Cretaceous Ammonites From the Lower Part of The Matanuska Formation Southern Alaska

By DAVID L. JONES

With a STRATIGRAPHIC SUMMARY

By ARTHUR GRANTZ

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CRETACEOUS AMMONITES FROM THE LOWER PART OF THE MATANUSKA FORMATION SOUTHERN ALASKA

By David L. Jones

ABSTRACT

The lower part of the Matanuska Formation comprises a thick and complexly intertongued assemblage of siltstone, shale, sandstone, and conglomerate that ranges in age from Early Cretaceous (Albian) to Late Cretaceous (Coniacian or Santonian). These rocks were deposited mainly on eroded Jurassic sedimentary and volcanic rocks in a tectonically narrow trough lying between an emergent area to the north in the area of the Talkeetna Mountains and the northern Copper River Lowland and a sporadically emergent area to the south, which is now part of the northern Chugach Mountains. The rocks are overlain by claystone and siltstone of Santonian and Campanian age at the base of the upper part of the Matanuska Formation. Deformation, uplift, and erosion during deposition of the Matanuska Formation produced intraformational unconformities which now bound many of the cartographic units into which the formation has been divided. Statigraphic and structural studies by Arthur Grantz have shown that after (and perhaps also during) deposition of the Matanuska Formation, the Nelchina area was broken into three major blocks by lateral movement on two splay faults of the Castle Mountain fault system, and that these major blocks display different rock sequences, informally termed the northern, central, and southern sequences. The stratigraphic record of each sequence differs significantly from the others, and detailed reconstruction of the history of sedimentation and deformation of the Matanuska Formation rests heavily on paleontologic correlations between these sequences.

The oldest beds of the Matanuska Formation in the Matanuska Valley-Nelchina area, near Limestone Gap in the northern sequence, consist of sandstone-bearing abundant specimens of *Aucellina* sp. and rare specimens of *Moffitites robustus*. These rocks are assigned to the early early Albian zone of *Moffitites robustus*. Upper lower Albian rocks assigned to the zone of *Brewericeras hulenense* occur in both the northern and southern sequences but have not been positively identified in the central sequence. Middle Albian rocks are unknown throughout the area, but upper Albian rocks may be present in the southern sequence.

Cenomanian rocks, characterized by *Desmoceras* (*Pseudouhligella*) *japonicum*, rare specimens of *Calycoceras* sp., and a new species of *Inoceramus*, are widespread in the central and southern sequences but absent in the northern sequence. These rocks are overlain by Turonian rocks that contain fairly abundant but fragmentary specimens of *Inoceramus* cf. *I. cuvierii*, several other species of *Inoceramus*, and rare ammonites, including *Otoscaphites teshioensis* and *Mesopuzosia* aff. *M. indopacifica*. The overlying rocks contain abundant specimens of *Inoceramus uwajimensis* and scarce specimens of *I. yokoyamai*, together with a few poorly preserved ammonites indicative of a Coniacian and possible Santonian age.

In this report, 20 species of ammonites are discussed and illustrated. Scrappy material and poor preservation of many specimens preclude specific identification of some forms and necessitates showing only the affinities of others. Although some of the forms discussed are apparently new, the scarce and poorly preserved material now at hand does not warrant assignment of new names at this time.

INTRODUCTION

The main purpose of this report is to provide paleontologic data to substantiate the correlation of complex sequences of upper Lower Cretaceous and lower Upper Cretaceous rocks in the Matanuska Formation of south-central Alaska (fig. 1). Ammonites from the upper part of the formation have been discussed by Jones (1964).

An account of the changing concepts concerning the age of the Matanuska Formation and a brief description of the entire formation were given by Grantz (1964) and Jones (1964) in earlier reports and will not be treated fully here. The lower part of the formation was considered by Imlay and Reeside (1954, p. 232) to be of Coniacian age on the basis of its stratigraphic position below beds bearing the Santonian species *Inoceramus undulatoplicatus*, the supposed presence of *Parapuzosia* and *Prohauericeras*, and the presence of *Inoceramus* close to *I. uwajimensis*. Imlay later changed the identification of *Prohauericeras* to *Sonninia* of Bajocian age (written commun., 1954) and that of *Inoceramus undulatoplicatus* to *I. schmidti* of Campanian age (written commun., 1955). Later studies by Jones showed that the *Parapuzosia* belongs to *Canadoceras* and that some of the specimens referred to as *I. uwajimensis* belong to a new species of Cenomanian age.

These changes, together with the identification by Imlay (1959) of Albian ammonites obtained from near the base of the formation, showed that previous interpretations as to the lower age limit of the formation required revision, although when first discovered, the stratigraphic significance of the Albian ammonites was equivocal, and Imlay (1960, p. 88) suggested that they might have been reworked into much younger beds.

In order to ascertain the stratigraphic position of the Albian fossils discussed by Imlay, and also to gather additional fossils from the lower part of the Matanuska Formation, Grantz and Jones visited the Matanuska Valley-Nelchina area in 1959. Field data showing that

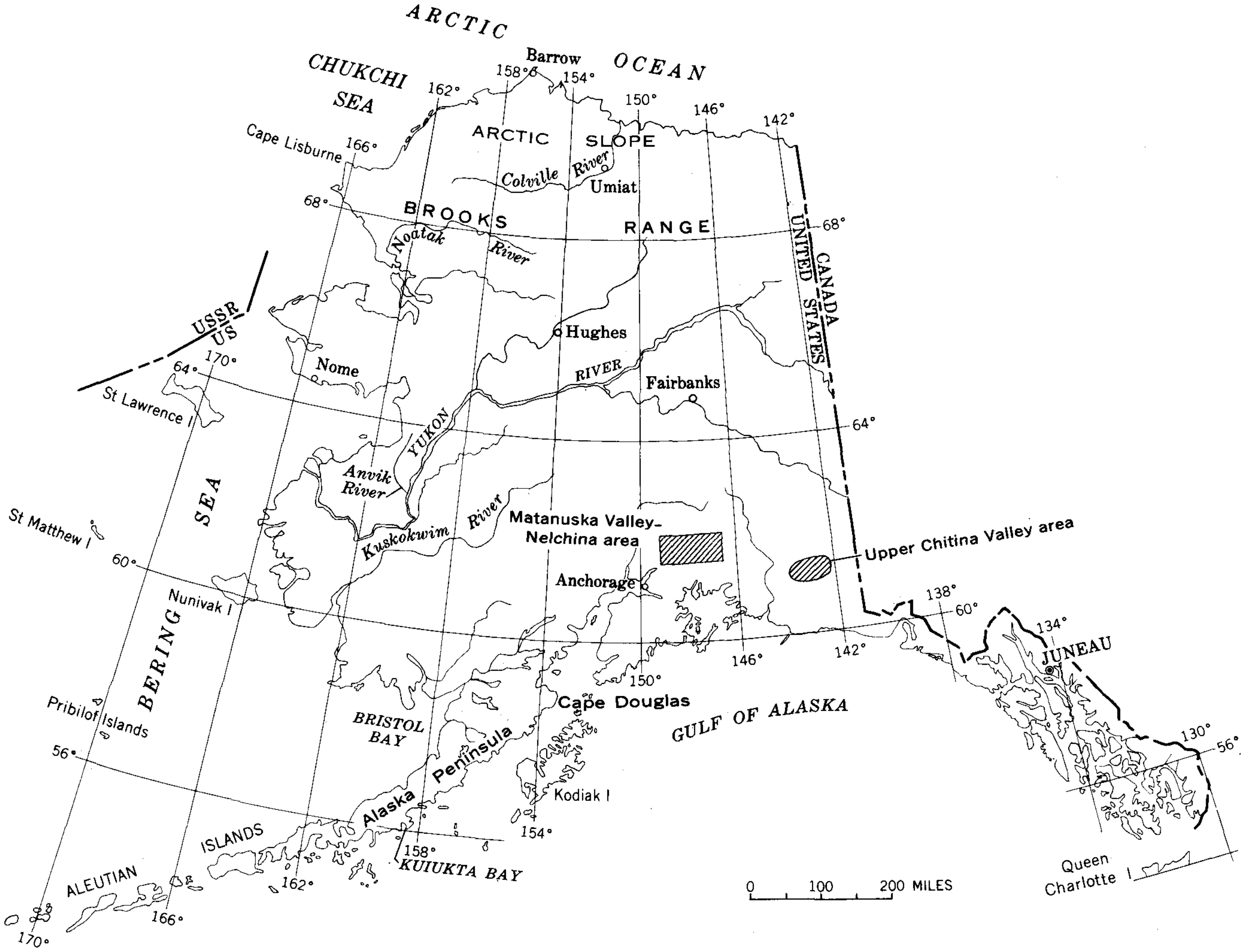


FIGURE 1.—Location of the Matanuska Valley-Nelchina area and the upper Chitina Valley area.

the Albian fossils were indeed in place, and that rocks of Cenomanian and probable Turonian ages were also present, were published in a preliminary note (Grantz and Jones, 1960). In that report, as well as in a later report on the ammonites from the upper part of the Matanuska Formation (Jones, 1964), it was suggested that strata of Coniacian and Santonian ages were missing and that Campanian beds rested directly on probable Turonian beds. This interpretation was based on a lack of identifiable fossils of known Coniacian and Santonian ages. In 1963 Grantz revisited the Nelchina area and collected well-preserved specimens of *Inoceramus uwajimensis* Yehara and other Inoceramii and ammonites indicative of Coniacian and possibly Santonian ages. These collections, augmented by additional fossils collected by Jones and Grantz in 1964, indicate that the total age span of the Matanuska Formation in the Nelchina area is from at least early Albian to early Maestrichtian, although deposition was not continuous and no single sequence contains a complete sedimentary record.

In the present report Grantz is responsible for discussion of the stratigraphy and for lithologic correlations within the Matanuska Valley-Nelchina area; Jones is responsible for local and regional paleontologic correlations and for systematic descriptions.

MID-CRETACEOUS FAUNAL SEQUENCE IN SOUTHERN ALASKA

In order to establish the age of the fossils from the structurally complex and lithologically heterogeneous rocks of the Matanuska Formation in the Matanuska Valley-Nelchina area, these fossils must be compared with those in a local standard of reference, preferably one with a structurally simple sequence of rocks containing abundant fossils that have been studied in some detail. In southern Alaska the most richly fossiliferous sequence of Albian and Cenomanian rocks occurs in the upper Chitina Valley, an area currently being studied by Jones. No detailed description of the Cretaceous rocks of the entire region is yet available, although a general account was given by Moffit and Capps (1911) and Moffit (1918, 1938), and the Cretaceous rocks of the McCarthy A-4 quadrangle have been mapped by Miller and MacColl (1964) and described by Jones and Berg (1964). Recently, Imlay (1959, 1960) and Matsumoto (1959a) have figured Cretaceous fossils from the upper Chitina Valley, but the stratigraphic relationships reported in these papers are either obscure or in need of partial revision. The following summary of the mid-Cretaceous faunal sequence in the upper Chitina Valley is presented here to provide a background to assist in understanding the age and facies relationships of the Matanuska Formation in the Matanuska Valley-Nelchina area, where the rock sequence is stratigraphically less complete, generally less fossiliferous, and structurally more complex.

ALBIAN

On the basis of studies of the ammonite faunas of the upper Chitina Valley, Imlay (1960) established several faunal zones of Albian age. The lowest zone, containing the "*Leconteites modestus* and *Puzosigella* faunules," was said to be characterized by *L. modestus* (Anderson), *Puzosigella* cf. *P. rogersi* (Hall and Ambrose), *P.* cf. *P. perrinsmithi* (Anderson), *P.* cf. *P. taffi* (Anderson), *Anagaudryceras aurarium* (Anderson), and *Aucellina* sp. Rocks bearing this faunule were correlated with the *Leconteites lecontei* zone of California and assigned an early or early middle Albian age (Imlay, 1960, p. 89).

From rocks overlying the *Leconteites modestus* and *Puzosigella* zone, Imlay recognized the "*Moffitites robustus* and *Leconteites deansi* faunule," characterized by *Moffitites robustus* Imlay, *Kennicottia bifurcata* Imlay, *Leconteites deansi* (Whiteaves), *L. crassicostatus* Imlay (*nomen nudum*), *Anagaudryceras aurarium* (Anderson), *Phyllopachyceras* cf. *P. shastalense* (Anderson), *Calliphylloceras* cf. *C. aldersoni* (Anderson), *Ptychoceras* cf. *P. laeve* (Gabb), *Callizoniceras* (*Wollemanniceras*) *alaskanum* Imlay, *C.* (*W.*) *fohlinense* Imlay, and other species. The correlation of this zone with the zonal sequence of California established by Anderson (1938) and Murphy (1956) was uncertain, and Imlay (1960, p. 91) suggested that it occupied a position intermediate between the zones of *Leconteites lecontei* and *Brewericeras hulenense*.

The *Moffitites robustus* zone is overlain, according to Imlay, by rocks containing the "*Brewericeras breweri* and *B.* cf. *B. hulenense* faunule" characterized by many species, the most important of which are *Brewericesras breweri* (Gabb), *B.* cf. *B. hulenense* (Anderson), *Puzosia alaskana* Imlay, *Parasilesites bullatus* Imlay, *Hulenites* cf. *H. reesidei* (Anderson), and *Lemuroceras* (*Subarcthoplites*) aff. *L. belli* McLearn. This zone was considered to be approximately equivalent to the zone of *B. hulenense* of northern California and was assigned a late early Albian age in the sense of Breistroffer (1947) and Wright (1957) or an early middle Albian age in the sense of Spath (1923, 1942).

A fourth faunule, the "*Freboldiceras singulare* faunule" known only from the Matanuska Formation in the Talkeetna Mountains, was also recognized by Imlay (1960, p. 92). This faunule included *Tetragonites* sp., *Beudanticeras* [=*Grantziceras* of the present report] *glabrum*, *Grantziceras multiconstrictum*, and *Lemuroceras* [=*Arcthoplites* of the present report] *talkeetnanum* and was of particular interest "because its component species show close affinities with Albian species in the western interior of Canada and in India, and because its genera and species have no known affinities with the Albian ammonites of California or Oregon, although they occur in the same marine basin as the Albian ammonites of the Chitina Valley that are closely related to ammonites in California and Oregon" (Imlay, 1960, p. 92). This fauna was suggested to be either slightly older or slightly younger than the *Brewericeras* zone of the upper Chitina Valley, and a younger age was favored (Imlay, 1960, p. 92).

Imlay's work was based on fossils collected by various geologists engaged in reconnaissance studies of the rocks of the upper Chitina Valley, and many of the collections could either not be located precisely or were derived from float. More detailed collecting by Jones, in conjunction with geologic studies by E. M. MacKevett, Jr., and the late Don J. Miller, both of the U.S. Geological Survey, was undertaken in 1961; Jones and Imlay jointly collected Cretaceous fossils from this area in 1962, and Jones made additional collections in 1963 and 1965. Preliminary studies of these collections necessitate a revision of Imlay's zonal scheme as summarized above. In brief, the major changes are as follows:

The *Moffitites robustus* fauna characterizes the lowest part of the Albian sequence of the upper Chitina Valley (fig. 4), and specimens of "*Leconteites modestum*" and "*Puzosigella* cf. *P. rogersi*" identical with those figured by Imlay have been found with this fauna. *Aucellina* is extremely abundant in this zone. The *Moffitites robustus* zone is probably equivalent to, or slightly older than, the early Albian *Leconteites lecontei* zone of California and Oregon (Jones and others, 1965).

The *Brewericeras hulenense* zone overlies the *Moffitites robustus* zone and can be correlated with the rocks bearing the "*Freboldiceras singulare* faunule" of the Talkeetna Mountains. This correlation is based on the presence, in the Talkeetna Mountains, of the following representatives of the *Brewericeras hulenense* zone: *B. hulenense*, *Parasilesites bullatus*, *Hulenites* sp., *Puzosia alaskana*, *Tetragonites* sp., and *Arcthoplites* spp. Also *Grantziceras* and *Freboldiceras* have been found by Jones in the *Brewericeras hulenense* zone of the Chitina Valley, so there is little doubt as to the equivalency of these two zones. The probable early Albian age for the *B. hulenense* zone in Alaska is confirmed by the discovery, in the upper Chitina Valley, of several specimens of *Douvilleiceras mammillatum* (Schlotheim). According to Spath (1942, p. 674), this fossil is restricted to the *regularis*, *monile*, and *inaequinodum* zones, which Breistroffer (1947) placed in the lower Albian.

In the upper Chitina Valley, strata of probable late Albian age directly overlie the *Brewericeras hulenense*-bearing beds. These younger rocks are characterized by *Desmoceras* (*Pseudouhligella*) *dawsoni* (Whiteaves) and many other species of ammonites including *Pseudhelicoceras* sp., *Marshallites cumshewaensis* (Whiteaves), *Marshallites* spp., *Zelandites inflatus* Matsumoto, and *Proplacenticeras* sp. Some of these ammonites have been described by Matsumoto (1959a). A similar fauna is known from the Queen Charlotte Islands, associated with the upper Albian ammonite *Mortoniceras*.

Strata of middle and early late Albian ages equivalent to the zone of *Oxytropidoceras packardi* and the lower part of the zone of *Pervinquieria hulenana* of northern California (Murphy, 1956) are missing or as yet unidentified in both the Chitina Valley and the Matanuska Valley-Nelchina area and have not been reported from any other localities in southern Alaska. Likewise, the absence in southern Alaska of the *Gastroplites* fauna of middle Albian age known from northern and north-central Alaska and the western interior of Canada perhaps can be explained by the absence of rocks of this age. On the Queen Charlotte Islands, B.C., beds containing *Brewericeras hulenense* and those containing *D.* (*P.*) *dawsoni* are separated by nearly 700 meters of sandstone and siltstone in which cleoniceratid and other ammonites are common. These middle Albian fossils also are unknown in southern Alaska.

CENOMANIAN

The beds in the Chitina Valley bearing *Desmoceras* (*Pseudouhligella*) *dawsoni* are overlain by strata containing *D.* (*P.*) *japonicum* Yabe together with many other species of ammonites, some of which were described by Matsumoto (1959a). Other characteristic species of this fauna include *Parajaubertella imlayi* Matsumoto, *Eogunnarites alaskaensis* Matsumoto, and *Turrilites acutus* Passy. This fauna is of undoubted Cenomanian age (Matsumoto, 1959a, p. 81) and characterizes the beds herein termed the zone of *Desmoceras* (*Pseudouhligella*) *japonicum*. Other forms common in, but not restricted to, this zone include *Zelandites inflatus* Matsumoto and *Marshallites cumshewaensis* (Whiteaves).

Upper Cenomanian and Turonian rocks were reported to occur in the upper Chitina Valley by Matsumoto (1959a, p. 86). These rocks crop out in the vicinity of Nikolai Creek and yielded fossils identified as *Inoceramus hobetsensis* Nagao and Matsumoto, *I.* cf. *I. pictus* Sowerby, and a new species of *Marshallites* close to an upper Cenomanian form from Japan. Additional collecting from this place has shown that *Desmoceras* (*Pseudouhligella*) *japonicum* occurs in the uppermost beds and *D.* (*P.*) cf. *D. japonicum* occurs lower in the section in brownish-yellow siltstone that yielded the *Marshallites* n. sp. Still lower in the section *Brewericeras hulenense* was collected, so this sequence can be correlated with the Albian and Cenomanian zones discussed above.

Poorly preserved fragments of *Inoceramus* similar to *I. cuvierii* were collected in 1965 from black shale in the McCarthy B–4 quadrangle. These fossils suggest that beds of Turonian age occur locally within the upper Chitina Valley area. The presence of Turonian beds within or near the lower Chitina Valley is suggested by a single specimen of *Subprionocyclus normalis* found on a mudcone in the eastern part of the Copper River Lowland. This specimen is figured in this report to demonstrate that upper Turonian strata are probably present in the subsurface of that area; possibly, these beds crop out in the lower Chitina Valley, but they have not yet been identified there.

STRATIGRAPHIC SUMMARY OF THE LOWER PART OF THE MATANUSKA FORMATION

By Arthur Grantz

The Matanuska Formation was deposited in a long but probably narrow trough with a complex history (the Matanuska geosyncline of Payne, 1955). This trough extended from the Chitina Valley on the east to beyond the tip of the Alaska Peninsula on the southwest. The formation, which crops out in the Matanuska Valley, the Nelchina area, and the southwest Copper River Lowland, comprises several overlapping prisms of clastic sedimentary rocks which are separated by unconformities (Grantz, 1960a, b; 1961a, b; 1965). These unconformities record important episodes of uplift and erosion, and thus the prisms they bound are lithogenetic units. Some of the prisms consist of a single dominant rock type; others consist of assemblages of rock types in characteristic arrangement. Silty claystone and siltstone are the common rocks in these prisms, but sandstone and conglomerate are abundant and in some prisms are complexly interbedded and intertongued with the claystone and siltstone. Because of these complexities, the character of the formation is best elucidated by delineating and mapping some of its unconformity-bounded prisms, as well as its strictly lithologic units.

The prisms which constitute the lower part of the Matanuska Formation range in age from Albian to Coniacian or Santonian. They rest unconformably on Jurassic and Lower Cretaceous rocks and are overlain by Santonian(?), Campanian, and Maestrichtian rocks in the upper part of the Matanuska Formation. The relationship of the main units in the lower part of the Matanuska Formation is summarized in figure 2, and the position of the major faults and fossil localities are shown on plate 10. The Albian units crop out in the Matanuska Valley, the Nelchina area, and the southwest part of the Copper River Lowland; the units of Cenomanian to Coniacian or Santonian age have so far been definitely identified only in the Nelchina area and the southwest part of the Copper River Lowland.

Rocks in the Matanuska Valley-Nelchina area have undergone moderately severe deformation, and the resulting structural complexities have made it difficult or impossible to study complete and undisturbed sections of the thicker units of the Matanuska Formation. In addition, important differences exist in the character of the Matanuska Formation across two major strike-slip faults which strike eastward across the Nelchina area, the Caribou fault, which strikes across its center, and a poorly exposed fault (probably an extension of the Castle Mountain fault system), which strikes across its southern part near the Matanuska

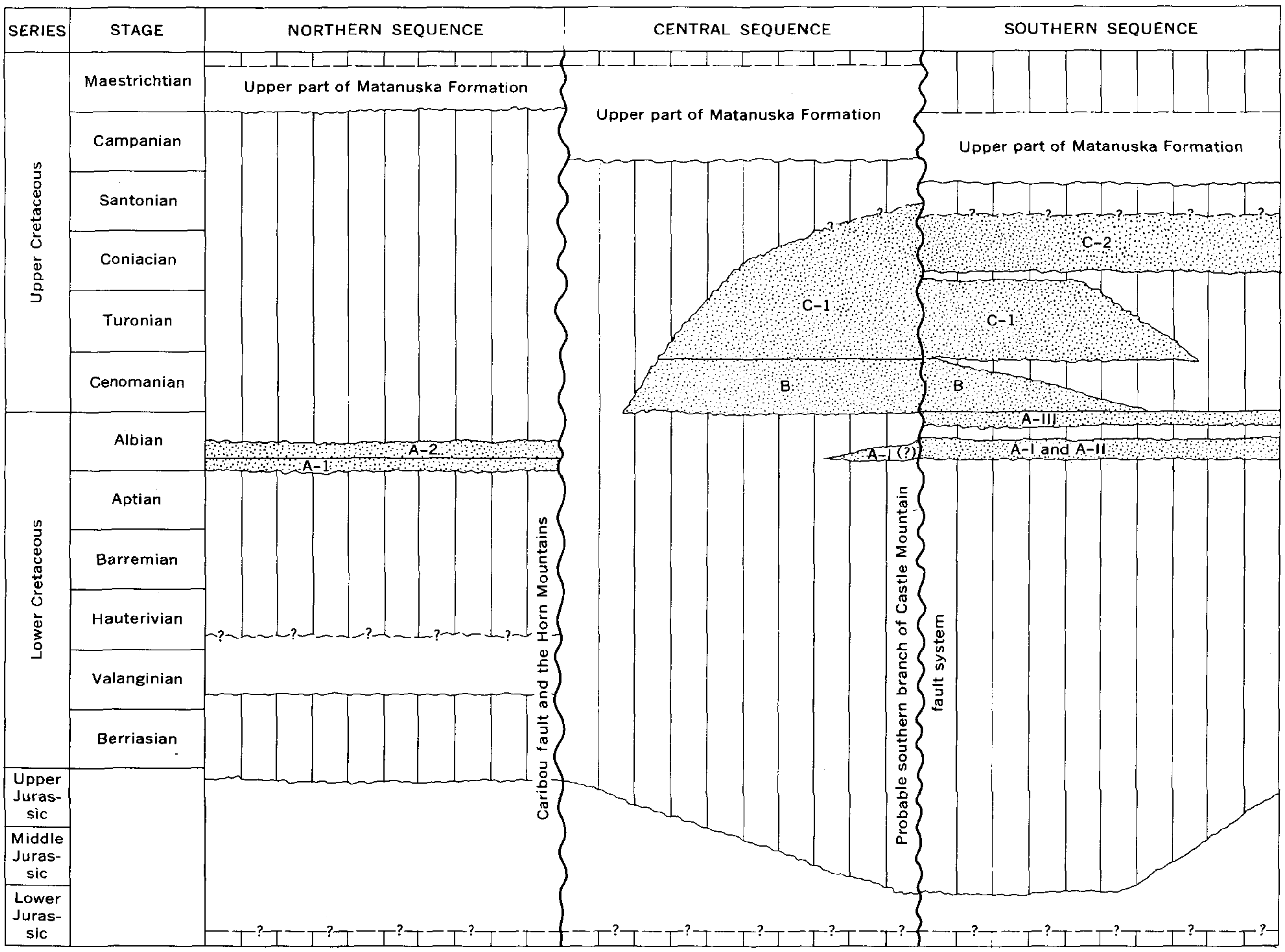


FIGURE 2.—Relationship of informal stratigraphic units of the lower part of the Matanuska Formation (stippled) in three structurally bounded sequences. Vertical ruled areas represent missing or as yet unidentified parts of the sequence. Unstippled units belong to the upper part of the Matanuska Formation or to other formations.

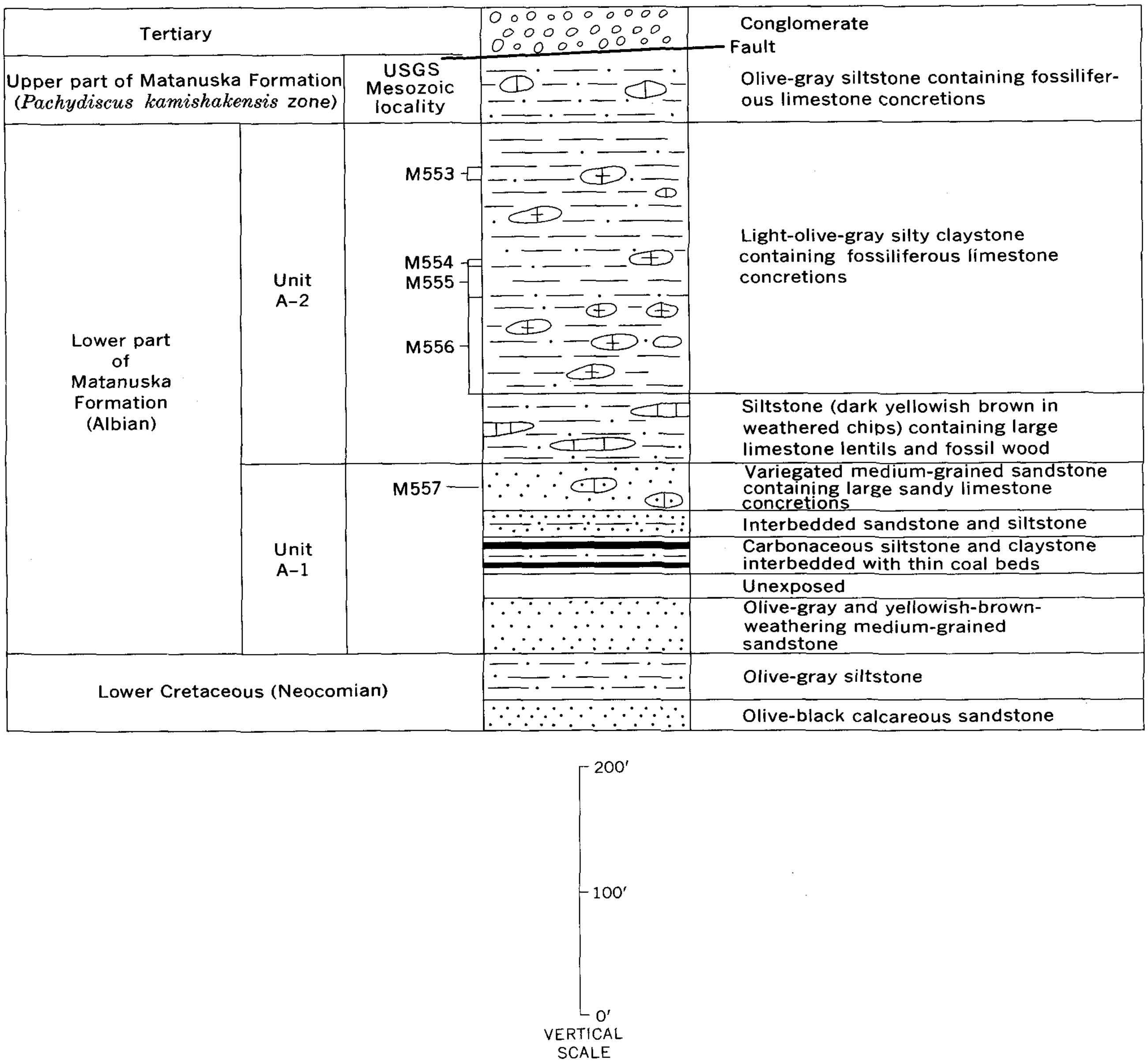


FIGURE 3.—Generalized columnar section of the Matanuska Formation in the Limestone Hills area.

River. These faults bound three stratigraphic sequences designated on figure 2 as the northern, central, and southern sequences. Because of these structural complexities, some of the stratigraphic sequences described below are incomplete, and a number of sections must be discussed to illustrate regional variations in the formation across its relatively narrow outcrop belt. Subdivisions of the formation will be designated informally by letters which are compatible with, but represent a revision of, the informal symbols for units of the Matanuska Formation used by Grantz and Jones (1960). For brevity, units consisting of mixtures of claystone, silty claystone, and siltstone, with or without shaliness, will in places be called lutite in the following discussion.

UNIT A, STRATA OF ALBIAN AGE

Albian strata lie at the base of the Matanuska Formation in the vicinity of Limestone Hills in the northern part of the Nelchina area and along the north front of the Chugach Mountains in the southern part of the Nelchina area. Between these Albian occurrences lie the important Caribou and Castle Mountain fault systems, which bound an area in which Cenomanian beds form the base of the formation. The Albian rocks in the Limestone Hills are relatively thin, are characterized by soft claystone and siltstone bearing a rich ammonite fauna, and contain sandstone and coal-bearing beds at their base (fig. 3). They rest with disconformity upon Hauterivian or younger calcareous sandstone. The Albian rocks of the Chugach front are grossly similar but they are entirely marine, contain fewer ammonites, and some outcrops contain beds of algal nodules. In the lower Matanuska Valley the Albian rocks rest unconformably on Upper Jurassic siltstone. In the Nelchina area and southwest Copper River Lowland, they rest on Lower Jurassic volcanic and associated sedimentary rocks. In addition to sandstone and shale, the Albian sequence of the Chugach front is characterized by hard siliceous claystone and siltstone bearing many poorly preserved *Inoceramus* valves in some beds.

The two rather different Albian facies of the Matanuska Valley-Nelchina area, that of the Limestone Hills to the north and that of the Chugach front to the south, are separated by two major faults and an area in which Albian rocks were either not deposited or were removed by uplift and erosion in the late Albian or early Cenomanian. The abrupt change from one sequence to another may be due to juxtaposition along the major fault systems. On the other hand, transitional beds may have existed in the intervening eroded area between the faults.

