Early Triassic (Smithian) Ammonites of Paleoequatorial Affinity from the Chulitna Terrane, South-central Alaska

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GEOLOGICAL SURVEY PROFESSIONAL PAPER 1121-B

U.S. DEPARTMENT OF THE INTERIOR
March 3, 1849

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Early Triassic (Smithian) Ammonites of Paleoequatorial Affinity from the Chulitna Terrane, South-Central Alaska

By K. M. NICHOLS *and* N. J. SILBERLING

GEOLOGIC FRAMEWORK OF THE UPPER CHULITNA DISTRICT, ALASKA

GEOLOGICAL SURVEY PROFESSIONAL PAPER 1121-B

Documentation of an equatorial fauna interpreted
to have been tectonically displaced northward

U.S. DEPARTMENT OF THE INTERIOR
March 3, 1849

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EARLY TRIASSIC (SMITHIAN) AMMONITES OF PALEOEQUATORIAL AFFINITY FROM THE CHULITNA TERRANE, SOUTH-CENTRAL ALASKA

By K. M. Nichols and N. J. Silberling

ABSTRACT

Lower Triassic limestone is part of the unique stratigraphic succession of the Chulitna terrane. This terrane is believed to be a greatly displaced lithosphere fragment whose exposures are limited to a 400 km^2 area on the south flank of the central Alaska Range in Alaska. The nearest known correlative Lower Triassic marine strata are located hundreds of kilometers distant in northern Alaska and northwestern British Columbia; in general, they are not represented elsewhere among the oceanic-volcanic pre-Tertiary sequences of the entire circumpacific margin.

Ammonites are the dominant megafossils in the Lower Triassic limestone of the Chulitna terrane and are represented in a single bed by 13 identifiable species assigned to 13 genera, of which *Meekoceras, Dieneroceras, Arctoceras,* and *Paranannites* are the most abundant.

Ammonites in the Chulitna fauna are entirely of species previously described from the western conterminous United States from rocks of early Smithian age that were deposited along the margin of the North American craton at paleolatitudes of about 10° north. The Chulitna fauna is much less similar to faunas of this age from localities in western Canada and the North American arctic, representing paleolatitudes greater than 20° north. Moreover, remnants of the original marine carbonate cement in the ammonite-bearing rock are acicular and evidently formed in warm water; their presence may indicate that the Lower Triassic limestone and associated rocks of the Chulitna terrane were tectonically transported from a site much farther south than their present location.

