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ULUNGARAT FORMATION - TYPE SECTION OF A NEW FORMATION, HEADWATERS OF THE KONGAKUT RIVER, EASTERN BROOKS RANGE, ALASKA

by

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INTRODUCTION

The rock record of the eastern Brooks Range has been divided into 3 unconformity-bounded megasequences: Franklinian, Ellesmerian, and Brookian (Lerand, 1973; Hubbard and others, 1987). Complexly deformed rocks of Early Devonian and older age characterize the Franklinian sequence. The Mississippian to Lower Cretaceous Ellesmerian sequence records the history of a south-facing continental margin. Rocks of the Lower Cretaceous and younger Brookian Sequence were derived from the south and are the depositional record of erosion of the Brooks Range orogen. The boundary between the Franklinian and Ellesmerian is a major regional unconformity which separates complexly deformed rocks of the Franklinian sequence from overlying strata. The Ellesmerian sequence records only Brookian deformation and does not share the complex deformation recorded in the underlying Franklinian sequence.

Reiser et al. (1980) mapped a unit of Devonian clastic rocks (unit Ds) in the southern Demarcation Point quadrangle near the headwaters of the Kongakut River. This unit is generally not considered in discussions of the megasequence stratigraphy, due to its lack of areal extent and a consequent lack of understanding of its stratigraphic relations and significance in the depositional and tectonic history of the region. The unit is located at the boundary between the Franklinian and Ellesmerian sequences. Reiser et al. (1980) reported the unit to be bound above and below by unconformities, but did not establish its position in the megasequence stratigraphy. These rocks have not previously been studied in detail and are the subject of this study, which describes the type section of a new formation, describes the

sedimentology and organization of the unit, and characterizes its environment of deposition, facies changes, and provenance.

The Devonian clastic rocks near the headwaters of the Kongakut River have been brought to the surface by major thrust faults, which bound the base of the Devonian section throughout the study area (Fig. 1). The top of the formation is a low-angle unconformity beneath the Mississippian Kekiktuk Conglomerate (Anderson, 1990).

The formation is here named the Ulungarat Formation; its type section is exposed in a north-flowing drainage at the east end of Ulungarat Ridge (new, informal name) in the NW1/4 of Section 7, T. 5 S., R. 38 E., Demarcation Point (A-4) quadrangle (69° 1.6' N, 143° 10.6' W) (Fig. 1). Ulungarat is an Inupiaq Eskimo word meaning "sloping ridge with one very steep side" (J. Nageak, personal communication), which describes the type locality.

TYPE SECTION

The Ulungarat Formation at its type locality is 375 meters thick and is a coarsening- and thickening-upward, shallow-marine to nonmarine fluvial sequence (Fig. 2). The rocks lack the strong deformational overprint that characterizes the Franklinian rocks of the northeastern Brooks Range (Anderson, 1989, 1991; Anderson and Wallace, 1990). The formation includes three informal members interpreted to have been deposited in a suite of basin-margin environments.

Lower member (A)

The lower depositional assemblage is 159 meters thick. The basal 32 meters is a green-gray weathering mudstone and black phyllite with sporadic

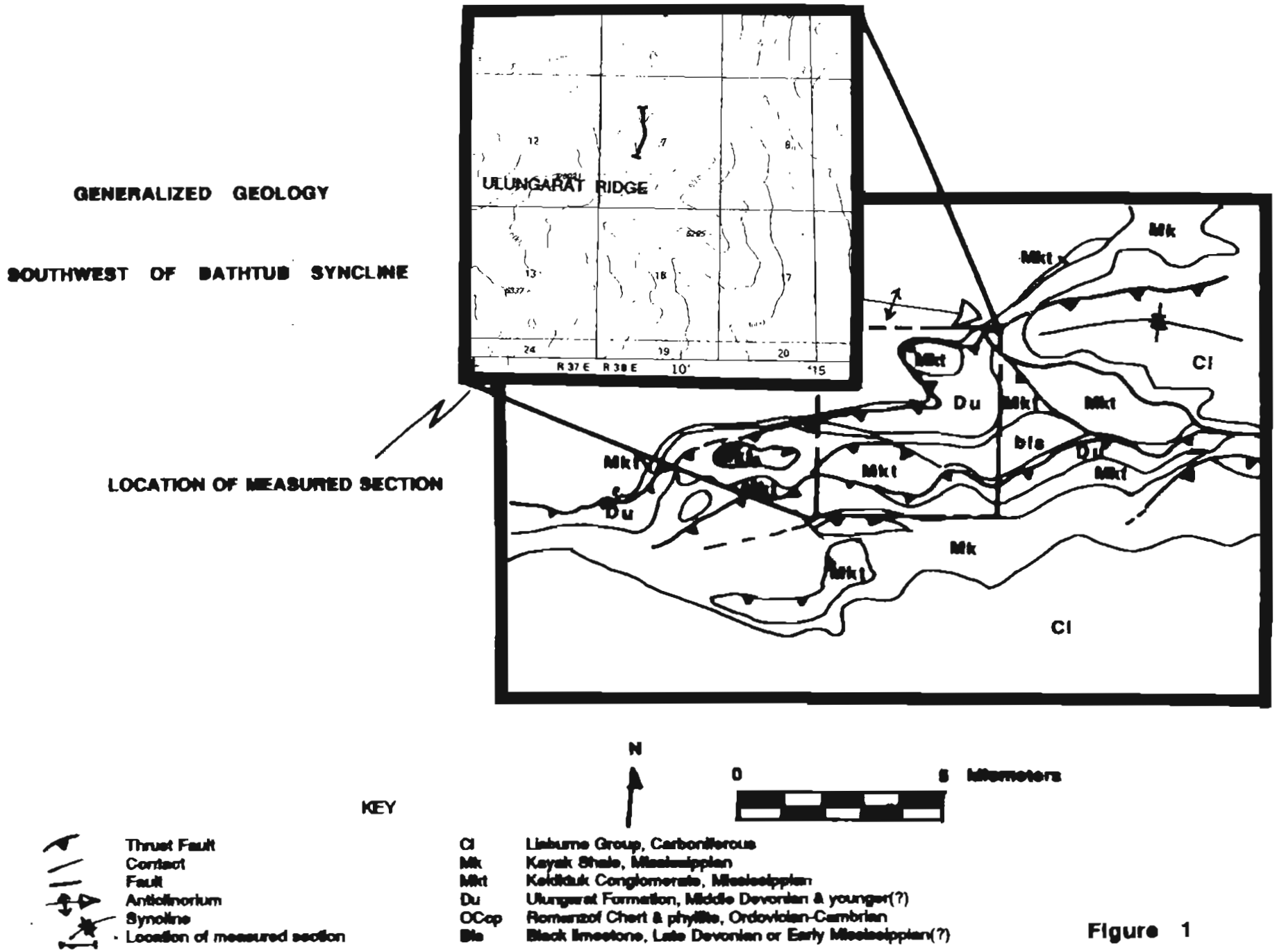
GENERALIZED GEOLOGY
SOUTHWEST OF BATHTUB SYNCLINE
LOCATION OF MEASURED SECTION
ULUNGARAT RIDGE
R 37 E
R 38 E
Mk
Mkt
Cl
Du
bls
N
0
5 Kilometers
KEY
Thrust Fault
Contact
Fault
Anticlinorium
Synocline
Location of measured section
Cl Lisburne Group, Carboniferous
Mk Kayak Shale, Mississippian
Mkt Kekiktuk Conglomerate, Mississippian
Du Ulungarat Formation, Middle Devonian & younger(?)
OCop Romanzof Chert & phyllite, Ordovician-Cambrian
Bls Black limestone, Late Devonian or Early Mississippian(?)

Figure 1

fine-grained, calcareous, fossiliferous beds 6 to 10 cm thick. The mudstone and phyllite form a steep slope below ledges formed by the upper 127 meters of the assemblage. The sandstone/shale ratio increases upsection, with amalgamated sandstone beds gradually becoming dominant. The sandstones are chert-arenites and calcarenites. Graded sandstone beds have erosional bases and ripple-drift cross-lamination. Vertical burrows are present. Evidence of bioturbation is abundant in the upper half of the assemblage

Preliminary examination of fossils collected from the lower member at the type locality and other locations reveals an abundant assemblage of marine invertebrate fossils. The assemblage includes Lingulid and reticulated brachiopods, pelecypods, trilobites, bryozoans, gastropods, alga, and tabulate corals. A murchisonid gastropod (new genus) and a Coelotrochium sp. (a dasycladacean alga) date the lower member as Eifelian (R. B. Blodgett, pers. comm., 1991).

The lower member is interpreted as a dominantly hemipelagic succession interrupted by episodic deposition of fossil hash and chert-arenite by storm events. The succession gradually shallows upward into a shoreface environment.

Middle member (B)

The middle depositional assemblage is composed of 108 meters of chert granule to pebble conglomerate, litharenite, and siltstone in fining-upward intervals in an overall coarsening-upward sequence. The assemblage crops out as thick ledges in a steep slope. The sandstone is composed dominantly of chert and argillaceous chert, with less than 40% quartz. Abundant radiolarian ghosts are visible in thin-sections of the chert pebbles.

The base of the assemblage is placed at the base of the lowermost thick, conglomeratic, channelized, fining-upward interval. This is coincident with the disappearance of marine fossils. Each fining-upward interval begins with a channelized chert pebble conglomerate and trough cross-stratified coarse-grained sandstone. The channel-fills have erosional bases marked by flute and groove casts. Epsilon cross-stratified sandstones extend laterally from channel margins. The sandstone at the top of each interval is ripple cross-laminated and is interbedded with and overlain by horizontal-laminated deposits. The siltstone contains root casts, mud cracks, and both horizontal and vertical burrows. In places, the siltstone has prominent rose-red and green-gray mottling that is interpreted to result from intense bioturbation. The top 38 meters of the assemblage is an interval of bioturbated siltstone. The middle member is interpreted to be the deposit of a sand-rich meandering fluvial system.

