

Fossils, Lithologies, and Geophysical Logs of the Mancos Shale from Core Hole USGS CL-1 in Montrose County, Colorado



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Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
inch (in)	0.3937	centimeter (cm)
inch (in)	0.03937	millimeter (mm)
foot (ft)	3.281	meter (m)
mile (mi)	0.6214	kilometer (km)
yard (yd)	1.094	meter (m)

Altitude, as used in this report, refers to distance above sea level.

Fossils, Lithologies, and Geophysical Logs of the Mancos Shale from Core Hole USGS CL-1 in Montrose County, Colorado

By Bridget A. Ball, W.A. Cobban, E.A. Merewether, R.I. Grauch, K.C. McKinney, and K.E. Livo

Abstract

As part of a multidisciplinary investigation of Mancos Shale landscapes in the Gunnison Gorge National Conservation Area in Delta and Montrose Counties of western Colorado by the U.S. Geological Survey, Bureau of Land Management, and Bureau of Reclamation, a core of the Upper Cretaceous Mancos Shale was obtained from a borehole, USGS CL-1, in NE1/4 sec. 8, T. 50 N., R. 9 W. (approximately lat 38.61717° N., long 107.90174° W.), near the town of Olathe. Geophysical records of the borehole include resistivity, gamma ray, and density logs. The core extends between depths of 20 and 557 ft and is about 2.5 in. in diameter. It is composed of calcareous silty shale, as well as scattered beds of limestone and bentonite which were deposited mainly in offshore marine environments during the Cenomanian, Turonian, and Coniacian Stages of the Cretaceous Series. The strata were sampled and analyzed to obtain geochemical data and to identify constituent fossils.

Stratigraphic units within the Mancos in the core include the following members, in ascending order: Bridge Creek Limestone (part), Fairport, Blue Hill, Juana Lopez, Montezuma Valley, and Niobrara (part). Strata herein assigned to the Bridge Creek Limestone are about 18 ft thick and consist of silty shale that contains ammonites, bivalves, and a coral of Late Cenomanian age. Strata assigned to the Fairport are about 22 ft thick and composed mainly of calcarenite-bearing, calcareous shale. Fossils in this member include ammonites and bivalves of early middle Turonian age. Overlying the Fairport is the Blue Hill Member, which is about 139 ft thick, and consists of glauconitic, shaley siltstone, and less silty shale. The Juana Lopez Member, overlying the Blue Hill, is about 138 ft thick and composed mainly of calcarenitic, silty shale. Beds in this member contain ammonites and bivalves of late middle and early late Turonian ages. Overlying the Juana Lopez is the Montezuma Valley Member, which is about 55 ft thick and consists of calcarenitic, calcareous silty shale. The Montezuma Valley Member contains ammonites and bivalves of late Turonian age. It is overlain by a lower part of the Niobrara Member of the Mancos Shale which is laterally equivalent to the Fort Hays Limestone Member and part of the overlying Smoky Hill Member of the Niobrara Formation at outcrops in central Colorado. Strata in the core comparable to the Fort Hays are about 39 ft thick and include shaley limestone and calcareous shale, which contain lower Coniacian bivalves. Strata in the core equivalent to part of the Smoky Hill are about 126 ft thick and consist mainly of calcareous silty shale which also contains lower Coniacian bivalves.

Introduction

A multidisciplinary investigation of landscapes in the Gunnison Gorge National Conservation Area (GGNCA) in Delta and Montrose Counties of west-central Colorado (fig. 1) was conducted by personnel of the U.S. Geological Survey (USGS), Bureau of Land Management (BLM), and Bureau of Reclamation (BOR). Chemical and physical properties of soils from trenches and from an extensive soil-sampling program on the GGNCA have been published in Tuttle and others (2007). A report concerning rainfall and erosion in the area has been provided by Elliott and others (2008). The investigation included drilling a hole, USGS CL-1, in NE1/4 sec. 8, T. 50 N., R. 9 W. (approximately lat 38.61717° N., long 107.90174° W.), near the town of Olathe, to obtain core of the Upper Cretaceous Mancos Shale. The main purpose of the present report is to locate, identify, and illustrate fossils found in the core.

The core (about 2 in. in diameter) spans depths between 20 and 557 ft and represents most of the Mancos Shale in that area. The lithologies, nomenclature, and correlations of strata in the core, as well as geophysical records of the borehole that include resistivity, gamma ray, and density logs, are presented in figures 2–4.

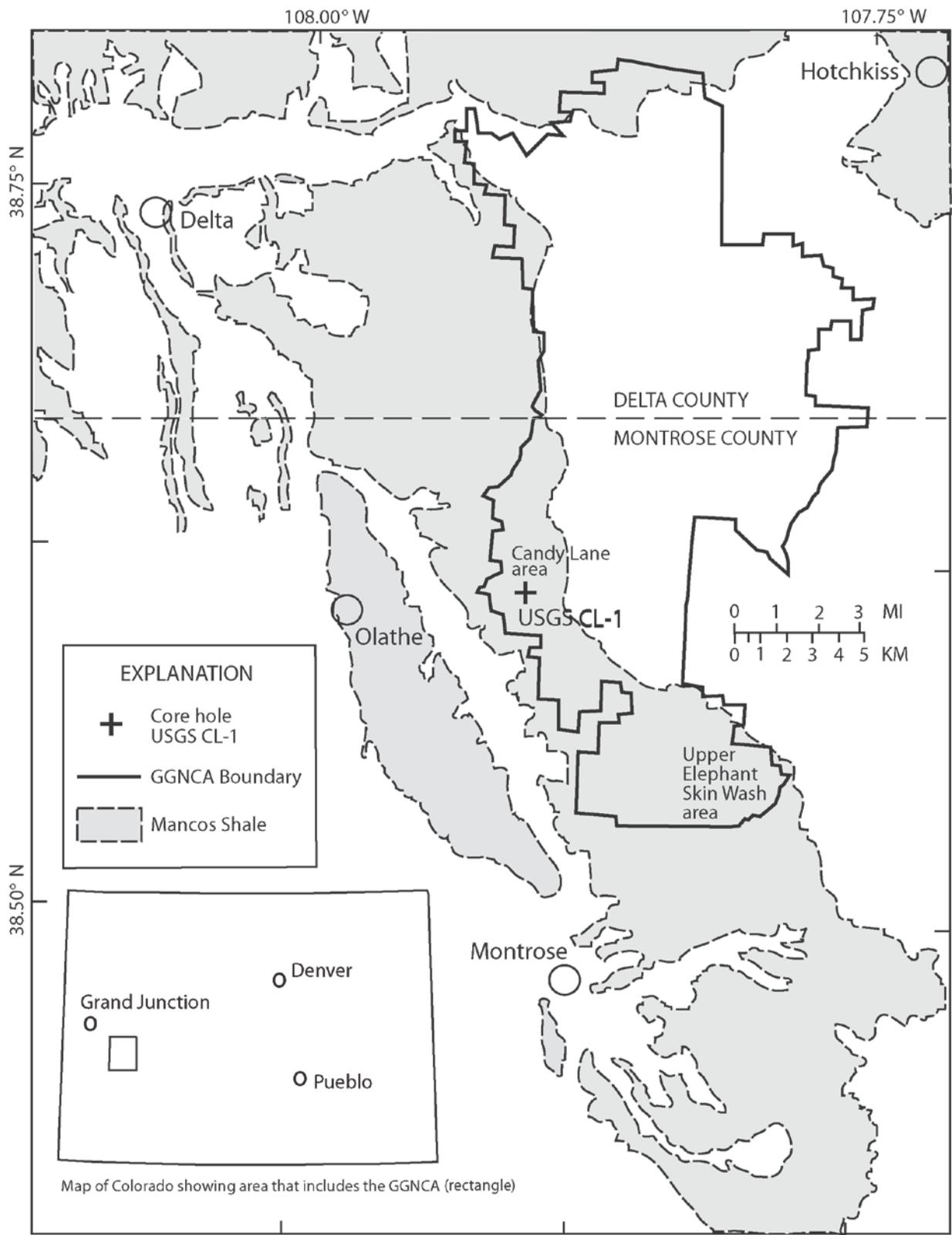


Figure 1. Map of area in west-central Colorado that includes the Gunnison Gorge National Conservation Area (GGNCA), outcrops of the Upper Cretaceous Mancos Shale, and the location of core hole USGS CL-1.

