is about 50 feet thick, and the overlying upper unit about 125 feet thick. Thicker sections are exposed near Canyon Creek in the A-4 quadrangle and near the boundary between the C-5 and C-4 quadrangles west of the Nizina River and south of Regal Glacier (fig. 2). At both of these localities the basal unit is about 100 feet thick and the upper unit about 375 feet.

The Kennicott Formation unconformably overlies older rocks, commonly Triassic rocks represented by the Nikolai Greenstone, the Chitistone and Nizina Limestones, and the lower member of the McCarthy Formation. Locally in the C-5 quadrangle it overlies Jurassic rocks including part of the upper member of the McCarthy Formation and the Nizina Mountain Formation. The Kennicott Formation overlies the Mississippian Strelna Formation in parts of the A-4 quadrangle and locally along the lower reaches of the Nizina River in the B-6 quadrangle.

Commonly the Kennicott Formation is conformably or disconformably overlain by younger Cretaceous rocks including the Schulze, Moonshine Creek, and Chititu Formations. Less commonly, as in the southwestern part of the C-6 quadrangle and the northwestern part of the B-6 quadrangle, it is uncomformably overlain by unconsolidated Quaternary sediments, chiefly stratified fluvioglacial deposits. The formation is cut by dikes, sills, and small plutons of felsic Tertiary intrusive rocks and uncommonly by mafic dikes. At its type locality the formation is locally overlain by a massive conglomerate about 80 feet thick that contains abundant shaly boulders derived from the lower member of the McCarthy Formation. The conglomerate is cut by a few felsic Tertiary dikes, but its precise age cannot be determined.

LITHOLOGY

The lower unit of the bipartite Kennicott Formation consists mainly of sandstone, but minor conglomerate is commonly present at its base. The overlying upper unit is composed of siltstone and subordinate amounts of shale, sandstone, and conglomerate.

Sandstones of the lower unit are dominantly fine grained and poorly bedded. Some are crossbedded and locally may exhibit scour and fill relationships or show graded bedding. Very fine grained to very coarse grained sandstones are subordinate. Most of the sandstones are dark greenish gray on fresh surfaces and light gray or light pinkish brown on weathered surfaces. Fossiliferous sandy calcareous concretions, as much as 2 feet in diameter, are locally abundant. Conglomerate, which occurs mainly at the base of the lower unit, is well indurated and consists of subrounded to angular cobbles, pebbles, and boulders whose composition closely reflects local provenances. The conglomerates grade upward into the typical sandstones of the lower unit. Their matrices consist mainly of medium-grained felspathic and lithic sandstone (wacke). Locally the basal beds contain blocky greenstone boulders as much as 10 feet in maximum dimension.

According to the classification of Williams, Turner, and Gilbert (1954, p. 290), which is used in this report, sandstones of the lower unit are mainly wackes and subordinately arenites. Most of the wackes and arenites are feldspathic; less commonly they are lithic or arkosic. The wackes of the lower unit are poorly to moderately sorted with subangular grains set in a microcrystalline matrix that constitutes between 10 and 35 percent of the rock's volume. The dominant clasts of the feldspathic wackes are quartz and plagioclase, chiefly labradorite or calcic andesine in various stages of alteration. The less abundant clasts include K-feldspar, lithic fragments, calcite, chlorite, glauconite, and opaque minerals, mainly leucoxene, hematite, ilmenite, and magnetite. Rare detrital clasts in the feldspathic wackes include apatite, clinozoisite, epidote, zircon, biotite, muscovite, and garnet. A few of the feldspathic wackes contain some minerals of probably authigenic origin, chiefly quartz overgrowths, chalcedony, secondary K-feldspar, and zeolites. Matrices of most of the wackes consist of chalcedony along with lesser amounts of clay minerals, chlorite, pervasive hydrous iron sesquioxides, and uncommonly sericite, calcite, siderite, ankerite, and carbonaceous debris. A few of the wackes contain sufficient glauconite to be termed "greensand".

