U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

WESTERN INTERIOR MISSISSIPPIAN LITHOSOMES: A PROGRESS REPORT

By

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Open-File Report 92-213

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[1]Washington, D. C.

1992

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WESTERN INTERIOR MISSISSIPPIAN LITHOSOMES: A PROGRESS REPORT

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Abstract

A lithosome is "a vertically and horizontally segregated body of sedimentary rock, characterized by its lithic content and inferred genetic significance, which mutually intertongues with one or more bodies of differing lithic constitution" (Sando, 1990). Lithosomes are useful for describing regionally significant variations in depositional environments derived mainly from detailed studies of stratigraphic sections. Although mentioned in the North American Stratigraphic Code, lithosomes are not part of the formal nomenclatural hierarchy, which is based on geologic mapping. They offer a convenient way to overcome difficulties posed by using mapping units to describe regional depositional history, without compromising the integrity and stability of geologic mapping.

This paper is a progress report on a comprehensive revision of Mississippian stratigraphy in the Western Interior region of the United States using the lithosome concept. It describes the operational procedure being used, and presents both a preliminary chronometric lithofacies profile and paleogeographic maps for the northern part of the Western Interior basin. Some examples of clarifications of stratigraphic relations by lithosome analysis are discussed.

INTRODUCTION

My current project work is concerned with analyzing the depositional history of Mississippian rocks in the Western Interior states of Arizona, California, Colorado, Idaho, Montana, Nevada, Nebraska, New Mexico, North Dakota, South Dakota, Utah, and Wyoming. This analysis will contribute important information on changes in Mississippian sea level and climate within the Western Interior basin, and these environmental changes can then be placed in a global event framework. In the following discussion, some new terms are used for paleotectonic features in order to distinguish crustal structure elements from superimposed depositional elements.

During Mississippian time, the Western Interior region of the USA was part of an extensive epicontinental marine basin located at the western margin of the North American protocontinent, which marked the junction of two colliding crustal plates (Fig. 1). The eastward-moving oceanic plate west of the continental margin was characterized by clastic and volcaniclastic sedimentation. The western edge of the protocontinent was marked by the Antler upwarp (new term=Antler uplift of previous authors), where Late Devonian plate collision produced a mountainous island chain that became a source of terrigenous detritus during Mississippian time. Plate collision also produced the Antler downwarp (new term=Antler foreland basin of previous authors) east of the Antler upwarp; this area was the site of terrigenous and carbonate sedimentation during the Mississippian. A broad cratonic platform (Western Interior platform, new term) east of the Antler downwarp also was a locus for Mississippian sedimentation. The platform was characterized by shelf carbonate deposition during most of Mississippian time, but also received terrigenous sediments that accumulated in cratonic depressions (Big Snowy-Williston depression, Wyoming depression, Uinta depression) formed in the Late Mississippian. The Western Interior platform was bounded on the east by the Transcontinental arch, which was a highland area that contributed terrigenous detritus to the Western Interior basin throughout the Mississippian.

Current stratigraphic and paleogeographic syntheses of the Western Interior Mississippian (Gutschick and others, 1980; Sandberg and others, 1982; Poole and Sandberg, 1991) are based on biostratigraphic and lithostratigraphic correlations of local, formal stratigraphic units defined mainly by geologic mapping. The latest such synthesis (Poole and Sandberg, 1991), an admirable step forward built mainly on conodont correlations, did not present detailed stratigraphic profiles across the entire Western Interior basin, and derived paleogeographic maps for only a few selected time slices.

Goals of my current study are to present a unified stratigraphic classification that reflects regionally significant bodies of sedimentary rock and to construct detailed chronometric lithofacies profiles across and along the depositional strike of the entire basin. Biostratigraphic correlations of the rock units are made by means of a composite biozonation based on foraminifers, corals, and conodonts. After a stratigraphic framework is compiled for the entire basin, this framework will be used to derive a series of detailed paleogeographic maps at close-spaced time slices through the entire Mississippian interval. Interpretation of the geologic history revealed by the time-slice sequence will provide a basis for classifying depositional models and for identifying local events that may have global significance. Such an approach should permit differentiation of effects of global eustatic events, local and regional sea floor subsidence, and local and regional uplift.

Data currently being evaluated consist of approximately 1,000 biostratigraphically- and lithostratigraphically-calibrated control points gleaned from nearly 40 years of original stratigraphic research and a large volume of published research by other investigators. This report describes the operational procedure of the study and presents some preliminary results.

