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Alaska Division of Geological and Geophysical Surveys

# PRELIMINARY DETAILED STRATIGRAPHIC SECTIONS OF THE CARBONIFEROUS LISBURNE GROUP, CENTRAL SHUBLIK TO THE NORTHERN FRANKLIN MOUNTAINS, NORTHEASTERN ALASKA

By

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This report summarizes the results of field work conducted during the summer of 1987 on the stratigraphy and sedimentology of the Carboniferous Lisburne Group in the central Shublik and northern Franklin Mountains, northeastern Alaska. This study was part of a cooperative research program of the University of Alaska-Fairbanks and the Alaska Division of Geological and Geophysical Surveys, and represents one of the integrated geologic research projects involving the structure and stratigraphy in the Arctic National Wildlife Range.

## OBJECTIVES OF THE PROJECT

The purpose of this study was to examine the Lisburne Group across its depositional strike along a north-south transect from the Shublik to the northern Franklin Mountains (Figures 1,2). A total of three composite sections were measured by Jacob's staff method and described in detail. Sections 87A - C (#10, Figures 1,2), representing a complete section of the Lisburne Group, were measured in the central Shublik Mountains. Another complete section, composed of sections 87D - E (# 11 Figures 1,2) was measured in a creek bed and along a ridge in the "Fourth Range". An incomplete composite section, represented by sections 87F - G (#12, Figures 1,2), was measured along a spur ridge in the Plunge Creek area. A talus slope covers most of the Alapah Formation, however, the uppermost 43 meters of the Alapah along with the entire Wahoo Formation is exposed in the Plunge Creek area section. A tentative correlation diagram for the three composite sections is shown in Figure 3. Detailed geologic maps and stratigraphic columns of the measured sections are given in Appendices 1 and 2.

Numerous samples were collected from each of these sections for petrography

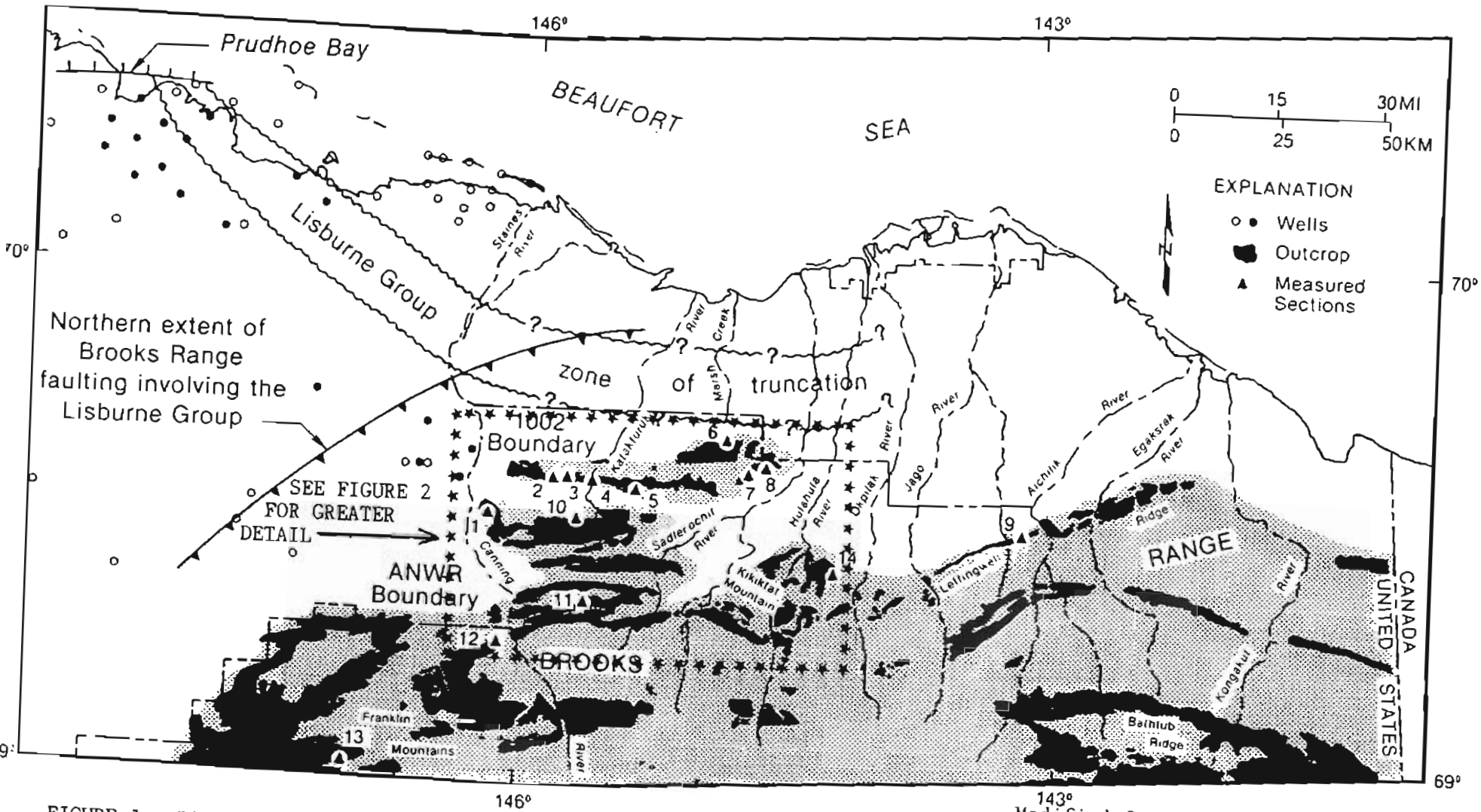
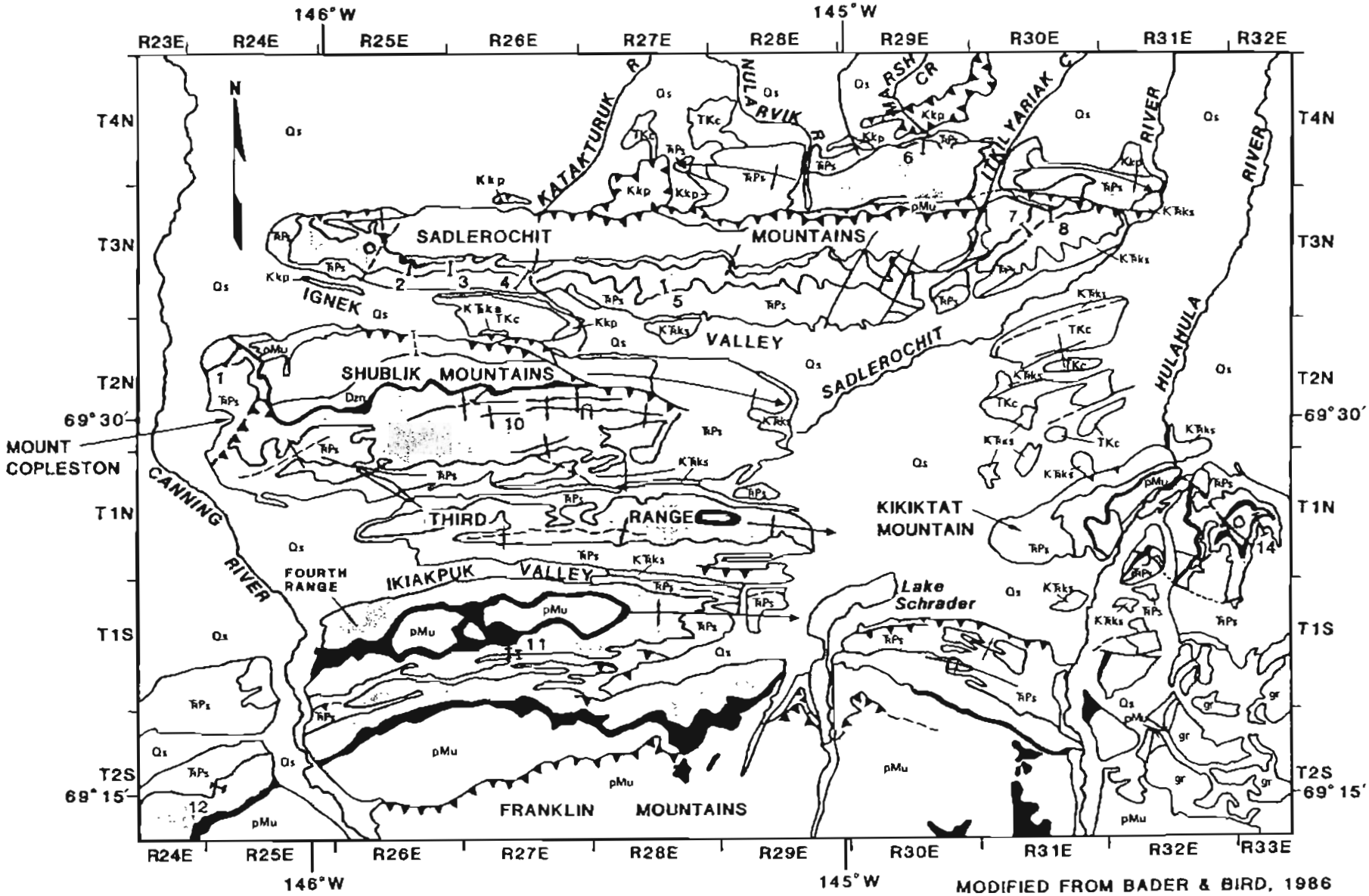



FIGURE 1. Black shaded areas represent Lisburne Group outcrops. Composite section 10 made up of 87A, 87B and 87C. Composite section 11 made up of 87D, 87E. Composite section 12 made up of 87F and 87G.

Modified from Bird and Molenaar, 1987




GEOLOGY OF THE NORTHWESTERN ARCTIC NATIONAL WILDLIFE REFUGE

FIGURE 2. Black shaded areas represent Endicott Group outcrops. Gray shaded areas represent Lisburne Group rocks. Composite section 10 equals 87A + 87B + 87C. Composite section 11 equals 87D + 87E. Composite section 12 equals 87F + 87G.

# LISBURNE GROUP – TENTATIVE STRATIGRAPHIC CORRELATION DIAGRAM
## CANNING RIVER TRANSECT

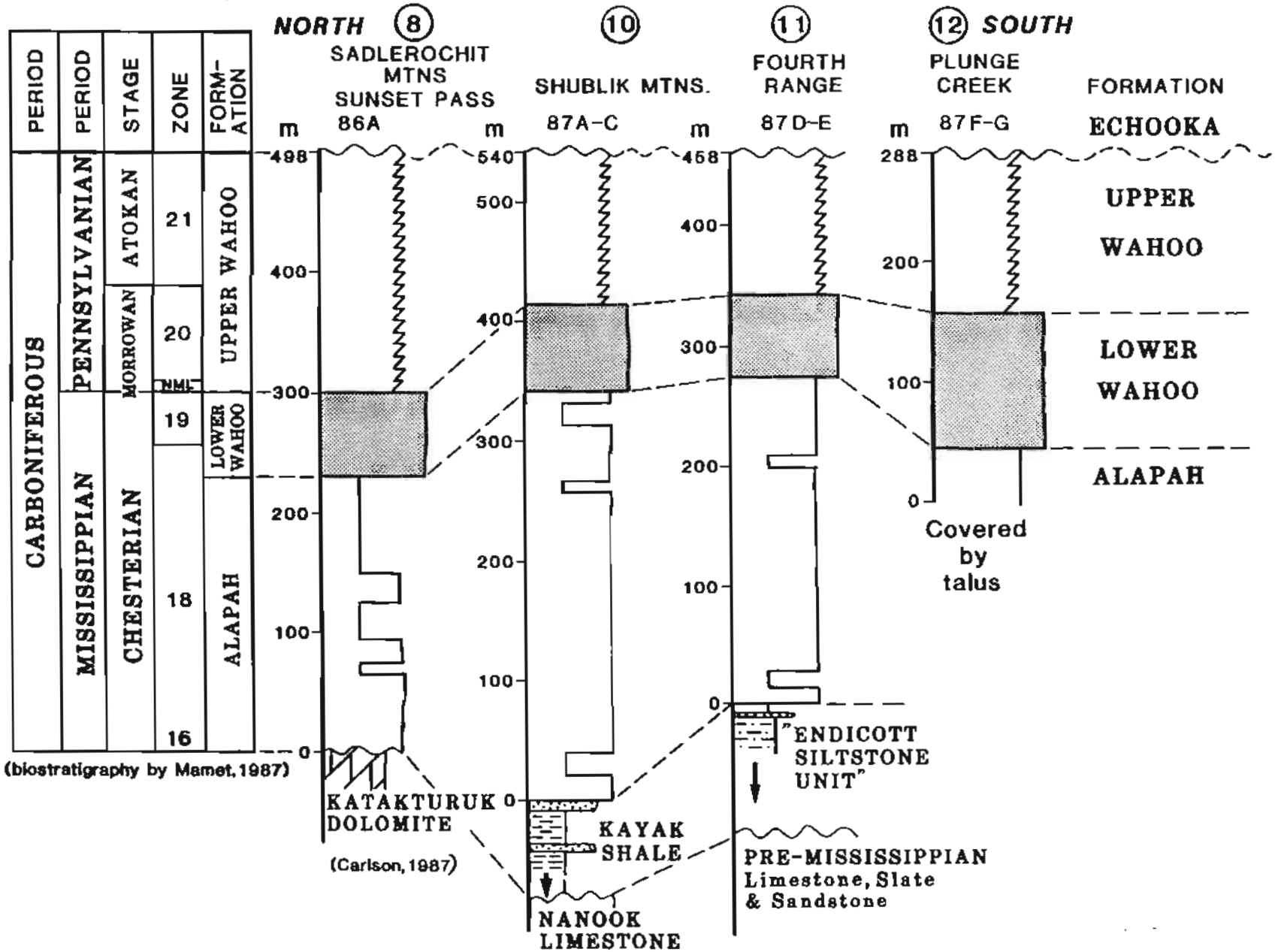



FIGURE 3

and biostratigraphy in order to determine carbonate microfacies, document lithologic cycles, and interpret depositional environments. The sampling interval varied for the different lithologic units. Sampling in the Pennsylvanian upper Wahoo Formation was at 0.5 meter intervals in order to document small-scale shallowing-upward cycles. The cliff-forming Mississippian lower Wahoo Formation had less lithologic variability, and was therefore sampled at 2.0 meter intervals. The Alapah Formation was sampled at a minimum of 5.0 meter intervals within the central Shublik Mountains and the "Fourth Range", and at a minimum of 3.0 meter intervals for the incomplete Alapah section of the Plunge Creek area.

This study will address four specific questions regarding how different aspects of the Lisburne Group carbonates are affected in a north-south transition:

1. What are the vertical and lateral relationships within the Lisburne Group?
2. What were the depositional environments across the depositional strike of the Lisburne Group platform?
3. What is the diagenetic history of the Lisburne Group rocks, and specifically, how has diagenesis affected the porosity and permeability of potential reservoir rocks?
4. What are the ages of the Lisburne Group rocks and the underlying and overlying bounding units? Can biostratigraphy or cyclic stratigraphy be used as a means of correlating similar shallowing-upward cycles across the carbonate platform?

## ACCOMPLISHMENTS OF THE PROJECT

The preliminary results of the field study are presented below. The units are discussed in stratigraphic order, with the oldest unit appearing first. Comparisons are drawn based on field observations of the individual units within the central Shublik and northern Franklin Mountains.

### ENDICOTT GROUP

The Endicott Group is represented by the Kayak Shale Formation in the section measured in the central Shublik Mountains. It is composed of mostly black, fissle shale in the lower part and grades upward to include thin-medium bedded sandy limestones in the upper part. The boundary between the Kayak Shale and the Alapah Formation is conformable and gradational. Petrographic analysis will be required to allow for a more precise definition of this gradational boundary. The thickness of the exposed Kayak Shale, including the sandy limestone beds, is estimated to be about 200 feet at the measured section area.

In the "Fourth Range", the Endicott Group is represented by the "unnamed siltstone unit" (Bader and Bird, 1986). Detatchment folding is common in the lower part of the unit and progressively dies out upsection. The lithology consists of red-brown, coarse-grained sandstones alternating with siltstone beds. Channelized conglomerate beds occur locally within the lower-middle part of the unit. The upper part of the unit is composed of black siltstone and silty shale interbedded with black, sandy(?) argillaceous limestones. Within the uppermost limestone bed of the Endicott "siltstone unit", colonial corals were observed. The boundary with the overlying Alapah Formation is conformable and is easily distinguished by the first appearance of buff/light-gray weathered limestone above the uppermost occurrence of black shale.

## LISBURNE GROUP

The Carboniferous Lisburne Group is divided up into the Alapah and Wahoo Formations (Brosgé, et al., 1962). The Wahoo Formation can be further subdivided into upper and lower mappable units.

### ALAPAH FORMATION

The lower Alapah in the central Shublik Mountain area contains several intervals of thick-bedded/massive, light/medium-gray, peloidal-oolitic grainstone intervals. The grainstones may have formed as shallow-marine shoals which extended from the Shublik Mountains south to the "Fourth Range". Less grainstone occurs farther to the south in the "Fourth Range" suggesting a slightly deeper water environment. Cyclicity is evident in the lower Alapah Formation, but will have to be examined in more detail petrographically in order to understand its nature and origin.

The upper Alapah is composed dominantly of dark-gray/black peloidal mudstones which are indicative of a restrictive (lagoonal?) depositional environment. Also associated with the upper Alapah Formation are dolomitic intervals, algal laminations, calcite replacement nodules, and collapse breccias formed in intertidal-supratidal environments.

Whereas Carlson (1986) and Imm (1986) were able to subdivide the Alapah Formation into a lower cliff-forming unit and an upper dark-colored slope-forming unit in the Sadlerochit and northwestern Shublik Mountains, recognition of these map units were not readily apparent within my study areas. The difference could be related to a decrease in the amount of cliff-forming grainstones towards the south.

Notable variations in the Alapah Formation occur within the central Shublik Mountains and "Fourth Range" (Figure 3). The greater thickness in

the central Shublik Mountain section may indicate increased sedimentation rates and/or subsidence rates in this area. Age control and petrographic data will allow me to better understand the cause of these thickness variations.

## WAHOO FORMATION

### Lower Wahoo Unit

The lower Wahoo forms a distinct mappable cliff-forming unit above the Alapah Formation. In all three measured sections, the unit was composed of primarily thick-bedded, light/medium-gray, crinoid-bryozoan packstone. The depositional environment of the lower Wahoo was an open-marine setting with good water circulation.

Of the three measured sections, the Plunge Creek area section has the thickest lower Wahoo unit and suggests that the unit is thickening to the south (Figure 3). Increased subsidence and sedimentation rates in the deeper portions of a south-facing ramp may be responsible for this thickening trend towards the south. Age control on the upper boundary is especially needed to understand this thickness variation, because the boundary was not as easily recognized at Plunge Creek in comparison to the sections farther to the north.

### Upper Wahoo Unit

The boundary between the lower and upper Wahoo units in the field was defined on the basis of the first appearance of a yellow weathering dolomite bed. Dolomite beds are common in the upper Wahoo giving it a yellow weathering appearance useful for mapping purposes. The upper part of the unit is characterized by ledge and slope topography which results from

numerous shallowing-upward sequences. This ledge and slope topography is best seen on weathered ridge tops, and is more difficult to recognize in fresher exposures such as those along steep drainages (Appendix 1, section 87E).

Oolitic grainstones are common in the upper Wahoo Formation of the central Shublik Mountains and are indicative of a shoaling environment. The oolitic grainstone facies becomes drastically reduced farther to the south in the "Fourth Range" and Plunge Creek areas. An increase in the amount of crinoids and bryozoans within these two areas to the south suggests more open-marine and less agitated depositional environments. Collectively, these observations seem to indicate that the east-west trending ooid grainstone belt pinched out toward the south.

Several fissle shale intervals were noted in the upper Wahoo Formation in the central Shublik Mountains and "Fourth Range". The shale intervals are important because they are used as a means of correlation on the electric logs for the wells in the Lisburne Field at Prudhoe Bay. Microfacies analysis of the shales and associated lithologies may help to determine if the shale represents terrigenous sediments mantling the carbonate platform during a relative sea water lowstand, or alternatively, a condensed transgressive shale that accumulated before carbonate sedimentation became re-established following the drowning.

Carlson (1987) has identified approximately thirty shallowing-upward cycles within the Pennsylvanian upper Wahoo unit in the eastern Sadlerochit Mountains (Figure 4). An important part of my research will be to determine if these cycles can be correlated with those in my measured sections, and

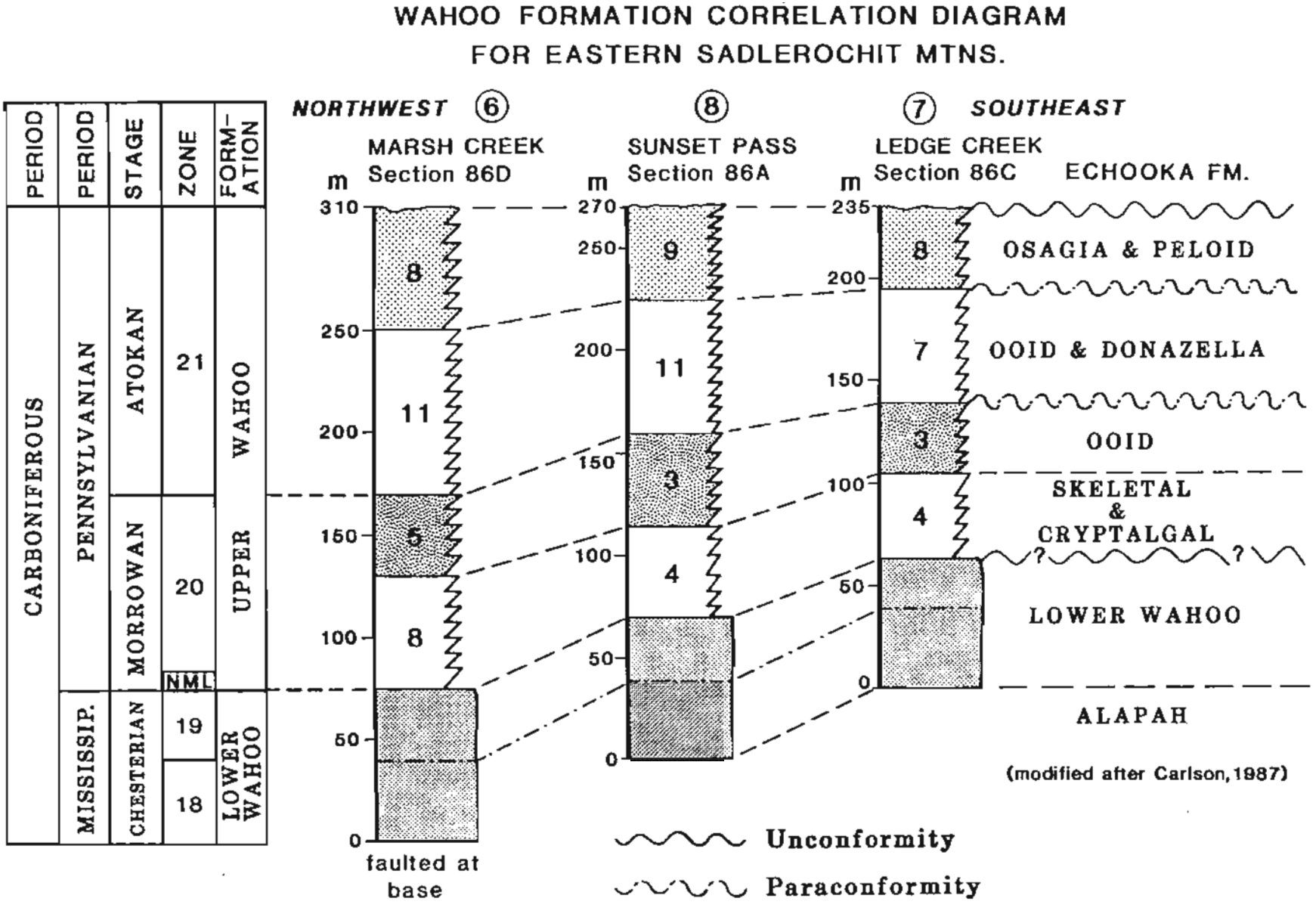

WAHOO FORMATION CORRELATION DIAGRAM
FOR EASTERN SADLEROCHIT MTNS.
PERIOD
PERIOD
STAGE
ZONE
FORM-ATION
CARBONIFEROUS
PENNSYLVANIAN
MISSISSIP.
ATOKAN
MORROWAN
CHESTERIAN
21
20
NML
19
18
WAHOO
UPPER
LOWER WAHOO
NORTHWEST
⑥
MARSH CREEK
Section 86D
⑧
SUNSET PASS
Section 86A
⑦
SOUTHEAST
LEDGE CREEK
Section 86C
ECHOOKA FM.
m
310
250
200
150
100
50
0
8
11
5
8
m
270
250
200
150
100
50
0
9
11
3
4
m
235
200
150
100
50
0
8
7
3
4
OSAGIA & PELOID
OOID & DONAZELLA
OOID
SKELETAL
&
CRYPTALGAL
LOWER WAHOO
ALAPAH
faulted at
base
Unconformity
Paraconformity
(modified after Carlson, 1987)

FIGURE 4.

how they relate to paleogeography farther to the south.

## ECHOOKA FORMATION

The Echooka Formation unconformably overlies the upper Wahoo unit and is composed of red-brown weathering, medium/coarse-grained, quartzitic sandstone. The contact in the three measured section intervals was not well-exposed, however, the contact was observed approximately 6 miles to the west of the central Shublik Mountain measured section on the ridge top just south of Nanook Creek. Here the Echooka consisted of a dark-green weathered, glauconitic sandstone. The upper Wahoo Limestone beneath the unconformity had numerous solution pits, and locally, a possible terra rosa soil was evident.

Channeling of the Echooka in the western Sadlerochit and Shublik Mountains as reported by Imm (1986) was not observed at the three measured sections or at the contact location. This could account for the greater thicknesses of the upper Wahoo unit measured at these locations in comparison to the upper Wahoo farther to the northwest.