The lithic wackes and the arkosic wackes are similar to the feldspathic wackes except that the lithic wackes contain between 10 and 25 percent lithic fragments and the arkosic wackes contain more than 25 percent total feldspar, in contrast to lesser amounts of total feldspar in the feldspathic wackes.

The arenites are mineralogically similar to the wackes. They differ from the wackes by containing abundant calcite cement, which in a few specimens forms as much as 40 percent of the rock. Like the wackes, the arenites of the lower unit are divided into feldspathic, lithic, and arkosic varieties on the basis of their relative contents of feldspars and lithic fragments.

The dominant siltstones of the upper unit are dark gray and weather to diverse shades of brown, generally pinkish brown. The siltstones grade into or are intercalated with shale, minor amounts of sandstone, and less commonly, conglomerate. These rocks are also mainly dark gray and weather brown. Most of the conglomerate beds are thin and form small lenses. Sandy calcareous concretions similar to, but generally less fossiliferous than those of the lower unit, mark several stratigraphic horizons in the upper unit.

The siltstones are principally finer grained replicas of the wackes and arenites. Their detritus is generally better sorted and more rounded than that in the wackes and arenites, and they contain proportionately less unstable clasts, such as feldspars, relative to quartz. Most of the siltstones resemble the wackes by having microcrystalline matrices, but a few siltstones are calcite cemented. Microfossils are fairly abundant in some of the siltstones.

The sandstones of the upper unit are similar to their counterparts in the lower unit and are mainly wackes and less commonly arenites. The uncommon shales in the upper unit consist of chalcedony-rich varieties that are aptly termed porcellanites and of clay-rich phases with very fine siliceous detritus. Both varieties are characterized by shaly partings and are rich in microfossils. Most conglomerates in the upper unit are well-cemented granule and pebble conglomerates that carry clasts of local derivation.

AGE

The Kennicott Formation, of Early Cretaceous age, can be subdivided into two well-defined faunal zones of early Albian age—a lower *Moffitites robustus* zone and an upper *Brewericeras hulenense* zone (Jones, 1967, p. 2–3). In the McCarthy A-3, A-4, and B-4 quadrangles a few scattered fossil collections indicate beds of probable middle Albian or early late Albian age, but fossils of these ages are too uncommon and the stratigraphic succession as yet too poorly understood to permit defining another zone in the upper part of the formation.

The lower unit at and near the type locality and in parts of the A-4 quadrangle contains abundant fossils of the pelecypod *Aucellina* as well as the ammonite *Moffitites* and is representative of the early Albian zone of *Moffitites robustus*. Elsewhere north of these localities, rocks of the lower unit are younger and are characterized by the ammonite *Brewericeras* and other fossils indicative of the late early Albian zone of *Brewericeras hulenense*.

Throughout most of its range the upper unit contains *Brewericeras* and other ammonites characteristic of the *Brewericeras hulenense* zone, but at a few localities it contains fossils suggestive of middle or early late Albian ages.

Both the upper and lower units are rich in fossils, chiefly ammonites and pelecypods, and less commonly gastropods. The basal rocks of the lower unit commonly also contain fossil wood and plant debris, and the shales and siltstones of the upper unit are locally rich in radiolarians and foraminifers.

Moonshine Creek Formation

NAME AND DISTRIBUTION

The name Moonshine Creek Formation is here applied to the thick, dominantly siltstone and sandstone sequence that is well exposed along Moonshine Creek in the McCarthy C-4 quadrangle, herein designated as the type area for the formation (fig. 2). The Moonshine Creek Formation is widely distributed in the southwestern part of the C-4 quadrangle. It underlies small areas in the C-5 quadrangle south of Regal Glacier and west of the Nizina River and in the northwestern and southeastern parts of the B-4 quadrangle.

THICKNESS AND STRATIGRAPHIC RELATIONS

The best exposed section of the formation, which is at its type area, is about 3,500 feet thick (fig. 2). Elsewhere the formation ranges from a few tens to a few thousands of feet in thickness. Many sections of the formation have been attenuated by erosion, and several hiatuses document gaps in its stratigraphic record.