LIMESTONE HILLS AREA

Coal-bearing beds lie at the base of the Matanuska Formation in and near the Limestone Hills (fig. 3). These beds, informally designated unit A–1, rest disconformably on calcareous marine sandstone of Hauterivian or younger age and grade upward into marine beds containing Albian mollusks. All known exposures are small erosional remnants and lie within 8 to 9 miles of Limestone Gap, at the center of the Limestone Hills. These basal coaly beds are sharply lenticular and variable in lithology, and their character is known only in a general way. At their base at Limestone Gulch (fig. 3) is about 50 feet of current-bedded medium- and fine-grained nonmarine sandstone. This is overlain by more than 30 feet, and locally by 100 feet or more, of brownish-dark-gray carbonaceous siltstone and claystone containing beds of bone and coal ranging from a few inches to at least 3 feet thick and a few beds of sandstone. In some sections the carbonaceous siltstone and claystone is overlain by 60 to 100 feet of medium-grained sandstone with current bedding and large sandy calcareous concretions. In its lower part this sandstone contains thin layers of siltstone and coaly shale and is thought to be nonmarine. At Limestone Gulch its middle and upper parts are littoral or inner sublittoral marine deposits and contain the pelecypod *Aucellina* (see pl. 4, figs. 27, 28) and rare specimens of the ammonite *Moffitites robustus* Imlay (USGS Mesozoic loc. M557) of early early Albian age (*Moffitites robustus* zone). The middle and upper (marine) parts of this sandstone are apparently represented by only a few thin sandstone beds or a pebbly siltstone near Flume Creek, less than 3 miles east of Limestone Gulch. Sandstone with coaly lenses, possibly correlative with the lower and middle (nonmarine) parts of the Limestone Gulch section, crops out on Mazuma Creek, on Caribou Creek near Chitna Creek, and perhaps elsewhere in the adjacent region; in each of these areas, it is overlain disconformably by beds of Campanian or Maestrichtian age.

In the Limestone Hills the basal sandy and coaly beds are overlain conformably by about 240 feet of marine silty claystone and siltstone, informally designated unit A–2, which is characterized in its lower beds by brownish-gray-weathering slopes and numerous limestone concretions containing well-preserved ammonites. The beds that form brownish-gray-weathering slopes are roughly 100 to 125 feet thick, light olive gray, and contain abundant limestone concretions and lentils throughout. Fossil wood occurs in about the basal two-fifths, and numerous ammonite-bearing concretions occur in about the upper three-fifths of these beds. About 110 to 135 feet or more of olive-gray silty claystone and siltstone containing fewer limestone concretions and ammonities forms the top of the claystone and siltstone unit and is overlain disconformably by siltstone of late Campanian or Maestrichtian age. The abundant ammonites in these claystones and siltstones (USGS Mesozoic locs. 24877, 25320, M553–M556, M559) show that all these beds belong to the *Brewericeras hulenense* zone of late early Albian age; identified forms include

Brewericeras hulenense (Anderson)
Anagaudryceras sacya (Forbes)
Arcthoplites talkeetnanus (Imlay)
Freboldiceras singulare Imlay
Grantziceras affine (Whiteaves)
G. glabrum (Whiteaves)
Lytoceras n. sp.
Hulenites sp.
Parasilesites bullatus Imlay
Puzosia alaskana Imlay

NORTH FRONT OF THE CHUGACH MOUNTAINS

MATANUSKA VALLEY

Lithic (epiclastic volcanic) marine sandstone, from 0 to about 25 feet thick, forms the base of the Matanuska Formation in the lower Matanuska Valley, where it is exposed at the north front of the Chugach Mountains near Wolverine Creek. The sandstone, informal unit A–I, rests uncomformably upon siltstone of the Naknek

Formation (Upper Jurassic), and its basal contact shows rough erosional microtopography. It is gray and brown weathering, grades from coarse and pebbly in its lower beds to very fine grained at the top, and contains limestone concretions and wood fragments. A few pelecypods and small ammonites belonging to *Anagaudryceras* of Albian age were collected from USGS Mesozoic locality M1168 (pl. 10) in the upper part of this sandstone. USGS Mesozoic locality M583 from the same outcrop may date the sandstone more precisely, for this locality contains *Brewericeras hulenense* of late early Albian age. However, the precise stratigraphic position of this locality is unknown; it might be from the sandstone itself, or from the overlying beds.

The basal sandstone is conformably overlain, but also overlapped, by fairly hard dark-green and medium-dark-gray silty claystone 250 to 300 feet or more thick. These beds are informal unit A–II. Abundant limestone nodules that in places are concentrated into lenses of limestone conglomerate 2 to 4 feet thick occur in the lowest 40 feet of this unit. Among the nodules are banded or layered masses produced by calcareous algae and some fragments of unidentifiable ammonite and pelecypod shells. At or near the top of the exposed part of the unit is fine- and medium-grained dark-greenish-gray graywacke sandstone 40 or more feet thick that contains some plant scraps. Because they are gradational, it is assumed that the sandstone and the silty claystone are of the same age; and because they rest conformably on beds with Albian fossils (unit A–I) and most closely resemble Albian lutite in the Matanuska Formation, they are tentatively assigned to the Albian. Mesozoic locality M583, which contains late early Albian fossils, is either from these beds or from the conformably underlying sandstone (unit A–I). A large covered interval separates the Albian beds near Wolverine Creek from Tertiary conglomerate which appears, from its structural position and attitude, to overlie them unconformably.

At a few localities in the upper Matanuska Valley, rather hard silty claystone overlies beds similar to unit A–I and may be correlative with unit A–II. At USGS Mesozoic locality M572 (pl. 10) these beds yielded poorly preserved ammonites similar to *Arcthoplites* of early to middle Albian age, a hamitid ammonite of uncertain age, and *Inoceramus* with ribbing similar to that of *Inoceramus* aff. *I. cuvierii* of Turonian age. Thus the age of this collection and the correlation of these rocks are equivocal.

NELCHINA AREA AND SOUTHWEST COPPER RIVER LOWLAND

The basal beds of the Matanuska Formation along the Chugach front in the upper Matanuska Valley-Nelchina area and southwest Copper River Lowland are marine epiclastic volcanic sandstones that are commonly crossbedded and probably correlate with the somewhat similar but much thinner and lenticular basal beds near Wolverine Creek. They therefore are assigned to the same informal unit (A–I). Unit A–I rests with angular unconformity and sharp erosional microtopography upon Lower Jurassic lavas and volcaniclastic rocks wherever studied. In a typical section on the East Fork of Matanuska River these beds consist of lithic (epiclastic volcanic) sandstone, the lower half being coarse and conglomeratic and containing some rhynchonellid brachiopods and the upper half being fine and medium grained. The character of these beds, however, varies considerably from place to place. For example, 3 miles southwest of the beds at the East Fork, the basal unit is tripartite, consisting of a basal pebbly sandstone with abundant fossil wood, a medial siltstone and fine-grained sandstone with limestone nodules and concretions, and an upper sandstone unit with large sandy limestone concretions. The thickness of unit A–I in the Nelchina and adjacent areas is also rather variable, ranging from 100 or less to almost 400 feet.

About 300 feet of pebbly epiclastic volcanic sandstone beds in a small area on the southeast side of Sheep Mountain may also belong to unit A–I, although their age has not been definitely established, and they possibly belong with the overlying beds of Cenomanian age (unit B). These beds contain small brachiopods, and, near the base, a conglomerate with zones of irregular limestone and calcareous (algal?) nodules.

Snails (USGS Mesozoic loc. M1962) and several ammonites (USGS Mesozoic locs. M2409, M2413), as well as brachiopods and wood, have been found in unit A–I. The ammonites, which include *Brewericeras* cf. *B. hulenense*, *Grantziceras* sp., *Anagaudryceras cappsi*, *Arcthoplites belli*, *Parasilesites bullatus*, and *Phyllopachyceras* sp., establish the late early Albian age (*Brewericeras hulenense* zone of unit A–I in this area. Unit A–I is thus equivalent to the claystone and siltstone of unit A–2 and is younger than the *Moffitites*-bearing beds of unit A–1 of the Limestone Hills area.

Conformably overlying the basal Albian sandstone (A–I) are greenish-gray, medium-dark-gray, and some olive-gray and brown siltstone and silty claystone with locally abundant interbeds of sandstone and coarse siltstone. This sequence, informal unit A–III, is characterized by numerous irregularly distributed beds and thick zones of hard (siliceous) claystone and siltstone cemented by diagenetic calcite and silica, by accumulations of generally fragmented *Inoceramus* valves in some beds, and locally by zones containing numerous irregularly shaped limestone and calcareous algal nodules. Limestone concretions and lentils are locally common, and calcareous intervals, thin layers of volcanic ash(?), and a few beds of glauconitic calcarenite are present. In the southern part of the Nelchina area some sections of this sequence are at least 700 or 800 feet thick, and south of Twin Lakes, in the southwest Copper River Lowland, similar rocks are at least 300 or 400 feet thick. Thicker sections may be present, but they are obscured by the extensive faulting which characterizes the Chugach front. In the southern part of the Nelchina area, unit A–III is overlain by softer lutite of Turonian age, and the similar rocks south of Twin Lakes are overlain by sandstone of Cenomanian age.

Beds and zones of hard (siliceous) lutite constitute the bulk of unit A–III and contain small ammonites and an unnamed species of *Inoceramus* which, although poorly preserved, suggest a late Albian or early Cenomanian age. The unnamed *Inoceramus* is a form with very fine concentric riblets that is similar to a species which occurs in the upper Albian rocks of the upper Chitina Valley; the ammonites include *Desmoceras* (*Pseudouhligella*) cf. *D.* (*P.*) *dawsoni* and a scrap that may be *Marshallites*. They were collected at USGS Mesozoic localities M590, M1774, M2410, M2411, M2412(?), M2414, M2415, and M2416.

South of Twin Lakes the hard (siliceous) beds of unit A–III rest on 200 feet or more of relatively soft greenish-gray lutite which contains an ammonite scrap that may belong to *Grantziceras* of late early Albian age (USGS Mesozoic loc. M2386). These softer beds may represent Unit A–II of Wolverine Creek. In the Nelchina area the hard (siliceous) beds of unit A–III appear to rest directly on unit A–I, the basal sandstone of late early Albian age, and soft beds that may represent unit A–II have not been recognized. In neither area have fossils of middle Albian age (the zone of *Oxytropidoceras packardi* of California) been found. These relationships suggest that the base of unit A–III may mark either a disconformity or a hiatus south of Twin Lakes and a disconformity in the southern part of the Nelchina area.

CORRELATION WITHIN THE MATANUSKA VALLEY-NELCHINA AREA

The Albian siltstone and silty claystone sequence of the Limestone Hills area (unit A–2) contains ammonites belonging to the *Brewericeras hulenense* faunizone throughout. It is thus correlative with (1) sandstone (unit A–I) at the base of the Matanuska Formation in the Chugach front in the Nelchina area, which also contains ammonites characteristic of this faunal zone and (2) at least some part of the Albian section near Wolverine Creek from which *B. hulenense* of late early Albian age was also collected. Unit A–1 at the base of the Matanuska Formation in the Limestone Hills area contains *Aucellina* and *Moffitites robustus* of early Albian age. It is therefore slightly older than unit A–I of the Chugach front in the Nelchina area and either correlates with unit A–I of the Wolverine Creek area or is slightly older. The latter view is supported by the apparent absence from the shallow marine sandstone that constitutes unit A–I near Wolverine Creek, of *Aucellina*, a common fossil in shallow marine rocks of early early Albian age in southern Alaska. Unit A–II near Wolverine Creek and units A–I and A–II(?) in the upper Matanuska Valley and south of Twin Lakes are all probably also correlative with unit A–2 of the Limestone Hills.

UNIT B, SANDSTONE OF CENOMANIAN AGE

A distinctive marine sandstone of Cenomanian age, generally with a basal siltstone member, is an important cartographic unit in the southern half of the Nelchina area. The Cenomanian beds, informal unit B, occur mainly where Albian beds either were never deposited or were removed by mid-Cretaceous erosion. Thus in most places they lie at the base of the Matanuska Formation. They rest upon Lower Jurassic volcanic and Middle and Upper Jurassic sedimentary rocks with angular unconformity, and the subjacent volcanic rocks locally are conspicuously weathered. Unit B has not yet been definitely recognized in the Matanuska Valley or along the north front of the Chugach Mountains except south of Twin Lakes, in the southwestern part of the Copper River Lowland, where it rests upon the hard siltstone (unit A–III) of late Albian age. Along the Chugach front west of the Twin Lakes area, unit B is either absent or is represented by beds which could not be differentiated in the field from the upper part of unit A–III. At most places sandstone of unit B is overlain with apparent conformity by siltstone of Cenomanian or Turonian age (unit C–1), but south of Horn Mountains in the central part of the Nelchina area unit B is locally overlain by Campanian beds of the upper part of the Matanuska Formation. Cenomanian beds are absent from the Nelchina area north of Horn Mountains and the Caribou fault system, where Campanian or younger beds rest directly upon Albian rocks.

The basal siltstone member of the Cenomanian sandstone unit rests upon a weathered erosion surface with locally sharp microrelief. The weathered zone is several feet thick where the surface was cut in Lower Jurassic volcanic rocks. Residual clay deposits as much as 2 feet thick and siltstone and sandstone as much as 6 feet thick containing angular granules to cobbles of volcanic rock occur locally at the base of the unit. In one area at the west end of Sheep Mountain, sandstone and coarse siltstone at the base of the basal siltstone member are a few tens of feet thick. Above these variable, lenticular, and commonly very thin basal beds is a thicker and more widespread siltstone that is prominent in unit B around Sheep Mountain. This siltstone was not found in the northernmost outcrops of unit B in the Nelchina area, but in places its position may be occupied by about 60 feet of silty olive-black sandstone. At Sheep Mountain the siltstone member is typically 50 to 200 feet thick, and in places it may rest directly on pre-Matanuska rocks. Typically an olive-, greenish-, or medium-dark-gray siltstone, it ranges from silty shale to coarse siltstone and very fine sandstone. At some localities the siltstone weathers reddish gray or is mottled reddish and greenish gray. It contains some limestone concretions, and coaly layers, coal fragments, and fragmentary plant remains were found in a number of outcrops. The siltstone is dated as Cenomanian (zone of *Desmoceras* (*Pseudouhligella*) *japonicum*) by the presence of the ammonite *Desmoceras* (*Pseudouhligella*) *japonicum* Yabe, in particular, and the ammonites *Marshallites* (?) sp., *Zelandites* (?) sp., *Eogunnarites alaskaensis* Matsumoto, and *Parajaubertella imlayi* Matsumoto at USGS Mesozoic localities 24857, M598, M2379, M2381, M2382, and M2385.

The most characteristic and widespread component of unit B is a greenish-gray fine- and very fine grained shallow marine sandstone that conformably overlies the basal siltstone. It contains common and locally abundant *Inoceramus* sp. "A," a moderate-sized fairly stout-shelled pelecypod, and rare ammonite fragments, including *Calycoceras* sp. indet. (USGS Mesozoic locs. M595, M1938). In its northernmost outcrops the sandstone is fine to medium grained and pebbly; to the south it is fine and very fine grained with coarse siltstone. Plant fragments are widespread but not abundant. The sandstone is thick bedded or massive, in many places crossbedded, and silty interbeds and small intraclasts of glauconitic siltstone occur locally, especially to the south. It is variously lithic or feldspathic, nowhere quartzose. Near the Caribou fault the sandstone is about 150 to 200 feet thick; near Sheep Mountain it is about 100 to 250 feet thick and possibly, at one place, about 300 feet thick.

Unit B is evidently the product of clastic deposition in a shallow seaway which transgressed an uneven weathered erosion surface; the main sandstone unit seems to have had a northern source, and deposition of the siltstone member is thought to have been terminated by the spread of partially winnowed sand from shallow, near-shore accumulation areas in the northern part of the Cenomanian basin. If this interpretation is correct, then the siltstone member is a basinward facies of the lower part of the sandstone member.

UNIT C, STRATA OF CENOMANIAN TO SANTONIAN(?) AGE

UNIT C–1, LUTITE OF CENOMANIAN TO CONIACIAN OR SANTONIAN AGE

Medium-dark-gray lutite (silty claystone and sandstone), informally designated unit C–1, conformably overlies unit B in the central part of the Nelchina area and along the Chugach front south of Twin Lakes in the southwest part of the Copper River Lowland. Along the Chugach front in the Nelchina area, unit C–1 rests with apparent conformity upon unit A–III. Unit C–1 is absent north of the Horn Mountains and crops out north of the Caribou fault only on the southeast flank of these mountains. It has not been definitely identified in the Matanuska Valley but probably occurs in at least the upper part of the valley. Medium-dark-gray silty claystone of Campanian (and locally Santonian?) age in the upper part of the Matanuska Formation disconformably(?) overlies unit C–1 north of the Matanuska River in the Nelchina area. Along the Chugach front, however, unit C–1 is overlain with angular unconformity by a unit of interbedded siltstone, sandstone, and conglomerate that is informally designated unit C–2.

Unit C–1 is rather similar in appearance to the dark lutite of the overlying Campanian beds (*Inoceramus schmidti* zone), and rocks of these two units have been mapped together in parts of the Nelchina area. Where rocks of the Matanuska Formation have not been strongly indurated by tectonic compression, these units can be distinguished by the greater abundance and larger size of limestone concretions with well-developed cone-in-cone structure in the Campanian beds and by the presence of large and locally abundant valves of *Inoceramus schmidti*. Also, the Campanian silty claystone has a bluish cast in many outcrops, in contrast to the gray color, in places with a strong greenish or purplish cast, of unit C–1. Furthermore, along the Chugach front, unit C–1 has thicker and more numerous beds of altered volcanic ash.

Unit C–1 is possibly 1,500 feet or more thick in the valley floor of the Matanuska River; it thins to about 400 feet on the northeast side of Sheep Mountain and to a feather edge in the west-central part of the Nelchina area. Late Cretaceous erosion of unit C–1 in the central Nelchina area is demonstrated by reworked limestone concretions with Coniacian fossils in a Campanian channel conglomerate at USGS Mesozoic locality M561 and by reworked Turonian or Coniacian fossils in Campanian lutite at USGS Mesozoic locality 25964. Because unit C-1 has been mapped with Campanian beds in many places, and because complete thick sections have not been found, its maximum thickness is not known. Around Sheep Mountain its basal beds are olive or greenish-gray siltstone, much of which is hard, sandy, or coarse. These beds grade into predominantly medium-dark-gray silty claystone and siltstone containing fossiliferous limestone concretions, thin interbeds of fine-grained detrital sandstone, some beds of glauconitic calcarenite rich in *Inoceramus* prisms and shell fragments, and a few thin shelly siltstone layers. Unit C–1 weathers typically to chunky fragments. South of the Matanuska River the unit is medium dark gray or greenish gray and commonly has a purplish cast. In places there, it is pebbly and contains sandstone beds and lenses and some thin beds of volcanic ash.

Unit C–1 contains fairly common *Inoceramus* fragments and some ammonites, but identifiable collections have not been found at enough places to completely define its age in all areas. Near Camp Creek a large collection of mollusks at USGS Mesozoic locality M600 from the base of the unit is of Cenomanian age. On the north side of the Matanuska River gorge, USGS Mesozoic locality M1989 in the lower part of C–1 contains fragments of the ammonite *Euomphaloceras*(?) sp. and other fossils indicative of a possible Cenomanian age. At all other places where datable mollusks were found near the base of unit C–1, the fossils are of probable Turonian age. This age assignment is based mainly on the presence of *Inoceramus* aff. *I. cuvierii*, the most common mollusk in most outcrops of unit C–1 (USGS Mesozoic locs. 25960, 25968, 25971, 25985, 25987, M569, M601, M1947, M1949, M1950, M1951, M1968, M1988, M2389, M2391, M2406). At some outcrops this pelecypod is associated with ammonites and other Inoceramii that are of probable Turonian age or that are known to range into the Turonian. These associated fossils include *Otoscaphites teshioensis*, *Mesopuzosia* aff. *M. indopacifica*, *Scaphites* cf. *S. planus gigas*, *Tetragonites* aff. *T. glabrus*, *Scalarites?* sp. indet., and *Inoceramus* cf. *I. concentricus nipponicus;* they were found mostly in unit C–1 (USGS Mesozoic locs. 24239, 24853, M601, M1945), but some of these forms occur as intraclasts in Campanian beds at USGS Mesozoic locality 25964.

The youngest faunule identified from unit C–1 occurs around Sheep Mountain and in the valley floor of the Matanuska River. It has not yet been found in the northernmost outcrops of unit C–1 near the south side of the Horn Mountains, although it occurs as reworked intraclasts in Campanian beds of the upper part of the Matanuska Formation at USGS Mesozoic locality M561. This faunule is dominated by *Inoceramus uwajimensis* Yehara of Coniacian age (USGS Mesozoic locs. 24189, 24231, 24232, 24233, 25972, 26730, M1942, M1943, M1958, M1959(?), M1986, M1987, M1992, M1994(?), M1995(?)). It also contains *I.* cf. *I. yokoyamai*, *Mesopozosia* sp., and *Scaphites* sp. indet. (USGS Mesozoic locs. M1992, M2384(?), M2408). The latter forms may range into the Santonian, and where they occur without *Inoceramus uwajimensis*, the beds may be of Santonian age.

UNIT C–2, COMPOSITE SEQUENCE OF CONIACIAN AND SANTONIAN(?) AGE

Unit C–2, a thick sequence of siltstone and silty claystone with numerous thin to very thick interbeds of sandstone and conglomerate, crops out along the Chugach front and in an adjacent lowland belt in the Nelchina area and south of Twin Lakes in the southwest Copper River Lowland. Lithologically similar beds crop out near the mouth of Tazlina Lake in the south-central part of the lowland, but the paleontologic evidence so far obtained to support the correlation of these beds with unit C–2 is equivocal. The composite unit rests with angular unconformity on beds as young as Coniacian in unit C–1 and as old as Early Jurassic in the Talkeetna Formation. It is overlain (disconformably?) by silty claystones of Santonian age which are the oldest beds in the upper part of the Matanuska Formation.

Unit C–2 is about 2,000 to 2,500 feet thick. It consists of predominantly medium-dark-gray siltstone and silty claystone containing myriad very thin to very thick interbeds of coarse siltstone, sandstone, pebbly sandstone, and conglomerate. The sandstone interbeds are composed chiefly of lithic grains and generally contain more feldspar than quartz, which is a relatively minor constituent. The interbeds occur irregularly, and the unit is constructed of successive sequences of siltstone, a few tens to a few hundreds of feet thick, containing different proportions and (or) types of interbeds. In some sequences sandstone predominates over siltstone, and thick-bedded and massive units of sandstone and conglomerate a few tens of feet thick are fairly common. The interbeds are characterized by graded bedding, sole-markings or "flysch figures," and both intraformational and extraformational clasts. Large-scale penecontemporaneous slump structures were noted at a number of localities. Small-scale crossbedding, some asymmetric ripple marks, scoured or channeled bases, and carbonaceous scraps and plant fragments are common in the sandstone interbeds. Typically, the pebbly sandstone and conglomerate beds are markedly channeled into their substrates, and some of these beds are sharply lenticular. Some thin beds are calcarenite composed of *Inoceramus* prisms, broken shells, and other small carbonate fragments. Limestone concretions occur in both sandstone and siltstone beds but are not abundant.

Several collections of *Inoceramus* and two collections containing ammonites have been found in the interbedded unit. The Inoceramii have been assigned to *Inoceramus uwajimensis* of Coniacian age (USGS Mesozoic locs. M1953, M1959(?), M2387(?), M2403(?)) and to a new species related to *I. uwajimensis* that may be of Coniacian or Santonian(?) age (USGS Mesozoic locs. 25979, M591, M1272, M1773, M1952, M1961, M2384(?), M2397, M2401, M2402, M2404, M2405). The ammonites include a scaphite from Shell Oil Co. locality T1006 that is similar to forms in the Turonian and Coniacian of Japan and a long-ranging species of *Neophylloceras* from USGS Mesozoic localities M591 and M1952. Their ages are compatible with, but do not add to, the Coniacian age suggested by the Inoceramii. The outcrops at the mouth of Tazlina Lake, which possibly belong to unit C–2, contain (at USGS Mesozoic locs. M2396 and M2397) the *Inoceramus* n. sp. related to *I. uwajimensis*, which is of Coniacian or Santonian(?) age and (at USGS Mesozoic loc. M1969) an ammonite scrap, which perhaps belongs to *Canadoceras* or *Mesopuzosia* of Santonian or Campanian age.

The composite unit is clearly younger than Coniacian beds in unit C–1 along the Chugach front, for it rests upon them with angular unconformity. The lutite of unit C–2, however, is similar to lutite in the upper part of unit C–1 near Sheep Mountain where unit C–2 is absent from the section. The upper part of C–1 in this area contains *Inoceramus uwajimensis*, as does unit C–2, and thin beds of fossiliferous-fragmental calcarenite and detrital sandstone. The similarity of these beds to unit C–2 suggests that C–2 may be a facies of the upper part of unit C–1 near Sheep Mountain and that a disconformity corresponding to the unconformity at the base of unit C–2 may be present in the upper part of C–1 north of the Chugach front; however, because the sections with and without unit C–2 are closely juxtaposed across the Matanuska River and its East Fork, transcurrent movement along a branch of the Castle Mountain fault system near these rivers was probably at least partly responsible for the absence of unit C–2 north of the Chugach front.

REGIONAL CORRELATION OF THE LOWER PART OF THE MATANUSKA FORMATION

The lower part of the Matanuska Formation comprises rocks ranging in age from Albian to Coniacian or Santonian, although the sequence is not complete and several unconformities are present (figs. 2, 4). The fossils of Albian and Cenomanian ages are similar to those from the upper Chitina Valley, and fairly close correlation between the rocks of the two areas can be achieved. The Albian faunas include species known from California as well as from the Arctic Slope of Alaska and the western interior of Canada. This joint occurrence permits a rather close tie between two faunal provinces, the Indopacific and the Western Interior, which previously could be correlated only by indirect means.

Cenomanian fossils are scarce and are generally similar to forms known elsewhere in the Indopacific faunal realm. This is also true for Turonian fossils, which for the most part are poorly preserved and fragmentary. The Coniacian fossils are similar to forms known from the upper Chitina Valley and are comparable, or identical, with Japanese species.

The basal sandstone beds of the Matanuska Formation in the vicinity of Limestone Gulch (unit A–1) are equivalent to the basal beds of the Albian sequence of the upper Chitina Valley, on the basis of the presence of *Moffitities robustus* and *Aucellina*. The overlying grayish-brown siltstone (unit A–2) containing the "*Freboldiceras singulare*" fauna as well as the basal sandstone (unit A–I) along the northern front of the Chugach Range south of the Matanuska River are correlative with beds bearing the *Brewericeras hulenense* fauna of the upper Chitina Valley, Queen Charlotte Islands, the Methow Valley area of northern Washington (Popenoe and others, 1960, p. 1535), unnamed beds near Mitchell in central Oregon, and part of the Chickabally Mudstone Member of the Budden Canyon Formation of Murphy, Peterson, and Rodda (1964) in northern California. This stratigraphic unit is equivalent to part of the Ono Formation of previous usage (Murphy, 1956).

Brewericeras hulenense reached its known northern extent in the Matanuska Valley-Nelchina area, where it mingled with representatives of the northern *Grantziceras* and *Arcthoplites* fauna. Elements of this northern fauna are known as far south as the Queen Charlotte Islands, British Columbia, but are unknown from Oregon and California. *Grantziceras* occurs at several localities in northern Alaska. Near Hughes several well-preserved specimens of *G. affine*, together with a probable new species of *Cleoniceras*, were collected by W. W. Patton, Jr., of the U.S. Geological Survey; Imlay (1961, p. 7) has reported *Grantziceras affine* and *G.* cf. *G. affine* from the lower part of the Torok and Fortress Mountain Formations of the Arctic Slope of Alaska. In Canada, *Grantziceras* [="*Beudanticeras*"] occurs commonly in the Moosebar and Gates Formations, the lower part of the Buckinghorse Formation, and the Loon River and Clearwater Formations (Henderson, 1954, p. 2285).

The basal beds of the Matanuska Formation near Sheep Mountain (unit B) are correlative with the *Desmoceras* (*Pseudouhligella*) *japonicum*-bearing beds of the upper Chitina Valley on the basis of the presence of *D.* (*P.*) *japonicum*, *Eogunnarites alaskaensis*, and

Parajaubertella imlayi. Rocks of the upper Albian *D.* (*P.*) *dawsoni* zone have not yet been positively identified, but they might be represented in the region south of the Matanuska River by the siliceous beds in the upper part of unit A–III. Rocks of mid-Cenomanian age are represented by sandstone beds in the upper part of unit B that bear rare specimens of *Calycoceras* sp. and a new species of *Inoceramus* characterized by a long thin overhanging umbo in the left valve. The overlying beds in the basal part of unit C–1 may be either late Cenomanian or early Turonian, as discussed below.

In California, the Bald Hills Member, and perhaps the uppermost part of the underlying Chickabally Mudstone Member of the Budden Canyon Formation (Murphy and others, 1964), are correlative with the *D.* (*P.*) *japonicum* and *D.* (*P.*) *dawsoni*-bearing rocks of the Chitina Valley and the Matanuska Valley-Nelchina area. Upper Albian rocks in central Oregon (Jones, 1960; Packard and Jones, 1962) may be somewhat older than the *D.* (*P.*) *dawsoni* zone of southern Alaska, although a precise correlation of the two is not possible. The Oregon rocks contain an abundant ammonite fauna characterized by *Mortoniceras* sp., *Anisoceras merriami*, and *Desmoceras* (*Pseudouhligella*) sp. This latter form was referred to *D.* (*P.*) *dawsoni* by Matsumoto (1959a, p. 61) but a study of large collections have convinced the writer of the present report that the Oregon specimens consistently have a more inflated whorl section than do the Alaskan forms and therefore are probably not conspecific.

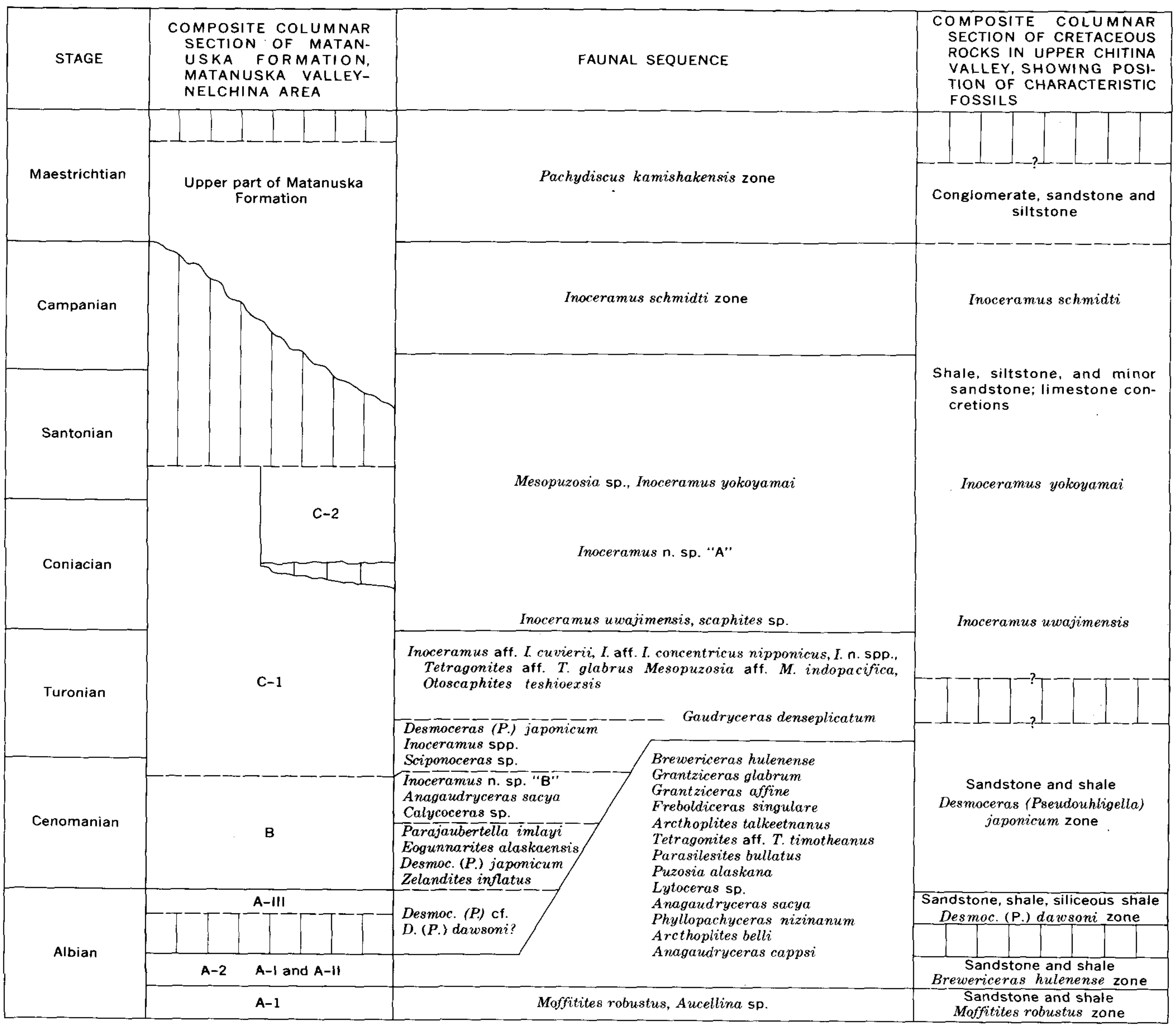


FIGURE 4.—Generalized columnar section of the Matanuska Formation showing faunal succession in the lower part of the formation and correlation with rocks in the upper Chitina Valley area.