INTRODUCTION

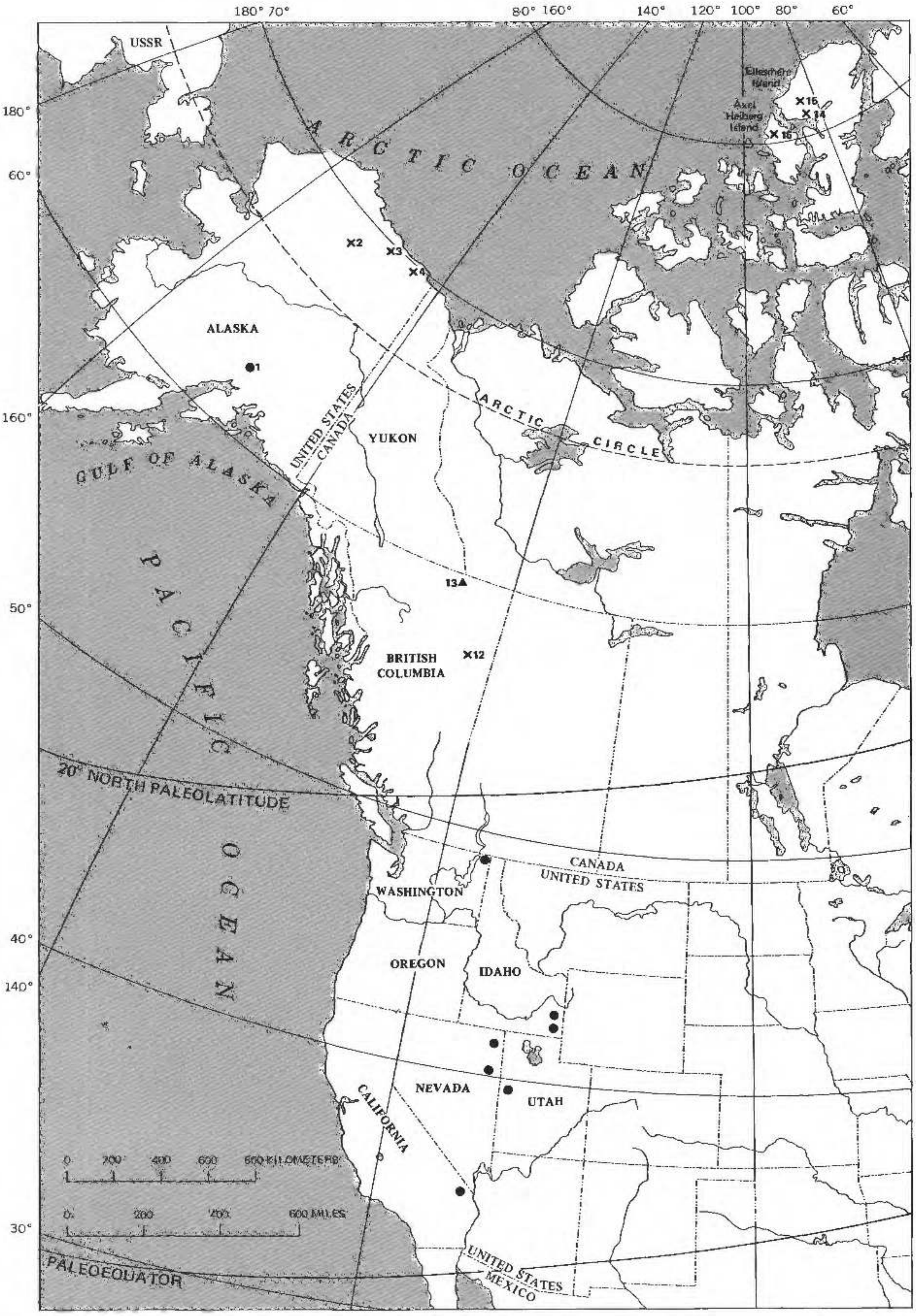
The Chulitna terrane (Jones and others, 1979) is characterized by a distinctive assemblage of depositionally or tectonically related Paleozoic and Mesozoic rocks. Its exposures are limited to a belt less than 10 km wide and 50 km long in the Upper Chulitna district on the south flank of the central Alaska Range, about 50–75 km east of Mt. McKinley. Despite the limited outcrop area of the terrane, pre-Cretaceous rocks included in it are in strong lithologic contrast with correlatives in adjacent and nearby terranes, and some parts of the Chulitna terrane have no parallel in Alaska. Jones and others (1979) infer that the Chulitna terrane is a tectonic fragment of a lithosphere plate that formed at a great distance from its present site and has been displaced generally northward.

One of the most unusual features of the Chulitna terrane is the occurence in it of fossiliferous marine Lower Triassic limestone. Other exposures of correlative marine rocks in North America are limited to settings well inland along the miogeoclinal western and northern edges of the craton. The closest known marine Lower Triassic strata are in northern Alaska and northeastern British Columbia (fig. 1). Both of these regions are at least hundreds of kilometers distant and are separated from the Upper Chulitna district by vast tracts whose complex and varied geology manifests large-scale tectonic displacements.

The purpose of this paper is to document the age of the marine Lower Triassic rocks of the Chulitna terrane on the basis of their ammonite fauna. In addition, the taxonomic character of this fauna is compared with that of other correlative faunas from North America to show that its affinities are with paleogeographically equatorial faunas.

OCCURRENCE

The ammonite-rich Lower Triassic limestone of the Chulitna terrane is known only from three small isolated exposures. One of these (USGS Mesozoic loc. M5027), which is locality 20 of Silberling and others (1978) and of Jones and others (1979, pl. 1), was discovered by Hawley and Clark (1974, pl. 1, loc. 6). Ammonites originally collected from this locality were discussed briefly by Silberling (in Hawley and Clark, 1974, p. B4–B5). This report is based on extensive new collections made in 1976 from this locality, which is a single, steeply dipping bed about 20 cm thick that was exposed for 2–3 m along strike in a bulldozer cut before being quarried away at the surface during collecting. This bed is in the middle part of about 10 m of stratigraphic section represented by scattered, partly artificial exposures of limestone. Nearby outcrops are of basalt and conglomeratic red beds whose age is interpreted as Late Triassic, more Lower Triassic limestone, and fine-grained clastic rocks of probable Permian age.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UNITED STATES
MEXICO
PALEOEQUATOR

Relations of these various rocks, which are cut by numerous faults, to the ammonite-bearing Lower Triassic limestone are obscured by poor exposure.