At its type area and in some other parts of the C-4 quadrangle, the Moonshine Creek Formation unconformably overlies the Nikolai Greenstone. Elsewhere it discomformably overlies the Kennicott Formation. Commonly the Moonshine Creek Formation is unconformably overlain by Tertiary nonmarine sedimentary rocks that are intercalated with the older flows of the Wrangell Lava. At a few places in the southeastern part of the B-4 quadrangle, the Moonshine Creek Formation is overlain by the Chititu Formation. The Moonshine Creek Formation is cut by a few Tertiary sills and dikes, chiefly felsic varieties.

LITHOLOGY

The Moonshine Creek Formation consists dominantly of siltstone and of sandstone that is of diverse grain sizes. It is divided into six informal members, designated from oldest to youngest as members 1 to 6. The basal unit, member 1, is about 900 feet thick and consists mainly of sandstone with minor interbedded concretionary gray siltstone. The sandstone grades downward into thin pebble and boulder conglomerates that mark the base of the formation. Member 2 is at least 700 feet thick and consists of poorly indurated olive-gray siltstone with abundant calcareous concretions. Member 3 is composed of massive cliff-forming greenish-gray sandstone between 300 and 400 feet thick that contains abundant fossiliferous calcareous concretions. Member 4 is about 1,000 feet thick and mainly consists of gray siltstone with abundant calcareous concretions. Member 5 is about 200 feet thick and consists of medium-grained green sandstone. Member 6 is also about 200 feet thick and is dominantly medium-grained greenish-gray sandstone with local conglomeratic and silty beds.

The siltstones of the Moonshine Creek Formation are moderately sorted, well-cemented rocks that contain subangular to subrounded clastic silt of quartz, plagioclase, and chlorite along with uncommon small lithic fragments and scattered opaque minerals in a clay-rich matrix. Subordinate constituents of the matrices are chlorite, calcite, epidote, heulandite, and sericite. The sandstones are chiefly feldspathic wacke and to lesser extents lithic wacke and arenite. Most of these rocks are moderately to poorly sorted and are composed of subangular to subrounded clasts, chiefly in the fine sand range, set in a microcrystalline matrix. Their dominant clasts are quartz and plagioclase, and their less abundant clasts include calcite, chlorite, glauconite, K-feldspar, biotite, epidote, lithic fragments, opaque minerals, and zircon. Matrices of the sandstones are mainly chlorite, chalcedony, and clay minerals, generally with dispersed secondary iron minerals and carbonaceous debris. Sericite, zeolites, calcite, and siderite are also rare matrix constituents. The arenites contain abundant calcite cement. The shales and mudstones consist largely of argillaceous minerals with subordinate sand and silt. Chalcedonic tests of microfossils are common in some of the pelitic rocks. The conglomerates range from boulder to granule conglomerate and commonly are gradational into sandstone. Their clasts are diverse and mainly were derived from older Cretaceous rocks and from Triassic rocks, particularly the Nikolai greenstone.

AGE

The Moonshine Creek Formation contains abundant ammonites and pelecypods, mainly *Inoceramus;* these fossils define three main faunal zones ranging in age from late Albian to late Cenomanian (Early and Late Cretaceous). These include the late Albian zone of *Desmoceras (Pseudouhligella) dawsoni,* the early Cenomanian zone of *Desmoceras (Pseudouhligella) japonicum,* and a late Cenomanian *Inoceramus* sp. zone. A few ammonites of possible middle Albian age also have been found near the base of the formation.

The formation probably was deposited in a restricted, rapidly sinking basin. It is partly contemporaneous with the upper part of the Kennicott Formation, with the much thinner Schulze Formation, and probably with the lower part of the Chititu formation.

Schulze Formation

NAME AND DISTRIBUTION

The Schulze Formation is here named for a thin sequence of dominantly siliceous pelitic rocks that are best exposed in the north-central part of the McCarthy B-5 quadrangle (fig.2). The name is taken from the nearby Schulze copper prospect in the B-5 quadrangle, which is held by Henry Schulze, a pioneer prospector.

