OF 77-12

REPORT ON 1977 FIELD INVESTIGATIONS ON LITHOLOGY OF METALINE LIMESTONE IN STEVENS AND PEND OREILLE COUNTIES, WASHINGTON

Field Report
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Introduction

The purpose of the field work completed during the summer of 1977 was to locate and describe outcrops that exposed significant thicknesses and lithologic relationships within the Metaline Limestone. An additional goal was to collect oriented samples tied to measured sections where ever possible. My final goal was to specifically define the scope and boundaries of my Ph.D. dissertation project.

I would like to thank the Washington Department of Natural Resources, the Geological Society of America, and the Northwest Scientific Association for financial support of this summer's field work. I am grateful to the Bunker Hill Company for providing lodging during the summer. My thanks also to Dr. John Bush for taking the time to visit my field area and for his enthusiastic support of the project.

Based on my observations last summer and on the field relationships seen during the present investigation, I have redefined my Ph.D. dissertation project. The title of my dissertation will now be: The Lithology of the Metaline Limestone, Metaline Falls Area, Northeastern Washington. The term "lithology" was chosen to reflect a distinction from traditional stratigraphic and petrographic investigations in the sense used by Middleton (1973).

Within this framework, it is my purpose to interpret the depositional environments of the subunits of the Metaline Limestone based on field relationships, sedimentary textures, structures, and lithologies. This mode of analysis will be applied where the formation is exposed in the Metaline quadrangle which was used by Park and Cannon (1943) as a base map. The rocks are described using the terminology of Dunham (1962) and its modification by Embry and Klovan (1971, in Wilson, 1975, p.13). Laboratory analysis of samples collected using polished slabs and acetate peels will supplement the field observations.

Observations

A major interest in selecting outcrops for this summer's study was to observe intraformational contacts, specifically those which exist between the Metaline units designated by Dings and Whitebread (1965) in the Metaline Falls area, and by Yates (1964) in the Deep Creek area.

Three major sections were measured and sampled, and two of these contained major subunit boundaries within them. These sections, (see figure 1), are detailed in the columnar sections attached to this report. Additional reconnaissance in the Deep Creek and Metaline Falls areas located many small, discontinuous outcrops so altered by structural or diagenetic complications that they were unable to be used in the present study. The three sections described however, contain lithologic relationships that greatly expand our knowledge of Metaline depositional environments and middle Cambrian paleogeography in the study area.

Each major section will be described (columnar sections show thicknesses and sample collection locations), the significance of structures and textures will be discussed, and the relationships between subunits with respect to depositional environments will be outlined.

Section 77-A, Boundary Dam: This section is exposed in a roadcut, 200-250 feet high, on the west side of the main road to Boundary Dam. The outcrop contains thin-to medium-bedded, gray limemudstones and tan, occasionally laminated, mottled dolomudstones.

Although this particular outcrop was not exposed prior to the construction of Boundary Dam, Dings and Whitebread (1965) show similar strikes and dips for rocks near this location, and they assign those rocks to the middle and upper Metaline Limestone. Based on published descriptions of these units and on field observations, I believe that the outcrop at Boundary Dam contains the upper portion of the middle Metaline, a transition zone containing interfingering limestone and dolostone (along stylolitic contacts), and the lower portion of the upper Metaline of Dings and Whitebread (1965). The total thickness, including covered in-