USGS CL-1 Core Hole, Montrose County, Colorado
 NE 1/4 sec. 8, T. 50 N., R. 9 W.
 lat 38.6172° N., long 107.9017° W.

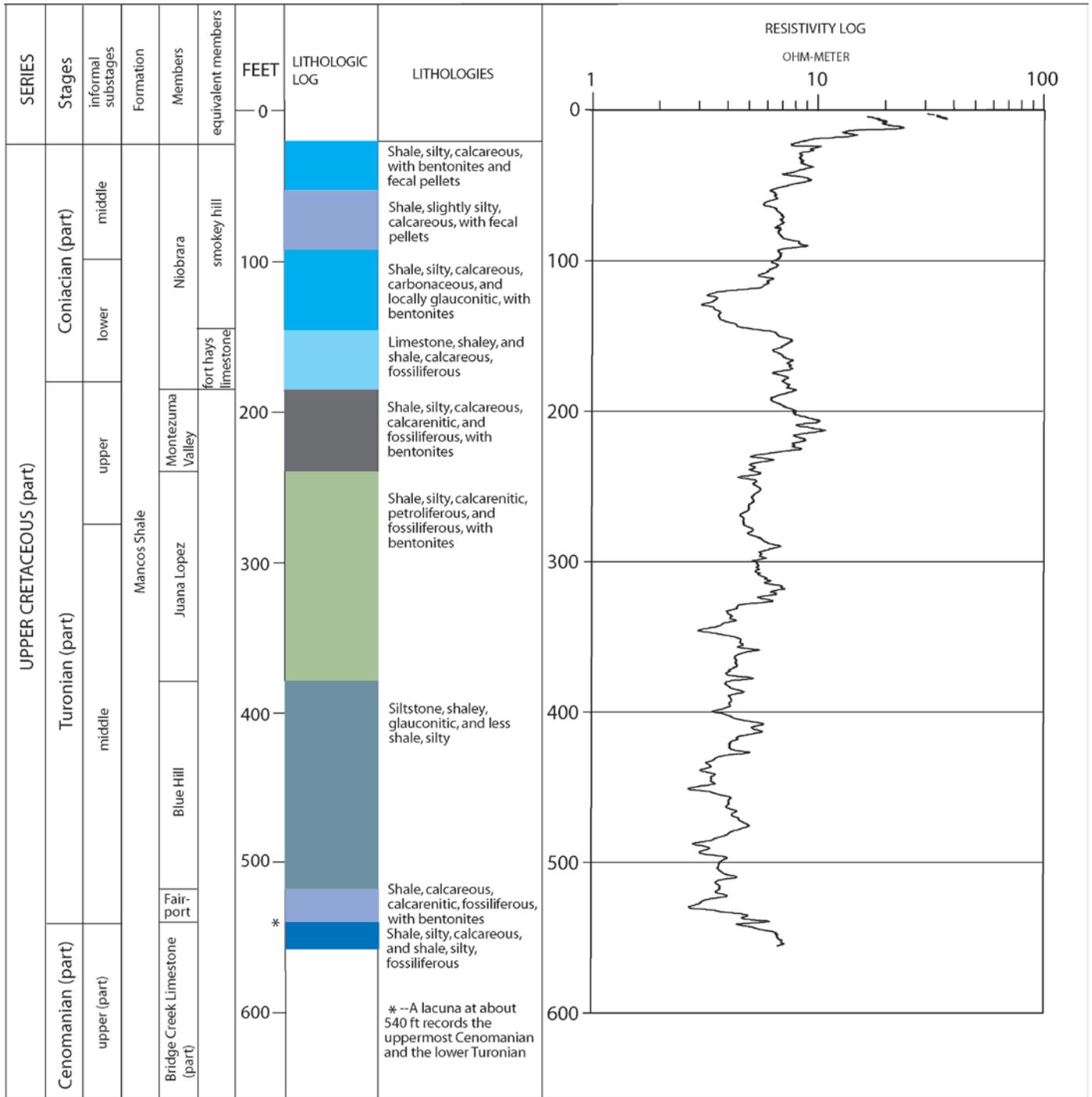


Figure 2. Lithology and resistivity log of part of the lower Upper Cretaceous Mancos Shale from core hole USGS CL-1 in Montrose County, Colorado.

USGS CL-1 Core hole, Montrose County, Colorado
 NE 1/4 sec. 8, T. 50 N., R. 9 W.
 lat 38.6172° N., long 107.9017° W.