The formation has a restricted distribution. It is best and most extensively exposed at the type area, particularly on the upland north of Sourdough Peak east of the upper reaches of Nikolai Creek in the B-5 quadrangle (fig. 2). It underlies small areas near the southwest corner of the C-5 quadrangle, near the southeast corner of the C-6 quadrangle, and in the high terrain near the western border of the B-4 quadrangle south of the Chitistone River (fig. 2). To the south the formation crops out locally along both flanks of MacColl Ridge in the A-4 quadrangle (fig. 2).

THICKNESS AND STRATIGRAPHIC RELATIONS

Most exposures of the formation are in high terrain where the rigorous alpine environment promotes fragmentation of the formation's thin-bedded and platy rocks and produces myriad chips that partly obscure many of the outcrops. Consequently, details of the formation's stratigraphy, which apparently include rapid changes in facies and in thickness, are not well understood. Estimated thicknesses for the formation range from 100 to about 225 feet or more.

The Schulze Formation overlies the Kennicott Formation with probable slight angular discordance. It is conformably overlain by the Chititu Formation and locally unconformably overlain by Quaternary surficial deposits. A few Tertiary felsic dikes and sills cut the formation.

LITHOLOGY

The Schulze Formation consists of siliceous rock that is aptly termed "porcellanite", of lesser amounts of interbedded sandstone, and of uncommon thin basal conglomerate. Most of these rocks are thin bedded. They are mainly light or medium gray when fresh, weather to pale yellow or to pale yellowish brown, and are conspicuously lighter colored than the other Cretaceous rocks of the region.

The porcellanites are dense, finely laminated, and platy rocks; they consist dominantly of chalcedony and grade into impure chert, which contains diverse amounts of very fine clastic grains that are widely dispersed in the chalcedonic matrix. These grains are chiefly calcite, but also include subordinate grains of quartz, magnetite, and hematite. Some of the porcellanites contain minor amounts of pyrite, limonite (?), carbonaceous debris, clay minerals, and sericite.

Sandstones of the formation generally are very fine grained feldspathic wackes and feldspathic arenites. The two rock types are compositionally similar and mainly consist of moderately well sorted very fine or fine grained subangular or subrounded grains set in a chalcedony-rich matrix that contains minor amounts of clay minerals, sericite, secondary iron minerals, and chlorite. The clasts include abundant quartz, fairly abundant plagioclase, calcite, glauconite, chert fragments, and chlorite, and uncommon opaque minerals, biotite, barite, and epidote.

The rare conglomerates at the base of the formation contain granules mainly derived from the Kennicott Formation set in a fine sandstone matrix.

AGE

Fossils in the Schulze Formation are mainly scraps of *Inoceramus* and microfossils, including calcareous tests of foraminifers and siliceous tests of radiolarians. Ammonites of the genus *Desmoceras (Pseudouhligella)* are common, but most shells are crushed and are too poorly preserved for specific determination. Several relatively undistorted specimens from the upper part of the formation are identified as *Desmoceras (Pseudouhligella) japonicum* of Cenomanian age.

The formation is contemporaneous with part of the Moonshine

Creek and Chititu Formations and has a probable age span from late Albian(?) to Cenomanian (Early(?) and Late Cretaceous).

The Schulze Formation probably was deposited in an isolated marine basin from which the abundant clastic debris of the Moonshine Creek Formation was restricted.

Chititu Formation

NAME AND DISTRIBUTION

The name Chititu Formation is applied here to the thick sequence of dominantly dark-gray to black pelitic rocks that are widely distributed in the McCarthy A-4, B-4, B-5, and B-6 quadrangles (fig. 2). The formation is named for Chititu Creek in the southeastern part of the B-5 quadrangle, but its type area is designated as the northwestern part of the McCarthy A-4 quadrangle both north and south of Young Creek and the southern part of the B-4 quadrangle south of the latitude of Copper Creek. Good reference sections for the formation extend north and south of Young Creek about 4 miles east of the western border of the A-4 quadrangle.