## CONTINUING STUDIES

Detailed petrographic study will allow me to develop a better understanding of lithologic cycles within the Lisburne Group. Approximately 1000 samples were collected during the field season and are currently being processed for thin section preparation. The rock types noted on the stratigraphic columns (Appendix 2) are tentative field calls, and will be refined during the petrographic study. Dr. Bernard Mamet, of the University of Montreal, has

offered to do biostratigraphy (forams and algae) on my samples and will provide age control. Conodont samples collected at major unit boundaries will be processed and will be examined by Anita Harris, of the U.S. Geological Survey, Reston, who will provide both age control and conodont alteration indices. Well-constrained age dates, coupled with a greater understanding of the lateral and vertical lithologic succession in the study areas, will allow for a more precise definition of the Lisburne Group depositional environments across the carbonate platform.

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Bird, K.J., and Molenaar, C.M., 1987, Stratigraphy, in Bird, K.J. and Magoon, L.B., eds., Petroleum geology of the northern part of the Arctic National Wildlife Refuge, northeastern Alaska: USGS Bulletin 1778, p.37-59.

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Imm, T.A., 1986, Preliminary detailed stratigraphic sections and bedrock maps of the Lisburne Group rocks, Mt. Michelson C-3 and C-4 quadrangles, western Sadlerochit Mountains and northwest Shublik Mountains, northeastern Alaska: Alaska Division of Geological and Geophysical Surveys Public Data File Report 86-86e.

# APPENDIX 1

## GEOLOGIC MAPS SHOWING LOCATION OF MEASURED SECTIONS

## MAP UNITS AND SYMBOLS FOR GEOLOGIC MAPS

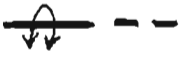
| | | |
|---|---|---|
| PTrs | - | Sadlerochit Group, undifferentiated (Permian-Triassic)<br>Ivishak Formation (Triassic)<br>Echooka Formation (Permian) |
| Pe | - | Echooka Formation (Permian) |
| MPw | - | Wahoo Limestone Formation, undifferentiated (Mississippian-Pennsylvanian) |
| Pwu | - | upper Wahoo Limestone Formation (Pennsylvanian) |
| Mwl | - | lower Wahoo Limestone Formation (Mississippian) |
| Ma | - | Alapah Limestone Formation (Mississippian) |
| Ms | - | unnamed siltstone unit, Endicott Group (Mississippian) |
| Mk | - | Kayak Shale (Mississippian) |
| DZn | - | Nanook Limestone (Devonian-Cambrian or Late Proterozoic) |
| pMu | - | sedimentary and metamorphic rocks, undifferentiated (pre-Mississippian) |



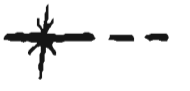
Contact - solid where well-exposed; dashed where approximated; dot-dashed where uncertain; queried where unknown.

Thrust fault - sawteeth on upper plate; solid where well exposed; dashed where approximated.

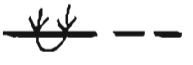
Axial trace of an anticline - solid where well-exposed; dashed where approximated.



Axial trace of an overturned anticline - solid where well-exposed; dashed where approximated.



Axial trace of a syncline - solid where well-exposed; dashed where approximated.



Axial trace of an overturned syncline - solid where well-exposed; dashed where approximated.


Strike and dip of beds

Measured section traverse

87A-G — Measured section designations (summer of 1987)

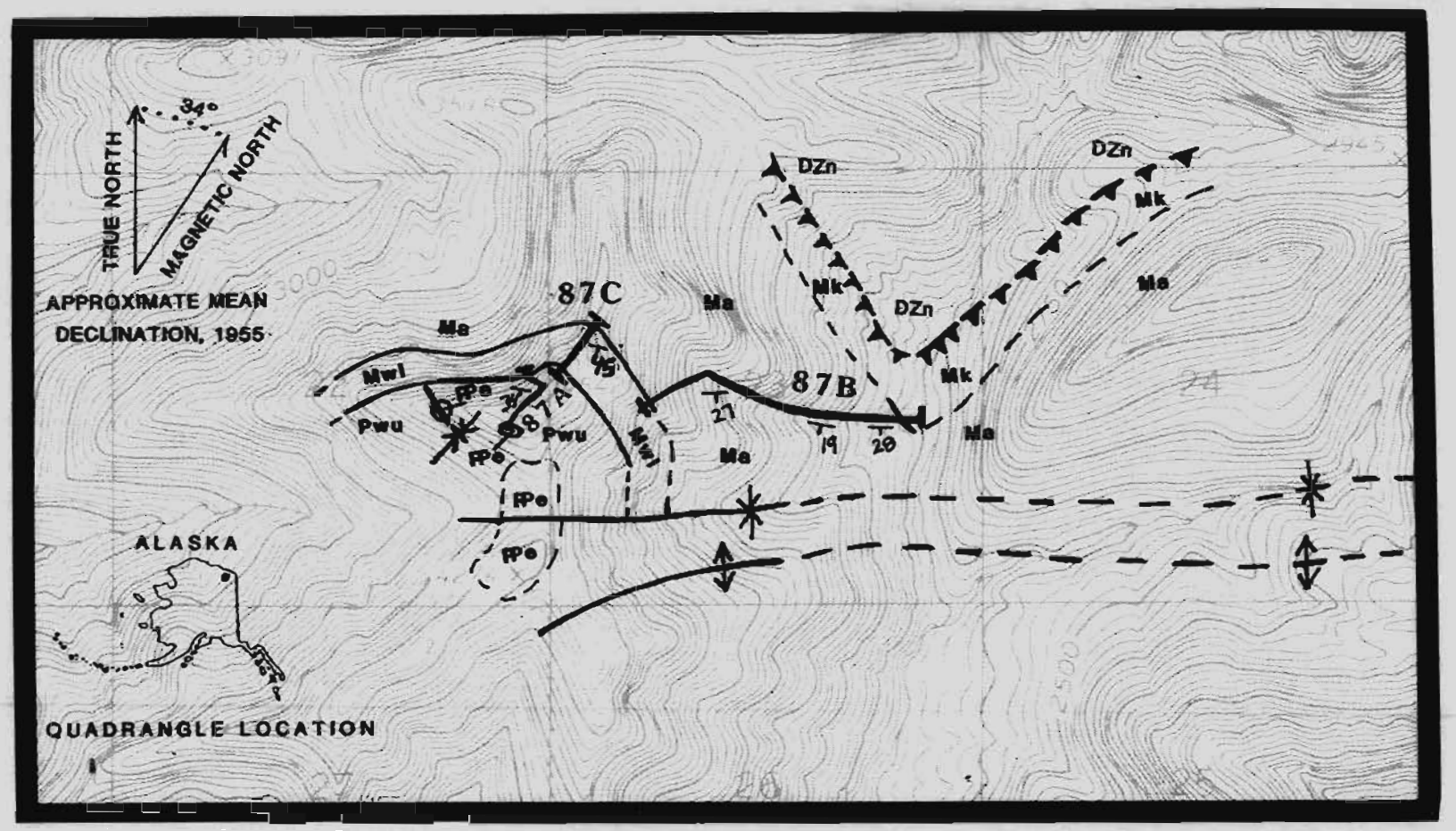
68A-1 — Measured section designation (Armstrong et al., 1970)

## COORDINATES OF MEASURED SECTIONS

Mt. Michelson Quadrangle

| MEASURED SECTION | TOWNSHIP | RANGE | SECTION |
|---|---|---|---|
| 87A | 2North | 26East | 22East |
| 87B | 2North | 26East | 23East-West |
| 87C | 2North | 26East | 23Northwest |
| 87D | 1South | 27East | 17SE, 20NE |
| 87E | 1South | 27East | 16SW, 21NW |
| 87F | 2South | 25East | 19South |
| 87G | 2South | 25East | 19Southeast |
| 68A-1* | 1South | 27East | 15S, 22S |

* see Armstrong et al., 1970 for description of section




SCALE 1 : 25,000

Base map by USGS, 1955

0 1 2 MILES

CONTOUR INTERVAL 50 FEET

# GEOLOGIC MAP OF THE LISBURNE GROUP IN PART OF THE MT. MICHELSON C-3 QUADRANGLE, CENTRAL SHUBLIK MOUNTAINS, NORTHEASTERN ALASKA

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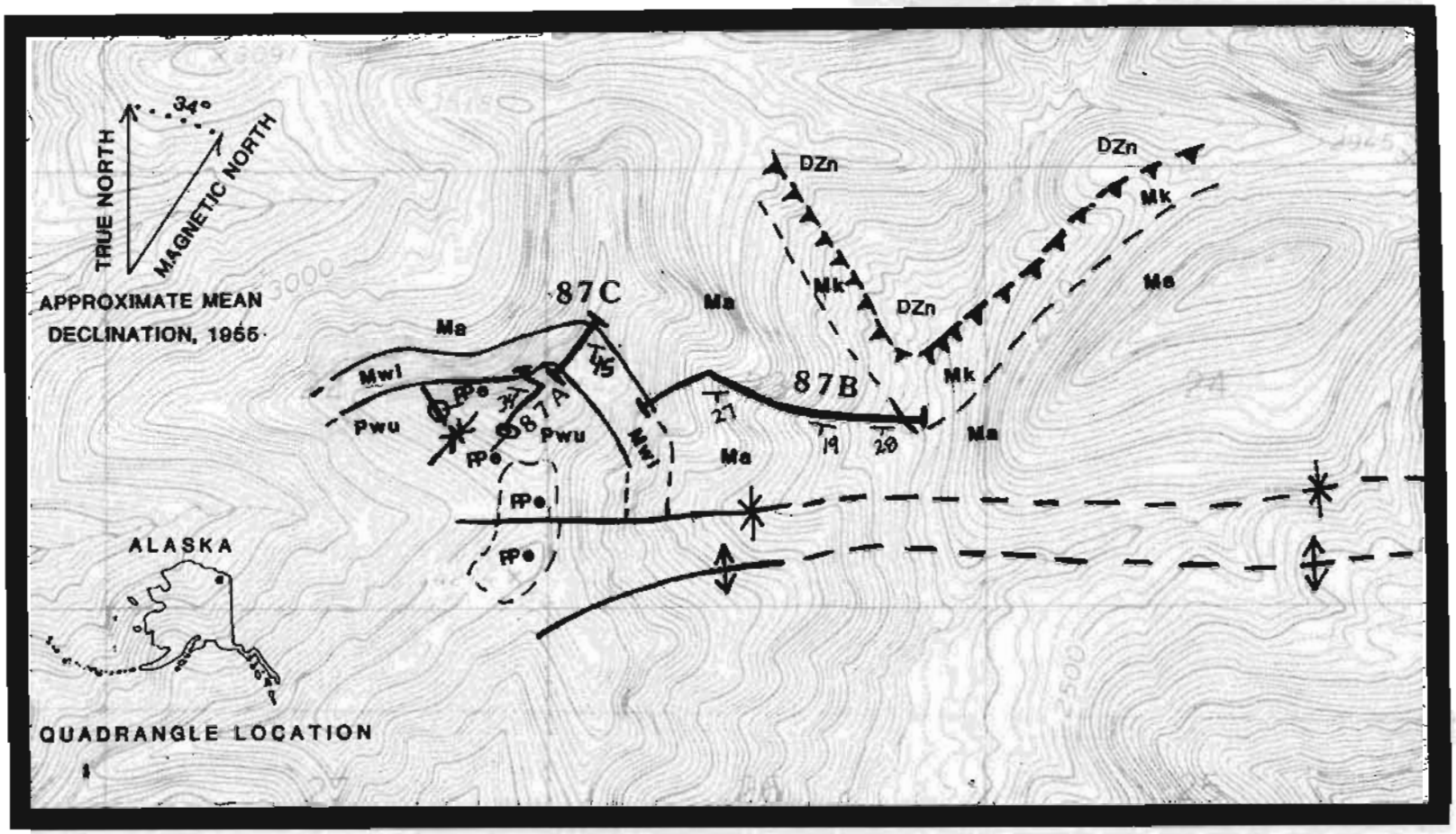


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Base map by USGS, 1955

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CONTOUR INTERVAL 50 FEET

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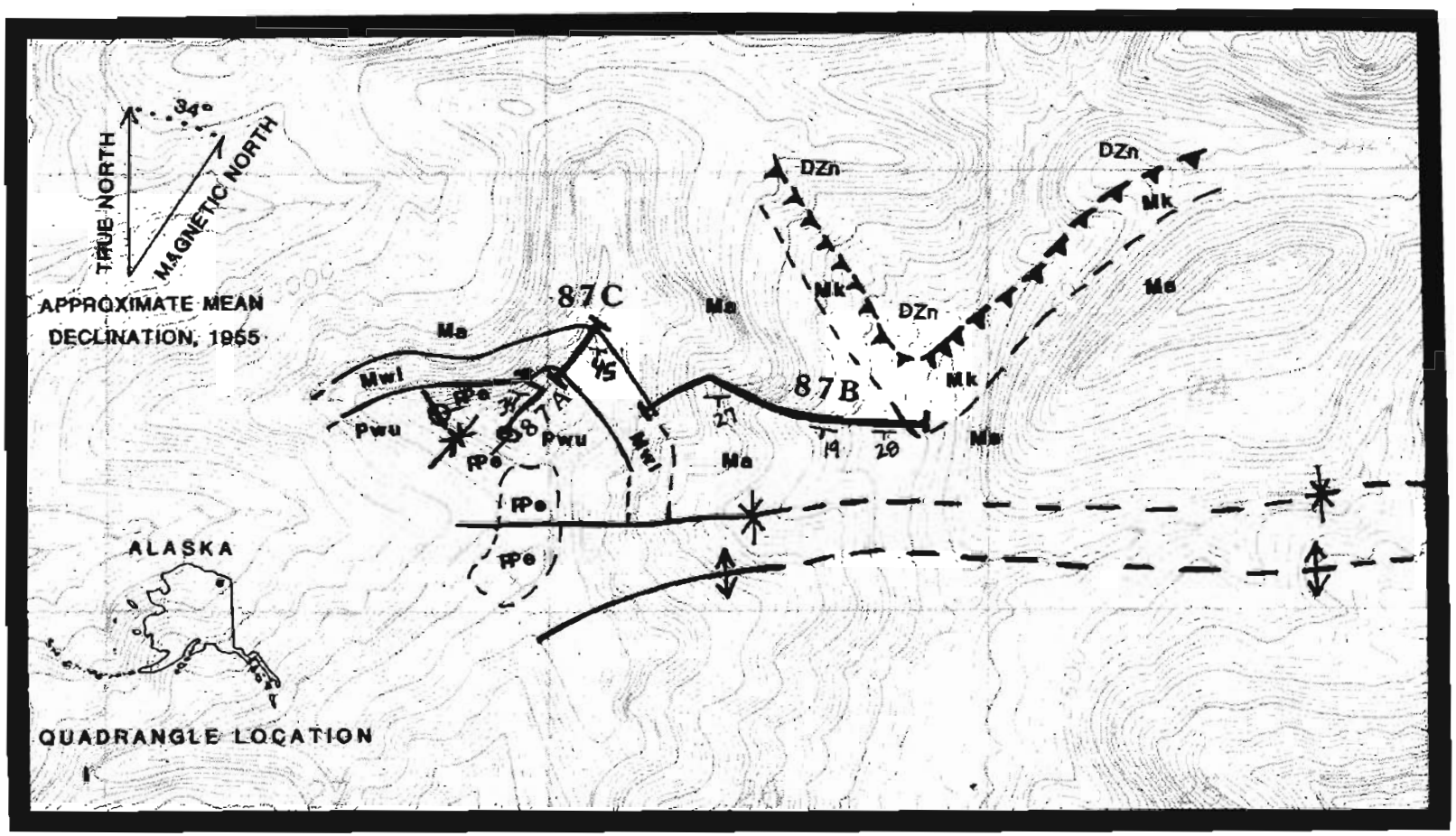


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Base map by USGS, 1955

0 1 2 MILES

CONTOUR INTERVAL 50 FEET

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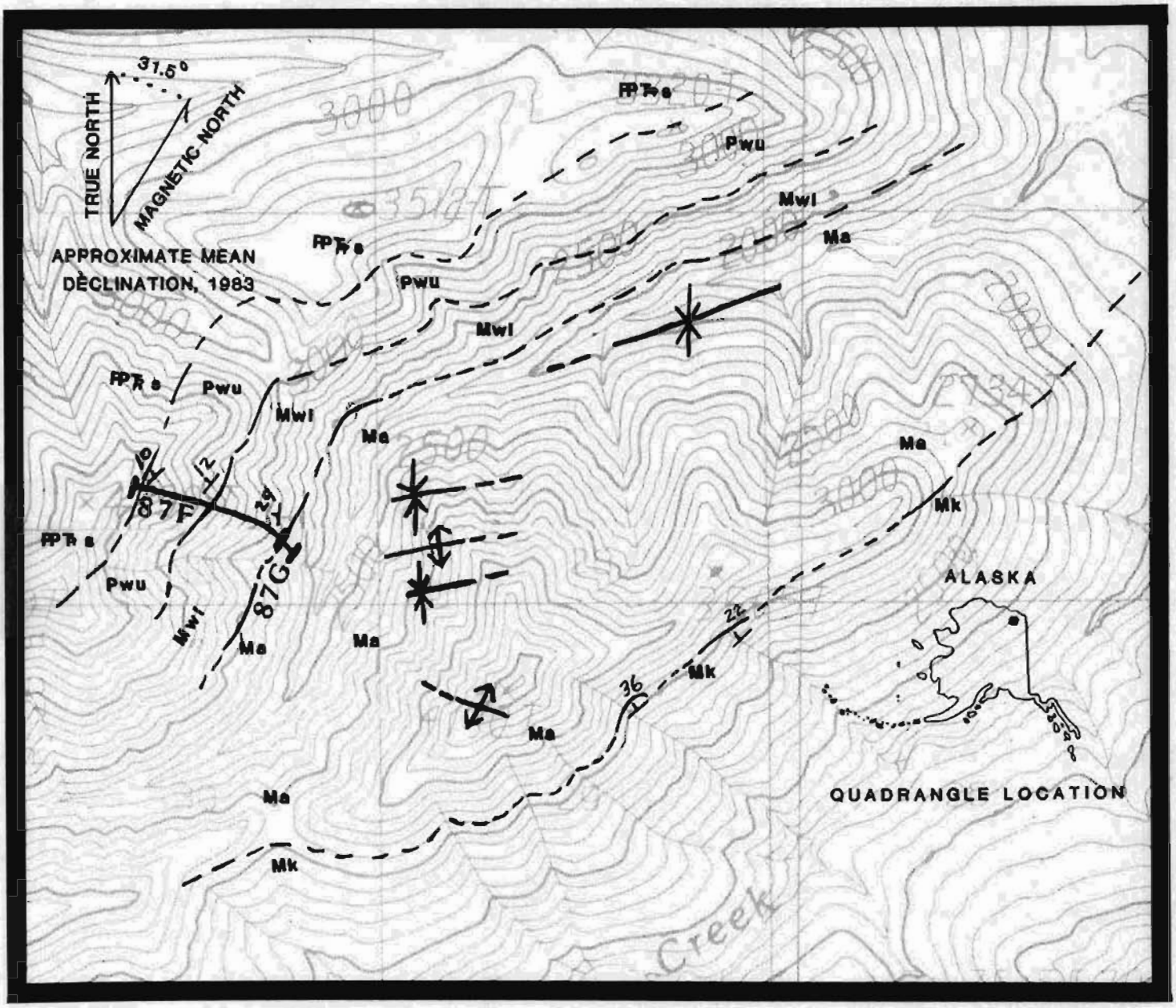



Base map by USGS, 1983

SCALE 1 : 25,000

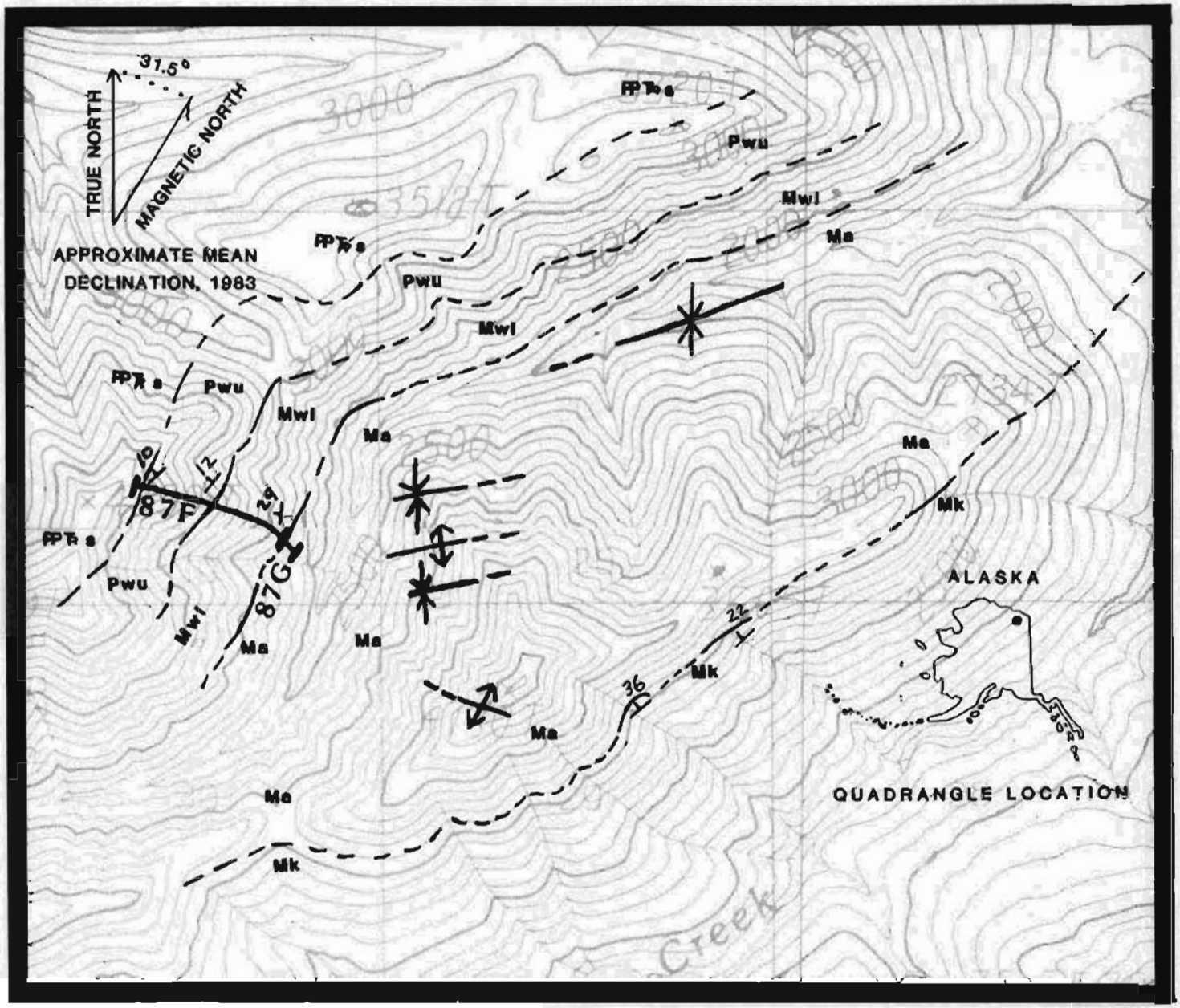
0 1 2 MILES

CONTOUR INTERVAL 100 FEET

# GEOLOGIC MAP OF THE LISBURNE GROUP IN PART OF THE MT. MICHELSON A-4 & B-4 QUADRANGLES, PLUNGE CREEK AREA, NORTHEASTERN ALASKA

By Paul D. Gruzlovic

February 1988




Base map by USGS, 1983

SCALE 1 : 25,000

0 1 2 MILES

CONTOUR INTERVAL 100 FEET

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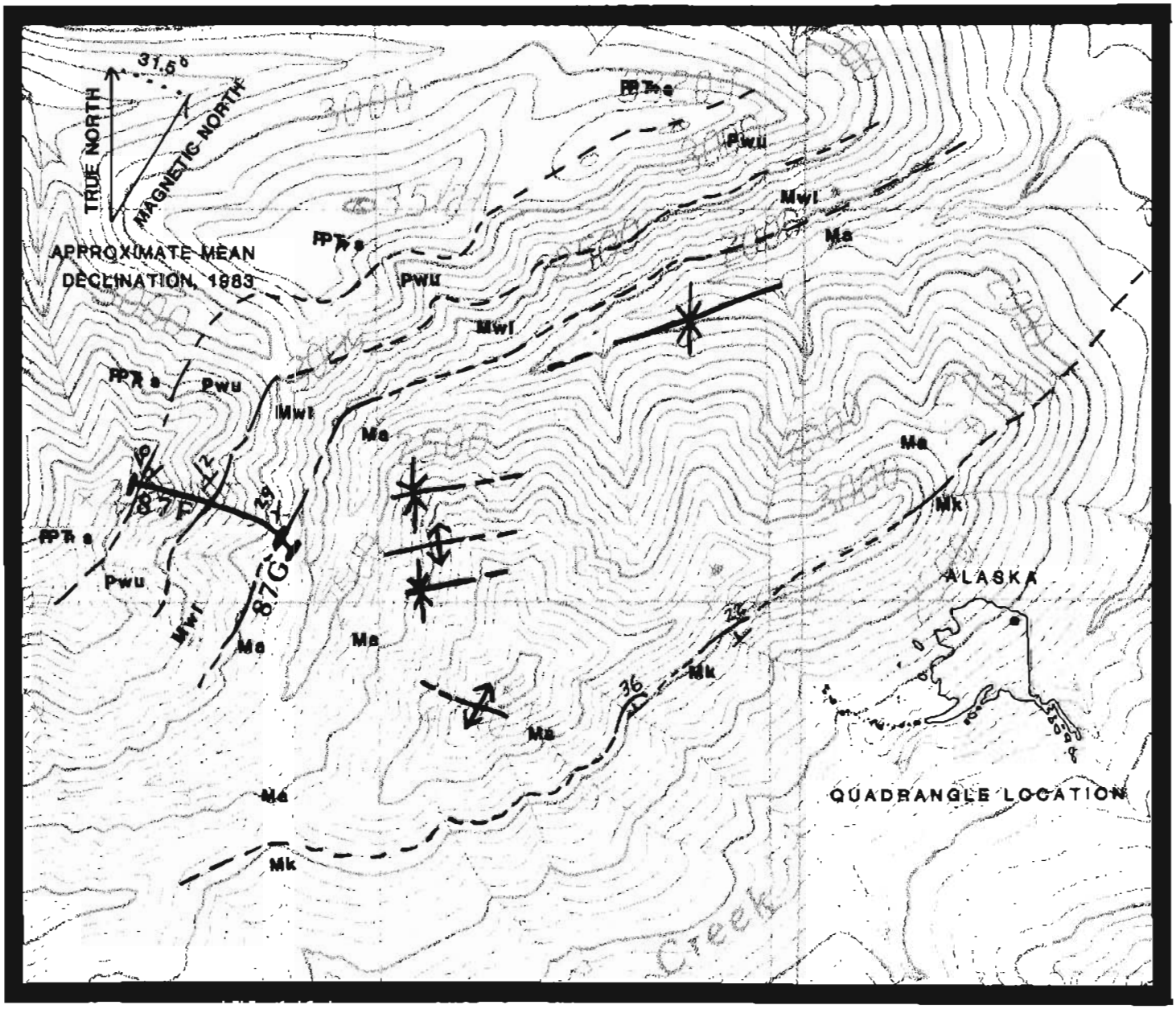