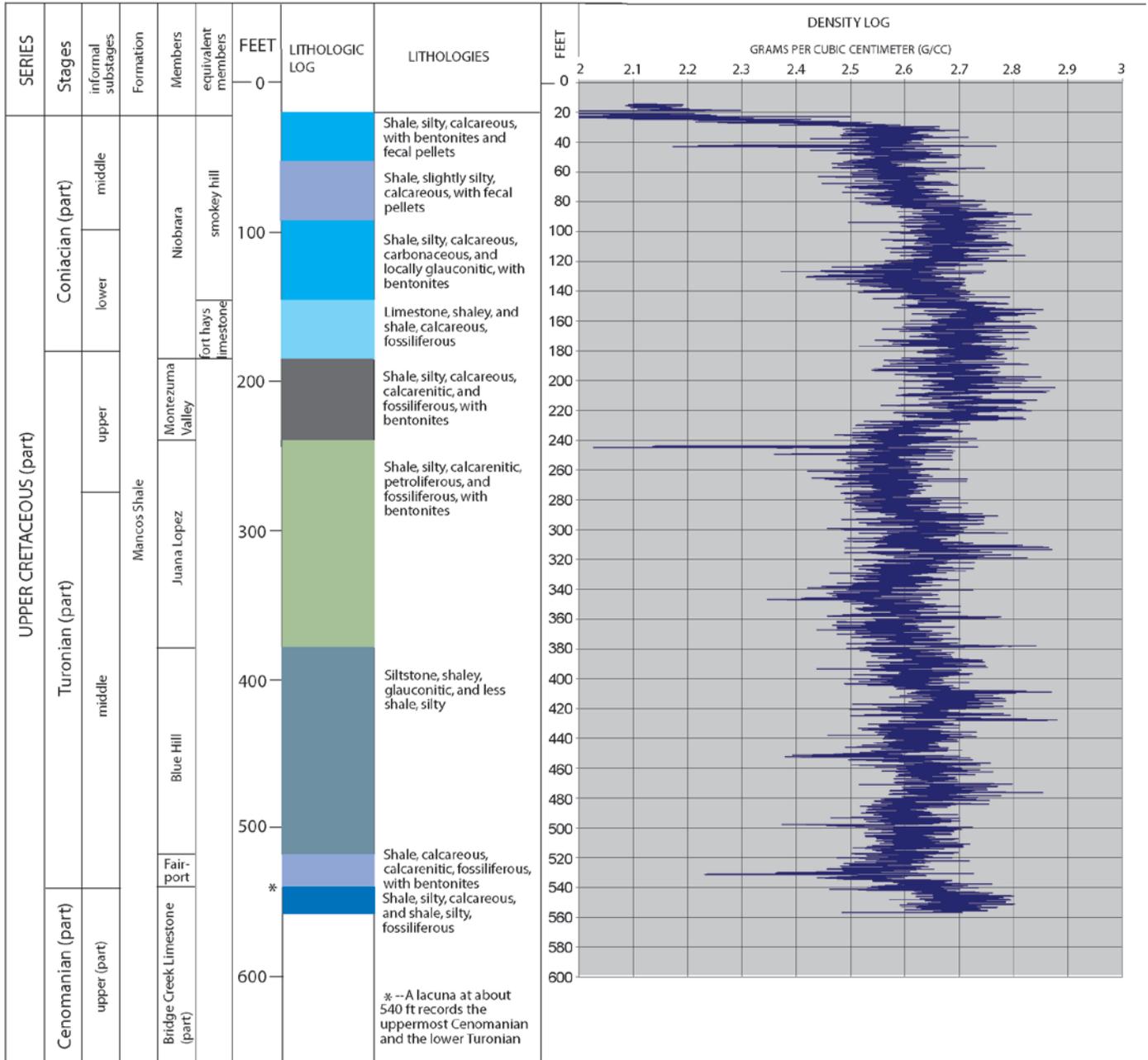


Figure 4. Lithology and density log of part of the lower Upper Cretaceous Mancos Shale from core hole USGS CL-1 in Montrose County, Colorado.

The Mancos Shale in this area is mostly calcareous silty shale, but it contains a few beds of limestone and scattered beds of bentonite. It was deposited mainly in offshore marine environments during Cenomanian, Turonian, and Coniacian Stages of the Upper Cretaceous.

These strata enclose a variety of molluscan fossils, mostly bivalves and ammonites (fig. 5), as well as a fossil coral and a shark tooth. In the core, fossils are abundant and most of them can be related to the molluscan fossil zones of Cobban and others (2006) (fig. 6). The fossils noted in the present report are not always listed in the zones of Cobban and others (2006) although their relationship to the zones has been established. They supplement the fossil record from several outcrops in the region (Leckie and others, 1997; Merewether and others, 2006; Merewether and others, 2007).

USGS CL-1 Core hole, Montrose County, Colorado
 NE 1/4 sec. 8, T. 50 N., R. 9 W.
 lat 38.6172° N., long 107.9017° W.

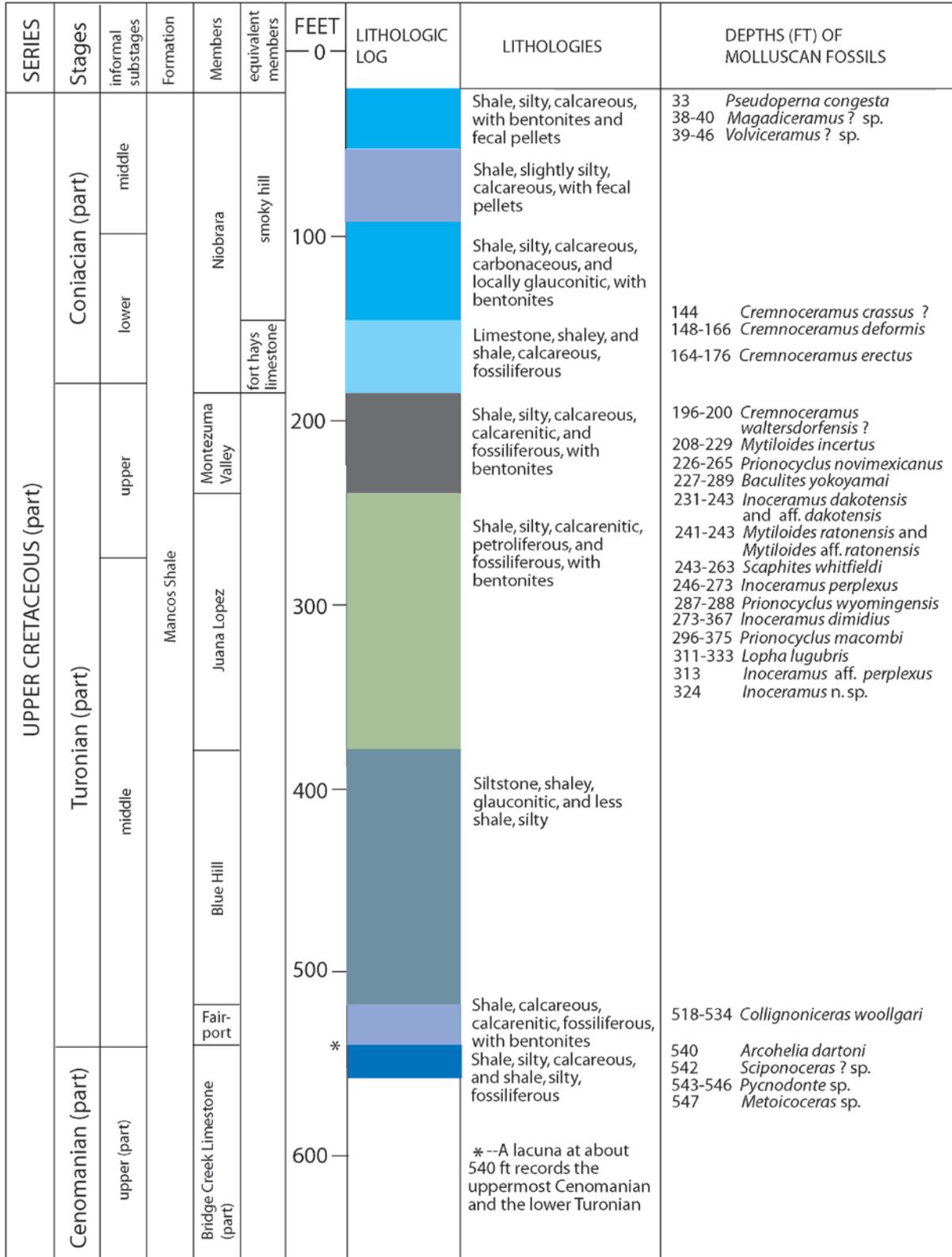


Figure 5. Lithology and constituent fossils of part of the lower Upper Cretaceous Mancos Shale from core hole USGS CL-1 in Montrose County, Colorado.