APPLICATION OF LITHOSOME CONCEPT TO WESTERN INTERIOR MISSISSIPPIAN STRATIGRAPHY

The basic unit used for lithostratigraphic analysis in this study is the <u>lithosome</u>, which is defined as "a vertically and horizontally segregated body of sedimentary rock, characterized by its lithic content and inferred genetic significance, which mutually intertongues with one or more bodies of differing lithic constitution" (Sando, 1990, p. E3). Lithosomes, although not a part of the formal stratigraphic hierarchy, are specifically provided for by the North American Stratigraphic Code (North American Commission on Stratigraphic Nomenclature, 1983, p. 850-851). A lithosome name is derived by contracting the geographic name of the formal stratigraphic unit that is most typical of the lithosome and printing the name in capital letters (Sando, 1990). The reference section for a lithosome may be the type section of a formal stratigaphic unit, or it may be a more representative locality discovered during later regional studies. New lithosomes may be created for units not previously recognized in the formal stratigraphic hierarchy. The history of the lithosome concept and reasons for using the concept for regional stratigraphic analysis are discussed by Sando (1990), which presents an example of its use in the Mississippian of Utah.

Lithosomes emphasize lithologic similarities and differences that are thought to represent regionally significant variations in depositional environments and are derived mainly from detailed studies of stratigraphic sections. Lithosomes are not intended to supplant formal stratigraphic units that emphasize local and regional lithic variations useful for geologic mapping and that are defined mainly by mapping studies.

OPERATIONAL PROCEDURE

Definition and recognition of lithosomes depends on four-dimensional regional stratigraphic analysis. Lithic units are established by field and laboratory study of each stratigraphic section. Chronometric units are established by means of a 26-zone composite biozonation for the Western Interior Mississippian (Fig. 2) from fossils collected during study of stratigraphic sections. Field data on variation in lithology, thickness, and stratigraphic position are combined with laboratory data on succession of faunal zones in a data sheet for each stratigraphic section control point (Fig. 3). Lithosome boundaries are identified, and environmental parameters are inferred from both lithic and biotic data.

Control points are plotted on state base maps (1:1,000,000) for primary locations. After selection of control points for chronometric lithofacies profiles, selected control points are transferred to a base map for the entire study area (Fig. 4). The example presented shows some preliminary profile locations for the northern part of the Western Interior basin.

Chronometric lithofacies profiles are compiled from data sheets for each control point (Fig. 5). The example presented shows one of the profiles located on Figure 4. The vertical dimension of the profile is time, measured both biometrically and radiometrically, and the horizontal dimension is distance along the profile transect. Some preliminary time-slice positions are indicated at the right side of the profile. Preliminary lithosomes are defined and labelled, and their gross lithologies are indicated by means of patterns in the example.

Paleogeographic maps (Fig. 6) are produced by compiling geographic positions of lithosome boundaries for each selected time slice on a base map containing all the profiles. Locations of boundaries in areas outside of the profiles are determined from other control points. The example shows the distribution of preliminary lithosomes and regionally significant environments for five time slices in Idaho, Montana, and Wyoming, based on chronometric lithofacies profile D-C (Fig. 5) and numerous other control points (not shown). Note that each lithosome (see Table 2 for preliminary data) is defined so as to represent a regionally significant depositional environment or environmental complex. Some of the lithosomes are confined to the area of the example, but others extend into adjacent areas; their precise geographic limits will not be known until the entire Western Interior basin is examined by the methods described above.

LITHOSOMES VS. FORMAL STRATIGRAPHIC UNITS

This brief report would be incomplete without giving some examples of how lithosomes facilitate regional stratigraphic analysis. The following examples are taken from the chronostratigraphic lithofacies profile illustrated herein (Fig. 5).

COCANUS

The COCANUS lithosome (Fig. 5) is an exact equivalent of the shale and siltstone facies of the upper tongue of the Cottonwood Canyon Member of the Madison Limestone in Wyoming and the Lodgepole Limestone in Montana and Wyoming. This rock unit, which ranges from a few centimeters to approximately 8 m thick, was regarded as a part of the underlying Three Forks Formation (Upper Devonian) on geologic maps published prior to its formal recognition by Sandberg and Klapper (1967). In fact, the entire Cottonwood Canyon Member (maximum thickness about 25 m), which includes subordinate stratigraphic units of both Early Mississippian and Late Devonian age, was included in the Three Forks before Sandberg (1963) described the complex relationships of its component lithic units by detailed studies of the lithology and conodont zonation of this stratigraphic interval, which was much too thin to map at conventional mapping scales. The recognition of these thin units permitted detailed description of the history of the earliest Mississippian transgression in the Western Interior basin (Sandberg and Klapper (1967).

The unmappability of the Cottonwood Canyon and its components delayed their acceptance as formal stratigraphic units and cast a shadow on their geological significance. Tradition was a barrier to separating them from the Three Forks Formation and classifying them as a part of the succeeding Madison Limestone. A cumbersome hierarchy of formation, member, tongues, and facies had to be devised in order to fit these important lithic units into the formal stratigraphic classification. Geologic mapping derived little or no benefit from the revision because the boundary originally used to differentiate mapping units remained the best choice for future mapping studies.