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0 1 2 MILES

CONTOUR INTERVAL 100 FEET

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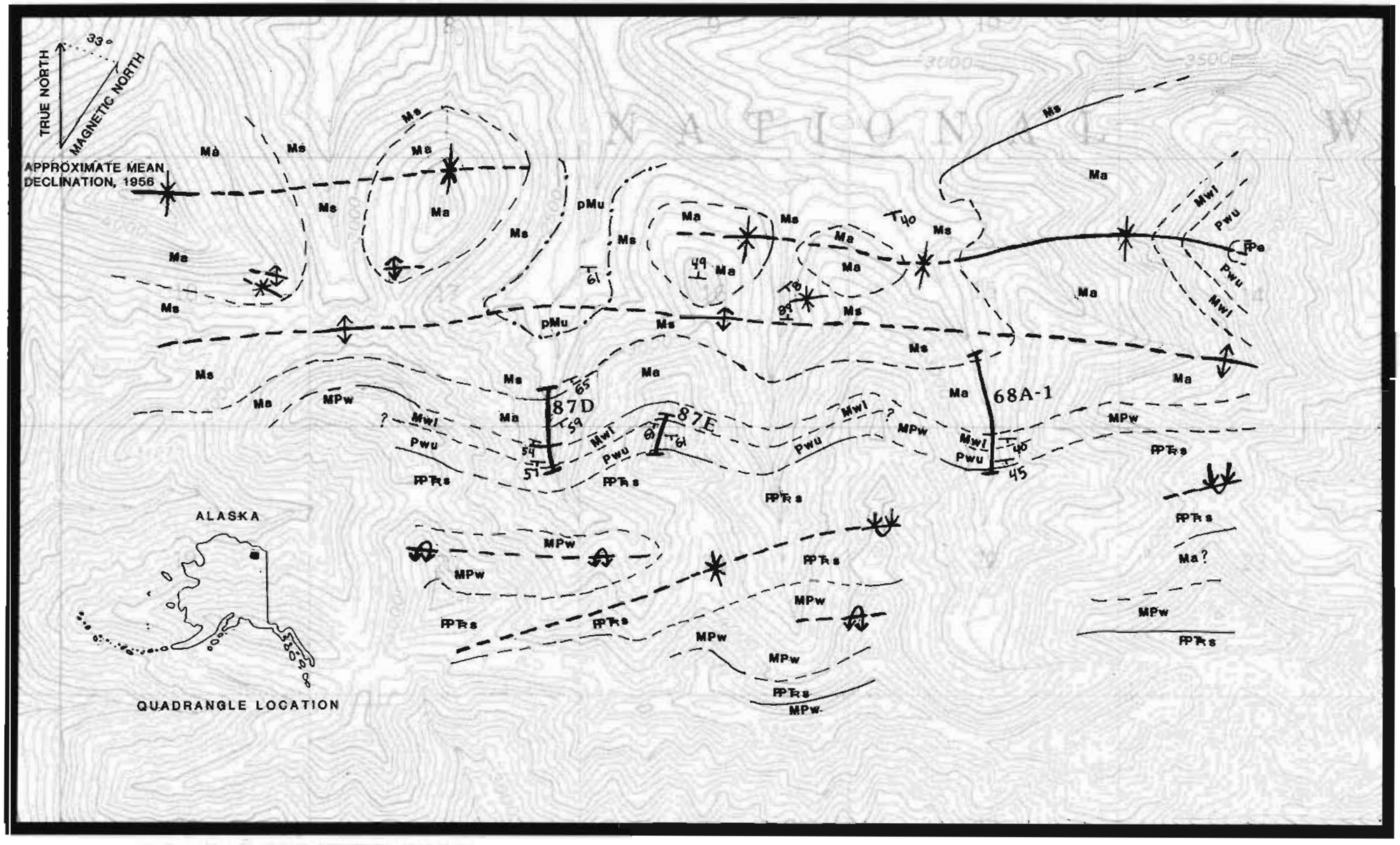



# GEOLOGIC MAP OF THE LISBURNE GROUP IN PART OF THE MT. MICHELSON B-3 QUADRANGLE, FOURTH RANGE, NORTHEASTERN ALASKA

By Paul D. Gruzlovic

February 1988

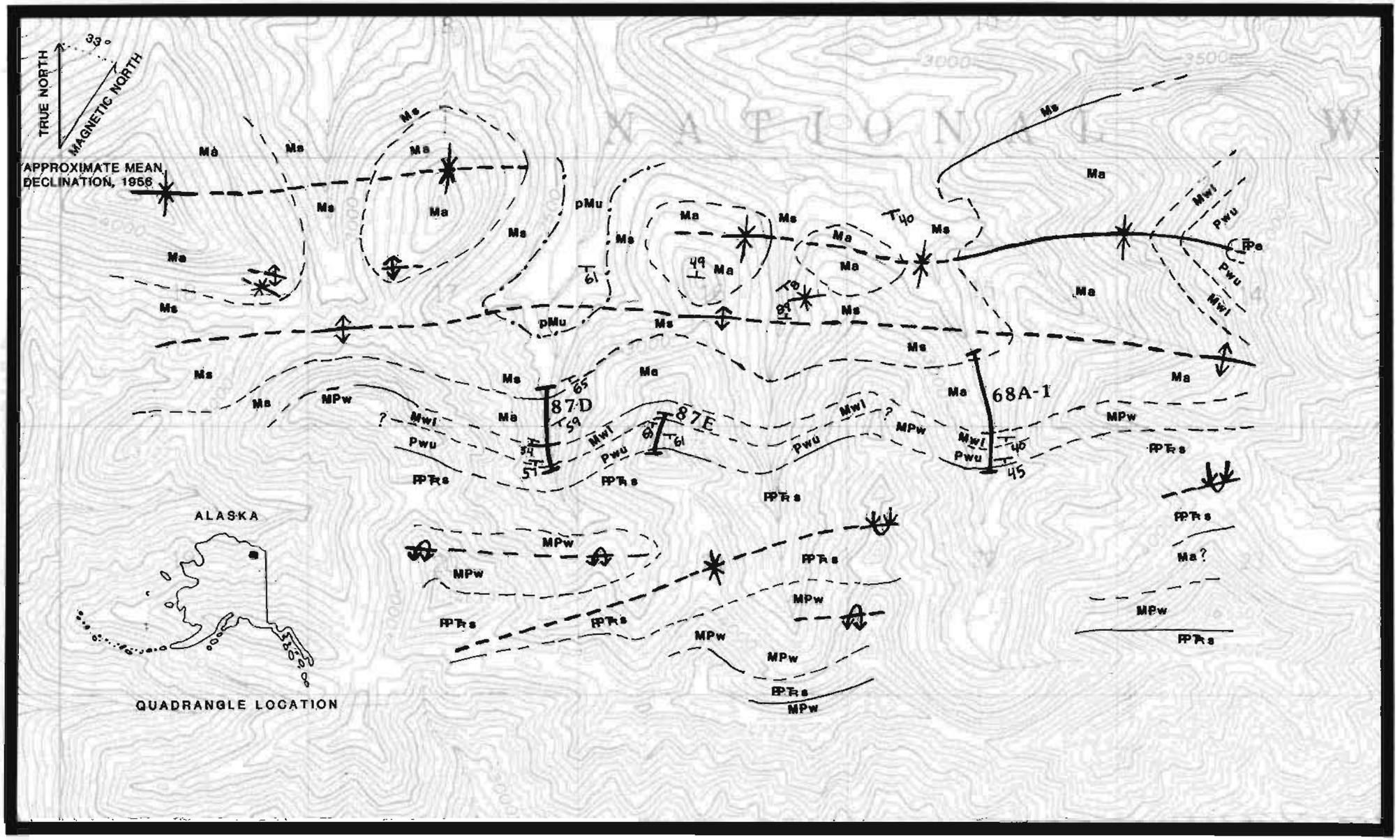
Base map by USGS, 1956

SCALE 1 : 25,000

MILES

0 1 2

CONTOUR INTERVAL 100 FEET




# GEOLOGIC MAP OF THE LISBURNE GROUP IN PART OF THE MT. MICHELSON B-3 QUADRANGLE, FOURTH RANGE, NORTHEASTERN ALASKA

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Base map by USGS, 1956

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MILES

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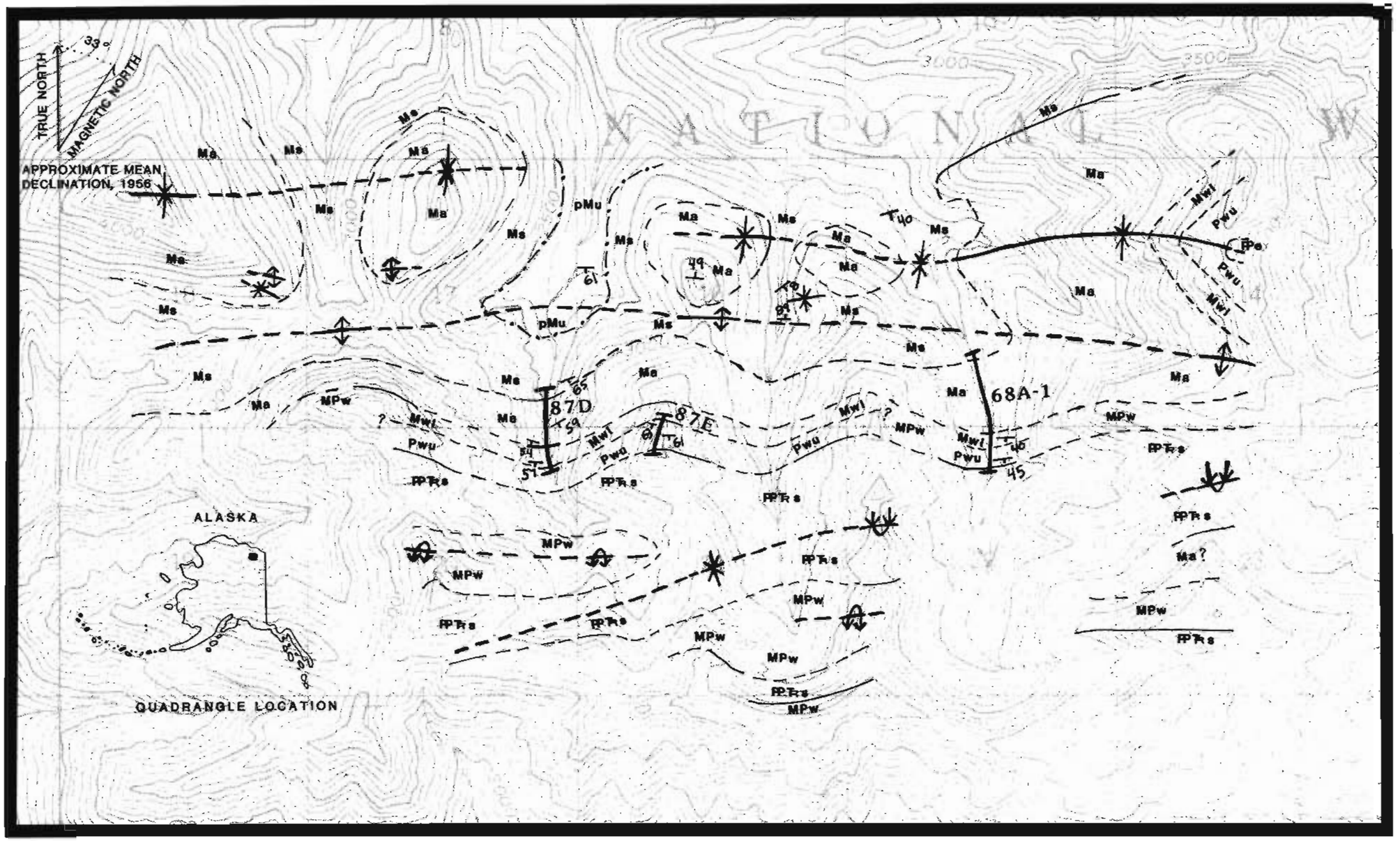
CONTOUR INTERVAL 100 FEET




# GEOLOGIC MAP OF THE LISBURNE GROUP IN PART OF THE MT. MICHELSON B-3 QUADRANGLE, FOURTH RANGE, NORTHEASTERN ALASKA

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Base map by USGS, 1956

SCALE 1 : 25,000

MILES

0 1 2

CONTOUR INTERVAL 100 FEET

# APPENDIX 2

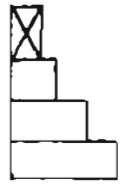
## Detailed Stratigraphic Sections

# SYMBOLS AND ABBREVIATIONS FOR STRATIGRAPHIC SECTIONS

## ROCK TYPES

M - Mudstone
W - Wackestone
P - Packstone
G - Grainstone
B - Boundstone
D - Dolomite
S - Shale

## WEATHERING PROFILE



Covered
Poor exposure
Good exposure
Excellent exposure

## BEDDING

Very thin bedded (< 5cm)
Thin bedded (5 - 20cm)
Medium bedded (20 - 50cm)
Thick bedded (50 - 150cm)
Massive (> 150cm)

## SEDIMENTARY STRUCTURES

 - Plane parallel laminae

 - Wavy laminae

 - Low-angle cross-laminae

 - Scour

 - Rip-up clasts

 - Burrow

## GRAIN TYPES

 - Crinoid

 - Bryozoan (undifferentiated)

 - Bryozoan (fenestrate)

 - Brachiopod

 - Solitary coral

 - Colonial coral

 - Bivalve

 - Gastropod

 - Bioclasts (undifferentiated)

 - Ooid (single coat)

 - Ooid (multiple coat)

 - Peloid

## DIAGENETIC FEATURES

 - Nodular chert

 - Lensoidal chert

 - Calcite replacement nodules

d - Dolomitic

p - Pyritic

s - Silicified skeletal grains

 - Styolitic

 - Fractures

## Units

Ms - Mississippian Endicott Siltstone
Mk - Mississippian Kayak Shale
Ma - Mississippian Alapah Limestone
Mwl - Mississippian Lower Wahoo Limestone
Pwu - Pennsylvanian Upper Wahoo Limestone
Pe - Permian Echooka

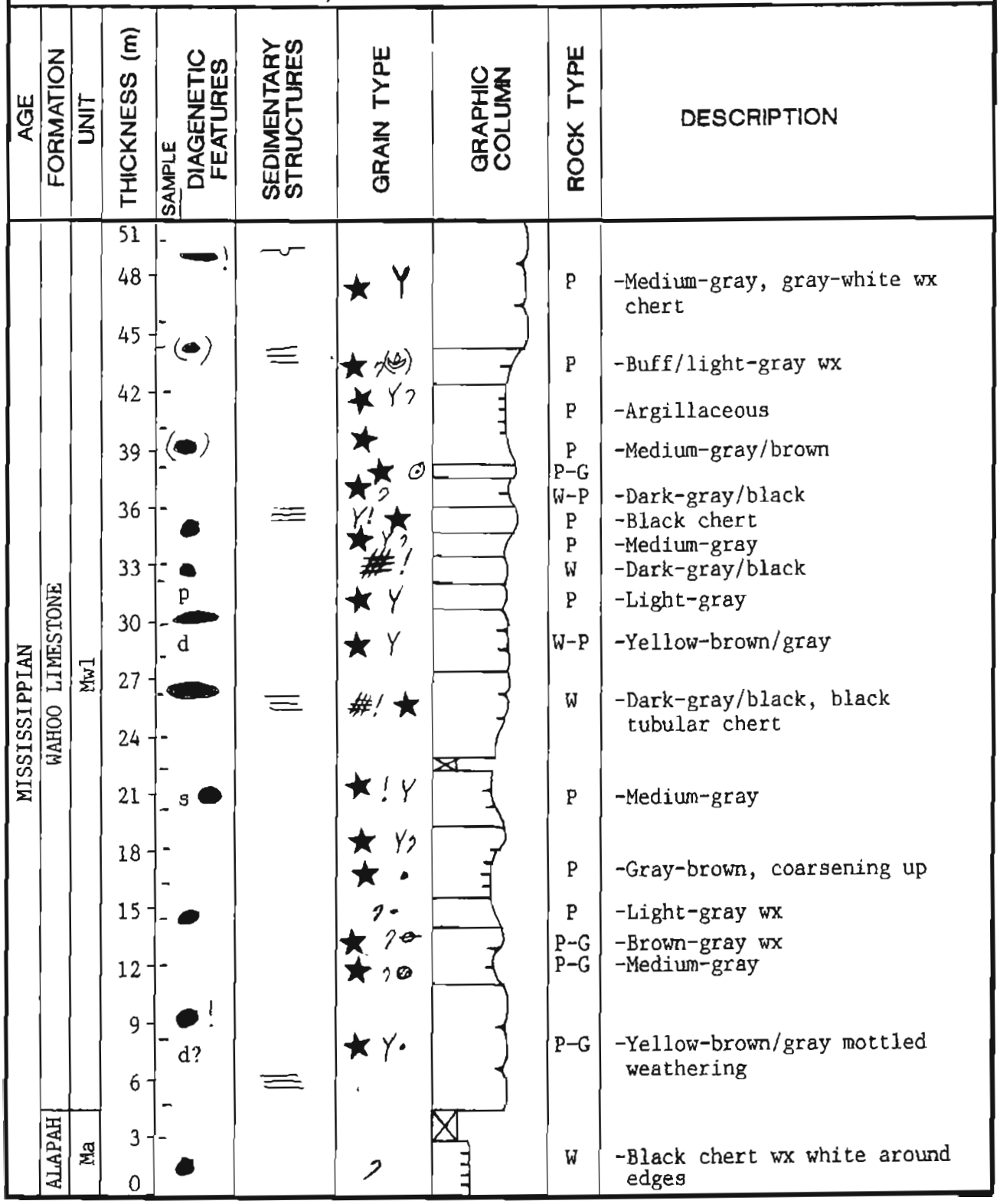
## OTHER

! - Abundant
() - Minor
? - Questionable
wx - weathered

# LISBURNE GROUP SECTION 87 C

**Central Shublik Mountains, NE Alaska**





# LISBURNE GROUP SECTION 87 C

**Central Shublik Mountains, NE Alaska**

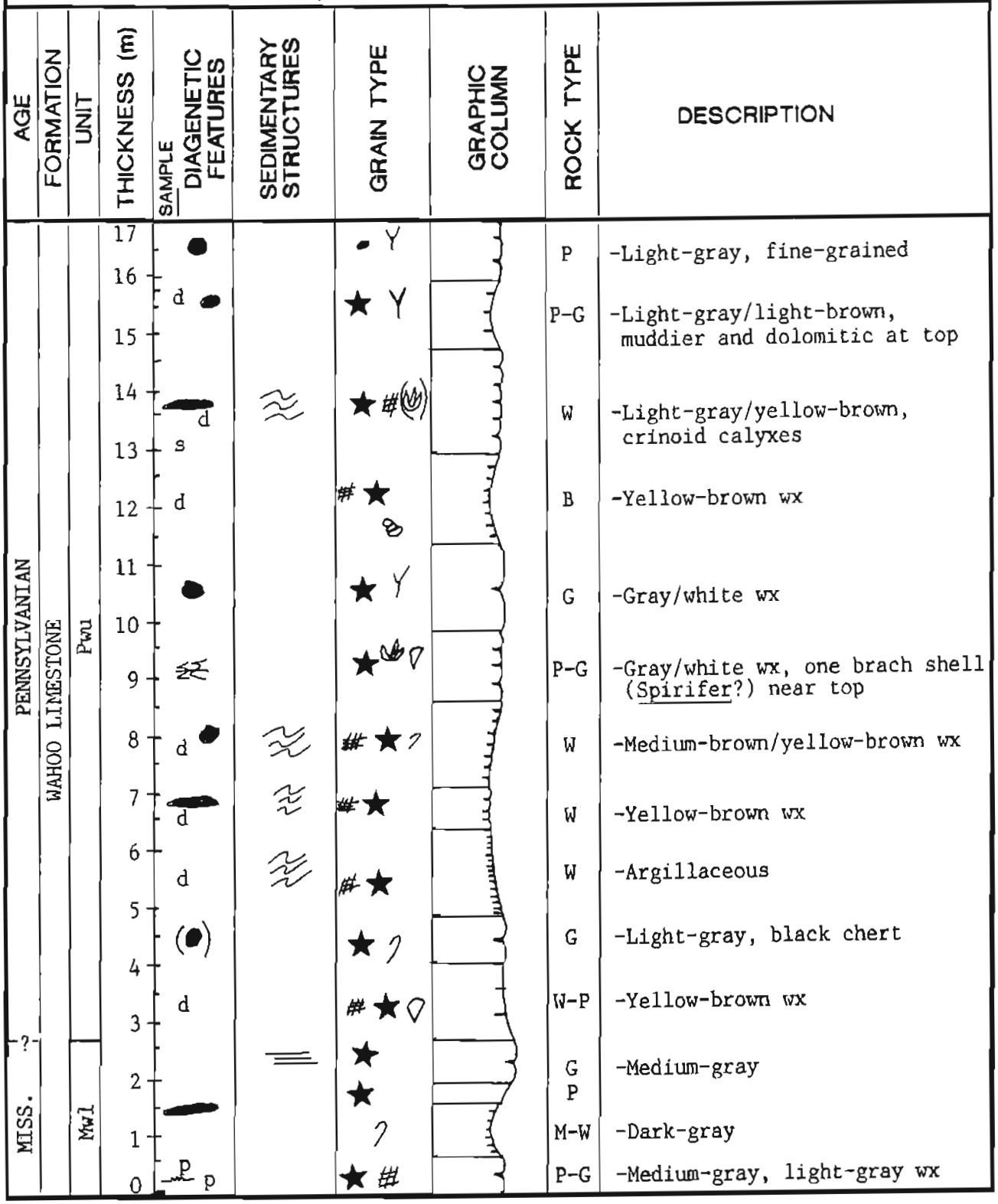


| AGE | FORMATION | UNIT | THICKNESS (m) | SAMPLE / DIAGENETIC FEATURES | SEDIMENTARY STRUCTURES | GRAIN TYPE | GRAPHIC COLUMN | ROCK TYPE | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| PENNSYLVANIAN | WAHOO LIMESTONE | Pwu | 87 | | | | | | |
| | | | 84 | | | ★ Y | | P-G | -Medium-gray |
| | | | | d | | ★ #, | | P | -Dark-brown wx chert |
| | | | 81 | | ≡ | ★ # | | P | -Brown-gray |
| | | | 78 | d | | ★ # | | W-P | -Orange/yellow wx, dolomitic |
| | | | 75 | ~ | | ★ Y! | | P | -Medium-gray, Spirifer? brachs |
| | | | 72 | ● | | ★ Y | | P | -Coarse-grained, brittle |
| | | | | d p | | ? | | W-P | -Fine-grained |
| | | | 69 | d p | ≡ | ★ # | | W-P | -Orange/light-gray wx |
| | | | 66 | p? | ≡ | ★ ⊙ | | G | -Light-gray |
| MISSISSIPPIAN | | Mwl | | (●) | ≡ | ★ ? | | P | -Medium-gray |
| | | | 63 | | | ★ Y• | | | |
| | | | 60 | ● | | | | P | -Coarse-grained, brittle |
| | | | 57 | | ≡ | ★ (#) | | P | -Medium-gray/orange splotchy wx |
| | | | 54 | ● | | ★ !#! | | P | -Medium-gray |
| | | | 51 | ! | | ★ Y | | P | -Medium-gray, gray-white wx chert |