In the upper Chitina Valley the Chititu Formation is widely distributed but is largely covered by fluvioglacial deposits and is exposed principally in cliffs along the rivers. It is widespread in the northern part of the A-4 quadrangle, chiefly along the flanks of MacColl Ridge, and it forms the dominant rock unit in the southern part of the B-4 quadrangle west of Canyon Creek (fig. 2). Likewise, it is widespread throughout the southern part of the B-5 quadrangle and in the B-6 quadrangle. Small outcrops of the Chititu Formation are in the C-6 quadrangle near its southern boundary.

THICKNESS AND STRATIGRAPHIC RELATIONS

Stratigraphic measurements of the Chititu Formation are impaired by the lack of continuously exposed sections and marker horizons and by minor folds and faults. At its reference sections the formation's apparent thickness is about 5,500 feet. Thicknesses of similar magnitude are indicated at other places where large sections of the formation are exposed, as elsewhere in the southern part of the B-4 quadrangle and the southeastern part of the B-5 quadrangle.

At most places the Chititu Formation overlies the Kennicott Formation with apparent conformity. The contact between the Kennicott and Chititu Formations is well exposed in cliffs bordering the lower part of the Nizina River in the B-6 quadrangle and south of Copper Creek in the B-4 quadrangle (fig. 2). Locally in the A-4 and B-5 quadrangles the Chititu Formation conformably overlies the Schulze Formation. In the southeastern part of the B-4 quadrangle it appears to overlie the Moonshine Creek Formation, although relationships there are obscure.

In the A-4 quadrangle and locally in the B-4 and B-5 quadrangles, the Chititu Formation is conformably overlain by the MacColl Ridge Formation. Throughout much of the lowland terrane the formation is unconformably overlain by stratified unconsolidated Quaternary fluvioglacial deposits. At a few places other Quaternary surficial deposits mantle the Chititu Formation.

Throughout much of its range the formation is cut by small plutons of granodiorite or felsic hypabyssal intrusive rocks, both of Tertiary age. Swarms of dikes and sills of the felsic intrusive rocks are abundant and extensive in much of the Chititu terrane, particularly the southeastern part of the B-5 quadrangle and the northern part of the B-6 quadrangle. The formation is also cut by a few dikes with intermediate or mafic affinities.

LITHOLOGY

The Chititu Formation consists mainly of pelitic rocks, chiefly mudstone and shale. It contains minor amounts of porcellanite, impure chert, and fine-grained sandstone, and uncommon thin beds and lenses of impure limestone. Calcareous concretions of diverse sizes are locally abundant. Sandstone dikes, generally less than 2 feet thick, transect parts of the formation, notably in the southeastern part of the B-5 quadrangle. Commonly the sandstone dikes cut the bedding at high angles. Adjacent to the granodiorite plutons, near Williams Peak and near Pyramid Peak (fig. 2), rocks of the Chititu Formation have been baked, silicified, and partly recrystallized. These altered rocks occupy contact aureoles as much as a mile wide that surround the plutons, and they weather to medium or dark brown in contrast to the dark-gray or black surfaces characteristic of most unaltered rocks of the formation.

The dominant mudstones and shales of the formation are mineralogically similar. The mudstones are massive, blocky, and commonly have hacky fracture, whereas the shales have fine partings or fissility. Many of the pelitic rocks, particularly the shales, are finely laminated. They generally contain subordinate silt clasts, chiefly of quartz, scattered throughout a microcrystalline matrix that consists mainly of chalcedony and clay minerals, mainly illite. The porcellanites and impure cherts are mainly microcrystalline rocks that consist almost entirely of chalcedony.

The arenaceous rocks of the formation include feldspathic wackes and lithic arenites. They consist of poorly to moderately sorted fine-grained clasts set in a chalcedony- or calcite-rich matrix. Commonly the clasts are subangular and are composed of quartz and plagioclase and subordinately of lithic fragments, opaque minerals, K-feldspar, calcite, dolomite, epidote, muscovite, zircon, and sphene.

The carbonate rocks of the formation include limestone breccias and impure micritic limestones. The limestone breccias contain small fragments of micritic limestone that are cemented by sparry calcite. The micritic limestones are extremely fine grained and composed of cloudy calcite that locally is cut by veinlets of limpid calcite. Most of the limestones contain widely scattered detrital grains, chiefly of quartz and opaque minerals.