SERIES	Stages		Western Interior ammonite age spans and radiometric ages (MY)	Zone nos.	Western Interior inoceramid age spans
	Informal substages				
UPPER CRETACEOUS (part)	Santonian (part)	Lower	<i>Clioscapites saxitonianus</i>	45	<i>Cladoceramus undulatopticatus</i>
	Coniacian	Upper	<i>Scaphites depressus</i> 87.14 ± 0.39	44	<i>Magadiceramus crenelatus</i> <i>Magadiceramus subquadratus</i>
		Middle	<i>Scaphites ventricosus</i>	43	<i>Volviceramus involutus</i>
				42	<i>Volviceramus koeneni</i>
		Lower	88.55 ± 0.59	41	<i>Cremnoceramus crassus crassus</i> <i>Cremnoceramus crassus inconstans</i> <i>Cremnoceramus deformis dobrogensis</i> <i>Cremnoceramus deformis erectus</i>
			<i>Scaphites preventricosus</i>	40	
	Turonian	Upper	<i>Scaphites mariasensis</i>	38	<i>Cremnoceramus waltersdorfensis</i>
			<i>Prionocyclus germari</i>	37	<i>Mytiloides scupini</i>
			<i>Scaphites nigricollensis</i>	36	<i>Mytiloides incertus</i>
			<i>Scaphites whitfieldi</i>	35	<i>Inoceramus dakotensis</i>
				34	<i>Inoceramus perplexus</i>
		Middle	<i>Scaphites ferronensis</i>	33	<i>Inoceramus dimidius</i>
			<i>Scaphites warreni</i>	32	
			<i>Prionocyclus macombi</i> 90.60 ± 0.46	31	<i>Inoceramus howelli</i>
			<i>Prionocyclus hyatti</i> 92.46 ± 0.58	30	
			<i>Collignoniceramus praecox</i>	29	
		<i>Collignoniceramus woollgari</i>	28	<i>Mytiloides hercynicus</i> <i>Mytiloides subhercynicus</i>	
		Lower	<i>Mammites nodosoides</i>	27	<i>Mytiloides mytiloides</i>
			<i>Vascoceras birchbyi</i> 93.48 ± 0.58	26	<i>Mytiloides kossmati</i>
			<i>Pseudaspidoceras flexuosum</i> 93.19 ± 0.42	25	
			<i>Watinoceras devonense</i>	24	<i>Mytiloides puebloensis</i>
			23	<i>Mytiloides hattini</i>	
	Cenomanian	Upper	<i>Nigericeras scotti</i>	23	<i>Inoceramus pictus</i>
			<i>Neocardioceras juddii</i> 93.32 ± 0.38 93.82 ± 0.30	22	
			<i>Burroceras clydense</i>	21	
			<i>Euomphaloceras septemseriatum</i> 93.99 ± 0.57	20	
			<i>Vascoceras diartianum</i>	19	
			<i>Dunveganoceras conditum</i>	18	
			<i>Dunveganoceras albertense</i>	17	
		<i>Dunveganoceras problematicum</i>	16	<i>Inoceramus prefragilis</i>	
		<i>Dunveganoceras pondi</i> 94.71 ± 0.49	15		
		Middle	<i>Plesiacanthoceras wyomingense</i>	14	<i>Inoceramus rutherfordi</i>
			<i>Acanthoceras amphibolum</i> 94.96 ± 0.50	13	
<i>Acanthoceras bellense</i>			12	<i>Inoceramus arvanus</i>	
<i>Plesiacanthoceras muldoonense</i>			11	<i>Inoceramus eulessanus</i>	
<i>Acanthoceras granerosense</i>	10				
<i>Conlinoceras tarrantense</i> 95.73 ± 0.51	9				
	8				
	7	(Gap in biostratigraphic record)			
	6				
Lower	<i>Neogastrolites maclearni</i>	98.88 ± 0.35	5	<i>Inoceramus maclearni</i>	
	<i>Neogastrolites americanus</i>		4		
	<i>Neogastrolites muelleri</i>		3		
	<i>Neogastrolites cornutus</i>		2		
	<i>Neogastrolites haasi</i>		1		
	99.6 ± 0.9				

Figure 6. Molluscan fossil zones, informal zone numbers, fossil-ranges, and radiometric ages for marine strata of Cenomanian, Turonian, Coniacian, and Santonian Stages (Upper Cretaceous) in the Western Interior of the United States (Modified after Cobban and others, 2006). MY, millions of years.

Stratigraphy

Bridge Creek Limestone Member (part)

The core from depths of 541.5 to 557 ft (fig. 2) is medium-gray, calcareous, silty shale of the Bridge Creek Limestone Member. However, the lowermost 4 ft is much less calcareous and resembles the Graneros Shale in outcrops to the east. These beds are of late Cenomanian age (fig. 6) and contain the fossils *Metoicoceras* sp. at 546.5 ft (fig. 7), *Pycnodonte* sp. at 543 and 545.5 ft, and *Sciponoceras?* sp. at 541.5 ft (fig. 8). Between depths of 539 and 541.5 ft, the beds are medium-gray, non-silty calcareous shale and at 540 ft contain *Arcohelix dartoni* (fig. 9).



Figure 7. *Metoicoceras* sp. of late Cenomanian age (fig. 6, zones 16, 17) from the Bridge Creek Limestone Member of the Mancos Shale from a depth of 546.5 ft in core hole USGS CL-1, Montrose County, Colorado.



Figure 8. *Sciponoceras* ? sp. of late Cenomanian age (fig. 6, zones 19-21 from the Bridge Creek Limestone Member of the Mancos Shale from a depth of 541.5 ft in core hole USGS CL-1, Montrose County, Colorado.



Figure 9. *Arcohelia dartoni* of late Cenomanian age (fig. 6, zones 19-21) from the Bridge Creek Limestone Member of the Mancos Shale from a depth of 540.09 ft in core hole USGS CL-1, Montrose County, Colorado.

Disconformity

The contact of beds in the Bridge Creek Limestone Member of late Cenomanian age with beds in the overlying Fairport Member of early middle Turonian age is a disconformity and probably represents part of the late Cenomanian and the early Turonian (fig. 9).

Fairport Member

At depths of 517 to 539 ft (fig. 2), the Fairport is characterized by light to medium-gray calcarenite-bearing calcareous shale and minor bentonite. A basal part of the member, which is 7 ft thick, is calcareous and silty. It includes bentonite at the base and 5 ft above the base, as well as the middle-Turonian ammonite *Collignoniceras woollgari* (fig. 10).

The upper part of the member, about 15 ft thick, consists of planar and cross-stratified laminae and lenses of shale and calcarenite. Carbonate content of the shale is less at the top of this sequence. This part of the member ranges from being slightly calcarenitic at the base to highly calcarenitic at the top and includes several thin beds of bentonite. The fossil species in these beds, from depths of 517.6 to 530.8 ft., is *Collignoniceras woollgari*.



Figure 10. *Collignoniceras woollgari* of middle Turonian age (fig. 6, zone 28) from the Fairport Member of the Mancos Shale from a depth of 533.88 ft in core hole USGS CL-1, Montrose County, Colorado.

Blue Hill Member

The Blue Hill was penetrated at depths of about 378 to 517 ft (fig. 2) and consists of light to dark-gray, non-calcareous, shaley siltstone and minor silty shale. Strata at the base of the member, which are 14 ft thick, are composed of shale that is slightly carbonaceous, slightly silty, and nonfossiliferous, although a shark tooth was found at a depth of about 481 ft. The overlying strata, at depths of 452 ft to 502 ft, are mainly shaley siltstone in beds that are either wavy or disrupted. In the uppermost beds, about 30 ft thick, glauconite is abundant.

Strata between depths of 437 and 452 ft are shaley but include beds and lenses of siltstone, sandstone, and glauconite. A thin bed of bentonite was found near the base of this sequence. Many of the siliciclastic beds contain small amounts of sulfide minerals. The lowermost strata, about 3.5 ft thick, consist of graded laminations and very thin beds.

Between depths of 401.5 and 437 ft, the beds are greenish-black shaley siltstone and minor silty shale, which enclose a calcareous concretion. Where the content of siltstone or sandstone is higher, glauconite and sulfide minerals are more abundant. Strata near the base of this sequence commonly are finely laminated or finely cross-stratified.

The uppermost beds of the Blue Hill, from depths of 378 to 401 ft, are comprised of silty shale, scattered thin calcarenites, and a thin bentonite.

Juana Lopez Member

Strata of the Juana Lopez, which were penetrated between depths of about 240 and 378 ft (fig. 2), consist mainly of medium-gray to black shale and light gray calcarenite. This sequence can be divided into three units.

