Stratigraphic Reconnaissance of the Matanuska Formation in the Matanuska Valley Alaska

By ARTHUR GRANTZ

CONTRIBUTIONS TO GENERAL GEOLOGY

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The Matanuska Formation in its type area—its character, age, and stratigraphic rank

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By Arthur Grantz

ABSTRACT

A thick sequence of clastic marine sedimentary rocks of Cretaceous age crops out widely in the Matanuska Valley of south-central Alaska. These rocks have been known for many years as the Matanuska Formation of Late Cretaceous age. However, a stratigraphic reconnaissance in the type area, the Matanuska Valley, and detailed mapping in the adjacent Nelchina area have demonstrated that this formation includes beds that range in age from Early Cretaceous (Albian) to Late Cretaceous (Maestrichtian). The formation also comprises several mappable lithologic units, and when these units are defined as formations, the Matanuska will merit elevation to group rank.

INTRODUCTION

SCOPE OF PROBLEM AND LOCATION OF AREA

Clastic marine sedimentary rocks of Cretaceous age form more than one-third of the bedrock outcrops in the Matanuska Valley of south-central Alaska (fig. 1). They were named the Matanuska Formation by Martin (1926, p. 317–327) for exposures in the Matanuska Valley and especially for a section of sandstone and lutite more than 4,000 feet thick exposed on Granite Creek. These rocks also underlie parts of the Copper River and Cook Inlet Lowlands, where they are of interest as a possible source of petroleum.

The Matanuska Valley is a poor site for establishing a type area or a type section for the thick Matanuska rocks because the geologic structure there is moderately complex and because the valley is underlain by widespread glacial deposits. Martin could recognize neither the top nor base of his Matanuska Formation nor could he reconstruct a complete section of it, and neither its thickness nor full age range was known. However, these rocks are more completely exposed in the Nelchina area, at the head of the Matanuska River drainage.

The rocks in the Nelchina area that are correlative with Martin's Matanuska Formation consist of several mappable units ranging in

FIGURE 1.—Index map of Matanuska Valley area, showing major physiographic features and location of Nelchina area and area of figure 2.

age from Albian to Maestrichtian. Some of these units are separated by unconformities and (or) gaps in the faunal succession. The Matanuska rocks in the Nelchina area therefore warrant designation as a formal group containing several lithologically defined formations. The present study was undertaken to determine whether the Matanuska in its type area also consists of several mappable units and whether these correspond in lithology and age to those in the Nelchina area.

ACKNOWLEDGMENTS

Ralph W. Imlay and David L. Jones, paleontologists for the U.S. Geological Survey, helped collect and identified the mollusks obtained from the Matanuska Formation. Jones is studying the faunas in detail, and the identifications and age assigments cited below are chiefly his. M. G. Ayres and L. J. Parkinson, Standard Oil Co. of California, made available the fossils of USGS Mesozoic locality M583.

GEOLOGIC SETTING

STRUCTURE

The Matanuska Valley proper (fig. 1) is a narrow structural valley 5 to 10 miles wide and 50 miles long where upper Mesozoic and Tertiary sedimentary rocks have been downdropped along faults and sharp flexures; older, more resistant rocks form the mountains which flank the valley on the north and south. The present valley was excavated mainly by the Matanuska Glacier, during repeated advances in Pleistocene time, and by the Matanuska River.

The sedimentary rocks in the Matanuska Valley are bounded on the north chiefly by the large high-angle Castle Mountain fault (fig. 2) and on the south by a sharp flexure and associated large faults along the structural and topographic north front of the Chugach Mountains. The rocks in the valley have been rather complexly faulted and also tilted and folded, and the Matanuska rocks are notably more indurated there than in the adjacent Nelchina area and Copper River Lowland. The belt of Matanuska and other sedimentary rocks is also narrower in the Matanuska Valley than in the adjacent areas. These contrasts exist because the Matanuska Valley has been more intensely deformed in post-Matanuska time than the Nelchina area and the Copper River Lowland.

TECTONIC SETTING AND PROVENANCE

The Matanuska beds are part of a distinctive sequence of Jurassic and Cretaceous sedimentary rocks, dominantly marine, that trends in a narrow elongate belt from the Canadian boundary to the outer Alaska Peninsula. These rocks were deposited in a trough whose northern shoreline was not far beyond the present north limit of the belt, and local evidence suggests that at least at certain times and places a southern shoreline may have existed in what is now the northern Chugach Mountains. This trough was named the Matanuska geosyncline by Payne (1955). The location of this and other major Mesozoic tectonic elements in the Matanuska Valley region is shown in figure 3.

The Matanuska geosyncline was differentiated in earliest Middle Jurassic time as a deeply subsiding nonvolcanic depositional trough superimposed upon somewhat deformed eugeosynclinal rocks (the Talkeetna Formation of Early Jurassic age) which have been intruded by plutonic rocks. The Matanuska geosyncline was less extensive than the preceding eugeosyncline, and was filled by detritus from local uplifts. It therefore conforms to the definition of an epieugeosyncline (Kay, 1951, p. 56 and 107). Its history as a marine depositional trough was terminated by orogeny in Paleocene and Eocene times.

Two tectonic elements which were positive during part of Mesozoic time, the Talkeetna and Seldovia geanticlines, flank the Matanuska geosyncline on the north and south, respectively (Payne, 1955). In the Matanuska Valley area these geanticlines now mainly expose marine volcanic and sedimentary rocks (the Talkeetna Formation) and plutonic rocks (dominantly quartz diorite and granodiorite of Middle Jurassic to Early Cretaceous age). However, schist and marble are also exposed. The volcanic and plutonic rocks in the geanticlines apparently contributed most of the detritus that constitutes the Matanuska rocks.

HISTORICAL REVIEW

THE MATANUSKA SERIES OF MENDENHALL (1900)

The first geologist to report on the Matanuska rocks was Mendenhall (1900, p. 307–309), who studied them briefly in 1898 during a hurried reconnaissance from the Gulf of Alaska to the Tanana Valley. He assigned these and all other unmetamorphosed sedimentary rocks he saw in the Matanuska Valley and the Nelchina area to a stratigraphic unit that he named the Matanuska Series. The only determinable fossils he found in this unit were obtained near the head of Bubb Creek, in the Nelchina area. T. W. Stanton identified these as *Aucella*[1] *crassicollis* Keyserling and considered they indicated an Early Cretaceous age (Mendenhall, 1900, p. 309). Mendenhall thought the fossils occurred near the top of the Matanuska Series and tentatively assigned it an Early Cretaceous and older age. In

[1] The name *Aucella* was ruled invalid in favor of *Buchia* by the International Commission on Zoological Nomenclature in Opinion 492.

table 1 the age of the Matanuska Series as understood by Mendenhall is compared with later age assignments of the rocks herein referred to as the Matanuska Formation.

A less hurried reconnaissance in 1905 by Martin (1906a, p. 89; 1906b, p. 9–15 and pl. 3) demonstrated that the Matanuska Series included both marine and nonmarine rocks and beds of several ages. Because of the various ages, and because he thought that most of the sedimentary rocks in the Matanuska Valley were not Cretaceous but Tertiary, Martin (1906b, p. 10) abandoned the term Matanuska Series stating: "Our present knowledge is so imperfect that it is not advisable either to restrict the term or to define new formations which can be included within it."

THE MATANUSKA FORMATION OF MARTIN (1926)

Marine rocks of Late Cretaceous age were found by Martin and Katz among the rocks in the Matanuska Valley formerly referred to as the Matanuska Series (Martin, 1911, p. 129–130 and pls. 8, 9; Martin and Katz, 1912, p. 34–39 and pl. 5). They described these Cretaceous rocks, separated them from the Tertiary rocks with which they had been mapped, showed their general distribution, and measured the most complete section they found. This section (Martin and Katz, 1912, p. 34–35), exposed on Granite Creek, is about 4,000 feet thick, but neither its top nor its base is exposed. Fossil mollusks from this section and elsewhere in the valley were determined by Stanton (Martin and Katz, 1912, p. 38) to be of Late Cretaceous age. Similar rocks containing a similar fauna were subsequently reported from the Nelchina area by Martin and Mertie (1914, p. 275 and 279) and by Chapin (1918, p. 38 and pl. 2).

In 1926 Martin proposed the term Matanuska Formation for the Upper Cretaceous marine rocks of the Matanuska Valley. His description (Martin, 1926, p. 317–327) is mainly a recapitulation of his earlier work with Katz (Martin and Katz 1912, p. 34–39). Martin reestablished Mendenhall's name Matanuska in this new context although he had earlier rejected the latter's term Matanuska Series. Martin (1926, p. 317) stated:

> * * * the larger part of the area which was supposed to be occupied by the original "Matanuska series" contains these Upper Cretaceous strata, and * * * nearly all the exposures on the banks of Matanuska River from its source to its mouth consist of these Upper Cretaceous rocks. It is consequently believed to be appropriate to revive this long-abandoned name as the Matanuska formation, although it must be given a very different definition and assigned to a different position from that of the original "Matanuska series."

