Public-data File 86-86d

STRATIGRAPHY OF THE LISBURNE GROUP, EASTERN SADLEROCHIT MOUNTAINS, NORTHEASTERN ALASKA

By

Randall Carlson[1]

Alaska Division of
Geological and Geophysical Surveys

November 1986

THIS REPORT HAS NOT BEEN REVIEWED FOR TECHNICAL CONTENT (EXCEPT AS NOTED IN TEXT) OR FOR CONFORMITY TO THE EDITORIAL STANDARDS OF DMGGS.

794 University Avenue, Suite 200
Fairbanks, Alaska 99709-3645

[1] University of Alaska Fairbanks

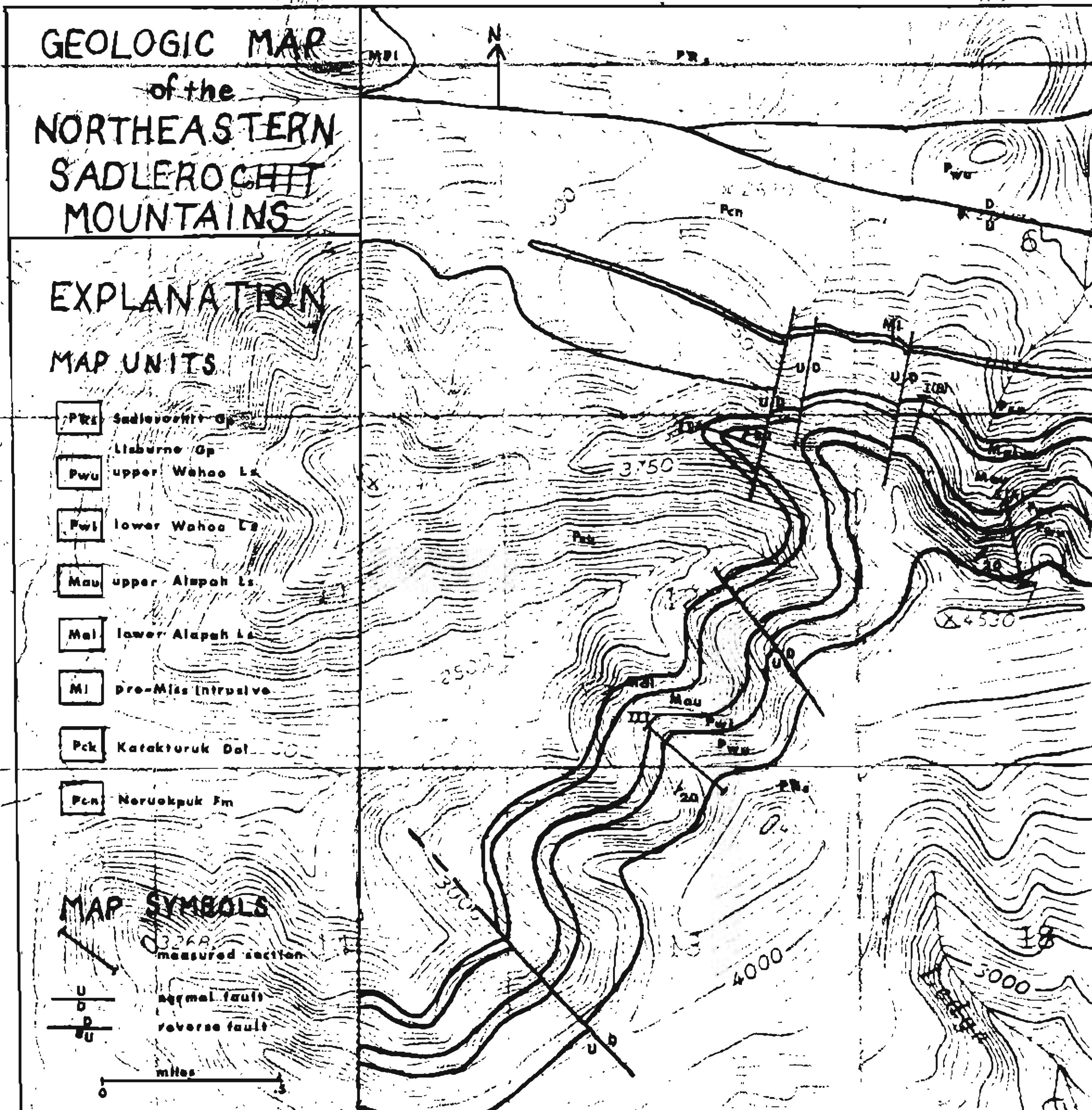


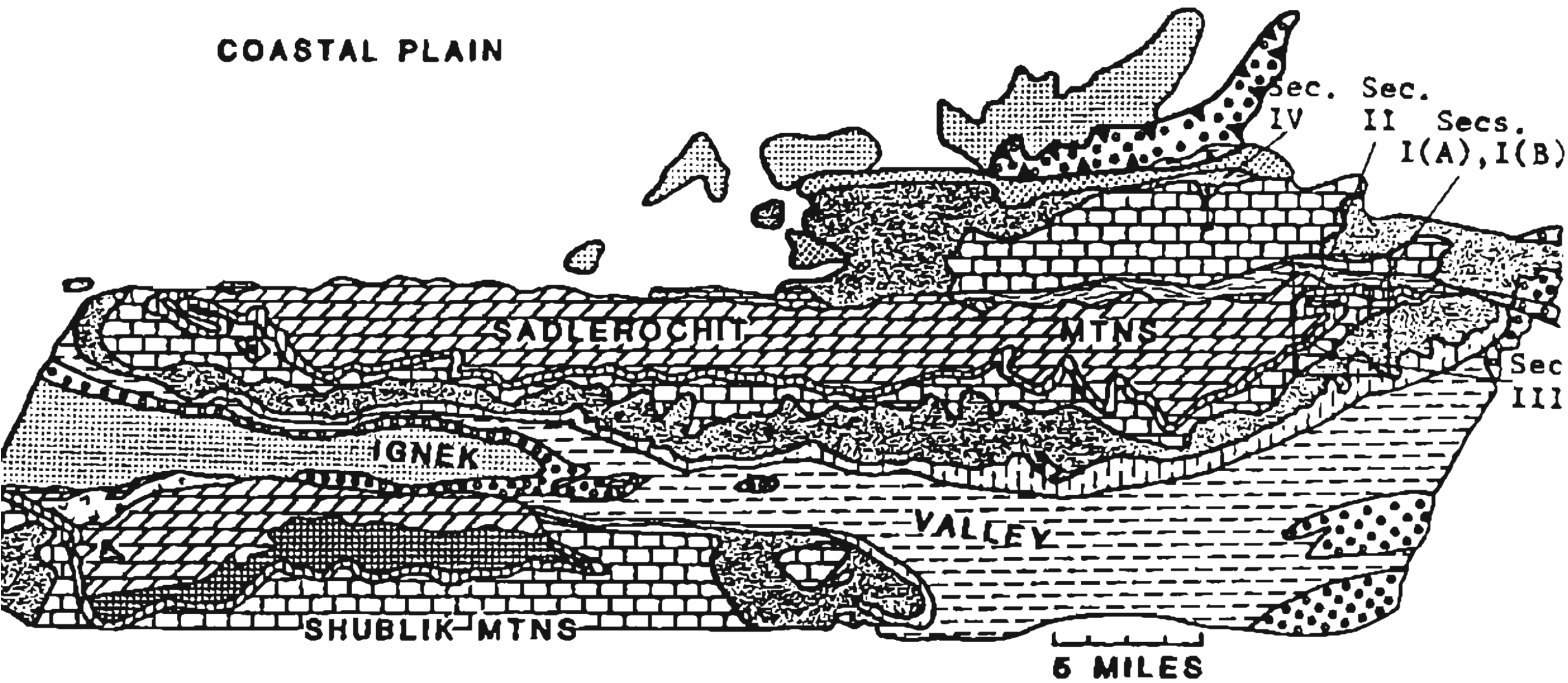
FIGURE 2 (see inset, FIG. 1)

This study was a part of the Alaska Division of Mining and Geological and Geophysical Surveys/University of Alaska-Fairbanks joint research project in the Arctic National Wildlife Refuge during the summer of 1986. The objective was to measure and describe the carbonate rocks of the Lisburne Group in the eastern Sadlerochit Mountains, northeastern Alaska. The observations and data contained in this report and that gained from petrographic examination of samples, will be analysed in later work with the objective of interpreting the depositional environment and diagenetic history of the Lisburne Group.

As one of the largest carbonate provinces in the world, the rocks of the Lisburne Group have both regional and global significance. As such, the description of the lateral variation and the vertical succession of its sedimentary facies is an important part of the history and occurrence of carbonate deposits worldwide. Lithologic cyclicity is well developed in the upper Wahoo Limestone. A study of its periodicity may have important implications for eustatic sea level changes during the Early Pennsylvanian.

This study is economically significant because of the hydrocarbon reservoir potential of the Lisburne Group at Prudhoe Bay (Bird and Jordan, 1977). An understanding of the relationships between lithofacies, depositional environment, diagenesis, occurrence of dolomite, and development of secondary porosity in rocks of the Lisburne Group might aid in developing any contained hydrocarbons.

In the Sadlerochit Mountains, the Lisburne Group is divided into 2 formations; the Alapah Limestone and Wahoo Limestone of Mississippian and Pennsylvanian age, respectively (Brosge and others, 1962). For the purposes of mapping during this study the Lisburne Group was divided into 4 units whose weathering profiles allow them to be recognised on air photos (Fig. 2): lower Alapah Limestone, consisting of cliff forming beds of peloid grainstone and packstone; upper Alapah Limestone, a slope froming dolomite and lime mudstone unit; lower Wahoo Limestone, consisting of masssive blocky cliffs of crinoid-bryozoan packstone and grainstone; and upper Wahoo Limestone, consisting of alternating cliffs and benches of beds of oolitic grainstone and dolomitic crinoid-bryozoan packstone. The base of the lower Alapah Limestone is defined above the last occurrence of red-stained sandstone where it overlies the Itkilyariak Formation (Mull & Mangus, 1972). In other measured sections to the south it lies directly on the Katakturuk Dolomite with angular discordance. The boundary between the lower and upper Alapah Limestone was picked at the first occurrence of a thick interval of lime mudstone up from the base of the section. The boundary between the upper Alapah Limestone and the lower Wahoo Limestone was chosen above the last occurrence of dark colored limestone, overwhich lies lighter colored, cliff-forming crinoid-bryozoan packstone and grainstone. The boundary between the lower Wahoo Limestone and the upper Wahoo Limestone was defined at the base of an interval of algal and plane laminated mudstone and wackestone that overlies crinoid-bryozoan packstone.