Albian or Cenomanian rocks correlative with those of the Matanuska Valley-Nelchina area may be present elsewhere in southern Alaska, although little is known of their occurrence. Parkinson (1960) reported that on the Alaska Peninsula, Lower Cretaceous rocks crop out in the Cape Douglas area and that some of these rocks are of Albian age on the basis of microfossils (L. J. Parkinson, written commun., 1961). Because field examination in 1965 by Jones and R. Detterman revealed only beds of probable late Neocomian age, the identification of the Albian strata could not be substantiated. Poorly preserved fossils in the Shell Oil Co. collection in Seattle, obtained from locality SOC M249, Kuiukta Bay, were examined by the writer and tentatively identified as *Desmoceras* (*Pseudouhligella*) *japonicum* and *Marshallites* sp. A large specimen of *Anagaudryceras sacya*, similar to the specimen of *A. sacya* from the Queen Charlotte Islands figured by Whiteaves (1884, pl. 25), was collected from Portage Bay by Prof. F. W. True of the U.S. Fish Commission. Unfortunately, there are three "Portage Bays" on the Alaska Peninsula, and it has not been possible to ascertain from which one the fossil was collected. The most likely place appears to be the Portage Bay located at the head of Kuiukta Bay, although it has not yet been demonstrated that Cretaceous rocks are exposed there.

Cenomanian rocks occur in northern Alaska, but with the exception of the Arctic Slope region, they have received little detailed study and have yielded a relatively meager fauna that has little or nothing in common with those from southern Alaska. The Nanushuk Group of the Arctic Slope is of probable late Albian and Cenomanian ages (Jones and Gryc, 1960, p. 153, fig. 31) based on *Inoceramus dunveganensis* McLearn, a species not known to occur in Alaska south of the Brooks Range, although erroneously reported to occur in the central Kuskokwim region (Cady and others, 1955, p. 45).

The Kuskokwim region probably does contain rocks of Cenomanian age, on the basis of the presence of species of *Inoceramus* similar to undescribed forms from the upper Chitina Valley area and a single specimen of *Turrilites acutus* of Cenomanian age from the upper Anvik River region.

Rocks of probable Turonian age, containing an abundant fauna of *Inoceramus* and rare ammonites, occur in informal unit C–1 of the Matanuska Formation. The *Inoceramus* specimens are generally fragmentary and whole valves are rare. The most common form is referred to *Inoceramus* cf. *I. cuvierii*, which is known from Turonian deposits of northern Alaska (Jones and Gryc, 1960) and elsewhere. Another common species is related to *Inoceramus concentricus nipponicus* Nagao and Matsumoto (1939), known from Cenomanian deposits of Japan. Associated with these species are several ammonites, including well-preserved specimens of *Otoscaphites teshioensis* (Yabe), *Mesopuzosia* aff. *M. indopacifica* (Kossmat), *Tetragonites* aff. *T. glabrus* (Jimbo), *Neophylloceras* sp., and *Gaudryceras* sp.

This fauna overlies beds in the lower part of unit C–1 from which a fauna of probable late Cenomanian or early Turonian age was obtained. Fossils from this fauna include *Sciponoceras* sp., *Tetragonites* aff. *T. glabrus*, *Gaudryceras* aff. *G. denseplicatum* (Jimbo), *Bostrychoceras* sp., fragments of a desmoceratid ammonite resembling *D.* (*Pseudouhligella*) *japonicum*, and *Inoceramus* sp.

The presumed Turonian fauna is overlain by beds yielding abundant specimens of *Inoceramus uwajimensis* of Coniacian age. With the exception of the upper Chitina Valley, Turonian rocks have not yet been positively identified elsewhere in southern Alaska, although the presence of a small specimen of *Subprionocyclus normalis* on a mud cone in the southeastern part of the Copper River Lowland (Grantz and others, 1962) suggests that upper Turonian deposits may be present locally in that area. The displacement of this fossil rules out any understanding of its stratigraphic significance, but it seems likely that it was brought up by connate water from subsurface marine deposits of Turonian age.

Further evidence for the presence of Turonian beds in the Matanuska Valley-Nelchina area is provided by Foraminifera studied by Bergquist (1961). In his lowest microfaunal unit, zone A, Bergquist (p. 2004–2005) reported the presence of

Bathysiphon alexanderi Cushman
B. taurinensis Sacco
"*Cribrostomoides*" *cretacea* Cushman and Goudkoff
Ammodiscus cretaceus (Reuss)
Glomospira aff. *G. gordialis* (Jones and Parker)
Robülus münsteri (Roemer)
Gyroidina florealis White
G. globulosa (Hagenow)
Eponides sp.
Globotruncana arca (Cushman)
Rectoglandulina sp.
Planulina spissocostata Cushman
Haplophragmoides sp.
Marssonella oxycona (Reuss)
Gaudryina cf. *G. bentonensis* (Carmen)
Marginulina bullata (Reuss)
"*Globigerina*" *cretacea* (d'Orbigny)
Pelosina complanata Franke
Cibicides stephensoni Cushman

Beds yielding this fauna occur from 100 to 400 feet above the base of the Matanuska Formation in the Squaw Creek area and from depths of 4,350 to 4,818 feet in the nearby Eureka test well 1. These beds were tentatively correlated by Bergquist with beds of the lower Cachenian Stage of California (G–2 of Goudkoff, 1945), mainly on the basis of the presence of *Cibicides stephensoni.* The lower Cachenian Stage was assigned a middle to late Turonian age by Popenoe, Imlay, and Murphy (1960, p. 1517). However, some of the forms listed above, for example, *Globotruncana arca*, are indicative of a post-Turonian age, so it seems possible that samples from low in the section were contaminated by fossils from higher in the section.

Turonian beds probably occur in the central Kuskokwim region of southwestern Alaska, where an undescribed fauna of *Otoscaphites*, *Scalarites*, and *Inoceramus* spp. is known from the Kuskokwim Group (Cady and others, 1955).

On the Arctic Slope of Alaska, Turonian beds are widespread and have yielded many fossils (Jones and Gryc, 1960; Cobban and Gryc, 1961), but these show only a slight relationship to faunas of southern Alaska.

Deposits of Coniacian age, represented by lutite of unit C–1, are characterized by fairly abundant specimens of *Inoceramus uwajimensis* and rare specimens of *I.* cf. *I. yokoyamai* and *Mesopuzosia* sp. The overlying sandstone of unit C–2 contains locally abundant valves of a new species of *Inoceramus* close to, and presumably derived from, *I. uwajimensis*, which may be of late Coniacian age. Unit C–1 is thus equivalent to the lower part of the dominantly siltstone and shale sequence of the upper Chitina Valley area that in the McCarthy A–4 quadrangle was designated unit K_2 (Miller and MacColl, 1964; Jones and Berg, 1964, p. 10, 11).

Elsewhere in southern Alaska, positive evidence is not available for the presence of Coniacian rocks, although Imlay (in Imlay and Reeside, 1954, p. 228) postulated that some deformed and fragmentary specimens of *Inoceramus* obtained from slate and graywacke near Girdwood in the Chugach Range and from Woody Island near Kodiak are of late Coniacian or early Santonian age. This age determination was based on comparison of the Alaskan specimens with those from Utah and Wyoming, as similar forms have not been found in other well-dated and richly *Inoceramus*-bearing rocks of Alaska. Such a long-range correlation without benefit of local stratigraphic control leaves this precise age determination open to some question, although undoubtedly the forms are of late Mesozoic age. Until confirming evidence is obtained, it seems best to leave open the exact age of the *Inoceramus*-bearing part of the Chugach slate and graywacke belt and regard as unconfirmed the determination of Coniacian fossils from this belt.

GEOGRAPHIC DISTRIBUTION OF AMMONITES

The collecting localities of the ammonites described in this report and of several undescribed forms and selected species of *Inoceramus* are shown on table 1. The general position of each locality is shown on plate 10, and detailed descriptions of the localities are given in table 2.

TABLE 1.—*Checklist of fossils from the lower part of the Matanuska Formation, Matanuska Valley-Nelchina area*

Fossil	USGS Mesozoic Locality No.																																						
	22123	24188	24189	24203	24204	24205	24206	24229	24231	24232	24233	24239	24850	24851	24853	24855	24856	24857	24877	25320	25960	25961	25962	25963	25965	25966	25967	25968	25971	25972	25974	25975	25978	25979	25985	25987	26730	M553	M555
Otoscaphites teshioensis												?			X																								
Scaphites sp. indet																																							
Mesopuzosia aff. *M. indopacifica*								X																															
sp																																							
Sciponoceras sp. indet																																							
Gaudryceras aff. *G. denseplicatum*																																							
Tetragonites aff. *T. glabrus*																																							
Subprionocyclus normalis																																							
Neophylloceras sp. juv															X																								
Calycoceras sp. indet																																							
Tetragonites cf. *T. timotheanus*																			X	X																			
Desmoceras (*Pseudouhligella*) *japonicum*																																							
(*Pseudouhligella*) sp. indet																																							
Marshallites sp																																							
Zelandites inflatus																																							
Eogunnarites alaskaensis																																							
Parajaubertella imlayi																		X																					
Anagaudryceras sacya																																							
Brewericeras hulenense																																							
Arcthoplites talkeetnanus																			X																				
Freboldiceras singulare																			X																			X	
Grantziceras affine																			X	X																			X
glabrum																																							
Lytoceras n. sp																																							
Puzosia alaskana																																							
Hulenites sp																																						X	X
Moffitites robustus																																							
Parasilesites bullatus																																							
Hamitid ammonite																																							
Euomphaloceras(?) sp																																							
Aucellina sp																																							
Inoceramus cf. *I. cuvierii*																					X							X	X						X	X			
n. sp. "B"	X				X	X	X						X	X			X						?	X		X	X					X							
n. sp. "A"																																		X					
uwajimensis			X						X	X	X																			X							X		
cf. *I. yokoyamai*																																							
spp		X		X								X				X						X			X						X		X						
cf. *I. concentricus nipponicus*																																							
Ammonite, gen. and sp. indet																																							
Anagaudryceras cappsi																																							
Arcthoplites belli																																							
Tetragonites sp																																							
Phyllopachyceras chitinanum																																							
Crab fragments																																							

Fossil	M556	M557	M559	M568	M569	M572	M574	M583	M590	M591	M595	M596	M597	M598	M599	M600	M601	M1168	M1270	M1272	M1773	M1774	M1795	M1939	M1942	M1943	M1945	M1947	M1949	M1950	M1951	M1952	M1953	M1958	M1959	M1961	M1968	M1986	M1987	M1988
Otoscaphites teshioensis																																								
Scaphites sp. indet																											X													
Mesopuzosia aff. *M. indopacifica*																	X																							
sp																																								
Sciponoceras sp. indet																X																								
Gaudryceras aff. *G. denseplicatum*																X								?																
Tetragonites aff. *T. glabrus*																X	X																							
Subprionocyclus normalis																							X																	
Neophylloceras sp. juv																																								
Calycoceras sp. indet											X																													
Tetragonites cf. *T. timotheanus*																																								
Desmoceras (*Pseudouhligella*) *japonicum*												X																												
(*Pseudouhligella*) sp. indet				X									X		X																									
Marshallites sp															X																									
Zelandites inflatus															X																									
Eogunnarites alaskaensis														X																										
Parajaubertella imlayi																																								
Anagaudryceras sacya	X			X																																				
Brewericeras hulenense	X		X					X																																
Arcthoplites talkeetnanus	X		X			?																																		
Freboldiceras singulare	X																																							
Grantziceras affine	X		X																																					
glabrum	X																																							
Lytoceras n. sp	X																																							
Puzosia alaskana	X																																							
Hulenites sp																																								
Moffitites robustus		X																																						
Parasilesites bullatus	X																																							
Hamitid ammonite					X																																			
Euomphaloceras(?) sp																																								
Aucellina sp		X																																						
Inoceramus cf. *I. cuvierii*					X												X											X	X	X	X						X			X
n. sp. "B"							X				X								X																					
n. sp. "A"										X										X	X											X				X				
uwajimensis																									X	X							X	X	?			X	X	
cf. *I. yokoyamai*																																								
spp						X			X							X						X																		
cf. *I. concentricus nipponicus*																	X											X			X									
Ammonite, gen. and sp. indet																		?																						
Anagaudryceras cappsi																																								
Arcthoplites belli																																								
Tetragonites sp																																								
Phyllopachyceras chitinanum																		?																						
Crab fragments																																								

TABLE 1.—*Checklist of fossils from the lower part of the Matanuska Formation, Matanuska Valley-Nelchina area*—Continued

Fossil	USGS Mesozoic Locality No.																																							
	M1989	M1992	M1994	M1995	Soc-T1006	M2379	M2381	M2382	M2383	M2384	M2385	M2386	M2387	M2388	M2389	M2390	M2391	M2392	M2393	M2396	M2397	M2398	M2399	M2400	M2401	M2402	M2403	M2404	M2405	M2406	M2408	M2409	M2410	M2411	M2412	M2413	M2414	M2415	M2416	M2417
Otoscaphites teshioensis																	X																							
Scaphites sp. indet					X													X																						
Mesopuzosia aff. *M. indopacifica*																	X																							
sp.		X													?						?																			
Sciponoceras sp. indet									X																															
Gaudryceras aff. *G. denseplicatum*									X								?																							
Tetragonites aff. *T. glabrus*																	X																							
Subprionocyclus normalis																																								
Neophylloceras sp. juv									X								X																							
Calycoceras sp. indet																																								
Tetragonites cf. *T. timotheanus*																																								
Desmoceras (*Pseudouhligella*) *japonicum*						?	X	X	X		X																													
(*Pseudouhligella*) sp. indet	X																																	X						
Marshallites sp.																																		X						
Zelandites inflatus						X	X																																	
Eogunnarites alaskaensis						X																																		
Parajaubertella imlayi																																								
Anagaudryceras sacya																																								
Brewericeras hulenense																																X								
Arcthoplites talkeetnanus																																								
Freboldiceras singulare																																								
Grantziceras affine												?																				X								
glabrum																																								
Lytoceras n. sp.																																								
Puzosia alaskana																																								
Hulenites sp.																																								
Moffitites robustus																																								
Parasilesites bullatus																																				X				
Hamitid ammonite	X	X													X									X																
Euomphaloceras(?) sp.	X																																							
Aucellina sp.																																								
Inoceramus cf. *I. cuvierii*															X		X													X										
n. sp. "B"											?																													
n. sp. "A"										?											X				X	X		X	X											
uwajimensis		X	?	?									?					X									?													
cf. *I. yokoyamai*		X								?																					X									X
spp.	X	X							X			X		X		X	X		X	X													X	X	X		X	X	X	
cf. *I. concentricus nipponicus*																	X							X						X										
Ammonite, gen. and sp. indet										X												X												X				X		
Anagaudryceras cappsi																																				X				
Arcthoplites belli																																				X				
Tetragonites sp.											X																													
Phyllopachyceras chitinanum																																				X				
Crab fragments																							X																	

TABLE 2.—*Ammonite and selected* Inoceramus*-bearing localities in the lower part of the Matanuska Formation, southern Alaska*

USGS Mesozoic Loc. No.	*Field No.*	*Collector, year of collection, description of locality, and stratigraphic position*
22123	49AEC 135	R. A. Eckhart, 1949. Anchorage D–2 quad., 3,100 ft north of Glenn Highway. Lat 61°48′50″ N., long 147°31′45″ W. Unit B.
24188	52AGz 18	A. Grantz, R. Hoare, R. Imlay, 1952. Anchorage D–2 quad. On south tributary of Squaw Creek, 1.95 miles N. 40° W. of southeast summit of Gunsight Mountain. Unit B.
24189	52AGz 20	A. Grantz, R. Hoare, R. Imlay, 1952. Anchorage D–2 quad. On south tributary of Squaw Creek, 2.01 miles N. 40.5° W. of southeast summit of Gunsight Mountain. Unit C–1.
24203	52AGz 55	A. Grantz, R. Hoare, R. Imlay, 1952. Anchorage D–2 quad., on south tributary of Squaw Creek, 2.47 miles N. 24° E. of southeast summit of Gunsight Mountain. Unit C–1.
24204	52AGz 58	A. Grantz, R. Hoare, R. Imlay, 1952. Anchorage D–2 quad., on south tributary of Squaw Creek, 2.25 miles N. 26° E. from southeast summit of Gunsight Mountain. Unit B.
24205	52AGz 59	A. Grantz, R. Hoare, R. Imlay, 1952. From talus, same locality as 24204. Unit B.
24206	52AGz 68	A. Grantz, R. Hoare, and R. Imlay, 1952. Anchorage D–2 quad., south tributary of Squaw Creek, 1.50 miles N. 30.5° E. of southeast summit of Gunsight Mountain. Unit B.
24229	52AHr 1	R. Hoare, 1952. Anchorage D–1 quad., borrow pit on north side of Glenn Highway at mile 120.25. Unit C–1.
24231	52AHr 5	R. Hoare, 1952. Anchorage D–1 quad., north side of Glenn Highway at mile 118.94. Unit C–1
24232	52AHr 6	R. Hoare, 1952. Same locality as 24231. Unit C–1.
24233	52AHr 7	R. Hoare, 1952. Anchorage D–2 quad., south tributary of Squaw Creek, 2.02 miles N. 60.5° W. of southeast summit of Gunsight Mountain. Unit B.
24239	52AGz 266	A. Grantz, 1952. Anchorage D–2 quad., on south side of Alfred Creek, 1.22 miles S. 55° W. of mouth of Pass Creek. Unit C–1.
24850	53AGz 6A	A. Grantz, 1953. Anchorage D–2 quad. Same locality as 22123. Unit B.

TABLE 2.—*Ammonite and selected* Inoceramus-*bearing localities in the lower part of the Matanuska Formation, southern Alaska*—Con.

USGS Mesozoic Loc. No.	*Field No.*	*Collector, year of collection, description of locality, and stratigraphic position*
24851	53AGz 8	A. Grantz, 1953. Anchorage D–2 quad., 2,200 ft north of Glenn Highway. Lat 61° 49′17″ N., long 147°32′10″ W. Unit B.
24853	53AGz 16	A. Grantz, L. Fay, 1953. Anchorage D–2 quad. Approximately 0.25 mile N. 57° W. of BM3117, 500 ft north of Glenn Highway. Lat 61°49′27″ N., long 147°26′48″ W. Unit C–1.
24855	53AGz 26	A. Grantz, 1953. Anchorage D–2 quad., north of Glenn Highway, approximately 0.24 mile N. 67° W. of BM3305 and 0.37 mile S. 22° W. from point where Camp Creek crosses Glenn Highway. Lat 61°50′12″ N., long 147° 25′02″ W. Unit B.
24856	53AGz 31	A. Grantz, L. Fay, 1953. Anchorage D–2 quad., north of Glenn Highway, about 0.25 mile N. 67° W. of BM3305 and 0.4 mile S. 21° W. from point where Camp Creek crosses Glenn Highway. Lat 61°50′12½″ N., long 147° 25′08″ W. Unit B.
24857	53AGz 52	A. Grantz, L. Fay, 1953. Anchorage D–2 quad., float from 2.75 miles north of Glenn Highway, on north branch of south tributary to Caribou Creek. Lat 61°50′22″ N., long 147°36′19″ W. Unit B.
24877	53AGz 137	A. Grantz, L. Fay, 1953. Talkeetna Mountains. A–2 quad., southern part of Limestone Gulch, east of Billy Creek. Lat 62°01′40½″ N., long 147°39′18″ W. Unit A–2.
25320	54AGz 53	A. Grantz, 1954. Talkeetna Mountains. A–2 quad., unnamed west tributary to Flume Creek. Lat 62°00′41″ N., long 147°34′46″ W. Unit A–2.
25960	55AGz 179	A. Grantz, 1955. Valdez D–8 quad., 3,000 ft southeast of southern shore of Twin Lakes, on unnamed tributary, elev 3,050 ft. Lat 61°54′41″ N., long 146° 52′08″ W. Unit C–1 or C–2.
25961	55AGz 183a	A. Grantz, 1955. Valdez D–8 quad., 7,500 ft south of Twin Lakes, elev 4,350 ft. Lat 61°54′02″ N., long 146°31′47″ W. Unit B.
25962	55AGz 184b	A. Grantz, 1955. Valdez D–8 quad., 2³⁄₁₀ miles south of Twin Lakes, elev 4,500 ft. Lat 61°52′58″ N., long 146°53′01″ W. Unit B.
25963	55AGz 186b	A. Grantz, 1955. Valdez D–8 quad., 1⁶⁄₁₀ miles south of southwest tip of Twin Lakes, elev 3, 900 ft. Lat 61°53′31″ N., long 146°54′01″ W. Unit B.
25965	55AGz 253b	A. Grantz, 1955. Anchorage D–1 quad., about 2, 300 ft north of Pass Creek. Lat 61°58′10″ N., long 147°21′09″ W. Unit B.
25966	55AGz 257a	A. Grantz, 1955. Anchorage D–1 quad., 1,500 ft north of Pass Creek. Lat 61°58′04″ N., long 147°21′51″ W. Unit B.
25967	55AGz 258a	A. Grantz, 1955. Anchorage D–1 quad., about 8,500 ft northeast of big bend of Pass Creek. Lat 61°58′50″ N., long 147°19′23″ W. Unit B.
25968	55AGz 266a	A. Grantz, 1955. Anchorage D–1 quad., 300 ft north of Pass Creek. Lat 61°57′50″ N., long 147°21′12″ W. Unit C–1.
25971	55AGz 289b	A. Grantz, 1955. Anchorage D–1 quad., Lat 61°52′12″ N., long 147°20′40″ W. Unit C–1.
25972	55AGz 300	A. Grantz, 1955. Anchorage D–2 quad., north side of Glenn Highway, 1,500 ft northeast of point where Camp Creek crosses highway. Lat 61°50′30″ N., long 147°24′09″ W. Unit C–1.
25974	55AGz 304g	A. Grantz, 1955. Anchorage D–1 quad., south bank of Pass Creek. Lat 61°57′49″ N., long 147°21′31″ W. Unit B.
25975	55AGz 306	A. Grantz, 1955. Anchorage D–1 quad., north side of Pass Creek. Lat 61°57′47″ N., long 147°22′23″ W. Unit B.
25978	55AGz 347	A. Grantz, 1955. Anchorage D–1 quad., south tributary to east fork of Matanuska River, about 5,000 ft above mouth. Lat 61°48′45″ N., long 147°20′ 40″ W. Unit C–2.
25979	55AGz 361	A. Grantz, 1955. Anchorage D–1 quad., east fork of Matanuska River. Lat 61°50′ 14″ N., long 147°14′00″ W. Unit C–2.
25985	55ACo 50a	H. Condon, 1955. Valdez D–8 quad. Lat 61°53′17″ N., long 146°39′41″ W. Unit A–III.
25987	55ACo 64a	H. Condon, 1955. Anchorage D–2 quad. Lat 61°50′42″ N., long 147°24′02″ W. Unit C–1.
26730	57AGz 67	A. Grantz, 1957. Anchorage D–2 quad. Lat 61°48′08″ N., long 147°36′36″ W. Unit C–1.
M553	59AGz M1g	A. Grantz, D. L. Jones, 1959. Talkeetna Mountains A–2 quad., Limestone Gulch. Lat. 62°1 40″ N., long 147°39′18″ W. Fossils from concretions in brown-weathering siltstone, 225 ft above base. Unit A–2.
M555	59AGz M1p	A. Grantz, D. L. Jones, 1959. Same locality as M553, but from 125 to 155 ft above base. Unit A–2.
M556	59AGz 1MQ	A. Grantz, D. L. Jones, 1959. Same locality as M553, but from 0 to 125 ft above base. Unit A–2.
M557	59AGz M3	A. Grantz, D. L. Jones, 1959. Talkeetna Mountains A–2 quad., Limestone Gulch. Lat 62°1′42″ N., long 147°39′15″ W. From sandstone at base of brown-weathering siltstone. Unit A–1.
M559	59AGz M7	A. Grantz, D. L. Jones, 1959. Talkeetna Mountains A–2 quad., west tributary to Flume Creek. Lat 62°00′45″ N., long 147°34′50″ W. Brown-weathering siltstone, about 100 ft above base. Unit A–2.

TABLE 2.—*Ammonite and selected* Inoceramus-*bearing localities in the lower part of the Matanuska Formation, southern Alaska*—Con.

USGS Mesozoic Loc. No.	Field No.	Collector, year of collection, description of locality, and stratigraphic position
M568	59AGz M31	A. Grantz, D. L. Jones, 1959. Valdez D–8 quad., float along ridge south of Twin Lakes. Lat 61°53′40″ N. to 61°53′55″ N., long 146°51′50″ W. to 146°52′15″ W. Unit B.
M569	59AGz M33	A. Grantz, D. L. Jones, 1959. Valdez D–8 quad., unnamed stream flowing northwest into Twin Lakes, elev 3,250 ft. Lat 61°54′35″ N., long 146°52′00″ W. Hard siltstone. Unit C–1.
M572	59AGz M44	A. Grantz, D. L. Jones, 1959. South unnamed tributary of Matanuska River, 1,400 ft south of mouth. Lat 61°46′55″ N., long 148°9′30″ W. Hard siltstone. Unit A–II or C–1.
M574	59AGz M60	A. Grantz, D. L. Jones, 1959. Anchorage D–2 quad., east end of Sheep Mountain. Lat 61°51′15″ N., long 147°24′20″ W. Unit B.
M583	Standard Oil Co. of California.	F. W. Godsey, L. J. Parkinson, 1959. Anchorage C–6 quad., about 2,500 ft north of Wolverine Creek. Lat 61°38′58″ N., long 148°55′30″ W. Unit A–I or A–II.
M590	59AGz M143	A. Grantz, D. L. Jones, 1959. Anchorage D–1 quad., east fork of Matanuska River. Lat 61°50′02″ N., long 147°13′45″ W. Hard siltstone. Unit A–III.
M591	59AGz M150	A. Grantz, D. L. Jones, 1959. Anchorage D–1 quad., east fork of Matanuska River. Lat 61°50′10″ N., long 147°14′00″ W. Interbedded siltstone and sandstone. Unit C–2.
M595	59AGz M155	A. Grantz, D. L. Jones, 1959. Anchorage D–2 quad., Camp Creek, 1,500 ft upstream from where creek crosses Glenn Highway. Lat 61°50′30″ N., long 147°24′50″ W., elev 3,490 ft. Unit B.
M596	59AG M162	A. Grantz, D. L. Jones, 1959. On hillside 100 ft above north bank of unnamed creek southwest of Camp Creek, 2,500 ft northwest of Glenn Highway. Lat 61°30′18″ N., long 147°26′25″ W. Unit B.
M597	59AGz M163	A. Grantz, D. L. Jones, 1959. Same as M596, but about 300 ft east. Unit B.
M598	59AGz M164	A. Grantz, D. L. Jones, 1959. Same as M597. Unit B.
M599	59AGz M164	A. Grantz, D. L. Jones, 1959. Anchorage D–2 quad., in unnamed creek south of Camp Creek, 2,200 ft northwest of Glenn Highway. Unit B.
M600	59AGz M166	A. Grantz, D. L. Jones, 1959. Anchorage D–2 quad., in unnamed creek south of Camp Creek, about 700 ft west of Glenn Highway. Lat 61°50′10″ N., long 147°24′50″ W. Base of Unit C–1.
M601	59AGz M193	A. Grantz, D. L. Jones, 1959. Anchorage D–1 quad., borrow pit on north side of Glenn Highway, 1,100 ft northeast of Mile 120. Lat 61°52′10″ N., long 147°20′40″ W. Unit C–1.
M1168	60AGz 11	A. Grantz, 1960. Anchorage C–6 quad., north tributary of Wolverine Creek. Lat 61°38′55″ N., long 148°55′30″ W. Unit A–I.
M1270	Standard Oil Co. of California	R. H. McMullen, 1961. Anchorage 1:250,000 quad., east end of Sheep Mountain,east of Gunsight Creek. Lat 61°51.6′ N., long 147°26.5′ W. Unit B.
M1272	Standard Oil Co. of California.	R. H. McMullin, 1961. Anchorage 1:250,000 quad., east fork of Matanuska River. Lat 61°49.9′ N., long 147°12.9′ W. Unit C–2.
M1773	62AGz 180	A. Grantz, W. Patton, 1962. Anchorage D–1 quad., east fork of Matanuska River, same locality as M591. Unit C–2.
M1774	6AGz 181	A. Grantz, W. Patton, 1962. Anchorage D–2 quad., south tributary of Matanuska River. Lat 61°47′05″ N., long 147°31′ 40″ W. Unit A–III.
M1795		Bill E. Shaw, 1960(?). West Klawasi mud cone, Copper River Lowland. About 8 miles north-northeast of Copper Center.
M1939	63AGz 5	A. Grantz, J. Stout, 1963. Anchorage D–2 quad., on Glenn Highway 1,500 ft northeast of where Camp Creek crosses highway. Lat 61°50.5′ N., long 147°24.12′ W. Unit C–1.
M1942	63AGz 13	A. Grantz, J. Stout, 1963. Anchorage D–2 quad., north of Glenn Highway. Lat 61°48.3′ N., long 147°35.4′ W. Unit C–1.
M1943	63AGz 18B	A. Grantz, J. Stout. Anchorage D–2 quad., on south bank of Matanuska River. Lat 61° 47.58′ N., long 147°37.58′ W. Unit C–1.
M1945	63AGz 28A	A. Grantz, J. Stout, 1963. Anchorage D–2 quad., south of Matanuska River. Lat 61° 47.45′ N., long 147°33.85′ W. Unit C–1.
M1947	63AGz 30	A. Grantz, J. Stout, 1963. Anchorage D–2 quad., south of Matanuska River. Lat 61°47.35′ N., long 147°33.75′ W. Unit C–1.
M1949	63AGz 37	A. Grantz, J. Stout. Anchorage D–2 quad., South of Matanuska River. Lat 61°47.3′ N., long 147°34.8′ W. Unit C–1.
M1950	63AGz 40	A. Grantz, J. Stout, 1963. Anchorage D–2 quad., south of Matanuska River. Lat 61° 47.4′ N., long 147°34.7′ W. Unit C–1.
M1951	63AGz 44	A. Grantz, J. Stout, 1963. Anchorage D–2 quad., south of Matanuska River. Lat 61°-47.3′ N., long 147°31.62′ W. Unit C–1.
M1952	63AGz 46C	A. Grantz, J. Stout, 1963. Anchorage D–2 quad., south of Matanuska River. Lat 61°-47.45′ N., long 147°31.38′ W. Unit C–2.

TABLE 2.—*Ammonite and selected* Inoceramus*-bearing localities in the lower part of the Matanuska Formation, southern Alaska*—Con.