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EXPLANATION

QUATERNARY

Pleistocene and Recent

Qd — Surficial deposits

TERTIARY

Oligocene

Tv — Volcanic rocks
Mainly basaltic lava flows

Paleocene, Eocene, and Oligocene

Ti — Hypabyssal intrusive rocks

Tc — Continental clastic sedimentary rocks
Includes Chickaloon, Wishbone, and Tsadaka Formations

CRETACEOUS

Lower and Upper Cretaceous

Km — Matanuska Formation
Marine clastic sedimentary rocks

Lower and Upper(?) Cretaceous

Kar — Arkose Ridge Formation
Nonmarine arkose, conglomerate, and siltstone

CRETACEOUS / JURASSIC

KJi — Plutonic intrusive rocks
Mainly quartz diorite and granodiorite. Age: Middle Jurassic to Early Cretaceous

JURASSIC

Middle and Upper Jurassic

Js — Marine clastic sedimentary rocks
Consists of Tuxedni, Chinitna, and Naknek Formations

Lower Jurassic

Jt — Talkeetna Formation
Dominantly marine intermediate volcanic and sedimentary rocks

PRECAMBRIAN OR PALEOZOIC

p€Pzc — Muscovite schist

Contacts

Faults
Dashed where inferred. Only a few of the largest are shown. Queried where doubtful

FOSSIL-BEARING LOCALITIES

●3
Fossils of Albian age

■6
Fossils of Campanian age

▲15
Fossils of late Campanian and Maestrichtian age

△22
Fossils questionably of late Campanian and Maestrichtian age

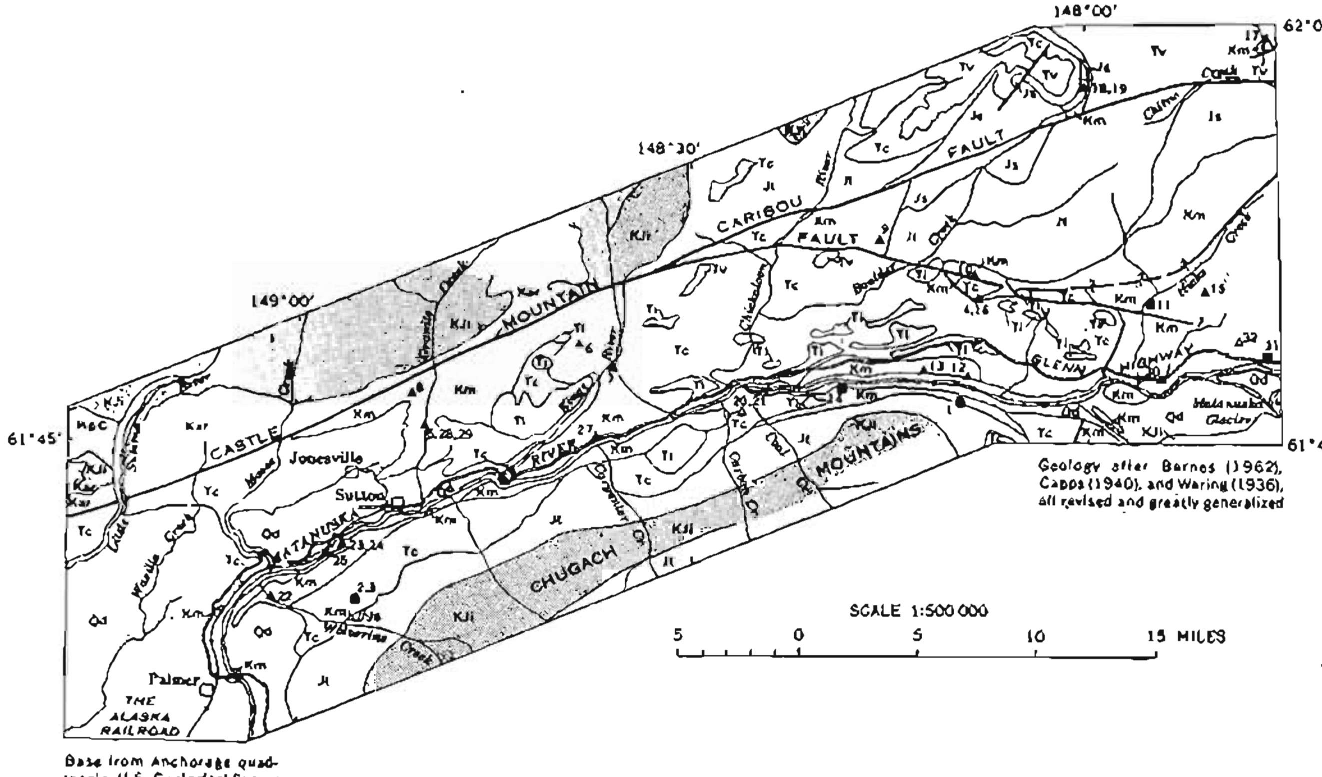

FIGURE 2.—Greatly generalized geologic map of Matanuska Valley area showing Cretaceous fossil-bearing localities. Locality descriptions and lists of fossils are given in tables 2 and 3.

TABLE 1.—*Stratigraphic nomenclature and age assignments applied from 1900 to the present time to rocks of the Matanuska Formation of this report. Section in Nelchina area presented for comparison*

System and series		Matanuska Valley: Mendenhall (1900)	Matanuska Valley: Martin (1906b)	Matanuska Valley: Martin and Katz (1912)	Matanuska Valley: Martin (1926)	Matanuska Valley: This report	Nelchina area: Imlay and Reeside (1954)	Nelchina area: Grantz and Jones (1960)	Nelchina area: Bergquist (1961)	Standard European stages	
TERTIARY	Pliocene										
	Miocene										
	Oligocene		? Shale, sandstone, and conglomerate, usually with coal ?						(Section near Squaw Creek only)		
	Eocene										
	Paleocene										
CRETACEOUS	Upper Cretaceous			Marine shale and sandstone	Matanuska Formation	? Matanuska Formation	? Matanuska Formation ?	? Matanuska Formation	Matanuska Formation	Maastrichtian	Senonian
										Campanian	
										Santonian	
										Coniacian	
										Turonian	
										Cenomanian	
	Lower Cretaceous									Albian	
										Aptian	
										Barremian	Neocomian
										Hauterivian	
		Matanuska Series								Valanginian	
										Berriasian	
JURASSIC		? ↓ ?									

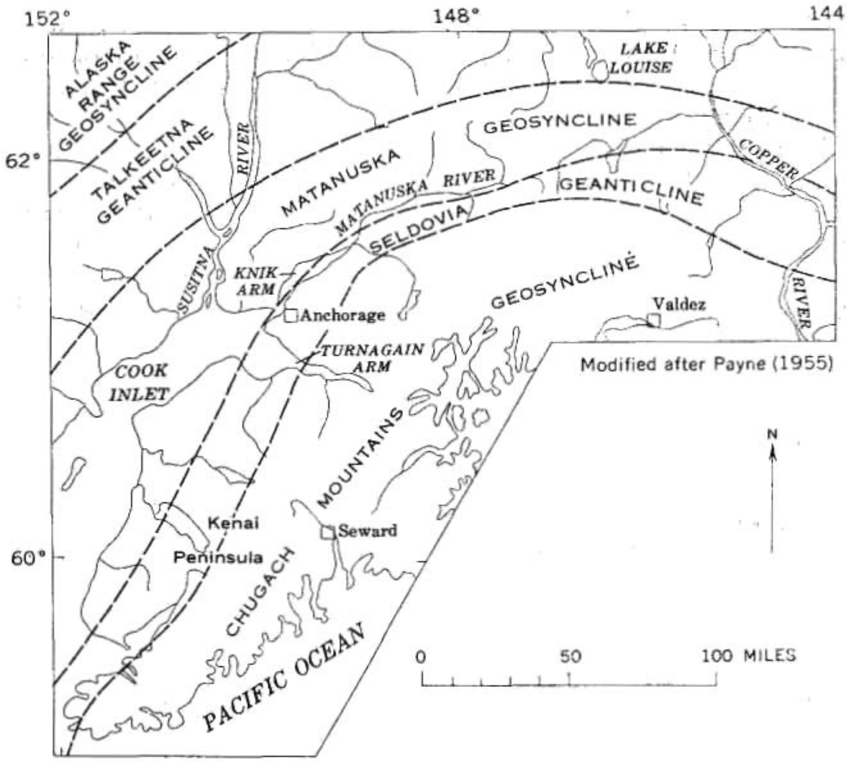

FIGURE 3.—Major Mesozoic tectonic elements in Matanuska Valley area.

The available fossil localities and Stanton's fossil identifications were included by Martin (1926, p. 321–327) in a very useful compilation of the then-existing paleontologic data concerning his Matanuska Formation. On the basis of the assembled data Martin assigned his Matanuska Formation to the upper part of the Upper Cretaceous (Martin, 1926, table facing p. 474).

CONTRIBUTIONS SINCE 1926 AND PRESENT INVESTIGATION

Capps (1927, p. 35–40 and pl. 2) mapped the Matanuska Formation in the upper Matanuska Valley and described its basal beds from outcrops south of the Matanuska River. Imlay and Reeside (1954, p. 231–233 and pl. 1) correlated the formation with the Coniacian to Maestrichtian Stages of the Upper Cretaceous of Europe on the basis of its mollusks, and Bergquist (1961) correlated the thick section of Matanuska rocks near Squaw Creek in the Nelchina area with the late Turonian to Maestrichtian Stages on the basis of foraminifers. Eckhart (1959, p. 38–45) described the lithology, petrography, and a partial section of the Matanuska rocks in the Kings River and Sutton areas. In recent years much geologic work has been accomplished in the Matanuska rocks by private companies engaged in petroleum exploration.