GENERALIZED GEOLOGIC MAP OF THE SADLEROCHIT AND NORTHERN SHUBLIK MOUNTAINS (MODIFIED FROM REISER, 1970)

EXPLANATION

Kc	Tertiary to Upper Cretaceous Colville Group
KpK	Lower Cretaceous Pebble Shale Unit and Kemik Sandstone
KpKt	Lower Cretaceous Pebble Shale Unit and Thin Kemik Sandstone Unconformably over Sadlerochit Group (NE Sadlerochit Mtns.)
KJk	Lower Cretaceous to Jurassic Kingak Shale
TRs	Triassic Shublik Formation
TRPs	Lower Triassic to Permian Sadlerochit Group
IPMl	Pennsylvanian to Mississippian Lisburne Group
Mk	Mississippian Kayak Shale and Kekiktuk Conglomerate
D€n	Devonian to Cambrian Nanook Limestone
p€k	Precambrian (?) Katakturuk Dolomite
p€u	Precambrian (?) Phyllite, Quartzite, and Calcilutite
pMv	Pre-Mississippian Mafic Extrusive and Intrusive Rocks

Figure 1

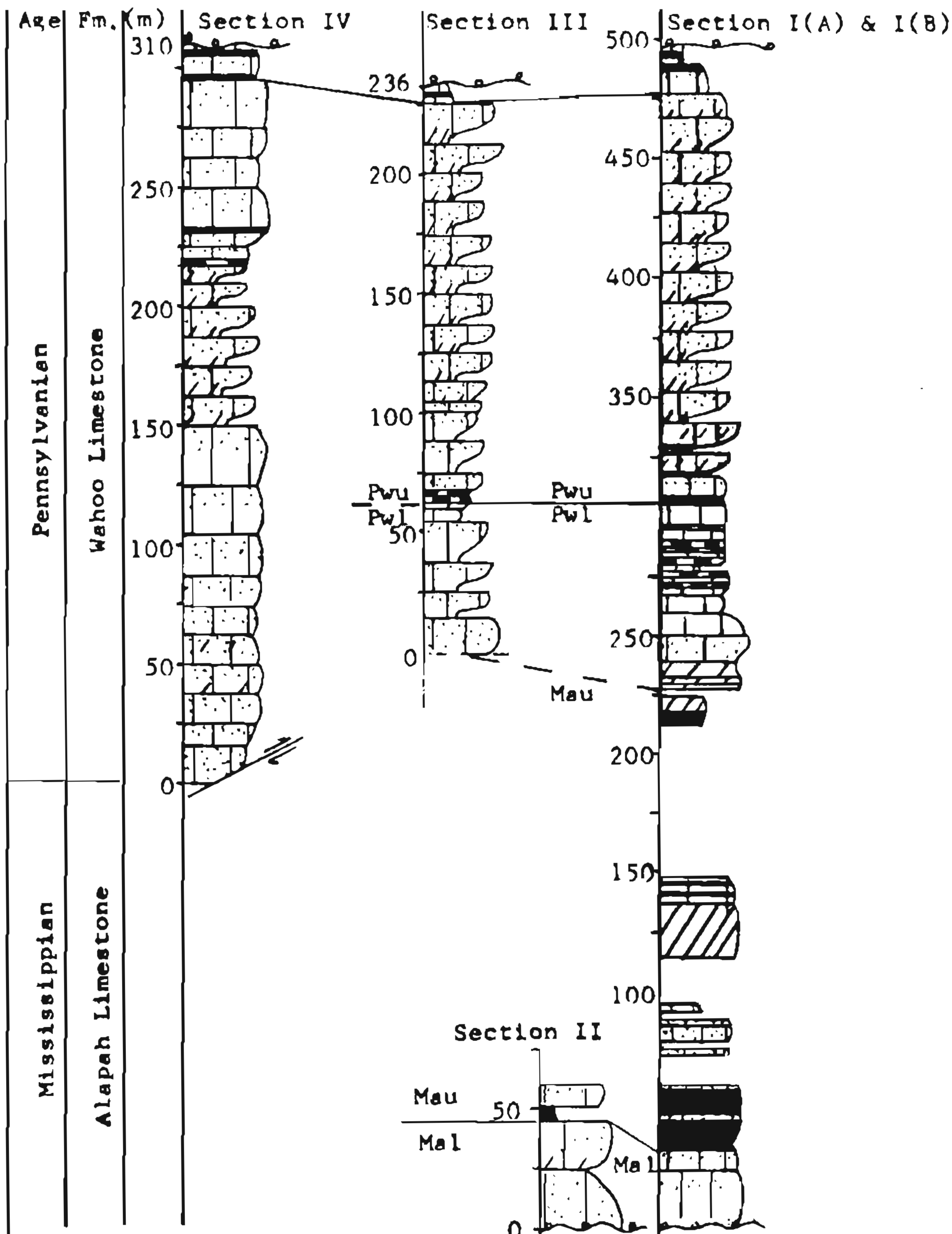


Figure 3: Correlation. Datum - lower Wahoo Limestone top.

Three stratigraphic sections of the Wahoo Limestone, one stratigraphic section of the Alapah Limestone and one of the lower Alapah Limestone were measured in the eastern Sadlerochit Mountains (Fig. 1 and Fig. 3). Measurements were made using a jacobs staff and samples were collected at .5 to 2 meter intervals. Observations made from thin sections of samples collected during previous feild work by Atlantic Richfield (ARCO) geologists in the area of Sections I and III were used to supplement the field description of the rocks. The limestone classification used throughout this report is that of Dunham (1962).

COMPARISON OF MEASURED STRATIGRAPHIC SECTIONS

The lower Alapah Limestone contains significant lateral variations in lithology and sedimentary structures. At the base of Section I(B) (Fig. 3 & 4), it consists of plane laminated, thick bedded, peloid packstone that overlies red stained sandstone and conglomerate of the Itkiliyariak Formation (Mull and Mangus, 1972). At Section II (Fig. 3, 5), 1 Km to the west, the basal beds of the Alapah Limestone consist of peloid and ooid grainstone with high amplitude cross-beds. Trough cross-bedding and scoured beds of grainstone are much more common here than at Section I(B). About 2 kilometers east of Section I(B), high amplitude cross-beds of oolitic grainstone also are present at the base of the Alapah Limestone. The rapid lateral changes in lithology and sedimentary structures indicates a high degree of variability in the local depositional environment. This probably represents a shallow near shore environment in which, calmer waters, at Section I(B), deposited mud-supported sediment and peloids in a lagoonal setting behind the protection of sand shoals where oolites and peloids were deposited by high energy waves and tidal currents.

Another difference between the base of Section I(B) and II is the rock units they overlie. At Section I(B) the Alapah Limestone is underlain by reddish stained sandstone and conglomerate of the Itkiliyarak Formation (3 meters thick) which unconformably overlies Precambrian phyllite and schist of the Neruokpuk Formation. At Section II the Alapah Limestone overlies the Katakturuk Dolomite (Precambrian?). No red sandstone occurs between outcrops of Lisburne Limestone and Katakturuk Dolomite. A basic question that arises is: is the nature of the basal Mississippian beds influenced by the bedrock type of which it was deposited (Mark Robinson, personal communication, 1986)? It can be argued that the high energy that must have been associated with the deposition of the large cross-beds overlying the Katakturuk Dolomite might have effectively removed the red bed sediments of the Itkiliyariak Formation. However, no occurrence of red beds was ever observed overlying the Kakakturuk Dolomite at any location. The answer to this question is made more difficult by the thinness of the Itkiliyariak Formation and the heavy cover of talus at the base of the cliffs of the lower Alapah Limestone.

The vertical succession of lithologies in the Wahoo Limestone can be divided into 3 basic intervals (Fig. 3). In the lower Wahoo Limestone, massive cliff forming beds of crinoid-bryozoan packstone and lesser grainstone are overlain by an interval of cyclic beds of the upper Wahoo Limestone. These cycles consist of medium to thin-bedded dolomite and crinoid-bryozoan packstone topped by beds of oolitic grainstone. The uppermost beds of the Wahoo Limestone comprise a third interval consisting predominately of peloid packstone and lime mudstone. Overall, Section I(A) has more packstone and mudstone in the lowest interval but the grain types show consistent trends at all locations. Oolitic grains were much more well developed at Section IV than at Section I(A) and III, which commonly contained only superficially coated grains in the upper parts of the cycles.

Significant differences in thickness were measured in the Wahoo Limestone at the different locations: Section I(A) - 270 meters, Section III - 236 meters, and Section IV - 310 meters. The difference between Section I(A) and III may be attribitable to a number of causes. One possibility is in the way the base of the lower Wahoo Limestone was recognised. It is ususally marked by a change in the weathering profile from a talus slope to excellent cliff outcrops. If the weathering characteristics of the basal beds of the Wahoo Limestone are not uniform, then the lower boundary may have been picked incorrectly at Section III due to recessive beds and extensive talus cover. On the other hand, Sections I(A) and III have similiar settings of SW dipping beds (20 - 25 degrees) exposed on the upper slopes of major spur ridges. No break in the continuity of the basal beds was observed at the scale of either outcrop location. Reconnaissance mapping of the lower Wahoo limestone also suggests that its thickness is locally variable in the Sadlerochit Mountains (Keith Watts, personal communication, 1986).

Another possibility for the variability in thickness might be due to the presence of carbonate mounds built by the baffeling action of the crinoid and bryozoan populations whose skeletons now compose the bulk of the beds in the lower Wahoo Limestone. Carbonate mounds dominated by crinoid-bryozoan packstone and lime mudstone are well documented for rocks of Carboniferous age (Wilson, 1975). Certainly, lithologic differences between Section I(A) and III argues for a mound geometry; the thicker part of the mound (Section I(A)) having a greater amount of packstone and lime mudstone than at Section III which has more grainstone and may represent a flanking to intermound area. A series of closely spaced measured sections and more detailed lateral facies mapping might answer such questions.

The base of the upper Wahoo Limestone was chosen below a thick bed of algal laminated lime mudstone that can be traced laterally throughout the exposures of the Wahoo Limestone in the eastern Sadlerochit Mountains. The thickness of the second interval which consists of cyclic crinoid-bryozoan packstone and oolitic grainstone, is nearly equal at Sections I(A) and III (164 and 161 meters respectively).

The third interval, consisting of peliod packstone and mudstone is 20 meters thick at Section I(A) and 7 meters thick at Section III. Because the boundary with the overlying Echooka Formation is an unconformity, this difference is probably due to erosional relief on the top of the Wahoo Limestone.

Section IV at Marsh Creek also has about 20 meters of peloid packstone and lime mudstone at the top of the section similiar to that at Section I(A). But here, the entire interval measured was 310 meters, much thicker than the other two sections. The basal beds of Section IV are not unlike the packstone to grainstone cycles seen at the base of the Wahoo Limestone at Sections I(a) and III. The difference occurs in the greater thickness of oolitic grainstone at Section IV: 175 meters versus about 100 meters at Sections I(a) and III.

The differences in the stratigraphic sections of the Wahoo Limestone in the eastern Sadlerochit Mountains reflect the local variability that can be found in any large carbonate producing environment. The data gathered here adds important constraints on questions of more regional scope such as basin trends and paleogeography.

MEASURED STRATIGRAPHIC SECTIONS

Section I(B): NW 1/4, Sec. 7, T3N, R31E, Mt. Michelson 1:250,000 quadrangle (Figure 4).

The section was exposed on the upper slope of a major spur ridge. It was measured uphill and sampled at 2 meter intervals. Offset 1/4 mile east at top of Alapah Limestone due to cliffs.

Section I(A): SW 1/4, NW 1/4, Sec. 7, T3N, R31E, Mt. Michelson 1:250,000 quadrangle (Figure 4).

Offset from Section I(B) 1/4 of a mile east. Measurement continued uphill within a narrow stream cut. Sampling was continued at 1 meter intervals.

Section II: NW 1/4, NE 1/4, Sec. 12, T3N, R30E, Mt. Michelson 1:250,000 quadrangle (Figure 5).

A partial section of the lower Alapah Limestone was measured at this location to study local lateral variations from Section I(B) which is about 1 Km to the east. The section is well exposed along a major ridge between Sections I(B) and III. North trending normal faults cross the line of section and measurement was discontinued when the first one was encountered. Samples were taken at 1 meter intervals.

Section III: SW 1/4, Sec. 12, T3N, R30E, Mt. Michelson 1:250,000 quadrangle (Figure 6).

Only the Wahoo Limestone of the Lisburne Group was measured at this location due to poor exposures in the Alapah Limestone. The section was measured up a spur ridge and sampled at 50 cm intervals for petrography and foram studies and also sampled at 10 meter intervals for porosity and permeability tests.

Section IV: Marsh Creek; NW 1/4, NE 1/4, Sec. 30, T4N, R30E, Mt. Michelson 1:250,000 quadrangle (Figure 7).

The base of this measured section is a high-angle reverse fault. It is defined by rubble outcrops of sandstone of the

Echooka Formation that structurally underlie overturned, steeply dipping limestone beds of the Lisburne Group. The basal beds of the section are similiar to the grainstone beds in the lower Wahoo Limestone that were examined at Sections I(A) and III. However, a boundary separating the Wahoo Limestone into lower and upper map units could not be recognized as it was in Sections I(A) and III. Furthermore, a complete section of the Wahoo Limestone may not be present due to the fault at the base of the section.