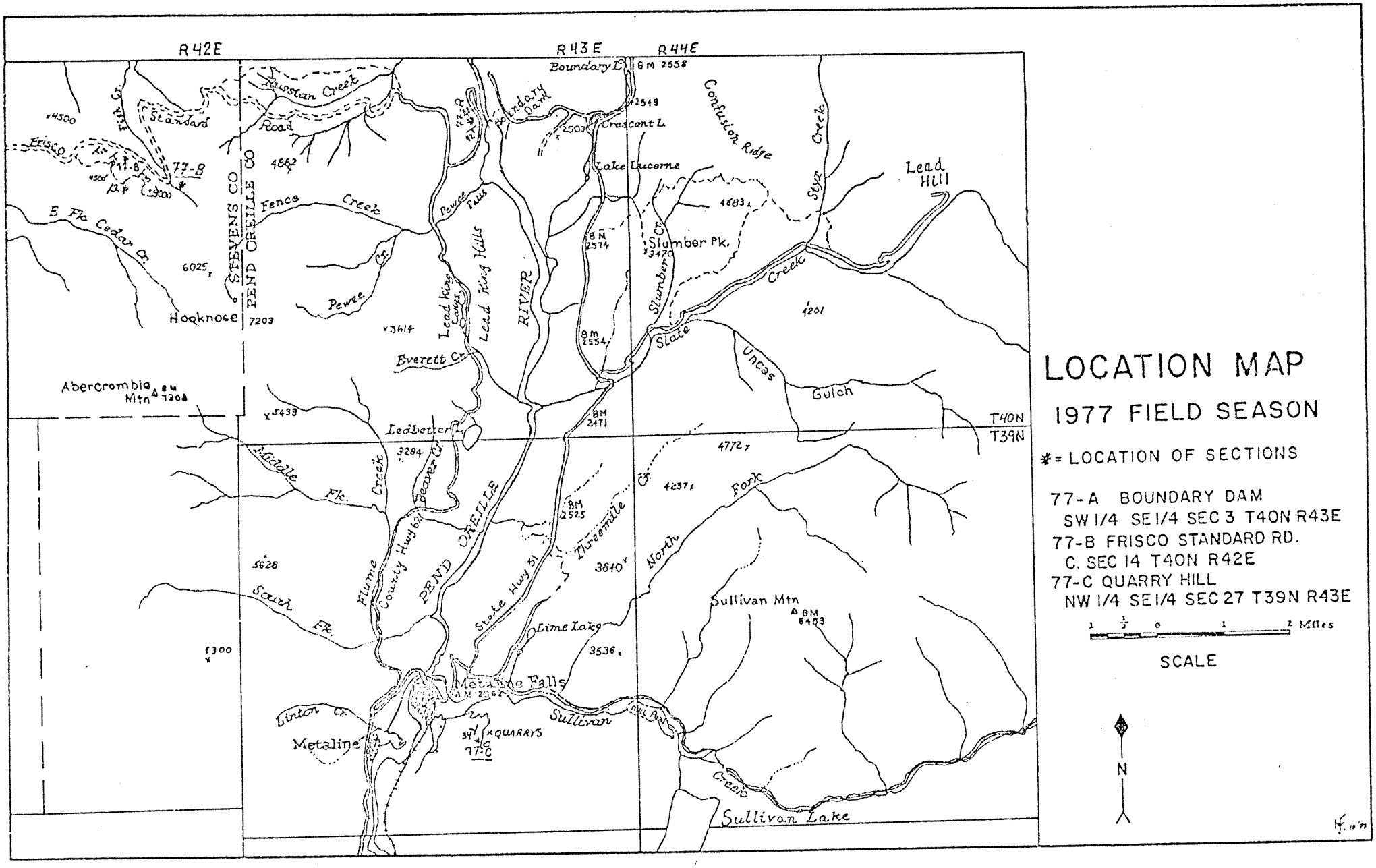
LOCATION MAP
1977 FIELD SEASON
✱ = LOCATION OF SECTIONS
77-A BOUNDARY DAM
SW 1/4 SE 1/4 SEC 3 T40N R43E
77-B FRISCO STANDARD RD.
C. SEC 14 T40N R42E
77-C QUARRY HILL
NW 1/4 SE 1/4 SEC 27 T39N R43E
1 1/2 0 1 2 Miles
SCALE
N
R42E
R43E
R44E
T40N
T39N
STEVENS CO
PEND OREILLE CO
Russian Creek
Road
Standard
Frisco
77-B
E Fk Cedar Cr
Fence Creek
Pewee Cr
Pewee Falls
Hoaknose
Abercrombie Mtn
Everett Cr
Lead King Hills
Lead King Lodes
RIVER
Boundary L
Boundary Dam
Crescent L
Lake Lucerne
Confusion Ridge
Slate Creek
Lead Hill
Slumber Pk.
Slumber Cr
Slate Creek
Uncas Gulch
Ledbetter L
Middle Fk. Creek
Beaver Cr
Plume Creek
County Hwy 62
PEND OREILLE
State Hwy 31
Threemile Cr
North Fork
Sullivan Mtn
South Fk.
Lime Lake
Metaline Falls
Linton Cr
Metaline
QUARRYS
77-C
Sullivan
Sullivan Lake
Creek

FIGURE 1

tervals represented at this locality, is 762 feet.