# LISBURNE GROUP SECTION 87 A

**Central Shublik Mountains, NE Alaska**

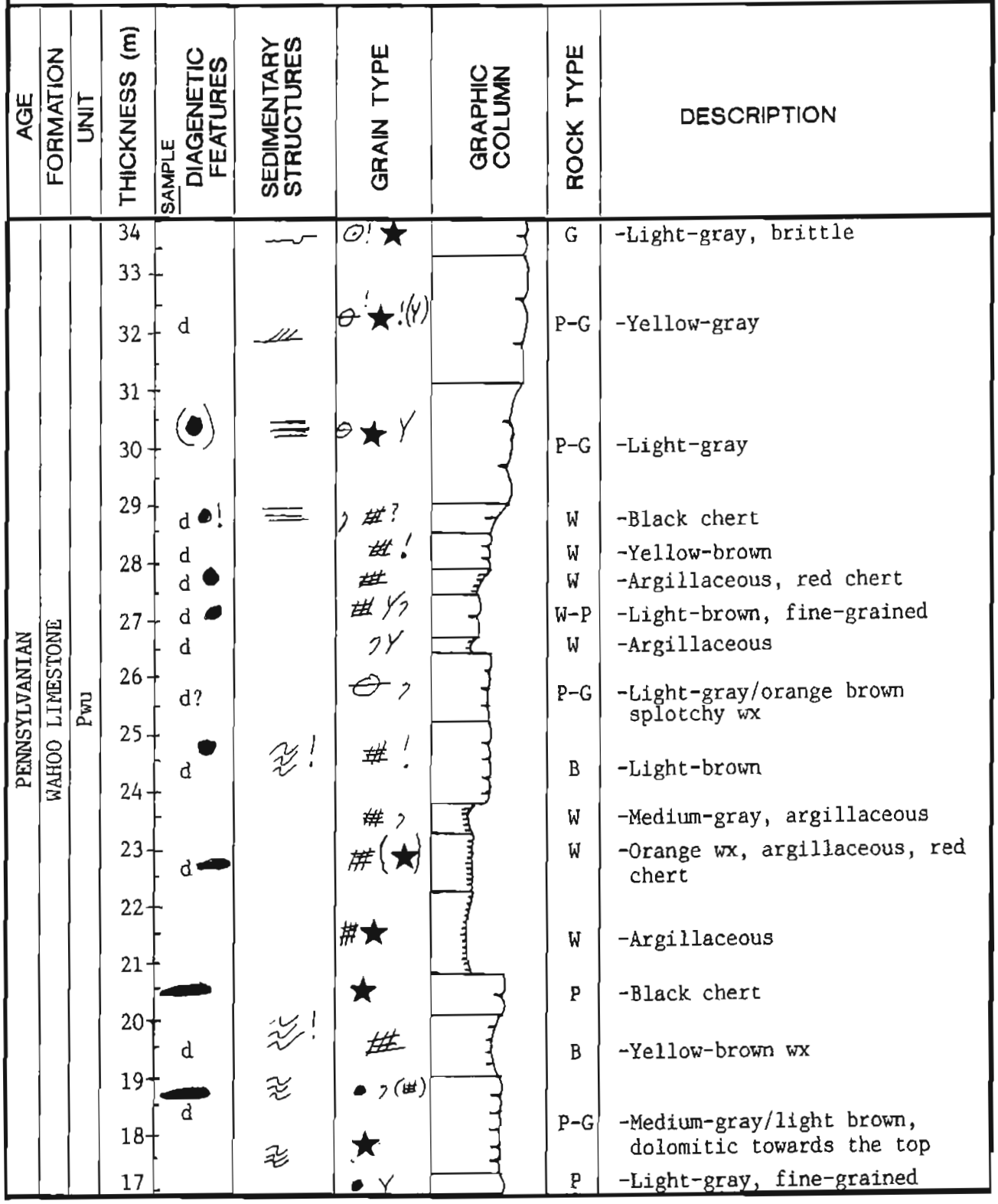




# LISBURNE GROUP SECTION 87 A

**Central Shublik Mountains, NE Alaska**

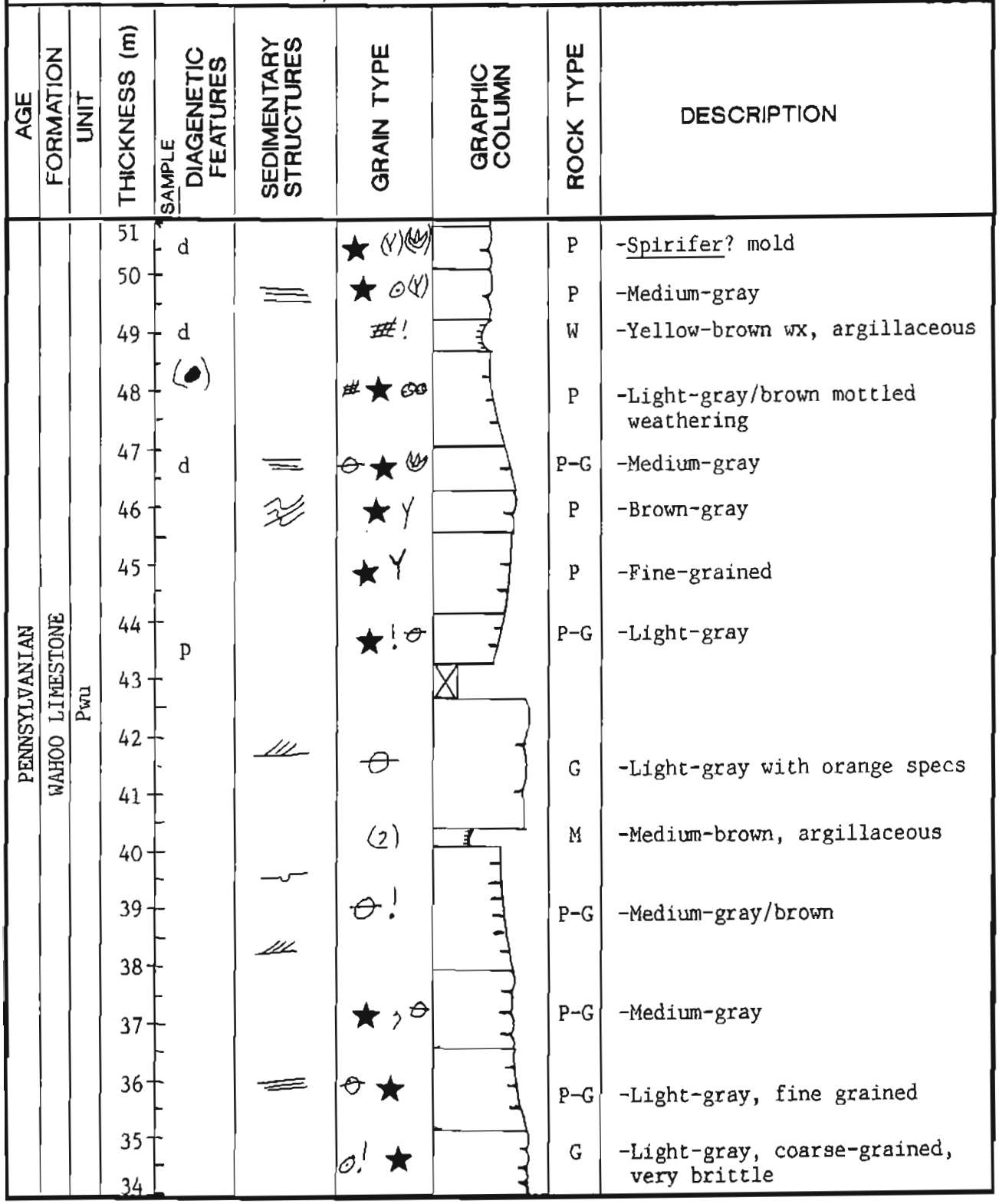




# LISBURNE GROUP SECTION 87 A



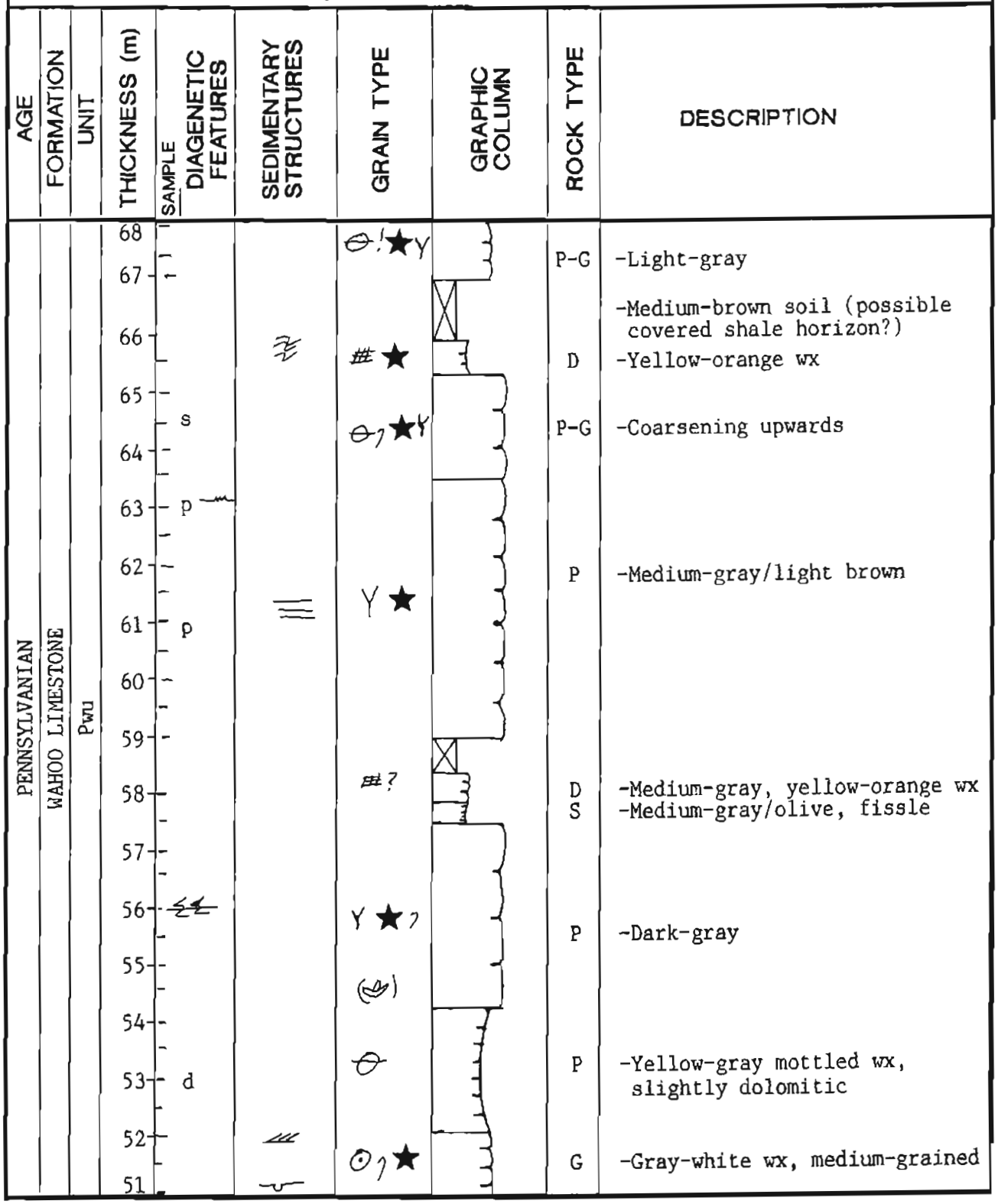
**Central Shublik Mountains, NE Alaska**