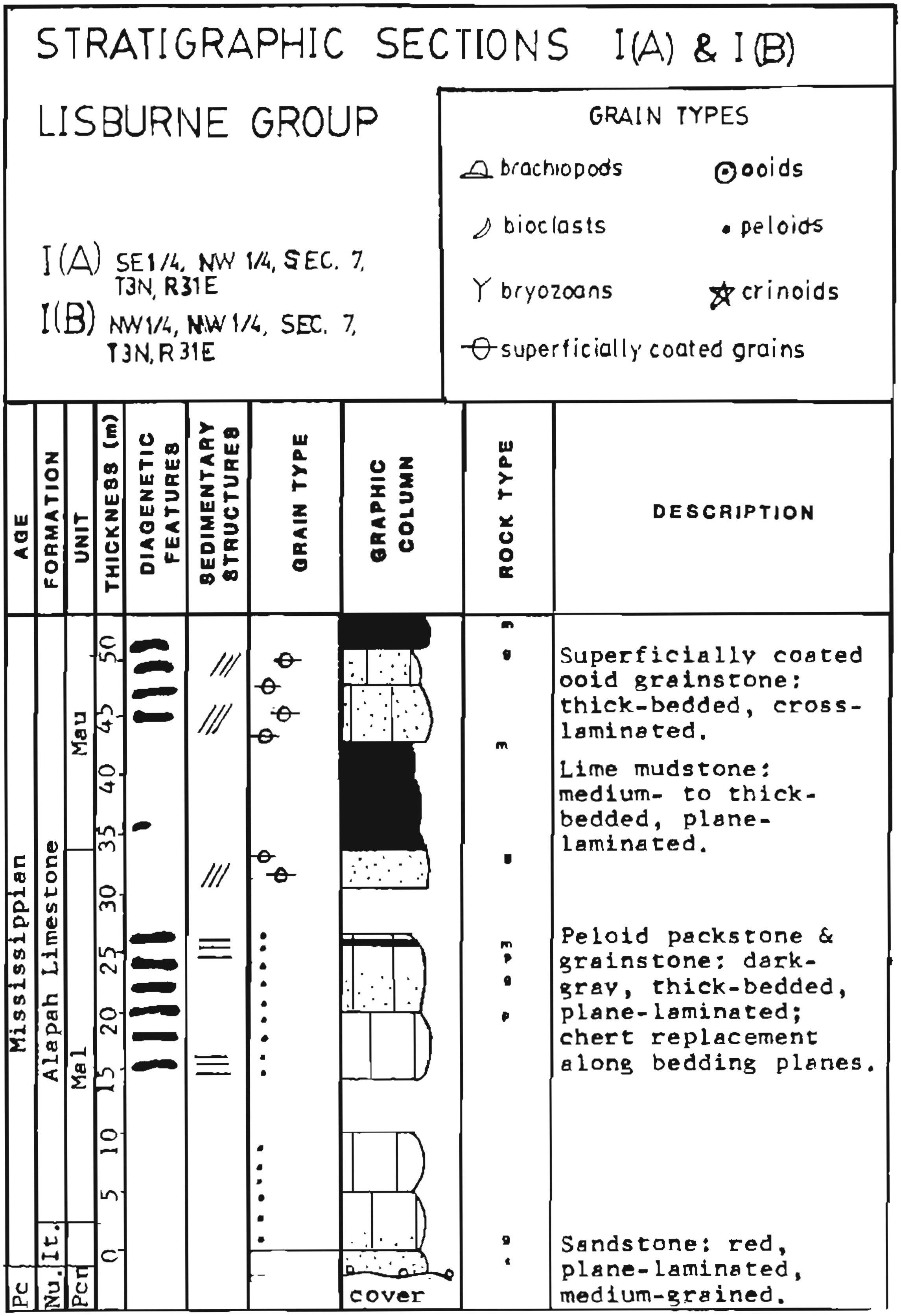


Figure 4: For explanation of symbols see Appendix I, p. 31 .

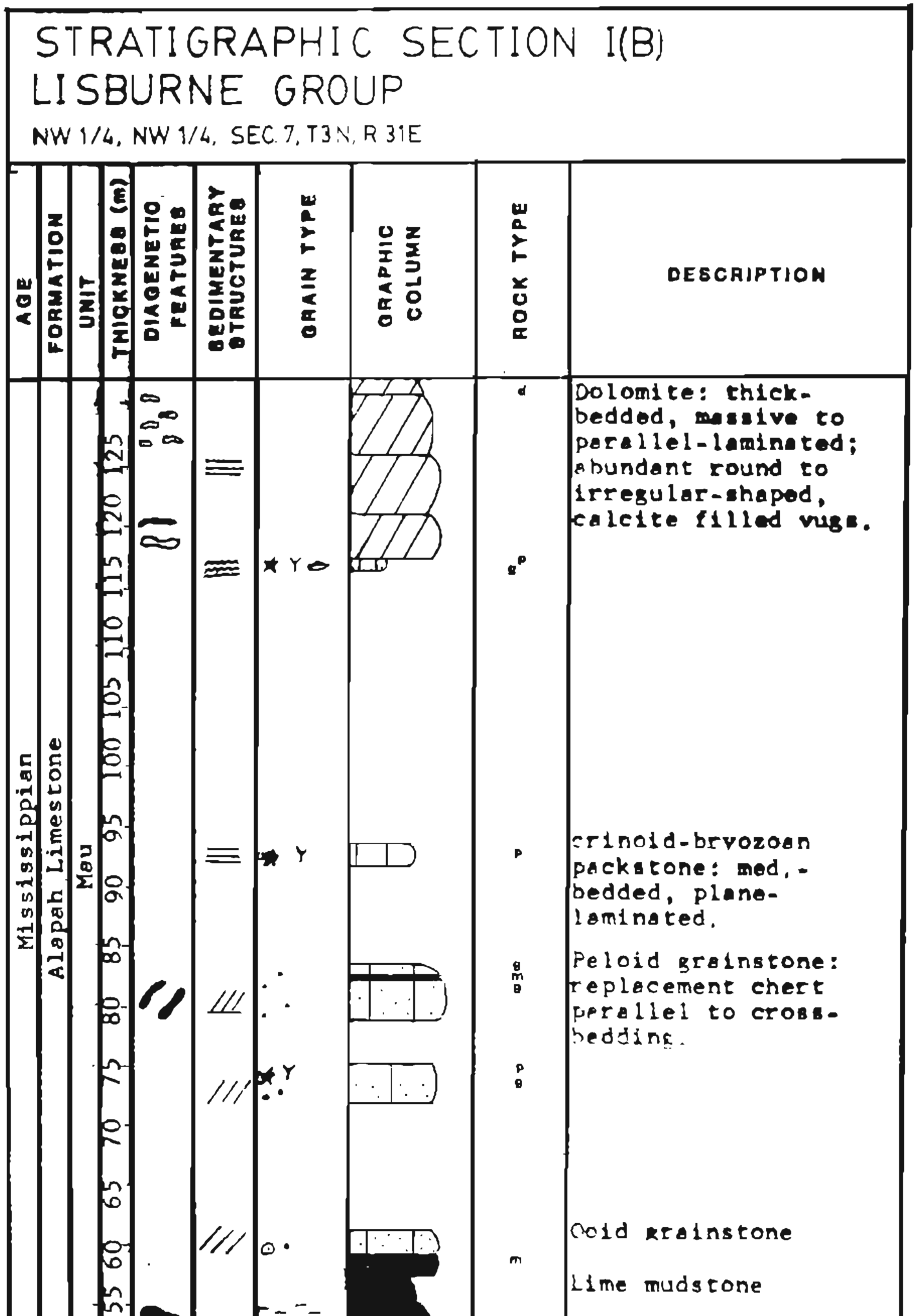


Figure 4: For explanation of symbols see Appendix I, p. 31.

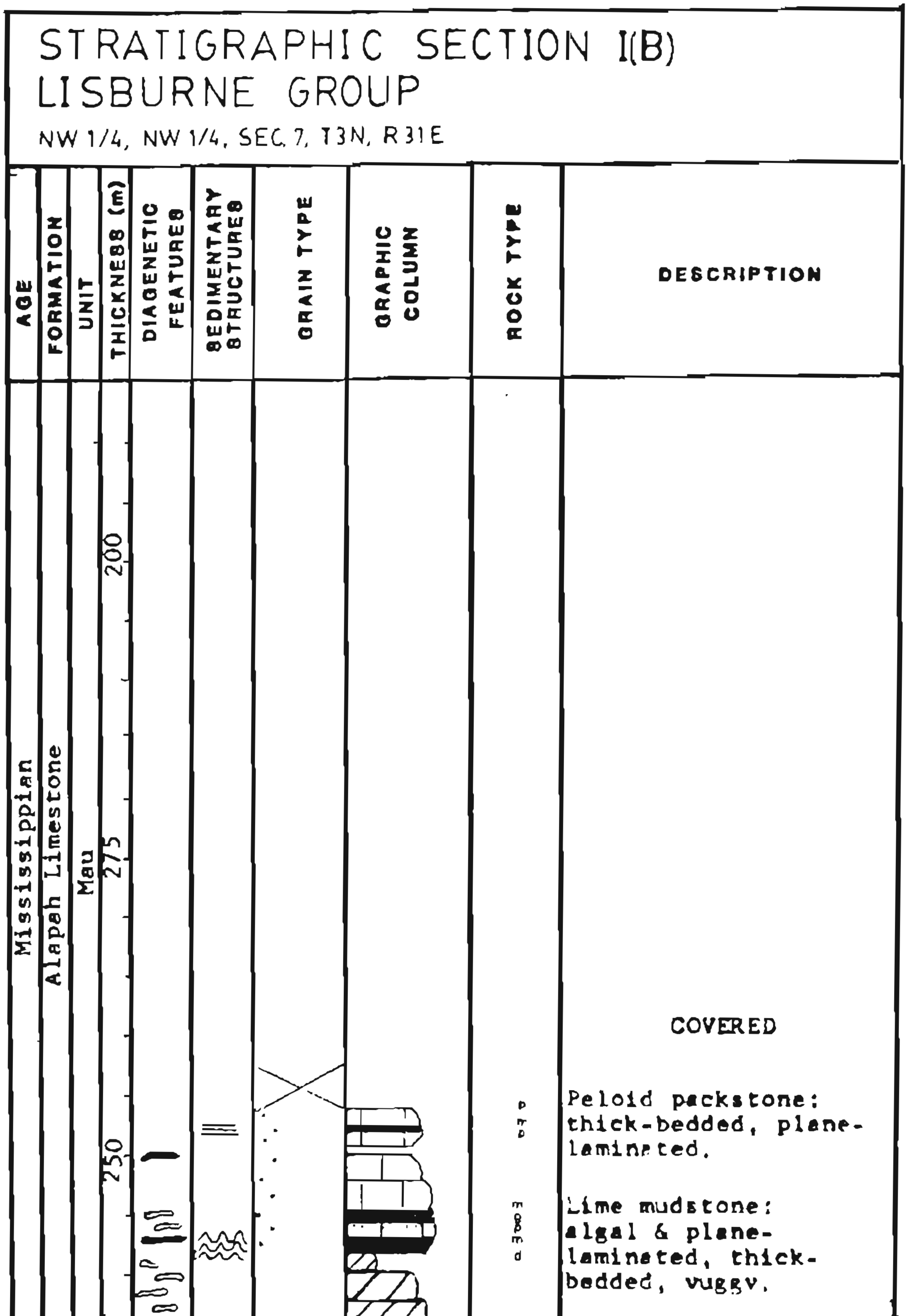


Figure 4; For explanation of symbols see Appendix I, p. 31.