The present investigation is an outgrowth of structural and stratigraphic studies in the Nelchina area in which the Matanuska rocks were a major concern. The Matanuska rocks were then briefly studied in their type area to help resolve problems of their nomenclature in the Nelchina area. The report is based upon 2 weeks' fieldwork in the Matanuska Valley in 1959, the earlier work in the Nelchina area, and study of the literature. The writer was accompanied in the field in 1959 by D. L. Jones. Preliminary paleontologic and stratigraphic results of this fieldwork are given in a short paper by Grantz and Jones (1960).

DEFINITION AND STRATIGRAPHIC RANK

The Matanuska Formation, as herein defined, includes: (1) the marine Cretaceous strata in the Matanuska Valley that Martin (1926) designated the Matanuska Formation and (2) the marine Cretaceous strata in the upper Matanuska Valley, Nelchina area, and southwest Copper River Lowland that Martin and later workers (Capps, 1927; 1940; Imlay and Reeside, 1954; Grantz, 1953; 1961a, b; Grantz and Jones, 1960; Barnes, 1962) assigned to the Matanuska Formation on basis of lithologic similarity and age of the entombed mollusks. Designation of formations within the Matanuska in the Matanuska Valley seems possible, but must await detailed geologic mapping and the establishment of a complete section there. However, a complete section of the Matanuska Formation has been established in the Nelchina area, where the formation consists of several thick lithologic units which have been mapped, and which warrant designation as separate formations (Grantz, 1961a, b). When these units are formally defined as formations the Matanuska will be elevated to group rank.

DISTINGUISHING FEATURES

The Matanuska Formation consists of marine clastic sedimentary rocks of the graywacke suite which are characterized by dark lutite, greenish-gray sandstone, and some conglomeratic mudstone and sandstone. The beds range in age from Albian to Maestrichtian. The underlying and overlying beds are separated from the Matanuska Formation by unconformities which represent tectonic activity and erosion. At most places these beds are readily distinguishable from the Matanuska Formation on the basis of lithology.

Descriptive terms applied to sedimentary rocks in this report are based upon the following classifications: (1) Rock colors are according to the rock-color chart prepared by the National Research Council (Goddard, 1948). (2) Clastic-grain grade sizes are mainly according to the Wentworth scale (Wentworth, 1922) but in part after the compatible scale proposed by the National Research Council (1947). (3) Descriptive terms for bedding thickness are according to the following scale:

0 to 2 inches	Very thin bedded
2 to 6 inches	Thin bedded
6 inches to 2 feet	Medium bedded
2 to 6 feet	Thick bedded
>6 feet	Very thick bedded

Descriptive terms are used instead of actual thickness because thickness of bedding was commonly estimated, rather than measured. (4) Lithologic descriptions are based mainly on hand lens examinations, but are supplemented by a few petrographic descriptions. The term "sandstone" is used to designate clastic rocks in which sand-sized grains are dominant; it has no other connotation. The term "graywacke" is used, in places, to designate sandstone containing more than 10 percent detrital matrix composed of grains finer than coarse silt (that is, finer than 1/32 mm in diameter). "Lutite" is used for rocks composed of silt and (or) clay-sized clastic particles. This and other terms of Grabau's classification of clastic rocks are used interchangeably with some of their common English counterparts.

TYPE AREA

The type area of the Matanuska Formation is the Matanuska Valley. However, a complete section of the formation in the valley is not known to the writer. Good partial sections can be studied on Granite Creek, Matanuska River, Kings River, Wolverine Creek, in cuts along the Glenn Highway, and between Moose Creek and Sutton along The Alaska Railroad branch line to Jonesville. Much more completely exposed sections of the formation can be studied in the Nelchina area, and principal reference sections for the formation and for its constituent units will be established there in a report that is in preparation.

DISTRIBUTION

The Matanuska Formation crops out in the Matanuska Valley from the vicinity of Palmer, near the mouth of the valley, to beyond the Matanuska Glacier at the head of the valley; in the drainage of Boulder and Caribou Creeks, tributaries of the Matanuska River from the north; in the Nelchina area; and in the southwest part of the Copper River Lowland as far east as a point a few miles east of Tazlina

Lake (figs. 1 and 2). Generally correlative rocks of similar character and tectonic aspect crop out in the Chitina Valley and on the Alaska Peninsula. In the latter area they have been referred to the Chignik and Kaguyak Formations of Late Cretaceous age.

CONTACTS

BASAL CONTACT AND BASAL BEDS

The basal beds of the Matanuska Formation are variously of Albian, Cenomanian, middle Campanian, and late Campanian or Maestrichtian age; they rest with discordance upon bedded rocks of Early Jurassic to Early Cretaceous age. The basal contact of the formation is exposed intermittently along the front of the Chugach Mountains from Wolverine Creek in the lower Matanuska Valley to Tazlina Lake in the southern Copper River Lowland, and in the Nelchina area.

At the north front of the Chugach Mountains near Wolverine Creek, the basal beds of the Matanuska Formation are of late early Albian age and rest with angular discordance upon Upper Jurassic siltstone (the Naknek Formation). However, along the mountain front east of Wolverine Creek in both the Matanuska Valley and the Nelchina area, the basal beds, which may be of late early or possibly of late Albian age, rest unconformably upon Lower Jurassic volcanic rocks (the Talkeetna Formation). This unconformity was not observed in the Matanuska Valley east of Wolverine Creek during the present study, but was reported by Capps (1927, p. 36).

In the axial portion of the belt of Matanuska rocks in the Nelchina area (between lat 61°50′ and 62°00′ N.) and in the headwaters of Hicks Creek, the basal beds of the Matanuska Formation are mainly of Cenomanian age. However, at one locality they are of middle Campanian age. These basal beds rest with angular discordance upon marine sedimentary rocks of Middle (the Tuxedni Formation) and Late Jurassic age (the Chinitna and Naknek Formations) as well as upon the Talkeetna Formation and a small pluton.

In the northern part of the Nelchina area the basal beds of the Matanuska Formation are locally of early Albian age, but these Albian beds are overlapped by latest Campanian or Maestrichtian beds in the most northerly outcrops of the formation in the headwaters of the Little Oshetna River. The Albian beds, which crop out in the headwaters region of the Little Nelchina River, rest unconformably upon Neocomian (Lower Cretaceous) beds. The latter are the youngest substrate of the Matanuska Formation that has been recognized to date. The most northerly outcrops of the formation overlap the Neocomian beds and rest unconformably upon Upper Jurassic rocks (the Naknek Formation).

The basal contact of the Matanuska Formation may be exposed in the drainage of Boulder Creek on the north side of the upper Matanuska Valley, but it is probably exposed nowhere on the north side of the lower Matanuska Valley. However, the nonmarine Arkose Ridge Formation of the southwest Talkeetna Mountains, which is of Albian or possibly Cenomanian age (Grantz and Wolfe, 1961), rests with nonconformity upon schist and upon the Talkeetna batholith. This formation is correlative with the lower part of the Matanuska Formation and is in contact with it along the Castle Mountain fault. The nonconformity at its base may correspond to the angular unconformity beneath either the Albian beds or the Cenomanian beds that occur at the base of the Matanuska Formation.

UPPER CONTACT

The Matanuska Formation is overlain by Paleocene(?) and Eocene coal-bearing rocks (the Chickaloon Formation) near Billy Creek in the Nelchina area and in the Matanuska Valley. The contact is not exposed in the Nelchina area and is apparently exposed at few places in the Matanuska Valley. Massive conglomerate at the base of the Chickaloon Formation rests with apparent unconformity upon beds low in the Matanuska Formation near Wolverine Creek, but the actual contact was not seen. In addition, rocks of the Matanuska Formation in the Matanuska Valley generally dip more steeply or are more severely faulted than rocks of the Chickaloon Formation in nearby outcrops. The Matanuska rocks are also harder, and in places Matanuska lutite has been altered to argillite. In contrast, the Chickaloon Formation, even where most severely deformed, is only moderately indurated. These contrasts in structure and induration suggest that the Matanuska Formation may have been subjected to deformation before the Chickaloon Formation was deposited, and tend to support the evidence for an angular unconformity between the Matanuska and Chickaloon Formations.

At many places in the Nelchina area the Matanuska Formation is overlain unconformably by nonmarine conglomerate and coal-bearing rocks of Oligocene age. This angular unconformity is probably also present on upper Boulder Creek, but Barnes (1962) indicates that Oligocene rocks are nowhere in contact with the Matanuska Formation in the lower Matanuska Valley.

CONSTITUENT UNITS

BEDS OF ALBIAN AGE

CHARACTER NEAR WOLVERINE CREEK

The oldest beds of the Matanuska Formation in the Matanuska Valley, which are of Albian age, crop out intermittently along the north front of the Chugach Mountains. Near Wolverine Creek these beds are shallow marine deposits which rest with unconformity upon siltstone of the Naknek Formation (Upper Jurassic), The unconformity has erosional relief, and angular cobbles of Naknek Formation siltstone locally constitute the basal 2 feet of the Albian beds. The Albian section is more than 300 feet thick near Wolverine Creek, and is apparently overlain unconformably by the Chickaloon Formation.