USGS Mesozoic Loc. No.	*Field No.*	*Collector, year of collection, description of locality, and stratigraphic position*
M1953	63AGz 47	A. Grantz, J. Stout, 1963. Anchorage D–2 quad., south of Matanuska River, 800 ft east of M1952. Lat 41°47.48′ N., long 147°31.1′ W. Unit C–2.
M1958	63AGz 62A	A. Grantz, J. Stout, 1963. Anchorage D–2 quad., north flank of Chugach Mountains. Lat. 61°46.78′ N., long 147°29.38′ W. Unit C–1.
M1959	63AGz 65	A. Grantz, J. Stout, 1963. Anchorage D–2 quad., 700 ft north of M1958. Lat 61°46.82′ N., long 147°29.45′ W. Unit C–1 or C–2.
M1961	63AGz 121	A. Grantz, J. Stout, 1963. Anchorage D–1 quad. Lat 61°51.15′ N., long 147°9.55 W. Unit C–2.
M1968	63AGz 158	A. Grantz, J. Stout, 1963. Valdez D–8 quad., southeast of Twin Lakes. Lat 61°54.7′ N., long 146°52.1′ W. Unit C–1.
M1986	63AGz 308A	A. Grantz, L. Mayo, 1963. Anchorage D–2 quad., north of Matanuska River. Lat. 61°47.7′ N., long 147°32.8′ W. Unit C–1.
M1987	63AGz 309A	A. Grantz, L. Mayo, 1963. Anchorage D–2 quad., north side of Matanuska River. Lat. 61°47.7′ N., long 147°34.15′ W. Unit C–1.
M1988	63AGz 310A	A. Grantz, L. Mayo, 1963. Anchorage D–2 quad., north side of Matanuska River. Lat. 61°47.68′ N., long 147°34.2′ W. Unit C–1.
M1989	63AGz 315	A. Grantz, L. Mayo, 1963. Anchorage D–2 quad., north side of Matanuska River. Lat. 61°47.7′ N., long 147°35.05′ W. Unit C–1.
M1992	63AGz 321	A. Grantz, L. Mayo, 1963. Anchorage D–2 quad., north side of Glenn Highway. Lat. 61°47.55′ N., long 147°42.1′ W. Unit C–1.
M1994	63AGz 325A	A. Grantz, L. Mayo, 1963. Anchorage D–2 quad., south of Glenn Highway. Lat. 61°47.35′ N., long 147°42.8′ W. Unit C–1.
M1995	63AGz 325B	A. Grantz, L. Mayo, 1963. Anchorage D–2 quad., south of Glenn Highway. Lat 61°47.35′ N., long 147°42.9′ W. Unit C–1.
	Soc–T1006	Collector unknown. Anchorage D–1 quad., east Fork of Matanuska River. Same as M590. Unit C–2.
M2379	64AGz 5	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina district, Anchorage D–2 quad., southwest Copper River Lowland. Lat 61°50.5′ N., long 147°25.1′ W. Unit B.
M2381	64AGz 9	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina district, Anchorage D–2 quad. Lat 61°50.55′ N., long 147°25.2′ W. Southwest Copper River Lowland. Unit B.
M2382	64AGz 10	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina district, Anchorage D–2 quad. Lat 61°50.25′ N., long 147°26.25′ W. Southwest Copper River Lowland. Unit B.
M2383	64AGz 11	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina district, Anchorage D–2 quad., Lat 61°50.1′ N., long 147°24.85′ W. Southwest Copper River Lowland. Unit C–1.
M2384	64AGz 12	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina district, Valdez D–8 quad. Lat 61°54.75′ N., long 146°52.35′ W. Southwest Copper River Lowland. Unit C–2(?).
M2385	64AGz 14	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina district, Valdez D–8 quad. Lat 61°53.65′ N., long 146°52.4′ W. Southwest Copper River Lowland. Unit B.
M2386	64AGz 15	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina district, Valdez D–8 quad. Lat 61°53.75′ N., long 146°52.35′ W. Southwest Copper River Lowland. Unit–III.
M2387	64AGz 18	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina district, Valdez D–8 quad. Lat 61°54.3′ N., long 146°52.9′ W. Southwest Copper River Lowland. Unit C–2.
M2388	64AGz 21	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina district, Valdez D–8 quad. Lat 61°54.65′ N., long 146°52.1′ W. Southwest Copper River Lowland. Unit C–1.
M2389	64AGz 22	D. L. Jones, A. Grantz, 1964. Alaska, Nelchina area, Valdez D–8 quad. Lat 61°54.7′ N., long 146°52.1′ W. Unit C–1.
M2390	64AGz 23	D. L. Jones, A. Grantz, 1964. Alaska, Nelchina area, Valdez D–8 quad. Lat 61°54.7′ N., long 146°52.2′ W. Unit C–1.
M2391	64AGz 24	D. L. Jones, A. Grantz, 1964. Alaska, Nelchina area, Anchorage D–1 quad. Lat 61°52.15′ N., long 147°20.7′ W. Unit C–1.
M2392	64AGz 25	D. L. Jones, A. Grantz, 1964. Alaska, Nelchina area, Anchorage D–2 quad. Lat 61°50.5′ N., long 147°24.12′ W. Unit C–1.
M2393	64AGz 26	D. L. Jones, A. Grantz, 1964. Alaska, Nelchina area, Anchorage D–2 quad. Lat 61°47.7′ N., long 147°35.05′ W. Unit C–1.
M2396	64AGz 30	D. L. Jones, A. Grantz, 1964. Alaska, Nelchina area, Gulkana A–5 quad. Lat 62°00.65′ N., long 146°13.15′ W. Unit C–2(?).
M2397	64AGz 31	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina area, Gulkana A–5 quad. Lat 62°00.65′ N., long 146°13.25′ W. Unit C–2(?).

TABLE 2.—*Ammonite and selected* Inoceramus-*bearing localities in the lower part of the Matanuska Formation, southern Alaska*—Con.

USGS Mesozoic Loc. No.	Field No.	Collector, year of collection, description of locality, and stratigraphic position
M2398	64AGz 35	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina area, Anchorage D–2 quad. Lat 61°46.72′ N., long 147°29.37′ W. Unit C–1.
M2399	64AGz 36	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina area, Anchorage D–2 quad. Lat 61°46.77′ N., long 147°29.37′ W. Unit C–1.
M2400	64AGz 37	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina area, Anchorage D–2 quad. Lat 61°46.8′ N., long 147°29.35′ W. Unit C–1.
M2401	64AGz 38	Alaska, Nelchina area, Anchorage D–2 quad. Lat 61°46.8′ N., long 147°29.25′ W. Unit C–2.
M2402	64AGz 39	Alaska, Nelchina area, Anchorage D–2 quad. Lat 61°46.82′ N., long 147°29.45 W. Unit C–1.
M2403	64AGz 40	Alaska, Nelchina area, Anchorage D–2 quad. Lat 61°47.2′ N., long 147°29.3′ W. Unit C–2.
M2404	64AGz 41	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina area, Anchorage D–2 quad. Lat 61°47.3′ N., long 147°29.3′ W. Unit C–2.
M2405	64AGz 42	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina area, Anchorage D–2 quad. Lat 61°47.45′ N., long 147°31.37′ W. Unit C–2.
M2406	64AGz 43	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina area, Anchorage D–2 quad. Lat 61°47.35′ N., long 147°33.75′ W. Unit C–1.
M2408	64AGz 45	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina area, Anchorage D–2 quad. Lat 61°47.6′ N., long 147°29.2′ W. Upper Matanuska Formation.
M2409	64AGz 46	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina area, Anchorage D–2 quad. Lat 61°46.8′ N., long 147°31.4′ W. Unit A–I.
M2410	64AGz 48	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina area, Anchorage D–2 quad. Lat 61°46.95′ N., long 147°31.2′ W. Unit A–III.
M2411	64AGz 52	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina area, Anchorage D–2 quad. Lat 61°47.05′ N., long 147°31.7′ W. Unit–III.
M2412	64AGz 53	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina area, Anchorage D–2 quad. Lat 61°47.22′ N., long 147°31.6′ W. Unit A–III.
M2413	64AGz 57	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina area, Anchorage D–2 quad. Lat 61°46.9′ N., long 147°33.55′ W. Unit A–I.
M2414	64AGz 58	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina area, Anchorage D–2 quad. Lat 61°47.17′ N., long 147°33.85′ W. Unit A–III.
M2415	64AGz 59	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina area, Anchorage D–2 quad. Lat 61°47.22′ N., long 147°33.85′ W. Unit A–III.
M2416	64AGz 60	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina area, Anchorage D–2 quad. Lat 61°47.25′ N., long 147°33.85′ W. Unit A–III.
M2417	64AGz 63	A. Grantz, D. L. Jones, 1964. Alaska, Nelchina area, Anchorage D–1 quad. Lat 61°49.8′ N., long 147°17.0′ W. Upper Matanuska Formation.

SYSTEMATIC DESCRIPTIONS

Suborder LYTOCERATINA
Family LYTOCERATIDAE
Subfamily LYTOCERATINAE

Genus LYTOCERAS Suess

1865. *Lytoceras* Suess, S. B. Akad. Wiss. Wien Math.—naturw. Cl., v. 52, no. 1, p. 78.

Type species (International Commission on Zoological Nomenclature Opinion 130) : *Ammonites fimbriatus* J. Sowerby.

Lytoceras sp.

Plate 1, figures 8, 9; text figure 5

Two fragmentary specimens of *Lytoceras* were obtained from USGS Mesozoic locality M556. Presumably, these fragments belong to the same species, but this cannot be demonstrated as there are no known specimens intermediate in size between the small example shown on plate 1, figures 8 and 9, and the large example shown in text figure 5. These fragments apparently belong to a new species, but the material at hand is insufficient for creating a new taxon.

As shown by the small specimen, the early whorls are depressed and inflated, with breadth greater than height. The umbilicus is wide with sloping walls that round evenly to meet the slightly inflated flanks. The venter is broadly arched. Ornamentation of the outer layers of the shell consists of very fine lirae, but this is preserved on only a few small patches. The internal mold shows periodic forwardly inclined shallow constrictions and irregularly developed inconspicuous riblets that are strongest on the venter. The large fragment (fig. 5) is very inflated and depressed and is septate to a whorl height of more than 70 millimeters. The outermost layer of shell is gone, but the thick inner layer shows very weak ornamentation consisting of low slightly prorsiradiate riblets and weak periodic constrictions. These constrictions are bordered by low, crinkled ridges that probably extended outward as flared ribs. Very indistinct spiral ornamentation is visible and the intersection of this with the radial riblets forms a faint reticulate pattern. The internal mold appears to be smooth. On the dorsal side, growth lines and riblets bend abruptly forward to form an adoral projection.

221–689 O—66——3

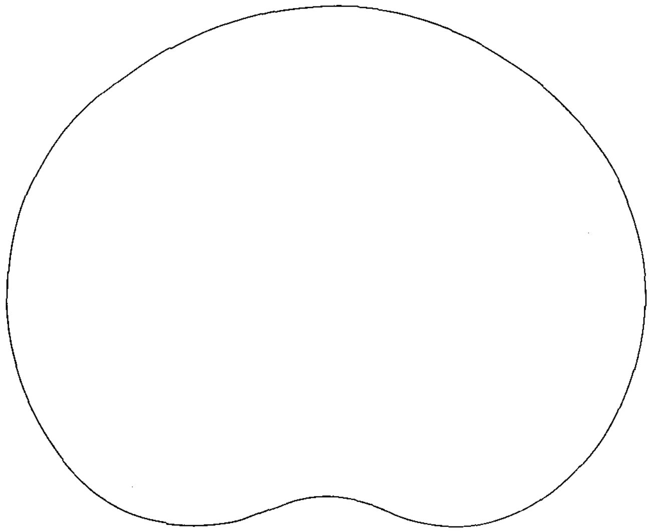


FIGURE 5.—Cross section of *Lytoceras* sp., USNM 132083a from USGS Mesozoic locality M556. × 1.

Examples of *Lytoceras* from Albian deposits of the Pacific Coast region of North America are rare. They are common, however, in older Cretaceous deposits ranging in age from Valanginian to Aptian. In California *L. batesi* (Trask) is very common in the *Gabbioceras wintunium* zone (Aptian) of the Ono Formation of former usage (Murphy, 1956, fig. 6; Murphy and others, 1964), but it does not range higher into the Albian. This species differs from the Alaskan form by having a nearly circular cross section and stronger and more regularly developed ribs. *L. mahadeva* (Stoliczka, 1866, p. 165, pl. 80) from the Utatur Group of southern India has a less depressed, more rounded whorl section and more regular crinkled ribs. *L. ezoënse* Yabe (1903, p. 9, 10, pl. 1, fig. 1) from Japan has a more compressed outer whorl and closely spaced crinkled ribs. *L. crenocostates* (Whiteaves, 1876, p. 45, pl. 9, fig. 2) from Queen Charlotte Island, originally based on a small specimen and later equated with *L. batesi*, is too poorly known for an adequate diagnosis; however, well-preserved specimens from Albian strata of Chitina Valley may be referable to this species. These specimens have a nearly circular cross section and widely spaced crinkled ribs. They do not show the closely spaced prominent ribs of *L. batesi* or the depressed whorl section of the Talkeetna Mountains specimen.

Measurements: The measurements of specimens are given in millimeters, except as indicated.

Specimen No.	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus (percent of diam)
USNM 132083a	----------	68	84	1.23	----------	----------
132083b	11.3	3.8	4.5	1.18	4.9	43.5
	----------	9.5	8.4	1.13	----------	----------
	----------	19.6	18.0	1.09	----------	----------

Figured specimens: USNM 132083a, 132083b.
Collecting locality: USGS Mesozoic loc. M556.
Stratigraphic position: Unit A–2; *Brewericeras hulenense* zone, late early Albian.

Family TETRAGONITIDAE

Genus GAUDRYCERAS GROSSOUVRE

1894. *Gaudryceras* Grossouvre, France, Service de la Carte Géol. Mem., Les ammonites de la craie supérieure, p. 225.

Type species (subsequent designation by Boule and others, 1906): *Ammonites mitis* Hauer.

Gaudryceras aff. G. denseplicatum (Jimbo)

Plate 1, figures 1–4

1894. *Lytoceras denseplicatum* Jimbo, Palaeont. Abh., Neue. Folge, v. 2, no. 3, p. 36, pl. 7, fig. 1.
1903. *Gaudryceras denseplicatum* (Jimbo). Yabe, Tokyo Imp. Univ., Coll. Sci. Jour., v. 18, art. 2, p. 30.
1959. *Gaudryceras* (*Gaudryceras*) *denseplicatum* (Jimbo). Matsumoto, Kyūshū Univ., Mem. Fac. Sci., ser. D, spec. v. 1, p. 142. (See this reference for complete synonymy.)

Several small poorly preserved fragments of *Gaudryceras* are known from the lower part of the Matanuska Formation. The shell is ornamented with numerous, closely spaced flexed ribs that arise at the umbilical seam, subdivide and bend strongly forward near the umbilical shoulder, are nearly radial at midflank, and cross the venter with moderate forward projection. Periodic constrictions are present, and these are bordered by low ridges on which the ribs are bundled.

The specimens are all deformed to varying degrees, so accurate measurements are impossible. The whorls are inflated, about as broad as they are high, with slightly rounded flanks, broadly rounded venter, abruptly rounded umbilical shoulder, and steep umbilical wall.

The characteristic feature of *G. denseplicatum* is the development in the adult of coarse major folds that bear numerous minor ribs; these ribs cannot be observed in the Alaskan specimens owing to their small size. However, these small specimens agree well with the inner whorls of large specimens of *G. denseplicatum* from California and Oregon that do show the major folds, but larger and better preserved specimens are needed for positive identification of the Alaskan forms.

Figured specimens: USNM 132145, 132146.
Collecting localities: USGS Mesozoic locs. M600, M2383, M1939(?), M2391(?).
Stratigraphic position: Lower part of unit C–1, probably late Cenomanian or early Turonian; fragments possibly belonging to this species found also in upper Turonian and Coniacian parts of unit C–1.

1934. *Anagaudryceras* Shimizu, Iwanami's series of geology and paleontology, p. 67.

Type species: Ammonites sacya Forbes.

Anagaudryceras sacya (Forbes)

Plate 1, figures 5–7, 13–15

1846. *Ammonites sacya* Forbes, Geol. Soc. London Trans., ser. 2, v. 7, p. 113, pl. 14, fig. 10.

1846. *Ammonites buddha* Forbes, idem, p. 112, pl. 14, fig. 9.

1959. *Anagaudryceras sacya* (Forbes). Matsumoto, Kyūshū Univ., Mem. Fac. Sci., ser. D, v. 8, no. 3, p. 72, pl. 22, figs. 4, 5a–c. (See this reference for complete synonymy.)

Two specimens of *Anagaudryceras sacya* are known from the lower part of the Matanuska Formation, both distorted. The smaller specimen (pl. 1, figs. 5–7) is similar to the specimen from the Chitina Valley figured by Matsumoto (1959, pl. 22, fig. 4) although the width of its umbilicus has been greatly reduced due to secondary crushing. The oblique only slightly flexed constrictions are similar on both specimens, as is the rounded whorl section with nearly equal height and breadth. On the larger specimen from the Talkeetna Mountains, the body chamber was also crushed down over the earlier whorls, and the umbilicus is distorted. Inner whorls of this specimen have five deep oblique constrictions per whorl. The outer septate whorls have flattened flanks, a subvertical umbilical wall, rounded umbilical shoulder, and a broadly rounded venter. Oblique only slightly flexed constrictions cross the flanks and are marked on the venter by a slightly raised ridge. The body chamber is covered with broad closely spaced slightly flattened sigmoidal ribs. Most of the outer shell layer is missing; but where preserved, the very fine lirae characteristic of *Anagaudryceras* can be seen.

Figured specimens: USNM 132085, 132086.
Collecting localities: USGS Mesozoic locs. M556, M568.
Stratigraphic position: Unit A–2; late early Albian zone of *Brewericeras hulenense*. Unit B of probable Cenomanian age.

Genus PARAJAUBERTELLA Matsumoto

1943. *Parajaubertella* Matsumoto, Imp. Acad. Japan Proc., v. 18, p. 667.

1956. *Parajaubertella* Matsumoto. Collignon, Madagascar. Annales Geol. Service Mines, pt. 23, p. 45.

The genera *Gabbioceras* Hyatt, *Jauberticeras* Jacob, and *Parajaubertella* Matsumoto are all generally similar in shell form, being characterized by inflated depressed early whorls with a deep umbilicus and a sharp umbilical shoulder. *Jauberticeras* was considered by Wright (1957, p. L203) to be a synonym of *Gabbioceras* (subfamily *Tetragonitidae*), and *Parajaubertella* (subfamily *Gaudryceratinae*) was accepted as a valid genus. Wiedmann (1962a) recently studied these genera and considered *Jauberticeras* and *Gabbioceras* to be distinct, but he rejected *Parajaubertella* as a synonym of *Gabbioceras*. Wiedmann's reason for this change was based on the nature of the internal suture; *Jauberticeras* has a more complex internal suture than does *Gabbioceras*, with three, rather than two, internal lobes (fig. 6). *Parajaubertella* also has only two internal lobes and was therefore not thought to be distinct from *Gabbioceras*. The sutural differences between *Gabbioceras* and *Jauberticeras*, as pointed out by Wiedmann seem to be sufficient to hold these two genera apart. The sutural similarities of *Gabbioceras* and *Parajaubertella*, however, are not sufficient to override other morphologic differences that serve to separate the two genera, particularly in view of the difference in age of the two forms; *Gabbioceras* is known from Aptian beds and *Parajaubertella* from Cenomanian beds. As was pointed out by M. A. Murphy (oral commun., 1963), the sutures of *Gabbioceras*, *Anagaudryceras*, and *Parajaubertella* are all basically similar (fig. 7), so other features must be used to subdivide this broad group of ammonites. *Parajaubertella* and *Gabbioceras* can be clearly distinguished by differences in the shape of the umbilicus (fig. 7). In *Parajaubertella* the umbilicus is steplike with a nearly vertical wall; in *Gabbioceras* it is funnel shaped with a sloping wall. The presence in both genera of an angular umbilical shoulder is best explained as a homeomorphic development.

Parajaubertella imlayi Matsumoto

Plate 1, figures 10–12; text figures 6*D*, 7*B*

1959. *Parajaubertella imlayi* Matsumoto, Kyūshū Univ., Mem. Fac. Sci., ser. D, v. 8, no. 3, p. 71, pl. 21, figs. 1, 2; text figs. 12, 13.

1962. *Gabbioceras imlayi* (Matsumoto). Wiedmann, Neues Jahrb. Geologie u. Paläontologie. Abh., v. 115, p. 20.

Only one specimen of *Parajaubertella imlayi* is known from the Talkeetna Mountains. It consists of a broken fragment showing a well-preserved body chamber and poorly preserved inner septate whorls. This specimen agrees closely in whorl proportions with Matsumoto's figured specimen from the Chitina Valley, but it differs by having well-developed ribs on the body chamber at a much smaller diameter. This difference is not significant, as recently obtained collections from the Chitina Valley demonstrate considerable variation in diameter at the time of appearance of this character. The ribs are rounded, slightly asymmetrical, with a steep adoral slope and a gentle adapical slope; they arise on the umbilical wall, are gently flexed on the flanks, and cross the

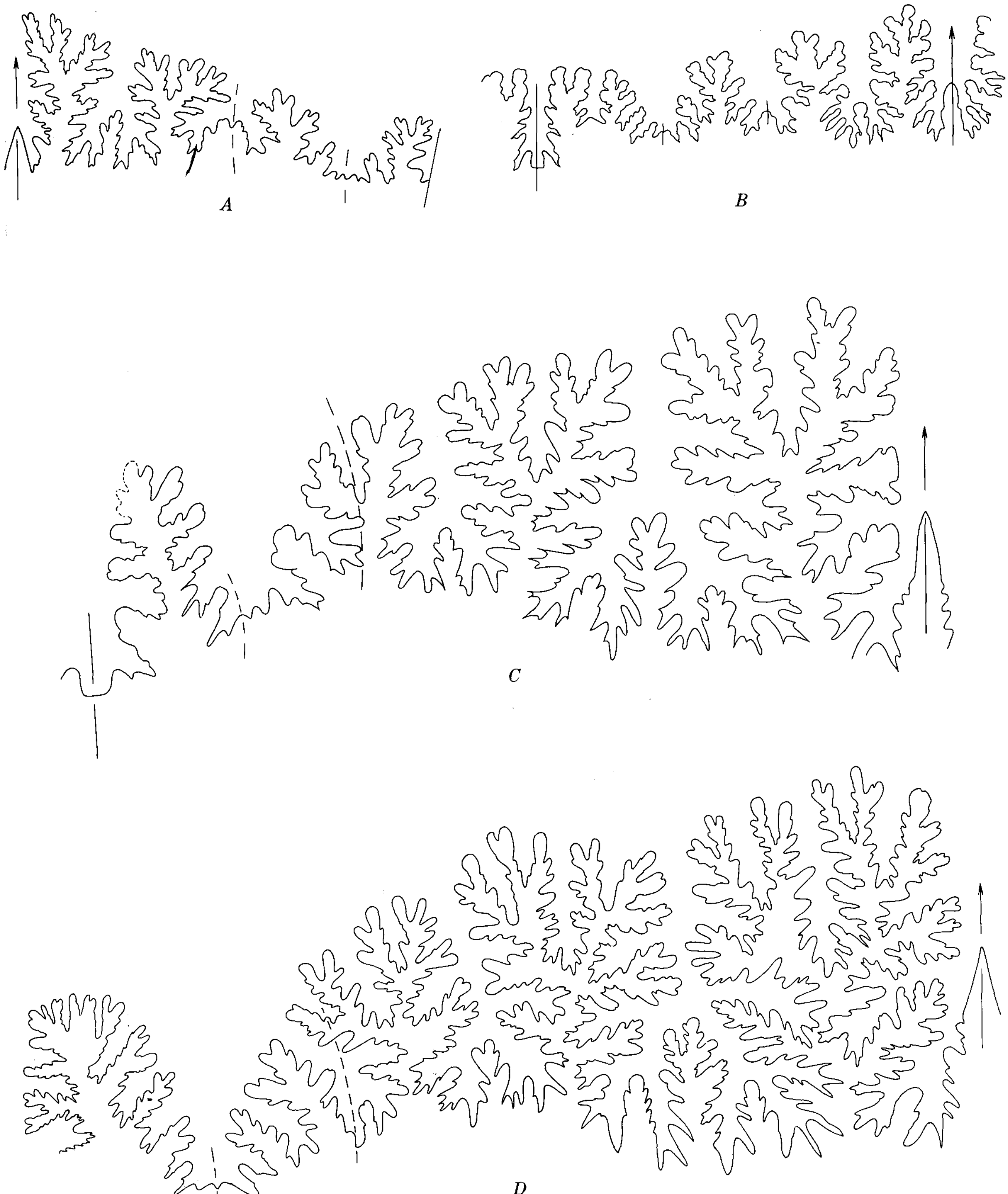


FIGURE 6.—Suture lines of *Gabbioceras*, *Jauberticeras*, *Parajaubertella*, and *Anagaudryceras*.

venter with a sight forward projection. These ribs are similar to those of *Anagaudryceras sacya*, but they tend to be more rounded; the more inflated whorl section of *Parajaubertella imlayi* readily distinguishes it from *A. sacya.* The poorly preserved inner whorls are inflated, with a narrow umbilicus, subvertical umbilical wall, and subangular umbilical shoulder.

Measurements: The measurements of specimens are given in millimeters, except as indicated.

Specimen No.	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus (percent of diam)
USNM 129248 [1]	30.5	13.0	18.2	1.4	----------	----------
129259 [1]	ca. 95	44	ca. 47	1.07	26.0	27
	75.5	35	37.6	1.07	20.2	27
	----------	19.7	22.7	1.15	12	----------
	----------	6.8	11.5	1.69	5.5	----------
132087	----------	24	27	1.17	----------	----------

[1] Measurements from Matsumoto (1959a, p. 71).

Holotype: USNM 129259.
Type locality: USGS Mesozoic loc. 25445, Chitina Valley, Alaska.
Figured specimens: USNM 132087, 132088.
Collecting locality: USGS Mesozoic loc. 24857.
Stratigraphic position: Float from lower(?) part of unit B; Cenomanian.

Genus TETRAGONITES Kossmat

1895. *Tetragonites* Kossmat, Paläontologie u. Geologie Österreich-Ungarns u. des Orients, Beitr., v. 9, p. 131.

Type species (original designation): *Lytoceras timotheanum* Mayor.

Tetragonites aff. T. glabrus (Jimbo)

Plate 2, figures 1–12, 23–26

Compare:

1910. *Lytoceras glabrum* Jimbo. Palaeont. Abh., Neue Folge, v. 2, no. 3, p. 34, pl. 6, fig. 2.
1942. *Epigoniceras glabrum* (Jimbo). Matsumoto, Imp. Acad. Japan Proc., v. 18, no. 10, p. 671.
1959. *Tetragonites glabrus* (Jimbo). Matsumoto, Kyūshū Univ. Mem. Fac. Sci., ser. D, spec. v. 1, p. 149, pl. 39, figs. 2, 3; text figs. 72, 73.

Specimens of *Tetragonites* aff. *T. glabrus* from the Matanuska Formation are poorly preserved, fragramentary, and mostly crushed or distorted. Therefore, accurate measurements and close comparison with other, better preserved specimens cannot be made. Small specimens have an inflated whorl section with flattened flanks and venter and a steep nearly vertical umbilical wall. Oblique constrictions are very weak and are clearly visible only on one specimen, where they appear as black lines that run obliquely across the flanks and form a shallow concave sinus on the venter. The umbilicus is fairly small, ranging from 23 to 30 percent of the diameter. Early whorls have a B/H (breadth to height) ratio equal to or greater than 1.0. Larger specimens lack constrictions, have a rounded rather than flattened venter, and are more compressed, the B/H ratio being less than 1.0.

The Matanuska specimens appear to be closely related to *T. glabrus*, but they differ by having somewhat more compressed whorls (see measurements below). Their whorl section is similar to that of *T. epigonum* Kossmat (1895, p. 135, pl. 17, figs. 4–8), but that species has well-developed oblique constrictions persisting to a larger diameter.

Measurements: The measurements of specimens are given in millimeters, except as indicated.

Specimen No.	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus (percent of diam)
USNM 132090	20	9	10.0	1.12	5.5	27.5
132092	31+	12	12	1.0	8	26
132094	34+	15	14.5	----------	----------	----------
132093	42	18	9×2	1.0	12.5	30
132095	77	37	15×2	.81	18	23
	----------	36	30	.83	----------	----------
California specimens [1]:						
1	51.1	24.2	26.5	1.09	11.3	22
2	42.5	20.0	21.5	1.07	11.0	26
3	30.0	14.5	15.5	1.07	8.1	27
4	----------	42.5	43.5	1.02	----------	----------
5	45.0	22.0	22.0	1.00	10.0	22

[1] Measurements from Matsumoto (1959a, p. 150).

Figured specimens: USNM 132090, 132091, 132092, 132093. 132094, 132095, 132096.
Number of specimens: 10 plus several fragments.
Collecting localities: USGS Mesozoic locs. M600, M601, M2391.
Stratigraphic position: Lower to middle(?) parts of unit C–1; upper Cenomanian or lower Turonian to probable upper Turonian.

EXPLANATION FOR FIGURE 6

A. Gabbioceras angulatum Anderson. From USGS Mesozoic locality 2269, near Ono. northern California. × 4½.
B. Jauberticeras subbeticum Wiedmann, holotype; at whorl height of 3.5 mm. Taken from Wiedmann, 1962a figure 1. Note three umbilical lobes.
C. Anagaudryceras sacya (Forbes). From USGS Mesozoic locality M1846, Queen Charlotte Islands, British Columbia. × 6.
D. Parajaubertella imlayi Matsumoto. From USGS Mesozoic locality M1369, upper Chitina Valley, Alaska. × 3. Note that *G. angulatum*, *P. imlayi*, and *A. sacya* have two umbilical lobes in contrast to *J. subbeticum*, which has three.

Tetragonites aff. T. timotheanus (Pictet)

Plate 2, figures 13–18

Compare:

1848. *Ammonites timotheanus* (Major) *in* Pictet, Grès Verts, v. 1, p. 295, pl. 2, fig. 6 (paratype); pl. 3. fig. 1 (lectotype) [fide Wiedmann, 1962b, p. 172].
1908. *Tetragonites kiliani* Jacob, Geol. Soc. France, Mem. Paléont., no. 38 (1907), p. 21, pl. 1, figs. 9a, 9b.
1959. *Tetragonites* sp. nov.? Matsumoto (in part, includes only the large measured adult shell from USGS Mesozoic loc. 9492), Kyūshū Univ. Mem. Fac. Sci., ser. D, Geol., v. 8, no. 3, p. 77.
1960. *Tetragonites* aff. *T. timotheanus* (Pictet). Imlay, U.S. Geol. Survey Prof. Paper 354–D, p. 100, pl. 12, figs. 24–28.
1962. *Tetragonites timotheanus* (Pictet). Wiedmann, Palaeontog., v. 118, pt. A, no. 4, p. 172, pl. 8, fig. 10; pl. 14, figs. 4–6; text figs. 30–33.

Two specimens generally similar to *Tetragonites timotheanus* are known from the Albian siltstone section exposed in Limestone Gulch (USGS Mesozoic loc. M556). On early whorls these specimens have a quadrate whorl section with flattened nearly parallel flanks, a flattened venter, and a moderately wide umbilicus with a vertical umbilical wall and angular umbilical shoulder. On the body chamber the flanks are slightly rounded, and the venter is low and broadly arched. Oblique rectilinear constrictions number about nine per whorl and are prominent on the flanks of the septate part and on the early part of the body chamber; on the outer part of the body chamber they have become obsolete.

According to Wiedmann (1962b, p. 172–174), *T. timotheanus* is characterized by a broad rectangular cross section, wide umbilicus, and early disappearance of prorsiradiate constrictions.

The two Alaskan specimens differ from those described by Wiedmann by having a slightly narrower umbilicus and constrictions that persist to a larger diameter.

Measurements: The measurements of specimens are given in millimeters, except as indicated.

Specimen No.	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus (percent of diam)
USNM 132097 [1]	27	11.5	15.5	1.34	9.5	35
		13	19	1.46		
132098	48	21	24.6	1.18	14.3	29.5
	ca. 22	ca. 9	12	1.34	7.5	ca. 34
		12.8	17	1.35		
		4.5	3.6×2	1.60		

[1] Slightly distorted.

Figured specimens: USNM 132097, 132098.
Collecting locality: USGS Mesozoic loc. M556.
Stratigraphic position: Unit A–2; late early Albian, *Brewericeras hulenense* zone.

Family SCAPHITIDAE

Genus SCAPHITES Parkinson

1911. *Scaphites* Parkinson, Organic remains of a former world, v. 3, p. 145.

Type species (subsequent designation by Meek, 1876, U.S. Geol. Survey Terr., v. 9, p. 413): *Scaphites aequalis* Sowerby.

Scaphites sp. indet.

Plate 4, figures 12–14, 21

One small, partly crushed specimen of *Scaphites* is known from Shell Oil Co. locality T1006. The septate whorls are poorly preserved, but they appear to have been depressed and inflated. The straight shaft and hook are likewise very broad with abruptly rounded flanks and slightly arched venter. Ornamentation is obscured on the septate part, although a few heavy ribs are visible on the flank. On the straight shaft, the flanks bear five or six fairly heavy widely spaced forward-inclined ribs that split on the ventrolateral shoulder into many fine threadlike riblets that cross the venter with a slight forward projection. The margin of the aperture is marked by a heavy projecting collar.

The Alaskan form shows affinities to both *S. pseudoaequalis* Yabe and *S. yonekurai* Yabe (1910, pl. 15), known from Turonian and Coniacian deposits of Japan (Matsumoto, 1954, p. 17). *S. pseudoaequalis* differs by having an apparent flat unribbed area low on the shaft and prominent ribs on the hook. *S. yonekurai* has finer, more numerous ribs on the flank of the shaft.