Plant fossils from the middle member have not yet been dated. The age is constrained only by the Middle Devonian (Eifelian) age of the underlying lower member and stratigraphic higher rocks of the Mississippian Kekiktuk Conglomerate.

Upper member (C)

The upper assemblage is a cliff-forming, 106 meter-thick succession of large-scale conglomeratic channel-fills. The poorly-sorted, clast-supported chert pebble conglomerate is similar to that in the underlying assemblage, but is coarser-grained and thicker-bedded. In places, amalgamated conglomeratic channels are as much as 3 meters thick. The channel-fill successions have erosional bases, internal trough cross-strata, and upward-fining cycles. Rip-up clasts occur at the base of some channels. The overlying ripple-drift cross-laminated, fine-grained sandstone part of each channel interval is rarely

preserved. Fine-grained deposits in the assemblage were generally removed due to erosion beneath the overlying channel succession. Small iron stained zones with flattened elliptical shapes are common. Where preserved, the siltstones and mudstones are usually red-maroon in color and bioturbated. The unique occurrence of green-tan mudstone at 248 meters shows a sharp change upward from pebble conglomerate to mudstone. This indicates an abrupt change in the competency of the fluvial system at that location. Some of the chert-pebble conglomerates have no matrix; the pore space is filled with quartz cement. This suggests a high flow regime that kept finer-grained detritus moving.

The channel-fill sequences coarsen and thicken upsection and are interpreted as the record of progradational meandering and braided fluvial sedimentation.

The contact between the middle member (B) and the upper member (C) is marked by the appearance of the thick conglomeratic channel-fill successions. At the type section of the Ulungarat Formation, the upper member (C) occupies a position that laterally is occupied by a thicker middle member (B), but the nature of the lateral contact is unclear. The lateral juxtaposition of the two members may be the result of an erosional contact or relief changes due to syndepositional faulting. The succession is unconformably overlain at a low-angle unconformity by rocks assigned to the Mississippian Kekiktuk Conglomerate. The precise age of the upper depositional assemblage is unknown, but is constrained by Middle Devonian fossils from the underlying lower member and by the unconformably overlying Kekiktuk Conglomerate which in the area contains plant fossils assigned a tentative Early Mississippian age (R. Spicer, pers. comm., 1989).

DISCUSSION

The Ulungarat Formation is an upward coarsening and thickening succession that records the southward progradation of shallow to non-marine siliciclastic dispersal systems along the south-facing Devonian continental margin of Arctic Alaska. The succession is divided into three members deposited in a variety of basin-margin environments. The lower boundary is everywhere a major thrust fault, so the depositional base of the formation has not been observed.

The Ulungarat Formation lacks the strong deformational overprint that characterizes structurally underlying rocks of the Franklinian sequence. The only structures present are Brookian structures equivalent in character and orientation to those in overlying strata previously assigned to the Ellesmerian sequence. Therefore, the Ulungarat Formation should be considered part of the Ellesmerian sequence and represents the earliest deposits of this sequence in northern Alaska.

Petrographic analysis shows the composition of clasts in the formation to be dominantly radiolarian chert and argillaceous chert with minor amounts of vein quartz. Close proximity to a source terrain is suggested by the coarse grain size and textural immaturity of the deposits. North of the upper Kongakut River, a regional anticlinorium exposes complexly deformed Cambrian-Ordovician chert and phyllite (OCcp of Reiser et al., 1980) of the Franklinian sequence. This is the closest possible source unit and it contains rocks visibly identical to clasts in the Ulungarat Formation. Therefore, the Franklinian sequence, including the OCcp unit, is the most likely source terrain for the Ulungarat Formation.

The top of the formation is a low-angle unconformity. The significance of this unconformity and the amount of time it represents are unclear. No precise age data are available for the upper two non-marine members of the Ulungarat Formation. However, their age is bracketed between the Middle Devonian (Eifelian) age of the underlying member and the Early Mississippian age of the unconformably overlying Kekiktuk Conglomerate. Detailed mapping and measurement of stratigraphic sections reveals that laterally the middle and upper members are partially or entirely missing beneath the Kekiktuk Conglomerate, suggesting removal by erosion.

PRELIMINARY CONCLUSIONS

Detailed description of the measured section and detailed mapping in the area suggests the following conclusions:

1. The Ulungarat Conglomerate is 375 meters thick and includes three informal members deposited in a suite of basin-margin environments. The formation is a coarsening- and thickening-upward succession of shallow-marine to nonmarine deposits.

2. The organization of the lower member (A) indicates an upward-shallowing marine-shelf to shoreface environment of deposition.

3. The middle member (B) records deposition by a sand-rich meandering fluvial system.

4. Sedimentology of the upper member (C) suggests deposition in a meandering and braided fluvial system.

5. The coarseness and textural immaturity of the deposits suggests close proximity to a tectonically active source terrain. The detritus is dominantly radiolarian chert and argillaceous chert. The probable source is the chert of the Franklinian sequence in the Romanzof Mountains north of the upper Kongakut River.

6. The age of the lower part of the Ulungarat Formation is Middle Devonian (Eifelian); the age of the upper part is bracketed between this age and the Early Mississippian age of the unconformably overlying Kekiktuk Conglomerate.

7. Laterally the middle and upper members are partially or entirely missing, suggesting removal by erosion beneath a low angle discordance with the overlying Mississippian Kekiktuk Conglomerate.

8. The Ulungarat Conglomerate does not share the complex deformational history of the Franklinian sequence. Therefore, it should be considered part of the Ellesmerian sequence and is the basal formation of that sequence.

Acknowledgments

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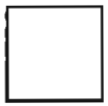
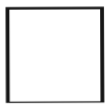
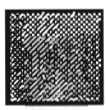
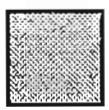
KEY TO SYMBOLS


Conglomerate


Sandstone


Siltstone


Siltstone and fine-grained sandstone


Thin-bedded


Lateral thinning of beds

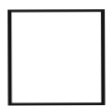

Phyllite, shale


Argillaceous limestone


Covered


Calcareous


Small internal channels


Bioturbation


Bryozoan


Brachiopod


Bivalve


Gastropod


Bioturbation


Trilobite

Grain Size

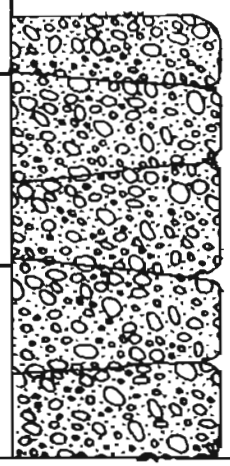
Gravel (G) — Cobbles (C), Pebbles (P)

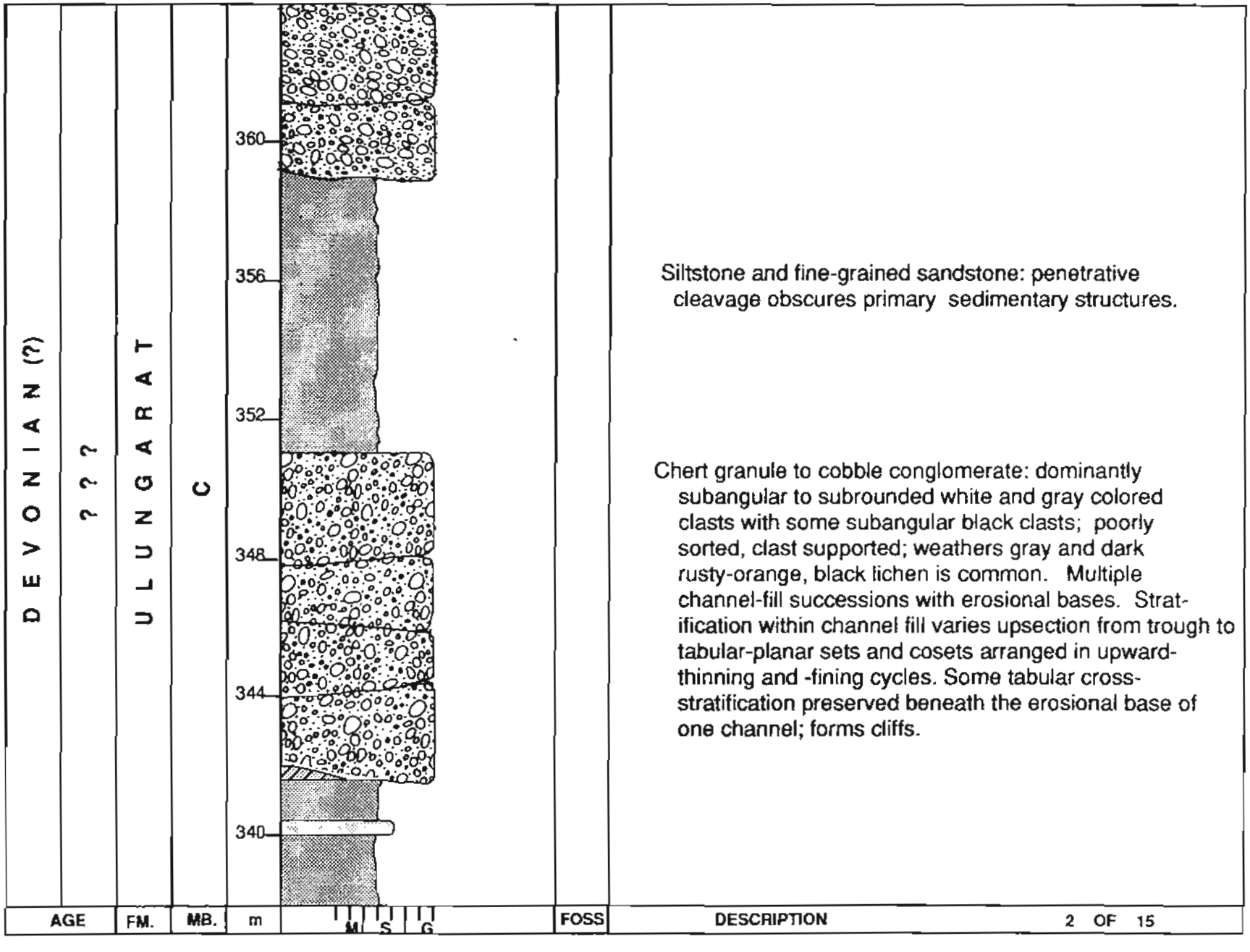
Sand (S) — Coarse (C), Medium (M), Fine (F)