The basal part of the Albian section at Wolverine Creek consists of lithic (epiclastic volcanic) graywacke 0 to about 30 feet thick. Most of the pebbles and sand grains in the rock are dark-gray or black volcanic rock fragments. The sandstone is coarse or very coarse grained and pebbly in the lowest beds, but grades upward into fine and very fine grained, slightly pebbly sandstone in the highest beds. The latter contain sandy limestone concretions, fossil mollusks, wood fragments, and grains of glauconite. A few ammonites and pelecypods were collected from the concretions. Locally cobbles of the sandstone itself are abundant in the lower beds. The sandstone weathers gray, but it is irregularly and extensively stained brown by iron oxide.

Originally the sandstone was rather poorly sorted, and its matrix was composed of comminuted rock and mineral fragments. However, at many places in the sandstone, the matrix and many of the sand-sized clasts of volcanic rock and plagioclase were replaced metasomatically by calcite. The calcite also forms veinlets in the sandstone and concretions in the upper fine-grained beds. The replacement has proceeded so far that a rock composed of volcanic grains and a little quartz and feldspar "floating" in a matrix composed primarily of diagenetic calcite has been produced at many places. Iron oxide also has replaced a little of the detrital matrix, especially around sand grains, and its mobilization during weathering has produced the irregular brown stain on much of the outcrop. A black sooty nickel and cobalt-bearing manganese mineral (X-ray spectrographic determination by James O. Berkland) has filled some joints in the sandstone and replaced a little of the matrix near its base.

The character of the lithic (volcanic) graywacke with original detrital matrix and its character where the matrix and sand grains have been extensively replaced by cryptocrystalline calcite are contrasted below by modal analyses of two thin sections. Both samples are coarse grained and from the lower part of the sandstone. Point counts for the modal analyses were made under the writer's direction by Paul G. Bower.

	Graywacke with detrital matrix (percent)	*"Graywacke" with metasomatic calcite cement (percent)*
Quartz	2	2
Plagioclase	3	1
Potassium feldspar	0	1
Mafic minerals	0	0
Rock fragments (mainly volcanic rocks)	75	45
Opaque minerals	<1	<1
Matrix or cement	19	50
	100	100
Point counts	232	300

Fairly hard dark-greenish-gray and medium-dark-gray silty claystone that is probably 200 or more feet thick overlies the sandstone. However the outcrop is faulted and the true thickness of the silty claystone is not known. The lowest 40 feet of the claystone contains abundant limestone nodules both irregularly scattered through it and concentrated in lenticular zones 2 to 6 feet thick. Where most concentrated, the nodules form cemented irregular masses of limestone conglomerate 2 to 4 feet thick. These masses are composed of limestone nodules, sandy limestone or marl containing many allogenic clastic grains, and some biogenic material. The biogenic material consists mainly of banded incrustations produced by calcareous algae but includes mollusk shells and shell fragments. A thin zone containing limestone nodules also occurs near the top of the silty claystone, and grains of glauconite occur in both the limestone and the claystone. The claystone contains a few very thin beds of tuffaceous(?) sandstone and, in its upper 5 feet, thin and medium interbeds of fine-grained sandstone.

Thick-bedded, fine- and medium-grained, dark greenish-gray graywacke sandstone 40 or more feet thick overlies the silty claystone. The graywacke is composed mainly of subangular and angular plagioclase and epiclastic volcanic grains and contains some plant scraps, iron sulfide, iron oxide, and angular pebbles of silty claystone. Its top is not exposed in the place studied. Fifty or more feet of silty claystone which is similar to the underlying silty claystone may overlie the graywacke, but because of extensive fracturing it was not possible to prove this relationship during the brief time available for field study.

The lower part of the Albian section near Wolverine Creek was deposited in the littoral and inner sublittoral marine zones. These environments are indicated by the unconformity upon which the Albian section rests, by the lenticularity and character of its basal sandstone, and by the presence in its lower part of marine mollusks, calcareous algae, glauconite, intraformational clasts of marl containing scattered allogenic clastic grains, and structures and textures formed in agitated water. The upper part of the section, characterized by thick beds of graywacke sandstone, was probably deposited in somewhat deeper water.

CHARACTER EAST OF WOLVERINE CREEK

The basal beds of the Matanuska Formation on the south side of the Matanuska Valley were described by Capps (1927, p. 36). He stated that they unconformably overlie the Talkeetna Formation and that at their base they "* * * include hard, dense sandstone and conglomerate, composed in large part of materials derived from the Lower Jurassic volcanic rocks." During the present study these beds were examined 6¼ miles S. 85° E. of the mouth of Chickaloon River. Here more than 75 feet (estimated) of sandstone and pebble conglomerate are overlain by more than 250 feet (estimated) of hard fractured dark olive-gray and dark-gray siltstone containing thin zones with many *Inoceramus* shell fragments and thin greenish-gray fine-grained sandstone layers. In lithology and degree of structural deformation, these beds resemble the basal sandstone and overlying lutite that occur at the base of the Matanuska Formation along the Chugach Mountains in the Nelchina area (Grantz, 1961b). A few hundred feet of similar siltstone, from which the fossils of USGS Mesozoic locality M572 were collected, crops out 9½ miles S. 88° E. of the mouth of Chickaloon River. The nodular zone and algal structures which characterize the lower part of the Albian section near Wolverine Creek were not found in the Matanuska Valley east of this creek during the present reconnaissance study.

FOSSILS AND AGE

Fossils were collected from the Albian beds at USGS Mesozoic localities M572, M583, and M1168. The fossils are listed in table 2; their locations are shown in figure 2. The presence of *Brewericeras hulenense* at an unrecorded level in the section near Wolverine Creek (Mesozoic loc. M583) dates at least part of this section, which is at the base of the Matanuska Formation. In California this ammonite is the guide fossil and index species for the local *Brewericeras* (=*Beudanticeras*) *hulenense* faunizone of probable late early Albian age (Imlay, 1960, p. 90–92; Popenoe and others, 1960, p. 1509). The age assignment is in accord with Wright's classification of the standard Albian zones in Western Europe (in Arkell and others, 1957, p. L128). The

TABLE 2.—*Fossil mollusks of Albian age from the Matanuska Valley*

[Identifications and age assignments by D. L. Jones. Location of collections shown in fig. 2]

Number (fig. 2)	USGS Mesozoic locality	Field No.	Stratigraphic position and lithology	Locality and collector	Fossils identified	Age
1	M572		Hard siltstone.	Anchorage (D-4) quadrangle. Near mouth of stream entering Matanuska River from south 9.6 miles upstream of mouth of Chickaloon River. Latitude 61°46'55" N.; longitude 148°09'30" W. Arthur Grantz and D. L. Jones, 1959.	*Lemuroceras talkeetnanum* Imlay(?) *Inoceramus* sp.	Albian(?)
2	M583	Standard Oil Co. of Calif., 13184.	Not known	Anchorage (C-6) quadrangle. Between 2,000 and 2,500 ft elevation on tributary entering Wolverine Creek from north 4.15 miles from its mouth. Latitude 61°38'55" N.; longitude 148°55'30" W. F. W. Godsey and L. J. Parkinson, Standard Oil Co. of Calif., 1959.	*Brewericeras hulenense* (Anderson).	Albian.
3	M1168		Near top of basal sandstone.	Locality same as M583 Arthur Grantz, 1960.	*Anagaudryceras* sp. *Phylloceras* sp.	Albian.

apparent presence of *Lemuroceras talkeetnanum* in an outcrop of hard siltstone in the upper Matanuska Valley (Mesozoic loc. M572) suggests that the basal part of the Matanuska Formation may be of late early Albian age in that area also (Imlay, 1960, p. 90–92). However, incomplete specimens of *Inoceramus* from the same locality seem similar to *Inoceramus cuvierii* of Turonian age. Thus the age of the basal beds in the upper Matanuska Valley is not yet firmly established, and alternative age assignments can be postulated from the available data. One such alternative is that these beds are of late Albian age. They and the basal beds in the southern part of the Nelchina area are similar in some respects to siliceous siltstone in the upper Chitina Valley which contains upper Albian fossils in its lower beds (D. L. Jones and H. C. Berg, written communication, 1963). The upper Chitina Valley is more than 150 miles east of the Nelchina area, but lies along the regional strike.

BEDS OF CENOMANIAN, TURONIAN, AND CONIACIAN AGE

Rocks containing fossils of Cenomanian, Turonian, and Coniacian age lie between the Albian and Campanian rocks in the Nelchina area and strike toward the upper Matanuska Valley. However, none of these rocks were identified in the Matanuska Valley during the present reconnaissance study except on the west side of upper Hicks Creek, immediately adjacent to the Nelchina area. A depositional contact between the beds of Albian and Campanian age was not identified in the Matanuska Valley, and the rocks of intervening ages could occur there. On upper Hicks Creek, beds lithologically similar to a sandstone unit of Cenomanian age in the Nelchina area lie at the base of the Matanuska Formation and are overlain by beds thought to be of Campanian age. These Cenomanian rocks have been mapped and described in the Nelchina area (Grantz, 1961a) but have not as yet been identified in the Matanuska Valley proper. They will not be described in this report. The wide distribution of fossil collections of Campanian and(or) Maestrichtian age in the Matanuska Valley and the absence of collections clearly of Cenomanian, Turonian, or Coniacian age suggest that if rocks of the latter ages are present at the surface in the Matanuska Valley proper, they have a relatively small extent. However, rocks of these ages are undoubtedly present in the subsurface of at least the upper part of the Matanuska Valley.