Due to structural complications, the uppermost portion of the section at Boundary Dam could not be measured. It is composed of a coarse-grained limestone breccia with abundant tan, argillaceous matrix. This lithology crops out on both sides of the Pend Oreille River at the point where Boundary Dam has been constructed.

Section 77-B, Frisco Standard Road: The outcrops along the Frisco Standard Road are apparently newly exposed since the earlier reports of Park and Cannon (1943) and Dings and Whitebread (1965). Park and Cannon did map outcrops near this location, but mistakenly and somewhat uncertainly designated them as Devonian in age (Park and Cannon, 1943, p.22). Dings and Whitebread (1965, p. 28) state, "...recent work by Yates and Robertson (1958) in the Leadpoint Quadrangle, west of the Metaline quadrangle, indicates that the intraformational breccias are of Cambrian age and are part of the Metaline Limestone." After examining rocks mapped as "intraformational breccia" by Yates (1964) in the Deep Creek area which lies between the Leadpoint and Metaline quadrangles, I agree with the assignment of this facies, along the Frisco Standard Road, as part of the Metaline Limestone.

The rocks exposed along Frisco Standard Road west of Fish Creek, comprise a distinct lithofacies of the Metaline Limestone. This aspect of the formation will hereafter be refered to as the floatstone facies, based on prominent masses (up to fifty feet thick) of black, dolomite floatstone. These are interbedded with black, thin-bedded, occasionally laminated, chert-bearing dolomudstones.

The term floatstone facies is used because it is a purely descriptive carbonate textural term and does not carry the genetic implication associated with "intraformational breccia". The new term will also serve to separate this lithology from other, more well-known breccia types (ore breccias) within the Metaline Limestone. The new terminology will also allow a separate environmental interpretation to be made for these rocks that may be different from that implied by the earlier terminology.

The total thickness of strata exposed is approximately 1500 feet (see columnar section 77-B). The upper portion appears to grade into a limey dolostone and then to a light-gray, phyllitic limestone. The outcrop is slumped and covered in the area surrounding the contact between these lithologies and consequently , some doubt exists about the nature of that contact. This upper unit may be the upper Metaline Limestone (Ꞓma) mapped by Yates (1964) in the Deep Creek area.

Since I believe that the floatstone facies has significant environmental implications, a further description of its componants is included. The floatstone beds range from five to fifty feet thick, and contain mostly non-rounded clasts that range from a few millimeters to greater than one meter in length. The clasts are enclosed in a matrix of dense, black, fine-grained dolomite. The clasts are usually broken abruptly at their terminations. In places, the grains are bent and folded, and the axes of the folds dip at random angles to bedding and to the axes of other folds. Locally, the clasts were observed to be of the same thickness and composition as adjacent, thin-bedded dolostones. The floatstone masses are often graded, but in many places, the grading appears to be reversed; larger clasts occur at the top of sedimentation units and smaller clasts at the bottom. The reason for this is still in question.

Section 77-C, Quarry Hill: This section was measured in the quarries of the Lehigh Portland Cement Company, southeast of Metaline Falls. The rocks observed have been described in part by Park and Cannon (1943, p. 18-19), and by Dings and Whitebread (1965, p. 10-12). This section can also be correlated with the section described by me at Marble Creek (1976).