The lowest unit of the member is about 76 ft thick and includes petroliferous, calcarenitic, slightly silty to silty shale as well as calcareous concretions and several thin beds of bentonite. Many of the calcarenites in this unit are cross-stratified and their lower and upper contacts are irregular or wavy. Middle Turonian fossils in these strata consist of *Prionocyclus macombi* (fig. 11), *Lopha lugubris* (fig. 12), and *Inoceramus dimidius* (fig. 13). An upper part of this unit, about 25 ft thick, also contains *Inoceramus* n. sp. and *Inoceramus* aff. *perplexus*.

The middle unit is 28 ft thick and consists of slightly calcareous, silty shale that is moderately calcarenitic, petroliferous, and highly fossiliferous. Calcarenites in these strata are commonly cross-stratified and have irregular or wavy contacts. This unit includes two beds of bentonite but no concretions. Middle Turonian fossils in the unit are: *Prionocyclus macombi*, *Prionocyclus wyomingensis* (fig. 14), *Scaphites* sp., *Inoceramus dimidius*, *Baculites yokoyamai* (fig. 15), *Baculites* sp., and *Inoceramus* sp.

The uppermost unit is 34.4 ft thick and consists of slightly calcareous, slightly silty shale that is finely calcarenitic, non-petroliferous, and moderately fossiliferous. Calcarenites in this unit are in thin, more planar laminations, in contrast to the middle unit. These strata include three laminae of bentonite but no concretions. The fossils are of late middle and early late Turonian ages and include: *Inoceramus dimidius*, *Baculites yokoyamai*, *Inoceramus perplexus* (fig. 16), *Scaphites whitfieldi* (fig. 17), *Prionocyclus novimexicanus* (fig. 18), *Mytiloides* aff. *ratonensis* (fig. 19), *Prionocyclus* sp., *Inoceramus* aff. *dakotensis* (fig. 20), and *Mytiloides ratonensis*.

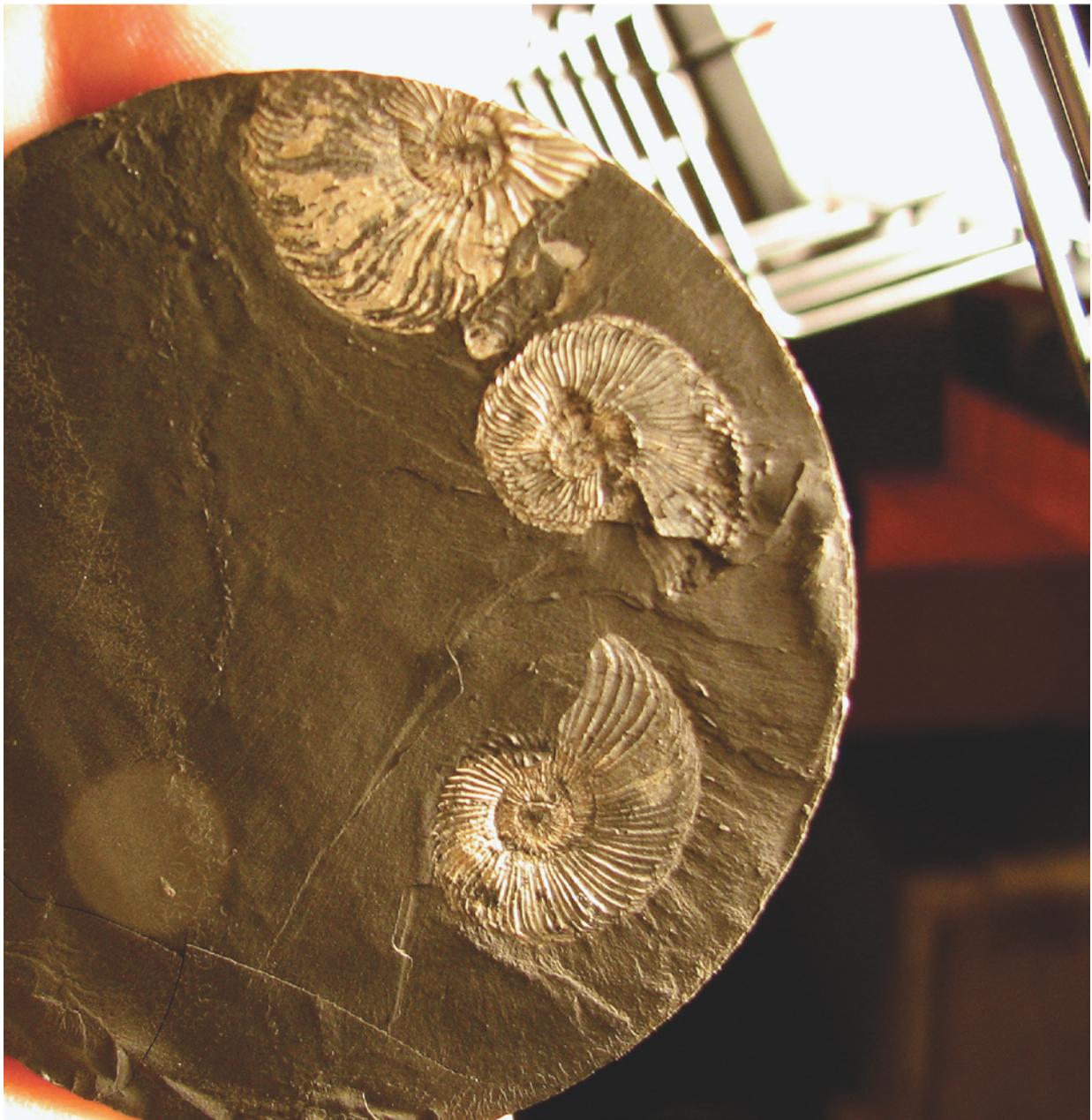


Figure 11. *Prionocyclus macombi* of middle Turonian age (fig.6, zone 31) from the Juana Lopez Member of the Mancos Shale from a depth of 343.92 ft in core hole USGS CL-1, Montrose County, Colorado.



Figure 12. *Lopha lugubris* of middle Turonian age (fig. 6, zones 31-33) from the Juana Lopez Member of the Mancos Shale from a depth of 311.00 ft in core hole USGS CL-1, Montrose County, Colorado.



Figure 13. *Inoceramus dimidius* of middle Turonian age (fig. 6, zones 31-33) from the Juana Lopez Member of the Mancos Shale from a depth of 285.15 ft in core hole USGS CL-1, Montrose County, Colorado.

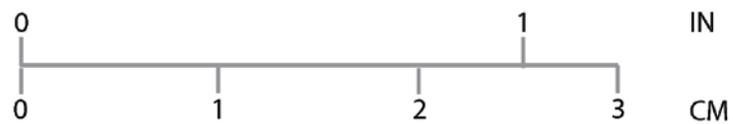


Figure 14. *Prionocyclus wyomingensis* of middle Turonian age (fig. 6, zones 31-33) from the Juana Lopez Member of the Mancos Shale from a depth of 287.35 ft in core hole USGS CL-1, Montrose County, Colorado.



Figure 15. *Baculites yokoyamai* of late Turonian age (fig. 6, zones 34-36) from the Juana Lopez Member of the Mancos Shale from a depth of 250.64 ft in core hole USGS CL-1, Montrose County, Colorado.