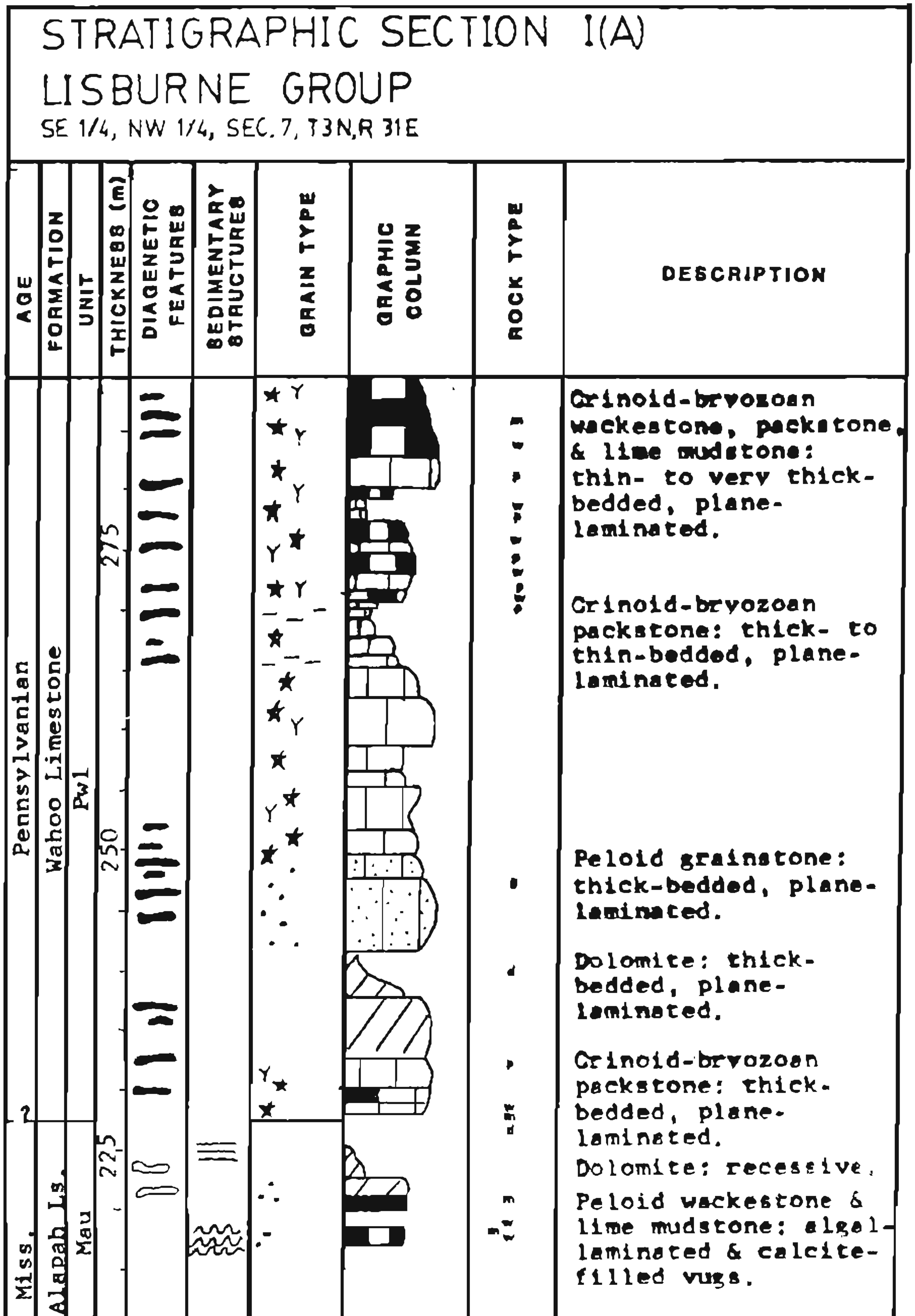


Figure 4: For explanation of symbols see Appendix I, p. 31.

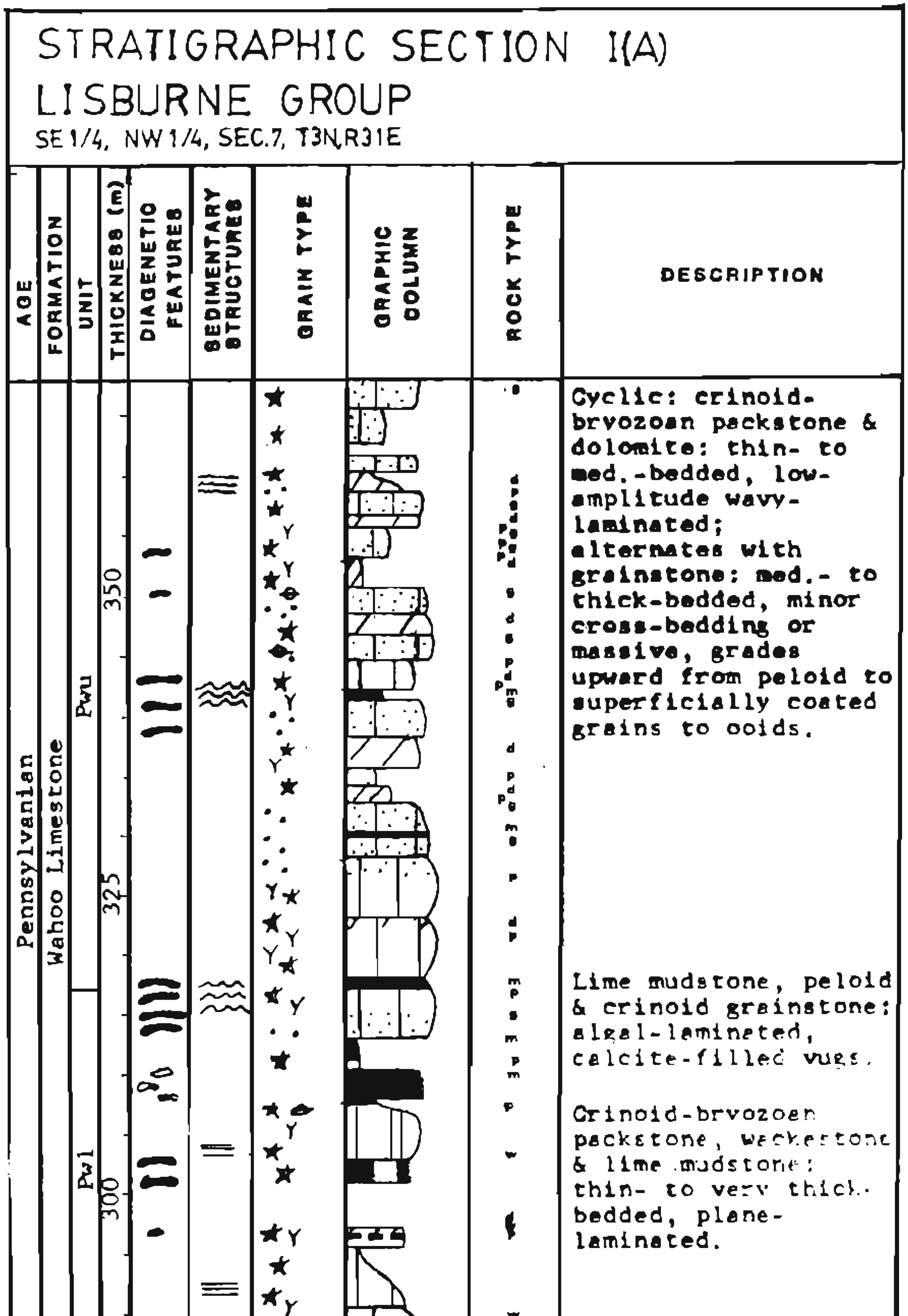


Figure 4: For explanation of symbols see Appendix I, p. 31.

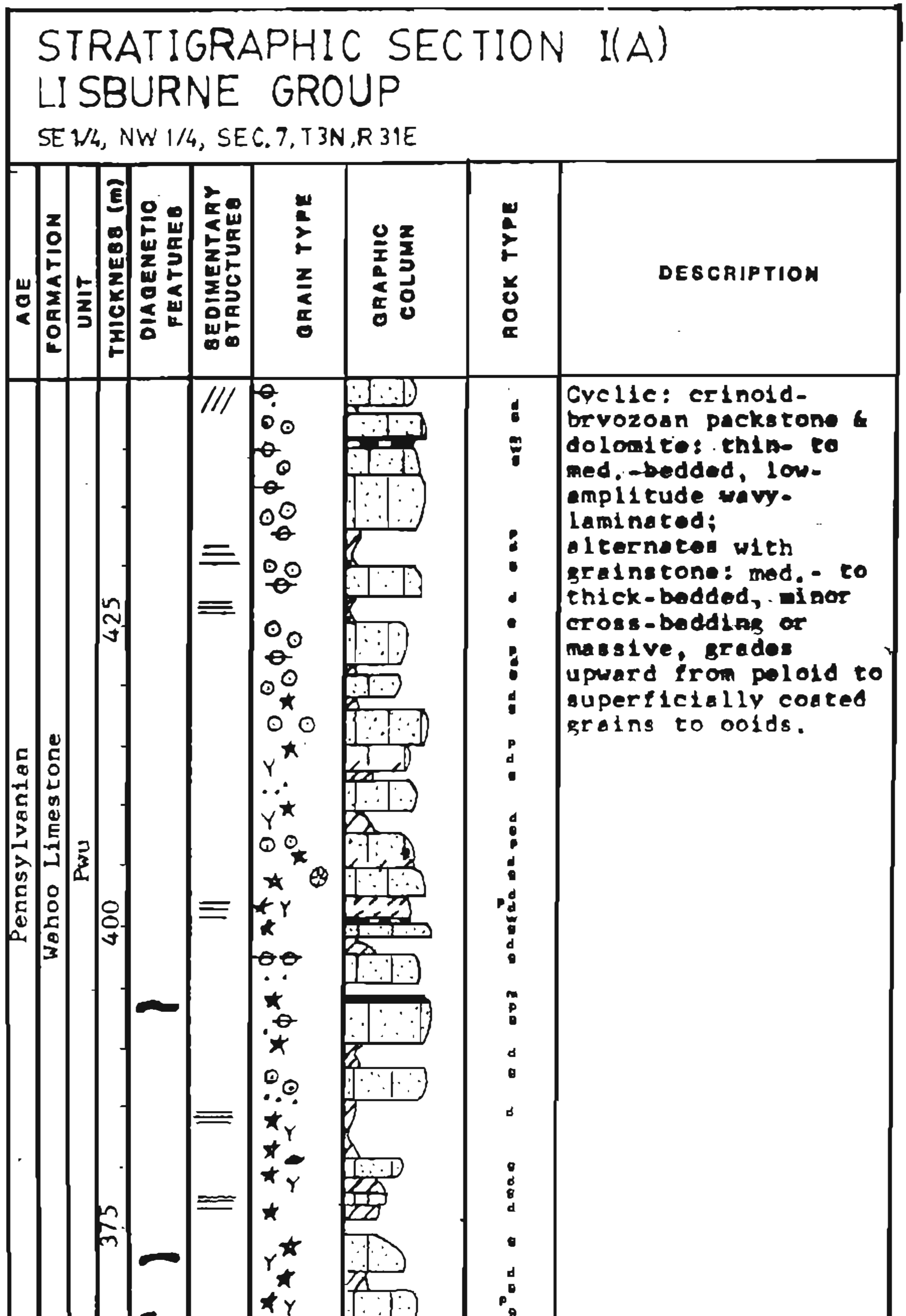


Figure 4: For explanation of symbols see Appendix I, p. 31.