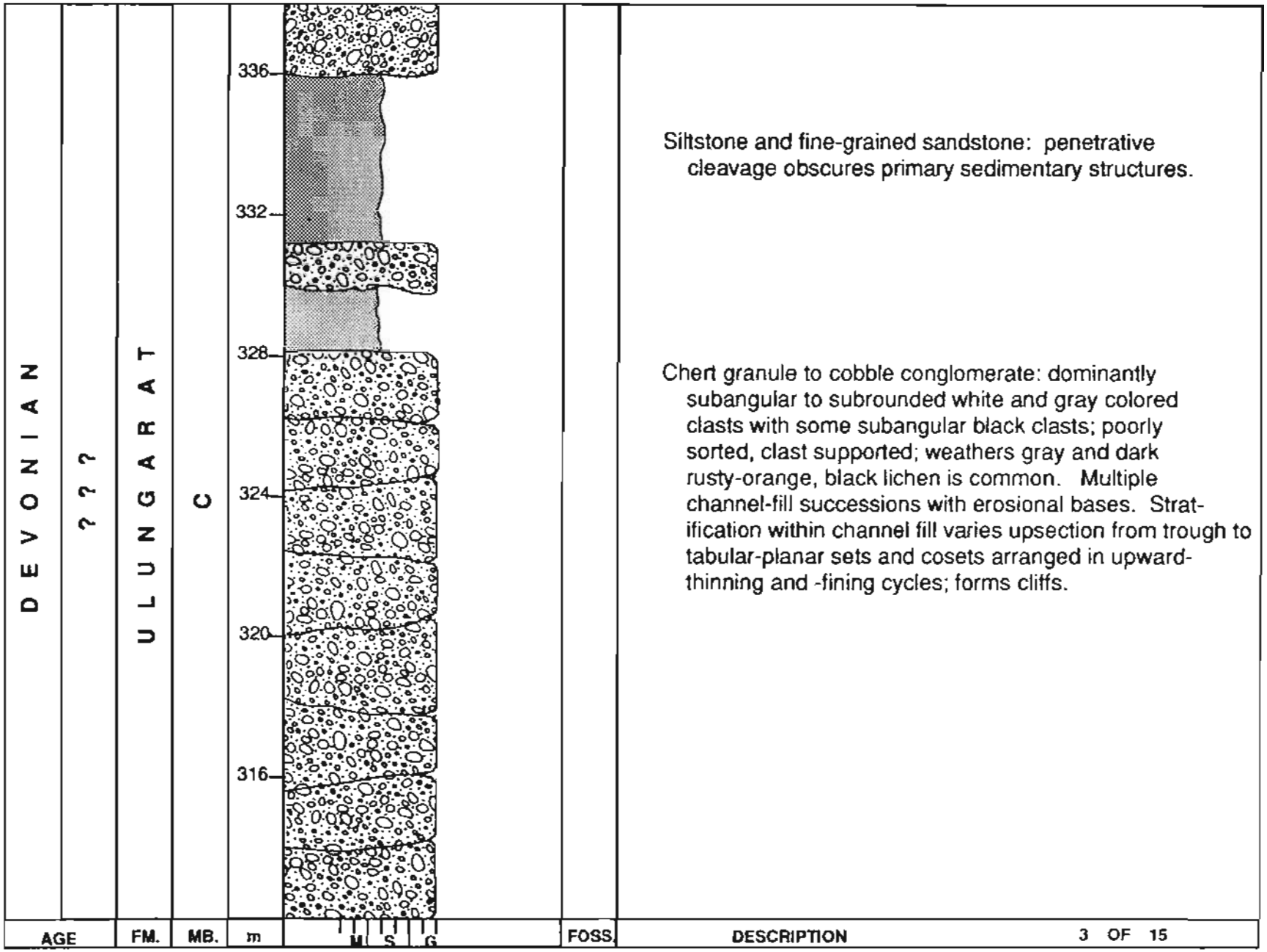
Mud (M) — Siltstone (S), Clay (C)

U L U N G A R A T F O R M A T I O N

Location 90A-31
Sec. 7, T. 5 S., R. 38 E.
Demarcation Point quadrangle, Alaska

PERIOD	EPOCH	FORMATION	MEMBER	METERS	GRAPHIC COLUMN (MUD / SAND / GRAVEL; C S F M C P C)	FOSSILS	DESCRIPTION
DEVONIAN (?)	? ? ?	ULUNGARAT	C	372 368			Top of the measured section is the topographic bench at the top of the uppermost thick conglomeratic channel-fill. The overlying rubble slope is assigned to the Kekiktuk Conglomerate. Chert granule to cobble conglomerate: dominantly subangular to subrounded white and gray colored clasts with some subangular black clasts; poorly sorted, clast supported; weathers gray and dark rusty-orange, black lichen is common. Multiple channel-fill successions with erosional bases. Stratification within channel fill varies upsection from trough to tabular-planar sets and cosets arranged in upward-thinning and -fining cycles; forms cliffs.


DEVONIAN (?)
? ? ?
ULUNGARAT
C
360
356
352
348
344
340
M
S
G
Siltstone and fine-grained sandstone: penetrative cleavage obscures primary sedimentary structures.
Chert granule to cobble conglomerate: dominantly subangular to subrounded white and gray colored clasts with some subangular black clasts; poorly sorted, clast supported; weathers gray and dark rusty-orange, black lichen is common. Multiple channel-fill successions with erosional bases. Stratification within channel fill varies upsection from trough to tabular-planar sets and cosets arranged in upward-thinning and -fining cycles. Some tabular cross-stratification preserved beneath the erosional base of one channel; forms cliffs.
AGE
FM.
MB.
m
FOSS
DESCRIPTION
2 OF 15


DEVONIAN
? ? ?
ULUNGARAT
C
336
332
328
324
320
316
M
S
G
Siltstone and fine-grained sandstone: penetrative cleavage obscures primary sedimentary structures.
Chert granule to cobble conglomerate: dominantly subangular to subrounded white and gray colored clasts with some subangular black clasts; poorly sorted, clast supported; weathers gray and dark rusty-orange, black lichen is common. Multiple channel-fill successions with erosional bases. Stratification within channel fill varies upsection from trough to tabular-planar sets and cosets arranged in upward-thinning and -fining cycles; forms cliffs.
AGE
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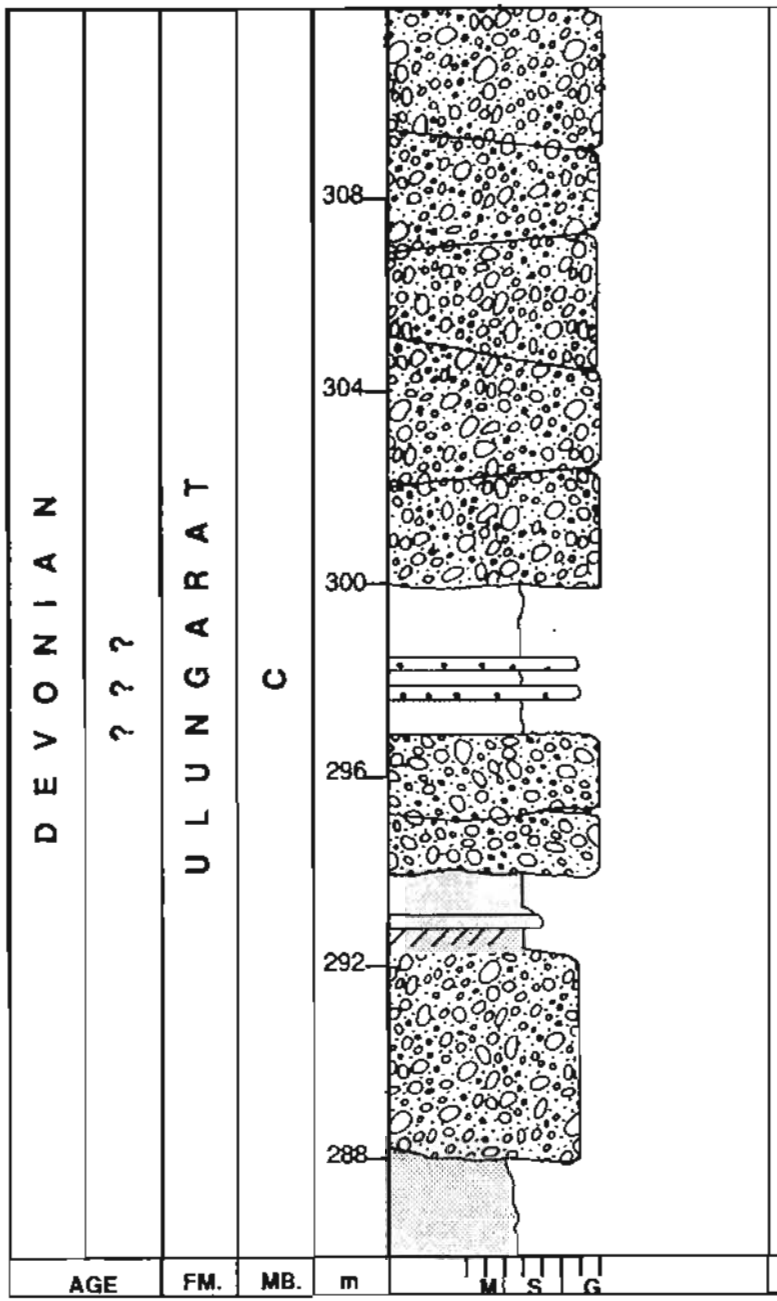
m
FOSS.
DESCRIPTION
3 OF 15