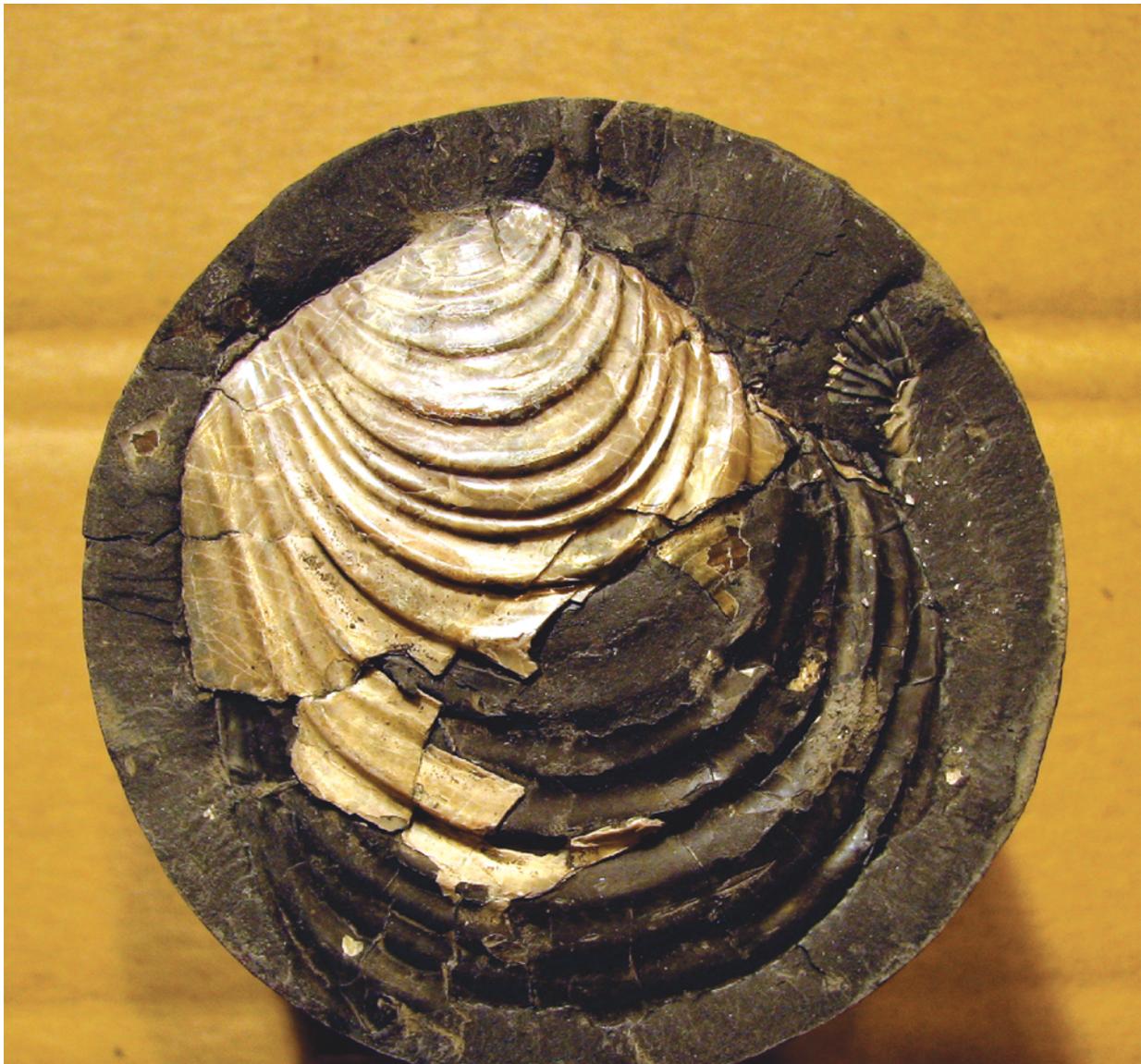


Figure 16. *Inoceramus perplexus* of late Turonian age (fig. 6, zone 34) from the Juana Lopez Member of the Mancos Shale from a depth of 264.30 ft in core hole USGS CL-1, Montrose County, Colorado.

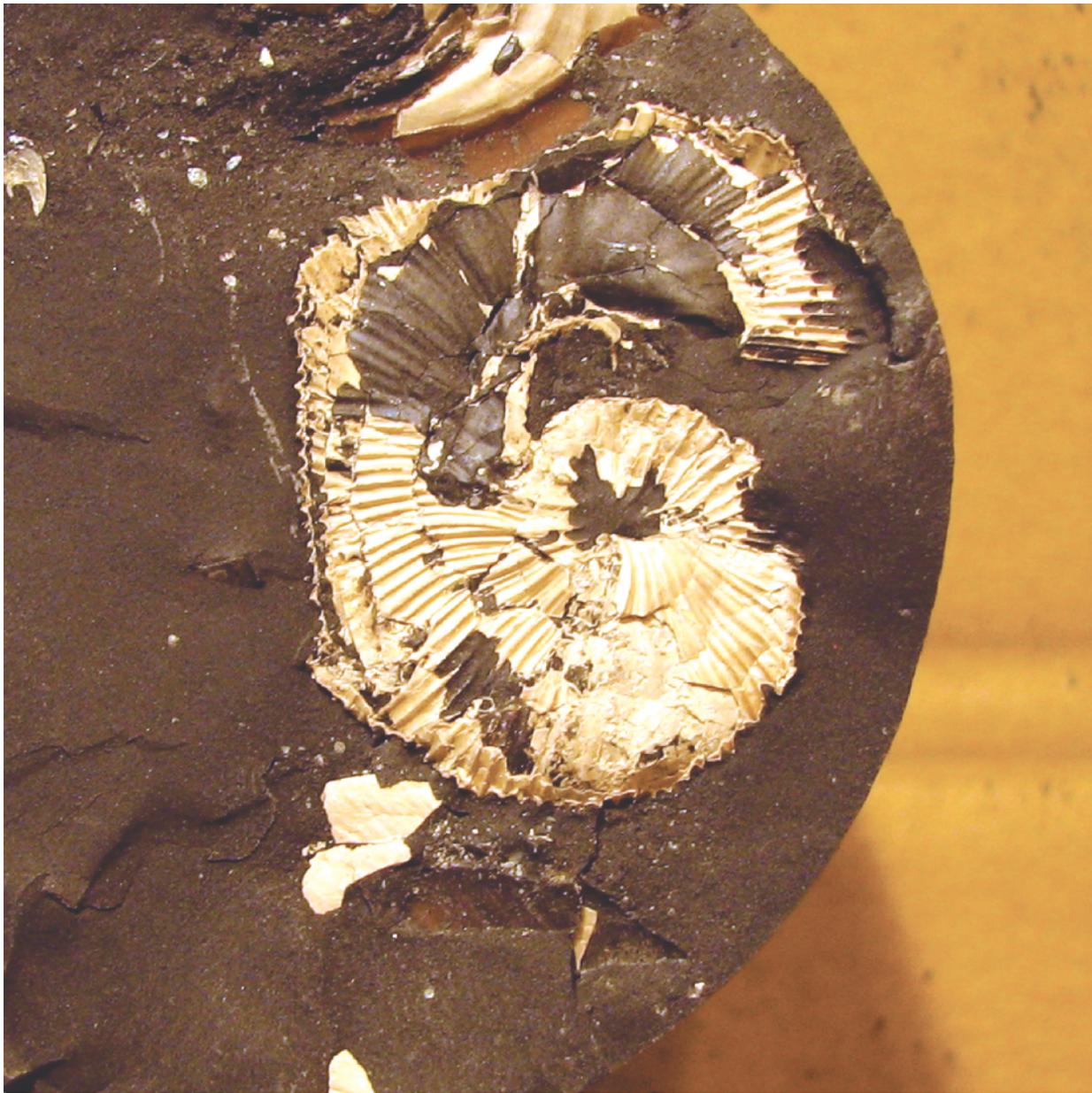


Figure 17. *Scaphites whitfieldi* of late Turonian age (fig.6, zones 34-35) from the Juana Lopez Member of the Mancos Shale from a depth of 242.57 ft in core hole USGS CL-1, Montrose County, Colorado.