Another exposure of these Lower Triassic rocks, discovered in 1977, is about 2 km west-southwest, at locality 19 of Silberling and others (1978) and of Jones and others (1979, pl. 1). Here, several of the same distinctive species of Smithian ammonites were collected from limestone whose exposed thickness is only about 1 m. A short distance uphill, across a covered interval, is a massive basalt flow about 10 m thick overlain by red conglomeratic sandstone lithologically similiar to that associated with fossiliferous Upper Triassic red beds elsewhere in the Chulitna terrane. On strike with this locality, about 200 m farther south, the Lower Triassic limestone reappears. Here, the Smithian ammonite fauna is poorly preserved, but the unconformable relation between the Lower Triassic and the overlying Upper Triassic red beds and associated basalt flows is better exhibited, as described in Jones and others (1979). None of the ammonites from these additional Lower Triassic localities represents any species different from those known previously from USGS Mesozoic locality M5027. Consequently, all of the ammonites treated in the present study are from locality M5027, a geographic description of which is:

U.S. Geological Survey Healy A–6 quadrangle; south flank of Alaska Range; Upper Chulitna district; Golden Zone mine area, about 2½ km south of West Fork of Chulitna River; 13.19 km N. 25.0° E. from VABM 5048 (Copeland); lat. 63° 13.2′ N., long. 149° 38.9′ W.

◀ FIGURE 1. Location of documented lower Smithian ammonite localities in North America. Localities marked by • denote faunas of equatorial paleolatitude affinity while those marked by × denote faunas of northern paleolatitude affinity. Faunal locality 13, marked by a triangle, is dominated by the pelecypod *Posidonia mimer*, which is interpreted by others to indicate northern paleolatitudes. The equator and the 20° N. latitude line of Early Triassic time are after Van der Voo and French (1974). Localities numbered on the map are as follows:

1. Upper Chulitna district, Alaska (Clark and others, 1972; Hawley and Clark, 1974; this report).
2. Atigun Gorge, Alaska (USGS Mesozoic loc. M2194).
3. Lupine River, Alaska (USGS Mesozoic loc. M2214).
4. Fire Creek, Alaska (USGS Mesozoic loc. M6050).
5. Inyo Mountains, California (Hyatt and Smith, 1905; Smith, 1932).
6. Confusion Range, Utah (Hose and Repenning, 1959).
7. Phelan Ranch, Elko County, Nevada (Smith, 1932).
8. Crittenden Spring, Nevada (Kummel and Steele, 1962).
9. Bear Lake County, Idaho (White, 1880; Smith, 1932).
10. Caribou County, Idaho (White, 1880; Smith, 1932).
11. Kelly Hill, Washington (Kuenzi, 1965).
12. Halfway River, British Columbia, Canada (Tozer, 1963, 1967, written commun., 1974).
13. Liard River, British Columbia, Canada (Tozer, 1967, written commun., 1974).
14. Smith Creek and Hare Fiord, Ellesmere Island, Arctic Canada (Tozer, 1961, 1967, written commun., 1974).
15. Lindström Creek, Ellesmere Island, Arctic Canada (Tozer, 1961, 1967, written commun., 1974).
16. Bunde Fiord, Axel Heiberg Island (Tozer, 1965, 1967, written commun., 1974).

NATURE OF FAUNA

Megafossils from locality M5027, as well as those in the small collections made from the two additional localities discussed above, are all cephalopods and bivalves. The exposures of Lower Triassic limestone in general contain only these kinds of megafossils except that some beds, other than the one containing the ammonite fauna, are largely composed of crinoid columnals. Within the ammonite-bearing bed the only abundant bivalve fossils are small shells of a *Posidonia*-like pectenacid (misidentified by Silberling in Hawley and Clark, 1974, p. B6, as *P. mimer* Oeberg). Mytilacid and aviculopectinid bivalves are represented by only a few specimens.