BEDS OF CAMPANIAN AND MAESTRICHTIAN AGE

DISTRIBUTION

Marine clastic rocks ranging in grain size from silty claystone and shale to conglomerate crop out widely in the Matanuska Valley, where they comprise most outcrops of the Matanuska Formation. These rocks are similar in age and gross lithology to map units in the Nelchina area which the author informally designated and mapped as claystone and siltstone (map symbol Kms), sandstone, siltstone, and conglomerate (map symbol Kisc), and siltstone, sandstone, and claystone (map symbol Kis) (Grantz, 1961a, b; see also table 4, this report). From these clastic rocks mollusks of Campanian and Maestrichtian age have been collected in the Matanuska Valley and the valleys of Chickaloon River and Boulder Creek. In this report the first map unit will be informally designated claystone and siltstone of Campanian and Maestrichtian age; the second and third map units will be collectively designated sandstone and siltstone of Maestrichtian age. The most complete section of these rocks recognized in the Matanuska Valley is on Granite Creek; the rocks are also well exposed on Kings River, Hicks Creek, Wolverine Creek, the valley of Boulder Creek, and the bluffs of the Matanuska River.

PARTIAL SEQUENCE

Only a partial sequence of the Campanian and Maestrichtian beds of the Matanuska Valley was observed during the present reconnaissance. The oldest beds of this partial sequence consist of hard medium dark-gray silty claystone containing reddish- or brownish-gray-weathering sandy limestone lentils and some plant fragments. These beds are at least 100 feet thick and probably are much thicker. They form a large outcrop on the south bank of the Matanuska River about 4½ miles upstream of the mouth of Chickaloon River at the probable location of USGS Mesozoic locality 8596. This locality yielded *Inoceramus schmidti* of Campanian age, which lithologically and faunally characterizes the lower two-fifths of the claystone and siltstone unit of Campanian and Maestrichtian age in the Nelchina area. This lower part of the unit in the Nelchina area consists of medium dark-gray silty claystone and siltstone and contains many limestone concretions.

Above the silty claystone containing *Inoceramus schmidti* is the lower, lutaceous part of Martin's section on Granite Creek. (See p. I 27.) The lutaceous section contains mollusks which are characteristic of a local faunizone of late Campanian and Maestrichtian age and which occur in roughly the upper half of the claystone and siltstone of Campanian and Maestrichtian age in the Nelchina area. Possibly hundreds or even a few thousands of feet of beds separate the base of the Granite Creek section and the beds on the Matanuska River containing *Inoceramus schmidti.*

The lutaceous beds are more than 1,200 feet thick on Martin's Granite Creek section. They consist mainly of medium dark-gray clayey siltstone and silty claystone occurring in medium to very thick beds, and some beds contain calcareous siltstone lentils or layers and iron sulfide nodules. *Inoceramus* shell fragments and a few entire *Inoceramus* valves and ammonite shells were found in the lutite, and in a few beds the fragments are abundant. The lutite is mainly chunky weathering, but some beds are shaly. Interbeds of greenish-gray sandstone occur at a few places.

The upper, arenaceous part of the Granite Creek section consists of units of interbedded sandstone and lutite and of units in which one or the other rock type greatly predominates. Conglomerate and pebbly beds are present but not abundant. In Martin's section this sequence is more than 2,000 feet thick. The sandstone beds range from very thin bedded to very thick bedded and in places form units a few tens of feet thick. The lutite forms very thin to thick interbeds with sandstone; there are also some massive units of lutite and sandy lutite several tens of feet thick. A few beds of the lutite contain thin limestone lentils.

Several other incomplete sections of the Campanian and Maestrichtian rocks were observed, but in the absence of detailed mapping these could not be correlated with the partial sequence described above, or with each other. One, along The Alaska Railroad branch line to Jonesville, is presented on p. I 23.

CHARACTER

The Campanian and Maestrichtian rocks of the Matanuska Valley are composed of varying proportions of lutite, arenite, and rudite, but the character of each class of sediment is rather uniform throughout the valley. The lutite is a mixture of clay and silt and is usually best described as silty claystone or clayey siltstone. It is mainly medium dark gray, but some is dark gray or grayish black, and the coarser siltstone tends to be greenish gray. Medium to very thick beds are most common, but some of the lutite is thin bedded. Conglomeratic siltstone and mudstone containing intraformational and rounded extraformational pebbles and cobbles occur, and some lutite beds contain rounded but widely separated pebbles to small boulders of extraformational origin. Chunky weathering predominates but fissile weathering is common, especially where the lutite is dark and probably more than usually clayey. Many beds contain thin to thick, light-, yellowish-, or brownish-gray-weathering limestone concretions and (or) lentils, and locally these are abundant. Small nodules of iron sulfide, very thin to thick sandstone interbeds, and a few very thin beds of altered volcanic ash(?) occur in some zones. Many beds contain shell fragments, but entire shells are uncommon and usually are found in limestone concretions. Zones containing large and almost unbroken *Inoceramus* shells 12 inches or more in length were seen in the section along The Alaska Railroad (see p. I 31) and at one other locality. It is inferred that these shells have not been reworked, as were the more common fragmented shells. Fossil plant fragments are common, and in some thin siltstone interbeds in sandstone sequences they are numerous.

The arenaceous rocks in the Campanian and Maestrichtian section are mainly greenish-gray fine- and medium-grained sandstone, but many beds are olive or medium gray. Grain size ranges from very fine to coarse grained, and some beds are conglomeratic. Where the sandstone is interbedded with equal or greater amounts of siltstone, it tends to be very thin, thin, or, less commonly, medium bedded; where it is predominant, it tends to be medium, thick, or very thick bedded. Some of the sandstone beds contain large, commonly reddish-brown-weathering sandy limestone concretions and (or) mollusk shell fragments. Micaceous minerals, carbonaceous flakes, and fossil plant fragments are abundant in some beds, and a few contain very thin and lenticular coaly seamlets. The sandstone in some outcrops is color banded, in others it is speckled with white and dark minerals, and some graded beds are mottled.

Rudaceous rocks are widely distributed but not abundant. They are most common in arenaceous parts of the section and form massive or thick-bedded units of pebble, cobble, or boulder conglomerate. Conglomeratic mudstone is associated with them in places. The extraformational rudite clasts are mainly rounded, and the largest are at least 18 inches in diameter. They were derived mainly from granitic and volcanic terranes; plutonic and volcanic rocks, quartz, and chert are common, and one cobble of Nelchina Limestone (Lower Cretaceous) was noted in a mudstone bed. Many of the conglomerate beds are channeled into their substrates, and some grade upward into conglomeratic mudstone.

A published petrographic description (Eckhart, 1959) and brief examination of several thin sections indicate that the Campanian and Maestrichtian sandstones are texturally and mineralogically immature and members of the graywacke suite. The sandstones are generally poorly sorted, and are composed of angular and subangular grains, a large percentage of which are labile. The matrix is composed of fine-grained detritus and of authigenic minerals interpreted to have formed diagenetically from labile constituents of the matrix. Eckhart (1959, p. 41) stated that a thin section of graywacke near the mouth of Kings River is "* * * composed of poorly sorted and sized angular to subangular fragments. These fragments consist largely of quartz and feldspar with subordinate amounts of muscovite, calcite, chlorite, rock fragments, biotite, epidote, zoisite, clinozoisite and apatite, in order of decreasing abundance * * *. A cement of sericite, clay, and chlorite is probably the principal bond between the constituent fragments of the graywacke, although some of the calcite contributes to the cementation."

Four modes of the Campanian and Maestrichtian sandstones, determined from thin sections, are presented below. Three are of graywacke from widely scattered points in the Matanuska Valley, the fourth is of matrix from conglomeratic mudstone on the north bank of the Matanuska River three-fourths of a mile east of Kings River. Point counts for these modes were made under the writer's direction by Paul G. Bower and Robert G. Rohrbacher.

	Graywacke (percent)			*Matrix of conglomeratic mudstone (percent)*
	Roadcuts near Hicks Creek	*Railroad cuts 2½ miles southwest of Sutton*	*Roadcuts 4 miles east of Chickaloon River*	*Roadcuts near Kings River*
Quartz	20	13	16	3
Chert	5	1	1	------
Plagioclase	22	47	52	10
Potassium feldspar	2	1	------	1
Mafic minerals	2	5	5	2
Rock fragments	18	7	7	18
Opaque minerals	----	------	------	2
Matrix (includes interstitial authigenic minerals)	30	26	19	63
Altered grains, original nature not determined. Probably mainly mafic minerals, volcanic rock clasts, and some plagioclase	1	------	------	1
	100	100	100	100
Point counts	466	300	307	300

The petrographic character of the lutite near the mouth of Kings River was studied by Eckhart (1959, p. 40–41). Thin sections, stain tests, and differential thermal analysis showed that it there "* * * consists of clay and very fine subangular mineral fragments. The clay is probably illite * * *. The mineral fragments are largely quartz and feldspar, with subordinate amounts of muscovite, biotite, chlorite, epidote, pyrite and (or) marcasite, amphibole and(or) pyroxene, and possibly opal." Organic matter was found also.