The lower part of the section is within the thin-bedded subunit of the lower Metaline (Dings and Whitebread, 1965, p. 11). The subunit contains thin-bedded, black limemudstones and wackestones with fragmental and occasionally complete trilobite carapaces. This lithology is also distinguished by pod-like masses of

limemudstone surrounded by dark gray-green shale, and by crystals and masses of pyrite. Above this lithology is a section of black, laminated limemudstones with occasional trilobite fragments. At the top of this subunit is a thin, laterally persistant layer of red-stained limemudstone above which is a black dolowackestone containing intraclasts. The section then becomes a dark-gray changing to tan, vuggy dolostone at the top of the quarry.

These units occur stratigraphically at the top of the lower Metaline and the base of the middle Metaline Limestone of Dings and Whitebread (1965). The total thickness measured is 134 feet (see columnar section 77-C).

Interpretation

By restricting the scope of this study to the area described above, a more detailed picture of major lithofacies within the Metaline Limestone is evolving. The field area now includes the classically described units of Park and Cannon (1943) and of Dings and Whitebread (1965), as well as the newly described floatstone facies of the Frisco Standard Road section.

The first part of this report discussed the units of the Metaline Limestone based on geographic and stratigraphic relationships. Since the lithologies at each location contain evidence of their depositional environments, they may also be grouped into packages of strata that represent lithofacies within the formation. The rocks can therefore be discussed in a second way, and subsequent analysis can be based on sedimentary structures, lithology, and relative position of each package (=facies) within the larger Metaline stratigraphy.

The transition zone of interfingering and interbedded limestones and dolostones seen in section 77-A has also been observed at two other locations which were described in last year's report. The section at Boundary Dam contains the best exposure of this

contact and confirms the observations made previously that the contact between the middle and upper Metaline is gradational. Interfingering of the two lithologies may be the result of diagenetic processes where dolomitization moves through a limestone and converts it to dolostone, or the dolomite may be penecontemporaneous and may have formed in unconsolidated lime sediments within the depositional environment. In the latter case, the transition zone may represent a lateral as well as vertical facies boundary between a lime producing environment and an adjacent early replacement environment yielding penecontemporaneous, supratidal type dolomites (Pray and Murray, Eds., 1965).

The dolostones do not easily show textures or structures in the field, but polished slabs have been shown to be very effective in revealing primary sedimentary features that have been masked by dolomitization. The final distinction of the depositional and diagenetic history of these rocks must rest with laboratory analysis of samples collected through and adjacent to the transition zone.

The environmental interpretation of the floatstone facies is of major importance in the reconstruction of the paleogeography of the Metaline Falls area. The rocks of the floatstone facies are so distinctly different from the other lithologies described in the Metaline Formation that it is not surprising that Park and Cannon (1943) were in doubt as to the stratigraphic position of these rocks. The facies is more extensively exposed in the Deep Creek area where it can by found in contact with more traditional Metaline lithologies (Yates, 1964).

In the part of the map area most nearly adjacent to the Frisco Standard Road section, Yates (1964) mapped his "intraformational breccia" unit (floatstone facies of this report) stratigraphically between the middle and upper Metaline. These bounding units are apparently the same as the intermediate bedded dolomite and upper massive limestone units of Dings and Whitebread (1965, p.10). Further field investigation in the area around section 77-B is needed before a specific stratigraphic assignment for the float-

stone facies relative to the rest of the formation in the Metaline Falls area is possible.

In spite of this stratigraphic uncertainty, I can now make a preliminary environmental statement about the floatstone facies. The lithologies and textures observed in these rocks lead me to believe that they were deposited in relatively deep water with a depo-slope of higher angle than the paleoslope of the remainder of the formation.

The dolomudstones are laminated, black, fine-grained, thin-bedded and lack obvious fossils or burrows. The laminations are indicative of low energy conditions, and the black color points to a reducing environment where organic matter could be preserved. Fine grain size and thin-bedding also point to low energy conditions at the time of deposition. Lack of body fossils and burrows as well as preservation of the laminations indicates conditions inimical to organisms capable of burrowing in and churning the bottom sediments (Heckel, 1972, p.244).