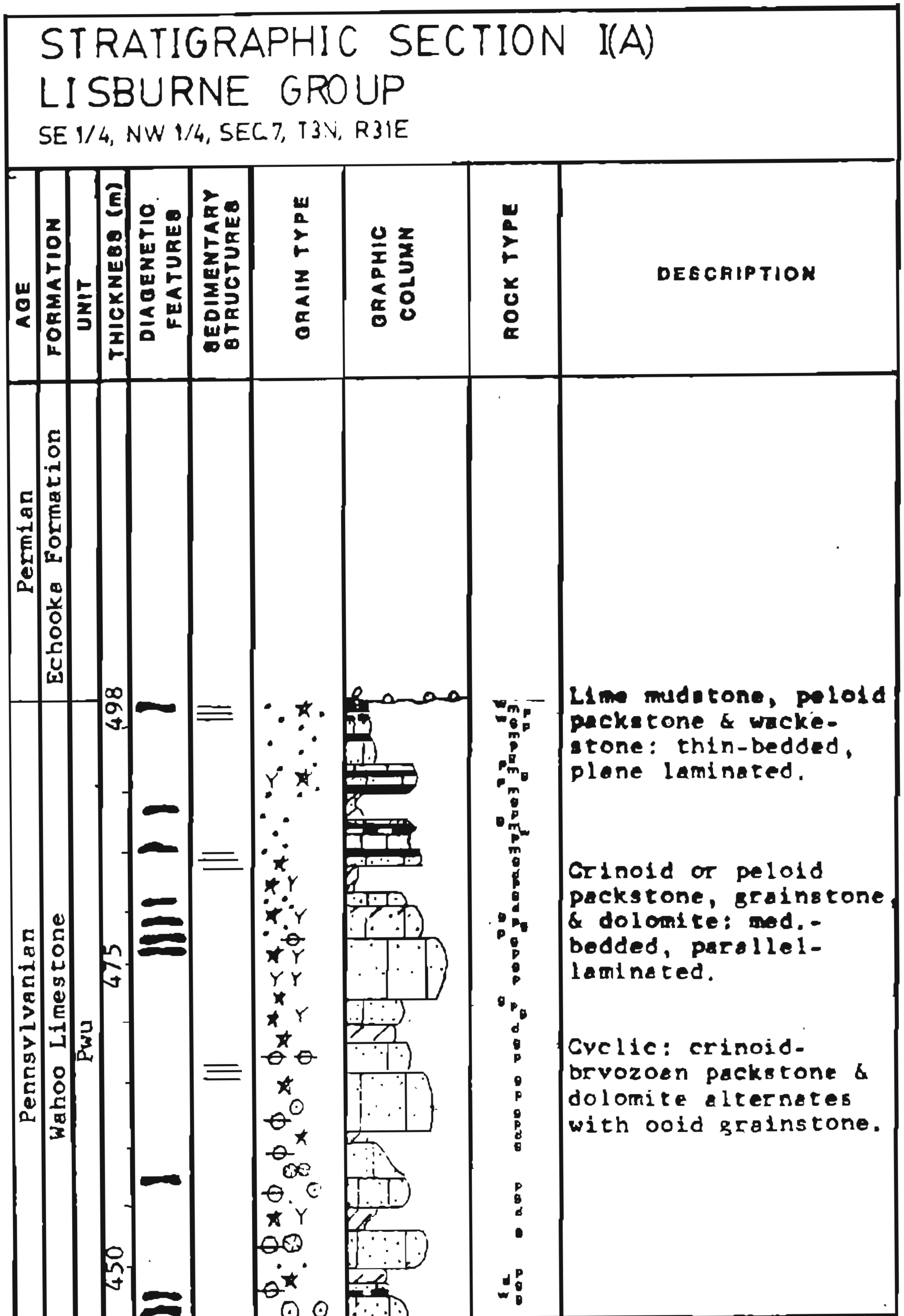


Figure 4: For explanation of symbols see Appendix I, p. 31.

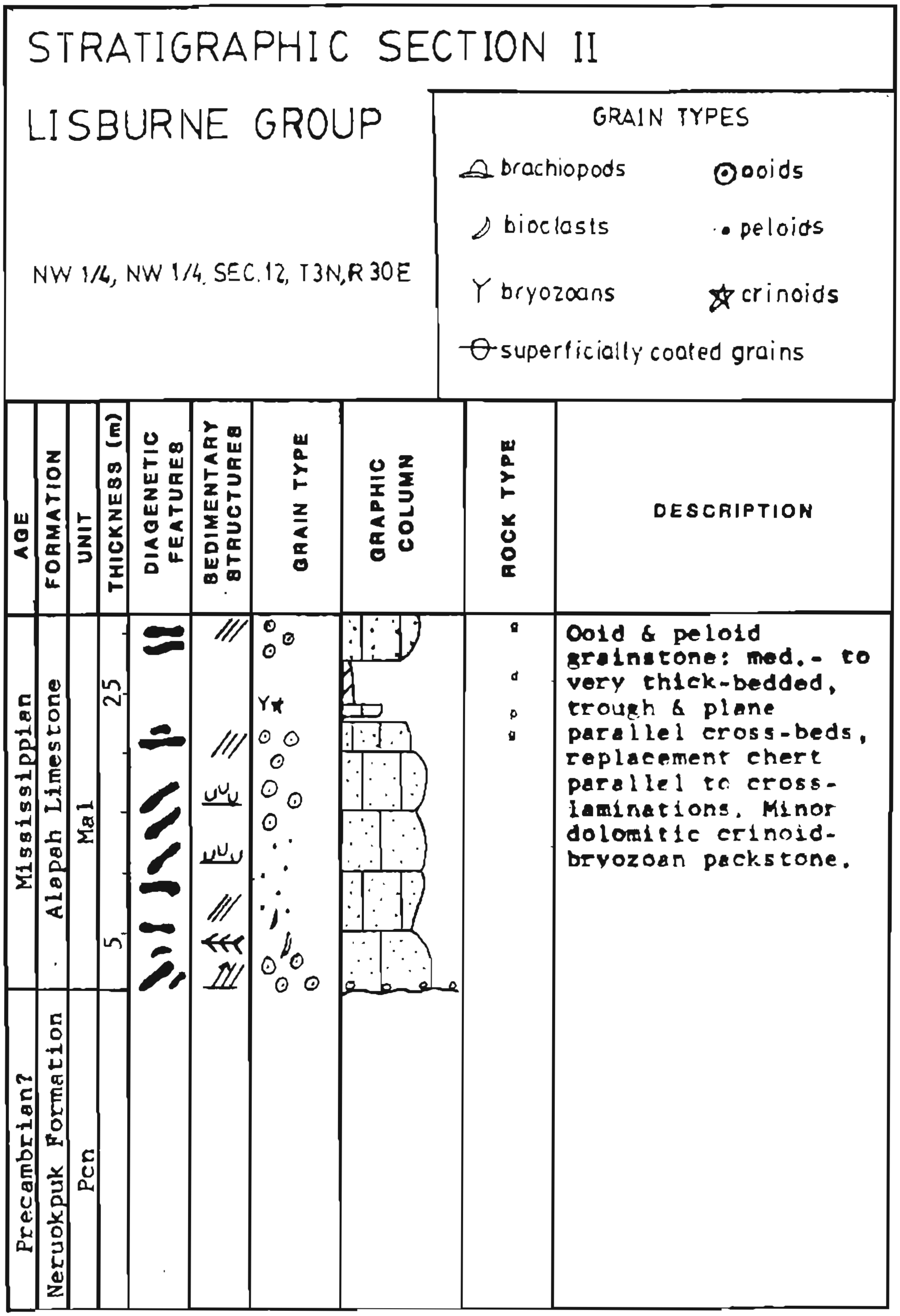


Figure 5: For explanation of symbols see Appendix I, p. 31.

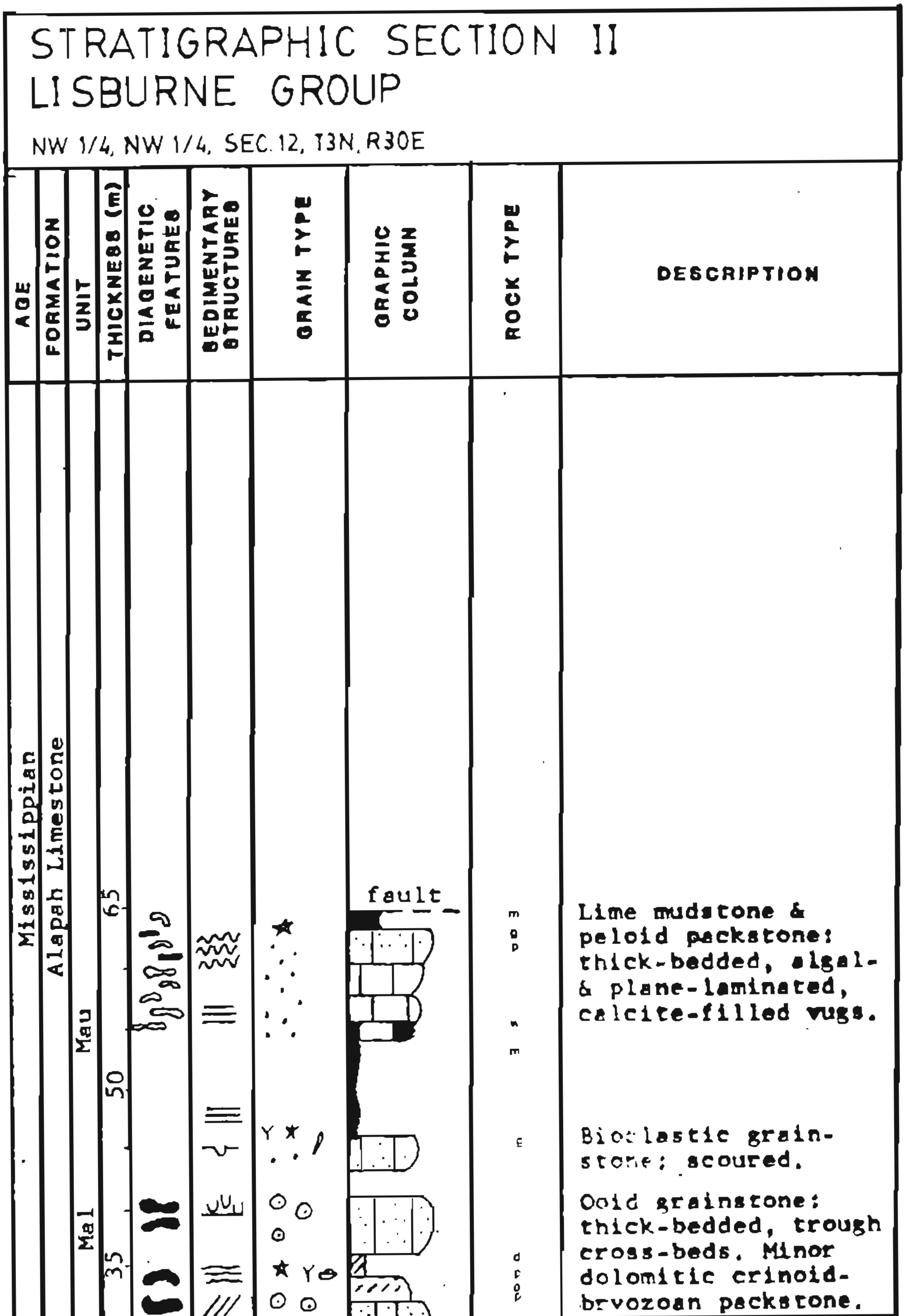


Figure 5: For explanation of symbols see Appendix I, p. 31 .