51

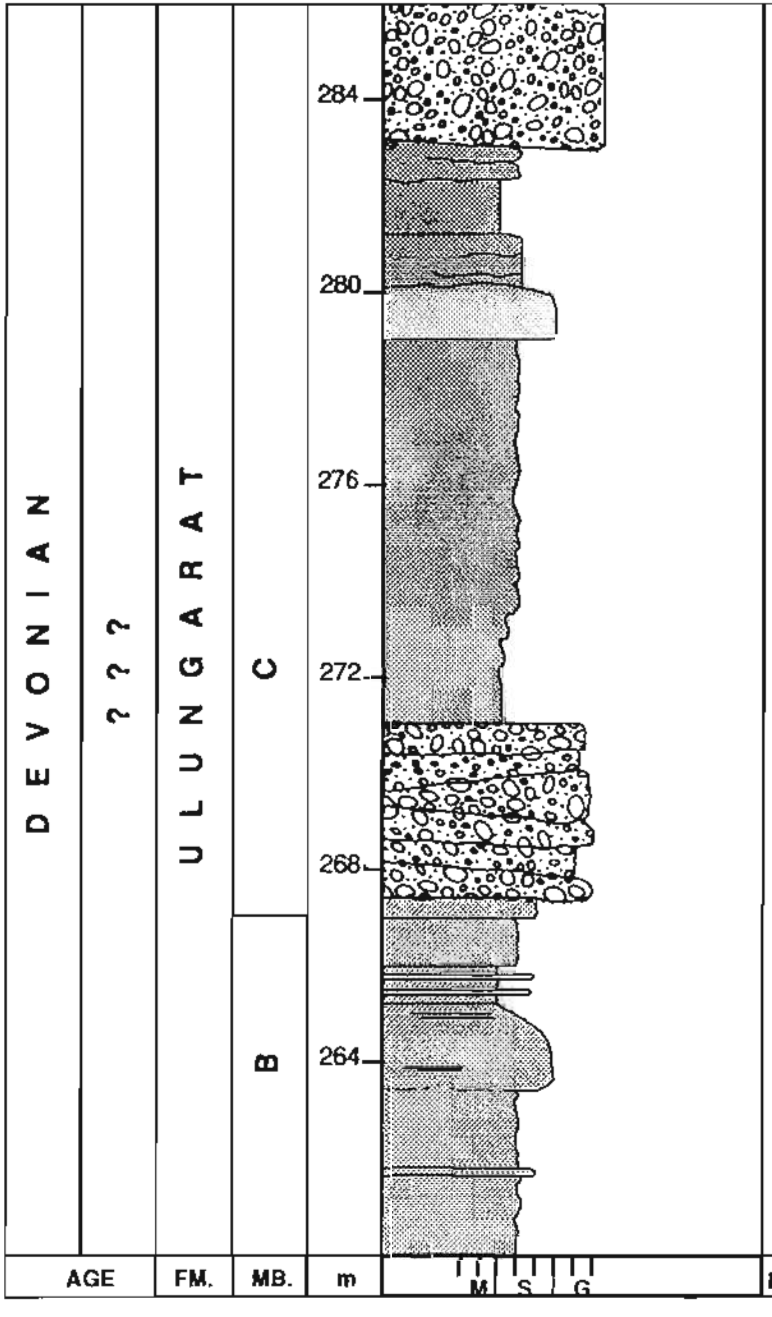


Chert granule to cobble conglomerate: dominantly subangular to subrounded white and gray colored clasts with some subangular black and rare raspberry colored; clasts to 8 cm, poorly sorted, clast-supported; weathers gray and dark rusty-orange, black lichen is common. Multiple channe- fill successions with erosional bases, internal poorly exposed stratification and grain size change suggest trough cross-stratification and upward-fining cycles; forms cliffs.

Litharenite: more resistant, coarser beds contain black pebble siltstone clasts at the base, sand-size siltstone clasts throughout; poorly sorted; possible trough cross-stratificated; beds less than 4 cm thick.

Chert pebble conglomerate: crudely fining-upward; abruptly overlain by fine-grained sandstone.

DESCRIPTION



Chert granule to pebble conglomerate: white and gray chert; trough cross-stratificated.

Chert arenite and sandy siltstone: Upward-fining beds (6 cm thick); internal ripple cross-laminated, erosional bases, lateral thinning of beds. Sandy siltstone weathers maroon color; penetrative cleavage.

Sandy siltstone: maroon with irregular green-gray zones throughout, intensely bioturbated; rare fine-grained chert-arenite beds with ripple cross-laminated; horizontal and vertical burrows; limonite-hematite surface stain.

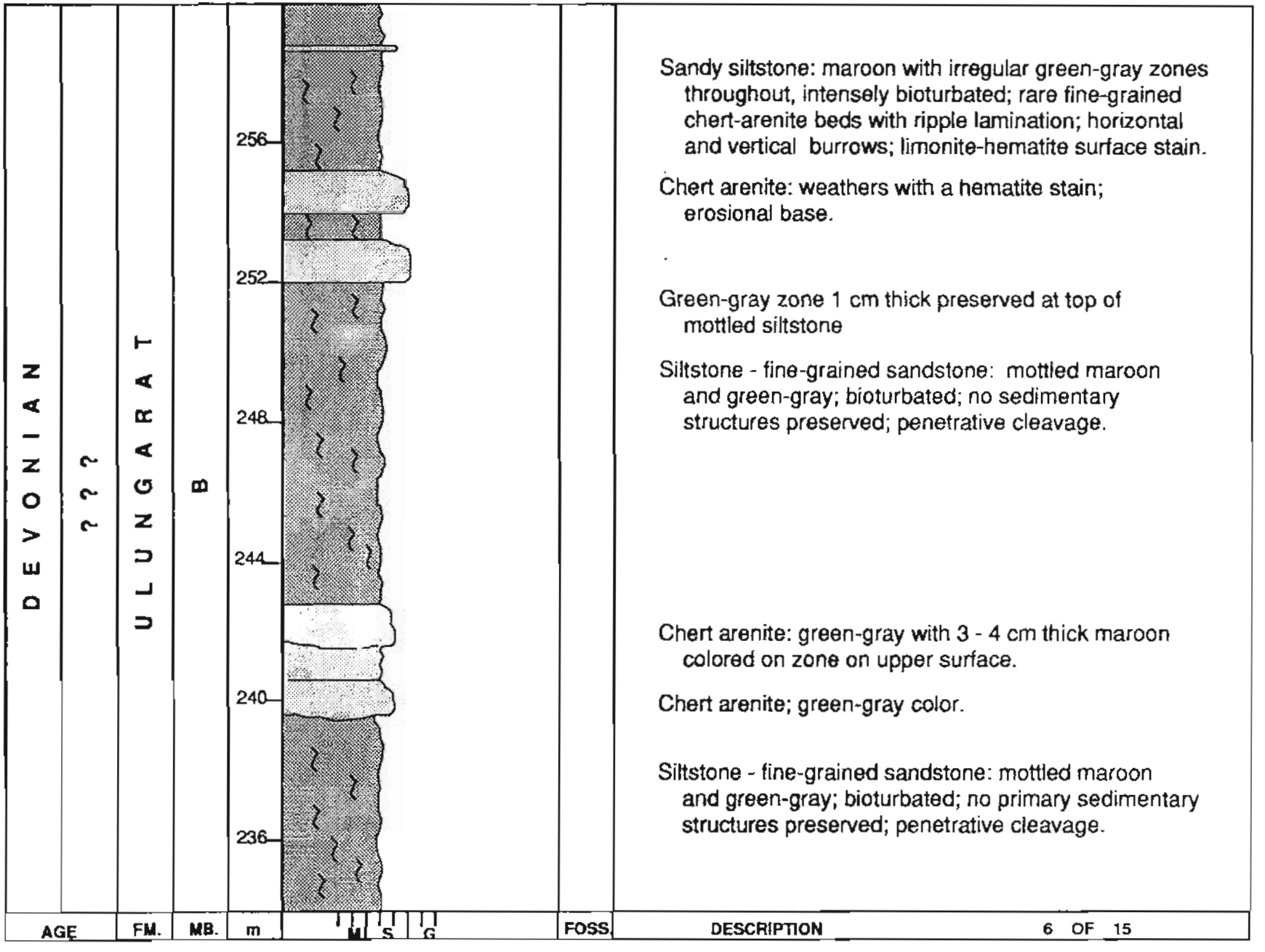
Chert pebble - granule conglomerate: subangular to subrounded clasts; weathers medium gray with hematite-limonite stain, abundant black lichen cover; high-angle trough cross-beds; erosional bases and truncated tops.

Litharenite with sand-size clasts apparently derived from underlying maroon siltstone; internally structureless; ripple cross-laminated at top.

Chert arenite: faint parallel laminations, otherwise internally structureless (bioturbated?); erosional base; thinly-bedded, ripple cross-laminated at top.