SEDIMENTARY STRUCTURES AND TEXTURES AND ENVIRONMENT OF DEPOSITION

Sedimentary structures and textures typical of graywacke sequences occur widely in the Campanian and Maestrichtian rocks and suggest deposition from turbidity currents and slumps on submarine slopes. Channels and a variety of sole markings are found at the base of many sandstone beds, and intraformational clasts of lutite and sandstone, some as large as cobbles, are common within then. Graded bedding, poorly to well formed, is dominant. The fine-grained uppermost parts of some graded sandstone beds are convoluted and in places show small-scale cut-and-fill, crossbedding and current ripple mark. Some lutite units contain slumped and contorted zones in which slump folds as much as 5 feet in amplitude (estimated) and slump-induced intraformational unconformities were seen. Conglomeratic mudstone beds that contain both intraformational and extraformational clasts and, locally, shell fragments are present. The extraformational clasts are of pebble to small boulder size and are usually well rounded.

The features just noted are commonly assumed to indicate that the sedimentary rocks which contain them were deposited in very deep water (the bathyal or even abyssal zones of the sea). However the Campanian and Maestrichtian rocks in the Matanuska Valley include at least two lutite interbeds which contain numerous large shells of *Inoceramus*. These are unfragmented and are therefore thought to be in place. The abundant large shells of *Inoceramus*, a filter feeder, suggest that the enclosing beds were deposited beyond the shallow-water (high-energy) zones of the sea, but probably in or not greatly below the photic zone, and thus at very moderate depths (D. L. Jones, oral communication, 1962). But the infrequent occurrence of such beds and of mollusks generally in the Campanian and Maestrichtian rocks suggests that these rocks were deposited near the limits of abundant molluskan life, perhaps in the middle and outer parts of the sublittoral zone. Evidence for a lower depth limit was not recognized, but it seems unlikely that the sea alternately deepened and shoaled so greatly and so rapidly as to interleave, within a few feet of beds, sublittoral with outer bathyal or abyssal zone deposits. It is therefore inferred that the lower depth limit may not have been below the inner part of the bathyal zone. The Campanian and Maestrichtian rocks may also have been deposited fairly near shore, for regional studies suggest that the shoreline to the north in Campanian and Maestrichtian time lay within several miles of the Matanuska Valley. The textural and mineralogical immaturity of the Campanian and Maestrichtian graywackes suggests, in addition, that the sediments were transported to their final sites of deposition without an extensive interval of abrasion and winnowing on a shallow-water shelf.

FOSSILS AND AGE

The mollusks found above the Albian rocks of the Matanuska Formation in the Matanuska Valley can be grouped into two local faunizones. These are of Campanian and of late Campanian and Maestrichtian age. The fossils and their ages are listed in table 3 and the localities are shown in figure 2. The local faunizone of Campanian age is characterized by the presence of *Inoceramus schmidti* and the absence of ammonites of late Campanian and Maestrichtian age. It has been identified on the south bank of the Matanuska River and on lower Hicks Creek. Matusmoto (1959, pl. 8) assigns *I. schmidti* a middle and late Campanian age in Japan and, where it occurs without late Campanian and Maestrichtian ammonites, the beds are possibly of middle Campanian age.

The local faunizone of late Campanian and Maestrichtian age contains *Inoceramus kusiroensis*, *Inoceramus* ex gr. *I. subundatus* and several ammonites of Campanian and Maestrichtian age, and lacks *Inoceramus schmidti*. The ammonites include *Pachydiscus ootacodensis*, *Baculites occidentalis*, *Diplomoceras notabile*, *Guadryceras tenuiliratum*, *Neophylloceras ramosum*, and *N. hetonaiense*. Regionally this faunizone is characterized by an unnamed species of the ammonite genus *Pachydiscus*, but in the Matanuska Valley the heteromorphic form *Diplomoceras notabile* is the most abundant ammonite (table 3). This faunizone, found at many localities north of the Matanuska River and on lower Wolverine Creek south of the river, is probably of latest Campanian or Maestrichtian age.

Nineteen of the collections from the Matanuska Valley contain either *Inoceramus kusiroensis* or *Inoceramus* ex gr. *I. subundatus* (table 3), but none contain both. *Inoceramus kusiroensis* in Japan (Matsumoto, 1959, p. 87 and pl. 6) occurs in stage K6β (Maestrichtian) but in California *Inoceramus subundatus* occurs with *Inoceramus schmidti* in beds of Campanian age. If their mutually exclusive occurrence in the Matanuska Valley can be shown to have stratigraphic significance, a more detailed zonation and correlation of these rocks would be possible. At present, however, the fossils from the

TABLE 3.—*Fossil mollusks of Campanian and Maestrichtian age from the Matanuska Valley*

[Identifications and age assignments by D. L. Jones. Location of collections shown in fig. 2. Age: C, Campanian; C-M, Campanian or Maestrichtian]

Number (fig. 2)	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
USGS Mesozoic locality	8319	6689	6692	6694	6696	8559	8562	8591	8592	8595	8596	8948	16398	M560	M563	M564	M570	M571	M576	M577	M578	M580	M582	M584	M585	M588	M589	M1993	M1996
Inoceramus schmidti Michael								X			X																	X	
ex gr. *I. subundatus* Meek		X					X		X				X	X					X			X	X						
kusiroensis Nagao and Matsumoto			X		X					?					?		?	?		X	?			?	?		?		?
Pseudophyllites indra (Forbes)							X						X																
Pachydiscus (*Pachydiscus*) n. sp.													X																
(*Pachydiscus*) *ootacodensis* (Stoliczka)					?								X																
Patagiosites n. sp.														X															
Desmophyllites phyllimorphum (Kossmat)													X																
Diplomoceras notabile Whiteaves	X			X	X		X			X		X	X			X								X		X			
Phyllopachyceras forbesianum (d'Orbigny)							X																						
Neophylloceras ramosum (Meek)														X					?										
hetonaiense Matsumoto					X	X	X						X	X									X						
Gaudryceras tenuiliratum Yabe													X	X						X									
sp. indet.									X																				
Baculites occidentalis Meek							X							X															
aff. *B. teres* Forbes																							X						
Didymoceras aff. *D. hornbyense* (Whiteaves)													X																
Pseudoxybeloceras? sp. indet.																					X								

Number (fig. 2)	USGS Mesozoic locality	Locality	Collector(s), year	Age
4	3319	South slope of Anthracite Ridge near Purinton Creek, altitude 3,450 feet.	G. C. Martin, 1905.	C-M.
5	6689	West bank of Granite Creek, between altitudes of 1,000 and 1,050 feet. (See Granite Creek section p. I 27.)	G. C. Martin, 1910.	C-M.
6	6692	Pass between Kings River and Young Creek.	do	C-M.
7	6694	East bank of Kings River three-fourths of a mile below U.S. Land Monument 1.	do	C-M.
8	6696	On creek entering Granite Creek from west 5 miles above main trail, about half a mile west of and 470 feet above Granite Creek.	do	C-M.
9	8559	First tributary to Boulder Creek from west above the canyon.	G. C. Martin, 1913.	C-M.
10	8562	North slope of Anthracite Ridge near crest at head of tributary to Boulder Creek next below East Fork.	do	C-M.
11	8591	Hicks Creek, opposite mouth of next to lowest tributary from the west.	G. C. Martin and R. M. Overbeck, 1913.	C.
12	8592	North bank of Matanuska River, 10 miles above mouth of Chickaloon River.	G. C. Martin, 1913.	C-M.
13	8595	North bank of Matanuska River, 4 to 5 miles below O'Brien's ford.	do	C-M.
14	8596	South bank of Matanuska River, 5 miles above mouth of Chickaloon River.	do	C.
15	8948	Ridge between Hicks Creek and Caribou Creek, 8½ miles north of Matanuska River.	T. Chapin, 1914	C-M.
16	16398	Headwaters of Chickootna Creek, Anthracite Ridge, N. 61°50¾′, W. 148°6¾′.	G. A. Waring, 1932.	C-M.
17	M560	Caribou Creek W. 147°46′40″, N. 61°59′25″.	A. Grantz and D. L. Jones, 1959.	C-M.
18	M563	Boulder Creek, W. 147°59′20″, N. 61°58′07″.	do	C-M?
19	M564	Boulder Creek, W. 147°59′55″, N. 61°57′50″.	do	C-M.
20	M570	Carbon Creek, W. 148°27′35″, N. 61°46′20″.	do	C-M?
21	M571	Carbon Creek, W. 148°27′30″, N. 61°46′15″.	do	C-M?
22	M576	Wolverine Creek, W. 149°02′30″, N. 61°39′33″.	do	C-M.
23	M577	Railroad cuts, W. 148°56′47″, N. 61°41′35″.	do	C-M.
24	M578	Railroad cuts, W. 148°50′40″, N. 61°41′30″.	do	C-M.
25	M580	Railroad cuts, W. 148°57′45″, N. 61°41′10″.	do	C-M.
26	M582	Highway cuts, W. 148°44′50″, N. 61°43′45″.	do	C-M.
27	M584	Highway cuts, W. 148°37′25″-38′00″, N. 61°45′00″-15″.	do	C-M.
28	M585	Granite Creek, W. 148°50′20″, N. 61°45′45″.	do	C-M?
29	M588	Granite Creek, W. 148°50′23″, N. 61°45′32″.	do	C-M.
30	M589	Pinochle Creek, W. 147°55′40″, N. 61°47′40″.	do	C-M?
31	M1993	Highway cuts, W. 147°46.6½′, N. 61°47.0′.	A. Grantz, 1963	C.
32	M1996	Hilltop at head of Dan Creek, W. 147°47.7′, N. 61°48.7½′.	do	C-M?