The floatstone masses are composed of non-rounded, bent and occasionally folded clasts randomly distributed in a matrix of fine-grained dolomite-micrite. Since the grains are in a mud-supported fabric (Dunham, 1962), they are thought to have formed by deposition as one mass (Bathurst, 1971, p.495). The non-rounded clasts and their random orientation indicate a very short transportation history in a low energy environment. The bent and folded nature of the clasts leads me to the conclusion that the clasts were semiconsolidated at the time of deposition. The random orientation of the fold axes is strong evidence for soft sediment deformation due to slumping (J. Bush, personal communication, 1977).

The floatstone facies of the Metaline Limestone looks much like limemudstones and floatstones from the Cambrian of Nevada that have been described and illustrated by Taylor and Cook (1976). The illustrations in their report were instrumental in my under-

standing and interpretation of these lithologies.

A third environmentally significant feature in the sections observed is the occurance of a laterally persistant layer of red-stained limemudstone directly overlain by a black dolowackestone at section 77-C. This contact may represent a disconformity of unknown duration between the lower and upper Metaline (Wilson, 1975, p. 80).

The occurance of wackestone indicates a change to higher energy conditions from those responsible for the deposition of the mudstones. Further field and laboratory investigation of the sediments surrounding the contact must be completed before a more detailed explaination of this occurance can be attempted. The time of dolomitization of the wackestone and the rocks above it must also wait for further analysis in the laboratory. I am hopeful that a dolomitization model for the middle Metaline will suggest itself when more data are available.

Conclusions

The second field season of my study of the Metaline Limestone resulted in a more precise definition of my dissertation project and greatly extended my understanding of the lithologic relationships within and between the units of the Metaline. A third field season is planned in which further details surrounding the sections and lithologies now documented can be obtained. From these observations, as well as from laboratory analysis of samples of the various lithologies, textures and structures within the Metaline Limestone, I hope to be able to construct a model of the depositional environments that existed during the middle Cambrian in the Metaline Falls area.

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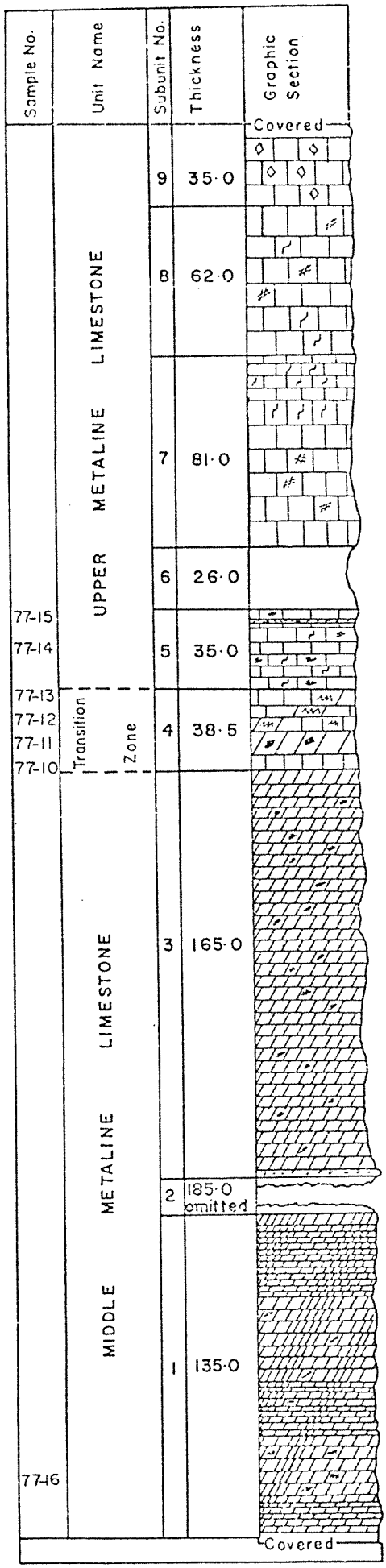

COLUMNAR SECTION of the METALINE LIMESTONE

SECTION NO. 77-A

MEASURED AT SW 1/4, SE 1/4, SEC. 3, T.40N, R. 43 E.