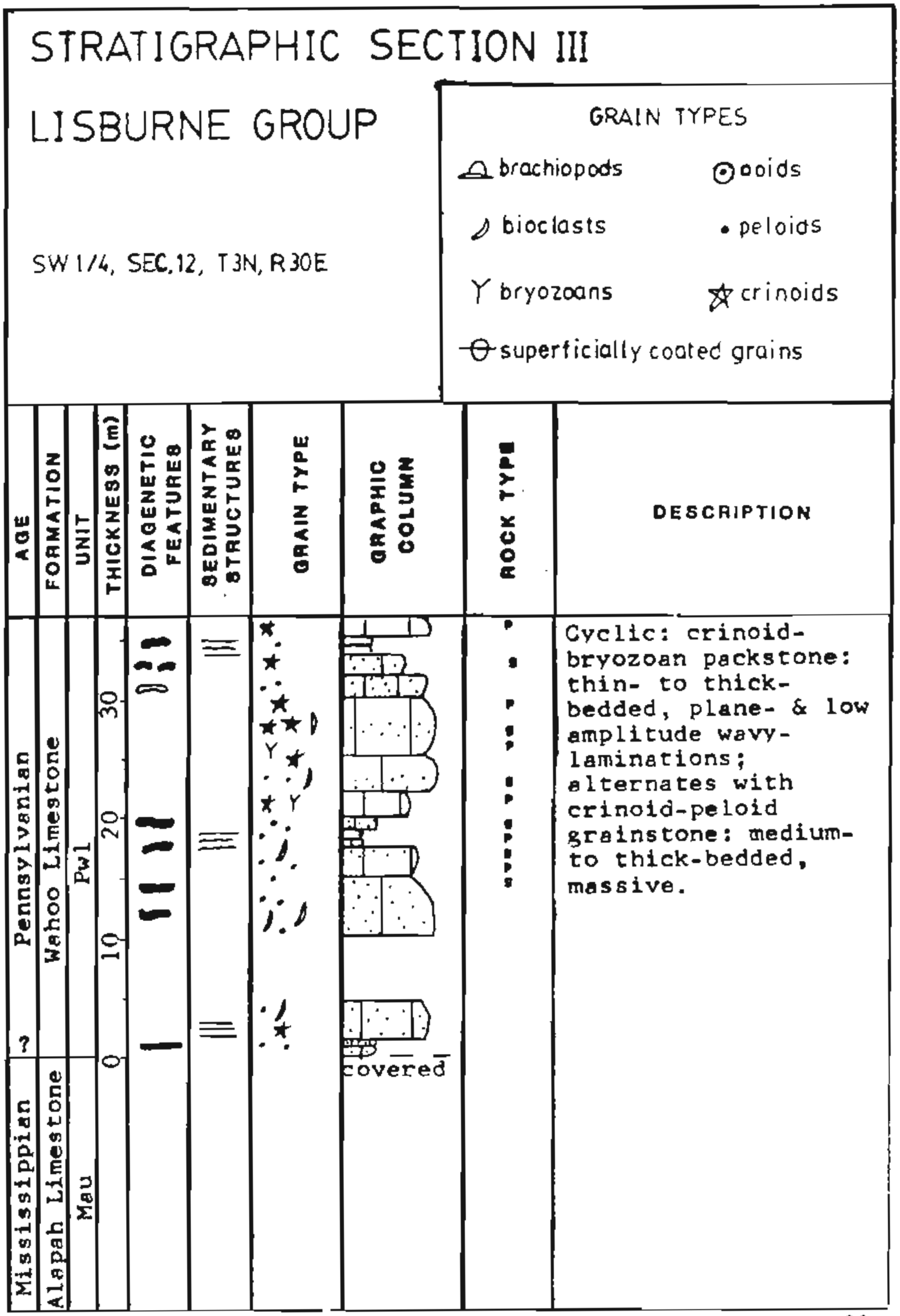


Figure 6: For explanation of symbols see Appendix I, p. 31.

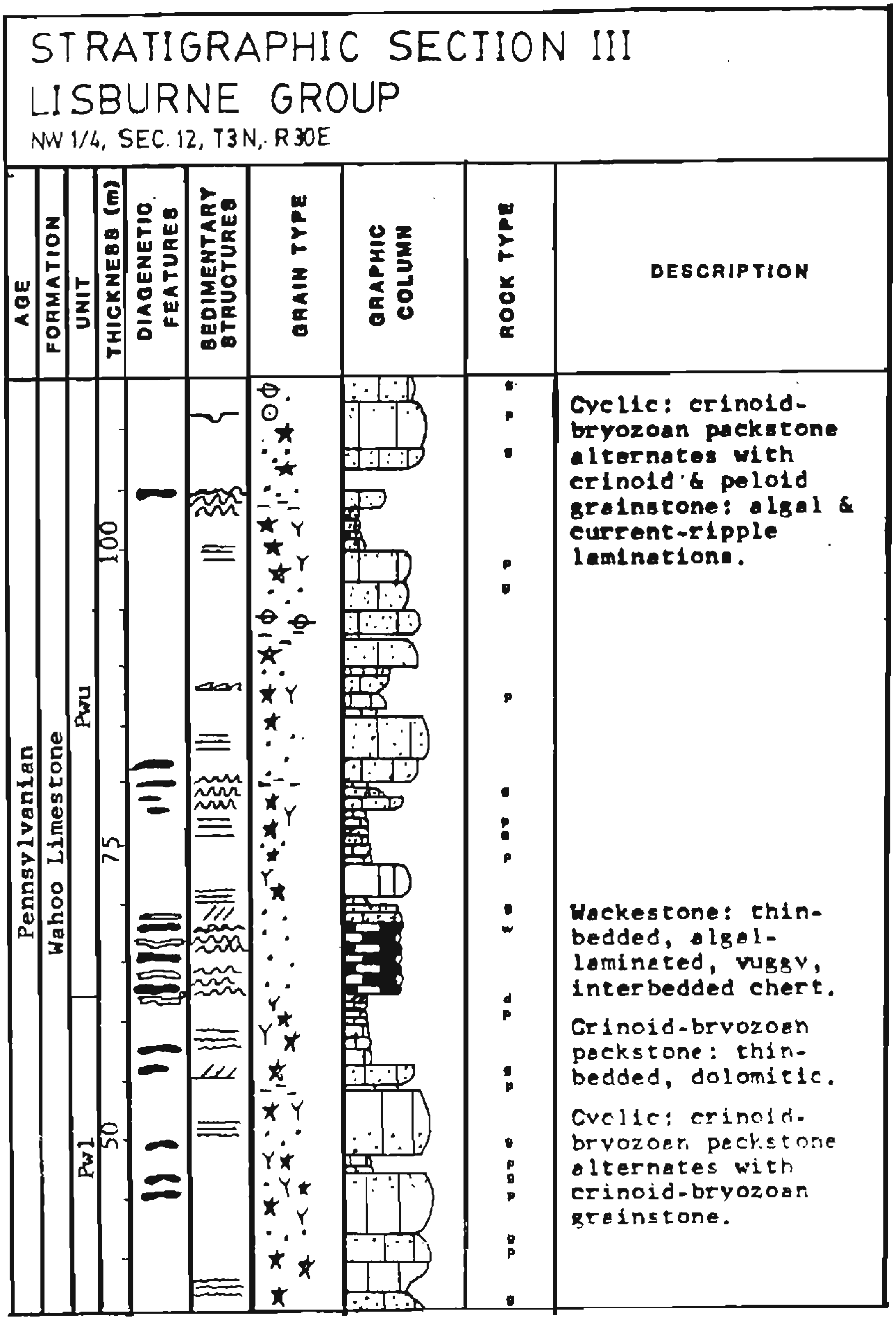


Figure 6: For explanation of symbols see Appendix I, p. 31.

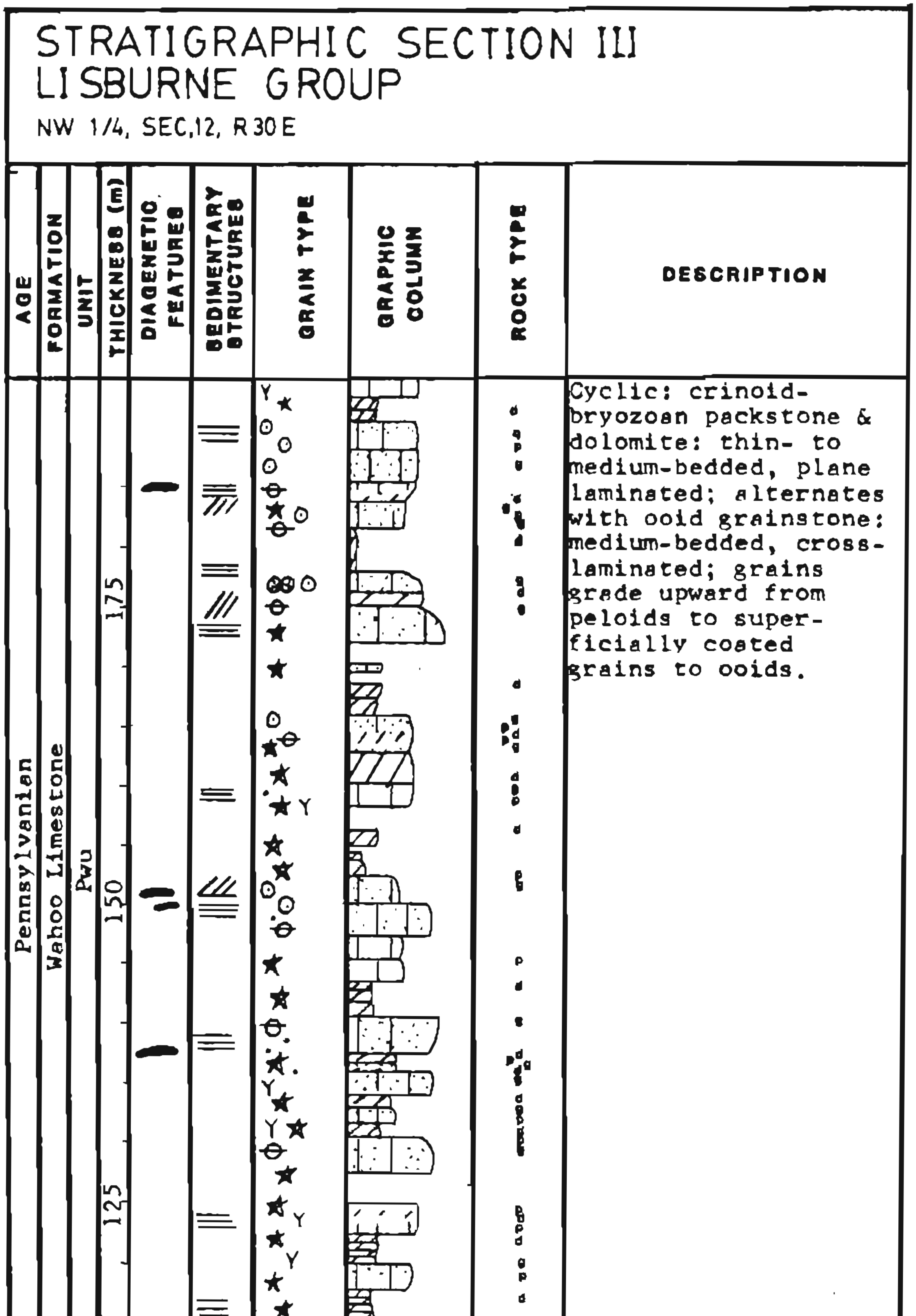


Figure 6: For explanation of symbols see Appendix I, p. 31.