AGE | FM. | MB. | m | FOSS. | DESCRIPTION

81


DEVONIAN
? ? ?
ULUNGARAT
B
256
252
248
244
240
236
M
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AGE
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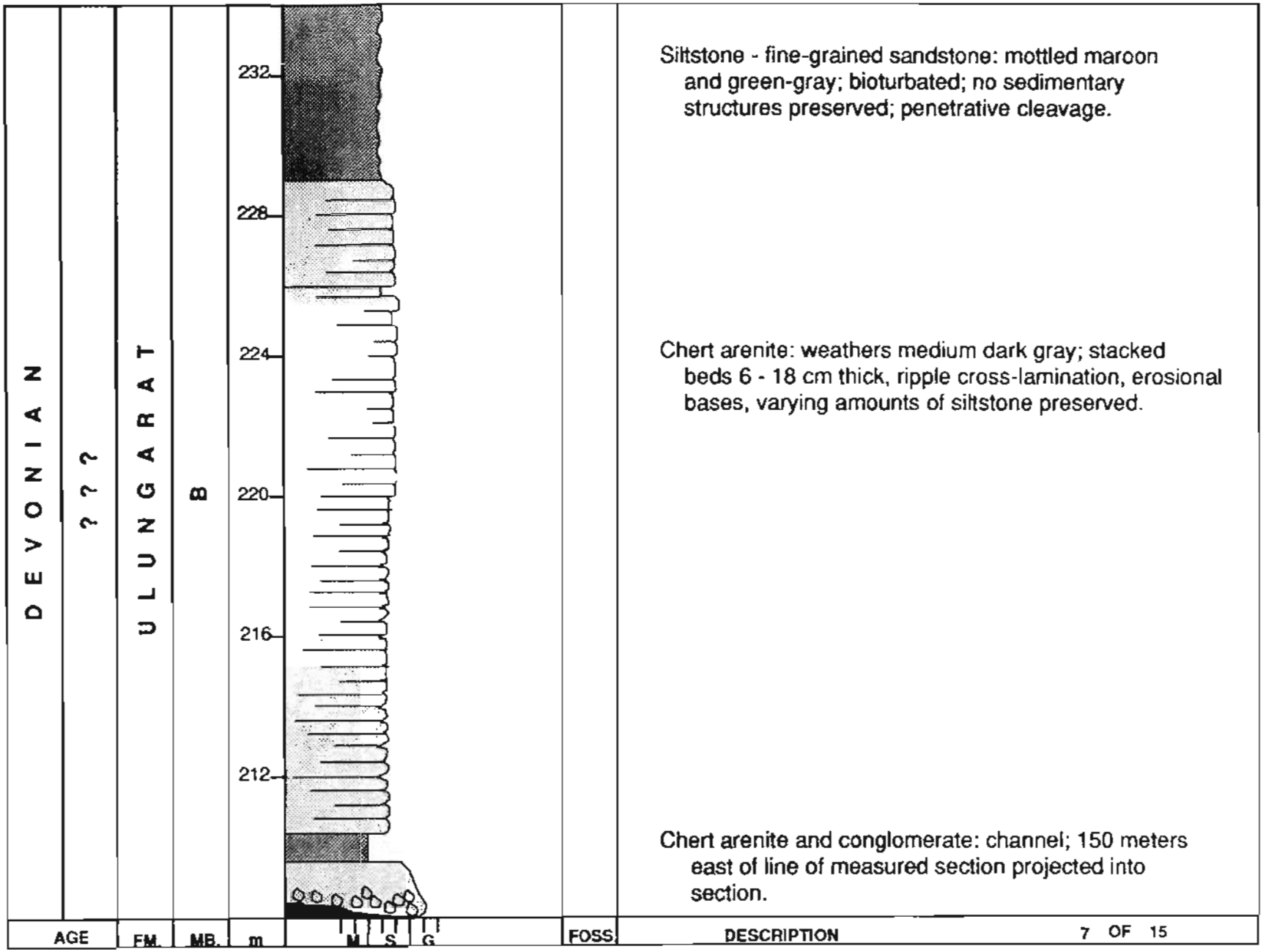
m
FOSS.
DESCRIPTION
6 OF 15
Sandy siltstone: maroon with irregular green-gray zones throughout, intensely bioturbated; rare fine-grained chert-arenite beds with ripple lamination; horizontal and vertical burrows; limonite-hematite surface stain.
Chert arenite: weathers with a hematite stain; erosional base.
Green-gray zone 1 cm thick preserved at top of mottled siltstone
Siltstone - fine-grained sandstone: mottled maroon and green-gray; bioturbated; no sedimentary structures preserved; penetrative cleavage.
Chert arenite: green-gray with 3 - 4 cm thick maroon colored on zone on upper surface.
Chert arenite; green-gray color.
Siltstone - fine-grained sandstone: mottled maroon and green-gray; bioturbated; no primary sedimentary structures preserved; penetrative cleavage.


DEVONIAN
? ? ?
ULUNGARAT
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232
228
224
220
216
212
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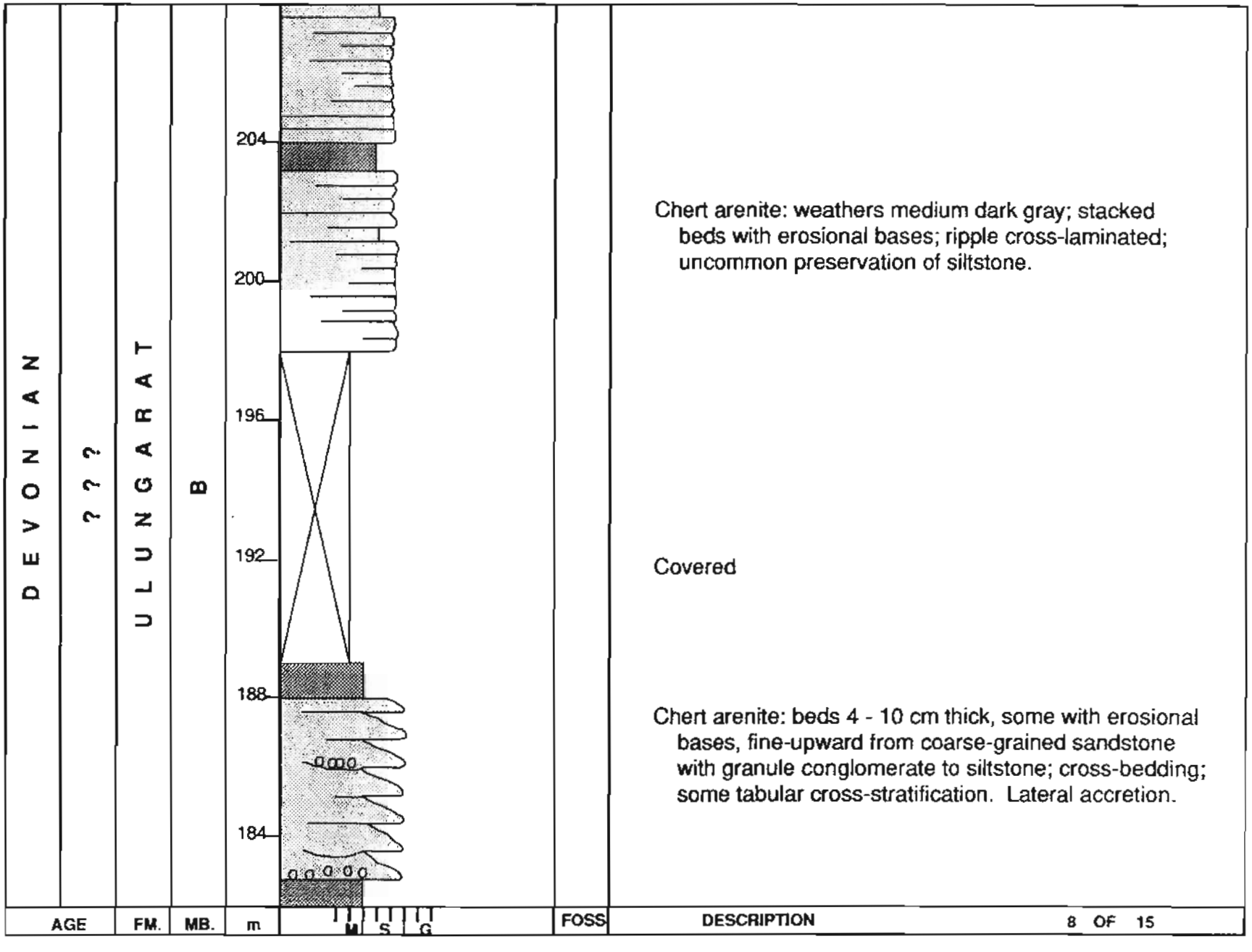
FOSS
DESCRIPTION
7 OF 15
Siltstone - fine-grained sandstone: mottled maroon and green-gray; bioturbated; no sedimentary structures preserved; penetrative cleavage.
Chert arenite: weathers medium dark gray; stacked beds 6 - 18 cm thick, ripple cross-lamination, erosional bases, varying amounts of siltstone preserved.
Chert arenite and conglomerate: channel; 150 meters east of line of measured section projected into section.