Figured specimen: USNM 132084.
Collecting locality: SOC. T–1006.
Stratigraphic position: Unit C–2; probably late Coniacian.

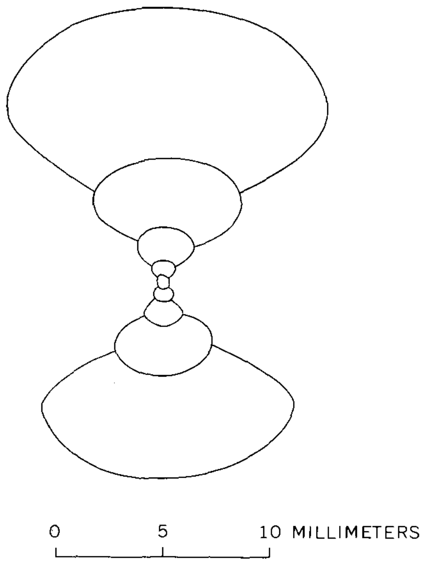
Genus OTOSCAPHITES Wright

1953. *Otoscaphites* Wright, Annals and Mag. Nat. Hist., ser. 12, v. 6, p. 475.

Type species (original designation): *Ammonites bladenensis* Schlüter, 1871.

According to Wright (1953, p.475), the characteristic features of *Otoscaphites* are: "Moderately evolute spire, followed by a fairly long, well-curved shaft and hook. Compressed to coronate whorl section. Mouth-border with more or less strong constriction and collar and long narrow lateral lappets. Spire with moderately strong ribs. Shaft with striae or fine ribs and sometimes ventrolateral or umbilical tubercles. Suture as in *Scaphites* of the same age and size."

This genus has a wide geographic distribution, occurring in Europe, Texas, California, Oregon, Japan, and



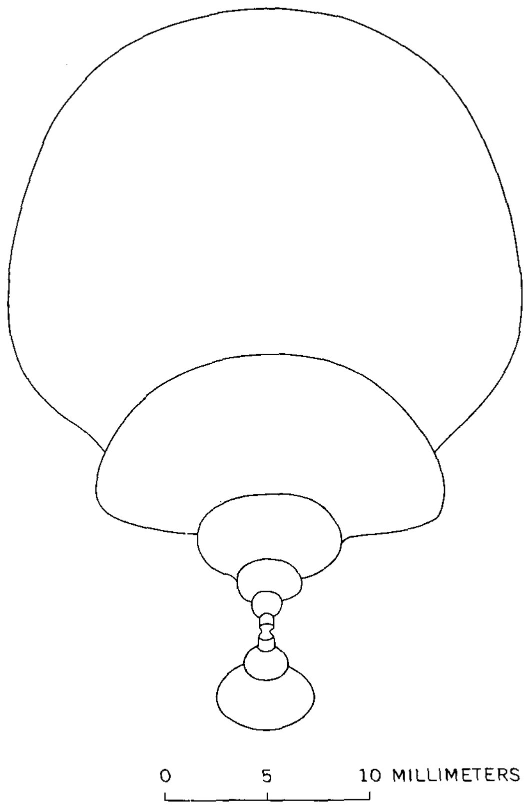


FIGURE 7.—Cross sections of *Gabbioceras* and *Parajaubertella*. *A* (upper), *Gabbioceras angulatum* Anderson from USGS Mesozoic locality 1066, Alderson Gulch near Ono, northern California; Aptian. *B* (lower), *Parajaubertella imlayi* Matsumoto from USGS Mesozoic locality M1655, upper Chitina Valley, Alaska; Cenomanian.

Alaska. Cobban and Gryc (1961) have recently reported on two species from the Arctic Slope of Alaska.

Otoscaphites teshioensis (Yabe)

Plate 4, figures 15–18; text figure 8

1910. *Yezoites puerculus* Jimbo var. *teshioensis* Yabe, Paläontologie u. Geologie Österreich-Ungarns u. des Orients, Beitr., v. 23, no. 3, p. 171, pl. 15, figs. 23–27.

Four complete specimens and several small fragments of *Otoscaphites teshioensis* are known from the Matanuska Formation. The coiled part of the shell is moderately evolute with rounded whorls (B/H ratio about 1). Ornamentation consists of primary ribs that arise on the umbilical slope, cross the umbilical shoulder with a forward projection, and bend backward on the lower flank. On the midflank the ribs have a radial course, and on the outer flank they split into two secondary ribs that cross the broadly rounded venter with a slight forward projection. On the outer part of the coiled septate part, small nodes appear at the point of rib bifurcation. These nodes become progressively larger with increased growth, and the ribs on the flanks and venter become progessively weaker. On the body chamber, which on the figured specimen is slightly deformed and squeezed into contact with the coiled part, the ornamentation consists of irregularly developed nodes on the ventrolateral shoulder, together with faint riblets that run obliquely from the nodes to the dorsal margin. Only faint irregular riblets and growth striae cross the venter. Eight ventrolateral nodes are visible on the figured specimen; both the adoral and adapical part of the body chamber are smooth except for growth striae. The suture line is moderately complex with irregularly trifid first lateral lobe (fig. 8).

Although *O. teshioensis* was first named as a variety of *O. puerculus* (Yabe), it differs from that species in having bifurcating primary ribs with ventrolateral nodes and well-developed ribs on the venter. Also the flanks of the body chamber are much broader and tend to be flatter on *O. teshioensis* than on *O. puerculus*. The study of large collections of *O. puerculus* from California and of several specimens from the Chitina Valley, Alaska, indicates that although the two forms are

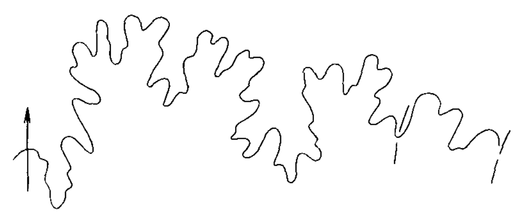


FIGURE 8.—Suture line of *Otoscaphites teshioensis* (Yabe), plesiotype USNM 132099 from USGS Mesozoic locality 24853. × 9.

probably closely related, they should be regarded as distinct species.

Two species of *Otoscaphites* described by Cobban and Gryc (1961) from the Seabee Formation of northern Alaska differ from *O. teshioensis* by being much smaller and by having more inflated and more involute whorls and different ornamentation.

Measurements (in millimeters), USNM 132099: Length, 25; height at last septum, 7; breadth at last septum, 6.7.

Figured specimen: USNM 132099 from USGS Mesozoic loc. 24853.

Collecting localities: USGS Mesozoic locs. 24853, 24239(?).

Stratigraphic position: Unit C–1, Turonian.

Family BACULITIDAE

Genus SCIPONOCERAS Hyatt

1894. *Sciponoceras* Hyatt, Am. Philos. Soc. Proc., v. 32, no. 143, p. 578.

Type species (original designation): *Hamites baculoides* Mantell.

Sciponoceras sp. indet.

Plate 2, figures 19–22; text figures 9, 10

Three fragments of *Sciponoceras* are known from the lower part of the Matanuska Formation, but their poor state of preservation prohibits positive identification. The largest fragment, shown on plate 2, figures 19 to 22, has an oval cross section (fig. 9) with nearly

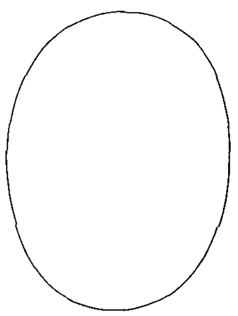


FIGURE 9.—Cross section of *Sciponoceras* sp. indet., USNM 132100 from USGS Mesozoic locality M800. × 4.

parallel sides. Ornamentation consists of weak ribs on the venter that run obliquely across the flanks and disappear on the dorsal side. The ribs number four to five in a distance equal to the section height. A strong oblique constriction is visible at the distal end.

A smaller specimen, whose suture is shown on figure 10, has a subcircular cross section and shows moderate taper (see measurements below). No ribs or constrictions are present on this specimen, but another crushed fragment shows two oblique constrictions.

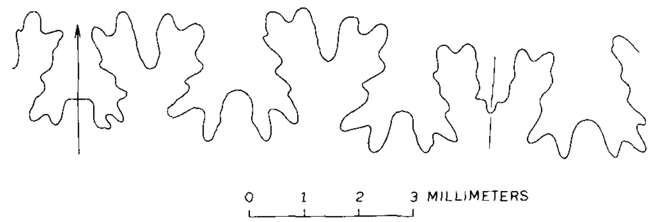


FIGURE 10.—Suture line of *Sciponoceras* sp. indet., USNM 132101 from USGS Mesozoic locality M2383, at height of 5 mm, breadth of 4.6 mm.

The Matanuska specimens are close to several species of *Sciponoceras* from Cenomanian and Turonian deposits of Japan recently described by Matsumoto and Obata (1963). The specimens of *S. baculoides* (Mantell), illustrated by Matsumoto and Obata (1963, p. 9, pl. 1, figs. 1–4; pl. 2, figs. 1–3; text figs. 3, 26–32), from Cenomanian deposits of Japan have a fairly similar whorl section but weaker ornamentation and more numerous and stronger constrictions. Specimens of *S. kossmati* (Nowak) from the Cenomanian and lower Turonian of Japan are very close in cross-sectional shape and ornamentation to the Alaskan forms but appear to have more frequent constrictions. The suture lines of the two are generally similar, although in the Alaskan form the suture line is more regular with a narrower stemmed internal saddle. *S. orientale* Matsumoto and Obata (1963, p. 18, pl. 3, fig. 1; pl. 6, figs. 1, 2; pl. 7, figs. 1–6; pl. 9, fig. 6; text figs. 33–97), from the Turonian of Japan, has coarser ribs, a more nearly round cross section, and a more highly incised suture.

Measurements: The measurements of specimens are given in millimeters, except as indicated.

Specimen No.	Height	Breadth	Ratio of breadth to height	Distance between measurements
USNM 132100	9.4 9.8	7.4 8.5	0.79 .85	25
132101	5.0 7.3	4.7 6.0	.94 .82	31

Figured specimens: USNM 132100, 132101.

Collecting localities: USGS Mesozoic locs. M600, M2383.

Stratigraphic position: Lower part of unit C–1, probably late Cenomanian or early Turonian.

Suborder AMMONITINA
Family DESMOCERATIDAE
Genus DESMOCERAS

Subgenus PSEUDOUHLIGELLA Matsumoto

1942. *Desmoceras* (*Pseudouhligella*) Matsumoto. Imp. Acad. Japan Proc., v. 18, p. 22, 25.

Type species of *Pseudouhligella* (original designation): *Desmoceras dawsoni japonica* Yabe.

Desmoceras (Pseudouhligella) japonicum Yabe

Plate 4, figures 10, 11

1904. *Desmoceras dawsoni* Whiteaves var. *japonica* Yabe, Tokyo Imp. Univ., Coll. Sci. Jour., v. 20, art. 2, p. 35, pl. 5, figs. 3, 4.
1938. *Desmoceras* (*Pseudouhligella*) *japonica Yabe*. Matsumoto, Geol. Soc. Japan Jour., v. 45, p. 23, text fig. 27.
1959. *Desmoceras* (*Pseudouhligella*) *japonicum* Yabe. Matsumoto, Kyūshū Univ. Mem. Fac. Sci., ser. D, Geol., v. 8, no. 3, p. 58, pl. 13, figs. 1a–c, 2a–c, 3a–c, 4a–c; pl. 14, figs. 1a, b. (See this reference for complete synonymy.)

Desmoceras (*Pseudouhligella*) *japonicum* is rare in the Matanuska Fomation; it is found in abundance only near Camp Creek on the south side of Gunsight Mountain. This scarcity is in marked contrast with that in the Cenomanian beds of the upper Chitina Valley, where this species occurs in great abundance. Most of the Matanuska specimens are small and crushed, but the characteristic features of the species are adequately shown, in particular, the inflated whorl section, flattened flanks, small pitlike umbilicus, and sigmoidal constrictions strongly projected on the venter. The ratio of breadth to height falls within the range of values given by Matsumoto (1959a, p. 58) for the Chitina Valley specimens, but the umbilicus of some of the Matanuska specimens is slightly narrower.

Measurements: The measurements of specimens are given in millimeters, except as indicated.

Specimen No.	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus (percent of diam)
USNM 132102	23	12.7	10.5	0.83	2.7	11.8
	----------	ca. 15	11	----------	----------	----------

Holotype: According to Matsumoto (1959a, p. 252), the holotype is GT. I–260, obtained along the Ikushunbetsu, 10 miles east of the Ikushunbetsu coal mines, Japan.

Figured specimen: USNM 132102.

Number of specimens: 8 to 12 relatively undistorted specimens, many crushed fragments.

Collecting localities: USGS Mesozoic locs. M596, M2381, M2382, M2383, M2385, M2380(?).

Stratigraphic position: Lower siltstone member of unit B Cenomanian; lowest part of unit C–1. Cenomanian or possibly lower Turonian.

Genus BREWERICERAS Casey

1954. *Brewericeras* Casey, Washington Acad. Sci. Jour., v. 44, no. 4, p. 112.

Type species (original designation): *Ammonites breweri* Gabb.

Brewericeras hulenense (Anderson)

Plate 6, figures 10, 11, 15–19; text figure 11

1938. *Beudanticeras hulenense* Anderson, Geol. Soc. America Spec. Paper 16, p. 190, pl. 44, figs. 3, 4; pl. 48, figs. 2, 3.
1954. *Brewericeras hulenense* (Anderson). Casey, Washington Acad. Sci. Jour., v. 44, no. 4, p. 112.
1960. *Brewericeras hulenense* (Anderson). Murphy and Rodda, Jour. Paleontology, v. 34, no. 5, pl. 105, fig. 3.
1960. *Brewericeras* cf. *B. hulenense* (Anderson). Imlay, U.S. Geol. Survey Prof. Paper 354–D, p. 106, pl. 17, figs. 11, 14–16.
1960. *Brewericeras breweri* (Gabb). Imlay, U.S. Geol. Survey Prof. Paper 354–D, p. 105, pl. 17, figs. 5–10, 12, 13.
1965. *Brewericeras hulenense* (Anderson). Jones, Murphy, and Packard, U.S. Geol. Survey Prof. Paper 503–F, p. 16, pl. 8, figs. 1, 2, 4; pls. 9, 10; pl. 11, figs. 1–3, 13–14.

Six specimens of *Brewericeras hulenense* from the Matanuska Formation are in the Survey's collection; three were obtained from USGS Mesozoic locality M556 in Limestone Gulch, one from locality M557 in a nearby unnamed canyon, one from locality M583 on upper Wolverine Creek, about 7 miles northeast of Palmer, and one crushed and eroded specimen from the basal sandstone south of the Matanuska River at locality M2409.

The specimens of *B. hulenense* from the Matanuska Formation agree well with typical California specimens and also with those from Chitina Valley figured by Imlay (1960) and Jones, Murphy, and Packard (1965). This species is variable in strength of ribbing, width of umbilicus, and ratio of breadth to width, but the few examples dealt with here are insufficient to establish the range of variation. The characteristic features of this species are: compressed whorl shape with flattened flanks; abruptly rounded or angular umbilical margin with nearly vertical umbilical wall; slightly excentric coiling; and variably developed falcate ribs that are most prominent on the outer part of the flanks. An indented spiral line on the umbilical wall, first described by Murphy and Rodda (1960, p. 851), is well developed on the Alaskan forms. The suture line (fig. 11) is complex with a narrow asymmetrical deeply inclined first lateral saddle, a very deep and narrow first lateral lobe, and an asymmetric second lateral saddle.

Measurements: The measurements of specimens are given in millimeters except as indicated.

Specimen No.	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus (percent of diam)
USNM 132103	33	18	9	0.50	5	15
132104	43	20	10	.50	8	18.6
132105	69	32	18	.56	14	20
	----------	43	24	.56	----------	----------
California specimens [1]:						
1	40	20	12	.60	7	17.5
2	55	26	14	.54	----------	----------
	----------	21	10.5?	.50	----------	----------
	54?	25	13.5	.54	9	15
4	42	21	10	.475	8	19
	55	26	15	.58	10	18

[1] Smooth specimens from the Ono area, northern California.

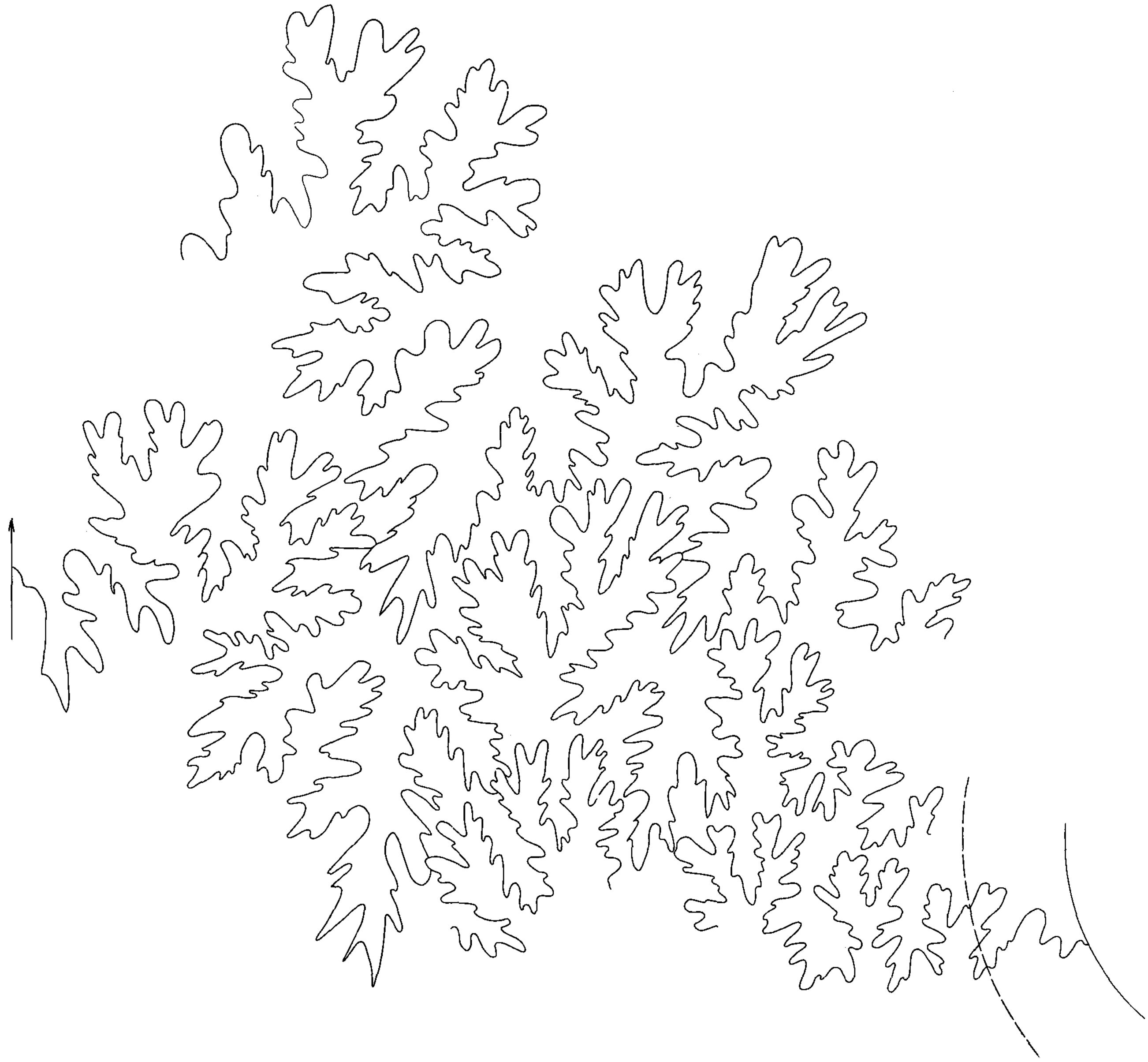


FIGURE 11.—Suture line of *Brewericeras hulenense* (Anderson), plesiotype USNM 132105 from USGS Mesozoic locality M556. × 6. Specimen illustrated on plate 6, figures 16–18.

Figured specimens: USNM132103, 132104, 132105.

Collecting localities: USGS Mesozoic locs. M556, M559, M583, M2409.

Stratigraphic position: Unit A–2 north of Matanuska River and Unit A–I south of the river (USGS Mesozoic loc. M583 may be from Unit A–II). Zone of *B. hulenense*, late early Albian.

Genus GRANTZICERAS Imlay

1960. *Beudanticeras* (*Grantziceras*) Imlay, U.S. Geol. Survey Prof. Paper 354–D, p. 105 (nomen nudum).

1961. *Beudanticeras* (*Grantziceras*) Imlay, U.S. Geol. Survey Prof. Paper 335, p. 56.

Type species (original designation): *Beudanticeras* (*Grantziceras*) *multiconstrictum* Imlay.

The name *Grantziceras* first appeared as a nomen nudum in Professional Paper 354–D, which was written later than Professional Paper 335, but released earlier.

Imlay (1961, p. 56) considered *Grantziceras* to differ from typical species of *Beudanticeras* by having numerous regularly spaced falciform constrictions that appear at an early age, broadly bundled striae on the flanks, and a scaphitoid body chamber. Other possible distinguishing features include a lack of strong periodic ridges on the shell and a larger size than other described species of *Beudanticeras*. None of these features seem to be critical in separating *Grantziceras* from *Beud-*

anticeras. For example, Casey (1961) has recently figured specimens of *Beudanticeras* which are fully as large as the Alaskan forms and also have falciform constrictions at an early age. The feature that clearly separates *Grantziceras* from *Beudanticeras*, however, is the nature of the umbilicus. In *Grantziceras* the umbilicus is narrow and funnel shaped with sloping walls that round gently and evenly to meet the flanks; in *Beudanticeras*, the umbilicus is steplike with vertical to subvertical walls and an abruptly rounded or angular umbilical shoulder.

Among the Alaskan specimens a complete gradation can be shown between constricted forms ("*Grantziceras multiconstrictum*") and nonconstricted forms, so subgeneric separation of these two is not warranted. Instead, the generic concept of *Grantziceras* is herein redefined to include not only the typical constricted form but also the more compressed involute shells with few or no constrictions. Other characteristic features of the genus include: narrow funnel-shaped umbilicus; sloping gently rounded umbilical walls; narrowly arched venter; ornamentation restricted to bundled striae; and weak riblets.

Grantziceras affine (Whiteaves)

Plate 5, figures 1–15; plate 6, figures 4–6; text figure 15

1893. *Desmoceras affine* Whiteaves, Royal Soc. Canada Trans., 1st ser., v. 10, p. 113, pl. 8; pl. 11, figs. 1, 1a.
1893? *Desmoceras affine* var. *glabrum* (Whiteaves). Whiteaves, idem, p. 115, pl. 9.
1931. *Beudanticeras glabrum* (Whiteaves). McLearn, Royal Soc. Canada Trans., ser. 3, v. 25, sec. 4, p. 3.
1937. *Beudanticeras* cf. *B. affine* (Whiteaves). Warren, Jour. Paleontology, v. 11, no. 1, p. 70, figs. 1, 2 (not fig 3?).
1945. *Beudanticeras affine* (Whiteaves). McLearn, Canada Geol. Survey Paper 44–17 (2d ed.), pl. 4, fig. 1.
1945. *Beudanticeras* cf. *glabrum* (Whiteaves). McLearn, idem, pl. 4, figs. 2, 3.
1947. *Beudanticeras glabrum* (Whiteaves). Warren, Jour. Paleontology, v. 21, no. 2, p. 121, pl. 30, figs. 3, 4 (not figs. 1, 2).
1960. *Beudanticeras glabrum* (Whiteaves). Imlay, U.S. Geol. Survey Prof. Paper 354–D, p. 105, pl. 16, figs. 14–18, 20–21 (not fig. 19).
1960. *Beudanticeras* (*Grantziceras*) *multiconstrictum* Imlay, idem, p. 105, pl. 14, figs. 1, 2.
1961. *Beudanticeras* (*Grantziceras*) *multiconstrictum* Imlay, U.S. Geol. Survey Prof. Paper 335, p. 56, pl. 14, fig. 1; pl. 15, figs. 1–12.
1961. *Beudanticeras* (*Grantziceras*) *affine* (Whiteaves). Imlay idem, p. 57, pl. 13, fig. 24(?); pl. 14, fig. 2.

The shell of *Grantziceras affine* is compressed, discoidal, and involute; the umbilicus is funnel shaped and narrow, ranging from 11 to about 23 percent of the diameter, with sloping walls that round evenly and gently to meet the slightly inflated and convergent flanks. The venter is narrow and evenly rounded. The outer layer of the shell is covered with fine growth striae that are bundled on the flanks and become more conspicuous on the venter. The internal mold bears variably developed falciform constrictions that arise above the umbilical seam, project forward to about the lower one-third of the flank, run radially across the midflank, and bend forward again at the outer one-third of the flank. These constrictions are visible only when the shell has been removed; on larger specimens with deep constrictions, the posterior edge of the constriction on the venter may be marked by a low ridge. The constrictions are asymmetrical, the adoral side being steeper than the adapical side.

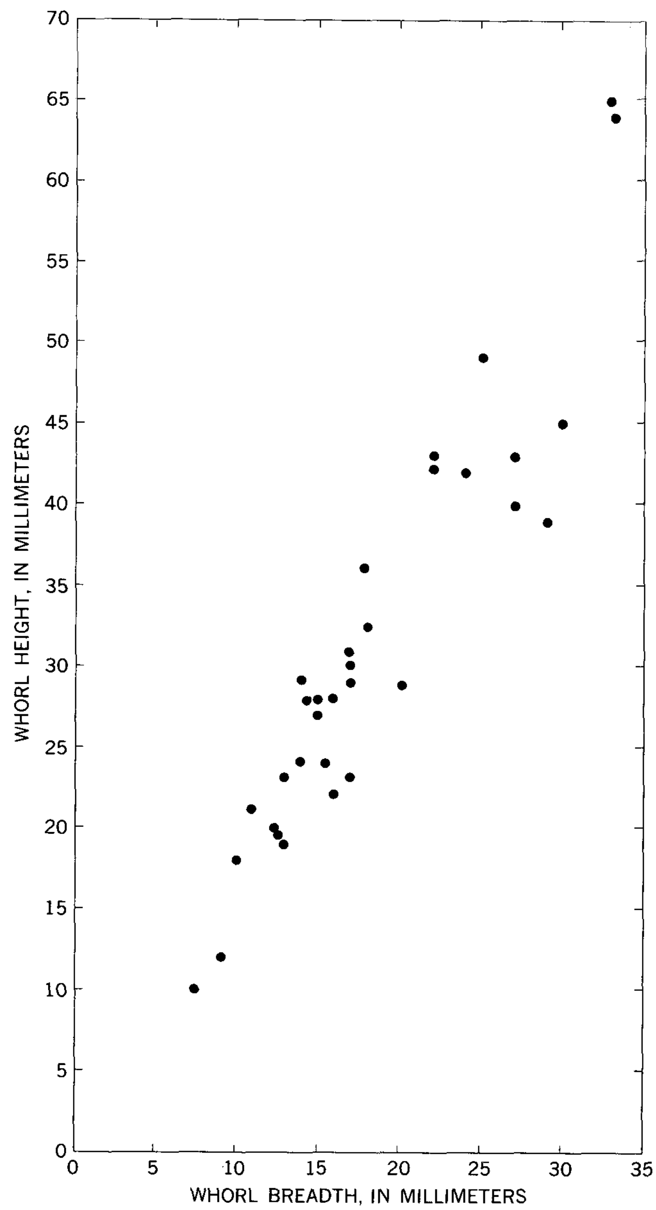


FIGURE 12.—Relation of whorl breadth to whorl height for *Grantziceras affine* from the Nelchina area.

As shown by the following measurements and text figures 12 and 13, the inflation of the whorl and the diameter of the umbilicus are variable. In general, the more inflated forms with B/H ratio of 0.65 or higher have an umbilical width greater than 17 percent of the diameter, and those with a B/H ratio of less than 0.65 have an umbilical width ranging from 11 to about 17 percent of the diameter. The more inflated forms also tend to have more and deeper constrictions, as was noted by Whiteaves (1893, p. 115), although compressed and highly constricted forms are also known.

Compressed specimens with B/H ratio ranging from 0.50 to 0.60 constitute about 55 percent of the presently known sample from the Matanuska Formation (fig. 14). Highly compressed individuals with B/H ratio less than 0.50 are rare, about 3 percent. Inflated forms with B/H ratio between 0.60 and 0.70, and those with a ratio greater than 0.70, constitute about 25 and 17 percent respectively. Because a continuous intergrading series exists between the compressed, poorly constricted forms and the inflated, more constricted forms, it is impossible to split this morphologic group into two subgenera and three distinct species, as others have done.

The suture line is very complex with successive sutures closely interlocked (text fig. 15). The first lateral saddle is asymmetrically bifid and finely subdivided with a narrow to moderately wide stem. The first lateral lobe is irregularly trifid and much deeper than the ventral lobe. The second lateral saddle is thin and asymmetrically bifid and nearly as high as the first lateral saddle. From the second lateral saddle the suture descends to the umbilical seam in a long series of successively smaller saddles, the number of which is variable depending on the size of the specimen and the inflation of the whorl. No basic sutural differences were found between highly constricted and nonconstricted forms, although apparently the first lateral saddle tends to be wider on more inflated varieties (compare figs. 15 *B*, *C*, and *D*).

G. affine differs from *G. glabrum* (Whiteaves), described below, mainly by having a more complexly subdivided suture, a somewhat more inflated whorl section, and a larger umbilicus with a more sloping umbilical wall.

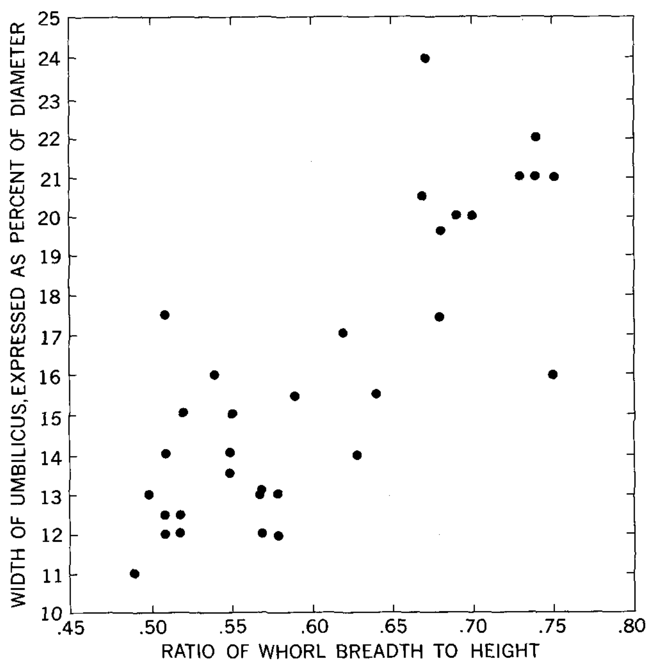


FIGURE 13.—Relation of width of umbilicus to ratio of whorl breadth to height for *Grantziceras affine* from the Nelchina area.

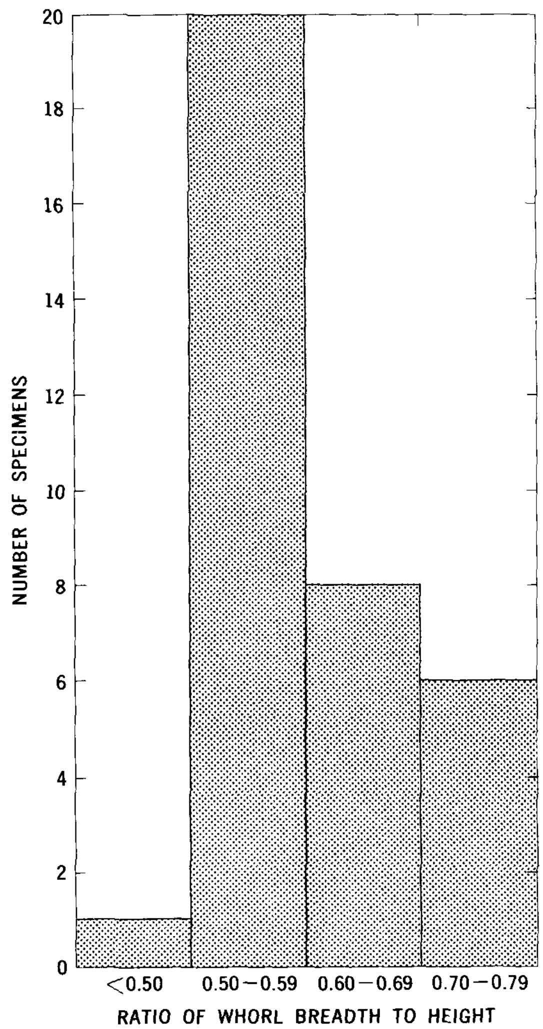


FIGURE 14.—Frequency distribution of the ratio of whorl breadth to height for *Grantziceras affine* from the Nelchina area.