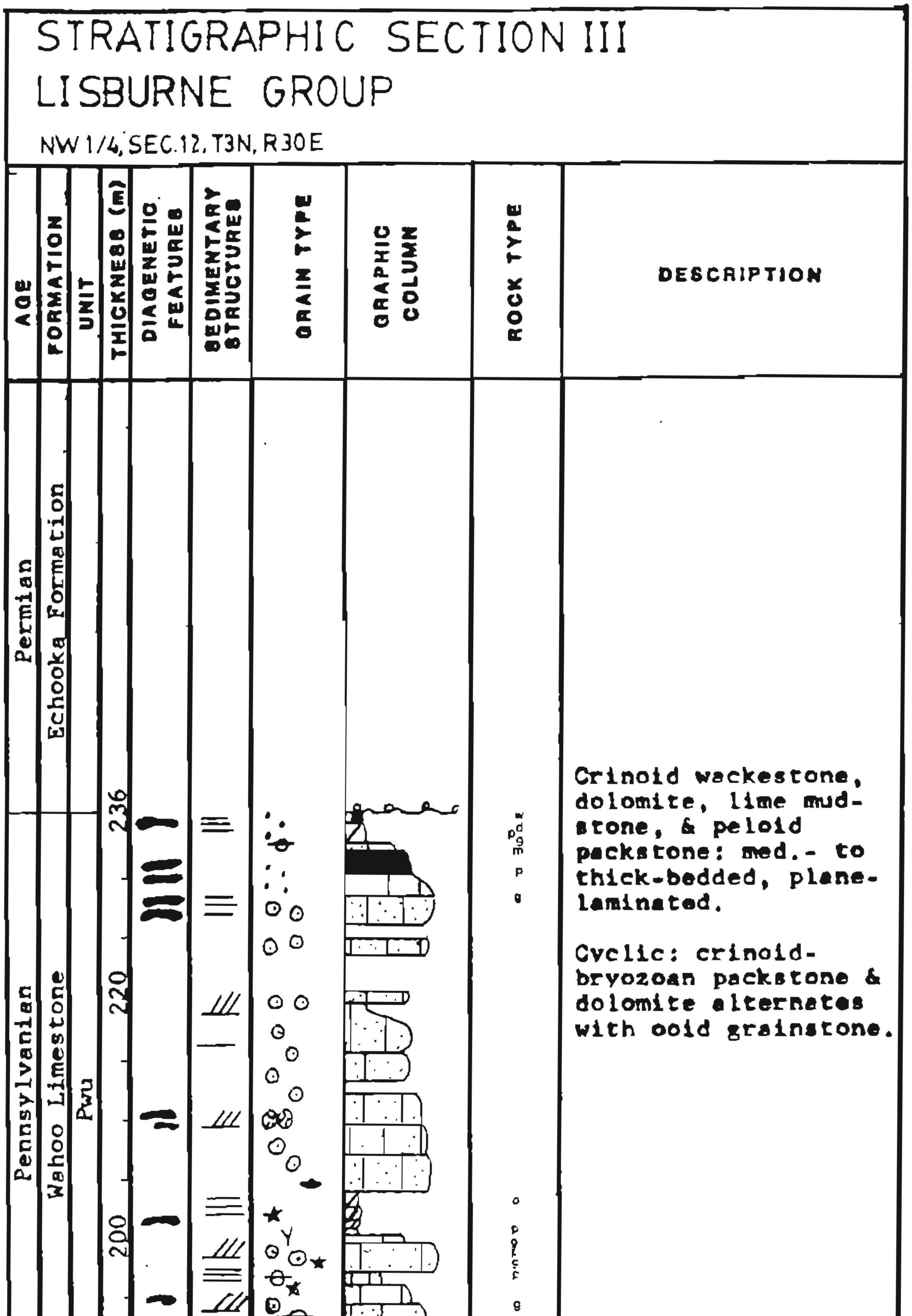


Figure 6: For explanation of symbols see Appendix I, p. 31.

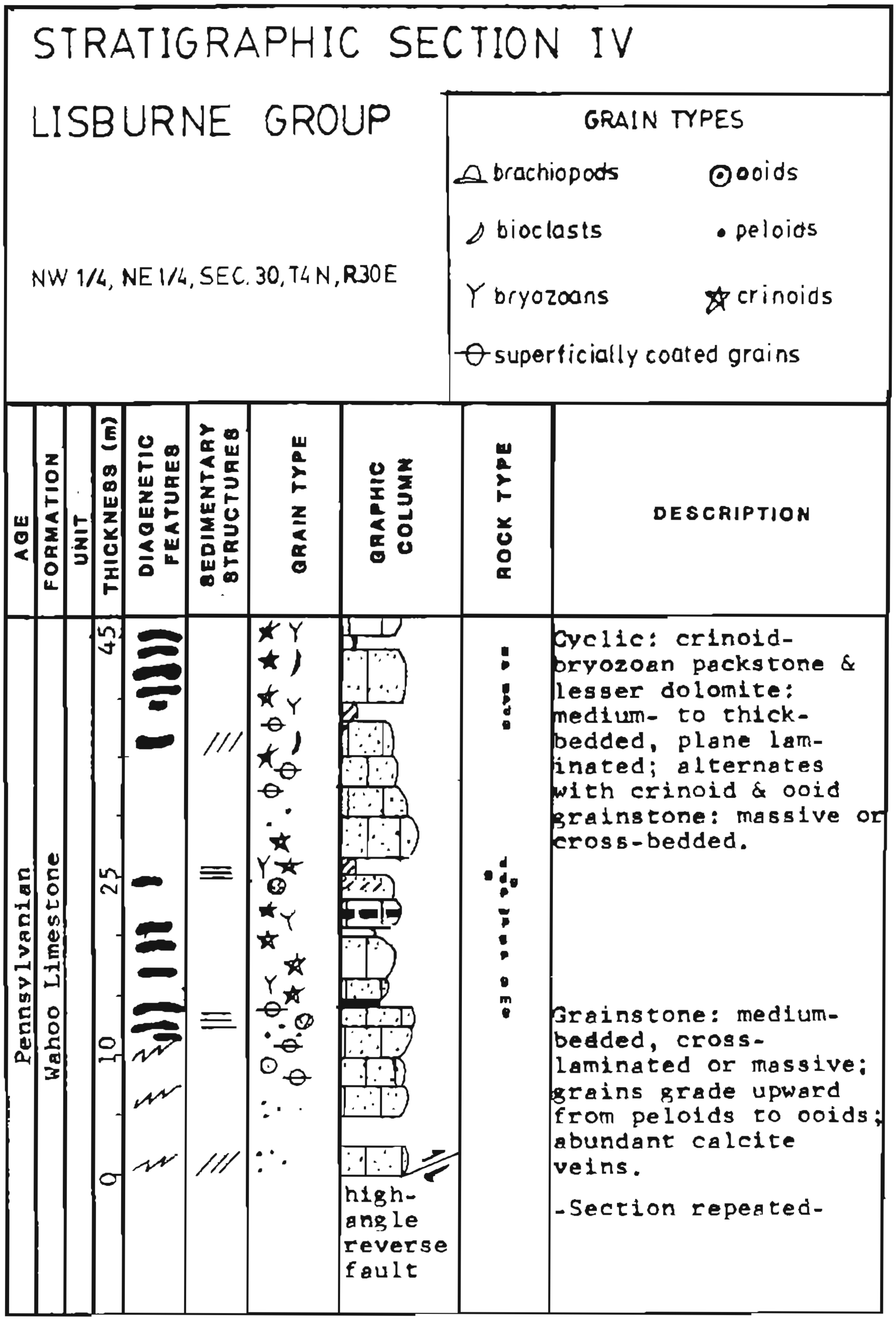


Figure 7: For explanation of symbols see Appendix I, p. 31 .

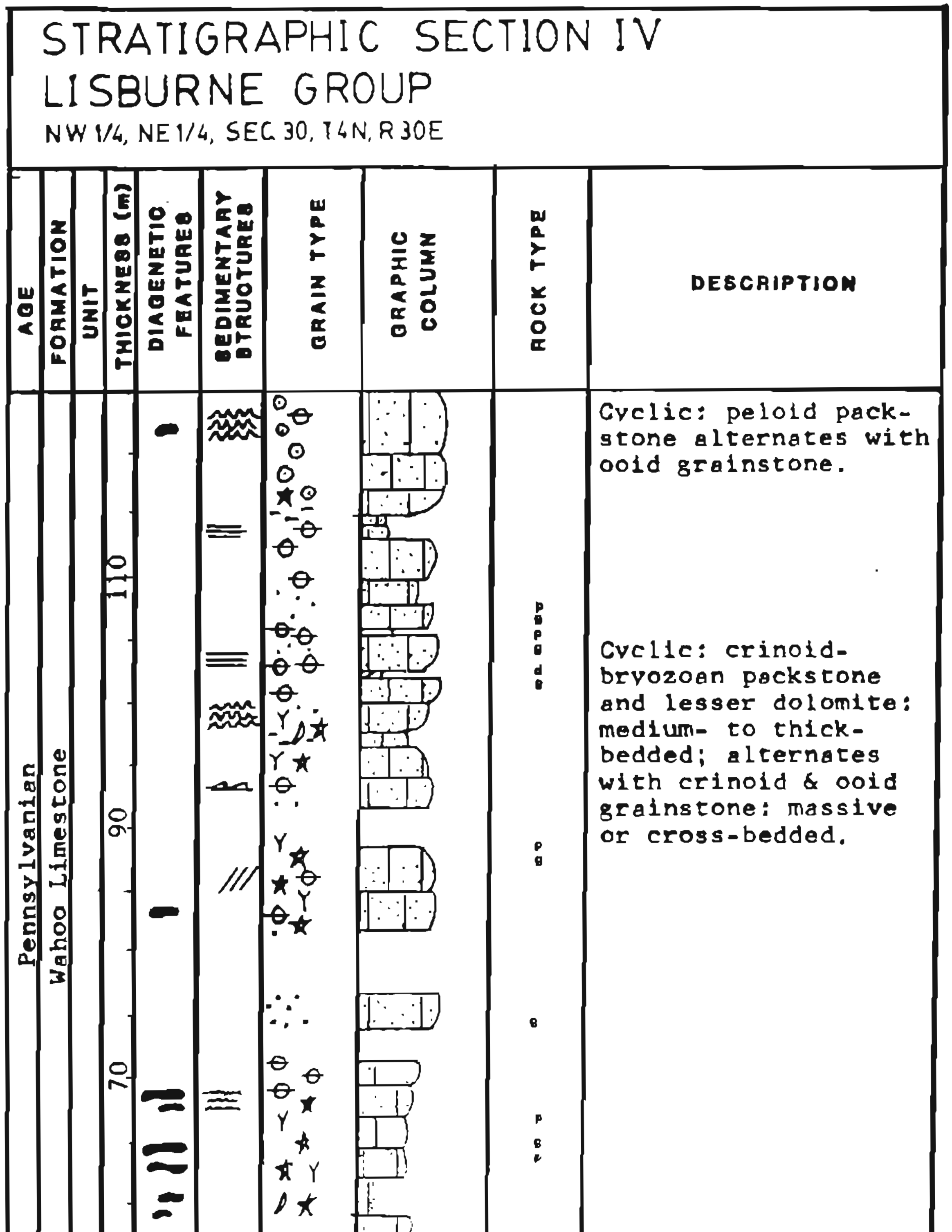


Figure 7: For explanation of symbols see Appendix 1, p. 31 .

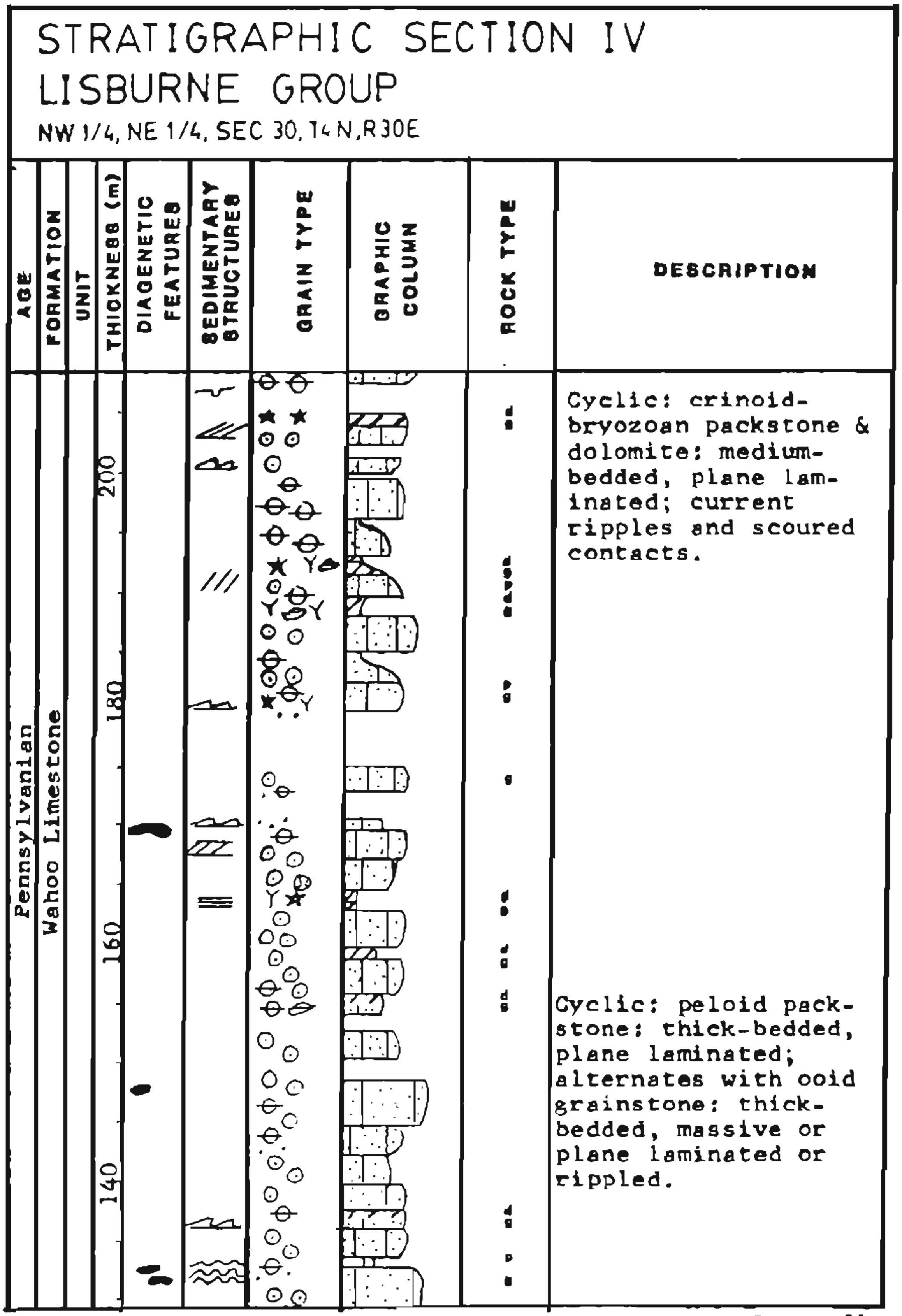


Figure 7: For explanation of symbols see Appendix I, p. 31.