Aside from large orthoconic nautiloids, all the cephalopods are ammonites which are assigned to an indeterminate species of *Pseudosageceras* and to the following 13 nominal species:

Xenoceltites intermontanus (Smith)
Meekoceras gracilitatis White
Wyomingites aplanatus (White)
Dieneroceras knechti (Hyatt and Smith)
Euflemingites cirratus (White)
Arctoceras tuberculatum (Smith)
Juvenites septentrionalis Smith
Paranannites aspenensis Hyatt and Smith
P. slossi (Kummel and Steele)
Owenites cf. *O. koeneni* Hyatt and Smith
Metussuria waageni (Hyatt and Smith)
Lanceolites compactus Hyatt and Smith
Aspenites acutus Hyatt and Smith

Of these ammonites, the species of *Meekoceras*, *Dieneroceras*, *Euflemingites*, *Arctoceras*, and *Paranannites* are most abundant; several of the other species listed are represented only by a single specimen. The total species diversity is about that to be expected from exhaustive sampling of ammonites from a single bed at one place (Tozer, 1971, p. 997).

All the ammonite species identified from locality M5027 are known only from strata of early Smithian age within the Lower Triassic.

PALEOGEOGRAPHIC INTERPRETATION

It is of particular importance for paleogeographic interpretation that the species of Lower Triassic ammonites from the Chulitna terrane are entirely the same as those known from the western conterminous United States; few of them are known from correlative faunas at northern latitudes comparable to that of the Alaskan locality. These relations are detailed in table 1, wherein comparison is made with other lower Smithian ammonite faunas from localities scattered north and south along the western and arctic margin of the North American craton. These localities are grouped into those representing equatorial paleolatitudes (less than 20° north) and northern paleolatitudes (more than 20° north). For most of them, their geologic settings assure that they have not been tectonically transported beyond these groupings. The fauna of the Chulitna terrane is compared with the total number of seemingly valid early Smithian genera and species in each of these two latitudinally separate regions. This procedure is used because the actual diversity at all possible levels within the lower Smithian for the entire western and northern margin of the North American craton cannot be known, whereas the diversity of the Chulitna-terrane fauna is known from a single 20-cm-thick bed.

The similarity of the ammonite fauna from the Chulitna terrane with that of the western conterminous United States and its lack of close affinity with that of northern North America are striking. An ammonite-bearing bed exactly like that at locality M5027 in its taxonomic makeup would not be out of place in northeastern Nevada or southeastern Idaho.

Assuming that the faunas on which figure 1 and table 1 are based represent, for both the high and low paleolatitude groups, a random sample for all different levels within the lower Smithian substage, the overall taxonomic diversity for the northern group seems to be significantly lower (by a factor of 0.5 or less) than that for the southern group. This finding matches that of Kummel (1973), who concludes that temperature is probably the primary controlling factor for this diversity pattern. The diversity of the Chulitna fauna from a single bed at one outcrop is about as great as the total known diversity for the entire early Smithian subage in high paleolatitudes of North America. This diversity alone is sufficient to suggest an origin at a relatively low paleolatitude.

TABLE 1.—*Comparison of the lower Smithian ammonoid fauna from the Chulitna terrane with ammonoid faunas of the same age from other parts of North America*

	Species	Genera
Number of taxa identified in Chulitna terrane	13	13
Taxa from Chulitna also recognized elsewhere:		
In equatorial faunas[1]	13	13
In northern faunas[2]	2	7
Total number of taxa recognized:		
In equatorial faunas[1]	41	24
In northern faunas[2]	17	12

[1] Faunas from localities near the paleoequator of Early Triassic time, shown as localities 5–11 on fig. 1.

[2] Faunas from localities north of paleolatitude 20° N. of Early Triassic time, shown as localities 2–4 and 12–16 on fig. 1.

Some extension of warm water temperatures into relatively high paleolatitudes in the Pacific basin may have resulted from the particular configuration of oceans and continents during Triassic time as modeled by Donn and Shaw (1977). However, in terms of its taxonomic composition and diversity, the Chulitna-terrane fauna is still more southern in its character than the correlative fauna from northeastern British Columbia, which represents a paleolatitude appreciably lower than that of the present site of the Chulitna terrane in Alaska.