Pachydiscus local faunizone are considered as a single assemblage that is probably of latest Campanian and Maestrichtian age.

AREAL DISTRIBUTION OF FAUNIZONES

The data are too sparse for firm generalizations, but the *Brewericeras hulenense* faunizone and rocks thought to be of this or later Albian age appear to crop out only along the southern margin of the Matanuska Valley, and the *Inoceramus schmidti* faunizone (Campanian) appears to crop out only in the southern half of Matanuska Valley. The *Pachydiscus* faunizone (latest Campanian or Maestrichtian) occurs structurally intermixed with the *I. schmidti* faunizone but extends north of it to the northern limit of Matanuska Formation outcrops. The apparent arrangement of the faunizones is due in part to the north dips that prevail in the Matanuska Formation along the Chugach Mountains, where its lowest beds are exposed in many places. However an additional factor is suggested by the similar arrangement of faunizones in the Nelchina area. There the base of the formation becomes, in general, younger to the north due to northward overlap of older by younger subdivisions.

CORRELATION WITH NELCHINA AREA

The Matanuska Formation is better understood in the Nelchina area than in the Matanuska Valley, and comparison of the presently known sections in the two areas suggests that the formation may contain a greater variety and thickness of beds in the Matanuska Valley than is now recognized. The approximate correlation of the presently known sections, based on similarities of lithology and fauna, is shown in table 4. In both areas the formation ranges in age from Albian to latest Campanian or Maestrichtian and contains local faunizones of Albian, Campanian, and latest Campanian or Maestrichtian age. These faunizones occur in units of similar although not identical lithology. The continuity in outcrop and the similarity in lithology and age of the Matanuska rocks in the two areas demonstrate that these rocks are part of the same large stratigraphic entity, but there are important differences. Sandstone is more abundant in the latest

Campanian or Maestrichtian claystone and siltstone of the Matanuska Valley. Furthermore, the unit of sandstone and siltstone in the upper part of the Granite Creek section contains more marine mollusks and fewer carbonaceous scraps than the sandstone and siltstone in the upper part of the Matanuska Formation in the Nelchina area and lacks lenticular channel conglomerates present in the Nelchina area. The upper part of the Granite Creek section may be equivalent to the sandstone and siltstone in the upper part of the Matanuska Formation in the Nelchina area but represent a more seaward facies. However, it may also represent a sandy facies of the upper part of the underlying claystone and siltstone of the Nelchina area. In the absence of a definite correlation based upon fossils or detailed mapping, either possibility or a combination of both must be admitted.

The thickness of the Matanuska Formation in the Matanuska Valley is probably at least half of that in the Nelchina area. If beds of Cenomanian, Turonian, and Coniacian age also are present in the valley, the formation may be about as thick there as in the Nelchina area, where it is apparently over 14,000 feet in aggregate thickness. Substantial thickness in the Matanuska Valley would be expectable because of the similarity and proximity of the two sequences, because partial sections of Matanuska rocks in the valley are thick, and because large areas of the valley having moderate to steep dips and numerous faults are underlain exclusively by these rocks.

MARTIN'S MEASURED SECTION ON GRANITE CREEK

The section that Martin (1926), presented when he named the Matanuska Formation is reproduced below. It is exposed on Granite Creek from about 1¾ to about 5 miles above its mouth. Neither the top nor the base of the Matanuska rocks is exposed here. Because the section contains "computed," estimated, and measured intervals, and intervals having no exposures, and because the effect of faults on the section was not determined, the recorded thickness of more than 4,000 feet is an approximation.

Fossils from the lower fourth of this section (USGS Mesozoic locs. 6689, M585, M588) are of latest Campanian or Maestrichtian age.

TABLE 4.—*Correlation of major units of Matanuska Formation in the Matanuska Valley and Nelchina area*

[Letter symbols are those used by Grantz (1960; 1961 a, b) to designate informal lithologic units of the Matanuska Formation mapped in the Nelchina area]

Matanuska Valley			Nelchina area		Matanuska Valley and Nelchina area		
Unit	Approximate maximum observed thickness (feet)		Unit	Approximate maximum observed thickness (feet)	Local guide fossils	Age	Epoch
Sandstone and siltstone. Exposed in the upper part of the section on Granite Creek, and elsewhere in the Matanuska Valley.	2,100+	4,000+	Sandstone, siltstone, and conglomerate (Kls and Klsc).	2,500+	Not identified	Maastrichtian or latest Campanian	Cretaceous
	---?---	?---?---			---?------?--------?---		
Claystone and siltstone. Exposed in the lower part of the section on Granite Creek, in the bluffs of the Matanuska River, and elsewhere in the Matanuska Valley. Contains many sandstone beds.	1,200+		Claystone and siltstone (Kms).	4,000±	*Inoceramus kusiroensis* Nagao and Matsumoto *Diplomoceras notabile* Whiteaves *Pachydiscus* spp.		
	100+			3,500±	*Inoceramus schmidti* Michael *Canadoceras* spp.	Campanian	

Not identified.		Not identified.			Not identified	Santonian		Late	Cretaceous
		Central part	*Southeast part* Siltstone, sandstone, and conglomerate (Kssc).	2,500+(?) (Kssc)	*Inoceramus uwajimensis* Yehara	Coniacian			
			Hiatus						
		Siltstone and silty claystone (Kst).	Siltstone and claystone with a basal sandstone member. (Includes some beds similar to, but not identical with, unit (Kss). Age of basal beds not definitely known; they may be as old as early Albian or as young as late Albian or Cenomanian) (Kacs).	1,500+ (Kacs)	*Mesopuzosia* aff. *M. indopacifica* (Kossmat) *Inoceramus* aff. *I. cuvieri* Sowerby	Turonian			
		Sandstone, locally with a basal siltstone member (Kss and Kssb).		475+ (Kss)	*Desmoceras* (*Pseudouhligella*) *japonicum* Yabe *Inoceramus* n. sp. aff. *I. yabei* Nagao and Matsumoto	Cenomanian			
		Not identified.			Not identified	Late	Albian	Early	
						Middle			
Silty claystone, siltstone, and sandstone, with a basal sandstone member. Exposed near Wolverine Creek and perhaps elsewhere along the south margin of the Matanuska Valley.	300+	Siltstone and claystone (Kbs).		250 (Kbs)	*Brewericeras hulenense* (Anderson) *Lemuroceras talkeetnanum* Imlay	Early			
Not identified.		Sandstone, coal-bearing claystone, and conglomerate (Ksc).		200+ (Ksc)	*Moffitites robustus* Imlay *Aucellina* sp.				
Total observed thickness	4,400+			14,000+					

Section of Matanuska Formation on Granite Creek, beginning at lower end of canyon, 1¾ miles from the mouth of the creek

[From Martin (1926, p. 319–320)]

	Feet
Black shale at base, overlain by thin-bedded gray sandstone, some of which is very fine and has contorted laminae, and gray or drab-gray shale (beds are interleaved lenses rarely more than 6 inches thick)	12
Black sandy shale	4–6
Thin-bedded gray sandstone and shale	15
Black nodular shale	8
Sandstone, mainly beds about 5 feet thick, with thin interbedded shale	30
Interbedded black shale and thin gray sandstone and shale	50
Massive sandstone, feldspathic and micaceous	20
Interbedded gray shale, gray sandstone, and black shale	40
Sandstone	12
Alternating beds, 1 to 8 feet thick, of gray sandy shale and black shale	250
Similar beds increasingly to dominantly sandy and light gray	80
Dark-colored sandstone and sandy shale	75
Light-gray sandstone, including several thick, massive beds and some very thin shale (in east bank; estimated thickness)	200
Dark shale in beds alternating with thin sandstone and light-colored shale	450
Sandstone, heavy bedded at the top but dominantly thin bedded (beds 1 to 2 feet and less than 1 foot), with many beds of very thin shaly sandstone having contorted laminae; also a few thin shale beds and an increasing number of beds of dark shale in the lower part	840
Exposures interrupted and inaccessible for 1,500 feet along the creek, equivalent to an estimated stratigraphic interval of	500
Dark bluish-black sandy shale outcropping for 200 feet in a direction about N. 17° E.; strike, N. 40° E.; dip, 60° SE.; computed thickness	80±
Exposure interrupted and inaccessible for 800 feet along the creek, equivalent to an estimated stratigraphic interval of	300±
Hard dark blue-black shale,[1] outcropping for about 200 feet in a direction N. 17° E.; strike, N. 28° E.; dip, 60° to 65° SE.; computed thickness	90±
Exposure interrupted and inaccessible for about 200 feet along the creek, equivalent to an estimated stratigraphic interval of	90±
Hard dark blue-black shale,[1] outcropping for 400 feet along the creek in a direction N. 17° E.; strike, N. 47° E.; dip, 50° SE.; computed thickness	170±
Exposure interrupted and inaccessible for 100 feet along the creek, equivalent to an estimated stratigraphic interval of	45±
Hard dark blue-black shale,[1] outcropping for about 1,000 feet along the creek; estimated thickness	400±
	3,760±
No exposure for 7,500 feet.	
Several small outcrops through 1,200 feet along the east bank of the creek in a northerly direction; strike, N. 23° E.; dip, 49° SE.; computed thickness	350±

[1] USGS Mesozoic loc. 6689; see table 3.