Specimen No.	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus (percent of diam)
1	19	10	7.5	0.75	3.7	16
2	28	12	ca. 9	.75	6	21
3	34	18	10	.55	5	15
4	39	19.5	13.6	.70	8	20
USNM 132106	41	20	12.4	.62	7	17
6	40	21	11	.52	5	12.5
7	51	28	ca. 15	.53	6	12
8	51	27	15	.55	7	14
USNM 132111	47	24	14	.58	6	13
10	58	29	20	.68	11	19
11	57	30	17	.57	7	12
12	51	28	15	.54	8	16
13	62	36	18	.50	8	13
14	53	28	16	.57	7	13
USNM 132108	53	29	14	.48	6	11
16	58	29	17	.58	9	15.5
USNM 132109 [1]	----	23	13	.56	----	----
18	75	42	24	.57	10	13
USNM 132113 [1]	64	33	18	.55	----	----
20	73	42	22	.52	11	15
21	95	49	25	.51	13	14
22	90	49	25	.51	11	12
USNM 132112	120	64	33	.52	15	12.5
USNM 132110	92	45	30	.67	19	20.5
25	85	43	27	.63	12	14
26	65	----	----	----	8	----
27	79	43	22	.51	10	12.5
28	56	29	20	.69	11	20
29	45	24	15.5	.64	7	15.5
30	40	19	13	.68	7	17.5
31	59	31	17	.55	8	13.5
128722a [2]	48	22	16	.73	10	21
128722b [2]	80	40	27	.67	19	24
128722c [2]	60	29	----	----	14	23.5
	50	23	17	.74	11	22
128721 [3]	85	39	29	.74	18	21
128723 [2]	120	65	33	.51	21	17.5
CGS 5030 [4]	185	88	54	.69	30	16
CGS 5020 [5]	263	134	----	----	42	16
	----	85	58	.68	----	----
CGS 5024 [6]	81	44	29	.66	11	13.5

[1] Deformed or crushed specimen.
[2] Measurements of plastotypes of *Grantziceras multiconstrictum* figured by Imlay (1960, 1961).
[3] Measurements of plastoholotype of *G. multiconstrictum*.
[4] Plastohypotype of *Desmoceras affine glabrum* Whiteaves from Peace River, Canada.
[5] Plastocotype of *D. affine* Whiteaves from Peace River, Canada. Specimen crushed.
[6] Cotype of *D. affine* Whiteaves (1893, pl. 11).

Number of specimens: 50+

Figured specimens: USNM 132106, 132107, 132108, 132109, 132110, 132111, 132112, 132113.

Collecting localities: USGS Mesozoic locs. 24877, 25320, M555, M556, M559, M2409, M2386 (?).

Stratigraphic position: Unit A–2 north of the Matanuska River, unit A–I and questionable A–III south of the River. Zone of *Brewericeras hulenense*, late early Albian.

Grantziceras glabrum (Whiteaves)

Plate 6, figures 1–3, 7–9; text figure 16

1889. *Placenticeras glabrum* Whiteaves, Contr. Canadian Paleontology, Geol. and Nat. Hist. Survey Canada, v. 1, pt. 2, p. 172, pl. 24, figs. 1, 1a, 1b.

1937. *Beudanticeras* cf. *B. affine* (Whiteaves). Warren, Jour. Paleontology, v. 11, no. 1, p. 70, fig. 2.

1947. *Beudanticeras glabrum* (Whiteaves). Warren, Jour. Paleontology, v. 21, no. 2, p. 121, pl. 30, figs. 1, 2 (not figs. 3, 4).

1947? *Beudanticeras affine* (Whiteaves). Warren, idem, p. 121, pl. 30, fig. 5.

1960. *Beudanticeras glabrum* (Whiteaves). Imlay, U.S. Geol. Survey Prof. Paper 354–D, p. 105, pl. 16, fig. 19 (not figs. 14–18, 20, 21).

According to Whiteaves (1893, p. 115), *Desmoceras affine* var. *glabrum* differs from *D. affine* in the total absence of constrictions. However, study of Whiteaves' types as well as abundant material from the Nelchina area shows that *Grantziceras glabrum* differs from *G. affine* mainly in the nature of the suture (fig. 16). In *G. glabrum* the suture is broad and shallowly incised with massive low elements; in *G. affine* the suture is complexly interlocked with narrow and highly incised elements. Other minor differences are that *Grantziceras glabrum* tends to have a more compressed whorl section, flatter flanks, more narrowly rounded venter, smaller umbilicus, slightly more angular umbilical shoulder, and less pronounced constrictions than *G. affine*.

The differences between these two forms are slight, but in the Matanuska material no intergradation has been observed between the forms with the highly incised interlocking sutures, which constitute the bulk of the sample, and the forms with broad, shallowly incised, more widely spaced sutures, known only in a few specimens. As yet, no geographic or stratigraphic differences are known in the distribution of these two species. Perhaps the sutural differences reflect only a response to slightly different ecological or physiological conditions and are not of specific importance. If so, the name *G. affine* should be rejected as a synonym. Whether or not this may be the case cannot be determined from study of the Matanuska material because of its limited occurrence. Perhaps study of these two forms in Canada, where more widespread geographic distribution and better stratigraphic control are available, will show the significance of the sutural variation.

Measurements: The measurements of specimens are given in millimeters, except as indicated.

Specimen No.	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus (percent of diam)
USNM 132115	----	36	19	0.53	----	----
	----	44	24	.54	----	----
	46	24	13.6	.565	6.6	14.4
132114	29	13.5	8	.515	3.7	12.8
	----	10	5.0	.50	----	----
GSC 5028	92	48	25	.52	11	12

Holotype: GSC 5028.

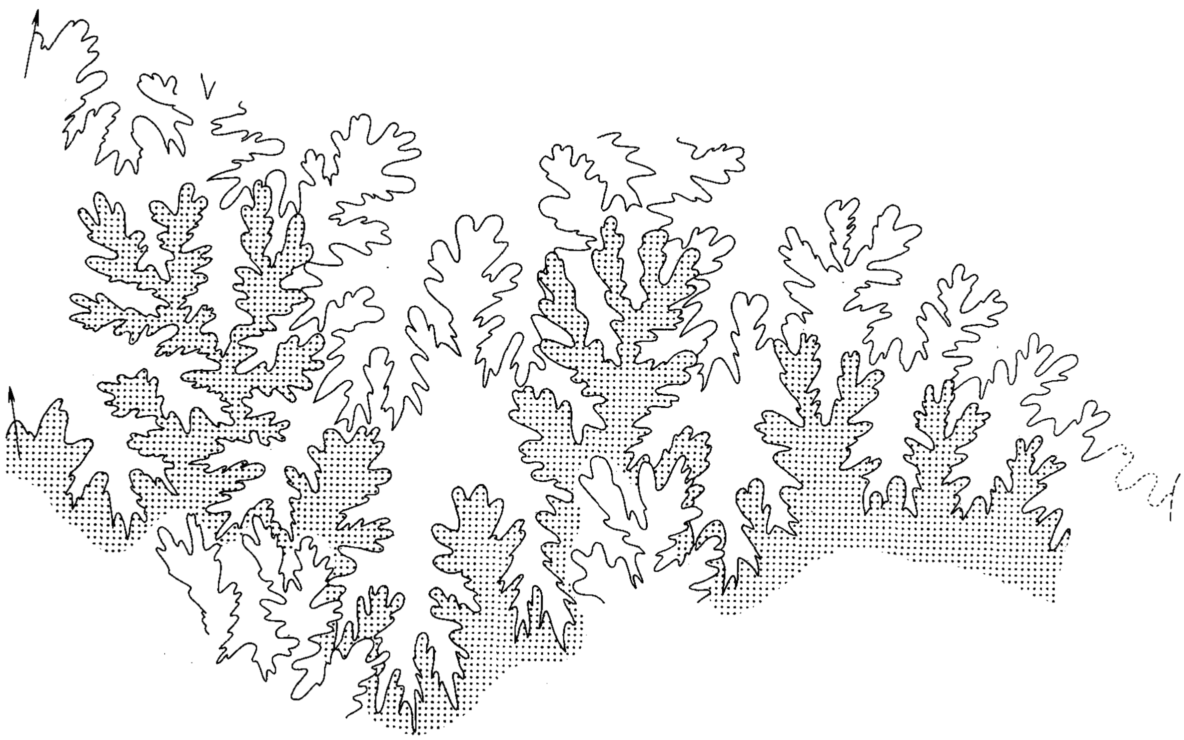
Figured specimens: USNM 132114, 132115 from USGS Mesozoic loc. M556.

Stratigraphic position: Unit A–2; *Brewericeras hulenense* zone.

Genus FREBOLDICERAS Imlay

1959. *Freboldiceras* Imlay, Jour. Paleontology, v. 33, no. 1, p. 182; Imlay, 1960, U.S. Geol. Survey Prof. Paper 354–D, p. 102.

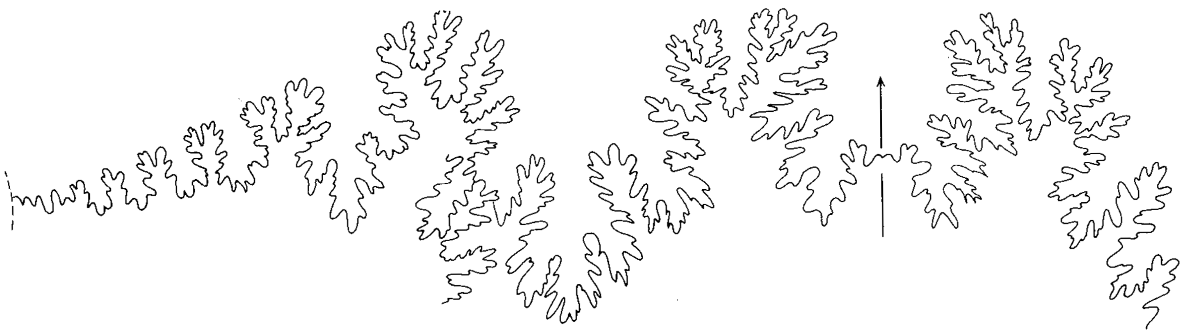
Type species (by original designation): *Freboldiceras singulare* Imlay.



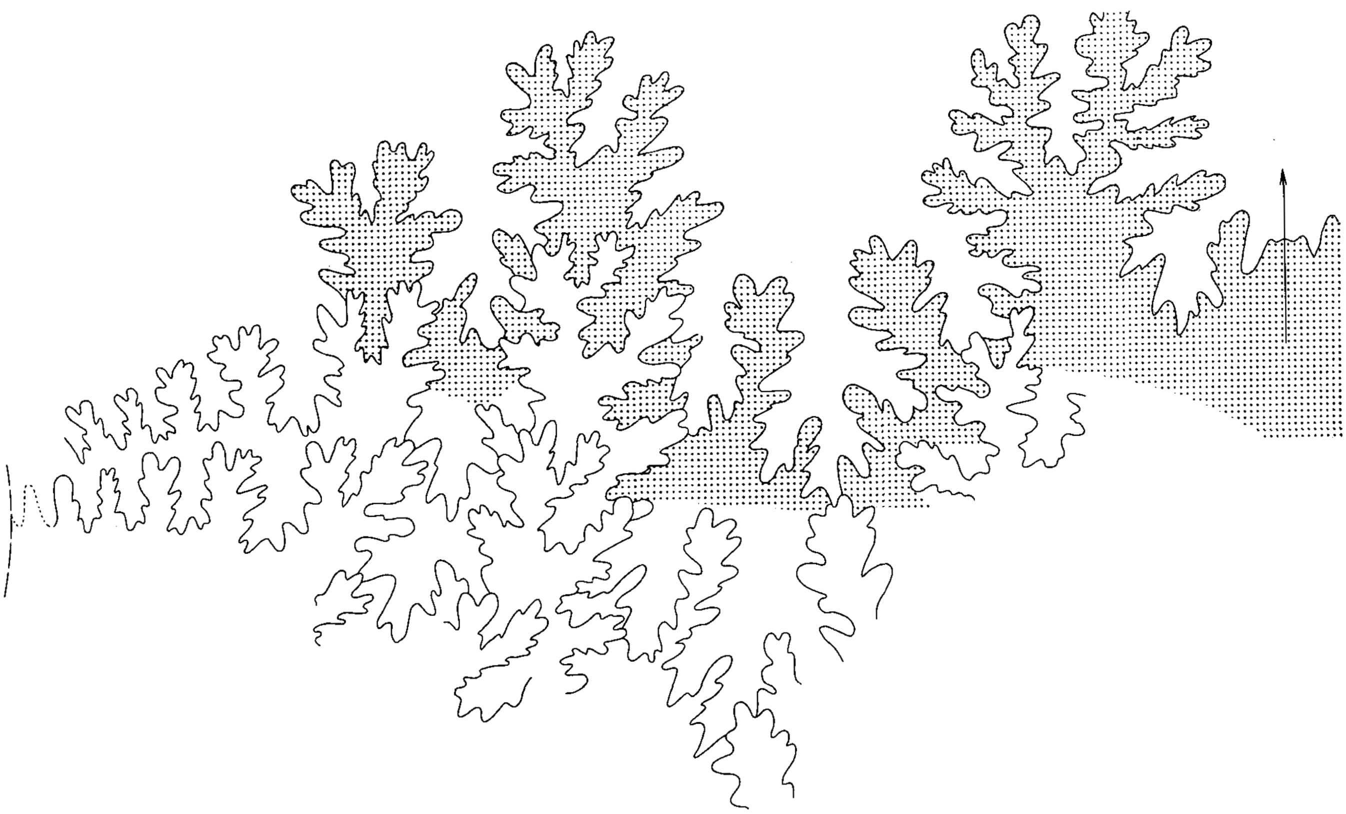
A. Plesiotype USNM 132112 from USGS Mesozoic locality M556. Nearly smooth poorly constricted form. × 3.

B. Plesiotype USNM 132107 from USGS Mesozoic locality M556. Specimen figures on plate 5, figures 4–6. Constrictions weakly developed. × 9.

FIGURE 15.—SUTURE LINES OF

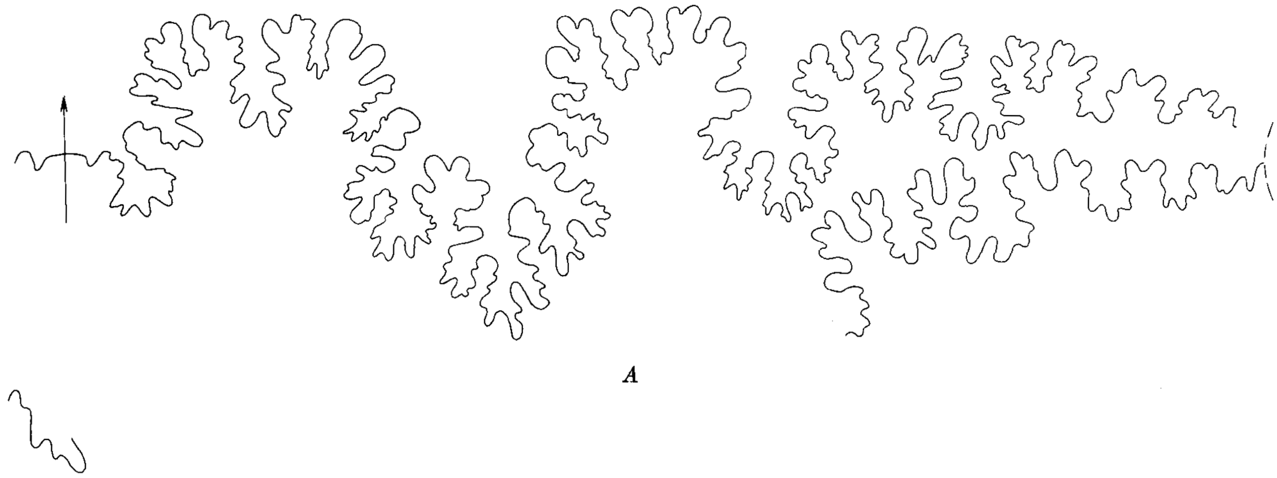


C. Plesiotype USNM 132113 from USGS Mesozoic locality M556. Highly constricted variety. × 3½.

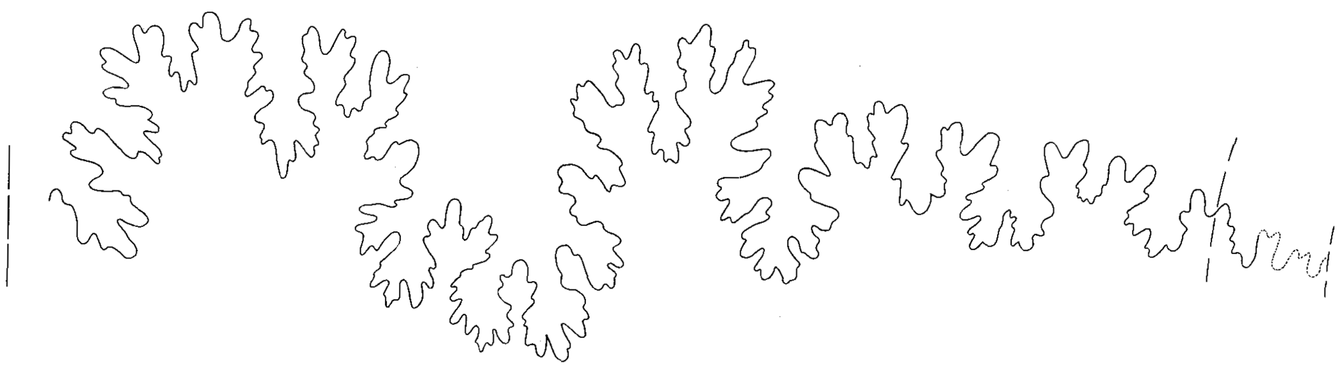


D. Plesiotype USNM 132109 from USGS Mesozoic locality M556. Specimen figured on plate 5, figures 8–10. × 5.

GRANTZICERAS AFFINE (WHITEAVES)



A



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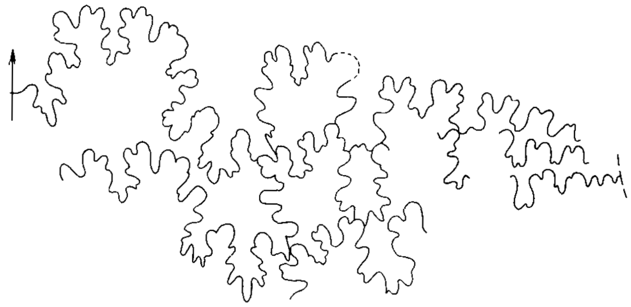

C

A. USNM 132114 from USGS Mesozoic locality M556. Specimen illustrated on plate 6, figures 7–9. × 3½.

B. Holotype GSC 5028. × 9.

C. USNM 132115 from USGS Mesozoic locality M556. Specimen illustrated on plate 6, figures 1–3. × 4½.

FIGURE 16.—SUTURE LINES OF *GRANTZICERAS GLABRUM* (WHITEAVES)

Freboldiceras was originally based on four specimens obtained from USGS Mesozoic locality 24877 on the south side of Limestone Gulch. The essential generic characters are a compressed subovate whorl section, gently convex flanks, narrowly rounded venter, and fairly narrow umbilicus with steeply inclined wall; ornamentation consists of prominent flexous primary ribs that are swollen near the umbilical margin and obsolete on the outer flanks, together with irregularly-spaced constrictions and flexous striae. The suture line is simple with a very wide, shallowly incised first lateral saddle and a deep, broad, slightly asymmetrical first lateral lobe. The second lateral saddle is strongly asymmetrical, the ventral part being lower than the dorsal part.

Since Imlay's (1959, 1960) study of *Freboldiceras*, additional specimens have been obtained from the type locality and nearby. These specimens show that the type species, *F. singulare*, is highly variable, particularly in regard to strength of ornamentation and development of secondary ribs. The more coarsely ribbed forms approach, and may even grade into, *Arcthoplites* [=*Lemuroceras* of Imlay, 1960, and *Subarcthoplites* of Casey, 1954, and Imlay, 1961]. This close relationship was suggested by Casey (1961, footnote, p. 167), who stated: "I have also been privileged to study casts of '*Lemuroceras*' *talkeetanum* Imlay—an interesting Alaskan form of *Subarcthoplites* in which the test is coarsely striated—and in which the umbilical ends of the primary ribs are delicately emphasized; further emphasis, accompanied by obsolescence of ribbing on the outer flank and venter, leads to *Freboldiceras*."

Although typical specimens of *Freboldiceras* and "*Subarcthoplites*" can be separated with no difficulty, a few passage forms with intermediate characters cannot readily be assigned to either taxon. In such a situation, two courses of action are open to the paleontologist. One is to lump together as one highly variable genus the representatives of both taxa; this successfully eliminates the problem of placement of the passage forms, but it may obscure fundamental differences in what might be two separately evolving lineages derived from a common ancestor. Lumping together of possibly intergrading forms also demands precise stratigraphic control and the demonstration that the fossils under consideration may have coexisted as a single population. This latter requirement can best be met by finding many specimens together in a single bed or in a single concretion, as in the thoroughly convincing study of ammonite variation published by Reeside and Cobban (1960).

Such precise control is lacking in the Alaskan forms under consideration: (1) because the fossils mainly occur singly in isolated calcareous concretions, many of which were concentrated on the surface of the ground by erosion of the enclosing shaly matrix, and have subsequently rolled downhill and are now out of their original stratigraphic position; (2) because of the difficulty and expense of reaching the type locality, sufficient time has not been available for trenching the outcrop and obtaining fossils in place.

The other alternative to lumping is, of course, to regard the two forms as constituting distinct, although closely related, genera, with the passage forms serving to demonstrate that both were probably derived from a common ancestor. This procedure is followed herein (text fig. 7) but with the full realization that it is arbitrary and that when more specimens and better stratigraphic control are available, it may be necessary to unite both taxa to form one highly variable genus.

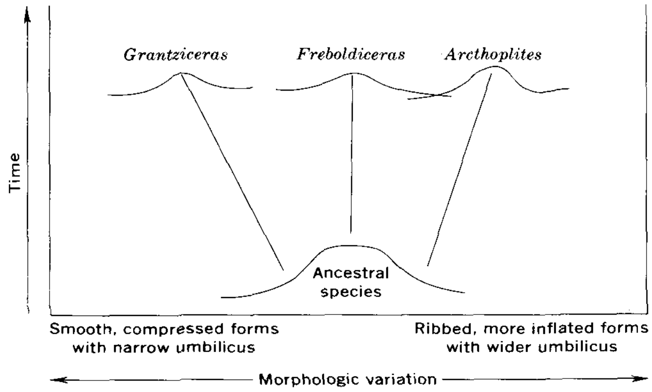

FIGURE 17.—Concept of derivation of *Grantziceras*, *Freboldiceras*, and *Arcthoplites* from a common ancestor. *Freboldiceras* and *Arcthoplites* overlap in certain characteristics which necessitates an arbitrary subdivision of the two.

Comparison of suture lines of *Freboldiceras*, *Arcthoplites*, and *Grantziceras* show basic similarities between the three groups. In particular, the suture of *G. glabrum* approaches that of *Freboldiceras*, so it seems possible that these three taxa were derived from common ancestral species as shown in figure 17.

Freboldiceras singulare Imlay

Plate 7, figures 1–25; text figure 18

1959. *Freboldiceras singulare* Imlay, Jour. Paleontology, v. 33, no. 1, p. 182, pl. 30, figs. 1–7.

1960. *Freboldiceras singulare* Imlay. Imlay, U.S. Geol. Survey Prof. Paper 354–D, p. 102, pl. 14, figs. 8–17.

The shell of *Freboldiceras singulare* is compressed with slightly inflated, rounded flanks, evenly rounded venter, and moderately wide, shallow umbilicus with sloping walls and a rounded shoulder. Ornamentation consists of ribs that are swollen on the umbilical shoulder and lower flanks and that are obsolete to varying degrees on the outer flanks and venter. The shell is smooth up to a diameter of 8 mm at which point low, widely spaced elongate riblets and bundled striae appear on the umbilical shoulder and lower flank (pl. 7, figs. 1–3). The riblets are radial and die out on the upper flank; the striae cross the venter with forward projection. The whorl is about as broad as it is high in early stages, and whorl height increases rapidly with increased diameter, so that at 16 mm the ratio of breadth to height is about 0.65. Ornamentation gradually becomes more prominent with increased growth, and at a diameter of 15 to 20 mm umbilical swellings become broader and higher, and irregular secondary ribs may appear on the outer flanks (pl. 7, figs. 4–6, 10–12); neither primary nor secondary ribs cross the venter. Development beyond this stage leads either to *F. singulare* through effacement of the secondary ribs or to

Arcthoplites talkeetnanus through emphasis of the secondary ribs and strengthening of the primary ribs. The specimen of *F. singulare* shown on plate 7, figures 7 to 9, has strong slightly flexed primary ribs with indistinct broad intercalated secondary ribs on the outer flank and venter. Such ribs are missing on the specimens shown on plate 7, figures 16 to 20, 24, and 25. On the latter specimen, ornamentation weakens at a fairly early stage, and the body chamber is nearly smooth except for shallow constrictions and bundled striae. Another variation in the ornamentation pattern is shown by the specimen figured on plate 7, figures 21 to 23, on which the primary ribs are very coarse on the lower flanks, become broad and flattened on the outer flank, and tend to bifurcate irregularly to form secondary ribs that cross the venter as low bulges. This specimen shows obvious affinities to the more coarsely ribbed specimen of *A. talkeetnanus* shown on plate 7, figures 26 to 28, and may be regarded as a passage between the two genera. Another similar, although larger, specimen with a diameter of 60 mm is in the paleontology collections of the University of California, Los Angeles, and was examined through the courtesy of Professor W. P. Popenoe. At a whorl height of 16 to 18 mm, thin strong primary ribs bifurcate on the outer flank and secondary ribs cross the venter with little decrease in strength, as is typical for *A. talkeetnanus*. At a whorl height of about 18 to 20 mm the whorl is constricted, and the primary ribs become obsolete on the outer flank and are marked on the venter by low faint ridges; this ornamentation is identical with that of the specimen of *F. singulare* shown on plate 7, figures 21 to 23. At larger whorl heights some primary ribs again bifurcate and are prominent on the venter. This specimen is clearly intermediate between *Freboldiceras* and *Arcthoplites*, as at different stages of its development it shows the characteristics of both genera.

The suture line (text fig. 18) of *F. singulare* is simple with broad, shallowly incised saddles and lobes. No

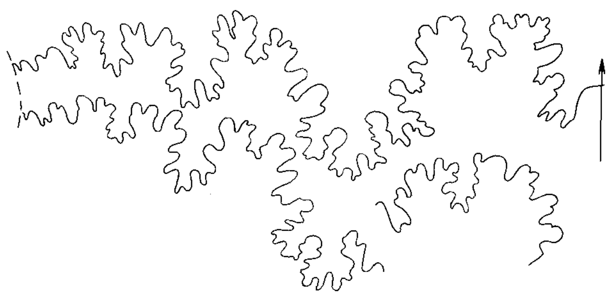

FIGURE 18.—Suture line of *Freboldiceras singulare* Imlay, plesiotype USNM 132121 from USGS Mesozoic locality M556. Specimen illustrated on plate 7, figures 16, 17, 24, 25. × 4½.

essential differences are seen between the sutures of *F. singulare* and *A. talkeetnanus*, and this further supports the concept of their close relationship. In addition, the suture line of *Grantziceras glabrum* (text fig. 16) is similar to that of *Freboldiceras*, and this suggests a common ancestor for these three genera.

Measurements: The measurements of specimens are given in millimeters, except as indicated.

Specimen No.	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus (percent of diam)
USNM 129868 [1]	35	24	19	0.79	14	25
132116	10	4.4	4.6	1.04	2.9	29
132117	21	9.4	7.3	.78	6	29
132118	31	13.5	11.+	.81	8	26
132119	22	9.6	7.5	.79	6.6	30
132120	31.6	14.5	11.3	.78	7.7	24
132121 [2]	52	26	16	.62	12	23
132122	41	18.6	15.5	.83	11	27
132123	42	14.7	18	.81	13	31

[1] Holotype, measurements from Imlay (1959, p. 183).
[2] Slightly crushed.

Holotype: USNM 129868.
Type locality: USGS Mesozoic loc. 24877.
Figured specimens: USNM 132116, 132117, 132118, 132119, 132120, 132121, 132122, 132123.
Collecting localities: USGS Mesozoic locs. 24877, M553, M556.
Stratigraphic position: Unit A–2; zone of *Brewericeras hulenense;* late early Albian.

Genus ARCTHOPLITES Spath

1925. *Arcthoplites* Spath, Ammonoidea of the Gault, p. 76.
Type species (by original designation): *Hoplites jachromensis* Nikitin.

Ammonites from Alaska and Canada herein referred to *Arcthoplites* have had a long and somewhat confused nomenclatural history. *Arcthoplites* was originally based on *Hoplites jachromensis* Nikitin (1888, p. 57, pl. 4, figs. 1–7), an ammonite that on early whorls is characterized by alternating long and short ribs and on later whorls by slightly flexed primary ribs that bifurcate high on the flanks to form a characteristic Y-shaped pattern.

McLearn found some arcthoplitid specimens near the Brule Rapids on the Athabasca River in Canada. He designated these specimens by the manuscript names *A.* (?) *limpidianus* and *A.* (?) *belli* and sent them to Spath (Spath, 1942, p. 688) for additional study. Spath referred these specimens to his new genus *Lemuroceras* (Spath, 1942, p. 687), and McLearn (1945) later validated *A.* (?) *belli* as *L. belli*. As originally proposed, *Lemuroceras* was without description or diagnosis and was based on a species, *Pseudohaploceras* (*Deshayesites?*) *aburense* Spath (1933, p. 801, pl. 128, figs. 3a, b, 6a, b), which was figured but not described. *Lemuroceras* as proposed was thus a nomen nudum, but this was rectified by Collignon (1949) who diagnosed both the genus and the type species and described nine new species. In 1953 Crickmay objected to referring *L. belli* McLearn to *Lemuroceras* and, instead, assigned it to his genus *Coloboceras*, which in turn was rejected by Casey (1954) as a homonym. Casey supported Crickmay's contention that *L. belli* was improperly assigned to *Lemuroceras*, and he created a new genus, *Subarcthoplites*, with *L. belli* as type species.

According to Casey (1954, p. 111), *Subarchthoplites* is: "Like *Arcthoplites*, but with more convex venter, the ribs bifurcating from a lower point on the flanks and without the pronounced tendency to cupid's-bow curvature. Umbilical wall subvertical, fairly high, with rounded rim. Suture line as in *Arcthoplites*." Casey further emphasized that *Subarcthoplites* is clearly distinct from *Lemuroceras*, as that genus is a more planulate form with an oblique generally rimless umbilical wall and with less frequent bifurcation of the ribs.

Imlay (1961, p. 59–60) reluctantly accepted *Subarcthoplites* and suggested that it is more closely related to *Lemuroceras* than to *Arcthoplites* and might be regarded as a subgenus of the former. Regarding the relationship of *Subarcthoplites* to *Arcthoplites*, Imlay (1961, p. 60) stated, "Some of the immature specimens of *Subarcthoplites belli* (McLearn) from Alaska are similar in appearance to the immature specimens of *Arcthoplites jachromensis* (Nikitin) (1888, pl. 4, fig. 7), but the adults are clearly differentiated by lower points of rib branching, by constrictions, and by a tendency for the ribbing to disappear on the body chamber instead of becoming coarser." In another paper by Imlay (1960, p. 109–111), written after but published before U.S. Geological Survey Professional Paper 335 (Imlay, 1961), he recognized *L. talkeetnanum* as well as *L.* (*Subarcthoplites*) aff. *L. belli* (McLearn).

Preliminary studies of many specimens of "*Lemuroeras*" *belli* obtained from the upper Chitina Valley, as well as the specimens of "*Lemuroceras*" *talkeetnanum* discussed below, indicate that both of these species can indeed be assigned to *Arcthoplites*, and that if *Subarcthoplites* is deemed to be useful, it should be regarded as a subgenus of *Arcthoplites*.