Petrographic examination of the ammonite-bearing bed at locality M5027 in the Upper Chulitna district reveals a distinctive early diagenesis that also suggests an origin in the relatively warm marine waters of low paleogeographic latitudes. Although the original carbonate fabrics of these rocks have been altered to a neomorphic mosaic of medium-crystalline equant calcite, and some of the carbonate has been replaced by silica, local intracrystalline impurities preserve ghosts of an original isopachous acicular carbonate cement (fig. 2). Water from which this cement crystallized was evidently as rich in magnesium as normal marine water and sufficiently warm to have had a relatively high crystallization rate with respect to calcium carbonate. (For example, see Folk, 1973.) Geologically young examples of this kind of carbonate cement are found only at modern-day equatorial latitudes.

On the basis of (1) the overall diversity of its ammonite fauna, (2) the taxonomic comparison of its ammonite fauna with other correlative faunas from known paleolatitudes in North America, and (3) its petrographic character, the Lower Triassic limestone of the Chulitna terrane supports the interpretation that this terrane has been displaced from a site much farther south than its present location.

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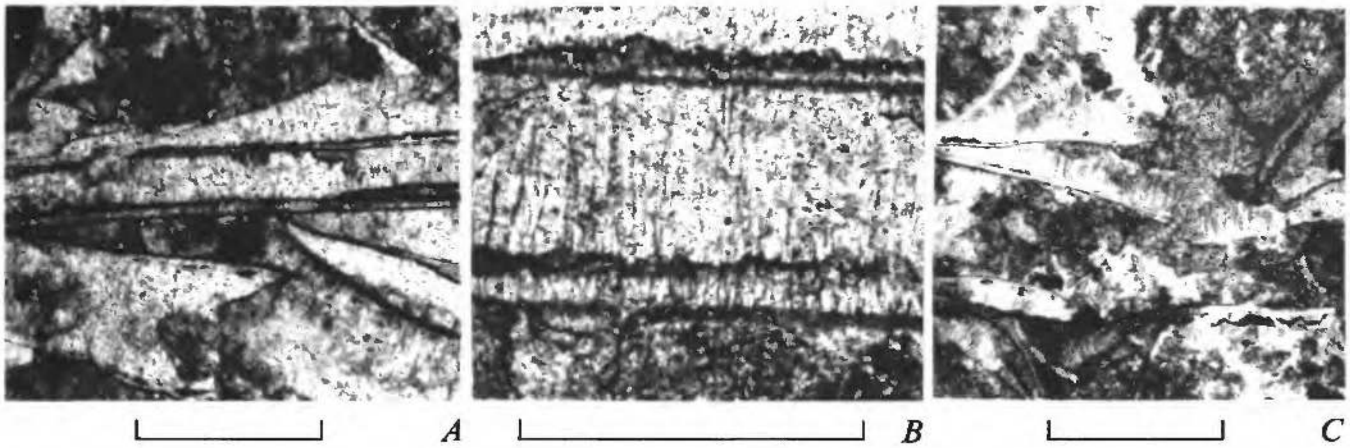

FIGURE 2.—Photomicrographs of limestone from USGS Mesozoic locality M5027, Chulitna district, Alaska. Bar scale = 0.50 mm. *A*, Neomorphosed skeletal grainstone with geopetal patches of pelletal micrite. Skeletal fragments are thin-shelled bivalves and ammonites, the outlines of which are preserved as very thin lines of impurities. Shells have been rimmed by two or more generations of intergranular acicular carbonate cement. *B*, Magnification of *A* showing two or more generations of fibrous calcite cement. A thin band of first-generation cement is adjacent to the shell fragments. This cement is separated by a fuzzy line of dark impurities from a subsequent thicker band of cement. *C*, Neomorphosed skeletal grainstone with very thin molluscan shell fragments cemented by intergranular acicular carbonate cement. The calcite cement has been partially replaced by length-fast fibrous chalcedony.

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PLATES 1–3

Contact photographs of the plates in this report are available, at cost, from U.S. Geological Survey Library, Federal Center, Denver, Colorado 80225

PLATE 1

[All figures natural size unless otherwise indicated]

Lower Triassic (Smithian) ammonites from USGS Mesozoic locality M5027, Upper Chulitna district, Alaska.

FIGURES 1–4. *Meekoceras gracilitatis* White.
  - 1–2. USNM 248596.
  - 3. USNM 248597.
  - 4. Suture line (×4) of USNM 248597.

5–9. *Arctoceras tuberculatum* (Smith).
  - 5–6. USNM 248598.
  - 7. Suture line (×5) of USNM 248598.
  - 8–9. USNM 248599.