MEASURED SECTION ALONG THE ALASKA RAILROAD

[Section exposed about 2¼ miles southwest of Sutton in cuts along The Alaska Railroad branch line to Jonesville. Thicknesses are from Eckhart (1959, p. 43–44). Lithology is after Eckhart but modified from observations made during the present study]

	Thickness (feet)
Top unexposed.	
Grayish-black massive silty shale containing 10 percent (estimated) mainly thin (but ranging to thick) interbeds of fine-grained sandstone and a few of coarse siltstone. Contains many small and a few large limestone concretions, a few limestone lentils, and very small iron sulfide nodules. A few thin layers of volcanic ash(?) and a small number of rounded extraformational pebbles occur in the shale. Many *Inoceramus* shells 12 to 18 inches long and about ¼ in. thick occur in one 15-ft-thick interval in the shale. (USGS Mesozoic locs. M577 and M578 from this unit)	490+
Interbedded dark-gray clayey siltstone and dark greenish-gray predominantly fine-grained (but ranging to medium-grained) sandstone. Interbeds thin to thick, siltstone slightly more abundant than sandstone. Plant fragments on some sandstone bedding planes	230
Thin to very thick bedded, predominantly fine-grained (but ranging to medium- and coarse-grained) greenish-gray sandstone estimated to constitute 90 percent of the unit interbedded with mainly very thin and thin-bedded (but ranging to thick-bedded) siltstone estimated to constitute 10 percent of the unit. In general the sandstone beds decrease in maximum thickness towards the top. Numerous plant fragments in some siltstone interbeds	700
Dark-gray silty shale containing an estimated 10 percent interbedded very thin bedded siltstone and very fine grained sandstone. Thin limestone lentils, small limestone concretions, and large unbroken *Inoceramus* shells occur. Some of the arenaceous material forms small irregular masses in the shale	230
Thin- to thick-bedded sandstone estimated to constitute 90 percent of the unit interbedded with thin-bedded siltstone estimated to constitute 10 percent of the unit	160
Massive dark-gray silty claystone or clayey siltstone containing small reddish-brown-weathering limestone concretions and thin limestone lentils. The limestone is estimated to constitute less than 10 percent of the unit	360+
Base unexposed.	
Total section exposed	2, 170

Fossils in or near this section (USGS Mesozoic locs. M577, M578, and M580) indicate it is of latest Campanian or Maestrichtian age, as are the beds on Granite Creek. Lithologically the section in the railroad cuts is similar to the upper part of the Granite Creek section, but the possibility that other levels in the latest Campanian and Maestrichtian rocks of the Matanuska Valley are similarly arenaceous precludes a definite correlation.

REFERENCES CITED

Arkell and others, 1957, Mollusca 4—Cephalopoda, Ammonoidea, pt. L *of* Moore, R. C., ed., Treatise on invertebrate paleontology: New York, Geol. Soc. American and Kansas Univ. Press [Lawrence], 490 pp.

Barnes, F. F., 1962, Geologic map of lower Matanuska Valley, Alaska: U.S. Geol. Survey Misc. Geol. Inv. Map I–359, scale 1:63,360.

Bergquist, H. R., 1961, Foraminiferal zonation in Matanuska Formation, Squaw Creek-Nelchina River area, south-central Alaska: Am. Assoc. Petroleum Geologists, v. 45, no. 12, pp. 1994–2011.

Capps, S. R., 1927, Geology of the upper Matanuska Valley, Alaska, with a section on the igneous rocks by J. B. Mertie, Jr.: U.S. Geol. Survey Bull. 791, 92 pp.

——— 1940, Geology of the Alaska Railroad region: U.S. Geol. Survey Bull. 907, 201 pp.

Chapin, Theodore, 1918, The Nelchina-Susitna region, Alaska: U.S. Geol. Survey Bull. 668, 67 pp.

Eckhart, R. A., 1959, Haydite raw material (black shale) in the Kings River and Sutton areas of the Matanuska Valley, Alaska, *in* Eckhart, R. A., and Plafker, George, Haydite raw material in the Kings River, Sutton, and Lawing areas, Alaska: U.S. Geol. Survey Bull. 1039–C, pp. 35–56.

Goddard, E. N., chm., and others, 1948, Rock-color chart: Washington, D.C., Natl. Research Council; repr. by Geol. Soc. America, 1951.

Grantz, Arthur, 1953, Preliminary report on the geology of the Nelchina area, Alaska: U.S. Geol. Survey open-file report, 3 maps, 9 figs.

——— 1960, Geologic map of Talkeetna Mountains (A–2) quadrangle, Alaska, and the contiguous area to the north and northwest: U.S. Geol. Survey Misc. Geol. Inv. Map I–313, scale 1:48,000.

———1961a, Geologic map and cross sections of the Anchorage (D–2) quadrangle and northeasternmost part of the Anchorage (D–3) quadrangle, Alaska: U.S. Geol. Survey Misc. Geol. Inv. Map I–342, scale 1:48,000.

———1961b, Geologic map of the north two-thirds of Anchorage (D–1) quadrangle, Alaska: U.S. Geol. Survey Misc. Geol. Inv. Map I–343, scale 1:48,000.

Grantz, Arthur, and Jones, D. L., 1960, Stratigraphy and age of the Matanuska formation, south-central Alaska: Art. 159 *in* U.S. Geol. Survey Prof. Paper 400–B, p. B347–B350.

Grantz, Arthur, and Wolfe, J. A., 1961, Age of Arkose Ridge Formation, south-central Alaska: Am. Assoc. Petroleum Geologists Bull., v. 45, no. 10, p. 1762–1765.

Imlay, R. W., 1960, Early Cretaceous (Albian) ammonites from the Chitina Valley and Talkeetna Mountains, Alaska: U.S. Geol. Survey Prof. Paper 354–D, p. 87–114.

Imlay, R. W., and Reeside, J. B., Jr., 1954, Correlation of the Cretaceous formations of Greenland and Alaska: Geol. Soc. America Bull. v. 65, no. 3, p. 223–246.

Kay, G. M., 1951, North American geosynclines: Geol. Soc. America Mem. 48, 143 p.

Lane, E. W., chm., and others, 1947, Report of the subcommittee on sediment terminology: Am. Geophys. Union Trans., v. 28, no. 6, p. 936–938.

Martin, G. C., 1906a, Preliminary statement on the Matanuska coal field *in* Brooks, A. H., and others, Report on progess of investigations of mineral resources of Alaska in 1905: U.S. Geol. Survey Bull. 284, p. 88–100.

Martin, G. C., 1906b, A reconnaissance of the Matanuska coal field, Alaska, in 1905: U.S. Geol. Survey Bull. 289, 36 p.

———1911, Preliminary report on a detailed survey of part of the Matanuska coal fields, *in* Brooks, A. H., and others, Mineral resources of Alaska, report on progress of investigations in 1910: U.S. Geol. Survey Bull. 480–F, p. 128–138.

———1926, The Mesozoic stratigraphy of Alaska: U.S. Geo. Survey Bull. 776, 493 p.

Martin, G. C., and Katz, F. J., 1912, Geology and coal fields of the lower Matanuska Valley, Alaska: U.S. Geo. Survey Bull. 500, 98 p.

Martin, G. C., and Mertie, J. B., 1914, Mineral resources of the upper Matanuska and Nelchina valleys, *in* Brooks, A. H., and others, Mineral resources of Alaska, report on progress of investigations in 1913: U.S. Geol. Survey Bull. 592-H, p. 273–299.

Matsumoto, Tatsuro, 1959, Zonation of the Upper Cretaceous in Japan: Kyushu Univ., Mem. Fac. Sci., ser. D, Geology, v. 9, no. 2, p. 55–93, pl. 6–11.

Mendenhall, W. C., 1900, A reconnaissance from Resurrection Bay to the Tanana River, Alaska, in 1898: U.S. Geol. Survey 20th Ann. Rept., pt. 7, p. 265–340.

Payne, T. G., 1955, Mesozoic and Cenozoic tectonic elements of Alaska: U.S. Geol. Survey Misc. Geol. Inv. Map I–84, scale, 1:5,000,000.

Popenoe, W. P., imlay, R. W., and Murphy, M. A., 1960, Correlation of the Cretaceous Formations of the Pacific Coast (United States and northwestern Mexico): Geol. Soc. America Bull., v. 71, no. 10, p. 1491–1540.

Waring, G. A., 1936, Geology of the Anthracite Ridge coal district, Alaska: U. S. Geol. Survey Bull. 861, 57 p.

Wentworth, C. K., 1922, A scale of grade and class terms for clastic sediments: Jour. Geology, v. 30, no. 5, p. 377–392.

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