# LISBURNE GROUP SECTION 87 A

**Central Shublik Mountains, NE Alaska**

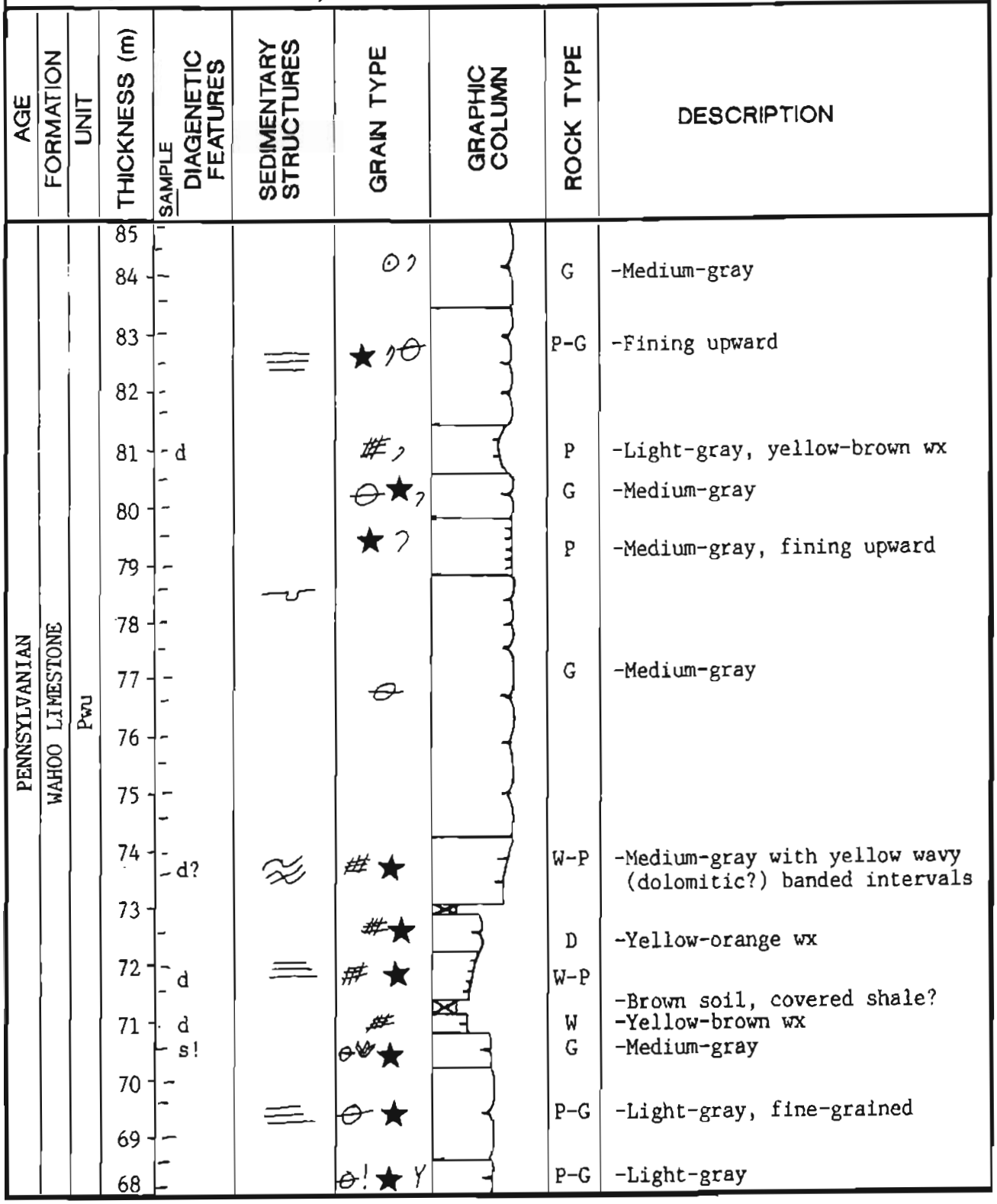




# LISBURNE GROUP SECTION 87 A

**Central Shublik Mountains, NE Alaska**

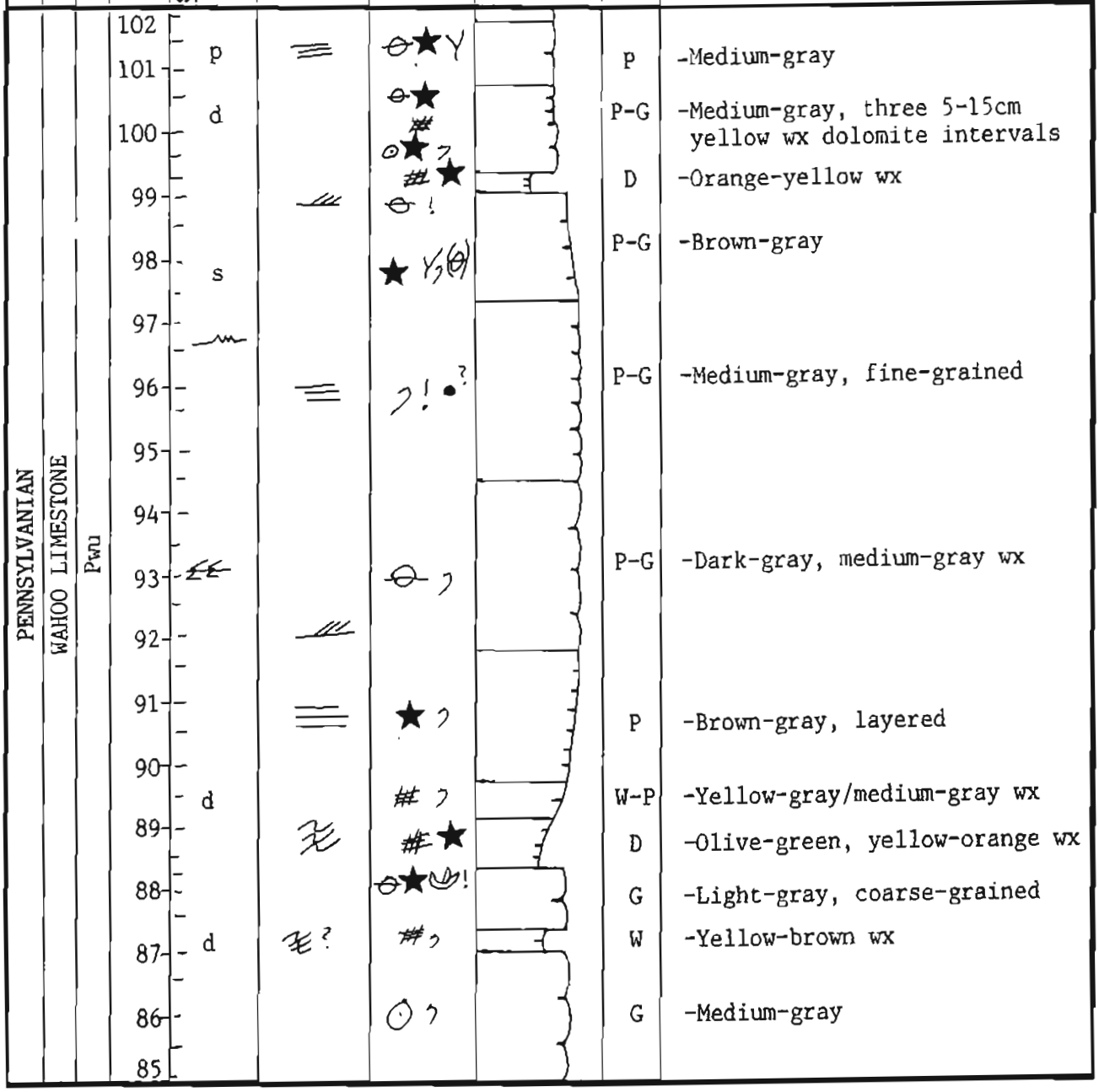




# LISBURNE GROUP SECTION 87 A

**Central Shublik Mountains, NE Alaska**

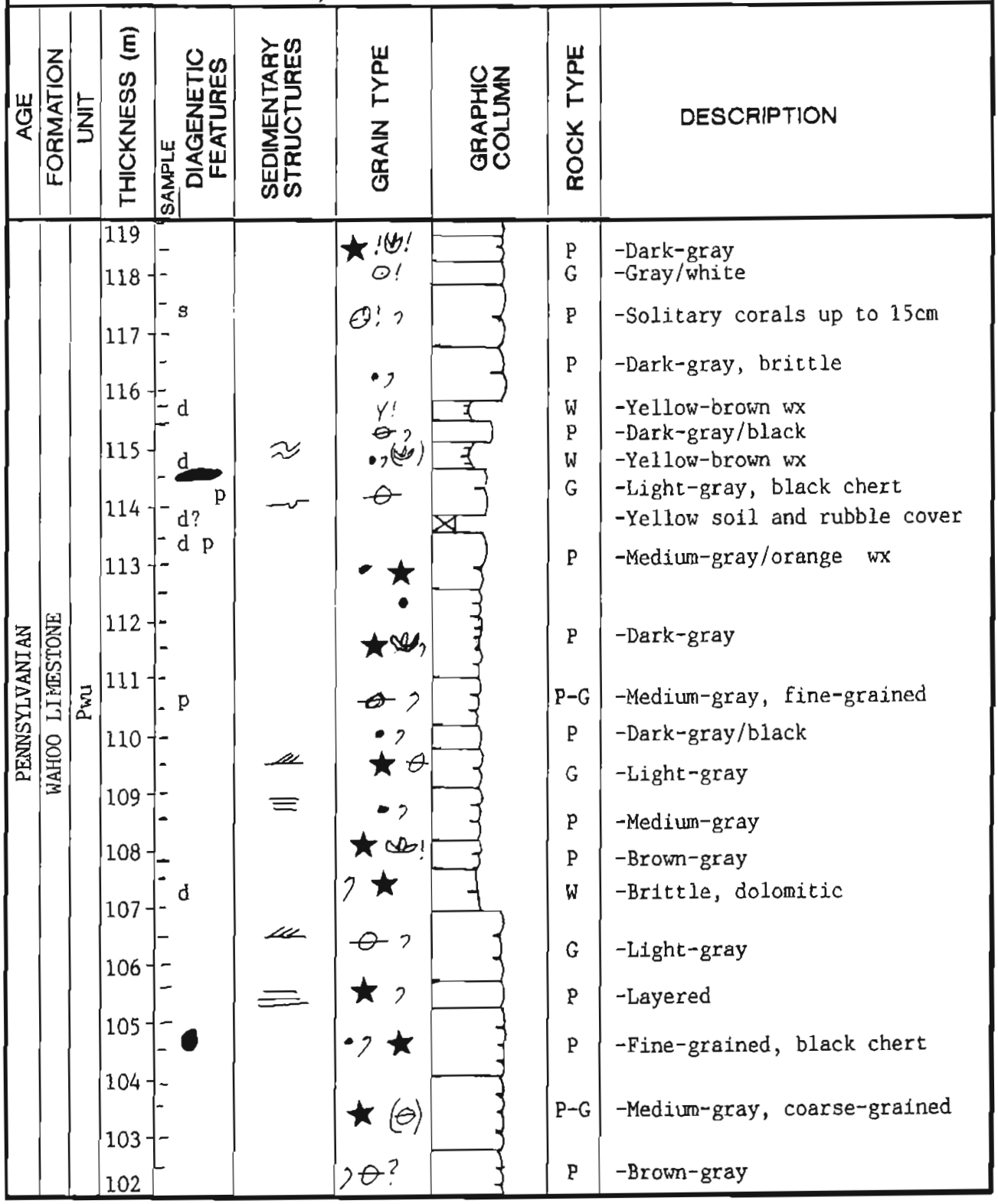




# LISBURNE GROUP SECTION 87 A

**Central Shublik Mountains, NE Alaska**

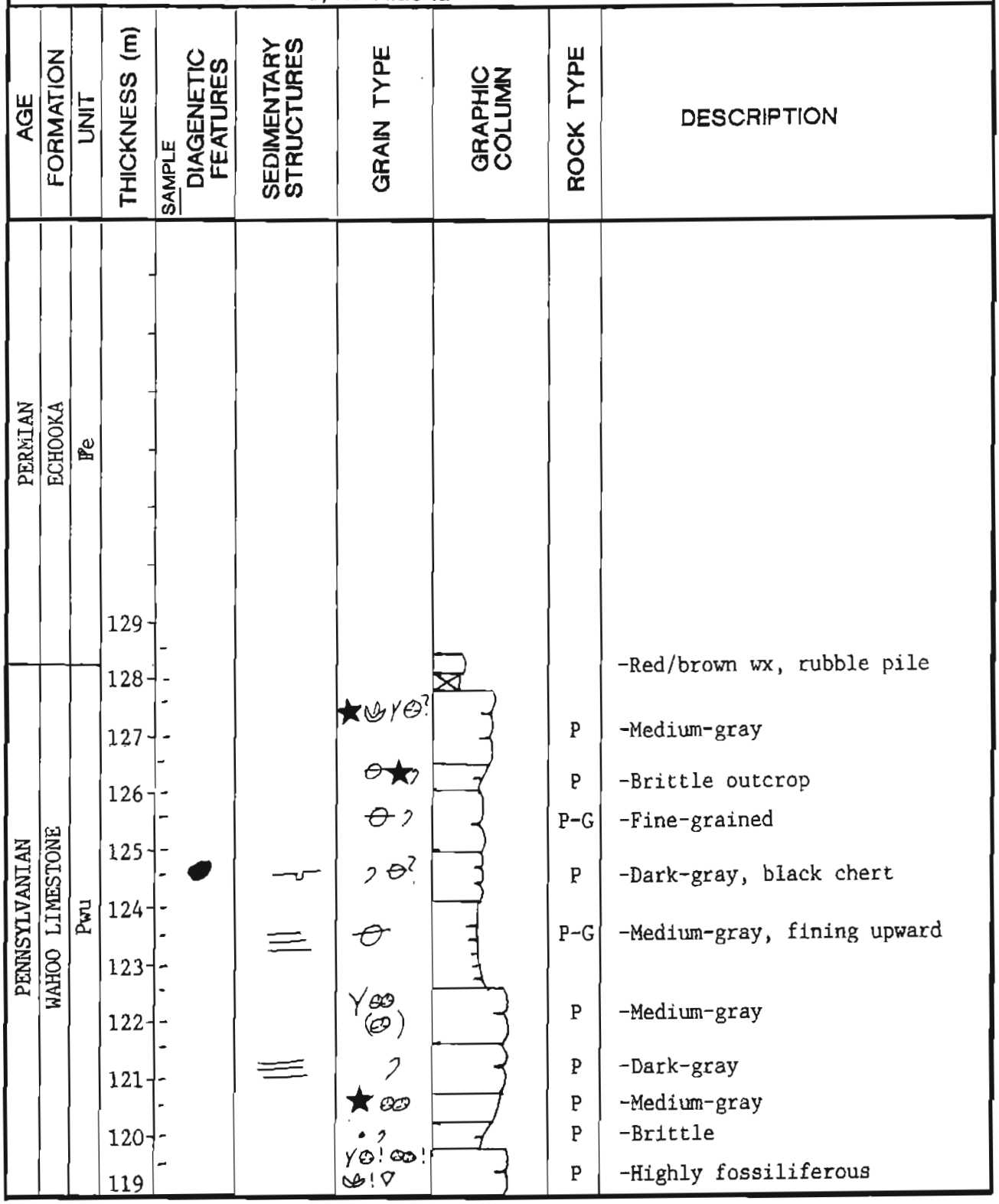




# LISBURNE GROUP SECTION 87 A



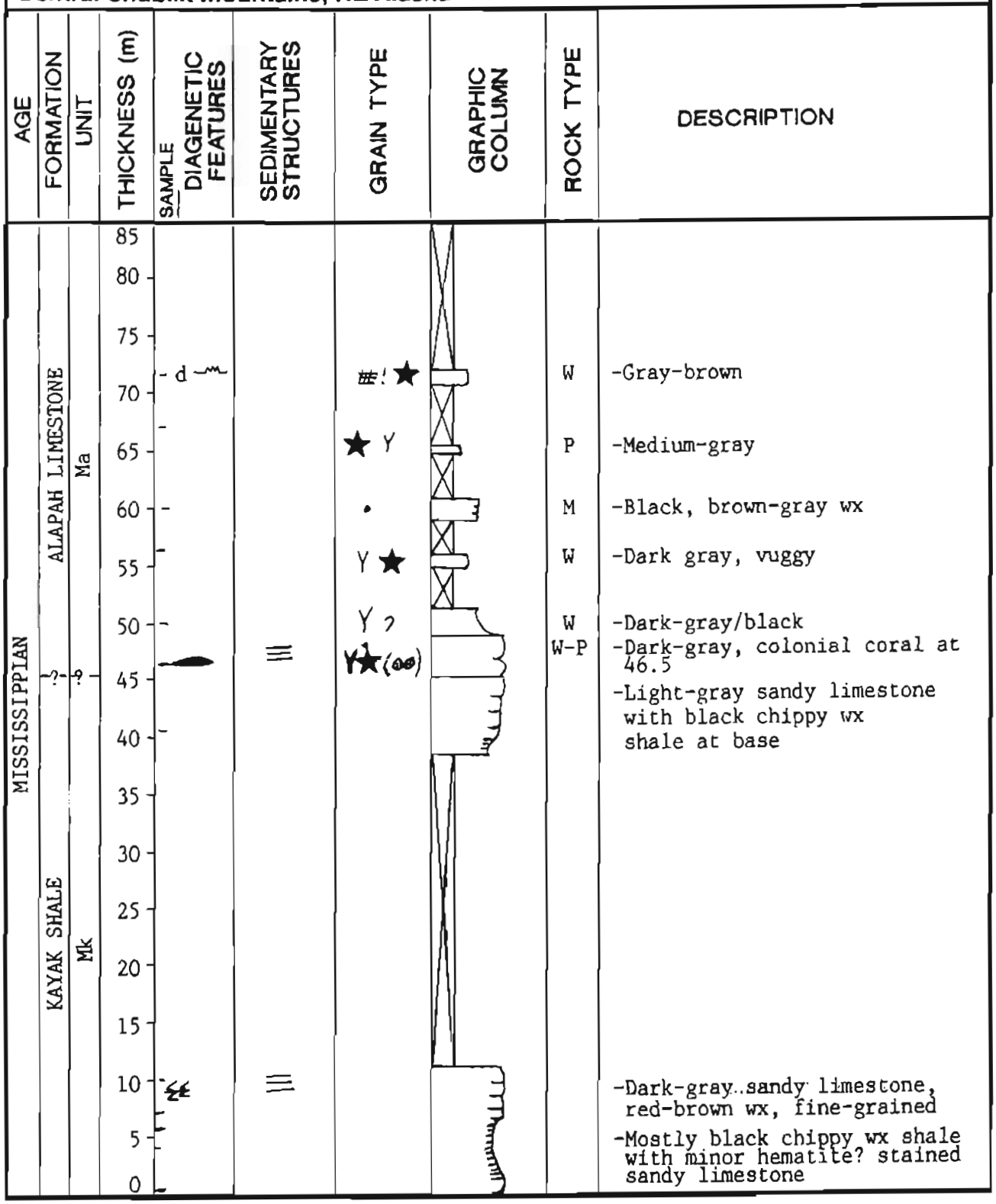
Central Shublik Mountains, NE Alaska



# LISBURNE GROUP SECTION 87 B



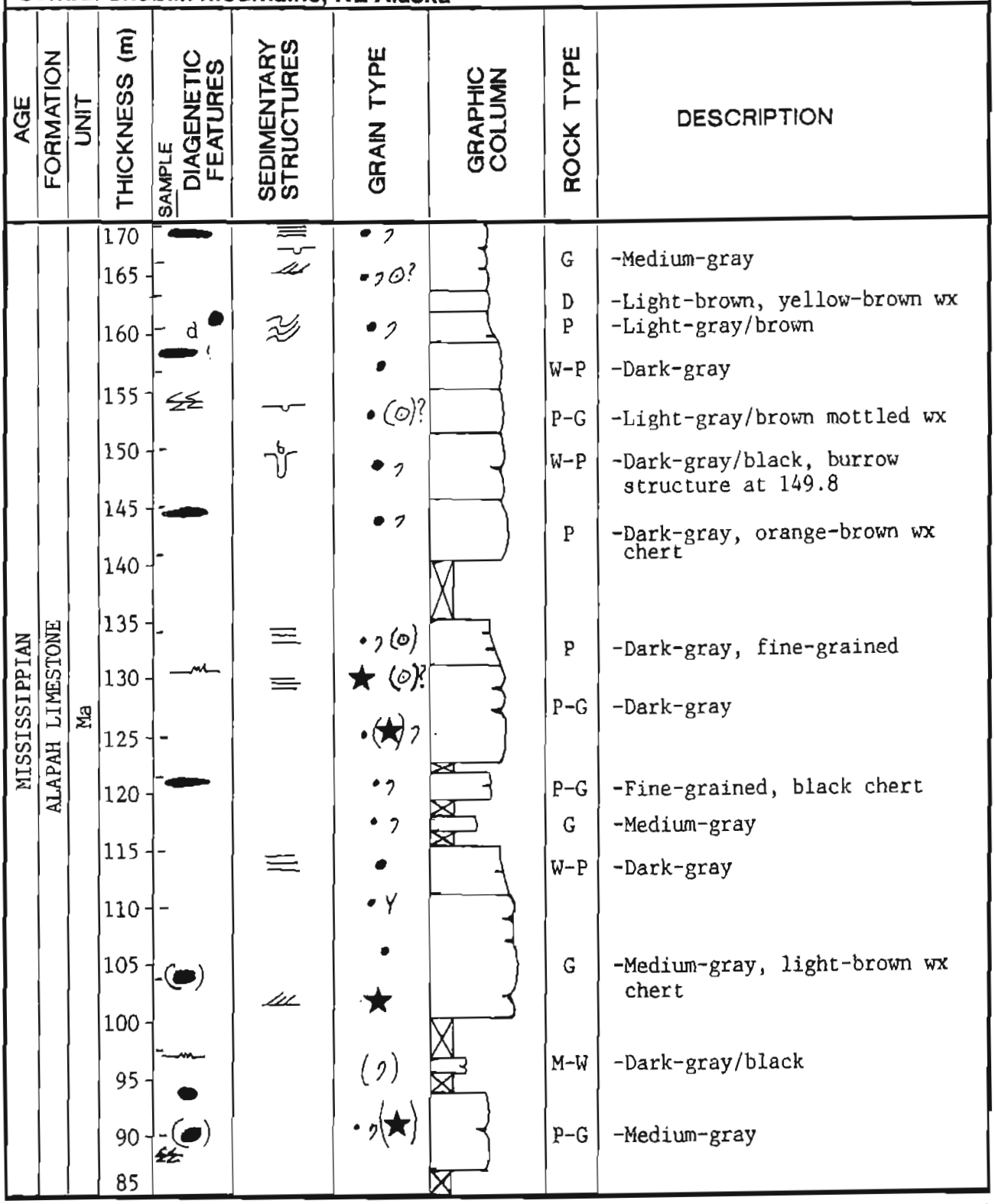
**Central Shublik Mountains, NE Alaska**



# LISBURNE GROUP SECTION 87 B



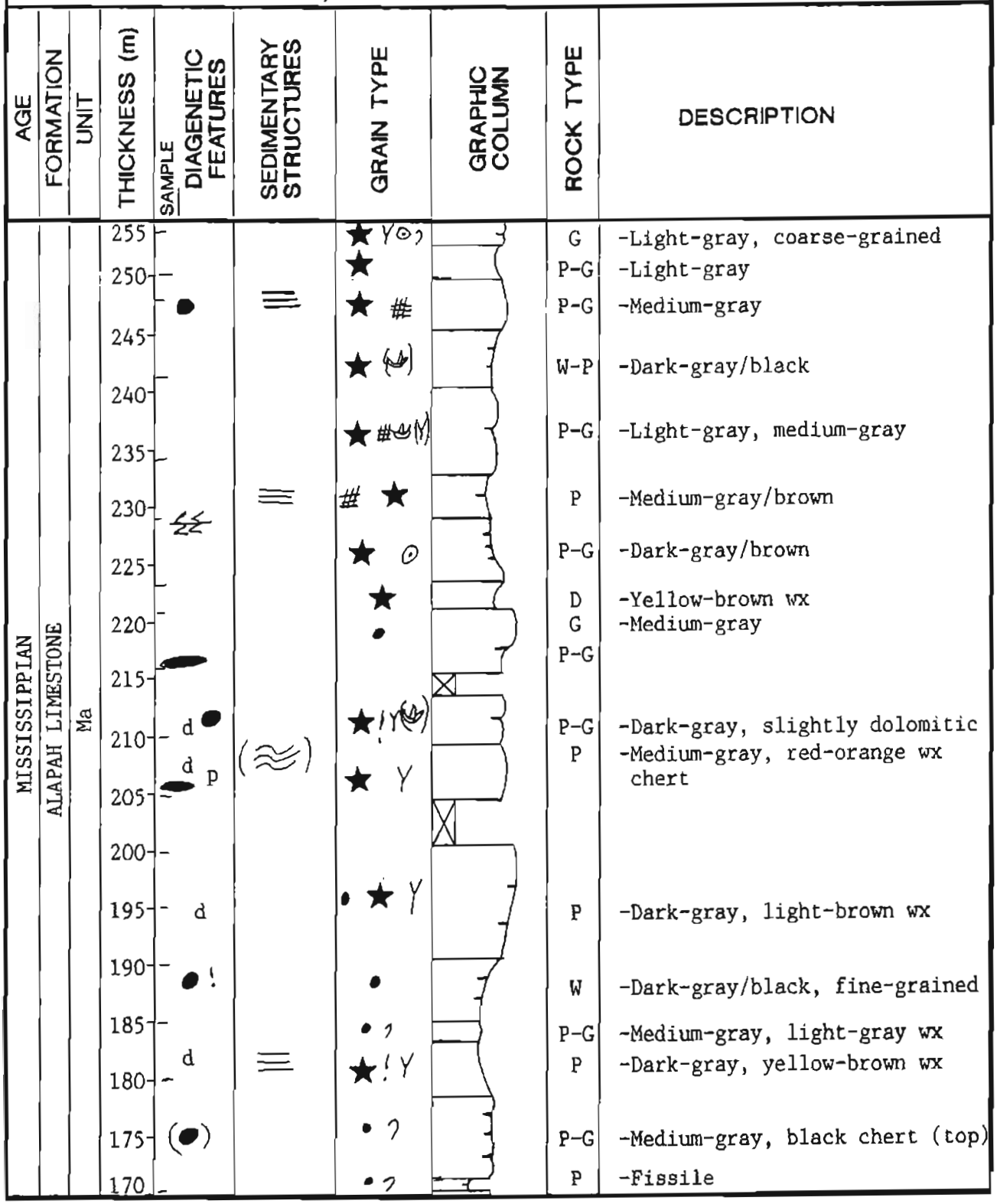
Central Shublik Mountains, NE Alaska



# LISBURNE GROUP SECTION 87 B

**Central Shublik Mountains, NE Alaska**

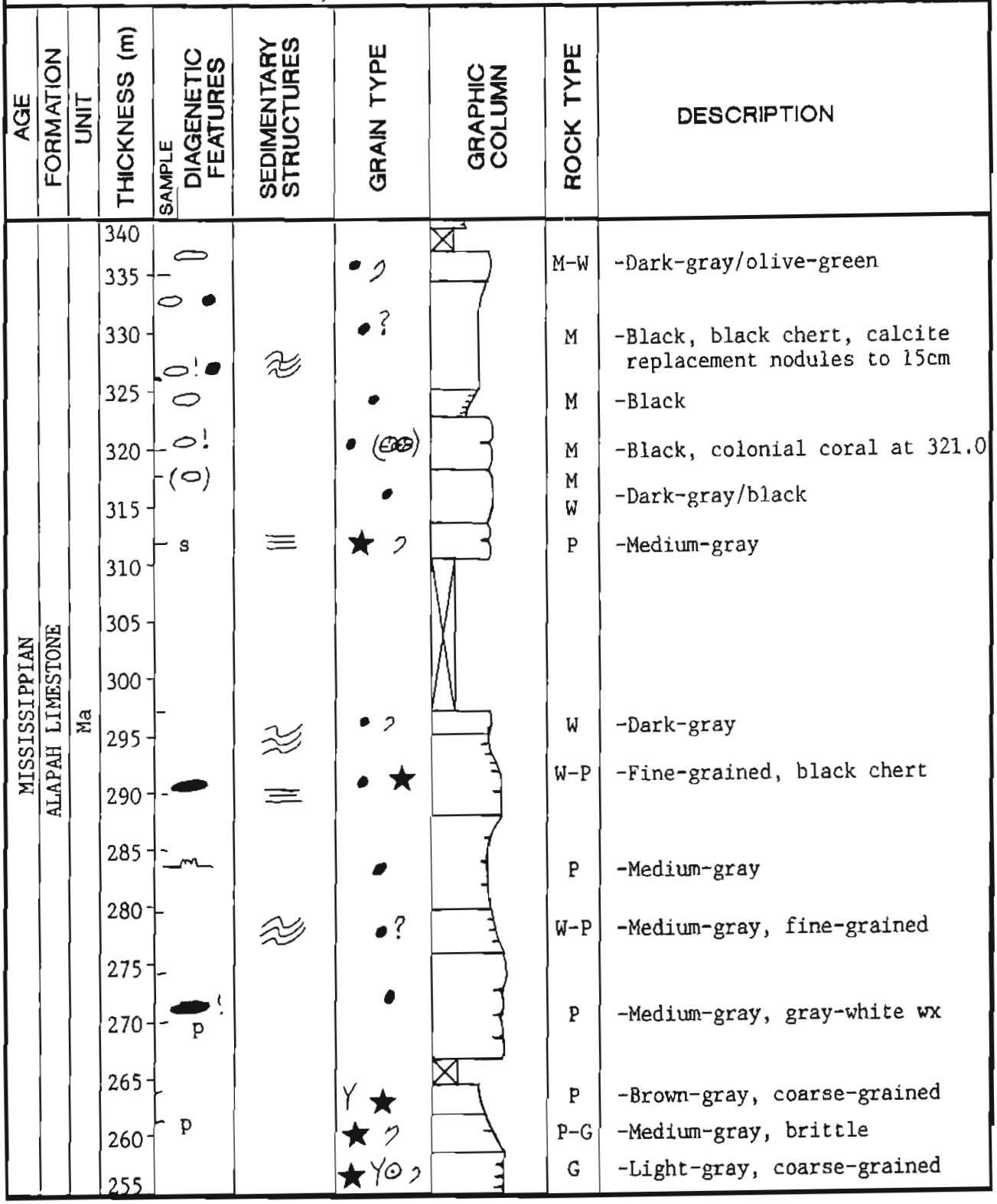




# LISBURNE GROUP SECTION 87 B



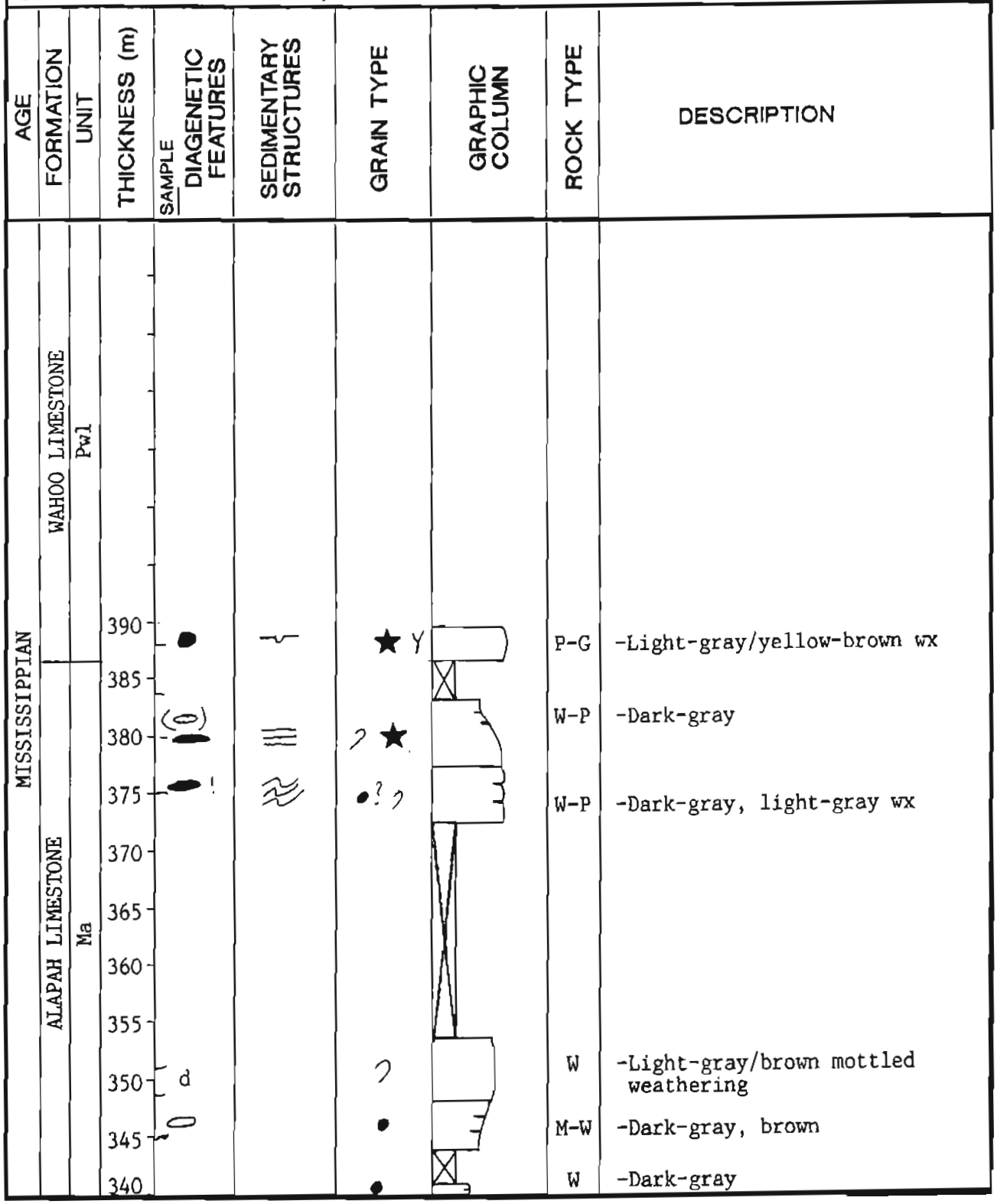
**Central Shublik Mountains, NE Alaska**