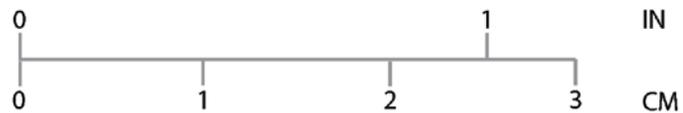


Figure 18. *Prionocyclus novimexicanus* of late Turonian age (fig. 6, zones 34-35) from the Juana Lopez Member of the Mancos Shale from a depth of 242.15 ft in core hole USGS CL-1, Montrose County, Colorado.

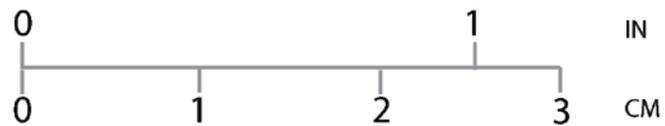


Figure 19. *Mytiloides* aff. *ratonensis* of late Turonian age (fig.6, zone 35) from the Juana Lopez Member of the Mancos Shale from a depth of 240.76 ft in core hole USGS CL-1, Montrose County, Colorado.



Figure 20. *Inoceramus* aff. *dakotensis* of late Turonian age (fig. 6, zone 35) from the Montezuma Valley Member of the Mancos Shale from a depth of 235.0 ft in core hole USGS CL-1, Montrose County, Colorado.

Montezuma Valley Member

The strata between depths of about 185 and 240 ft are assigned to the Montezuma Valley Member of the Mancos (fig. 2). They consist mainly of calcareous, calcarenitic, slightly silty to silty shale that is moderately fossiliferous and contain fragments of fossils, fish scales, and carbonized plant remains. These siliciclastic beds are moderately-well to well indurated. The member also includes at least nine beds or laminae of bentonite, several of which have apparently been reworked.

The lower part of this member is medium-gray and the basal strata, about 7 ft thick, are weakly calcareous and include abundant silty laminations. At depths between 208 and 214 ft, the strata include three thin beds of very calcareous, sandy and silty shale that are well indurated and strongly bioturbated. Fossils of late Turonian age that were found between depths of 227 and 237 ft are *Prionocyclus novimexicanus*, *Baculites yokoyamai*, *Inoceramus dakotensis*, *Inoceramus* aff. *dakotensis*, and *Mytiloides incertus* (fig. 21). Between depths of about 210 and 227 ft, only *Mytiloides incertus* was recognized.

In the uppermost beds of the member, about 23 ft thick, the stratification is more prominent and the beds contain small oval white pellets. The fossils identified in these beds are *Cremonoceramus waltersdorfensis* ? of late Turonian age. The contact of the Montezuma Valley Member and the overlying Niobrara Member probably is a minor disconformity.

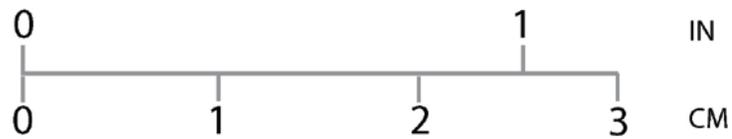


Figure 21. *Mytiloides incertus* of late Turonian age (fig. 6, zone 36) from the Montezuma Valley Member of the Mancos Shale from a depth of 227.0 ft in core hole USGS CL-1, Montrose County, Colorado.

Niobrara Member

Strata in the core herein assigned to the Niobrara are laterally equivalent to the Fort Hays Limestone Member and to part of the overlying Smoky Hill Member of the Niobrara Formation in outcrops to the east (Scott and Cobban, 1964; Scott, 1969). At depths of 146.3 to 184.9 ft, strata equivalent to the Fort Hays are generally massive and consist of medium-dark gray, shaley and slightly silty limestone and calcareous shale. They are moderately fossiliferous, containing *Cremonceramus erectus* (fig. 22) at depths of 164 to 182 ft, and *Cremonceramus deformis* (fig. 23) at depths of 148 to 158 ft. The lowermost bed in this sequence includes a reworked bentonite.

Strata at depths of 20.0 to 146.3 ft, which are equivalent to part of the Smoky Hill Member in eastern Colorado, are informally divided into a shale and limestone unit at depths of 92.2 to 146.3 ft, a lower shale unit at depths of 52.5 to 92.2 ft, and a lower limestone unit at depths of 20.0 to 52.5 ft. The basal unit consists mainly of medium-dark gray, carbonaceous, calcareous shale that is slightly silty and locally glauconitic and which includes five laminae of bentonite. This unit contains fish scales, minor burrows, plant remains, the bivalve *Cremonceramus crassus* ? (fig. 24), and inoceramid prisms.

The lower shale unit is a medium-gray, slightly silty to silty, calcareous shale that contains larger silt grains and iron minerals on the bedding planes. It displays a few burrows and abundant compacted fecal pellets. Molluscan fossils were not recognized in this unit.

In the upper part of the core, the lower limestone unit is composed mostly of medium to dark greenish-gray, silty, calcareous shale. The unit includes two bentonites. Where stratification is evident, the laminae can contain detrital minerals, iron oxide, carbonaceous matter, fecal pellets, and fossil bivalves. The fossils are *Volvicceramus* ? sp. (fig. 25), *Magadiceramus* ? sp. (fig. 26), and *Pseudoperma congesta* (fig. 27).

Shallow trenches in outcrops of the Niobrara Member (lower limestone unit of the Smoky Hill) near the borehole yielded fossils of late Coniacian age (fig. 6, zone 44), as follows: *Magadiceramus subquadratus* (fig. 28), *Magadiceramus stantoni* (fig. 29), *Pseudoperma congesta*, and bones.