A. belli will be thoroughly discussed in another paper; briefly, the reasons for its inclusion in *Arcthoplites* are summarized as follows: This species has been found to be highly variable morphologically, and previous descriptions based on one or two specimens are inadequate. For example, the position of rib branching is variable; on some specimens it occurs lower on the flanks than on typical *A. jachromensis*, but on other specimens it is equally high. Also, on some specimens the cupid's-bow, or Y-shaped branching pattern, is well developed, but on others the secondary ribs may be intercalated freely or only weakly joined to the primaries so that the branching pattern is not as apparent. The convexity of the venter is also variable and is mainly dependent on the inflation of the whorls. Some specimens of *A. belli* have a flattened venter identical with that of Nikitin's (1888) specimen figured by him on plate 4, figure 7.[1]

Arcthoplites talkeetnanus (Imlay)

Plate 7, figures 26–31; plate 8, figures 1–18; plate 9, figures 1–2; text figure 19

1960. *Lemuroceras talkeetnanum* Imlay, U.S. Geol. Survey Prof. Paper 354–D, p. 109, pl. 18, figs. 34–41.

1961. *Subarcthoplites talkeetnanum* (Imlay) Casey Palaeontog. Soc. Mon., pt. 3, footnote, p. 167.

Arcthoplites talkeetnanus has a compressed whorl section with slightly inflated flanks, broadly and evenly rounded to slightly flattened venter, moderately wide umbilicus with sloping umbilical walls, and evenly rounded shoulder. Ornamentation is prominent and variable. On early whorls, at diameters up to about 8 mm, the shell is smooth. Up to a diameter of 15 mm, the shell is similar to that described for *Freboldiceras singulare*. At a diameter of 18 to 20 mm, primary ribs are well developed and spring from elongate swellings or bullae on the umbilical shoulder and lower flank; secondary ribs are also present and either arise freely below the midflank or split from the primary ribs. Both primary and secondary ribs cross the venter with forward projection and with a tendency to weaken along the midventral line (pl. 8, figs. 4–6; 10–12). Some specimens at this stage exhibit a well-developed Y-shaped pattern of bifurcation of the primary ribs (pl. 8, fig. 3), but this is more commonly developed at somewhat larger diameters. At diameters of more than 20 mm, ornamentation is variable; some specimens show coarse flexed ribs that bifurcate regularly high on the flanks to produce the cupid's-bow pattern typical for the genus (pl. 7, figs. 26–28). These specimens tend to be inflated with a wide umbilicus. On other, generally more compressed forms the umbilicus is narrower, the ribs split lower on the flanks (pl. 7, figs. 29–31), and additional intercalated ribs may appear high on the flanks (pl. 8, fig. 7). At diameters of about 50 mm ornamentation begins to weaken, and the ribs become more rectilinear with a less pronounced tendency to split into secondary ribs (pl. 8, figs. 13–17). The diameter at which ornamentation becomes obsolete is variable, however, as is shown by the specimen on plate 8, figures 1 to 3, on which the ribs begin to weaken at a diameter of about 30 mm. At very large diameters the

[1] Jeletzky (1964, pls. 25, 26) also refers "*Lemuroceras*" *belli* to *Arcthoplites* and rejects "*Subarcthoplites*" as unnecessary.

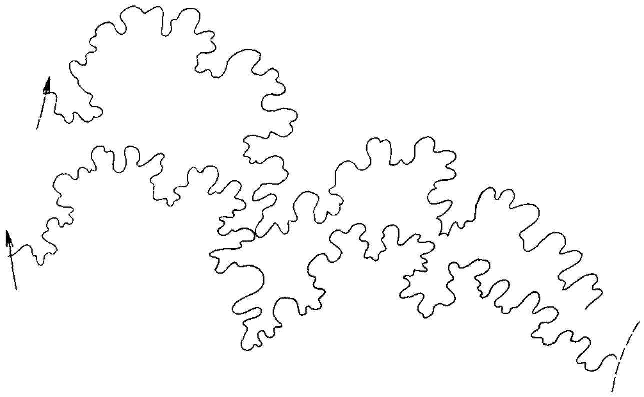

FIGURE 19.—Suture line of *Arcthoplites talkeetnanus* (Imlay), plesiotype USNM 132126 from USGS Mesozoic locality M556. Specimen illustrated on plate 8, figures 1–3. Compare with similar suture of *Freboldiceras singulare*. × 6.

shell is smooth except for bundled growth striae and irregular riblets (pl. 8, fig. 18; pl. 9).

The suture line (text fig. 19) is similar to that of *F. singulare* with a first lateral saddle that is very broad and shallowly incised; the first lateral lobe is somewhat deeper than the ventral lobe, and the second lateral saddle is highly asymmetric.

A. talkeetnanus is closely related to *A. belli* (McLearn). It differs from that species mainly by having coarser bullae along the umbilical shoulder, particularly on the early whorls. This difference is especially apparent when comparing the more coarsely ribbed variants of each species; that part of each whorl exposed within the umbilicus bears low, indistinct bullae on *A. belli* and very prominent swollen bullae on *A. talkeetnanus*. No intergradation in this feature has been observed between the two species.

Measurements: The measurements of specimens are given in millimeters, except as indicated.

Specimen No.	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus (percent of diam)
USNM 13015 [1]	----------	17	13	0.76	----------	----------
132124	39	15.5	14.5	.93	12	30.5
132126	24	11	8.7	.80	6	25
132128	31	13	10.5	.81	9.7	31.5
132129	26	11	9	.82	6.7	26
132130a	50	19	17	.90	12	24
132130b	75	33	23	.72	16	21.5
132130c	185	78	55	.71	45	24.5

[1] Holotype, measurements from Imlay (1960, p. 110).

Holotype: USNM 13015.
Type locality: USGS Mesozoic loc. 24877.
Figured specimens: USNM 132124, 132125, 132126, 132127, 132128, 132129, 132130.
Collecting localities: USGS Mesozoic locs. 24877, M556, M559, M572.
Stratigraphic position: Unit A–2; zone of *Brewericeras hulenense*, late early Albian.

Genus PUZOSIA Bayle

1878. *Puzosia* Bayle, Explication. Carte France, v. 4, Atlas, pt. 1, pl. 45.

Type species: Puzosia planulata Bayle.

Puzosia alaskana Imlay

Plate 4, figures 1–9

1960. *Puzosia alaskana* Imlay, U.S. Geol. Survey Prof. Paper 354–D, p. 104, pl. 16, figs. 1–13.

Four small specimens of *Puzosia alaskana* are known from USGS Mesozoic locality M556, the largest measures 21 mm in diameter. These specimens agree in all characteristics with type specimens from the Chitina Valley. They exhibit the usual compressed whorl shape, flattened flanks that round abruptly to meet the venter, falcate constriction and growth lines, and lack of ornamentation on early whorls. Up to a diameter of about 13 mm, the shell is smooth except for very fine sigmoidal growth lines (pl. 4, figs. 1–6); the first constriction appears at about 9 mm. At a diameter of about 20 mm growth lines are coarse and tend to bundle to form fine sigmoidal riblets (pl. 4, fig. 7). Distinct ribs on the ventral area are developed only on much larger specimens than are known from the Matanuska Formation. (See Imlay, 1960, pl. 16, fig. 13.)

Measurements: The measurements of specimens are given in millimeters, except as indicated.

Specimen No.	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus (percent of diam)
USNM 132131	13.5	6.5	5	0.77	4.8	36
132132	9	4.3	3.4	.79	2.8	31
132133	22	8.4	6.5	.77	6.9	31
130143 [1]	41	17	13	.76	13.5	33
130144 [2]	29	12	10	.74	8.5	29

[1] Holotype, measurements from Imlay (1960, p. 104).
[2] Paratype, measurements from Imlay (1960, p. 104).

Holotype: USNM 130143.
Type locality: USGS Mesozoic loc. 9492, Chitina Valley, Alaska.
Figured specimens: USNM 132131, 132132, 132133.
Number of specimens: Four.
Collecting locality: USGS Mesozoic loc. M556.
Stratigraphic position: Unit A–2; zone of *Brewericeras hulenense*, late early Albian.

Genus MESOPUZOSIA Matsumoto

1954. *Mesopuzosia* Matsumoto, Kyūshū Univ., Mem. Fac. Sci., ser. D., v. 5, no. 2, p. 79.

Type species (original designation): *Mesopuzosia pacifica* Matsumoto.

Mesopuzosia aff. M. indopacifica (Kossmat)

Plate 4, figures 30–35

Eight specimens from the Matanuska Formation show affinities with *Mesopuzosia indopacifica*, but they are too poorly preserved for positive identification. All these specimens are fragmentary and have been crushed and deformed to varying degrees. The whorls are moderately compressed with slightly inflated flank, broadly rounded venter, subvertical umbilical wall, and abruptly rounded umbilical shoulder. Ornamentation is variable at different growth stages and also between individuals. At diameters of less than 30 mm, the shell is apparently smooth except for periodic constrictions. At a diameter of about 50 mm, ornamentation consists of fine alternating long and short ribs, the long ribs predominating. The long ribs arise near the umbilical shoulder and the short ribs on the lower flank or near midflank. The long ribs have a slightly sinuous course on the flank, and both sets of ribs cross the venter with equal strength and with strong forward projection. The fairly deep broad constrictions have a slightly oblique course across the flanks and are projected forward, parallel to the ribs, on the venter. The constrictions are usually bordered by a strong ridge that may occur on either side but more commonly on the posterior side. On large specimens, of which only fragments are known from Alaska, the ornamentation is variable in strength and in number of intercalated secondary ribs. On the specimen shown on plate 4, figure 32, differentiation between secondary ribs and primary ribs is slight, and secondary ribs that arise near midflank are few. On the specimen shown on plate 4, figure 31, as many as three secondary ribs are intercalated between the primaries, and these arise at about midflank.

The Alaskan specimens differ from Kossmat's (1898, pl. 17, fig. 2) figured specimen by having finer more distinctly developed alternating long and short ribs with less pronounced forward projection on the venter. Matsumoto (1954, p. 85) has described specimens of this species from Japan on which the ornamentation consists of distinctly alternating long and short ribs.

M. pacifica Matsumoto (1954, p. 82, pl. 14, fig. 1; pl. 15, fig. 1, 2; pl. 16, figs. 1–3; text fig. 2) is closely related to *M. indopacifica* and may not be specifically distinct. According to the original description, *M. pacifica* differs from M. *indopacifica* by having inflated flanks, a somewhat broader whorl, and ribs with a slightly more flexed course on the flanks. Specimens from Madagascar identified by Collignon (1961, p. 50, pl. 15, fig. 2, pl. 20) as *M. pacifica* appear to be similar to the Alaskan forms, but their preservation is too poor to permit detailed comparisons.

Most of the Japanese specimens of *M. pacifica* differ from the Alaskan forms by having stronger ornamentation on the lower flanks, with primary ribs continuing to the umbilical seam. Likewise, the specimen from California, identified by Matsumoto (1959b, p. 19, 20) as *M. indopacifica* [=*Puzosia* (*Parapuzosia*) *hearni* Anderson, 1958, p. 238, pl. 38, fig. 1] has somewhat stronger ribs on the lower flanks, but in density and pattern of ribbing it agrees closely with the Alaskan specimens.

Figured specimens: USNM 132134, 132135, 132136, 132137, 132138.

Collecting localities: USGS Mesozoic localities 24229, M601.

Stratigraphic position: Unit C–1, associated with *Inoceramus* cf. *I. cuvierii* and other species of probable Turonian age.

Genus MOFFITITES Imlay

1959. *Moffitites* Imlay, Jour. Paleontology, v. 33, no. 1, p. 181; Imlay, 1960, U.S. Geol. Survey Prof. Paper 354–D, p. 101.

Type species (by original designation): *Moffitites robustus* Imlay, 1959.

The genus *Moffitites* is characterized by moderately to extremely inflated whorls, moderate involution, and primary ribs that bifurcate on the ventrolateral shoulder to form secondary ribs. These ribs cross the venter with moderate forward projection and with a tendency to weaken along the midventral line; shallow constrictions are variably present and are parallel to the ribs. This genus was named from specimens obtained from the Chitina Valley; the specimen from the Matanuska Formation of the Talkeetna Mountains is the only one known outside of the type area.

Moffitites robustus Imlay

Plate 4, figures 24–26; text figure 20

1959. *Moffitites robustus* Imlay, Jour. Paleontology, v. 33, no. 1, p. 181, pl. 29, figs. 9–14.

1960. *Moffitites robustus* Imlay. Imlay, U.S. Geol. Survey Prof. Paper 354–D, p. 102, pl. 13, figs. 1–13

Moffitites robustus is represented by one small specimen from the Matanuska Formation obtained from USGS Mesozoic locality M557, where it occurs in association with *Aucellina* sp. (pl. 4, figs. 27–29). This specimen agrees well with Chitina Valley specimens, particularly the one illustrated by Imlay (1960) on plate 13, figures 11 and 12, although its ribs are slightly coarser and constrictions appear at a much earlier stage. Such minor differences are not important, however, as preliminary studies of recently obtained large collections of *Moffitites* from the type locality and elsewhere in the Chitina Valley indicate a wide range of morphologic variation for this species.

Holotype: USNM 129874.

Type locality: USGS Mesozoic loc. 2191, Fohlin Creek, Chitina Valley, Alaska.

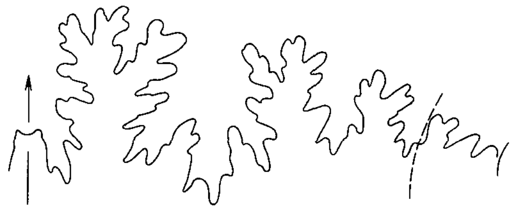

FIGURE 20.—Suture line of *Moffitites robustus* Imlay, plesiotype USNM 132139 from USGS Mesozoic locality M557. Specimen illustrated on plate 4, figures 24–26. × 9.

Figured specimen: USNM 132139.
Collecting locality: USGS Mesozoic loc. M557.
Stratigraphic position: Unit A–1; zone of *M. robustus*, early early Albian.

Family ACANTHOCERATIDAE

Genus CALYCOCERAS Hyatt

1900. *Calycoceras* Hyatt, *in* Zittel, Text-book of paleontology (translated and edited by C. R. Eastman), p. 589.

Type species (original designation): *Ammonites navicularis* Sharp.

Calycoceras sp. indet.

Plate 3, figures 1, 2; text figure 21

One large and several smaller fragments of *Calycoceras* are present in the Survey's collections from the Matanuska Formation, and three fragments are present in the Shell Oil Co. collections in Seattle, Wash. All these specimens are crushed, and positive specific identification cannot be made, although they appear to be most similar to *C. stoliczkai* Collignon. The figured specimen consists of a large fragment of a body chamber that has been distorted and deeply eroded on one side. Ornamentation consists of very prominent thin ribs separated by wide rounded interspaces. The ribs are alternately long and short; the long ribs begin at the umbilical seam and bear a distinct tubercle at the umbilical shoulder; the short ribs arise freely on the lower flank, and both primary and secondary ribs cross the venter with equal strength. Preservation of the ventral part of the figured specimen is too poor to determine positively if ventrolateral tubercles are present, but one of the Shell Oil Co. specimens shows a low node in this position.

A reconstruction of the whorl section of the figured specimen (text fig. 21) shows that the whorl is depressed, broader than high, with a rounded between-rib cross section. This reconstruction is probably not accurate enough to permit determination of the ratio of breadth to height.

Matsumoto (in Matsumoto and others, 1957, p. 19) has described *Calycoceras cf C. stoliczkai* Collignon from the Cenomanian of Japan, which appears to be close to the Alaskan specimens. According to Matsumoto, on the Japanese form, "The outer whorl is ornamented with very strong ribs that are usually alternating long and short. The long ribs are provided with prominent tubercles at the umbilical shoulder, while the short ribs disappear just above it. Other tubercles are nearly completely obsolete on the outer whorl, but are discernible on the inner whorls." This description fits the Alaskan forms, but better preserved specimens are needed for positive identification.

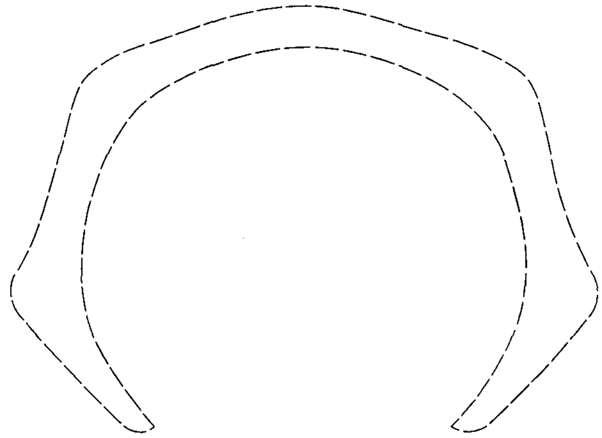

FIGURE 21.—Reconstructed cross section of *Calycoceras* sp. indet., USNM 132140 from USGS Mesozoic locality M595. × 7/10.

Figured specimen: USNM 132140.
Collecting locality: USGS Mesozoic loc. M595.
Stratigraphic position: Sandstone member of unit B, probably of about mid-Cenomanian age.

Family COLLIGNONICERATIDAE

Genus SUBPRIONOCYCLUS Shimizu

1932. *Subprionocyclus* Shimizu, Japanese Jour. Geology, v. 10, p. 1–4.

Type species (original designation): *Prionocyclus hitchinensis* Billinghurst.

Subprionocyclus normalis (Anderson)

Plate 6, figures 12–14; Text figure 22

1958. *Oregoniceras normale* Anderson, Geol. Soc. America Mem. 71, p. 268, pl. 25, fig. 8.
1959. *Subprionocyclus normalis* (Anderson). Matsumoto, Kyūshū Univ., Mem. Fac. Sci., ser. D, spec. v. 1, p. 118, pl. 29, fig. 1; pl. 31, figs. 1–5; text figs. 64–66.

Only one small specimen of *Subprionocyclus normalis* is known from southern Alaska, and this is the only North American representative of the genus known from north of Oregon. This single specimen is of particular interest, as it was found on the top of a mud cone in the Copper River Basin, many miles from the

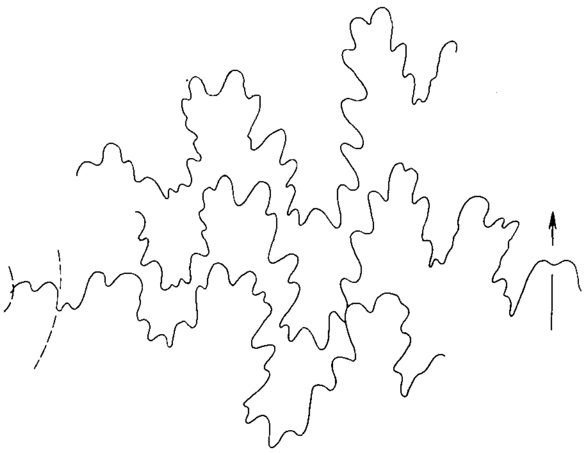

FIGURE 22.—Suture line of *Subprionocyclus normalis* (Anderson), plesiotype USNM 132141 from USGS Mesozoic locality M1795. Specimen illustrated on plate 6, figures 12–14. × 9.

nearest outcrop of Cretaceous rocks (Grantz and others, 1962, p. 1997–1998), and its presence substantiates the probable existence at depth of upper Turonian strata within the Copper River Lowland region.

R. W. Imlay (written commun., 1963) first determined that this specimen belongs to *Subprionocyclus*. It is a small fragment consisting of about half a septate whorl and is characterized by a small umbilicus, flat slightly convergent flanks, and a narrow fastigate venter which bears a sharp median heel. Ornamentation consists of flexed primary ribs that spring in pairs from radially elongate umbilical bullae together with occasional secondary ribs that arise freely between the primaries at about midflank. Clavate tubercles are well developed on the ventral shoulder, although the lower set usual for this genus is scarcely discernible. In this regard, the specimen approaches *Reesidites*, which is characterized by a single row of ventrolateral tubercles; however, typical specimens of *S. normalis* do not show the double ventrolateral tubercles until a diameter larger than that of the Alaskan specimen is attained. The suture line is relatively simple with a wide asymmetrically bifid first lateral saddle and a narrow first-lateral lobe that is deeper than the ventral lobe. This suture agrees well with that figured by Matsumoto (1959b, p. 120, fig. 66b) for a specimen of *S. normalis* from California.

Large collections of *S. normalis* obtained from a single locality near Redding, Calif., show that this species is highly variable. Matsumoto (1959b, p. 120) reported that the ratio of width of umbilicus to diameter ranges from 15 to 30 percent and that the B/H ratio is normally less than 0.7 and commonly between 0.5 and 0.6. Ornamentation is also variable, both in strength and number of ribs and in prominence of umbilical and ventrolateral tubercles. The Alaskan specimen falls well within the range of variation of the California specimen, as shown by the following measurements:

Measurements: The measurements of specimens are given in millimeters, except as indicated.

Specimen No.	Diameter	Height	Breadth	Ratio of breadth to height	Width of umbilicus	Umbilicus (percent of diam)
USNM 132141	ca. 20				4	20
		7.9	4.6	0.58		

Figured specimen: USNM 132141.

Collection locality: USGS Mesozoic loc. M1795, on mud cone in Copper River Lowland.

Stratigraphic position: Unknown.

Family KOSSMATICERATIDAE

Genus EOGUNNARITES Wright and Matsumoto

1954. *Eogunnarites* Wright and Matsumoto, Kyūshū Univ., Mem. Fac. Sci., ser. D, v. 4, no. 2, p. 125.

Type species (original designation): *Olcostephanus unicus* Yabe.

Eogunnarites alaskaensis Matsumoto

Plate 3, figure 3

1959. *Eogunnarites alaskaensis* Matsumoto, Kyūshū Univ., Mem. Fac. Sci., ser. D, v. 8, no. 3, p. 66, pl. 18, fig. 1; pl. 19, fig. 1; pl. 20, fig. 1.

Only one specimen of *Eogunnarites alaskaensis* is known from the Matanuska Formation of the Talkeetna Mountains, although several crushed fragments may belong to this species. The figured specimen is a large fragment of a crushed body chamber and a fragment of the ventral part of the preceding whorl. Identification of this specimen is based mainly on the nature of the ornamentation, which consists of sharp, closely spaced, narrow primary ribs which bifurcate on the flanks to produce secondary ribs of equal strength. Rib interspaces are rounded and wider than ribs. One broad, deep constriction is present which appears to cut the ribbing at a slight angle. The venter, as shown by the undeformed septate fragment, is broad and evenly rounded.

Despite the poor perservation of the Talkeetna Mountains specimen, the characteristic ornamentation and whorl shape permit identification of this species.

Figured specimen: USNM 132142.

Holotype: USNM 129257.

Type locality: USGS Mesozoic loc. 25444, Chitina Valley, Alaska.

Collecting locality: USGS Mesozoic loc. M598.

Stratigraphic position: Lower siltstone member of unit B; zone of *Desmoceras* (*Pseudouhligella*) *japonicum*, Cenomanian.

Genus HULENITES Matsumoto

1955. *Hulenites* Matsumoto, Japanese Jour. Geology Geography. v. 26, nos. 1, 2, p. 122.

Type species (original designation) : *Puzosia reesidei* Anderson.

Hulenites sp.

Plate 4, figures 19–20, 22–23; text figure 23

Two specimens referable to *Hulenites* were obtained from USGS Mesozoic locality M556. These are similar to specimens from the Chitina Valley figured by Imlay (1960, pl. 18, figs. 18–21) as *Hulenites* cf. *H. reesidei* (Anderson). The smaller specimen has rounded whorls, deep oblique constrictions, and numerous very fine threadlike ribs that arise on the lower flank and cross the venter with a forward projection and without appreciable weakening. The larger specimen is generally similar, but the constrictions and ribs are more sinuous. The ribs arise just below midflank, either singly or in bundles of two or more, bend backward at midflank and curve forward on the outer flanks, and weaken on the venter. Faintly bundled striae trend obliquely forward on the lower flank. On the body chamber, which is crushed, the ribs are sinuous, very sharp, narrow, and bifurcate on the outer flank. The constrictions, which cut the ribs obliquely, are bordered on the adoral side by ridges slightly more prominent than the ribs.

These specimens are close to a paratype (CAS 8842) of *H. reesidei* from California, as was pointed out by Imlay. They differ from that specimen by having slightly more sinuous constrictions and ribs and rounded, rather than flat, flanks. On the holotype of *H. reesidei*, a distinct spiral groove occurs at about midflank on the internal mold; this is not visible on the exterior, as it is due to a thickening of the inside of the shell. The smaller paratype of *H. reesidei* likewise has a faint spiral groove, but this feature is not present on the Alaskan specimens. According to Murphy (1956, fig. 6), *H. reesidei* occurs in the *Acanthohoplites gardneri* and *H. reesidei* (latest Aptian or earliest Albian) zones of California and thus is older than the Alaskan species.

H. jimbo (Anderson) and *H. onona* (Anderson) are also closely related to the Alaskan forms and apparently are of approximately the same age. *H. jimbo* has coarser ribs, and *H. onona* has much less conspicuous constrictions.

Figured specimens: USNM 132143a, 132143b.
Collecting localities: USGS Mesozoic locs. M553, M555.
Stratigraphic position: Unit A–2; zone of *Brewericeras hulenense*, late early Albian.

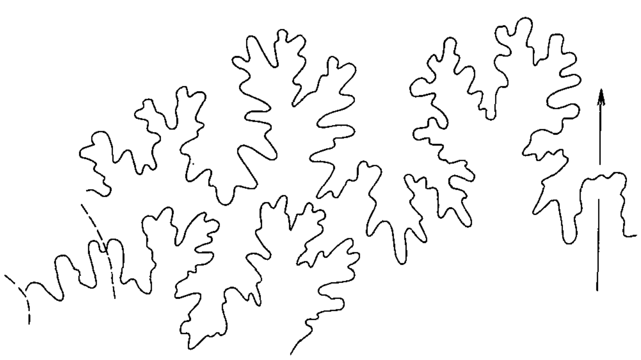

FIGURE 23.—Suture line of *Hulenites* sp., USNM 132143a from USGS Mesozoic locality M553. Specimen illustrated on plate 4, figures 19, 20. × 9.

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PLATE 1

[All figures natural size]

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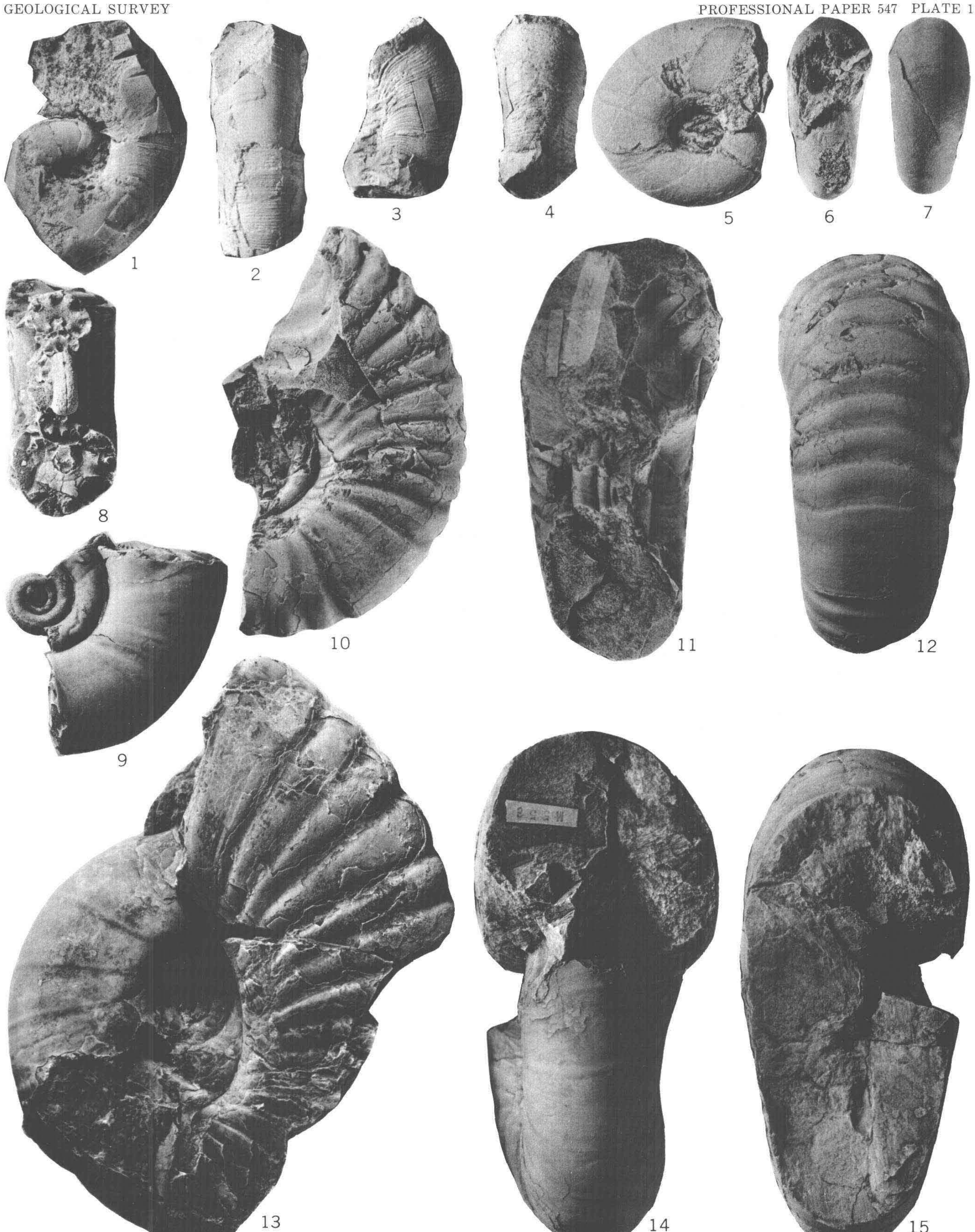

CRETACEOUS AMMONITES FROM THE LOWER MATANUSKA FORMATION

PLATE 2

[All figures natural size]

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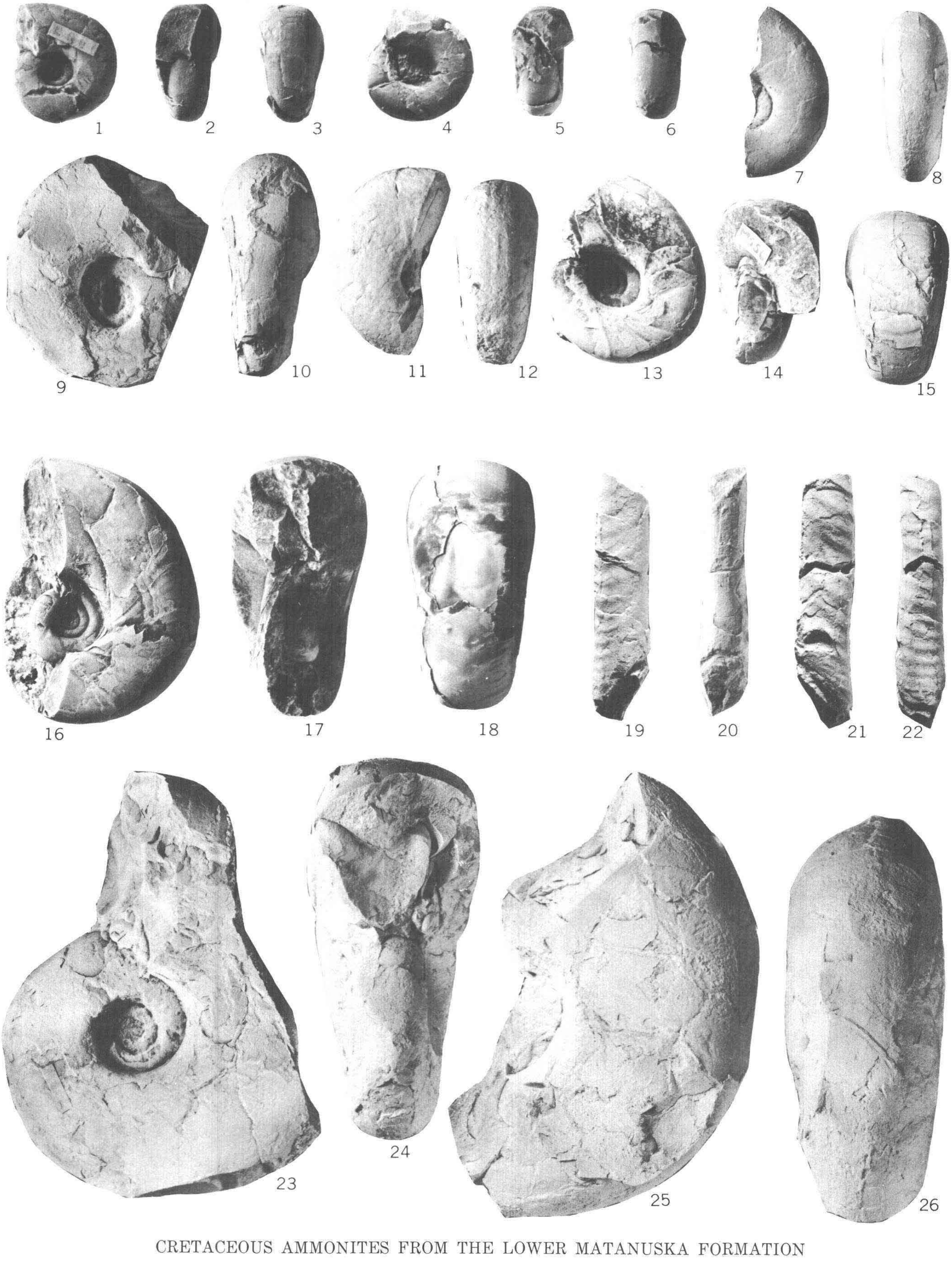
19. Left side.