# LISBURNE GROUP SECTION 87 B

**Central Shublik Mountains, NE Alaska**

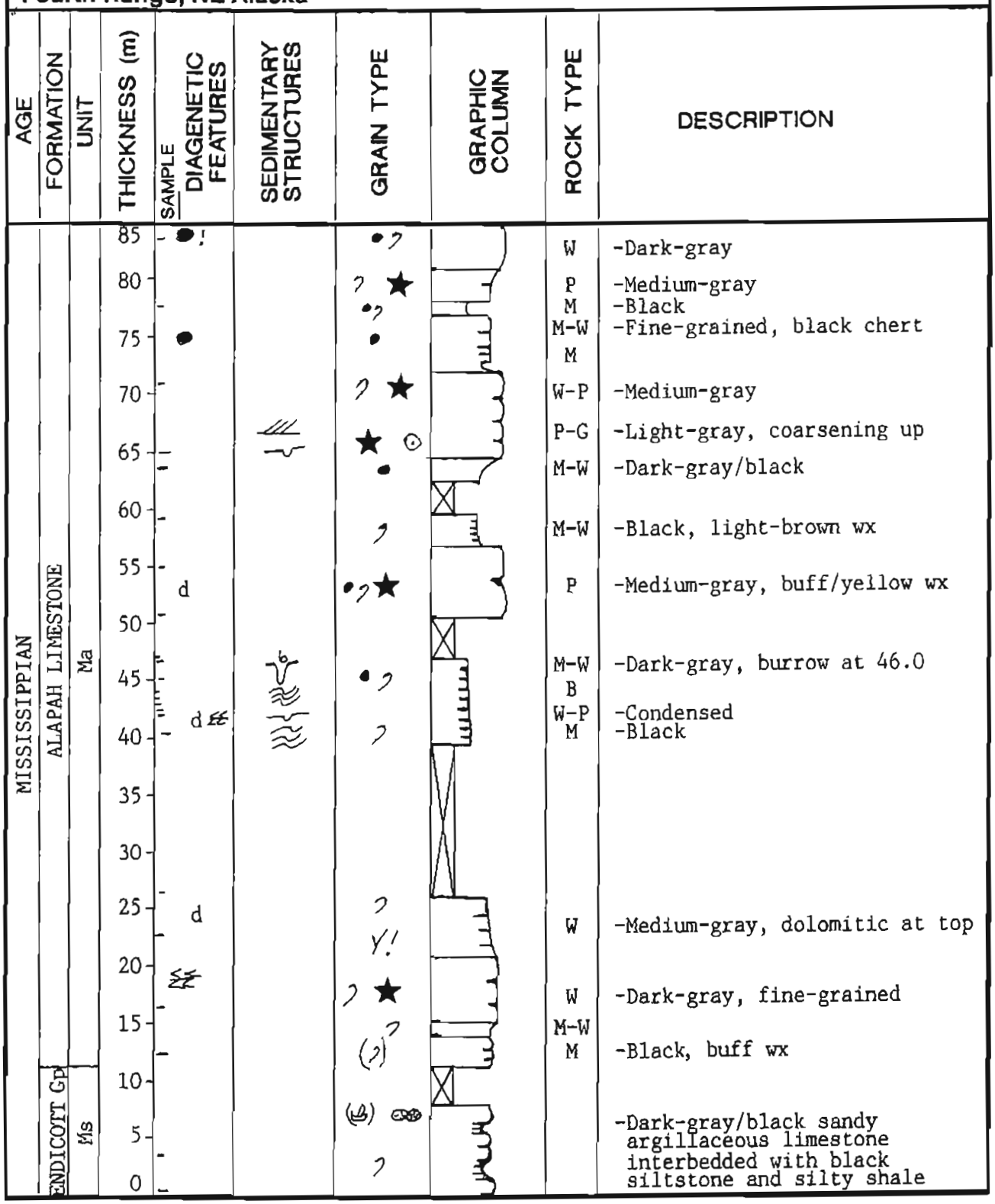




# LISBURNE GROUP SECTION 87 D



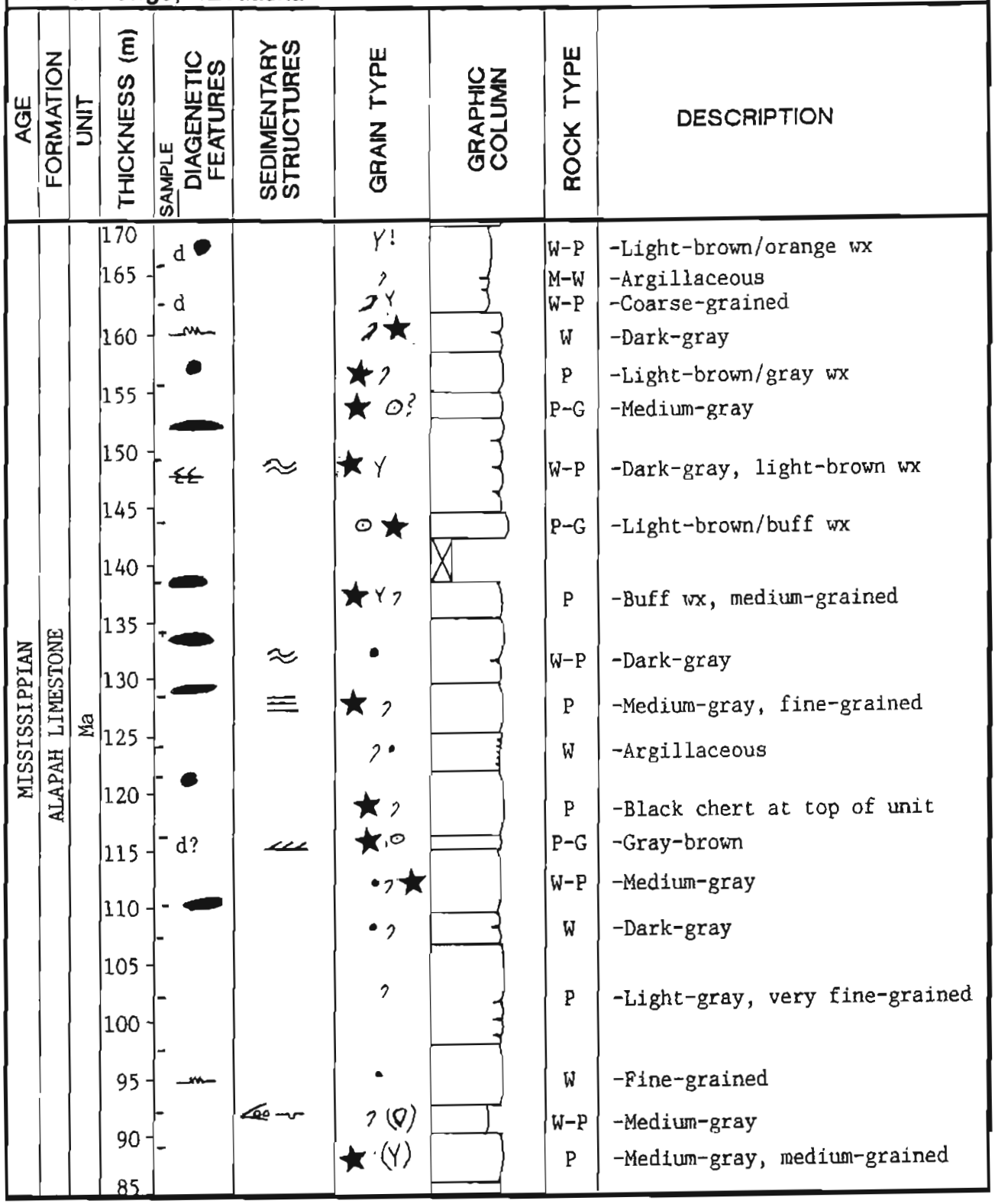
**Fourth Range, NE Alaska**



# LISBURNE GROUP SECTION 87 D

**Fourth Range, NE Alaska**

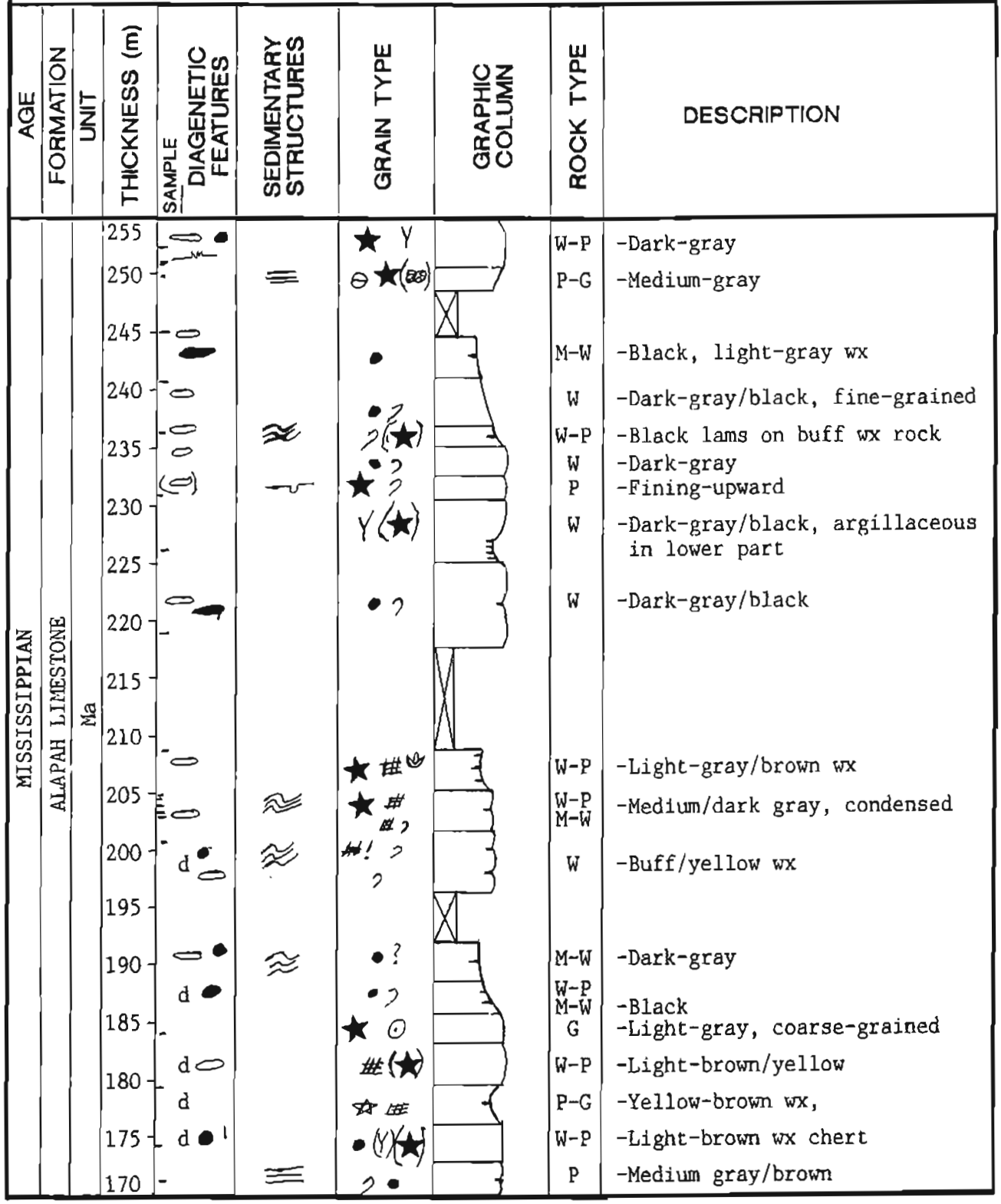




# LISBURNE GROUP SECTION 87 D

**Fourth Range, NE Alaska**

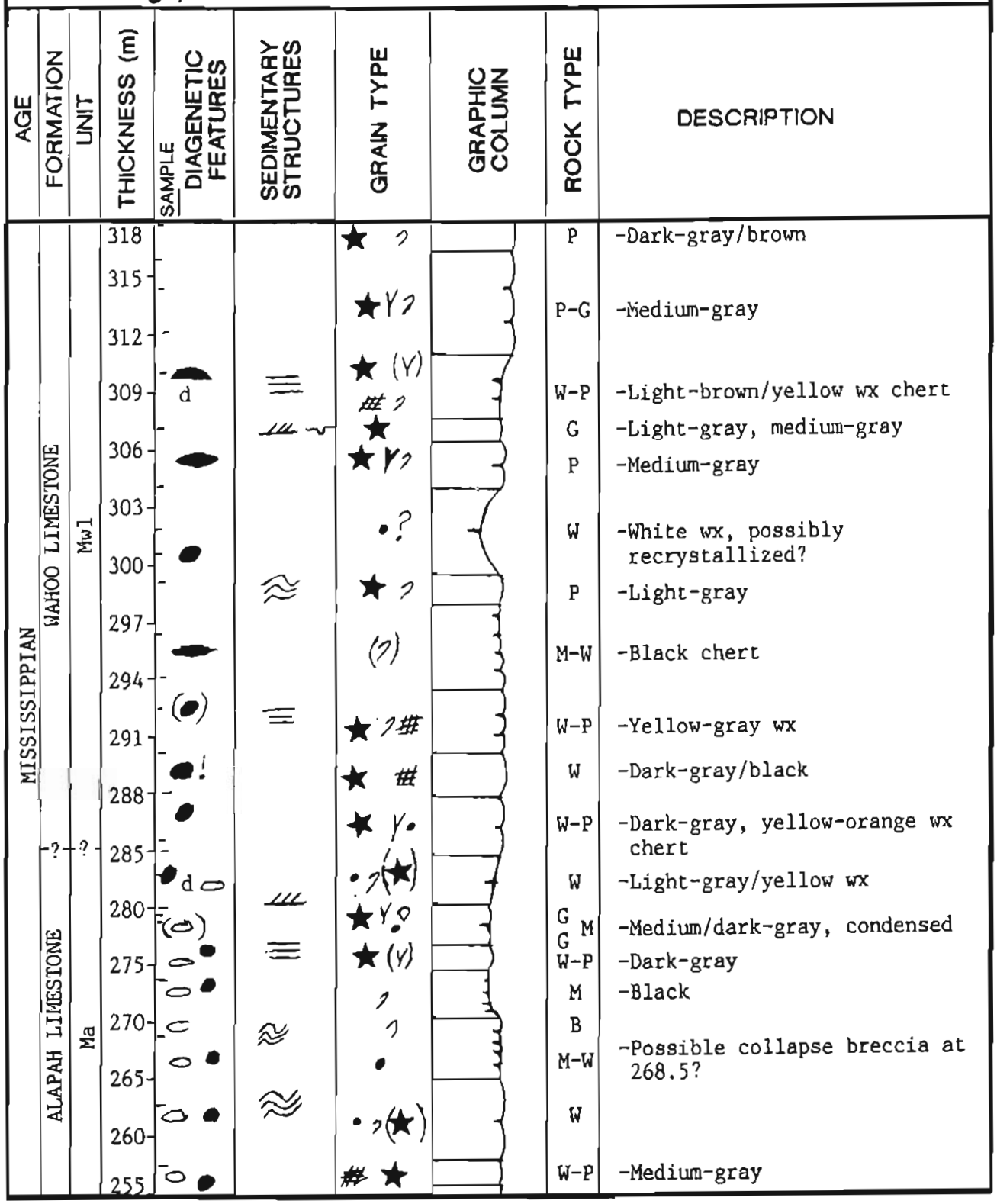




# LISBURNE GROUP SECTION 87 D

**Fourth Range, NE Alaska**

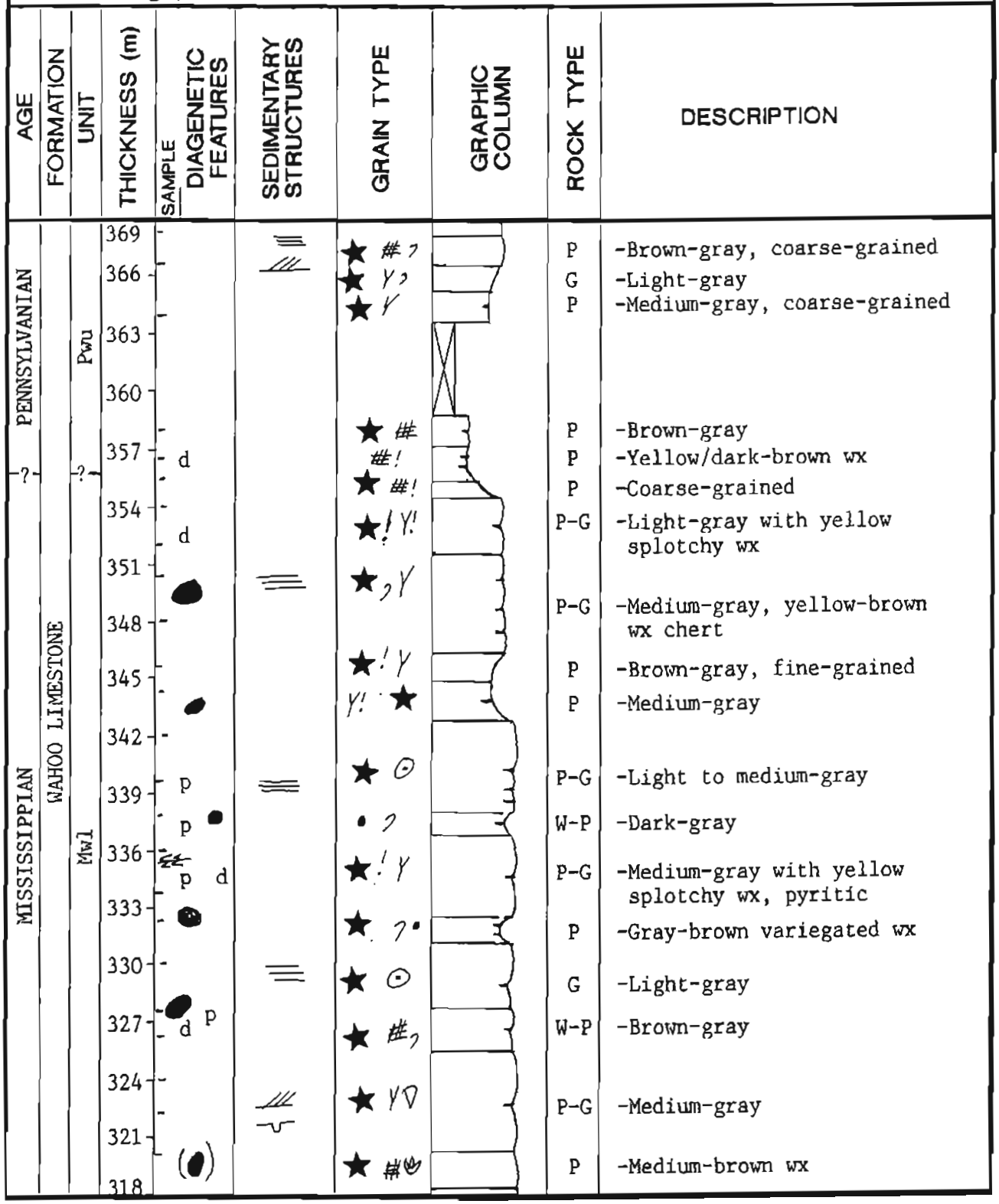




# LISBURNE GROUP SECTION 87 D

**Fourth Range, NE Alaska**





# LISBURNE GROUP SECTION 87 D

**Fourth Range, NE Alaska**

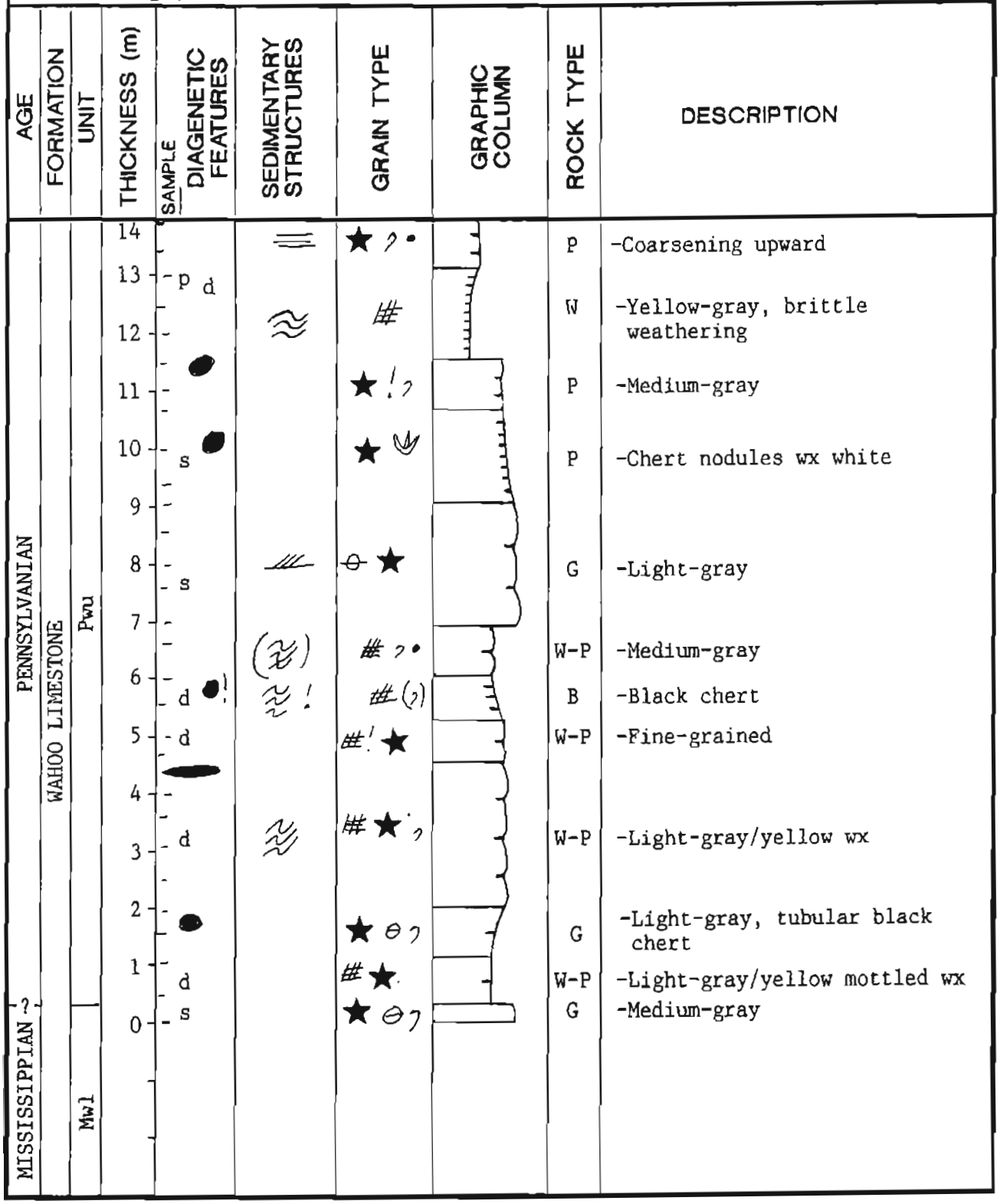


| AGE | FORMATION | UNIT | THICKNESS (m) | SAMPLE / DIAGENETIC FEATURES | SEDIMENTARY STRUCTURES | GRAIN TYPE | GRAPHIC COLUMN | ROCK TYPE | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| PENNSYLVANIAN | WAHOO LIMESTONE | Pwu | 372 | | | | | | |
| | | | 369 | - d? | ≈ | ★ ✹ | | W-P | -Light-gray/yellow wx |

# LISBURNE GROUP SECTION 87 E

**Fourth Range, NE Alaska**

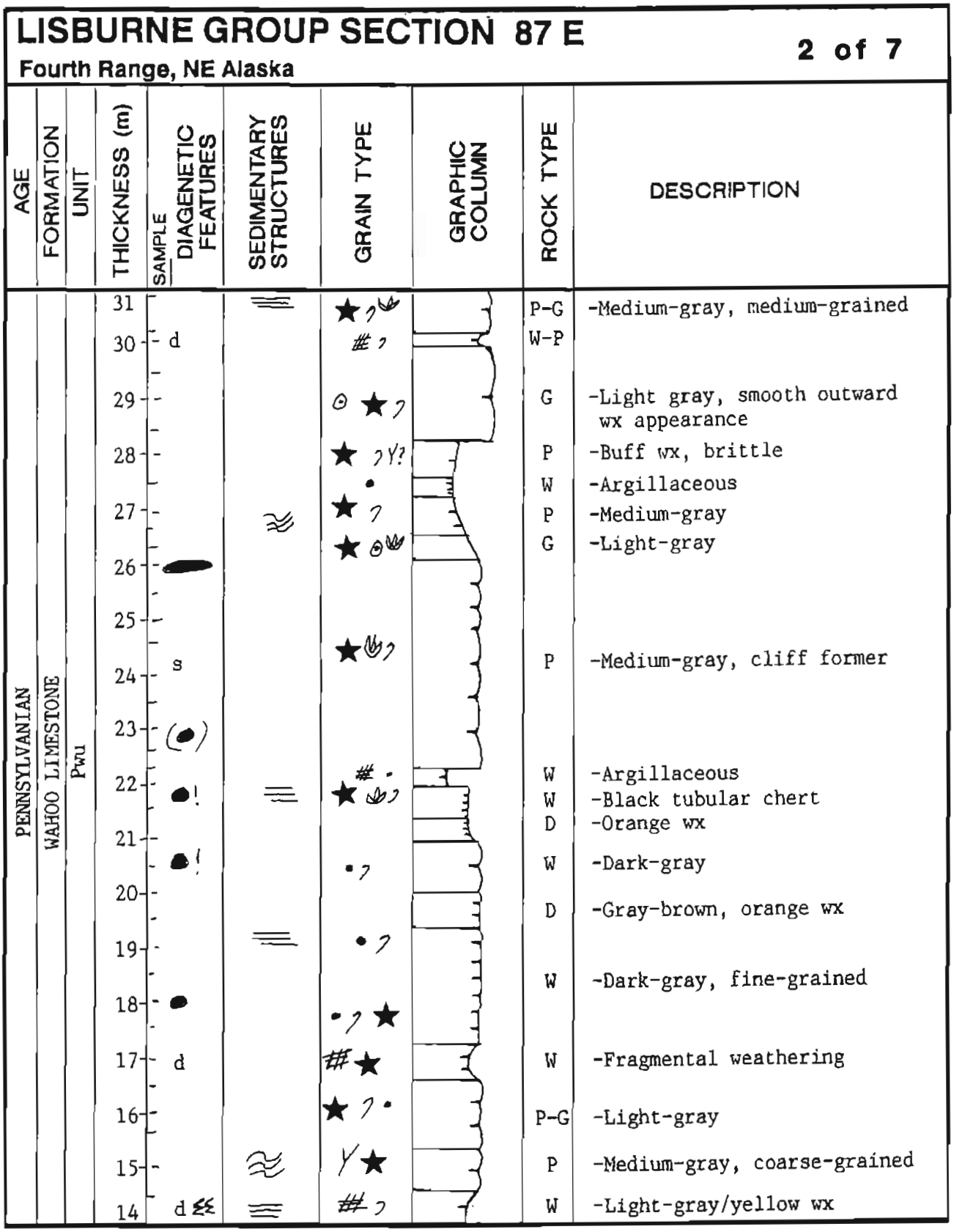




# LISBURNE GROUP SECTION 87 E

**Fourth Range, NE Alaska**





# LISBURNE GROUP SECTION 87 E

**Fourth Range, NE Alaska**



| AGE | FORMATION | UNIT | THICKNESS (m) | SAMPLE / DIAGENETIC FEATURES | SEDIMENTARY STRUCTURES | GRAIN TYPE | GRAPHIC COLUMN | ROCK TYPE | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| PENNSYLVANIAN | WAHOO LIMESTONE | Pwu | 48 | d | | ★ • ? | | P | -Gray-brown |
| | | | 47 | | | ★ ! ? • | | | |
| | | | 46 | | ≡ | • ★ ? | | P | -Medium-gray, brittle towards the top |
| | | | 45 | | | | | | |
| | | | 44 | | ≡ | • ? | | W | -Dark-gray/black, very fine-grained |
| | | | 43 | d p | | • ★ ? | | W-P | -Dark-gray, medium-grained |
| | | | | d | | ★ • ? | | P | -Coarse-grained |
| | | | 42 | | | | | | |
| | | | 41 | | | ? • | | P | -Medium-gray, smooth outward wx appearance |
| | | | 40 | d | | | | | |
| | | | 39 | d | | • (★) ? | | P | -Medium-gray with orange specs |
| | | | 38 | | ≡ | ★ ? | | P | -Medium-grained |
| | | | 37 | | | • ? | | P | -Medium-gray |
| | | | 36 | d | | ★ ? | | P-G | -Coarse-grained |
| | | | 35 | | | | | | |
| | | | 34 | | | ★ θ ? | | G | -Light-gray, cliff forming unit |
| | | | 33 | | | | | | |
| | | | 32 | d? | | ★ ! | | P | -Orange-brown/light-gray wx, coarse-grained |
| | | | 31 | | ≡ | ★ ? | | P-G | -Medium-gray, medium-grained |

# LISBURNE GROUP SECTION 87 E

**Fourth Range, NE Alaska**

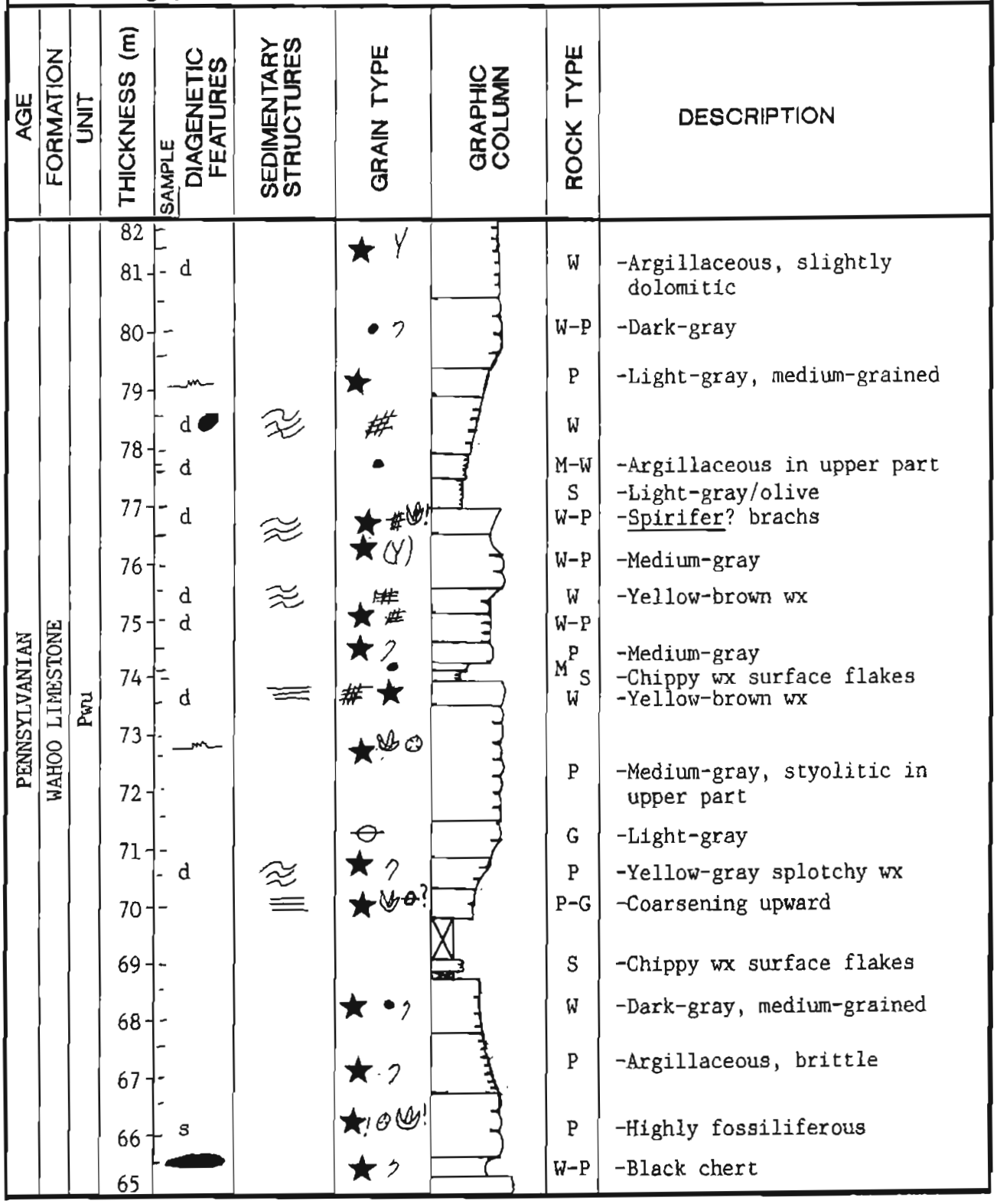


| AGE | FORMATION | UNIT | THICKNESS (m) | SAMPLE / DIAGENETIC FEATURES | SEDIMENTARY STRUCTURES | GRAIN TYPE | GRAPHIC COLUMN | ROCK TYPE | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| PENNSYLVANIAN | WAHOO LIMESTONE | Pwu | 65 | | | ★ | | W-P | -Dark-gray, coarse-grained |
| | | | 64 | | | | | | |
| | | | 63 | s | | ★ | | P | -Black chert |
| | | | | s | | ★ ! | | P | -Medium-gray/brown |
| | | | 62 | | | ★ | | P | -Medium-gray, coarse-grained |
| | | | 61 | d | | ★ | | W-P | -Brittle weathering |
| | | | 60 | d | | ★ | | P | -Fining upward |
| | | | 59 | | | • | | W | -Dark-gray, fine-grained |
| | | | 58 | | | | | | |
| | | | 57 | d | | • | | P | -Medium-gray |
| | | | | | | • | | W | -Dark-gray/black |
| | | | 56 | | | ★ | | P | -Fining upward, dolomitic at the base |
| | | | | d | | ★ | | D | -Blocky weathering |
| | | | 55 | | | ★ | | P | |
| | | | | | | • | | W-P | -Dark-gray, fine-grained |
| | | | 54 | | | | | P | -Medium-gray |
| | | | 53 | | | ★ | | P | -Medium-gray, medium-grained |
| | | | | s | | ★ | | | |
| | | | 52 | | | ★ • | | | |
| | | | 51 | | | • | | P | -Medium-gray |
| | | | | | | • | | W | -Dark-gray |
| | | | 50 | | | | | | |
| | | | 49 | d | | ★ • | | P | -Gray-brown |
| | | | 48 | | | | | | |