61


DEVONIAN
???
ULUNGARAT
B
204
200
196
192
188
184
M
S
G
Chert arenite: weathers medium dark gray; stacked beds with erosional bases; ripple cross-laminated; uncommon preservation of siltstone.
Covered
Chert arenite: beds 4 - 10 cm thick, some with erosional bases, fine-upward from coarse-grained sandstone with granule conglomerate to siltstone; cross-bedding; some tabular cross-stratification. Lateral accretion.
AGE
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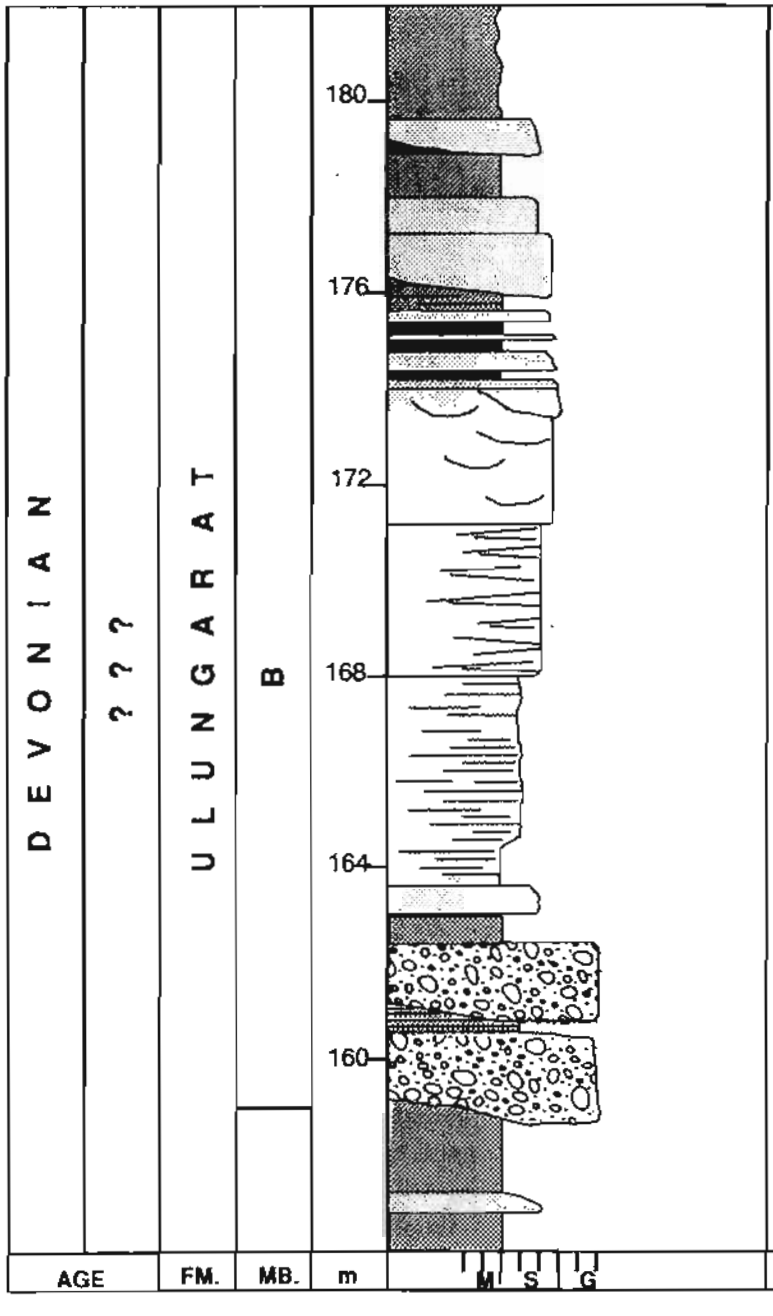
MB.
m
FOSS
DESCRIPTION
8 OF 15



Marine fossils are found only below 159 meters.

Siltstone: weathers rose-maroon color.

Chert arenite: weathers medium-gray; channels erosional into underlying shale and siltstone; thin laterally; fines upward.

Chert arenite: small channels (10 cm thick) with erosional bases; rare preservation of siltstone; root casts, mud cracks(?), ripple cross-laminated; some channels fine-upward from medium-grained sandstone with granule conglomerate to fine-grained sandstone; others show no change in grain size. Point bar and overbank deposits.

Chert arenite: weathers medium gray with black lichen; beds 10 - 18 cm thick, thin laterally.

Siltstone to fine-grained chert arenite: thin-bedded (1/2 - 2 cm thick); weathers green-gray to bronze with limonite spots.

Conglomerate: pulses of black and white chert pebbles fine upward to coarse-grained chert arenite; erosional base, flute casts, trough cross - stratified; overlying siltstone rarely preserved.

Siltstone to fine-grained chert arenite: some black shale; weathers medium gray; ripple cross-laminatied; medium-grained chert arenite bed 40 cm thick, cross-bedded.

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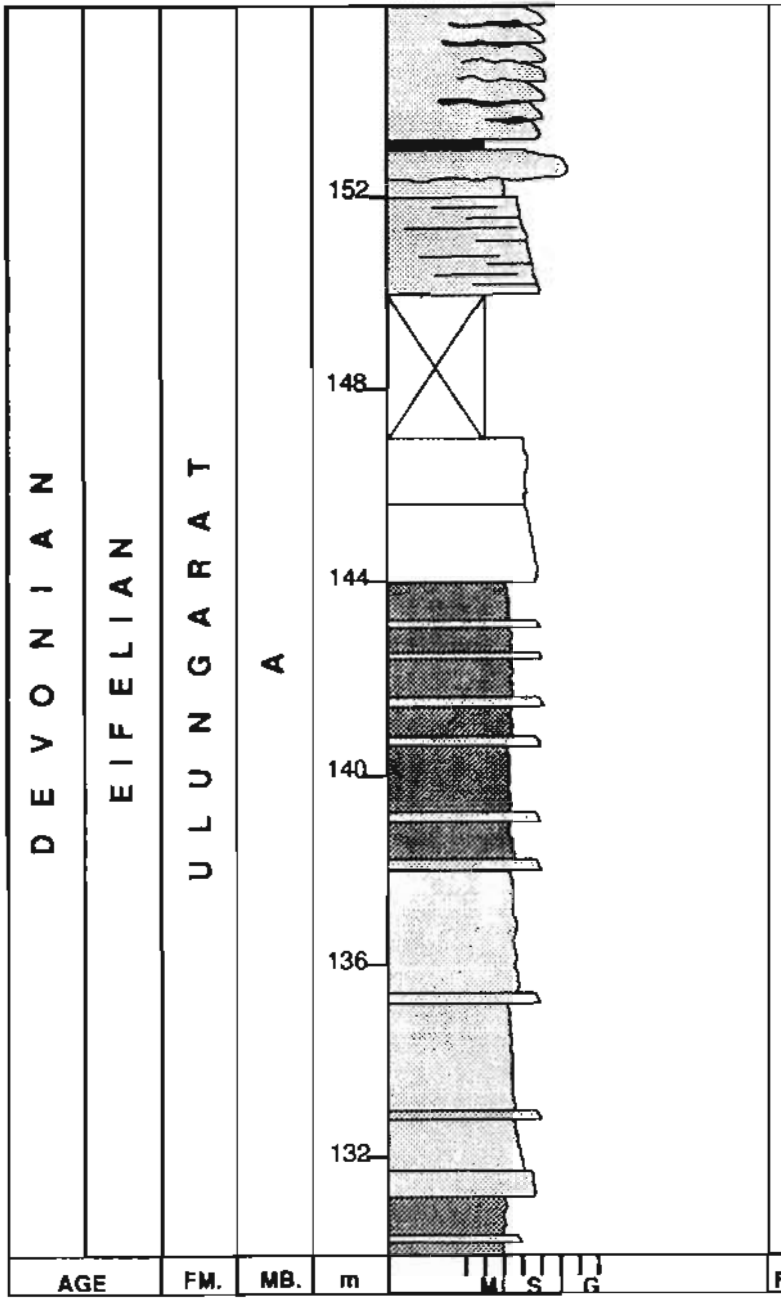

Chert arenite: beds 2 - 5 cm thick, thin laterally; ripple cross-laminated; bioturbated.

Chert arenite: fining-upward; beds 30 - 40 cm thick; erosional bases.

Chert arenite: 1 - 2 cm thick beds; ripple cross-laminated; some bioturbation; overlain by bioturbated siltstone.

Covered: float of silty shale.

Siltstone, sandstone, and shale: beds fine-upward; bioturbation.

Chert arenite: ripple cross-laminated; beds 2 - 4 cm thick; bioturbated with vertical burrows 1/4 cm across.

Siltstone with fine-grained sandstone intervals: weathers medium gray; rare medium-grained chert arenite beds with basal clasts to 1/2 cm; beds 2 - 3 cm thick and laterally discontinuous; 1 cm thick ironstone beds. Forms ragged weathering steep slope.