EXPLANATION

Lithology

- Limemudstone
- Dolomudstone
- Limestone Breccia
- Calcareous Claystone
- Lamprophyre Dike
- Covered

Sedimentary Structures

- Burrows
- Mottled
- Stylolites
- Coarse Calcite

Bedding

- Massive
- Medium
- Thin

50 feet
40
30
20
10
0

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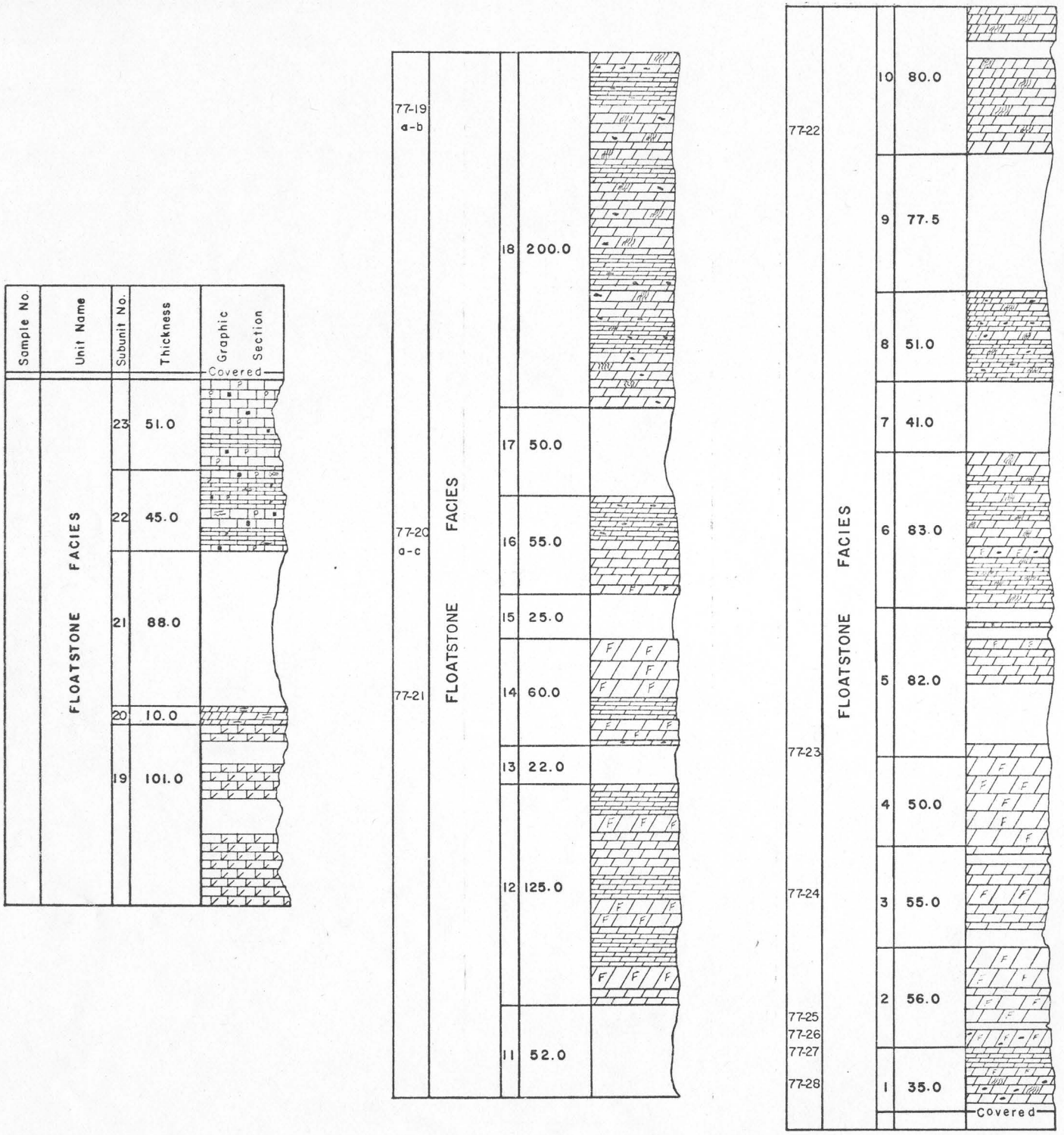
COLUMNAR SECTION OF THE METALINE LIMESTONE