# LISBURNE GROUP SECTION 87 E

**Fourth Range, NE Alaska**

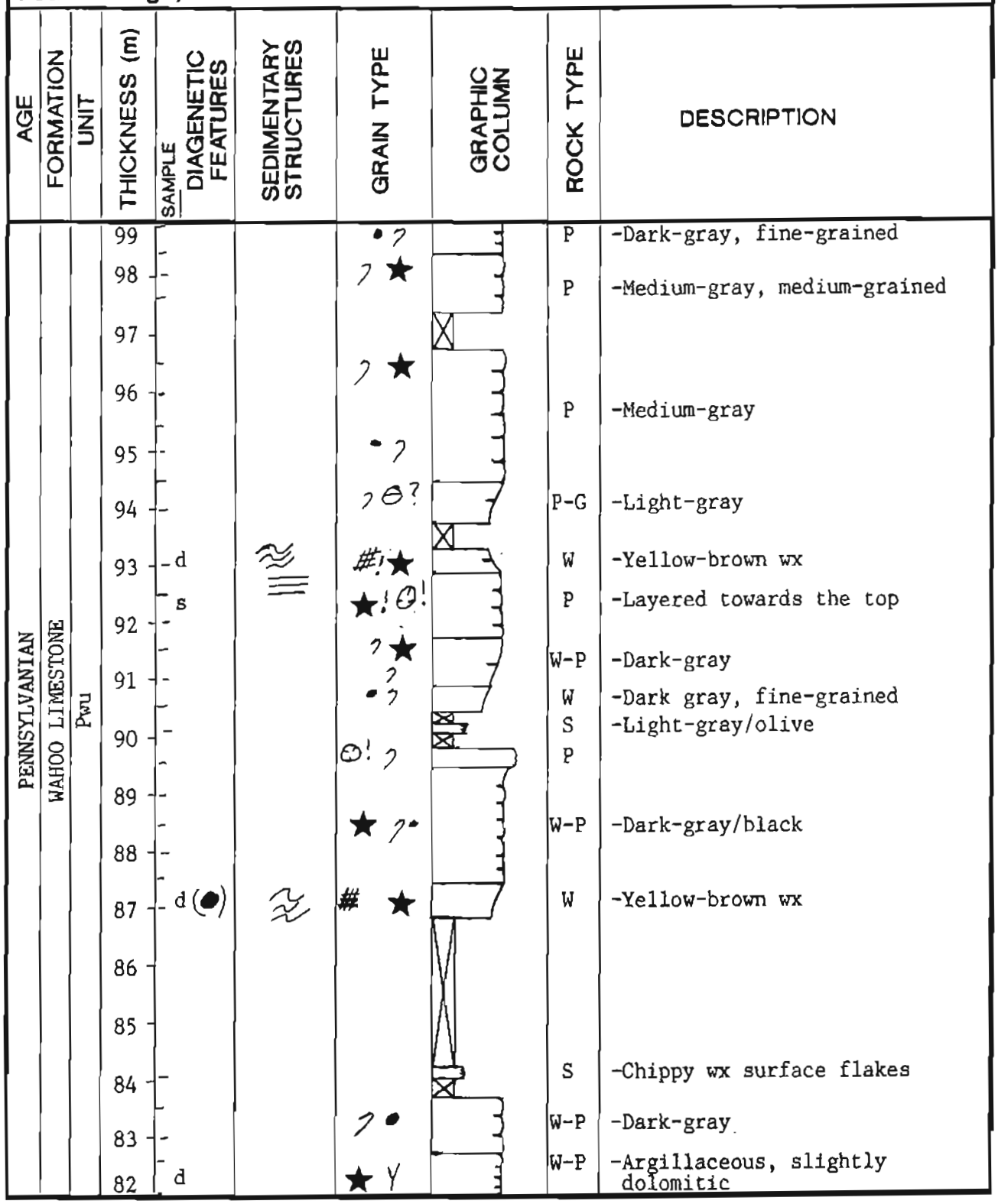




# LISBURNE GROUP SECTION 87 E

**Fourth Range, NE Alaska**

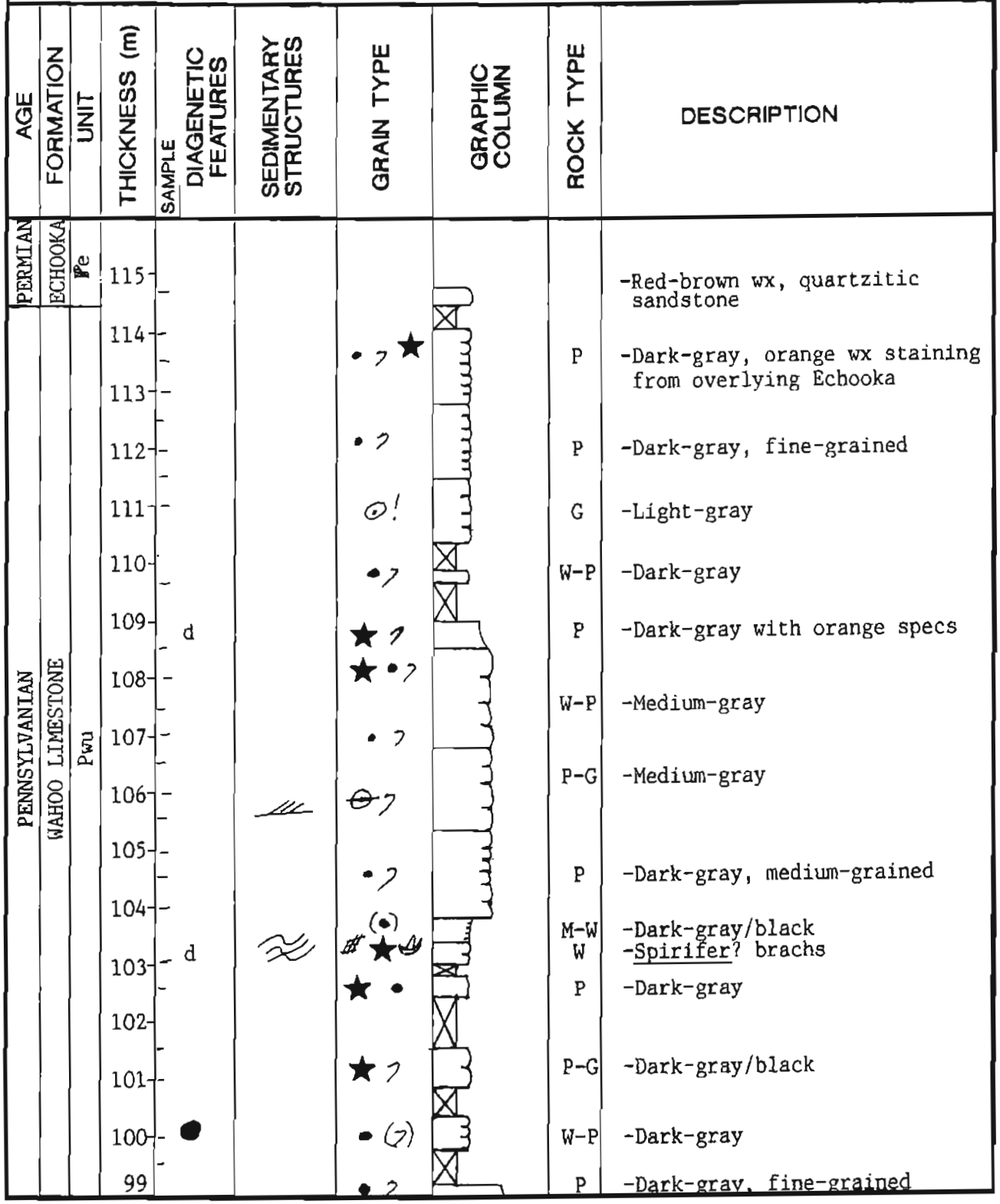




# LISBURNE GROUP SECTION 87 E

**Fourth Range, NE Alaska**

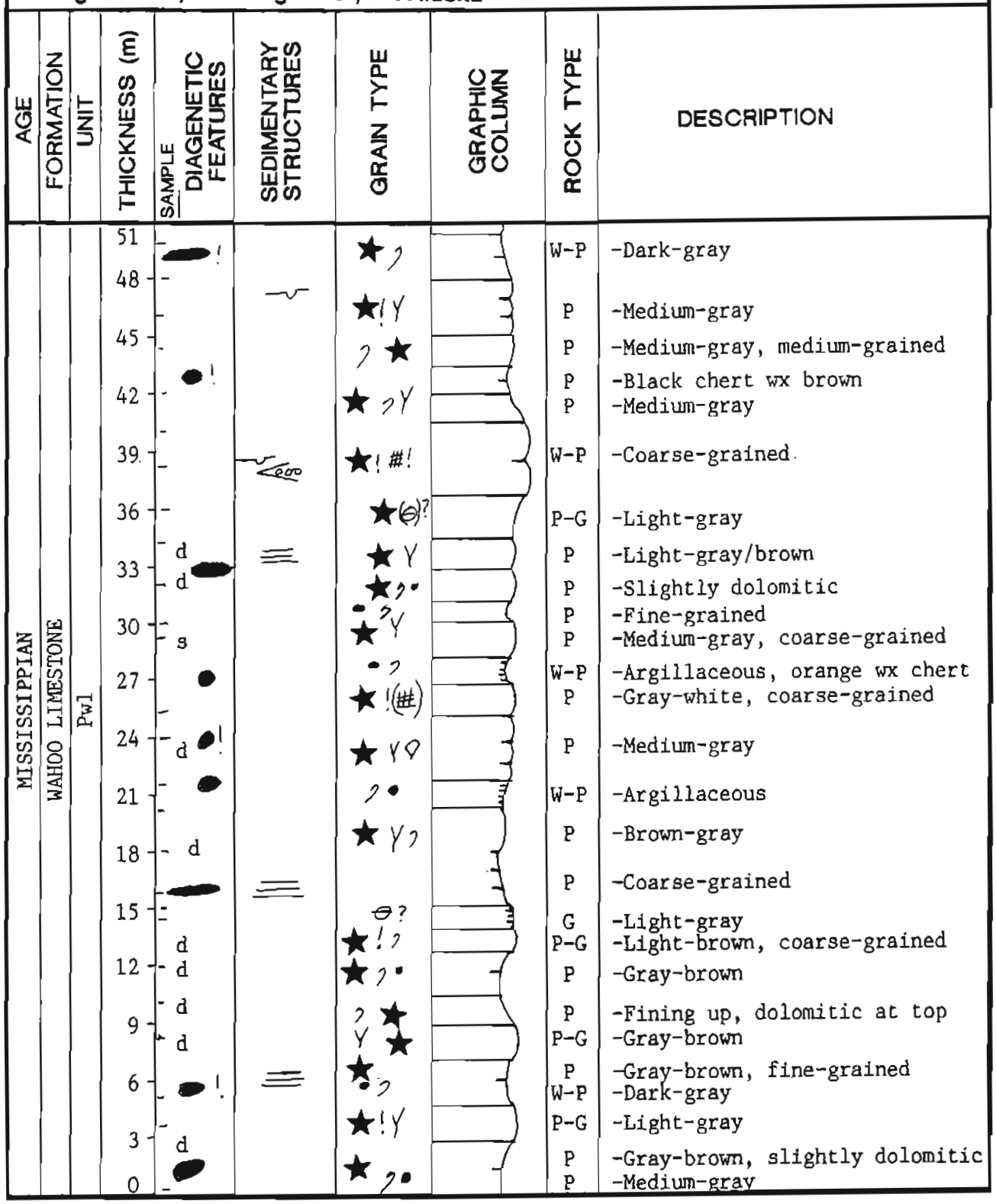




# LISBURNE GROUP SECTION 87 F

**Plunge Creek, Canning River, NE Alaska**

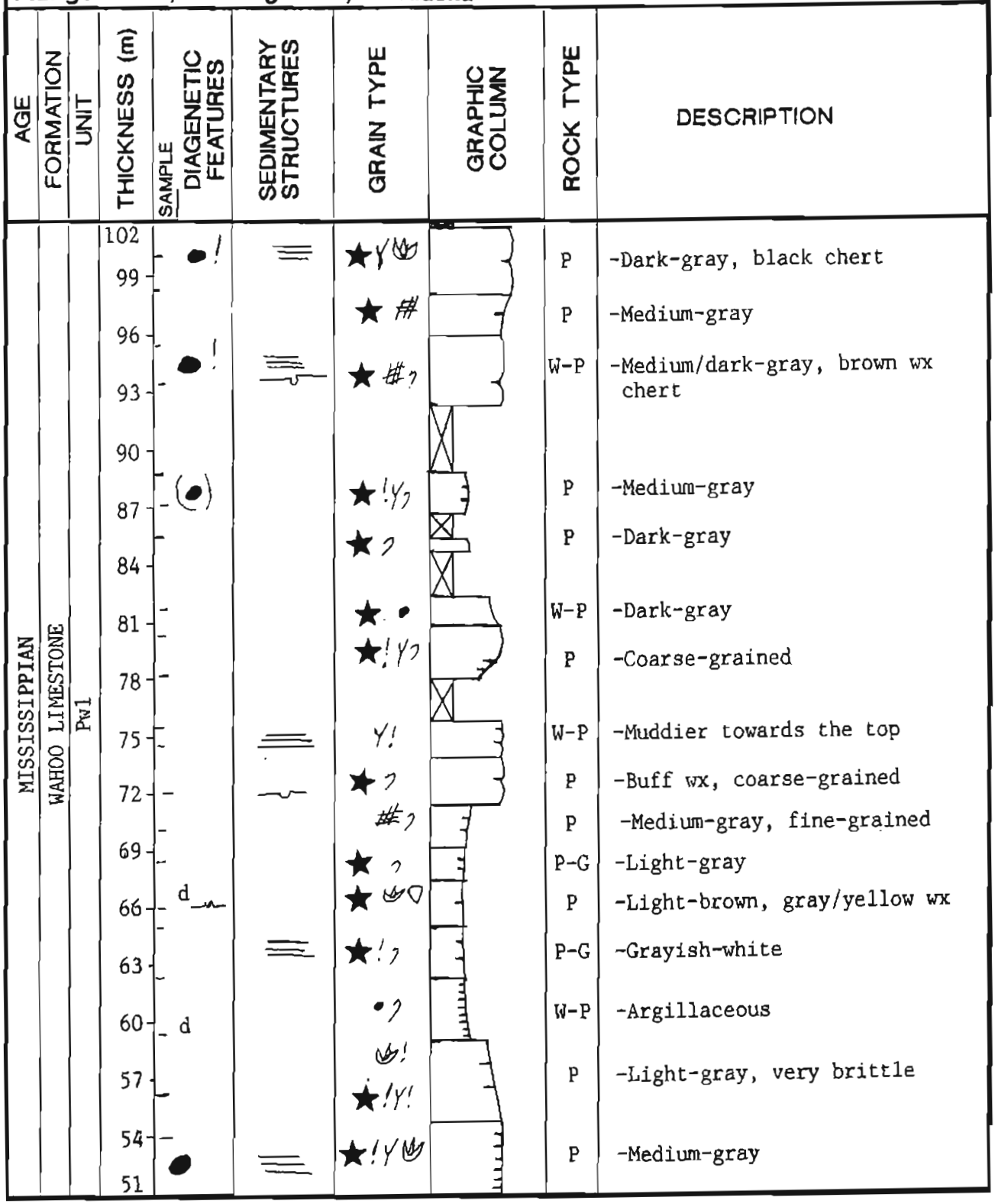




# LISBURNE GROUP SECTION 87 F



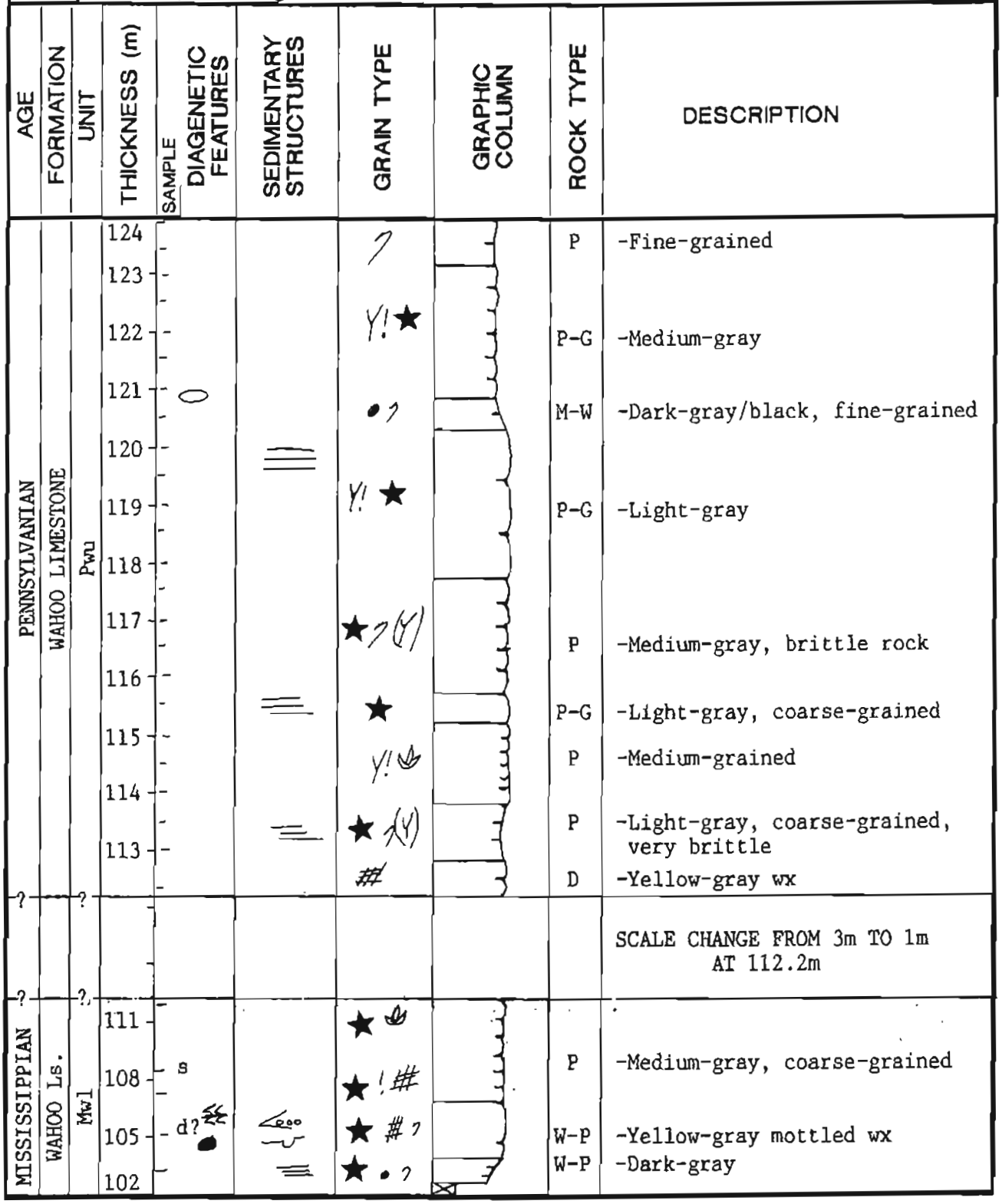
**Plunge Creek, Canning River, NE Alaska**