10–11. *Aspenites*? cf. *A. acutus* Hyatt and Smith. USNM 248602.

12–14. *Aspenites acutus* Hyatt and Smith.
  - 12–13. USNM 248603 (×2)
  - 14. Suture line (×10) of USNM 248603.

15–16. *Aspenites* cf. *A. acutus* Hyatt and Smith. USNM 248604 (Fig. 16 is a broken cross section).

17–18. *Owenites* cf. *O. koeneni* Hyatt and Smith.
  - 17. USNM 248605 (×2).
  - 18. Suture line (×10) of USNM 248605.

19–21. *Wyomingites aplanatus* (White).
  - 19–20. USNM 248608.
  - 21. Suture line (×12) of USNM 248608.

22–26. *Dieneroceras knechti* (Hyatt and Smith).
  - 22–23. USNM 248600.
  - 24. Suture line (×5) of USNM 248600.
  - 25–26. USNM 248601.

27–29. *Xenoceltites* sp.
  - 27–28. USNM 248607.
  - 29. Suture line (×8) of USNM 248607.

30–32. *Xenoceltites intermontanus* (Smith).
  - 30–31. USNM 248606.
  - 32. Suture line (×9) of USNM 248606.


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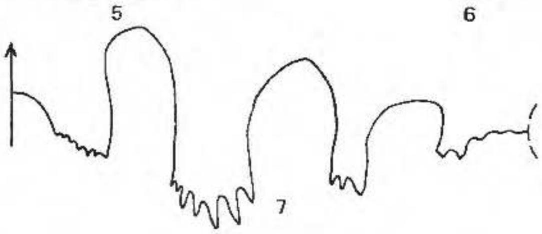
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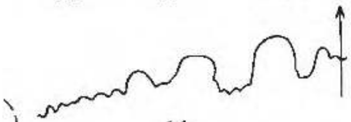
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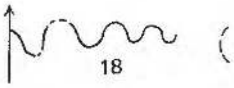
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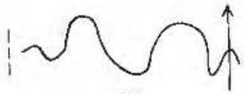
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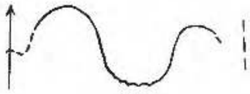
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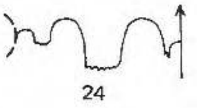
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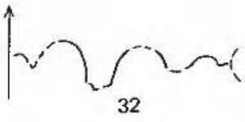
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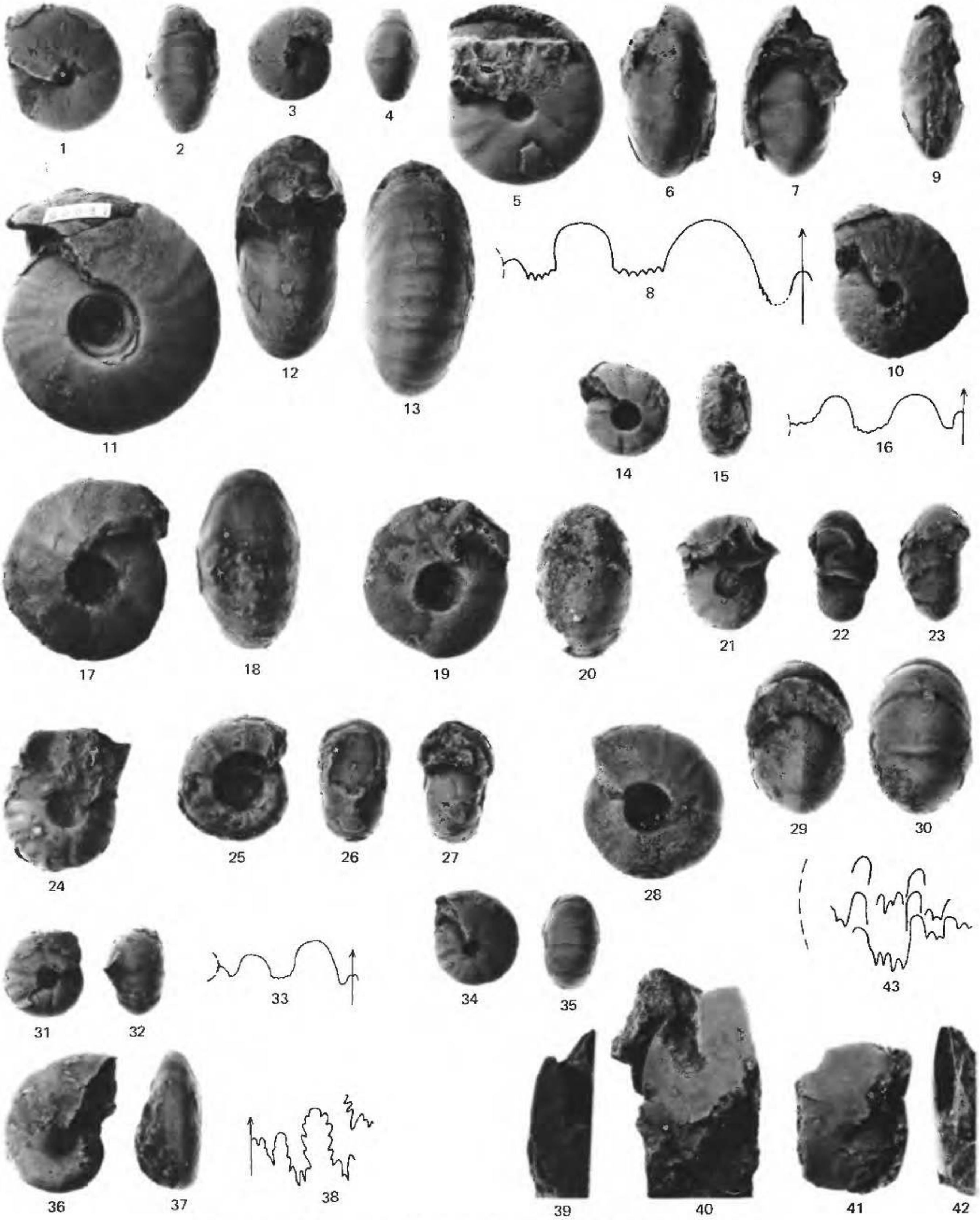
MEEKOCERAS, ARCTOCERAS, DIENEROCERAS, ASPENITES, OWENITES, XENOCELTITES, AND *WYOMINGITES*