AGE

Fossils in the Chititu Formation consist mainly of *Inoceramus* and less commonly of ammonites that are generally enclosed in concretions. Microfossils, chiefly radiolarians, are abundant in some of the silica-rich pelites and less common in the other rocks. The megafossils indicate that the formation is mainly Late Cretaceous, with an age span extending from at least Cenomanian to Late Campanian. The base of the formation appears to vary in age from place to place, and may be as old as early Albian along the lower Nizina River, latest Albian near Copper Creek, and as young as Coniacian on MacColl Ridge.

MacColl Ridge Formation

NAME AND DISTRIBUTION

A coarse sandstone sequence that is well exposed on MacColl Ridge in the McCarthy A-4 quadrangle is named here the MacColl Ridge Formation. The type section is about 3 miles east of the west boundary of the A-4 quadrangle (fig. 2) and trends southward from the contact with the Chititu Formation to near the crest of MacColl Ridge where the uppermost exposed strata of the formation occupy the core of a syncline.

The formation is not extensively distributed, and it is largely confined to high mountainous terrain where its erosion-resistant strata form bold outcrops (see Jones and Berg, 1964, figs. 3–5). Besides capping much of MacColl Ridge, the formation is exposed in the summit areas and flanks of some of the higher peaks in the southern part of the B-4 quadrangle and to a lesser extent in the southeastern part of the B-5 quadrangle.

THICKNESS AND STRATIGRAPHIC RELATIONS

The thickness of the entire formation is not determinable because its top is not preserved. The formation is about 2,500 feet thick at its type section (fig. 3), and similar maximum thicknesses are known elsewhere.

The MacColl Ridge Formation overlies the Chititu Formation with apparent conformity. It is not in contact with any post-Cretaceous consolidated sedimentary rocks. Near Pyramid Peak and elsewhere in the southwestern part of the B-4 quadrangle the formation is cut by Tertiary granodiorite plutons, and also by a few dikes and sills of Tertiary felsic intrusive rocks. Locally the formation is overlain by unconsolidated Quaternary surficial deposits and by permanent snow and ice.

LITHOLOGY

The MacColl Ridge Formation consists dominantly of coarse-grained sandstone which locally grades into very coarse grained sandstone and granule to pebble conglomerate or into medium- or fine-grained sandstone and siltstone. Most rocks of the formation are light or medium gray when fresh and diverse shades of brown when weathered, but the siltstone is dark gray to black when fresh and dark brown when weathered.

The sandstone includes feldspathic, lithic, and arkosic wacke. These rocks consist of subangular clasts set in chalcedony-chlorite-clay matrices that constitute between 10 and 35 percent of their volumes. The wackes are poorly sorted, and their clasts have size differentials between ten and a hundredfold.

The dominant clasts in most of the wackes are lithic fragments, quartz, and plagioclase. Their less abundant clasts include K-feldspar, chlorite, biotite, and opaque minerals; their rare clasts are calcite, apatite, actinolite, hornblende, epidote, muscovite, zircon, sphene, and augite. Their lithic fragments are chiefly chert and less commonly porphyritic intrusive rocks, siltstone, and diverse metamorphic rocks. Except for containing coarser clasts and a preponderance of lithic clasts the conglomerate is similar to most of the wackes. Clasts in the siltstones are finer than those in the sandstones and are predominantly of stable constituents. Some of the siltstones contain carbonaceous debris. Near the granodiorite pluton, rocks of the formation have been baked and partly recrystallized.

The formation's limited distribution, together with the coarseness of the clasts and the abundance of the lithic fragments, indicates rapid deposition, probably adjacent to a locally uplifted area.

AGE

The precise age of the MacColl Ridge Formation cannot be ascertained because of the lack of diagnostic fossils. On the basis of its superposition above Campanian strata and on the basis of its relation to intrusive Tertiary rocks, the MacColl Ridge Formation is considered to be of Late Cretaceous (late Campanian or Maestrichtian) age. The only fossils that have been found in the formation are poorly preserved plant remains, fragments of *Inoceramus*, and possibly reworked fragments of unidentifiable ammonites.

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