# LISBURNE GROUP SECTION 87 F

**Plunge Creek, Canning River, NE Alaska**

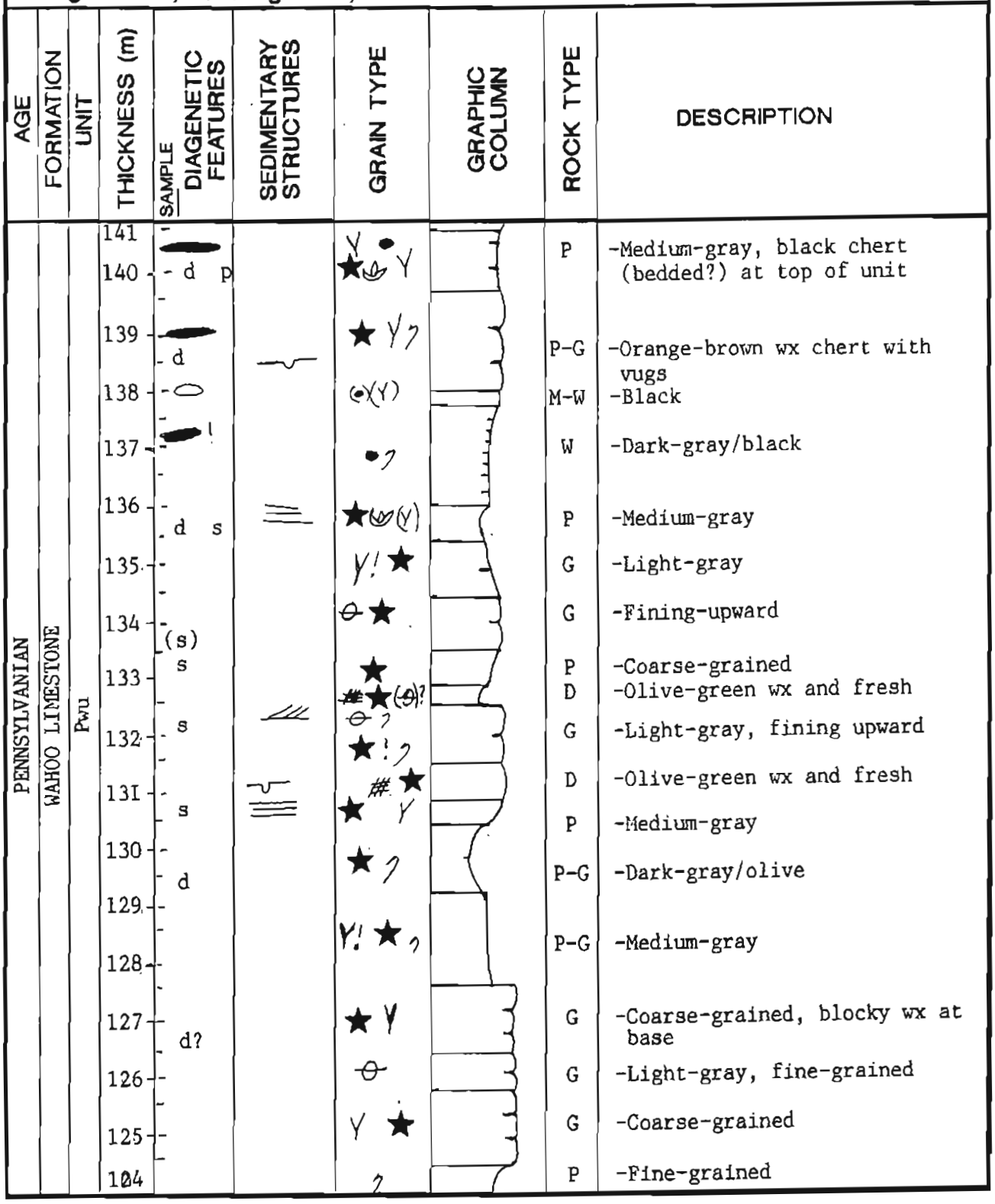




# LISBURNE GROUP SECTION 87 F

**Plunge Creek, Canning River, NE Alaska**

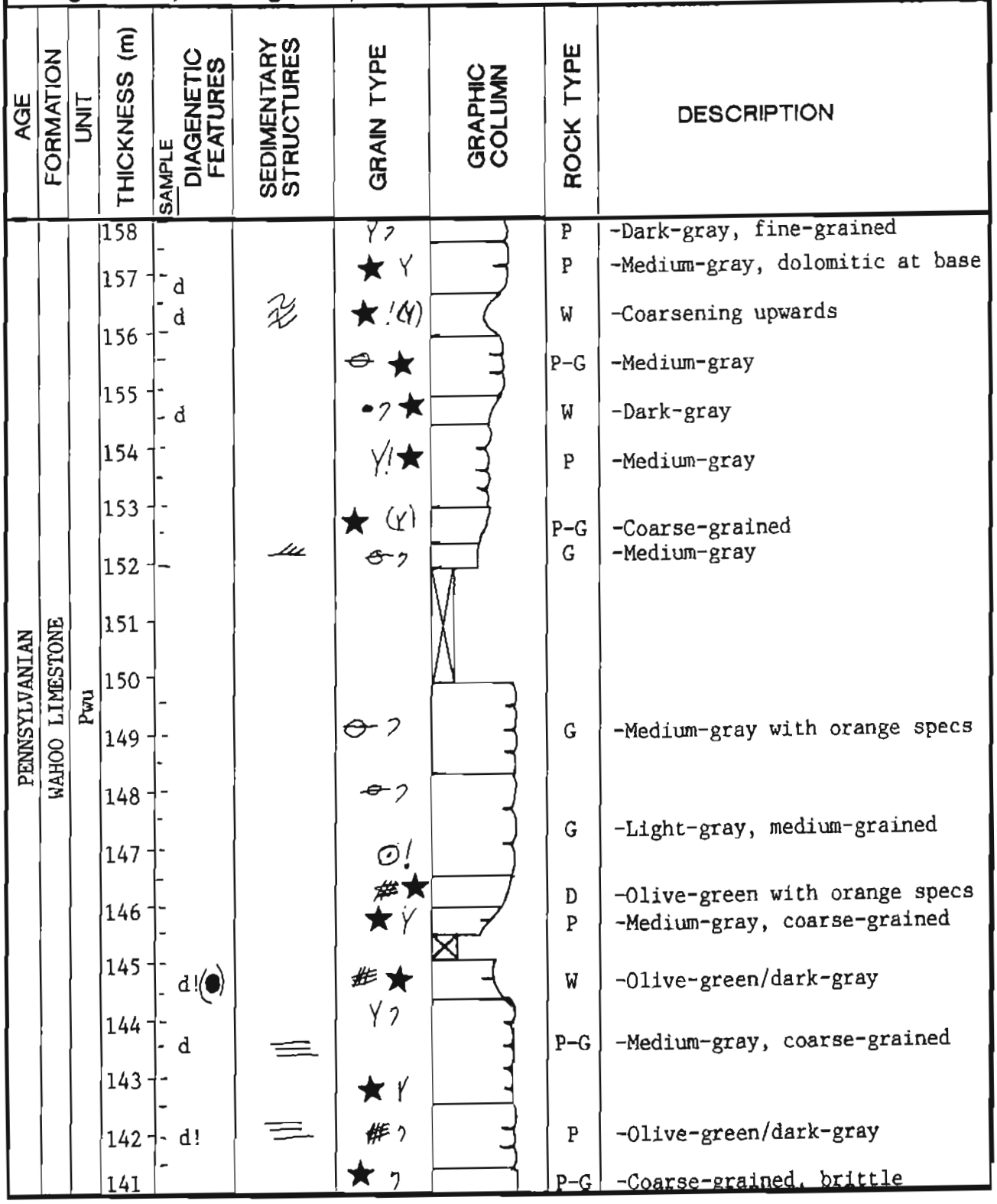




# LISBURNE GROUP SECTION 87 F

**Plunge Creek, Canning River, NE Alaska**

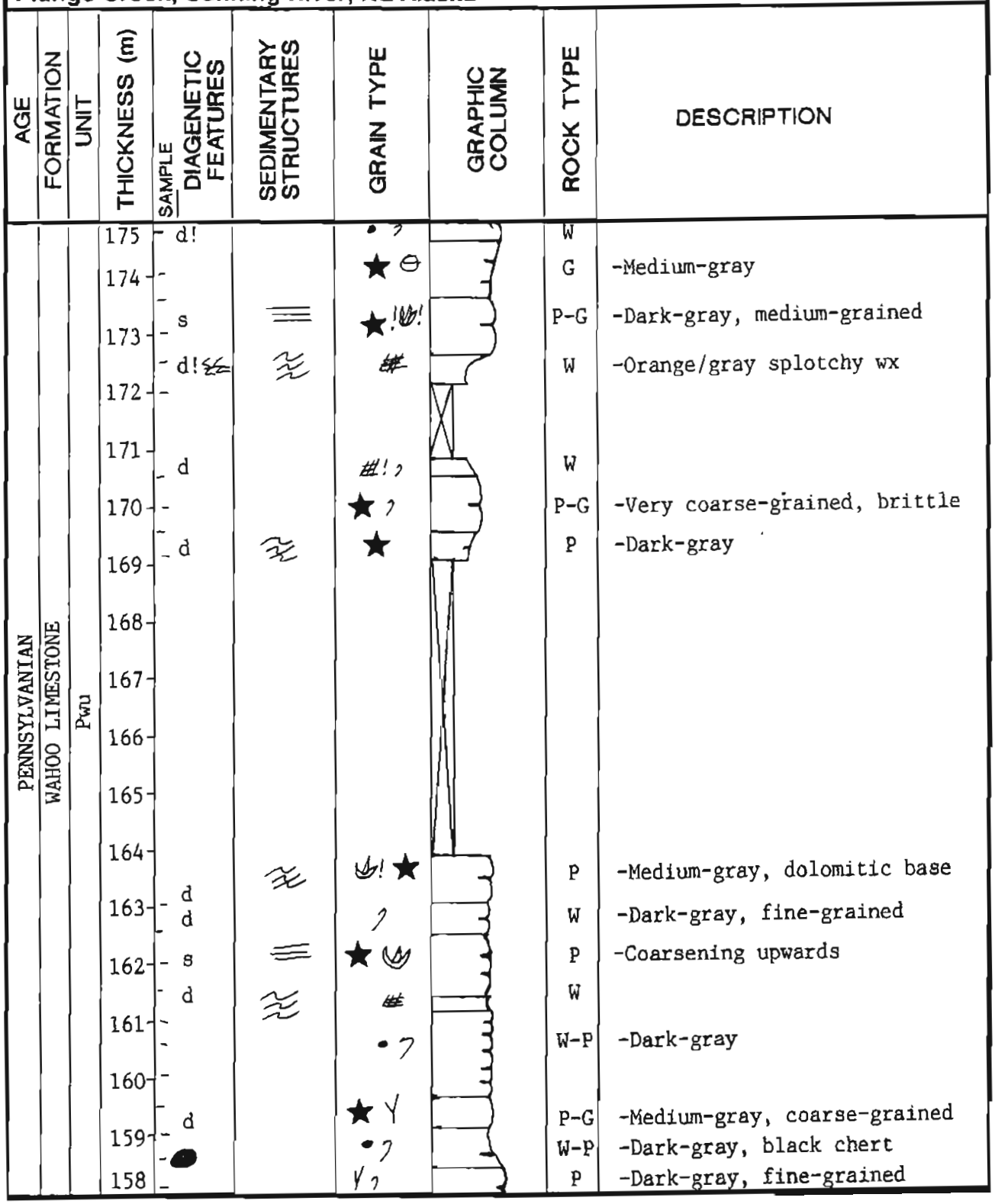




# LISBURNE GROUP SECTION 87 F

**Plunge Creek, Canning River, NE Alaska**

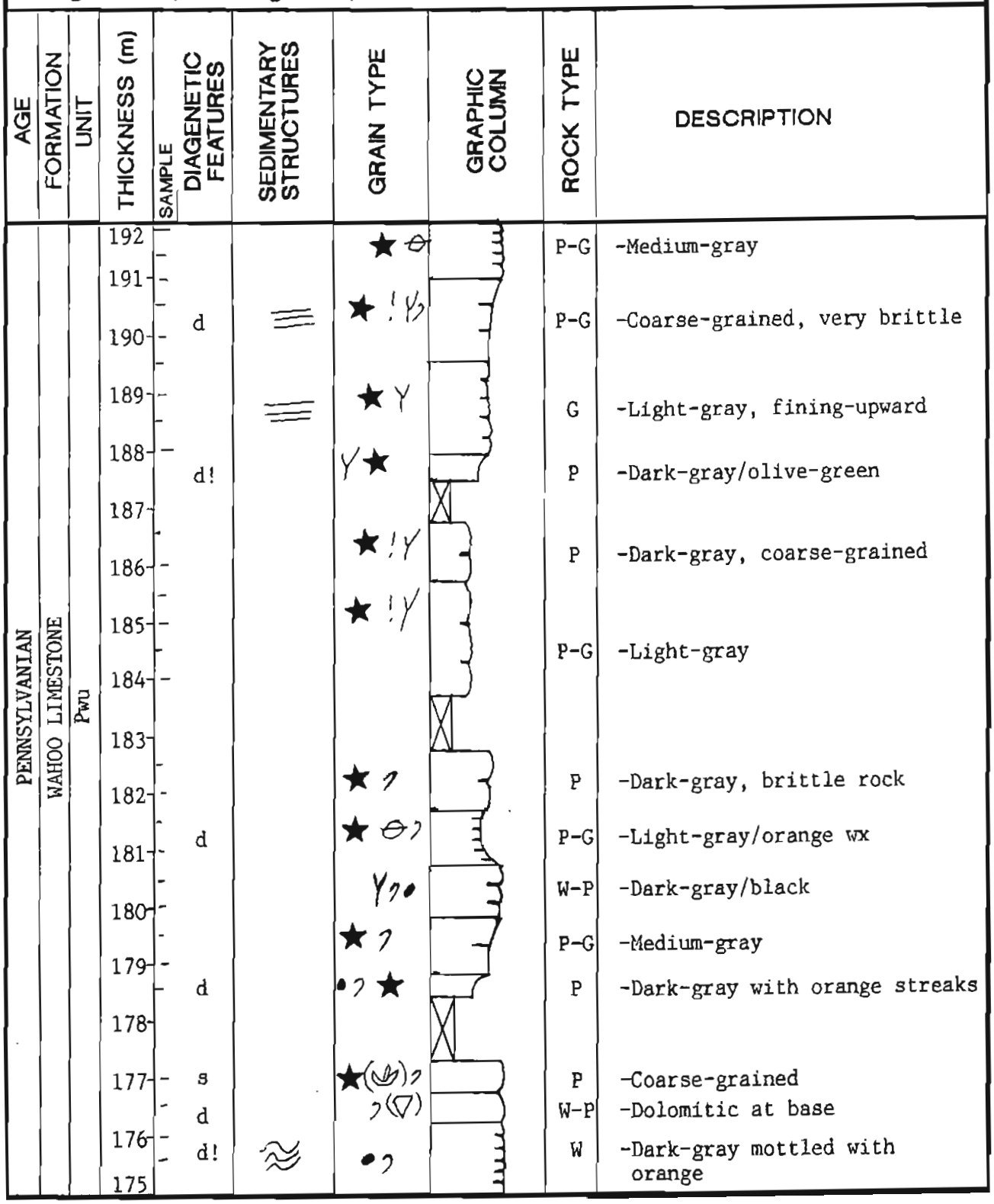




# LISBURNE GROUP SECTION 87 F

**Plunge Creek, Canning River, NE Alaska**

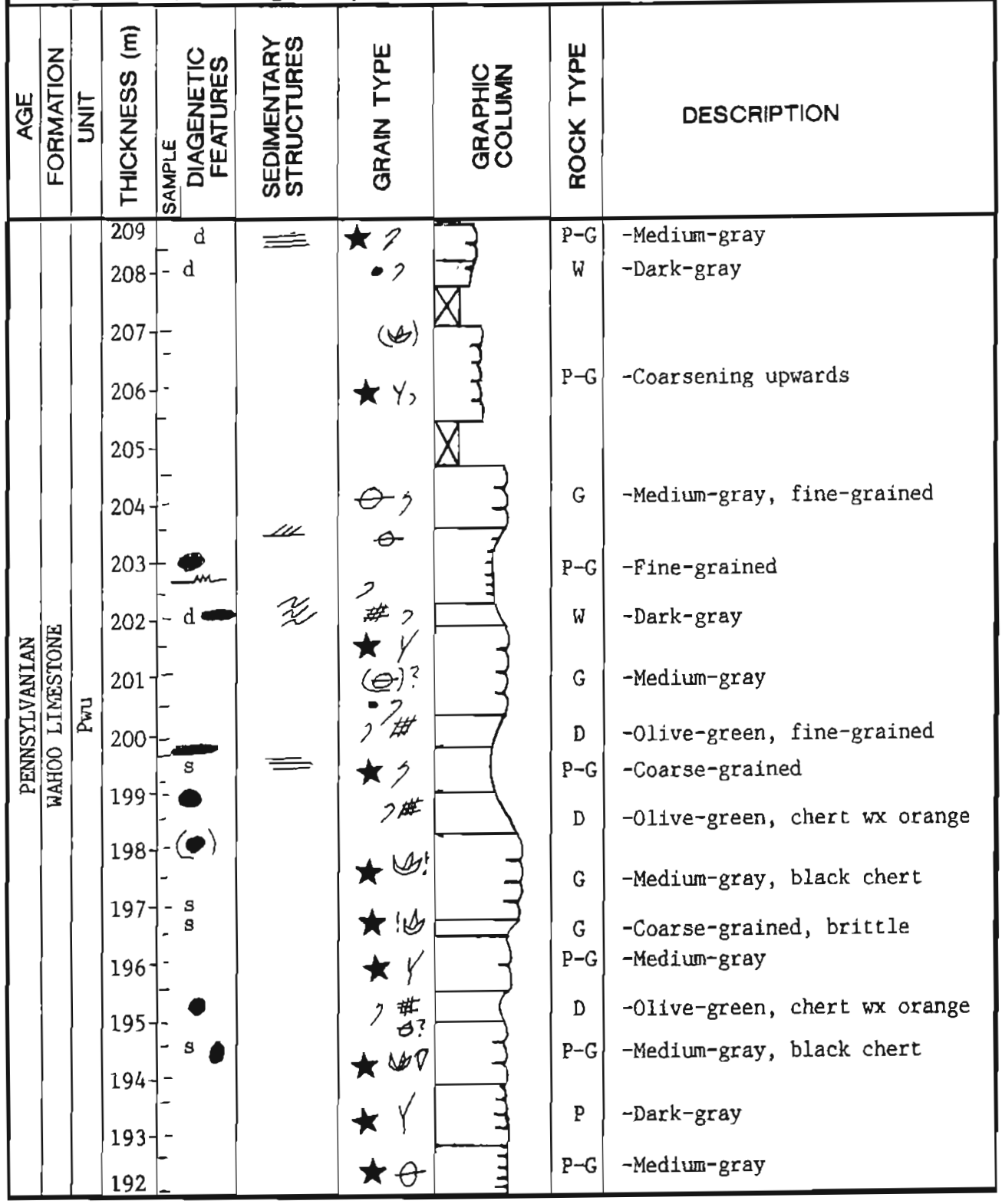




# LISBURNE GROUP SECTION 87 F

**Plunge Creek, Canning River, NE Alaska**

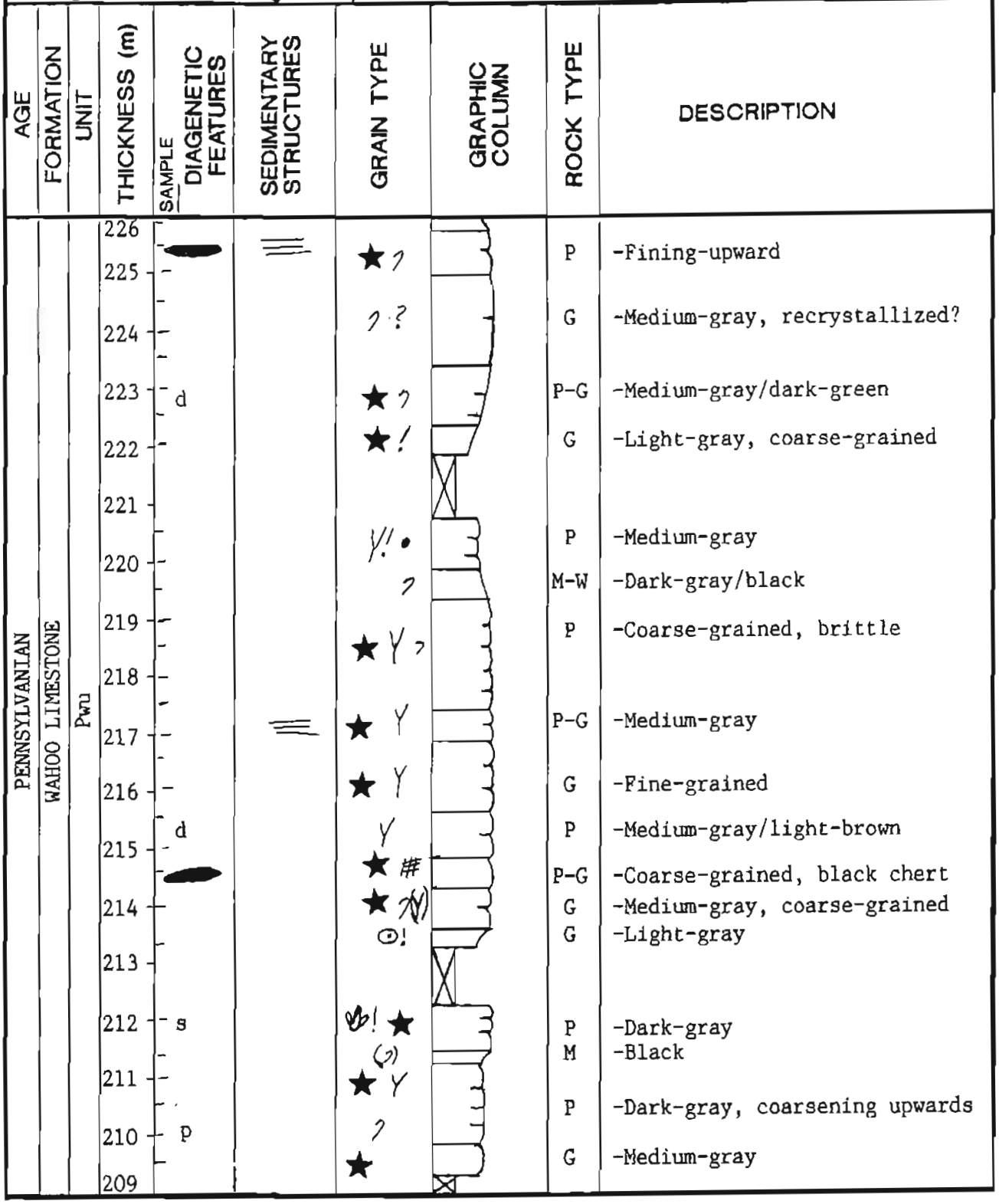




# LISBURNE GROUP SECTION 87 F



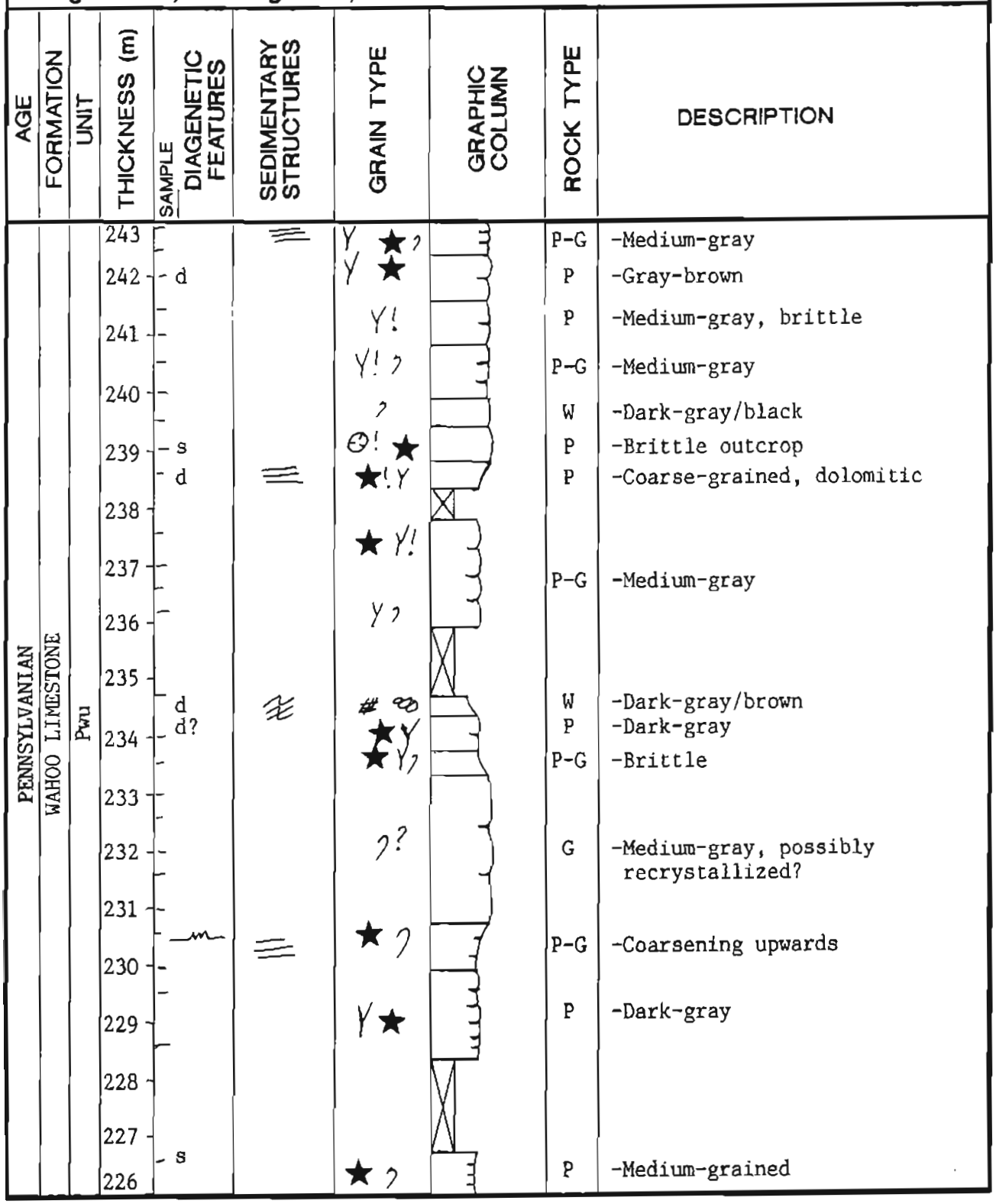
Plunge Creek, Canning River, NE Alaska



# LISBURNE GROUP SECTION 87 F

**Plunge Creek, Canning River, NE Alaska**

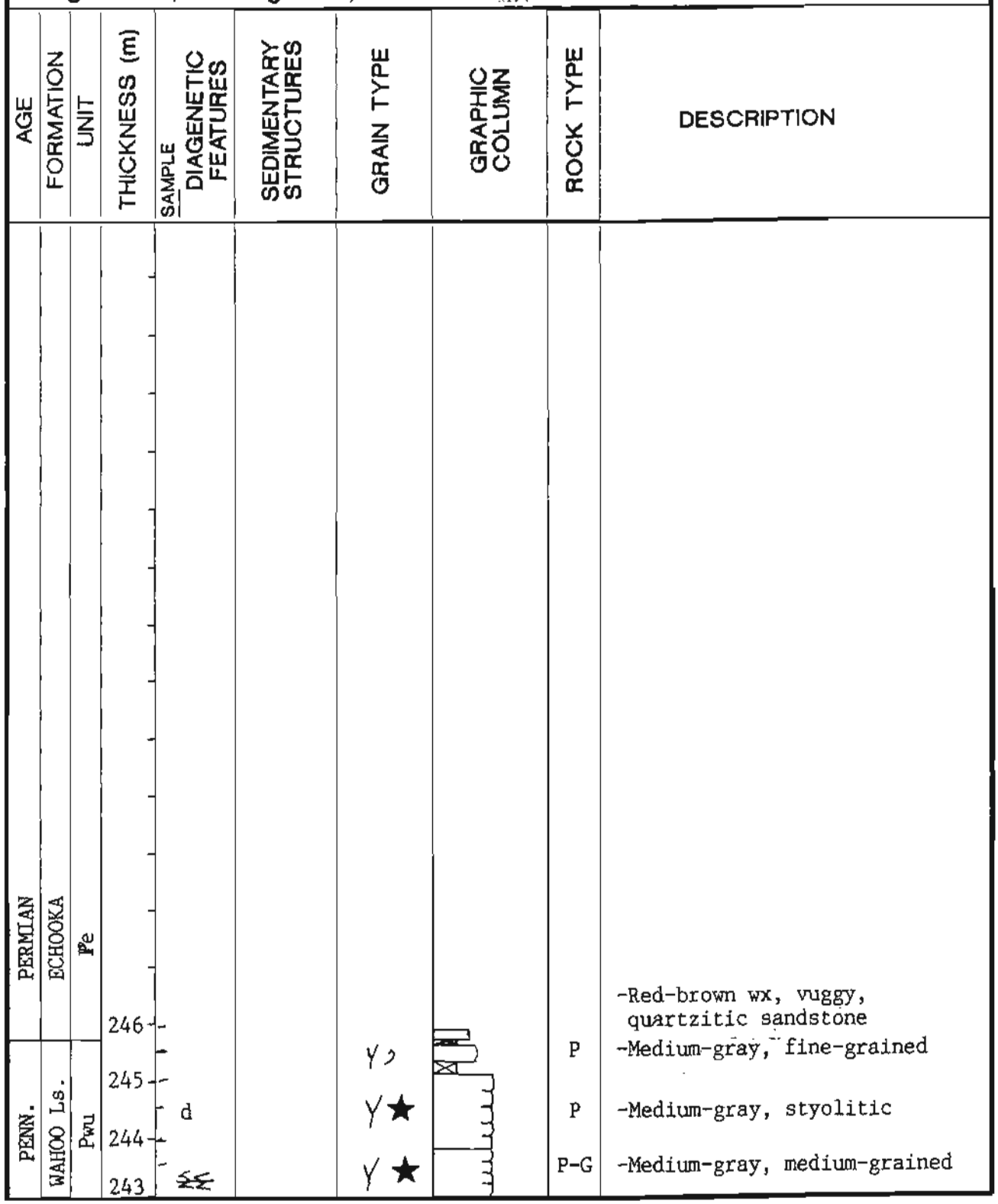




# LISBURNE GROUP SECTION 87 F

**Plunge Creek, Canning River, NE Alaska**





# LISBURNE GROUP SECTION 87 G

**Plunge Creek, Canning River, NE Alaska**