Recognition of COCANUS as a distinct lithosome places emphasis on its importance for analyzing regional depositional history and frees it from the cumbersome formal hierarchy that tends to belittle its importance. Geologic mapping is unaffected by this approach because lithosomes are not part of the formal stratigraphic nomenclature and do not have to be recognized on geologic maps.

SCOTT, RAILCAN, AND SURCAN

Four formations (in ascending order) make up most of the thick Upper Mississippian sequence mapped extensively in the Lost River and Lemhi Ranges of south-central Idaho (in ascending order): Scott Peak Formation (carbonates about 700 m thick), South Creek Formation (shale and carbonate about 125 m thick), Surrett Canyon Formation (carbonate about 300 m thick), and Arco Hills Formation (shale and carbonate about 125 m thick) (Skipp and others, 1979a). Another formation, the Railroad Canyon Formation (shale and carbonate about 260 m thick), has been mapped above the Scott Peak in the Beaverhead Mountains near the Idaho-Montana boundary (Ruppel and Lopez, 1988). In the Tendoy Range of southwestern Montana, W. J. Perry, Jr. (written commun., 1987) mapped Scott Peak, South Creek, and Surrett Canyon Formations in his Medicine Lodge thrust sheet.

Wardlaw and Pecora (1985) proposed a new nomenclature for Upper Mississippian rocks previously called Big Snowy Group in southwestern

Montana, and this new classification included the Lombard Limestone, a formation that was correlated with the Railroad Canyon Formation. W. J. Perry, Jr. (written commun., 1987, and in Perry and others, 1989) mapped the Lombard Limestone in his McKenzie thrust system and Four Eyes Canyon thrust sheet in the Tendoy Range and in his Snowcrest-Greenhorn thrust system northeast of the Tendoy Range. Wardlaw (1985, fig. 3) showed the temporal relationships of Upper Mississippian formations in southwestern Montana and south-central Idaho based on conodont distributions.

Skipp and others (1979a, p. AA21-22) correctly interpreted the main depositional geometry of the Scott Peak, Surrett Canyon, and South Creek Formations in Idaho as representing "carbonate-bank and forebank deposits", and Wardlaw (1985, fig. 3) refined these paleogeographic concepts. However, the constructions of these authors suffered somewhat from obfuscation of the unity of the South Creek and Arco Hills with the Railroad Canyon, the lower part of the Lombard with the Scott Peak, and the upper part of the Lombard with the Surrett Canyon, because they had to deal with formational units implying different environmental facies in different areas and did not consider the entire area in which the same lithic facies were developed.

A lithosome approach to the depositional geometry (Fig. 5, sections 36-44) clarifies the depositional relationships. In this construction, SCOTT=Scott Peak+lower part of Lombard, RAILCAN=Railroad Canyon+South Creek+Arco Hills, and SURCAN=Surrett Canyon+upper part of Lombard. A time-slice paleogeographic map based on the lithosome equations (Fig. 6, Time slice 16) shows SCOTT as an extensive shelf-carbonate production area and SURCAN and RAILCAN as allochthonous deposits in a deep basin adjacent to the shelf. Preliminary paleogeographic studies indicate that the SCOTT shelf extended southward from British Columbia (upper part of Mt. Head Formation) across Idaho to the Idaho-Utah line.

CONCLUSIONS

The foregoing examples deal with only a few of the many lithosome equations anticipated as results of complete regional analysis. Although some lithosomes not previously recognized in the existing formal stratigraphic classification will be discovered in the process, the net result will be a reduction in the number of lithic units. This procedure will provide a better basis for understanding the history of Mississippian sedimentation in the Western Interior basin.

REFERENCES CITED

Blackwelder, Eliot, 1918, New geological formations in western Wyoming: Washington Academy of Science Journal, v. 8, no. 13, p. 417-426.

Easton, W. H., 1962, Carboniferous formations and faunas of central Montana: U.S. Geological Survey Professional Paper 348, 126 p.

Gardner, L. S., Hendricks, T. A., Hadley, H. D., and Rogers, C. P., Jr., 1946, Stratigraphic sections of upper Paleozoic and Mesozoic rocks in south-central Montana: Montana Bureau of Mines and Geology Memoir 24, 100 p.

Gutschick, R. C., Sandberg, C. A., and Sando, W. J., 1980, Mississippian shelf margin and carbonate platform from Montana to Nevada, in Fouch, T. D., and Magathan, E. R., eds., Paleozoic paleogeography of west-central United States: West-central United States

Paleogeography Symposium 1, Rocky Mountain Section, Society of Economic Paleontologists and Mineralogists, p. 111-128.