PLATE 2

[All figures natural size]

Lower Triassic (Smithian) ammonites from USGS Mesozoic locality M5027, Upper Chulitna district, Alaska.

FIGURES 1–10. *Parannannites aspenensis* Hyatt and Smith.
1–2. USNM 248612.
3–4. USNM 248613.
5–7. USNM 248614.
8. Suture line (×7) of USNM 248614.
9–10. USNM 248615.
11–13. *Paranannites* sp. USNM 248616.
14–24. *Juvenites septentrionalis* Smith
14–15. USNM 248621.
16. Suture line (×8) of USNM 248621.
17–18. USNM 248617.
19–20. USNM 248618.
21–23. USNM 248620.
24. USNM 248619.
25–30. *Juvenites sp.*
25–27. USNM 248622.
28–30. USNM 248623.
31–35. *Paranannites slossi* (Kummel and Steele).
31–32. USNM 248624.
33. Suture line (×9) of USNM 248624.
34–35. USNM 248625.
36–38. *Metussuria waageni* (Hyatt and Smith).
36–37. USNM 248609.
38. Suture line (×6) of USNM 248609.
39–42. *Lanceolites compactus* Hyatt and Smith.
39–40. USNM 248611.
41–42. USNM 248610
43. Suture line (×3) of USNM 248610.



PARANANNITES, METUSSURIA, LANCEOLITES, AND *JUVENITES*

PLATE 3

[All figures natural size]

Lower Triassic (Smithian) ammonites from USGS Mesozoic locality M5027, Upper Chulitna district, Alaska.

FIGURES 1–4. *Euflemingites cirratus* (White).
- 1. USNM 248628.
- 2. USNM 248627.
- 3. USNM 248626.
- 4. Suture line (×10) of USNM 248626.

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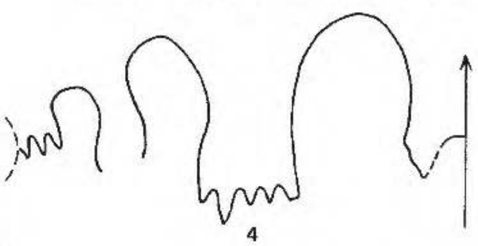

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