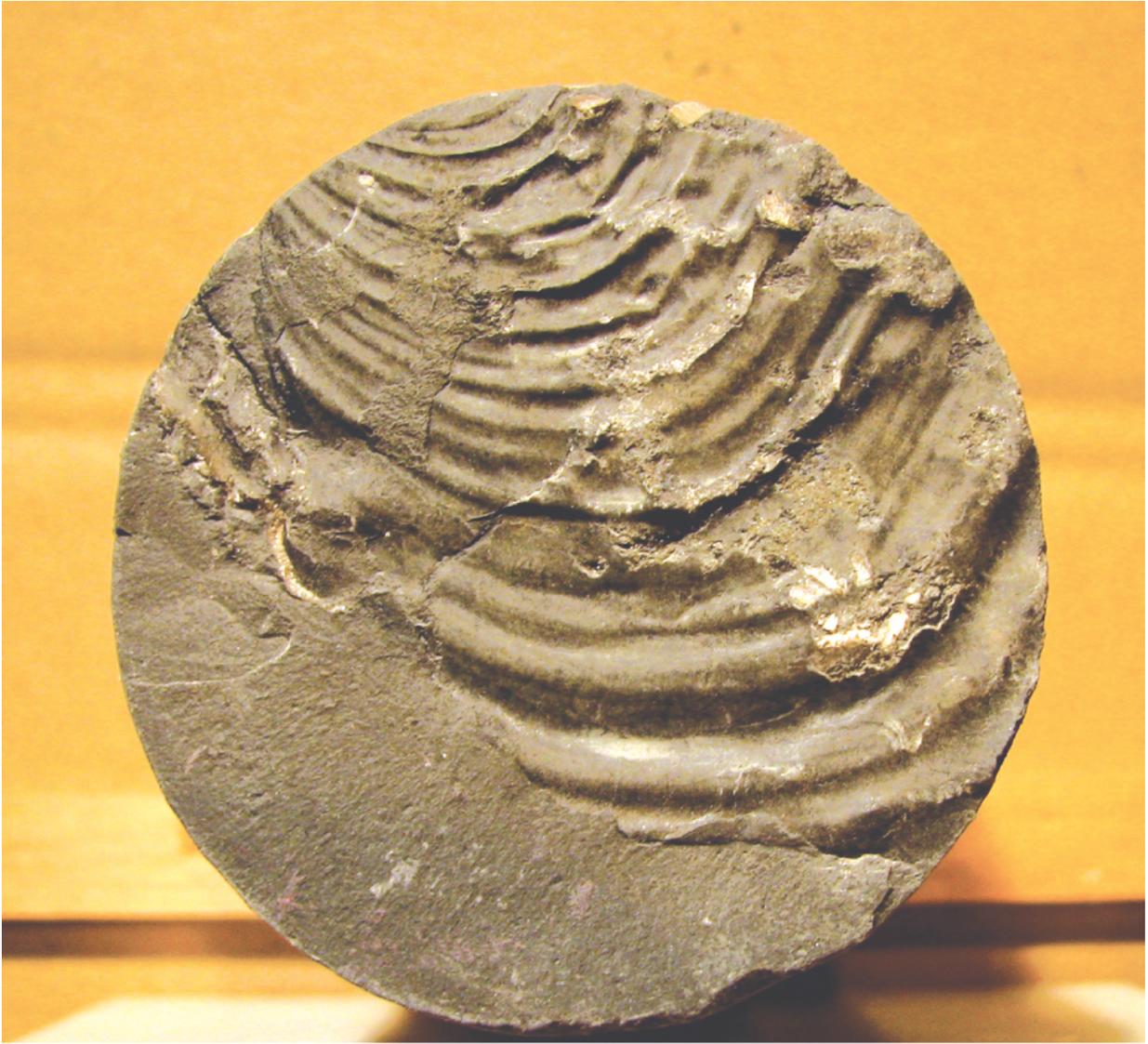


Figure 22. *Cremnoceramus erectus* of early Coniacian age (fig. 6, zone 39) from the Niobrara Member (Fort Hays Limestone Member equivalent) of the Mancos Shale from a depth of 170.55 ft in core hole USGS CL-1, Montrose County, Colorado.

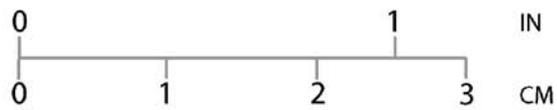


Figure 23. *Cremnoceramus deformis* of early Coniacian age (fig. 6, zone 40) from the Niobrara Member (Fort Hays Limestone Member equivalent) of the Mancos Shale from a depth of 155.93 ft in core hole USGS CL-1, Montrose County, Colorado.

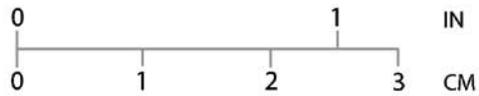


Figure 24. *Cremnoceramus crassus*? of early Coniacian age (fig.6, zone 41) from the Niobrara Member (Smoky Hill Member equivalent) of the Mancos Shale from a depth of 143.98 ft in core hole USGS CL-1, Montrose County, Colorado.

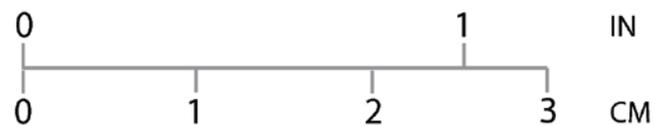


Figure 25. *Volviceramus*? sp. of middle Coniacian age (fig. 6, zones 42-43) from the Niobrara Member (Smoky Hill Member equivalent) of the Mancos Shale from a depth of 39.27 ft in core hole USGS CL-1, Montrose County, Colorado.

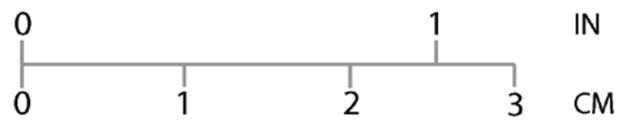


Figure 26. *Magadiceramus* ? sp. of late Coniacian age (fig. 6, zone 44) from the Niobrara Member (Smoky Hill Member equivalent) of the Mancos Shale from a depth of 38.5 ft in core hole USGS CL-1, Montrose County, Colorado.

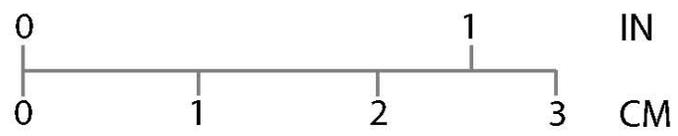


Figure 27. *Pseudoperla congesta* of middle Coniacian age (fig. 6, zones 42, 43) from the Niobrara Member (Smoky Hill Member equivalent) of the Mancos Shale from a depth of 33 ft in core hole USGS CL-1, Montrose County, Colorado.



0 1 IN
0 1 2 3 CM

Figure 28. *Magadiceramus subquadratus* of late Coniacian age (fig. 6, zone 44) from the Niobrara Member (Smoky Hill Member equivalent) of the Mancos Shale from a trench in NW1/4, sec. 8, T.50 N., R. 9 W., Montrose County, Colorado.

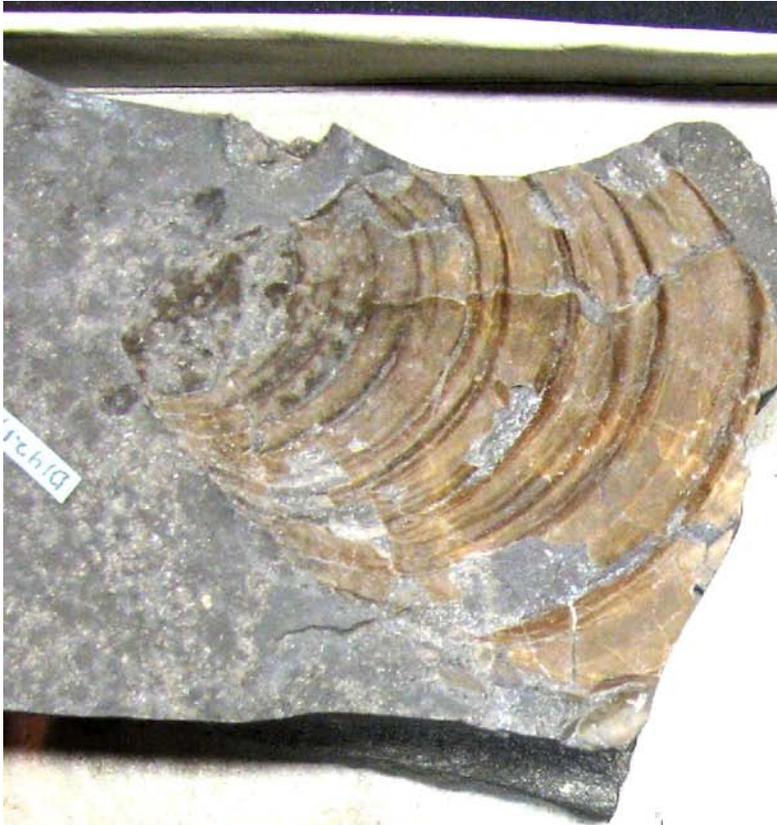
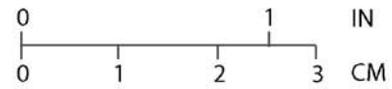


Figure 29. *Magadiceramus stantoni* of late Coniacian age (fig. 6, zone 44) from the Niobrara Member (Smoky Hill Member equivalent) of the Mancos Shale from a trench in NW1/4, NE1/4 sec. 8, T. 50 N., R. 9 W., Montrose County, Colorado.



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