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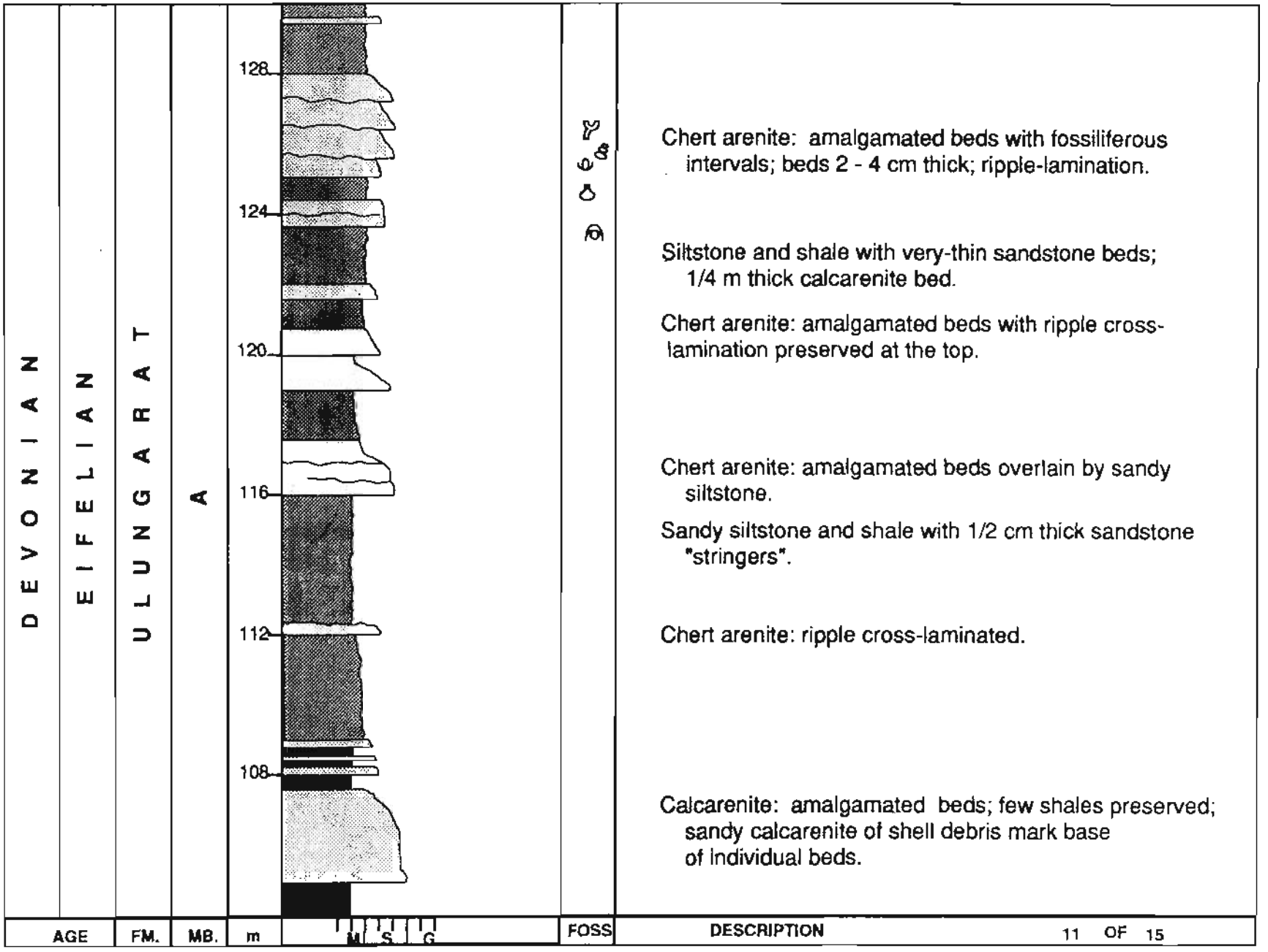
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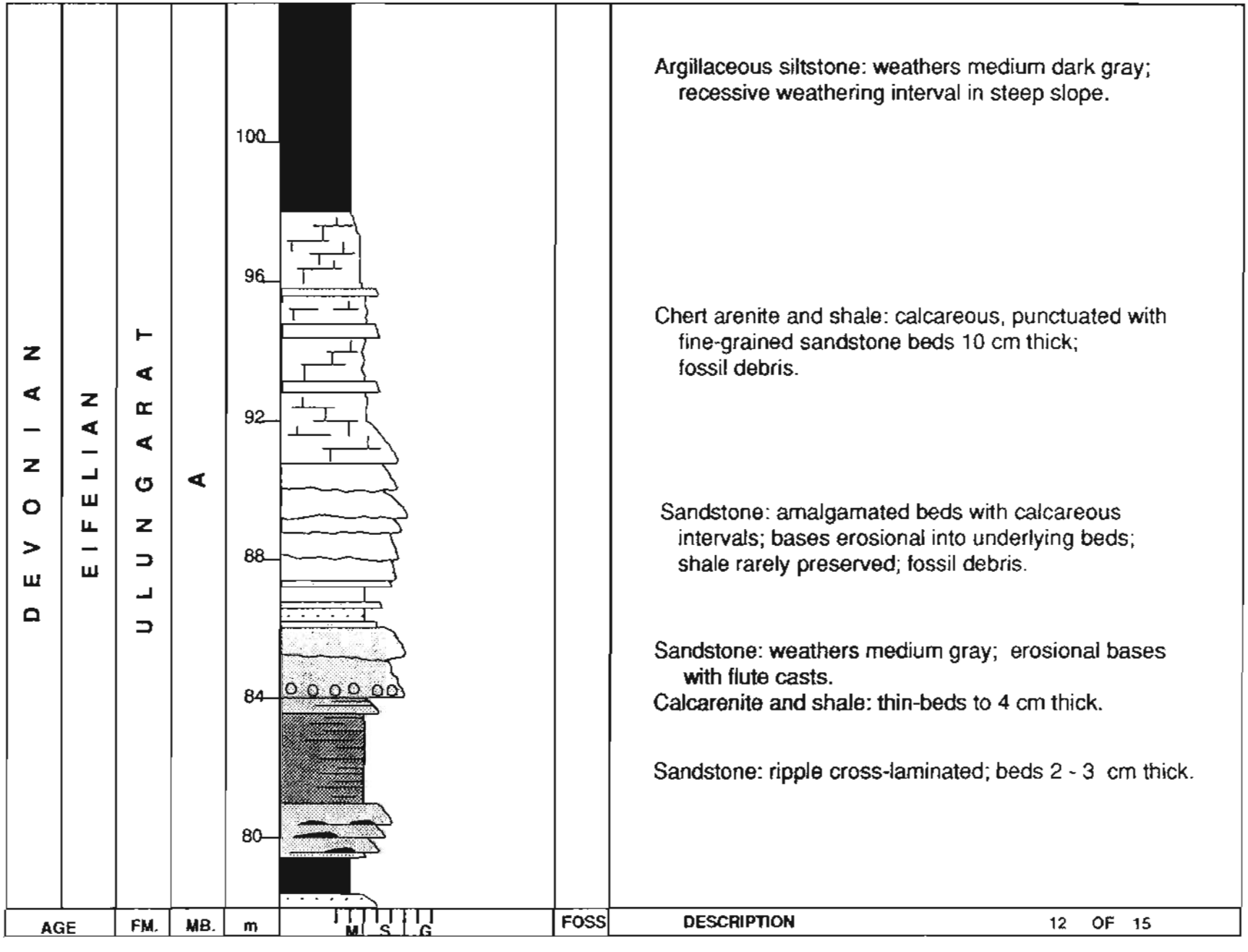
Chert arenite: amalgamated beds with fossiliferous intervals; beds 2 - 4 cm thick; ripple-lamination.
Siltstone and shale with very-thin sandstone beds; 1/4 m thick calcarenite bed.
Chert arenite: amalgamated beds with ripple cross-lamination preserved at the top.
Chert arenite: amalgamated beds overlain by sandy siltstone.
Sandy siltstone and shale with 1/2 cm thick sandstone "stringers".
Chert arenite: ripple cross-laminated.
Calcarenite: amalgamated beds; few shales preserved; sandy calcarenite of shell debris mark base of individual beds.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Argillaceous siltstone: weathers medium dark gray; recessive weathering interval in steep slope.
Chert arenite and shale: calcareous, punctuated with fine-grained sandstone beds 10 cm thick; fossil debris.
Sandstone: amalgamated beds with calcareous intervals; bases erosional into underlying beds; shale rarely preserved; fossil debris.
Sandstone: weathers medium gray; erosional bases with flute casts.
Calcarenite and shale: thin-beds to 4 cm thick.
Sandstone: ripple cross-laminated; beds 2 - 3 cm thick.
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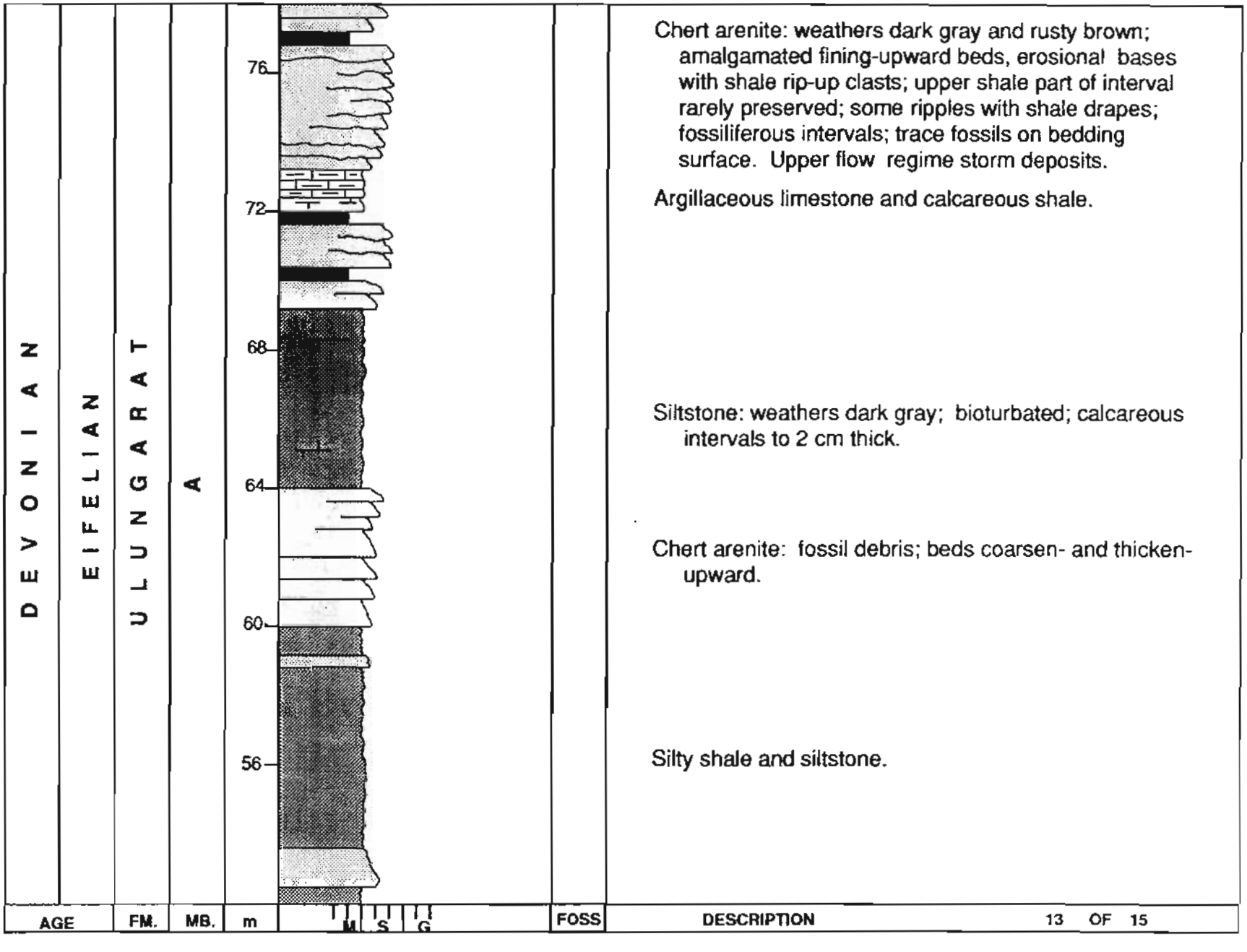