20. Dorsal side.

21. Right side.

22. Ventral side.



CRETACEOUS AMMONITES FROM THE LOWER MATANUSKA FORMATION

PLATE 3

[Figures natural size except as indicated]

FIGURES 1–2. *Calycoceras* sp. indet. (p. 42).
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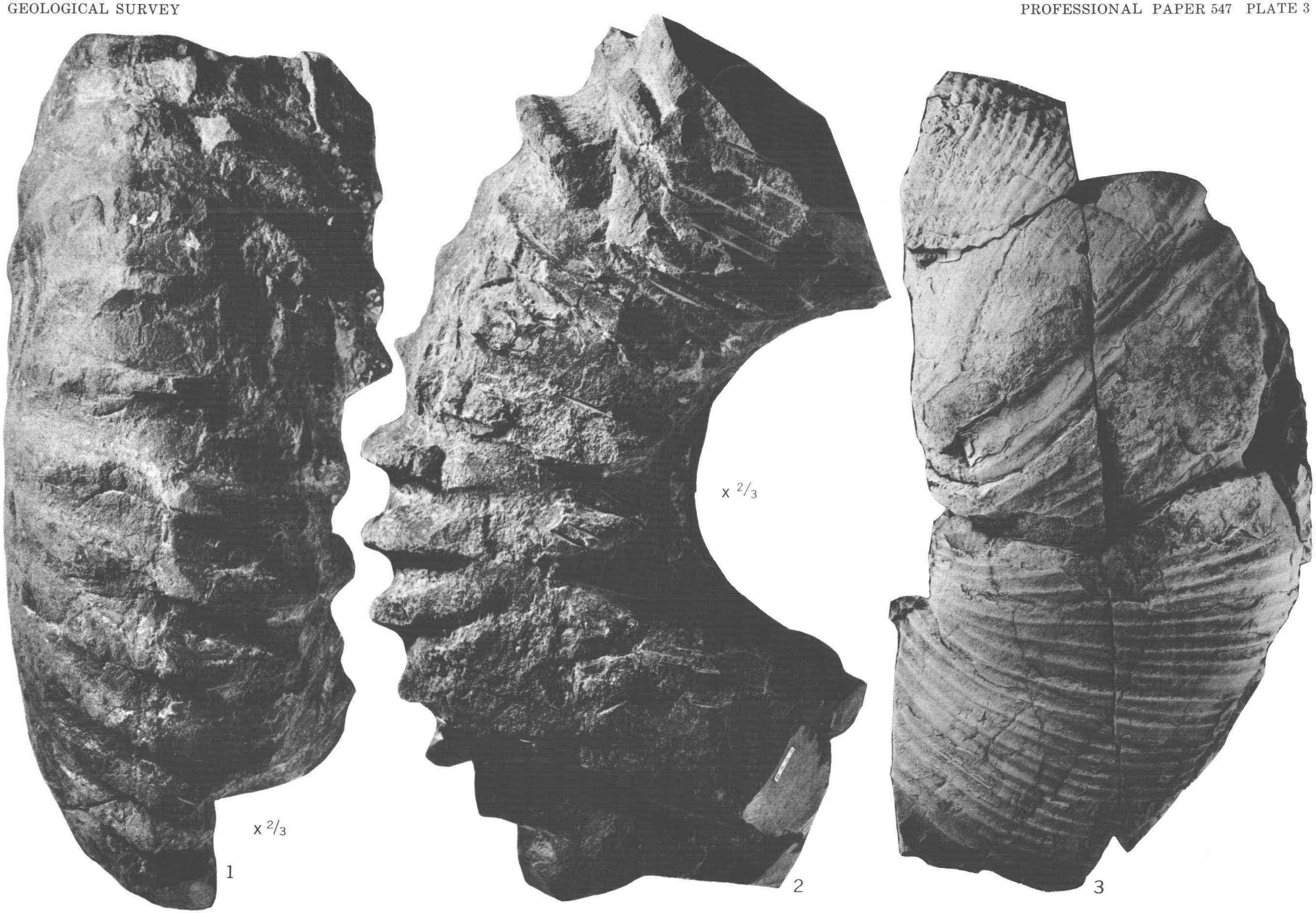

CRETACEOUS AMMONITES FROM THE LOWER MATANUSKA FORMATION

PLATE 4

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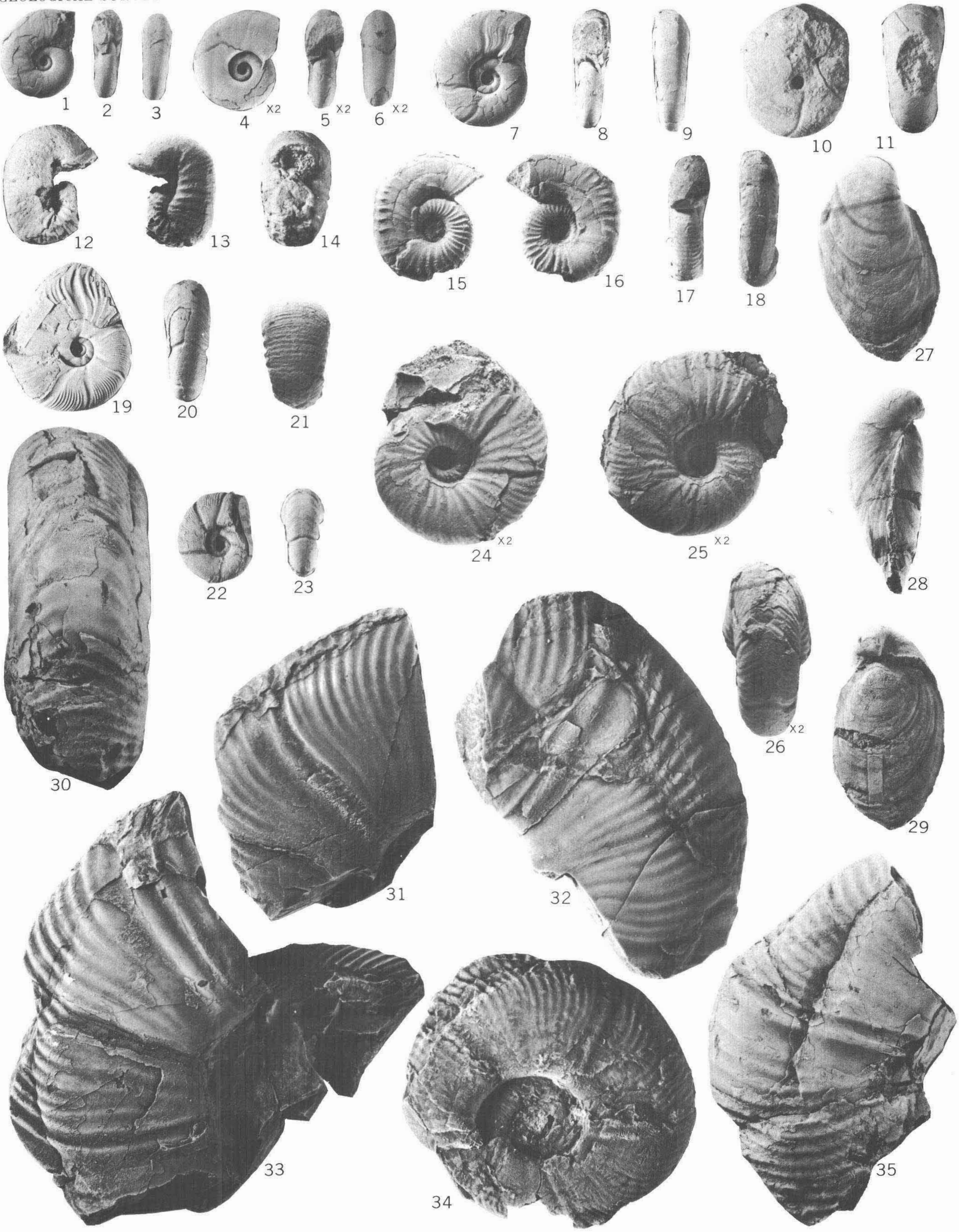
33. Side view of USNM 132137.
34. Side view of USNM 132138.



CRETACEOUS AMMONITES FROM THE LOWER MATANUSKA FORMATION

PLATE 5

[All figures natural size. All specimens from USGS Mesozoic loc. M556]

FIGURES 1–15. *Grantziceras affine* (Whiteaves) (p. 31).

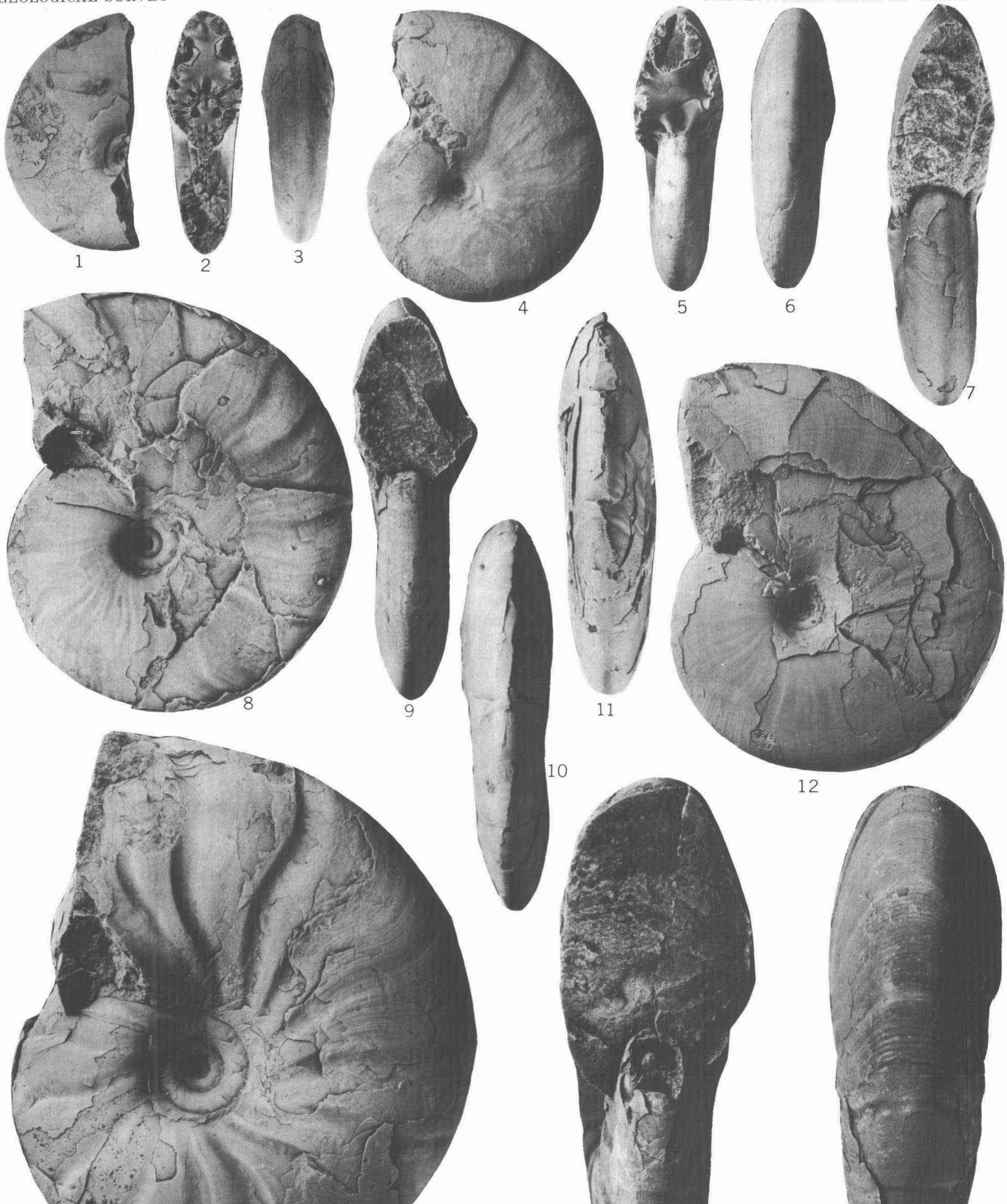
1–3. Side, front, and back views of plesiotype USNM 132106. Only incipient constrictions developed.

4–6. Side, front, and back views of plesiotype USNM 132107. Note one distinct and two incipient constrictions.

7, 11, 12. Front, back, and side views of plesiotype USNM 132108. Constrictions poorly developed. Note bundled striae and feather structure.

8–10. Side, front, and back views of plesiotype USNM 132109. Note abundant shallow constrictions on body chamber.

13–15. Side, front, and back views of plesiotype USNM 132110. Intensely constricted inflated form. Note width of umbilicus and prominence of constrictions increase with inflation of whorl section.



CRETACEOUS AMMONITES FROM THE LOWER MATANUSKA FORMATION

PLATE 6

[Figures natural size except as indicated]

FIGURES 1–3, 7–9. *Grantziceras glabrum* (Whiteaves) (p. 33).

Both specimens from USGS Mesozoic loc. M556.

1–3. Side, front, and back views of plesiotype USNM 132115.

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4–6. *Grantziceras affine* (Whiteaves) (p. 31).

Side, front, and back views of plesiotype USNM 132111 from USGS Mesozoic loc. M556. Note slightly larger umbilicus and more broadly rounded venter than on *G. glabrum*.

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16–18. Side, front, and back views of large specimen, plesiotype USNM 132105 from USGS Mesozoic loc. M556.

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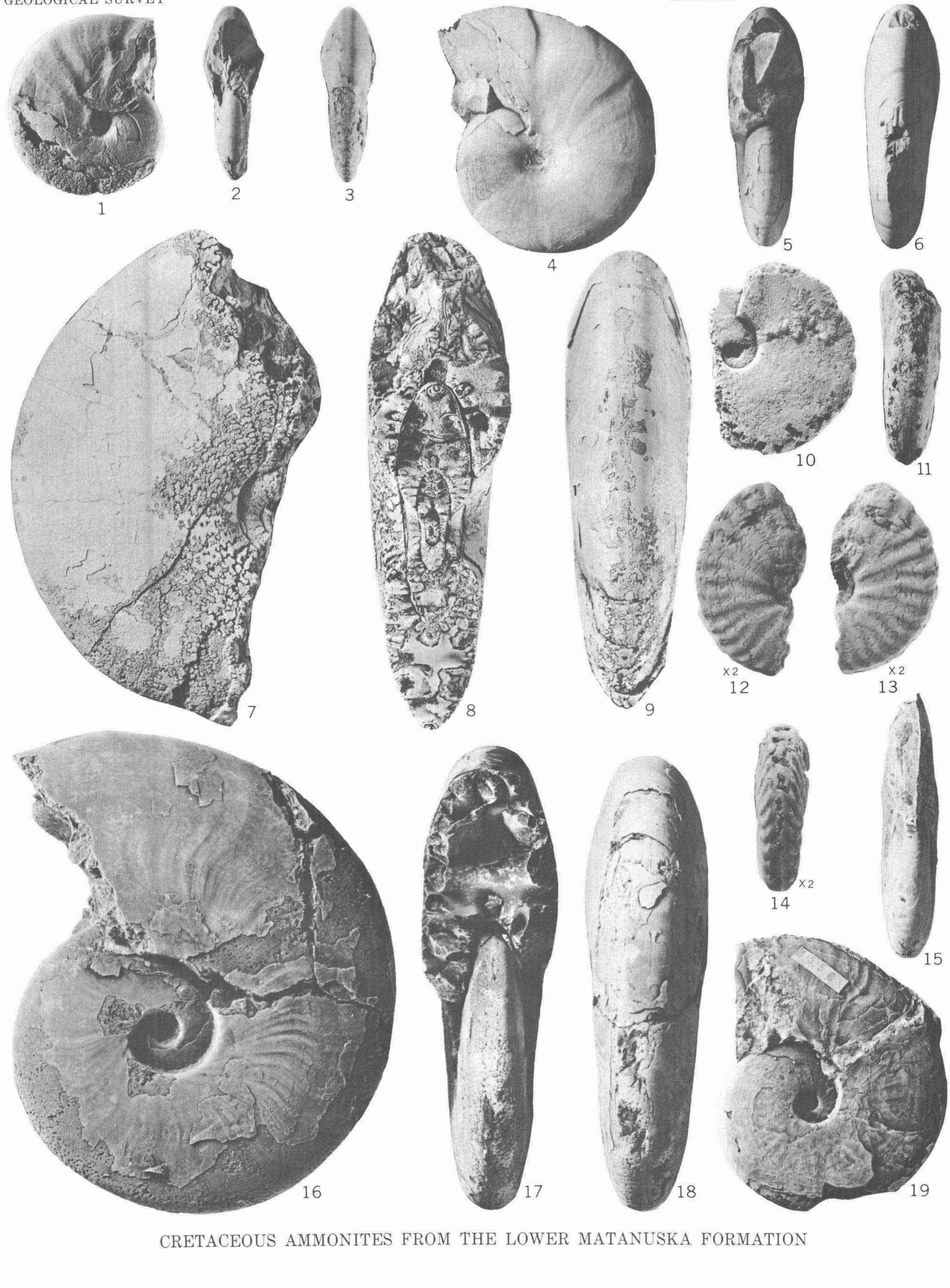
Side and back views of plesiotype USNM 132141 from USGS Mesozoic loc. M1795; found on top of mud cone in Copper River Basin. $\times 2$.



CRETACEOUS AMMONITES FROM THE LOWER MATANUSKA FORMATION

PLATE 7

[Figures natural size except as indicated. All specimens from USGS Mesozoic loc. M556]

FIGURES 1–25. *Freboldiceras singulare* Imlay (p. 37).

1–2. Side, front, and back views of USNM 132116 showing smooth inner whorls and first appearance of ribs on flank. × 2.

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7–9. Side, front, and back views of USNM 132118 showing faint secondary ribs on outer flank and venter.

10–12. Side, front, and back views of USNM 132119 showing secondary ribs on early part of whorl and normal "*Freboldiceras*" type of umbilical swellings on later part of whorl.

13–15. Side, front, and back views of USNM 132120.

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21–23. Side and back views of USNM 132123. Coarsely ribbed variant showing tendency of primary ribs to bifurcate to produce secondary ribs of *Arcthoplites*-type.

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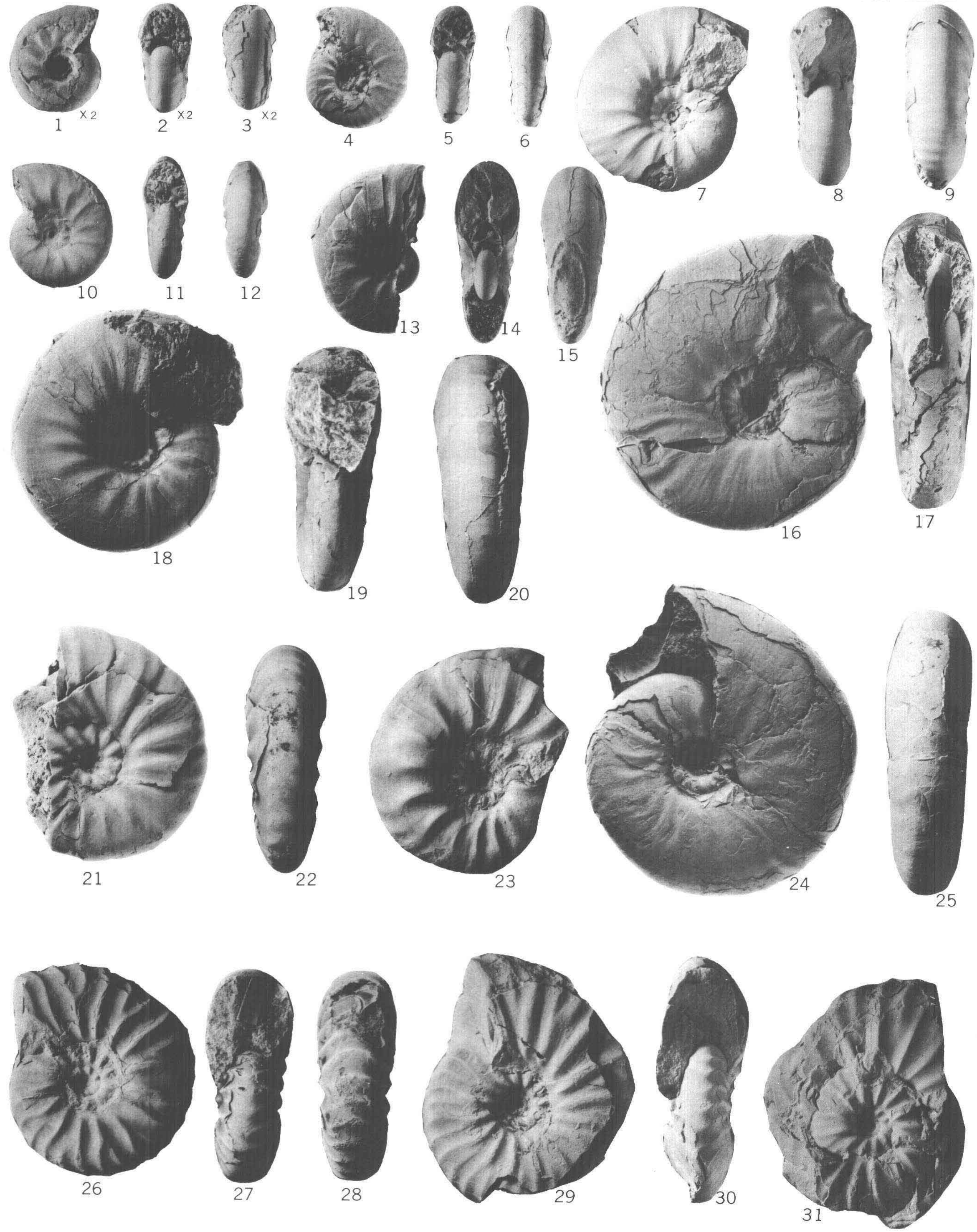
29–31. Side and front views of USNM 132125. A more compressed form with ribs branching lower on flanks.



CRETACEOUS AMMONITES FROM THE LOWER MATANUSKA FORMATION

PLATE 8

[All figures natural size. All specimens from USGS Mesozoic loc. M556]

FIGURES 1–18. *Arcthoplites talkeetnanus* (Imlay) (p. 39).

1–3. Side and front views of USNM 132126 showing rapid disappearance of ribbing.

4–6. Side, front, and back views of USNM 132127.

7–9. Side, front, and back views of USNM 132128. Variant with two secondary ribs intercalated between primary ribs on outer flank.

10–12. Side, front, and back views of USNM 132129.

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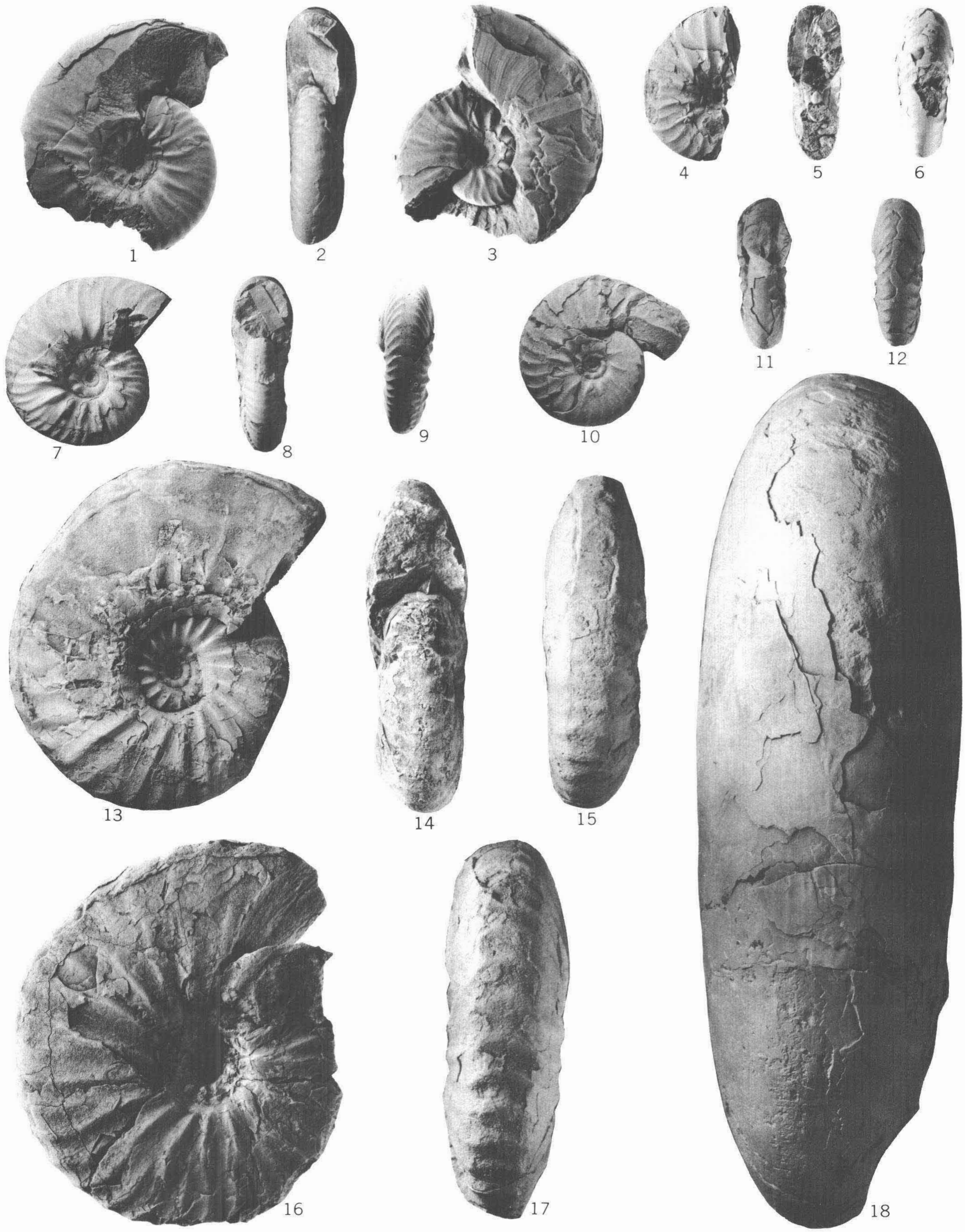
18. Back view, USNM 132130c.

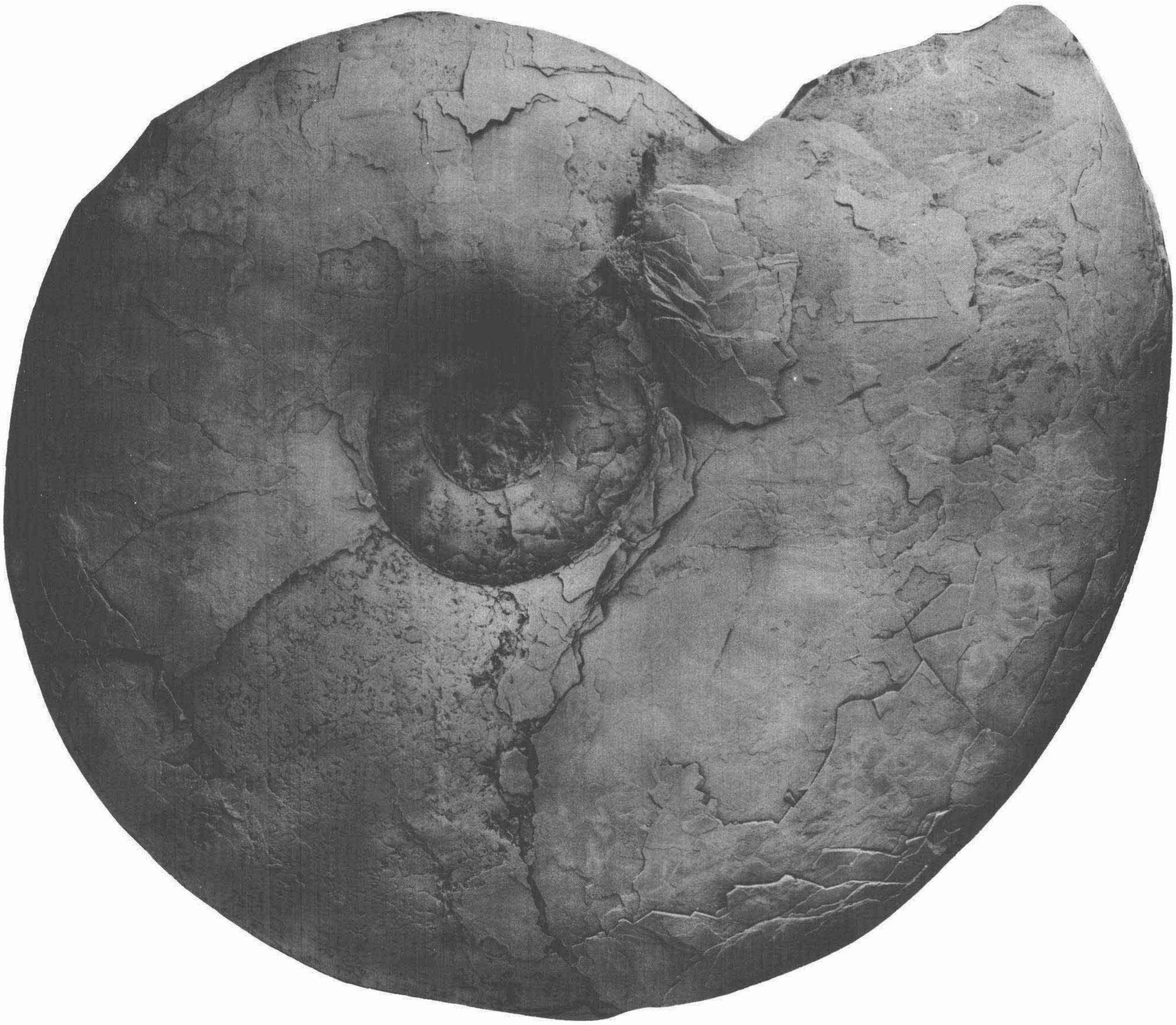


CRETACEOUS AMMONITES FROM THE LOWER MATANUSKA FORMATION

PLATE 9

[All figures natural size]

FIGURES 1–2. *Arcthoplites talkeetnanus* (Imlay) (p. 39).
Side and front views of USNM 132130c showing disappearance of ribbing at large diameter.



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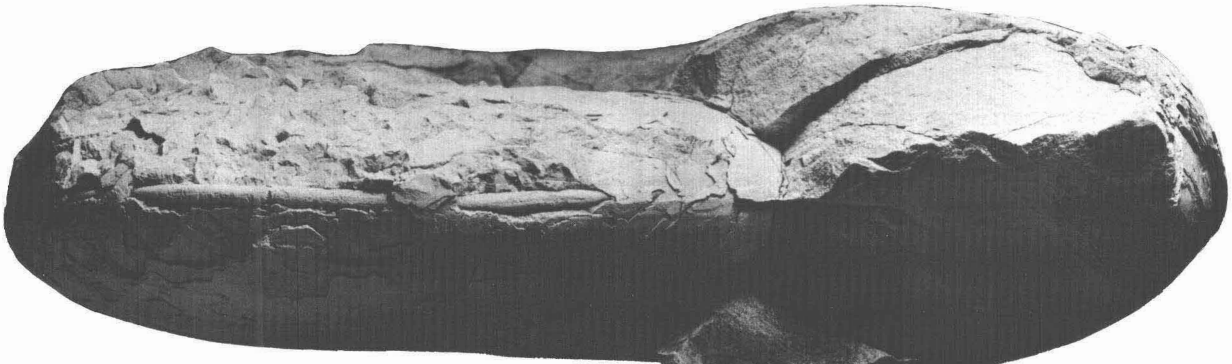

2

CRETACEOUS AMMONITES FROM THE LOWER MATANUSKA FORMATION