SECTION 77-B

MEASURED AT NE 1/4 SEC. 14, T.40N R.42E - IN THREE PARTS



EXPLANATION

Lithology

- Limemudstone
- Dolomudstone
- Floatstone
- Dolomitic Limestone
- Phyllitic Limestone
- Pyrite
- Chert Nodules
- Zebra Banding

Sedimentary Structures

- Lamination

Bedding

- Massive
- Thin
- Very Thin
- Covered

50 Feet
40
30
20
10
0

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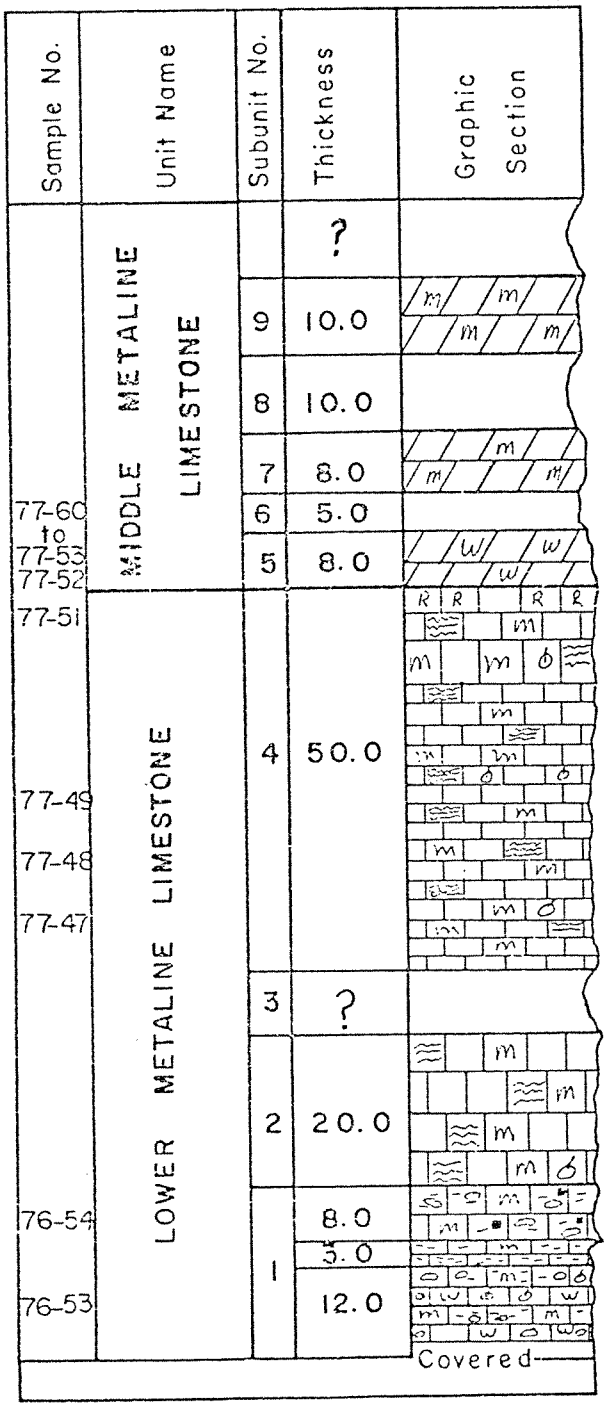
COLUMNAR SECTION of the METALINE LIMESTONE



SECTION 77-C

COMPOSITE SECTION
MEASURED AT NW1/4 SE1/4
SEC. 27, T.39N R.43E.

EXPLANATION

Lithology

- Limestone
- Dolostone
- Argillaceous Limestone
- Mudstone
- Wackestone
- Pyrite
- Fossil Fragments

Sedimentary Structures

- Nodular Bedding
- Lamination
- Red Oxidized Zone

Bedding

- Thin
- Very Thin
- Covered

25 Feet
20
15
10
5
0

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