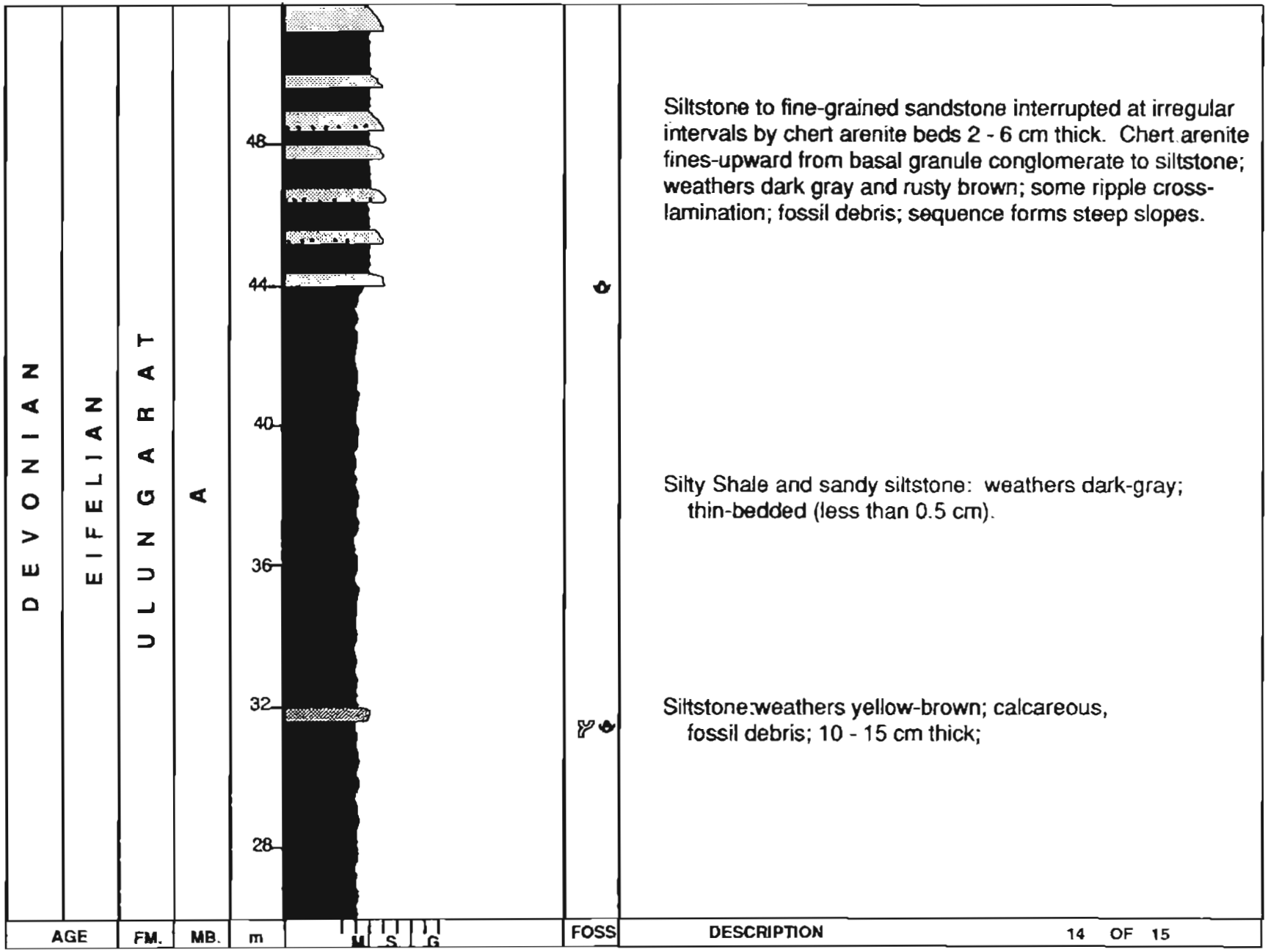
Chert arenite: weathers dark gray and rusty brown; amalgamated fining-upward beds, erosional bases with shale rip-up clasts; upper shale part of interval rarely preserved; some ripples with shale drapes; fossiliferous intervals; trace fossils on bedding surface. Upper flow regime storm deposits.

Argillaceous limestone and calcareous shale.

Siltstone: weathers dark gray; bioturbated; calcareous intervals to 2 cm thick.

Chert arenite: fossil debris; beds coarsen- and thicken-upward.

Silty shale and siltstone.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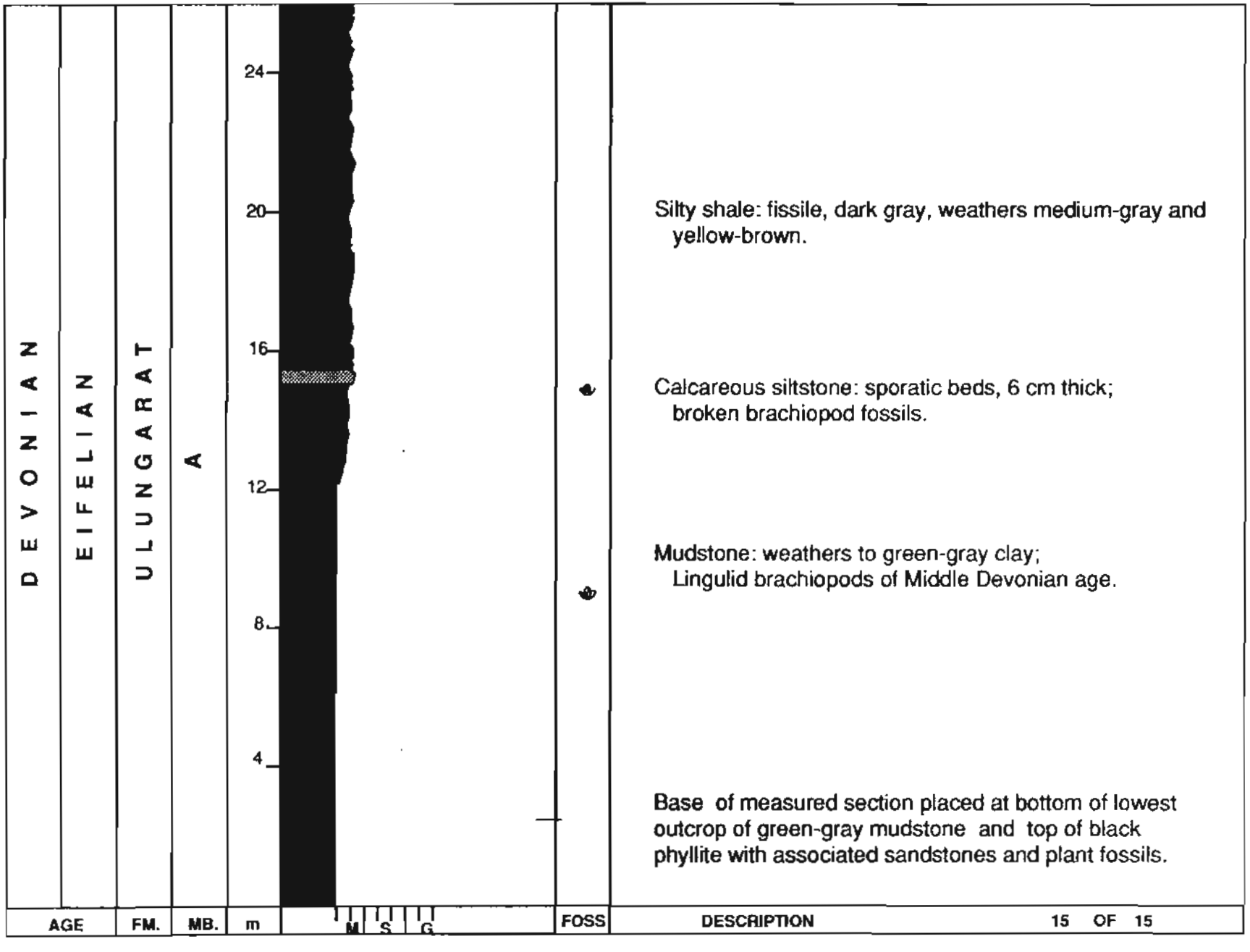
Siltstone to fine-grained sandstone interrupted at irregular intervals by chert arenite beds 2 - 6 cm thick. Chert arenite fines-upward from basal granule conglomerate to siltstone; weathers dark gray and rusty brown; some ripple cross-lamination; fossil debris; sequence forms steep slopes.
Silty Shale and sandy siltstone: weathers dark-gray; thin-bedded (less than 0.5 cm).
Siltstone:weathers yellow-brown; calcareous, fossil debris; 10 - 15 cm thick;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Silty shale: fissile, dark gray, weathers medium-gray and yellow-brown.
Calcareous siltstone: sporatic beds, 6 cm thick; broken brachiopod fossils.
Mudstone: weathers to green-gray clay; Lingulid brachiopods of Middle Devonian age.
Base of measured section placed at bottom of lowest outcrop of green-gray mudstone and top of black phyllite with associated sandstones and plant fossils.
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