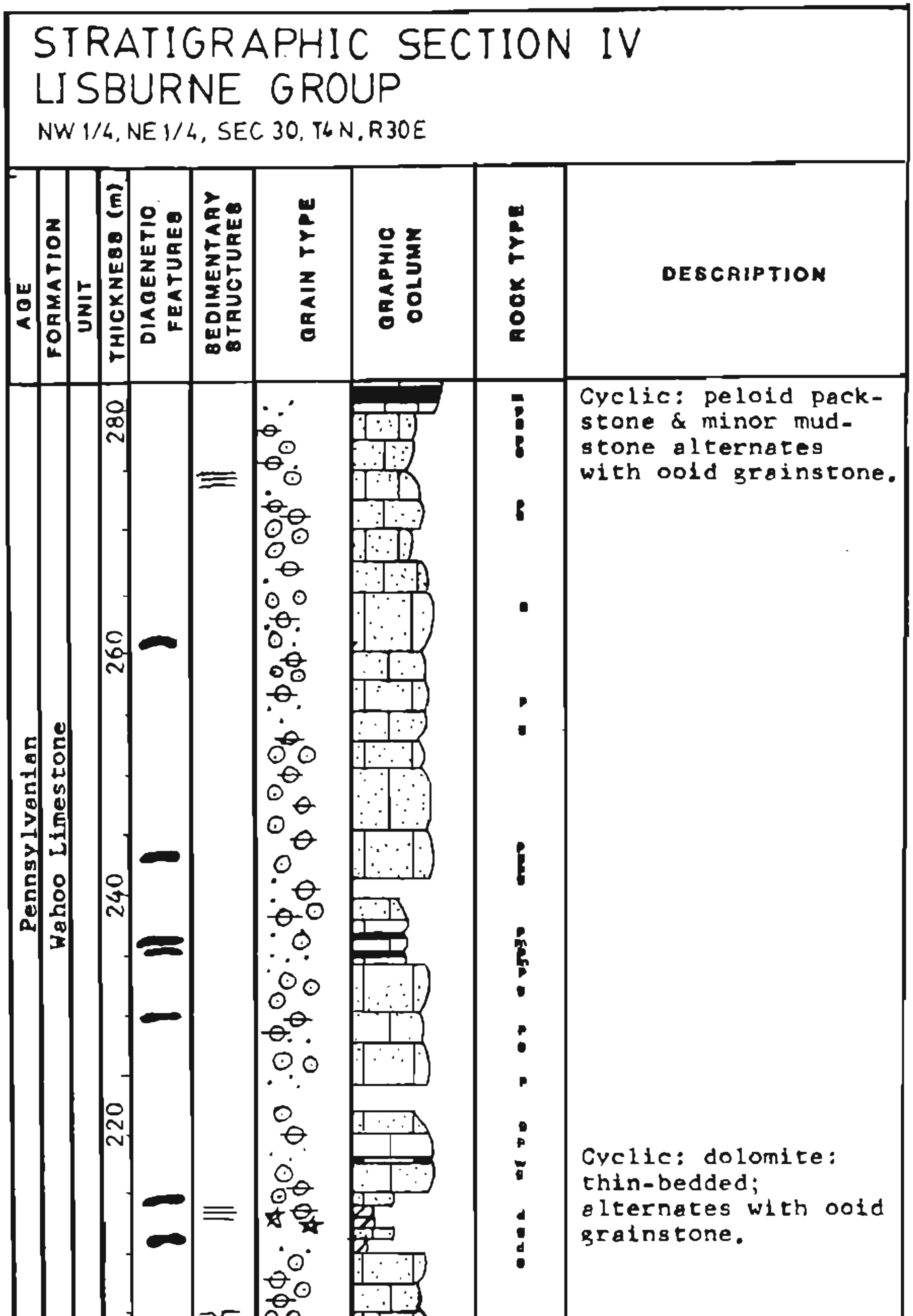


Figure 7: For explanation of symbols see Appendix I, p. 31.

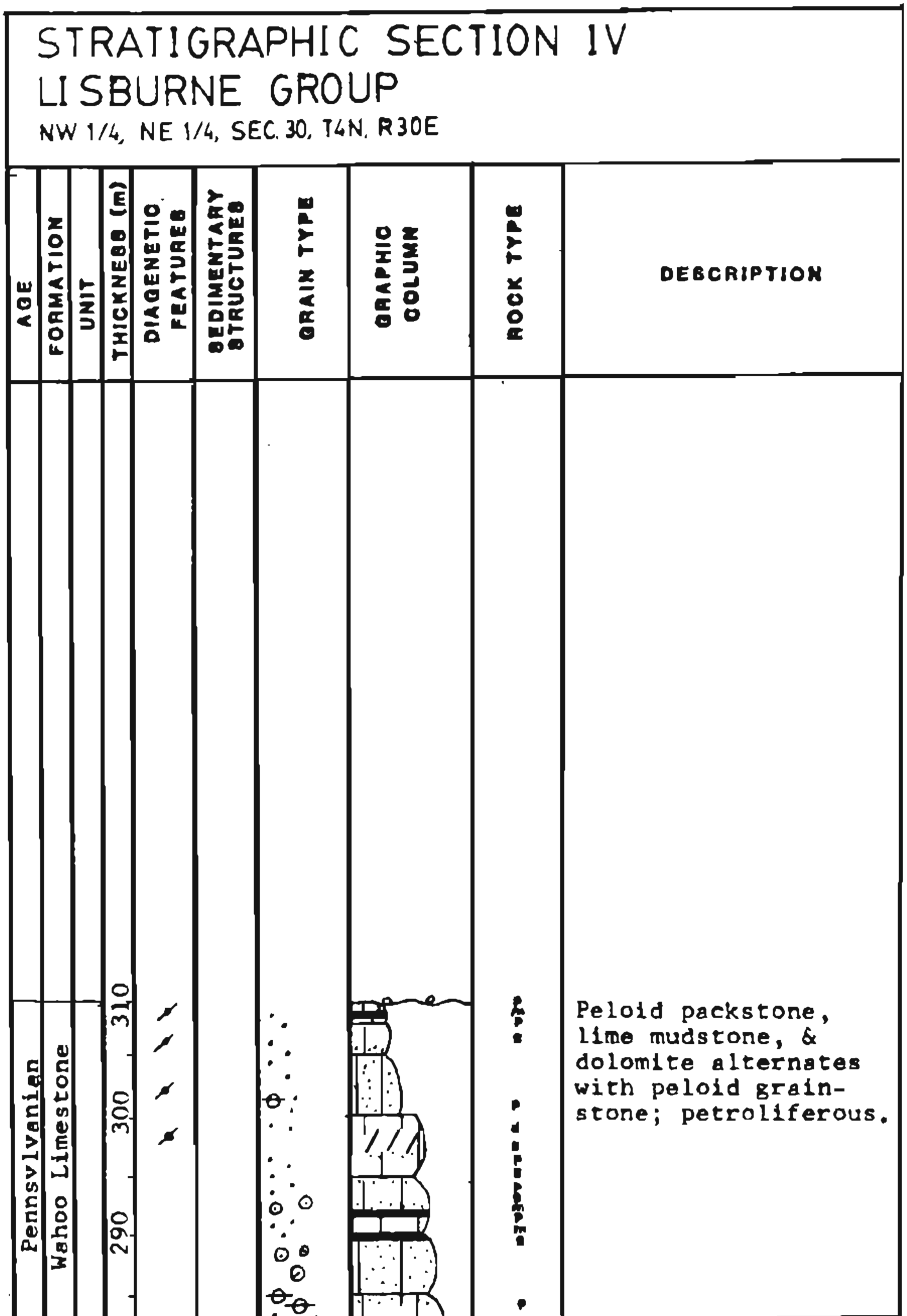


Figure 7: For explanation of symbols see Appendix I, p. 31 .

Appendix I

Symbols and abbreviations:

plane parallel laminae (horizontal)

low amplitude wavy laminations

algal mats

current ripple laminae

cross-bedding undifferentiated

low amplitude plane parallel cross-bedding

high amplitude plane parallel cross-bedding

trough cross-bedding

herringbone cross-lamination

crinoids

bryozoans

solitary coral

colonial coral

ooids

superficially coated grains

peloids

chert beds (solitary) and chert nodules

vugs

petroliferous

It. Itkilyariak Formation

Nu. Neruokpuk Formation

Pcn Precambrian Neruokpuk Formation

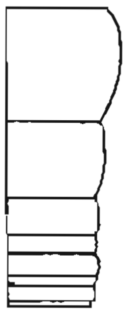
Pck Precambrian Katakturuk Dolomite

Pc Precambrian

calcite veins - stressed rock

Appendix I continued.

Bedding:

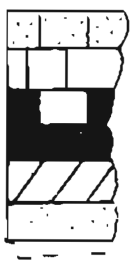


very thick-bedded (greater than 2 meters)

thick-bedded (1 - 2 meters)

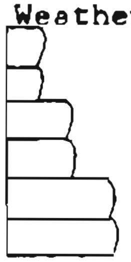
medium bedded (.25 - 1 meter)
thin-bedded (.1 - .25 meter)
very thin-bedded (less than .1 meter)

Lithology:



grainstone(g)
packstone(p)
wackestone(w)
lime mudstone(m)
dolomite(d)
sandstone(s)
shale

Weathering profile:



poorly exposed

good outcrops

excellent outcrops

REFERENCES

Bird, K. J., and Jordan, C. F., 1977, Lisburne Group (Mississippian and Pennsylvanian), potential major hydrocarbon objective of arctic slope, Alaska: Bulletin of American Association of Petroleum Geologists, v. 61, no. 9, p. 1493-1512.

Brosge, W. P., Dutro, J. T. Jr., Mangus, M.D., and Reiser, H. N., 1962, Paleozoic sequence in eastern Brooks Range, Alaska: Bulletin of American Association Petroleum Geologists, v. 46, no. 12, p. 2174-2198.

Dunham, R., 1962, Classification of carbonate rocks according to texture: in Ham, W. E., (ed.), Classification of carbonate rocks: Am. Assoc. Petroleum Geol. Mem. no. 1, p. 108-121.

Mull, C. G., and Mangus, M. D., 1972, Itkilyariak Formation: New Mississippian Formation of Endicott Group, Arctic Slope of Alaska: Bulletin of American Association of Petroleum Geologists, v. 56, no. 8, p. 1364-1369.

Reiser, H. N., 1970, Northeast Brooks Range: in Adkinson, W. K., and Brosge, M. M., (eds.), Proceedings on the geologic seminar on the north slope of Alaska: AAPG Pacific Section Meeting, Los Angles, p. K1-K13.

Wilson, J. L., 1973, Carbonate facies through geologic time, Springer Verlag, New York.