Holland, F. D., Jr., Hayes, M. D., Thrasher, L. C., and Huber, T. P., 1987, Summary of the biostratigraphy of the Bakken Formation (Devonian and Mississippian) in the Williston basin, North Dakota, in Carlson, C. G., and Christopher, J. E., eds., Fifth International Williston Basin Symposium: Saskatchewan Geological Society, Special Publication 9, p. 68-76.

Huh, Oscar, 1967, The Mississippian System across the Wasatch Line, east-central Idaho, extreme southwestern Montana, in Centennial basin of southwest Montana: Montana Geological Society, 18th Annual Field Conference Guidebook, p. 31-62.

_____ 1968, Mississippian stratigraphy and sedimentology across the Wasatch-Line, east-central Idaho and extreme southwestern Montana: Pennsylvania State University, unpublished Ph.D. thesis, 175 p.

Mamet, B. L., Skipp, Betty, Sando, W. J., and Mapel, W. J., 1971, Biostratigraphy of Upper Mississippian and associated Carboniferous rocks in south-central Idaho: American Association of Petroleum Geologists Bulletin, v. 55, no. 1, p. 20-33.

Maughan, E. K., and Roberts, A. E., 1967, Big Snowy and Amsden Groups and the Mississippian-Pennsylvanian boundary in Montana: U.S. Geological Survey Professional Paper 554-B, 27 p.

North American Commission on Stratigraphic Nomenclature, 1983, North American Stratigraphic Code: American Association of Petroleum Geologists Bulletin, v. 67, no. 5, p. 841-875.

Pecora, W. C., 1981, Bedrock geology of the Blacktail Mountains, southwestern Montana: Wesleyan University, unpublished M.A. thesis, 203 p.

Perry, W. J., Jr., Dyman, T. S., and Sando, W. J., 1989, Southwestern Montana recess of Cordilleran thrust belt, in French, D. E., and Grabb, R. F., Geologic Resources of Montana: Montana Geological Society, Field Conference Guidebook, V. 1, p. 261-270.

Peterson, J. A., 1984, Stratigraphy and sedimentary facies of the Madison Limestone and associated rocks in parts of Montana, Nebraska, North Dakota, South Dakota, and Wyoming: U.S. Geological Survey Professional Paper 1273-A, 34 p.

Poole, F. G., and Sandberg, C. A., 1991, Mississippian paleogeography and conodont biostratigraphy of the western United States, in Cooper, J. D., and Stevens, C. H., eds., Paleozoic paleogeography of the western United States-II: Pacific Section, Society of Economic Paleontologists and Mineralogists, v. 67, p., 107-136.

Ruppel, E. T., and Lopez, D. A., 1988, Regional geology and mineral deposits in and near the central part of the Lemhi Range, Lemhi County, Idaho: U.S. Geological Survey Professional Paper 1480, 122 p.

Sandberg, C. A., 1963, Dark shale unit of Devonian and Mississippian age in northern Wyoming and southern Montana: U.S. Geological Survey Professional Paper 475-C, p. C17-C20.

_____ 1975, McGowan Creek Formation, new name for Lower Mississippian flysch sequence in east-central Idaho: U.S. Geological Survey Bulletin 1405-E, 11 p.

Sandberg, C. A., and Gutschick, R. C., 1984, Distribution, microfauna, and source-rock potential of Mississippian Delle Phosphatic Member of Woodman Formation and equivalents, Utah and adjacent States, in Woodward, Jane, Meissner, F. F., and Clayton, J. L., eds.,

Hydrocarbon source rocks of the Greater Rocky Mountain region: Rocky Mountain Association of Geologists, p. 135-178.
Sandberg, C. A., Gutschick, R. C., Johnson, J. G., Poole, F. G., and Sando, W. J., 1982 [1983], Middle Devonian to Late Mississippian geologic history of the Overthrust belt region, western United States: Rocky Mountain Association of Geologists, Geologic studies of the Cordilleran thrust belt, v. 2, p. 691-719.
Sandberg, C. A., and Klapper, 1967, Stratigraphy, age, and paleotectonic significance of the Cottonwood Canyon Member of the Madison Limestone in Wyoming and Montana: U.S. Geological Survey Bulletin 1251-B, 70 p.
Sando, W. J., 1960, Corals from well cores of Madison Group, Williston basin: U.S. Geological Survey Bulletin 1071-F, 190 p.
_____ 1968, A new member of the Madison Limestone (Mississippian) in Wyoming: Geological Society of America Bulletin, v. 79, p. 1855-1858.
_____ 1976a, Mississippian history of the northern Rocky Mountains region: U.S. Geological Survey Journal of Research, v. 4, no. 3, p. 317-338.
_____ 1976b, Madison Limestone (Devonian and Mississippian), east flank of Bighorn Mountains, Wyoming: Wyoming Geological Association, 28th Field Conference Guidebook, p. 45-52.
_____ 1978, Coral zones and problems of Mississippian stratigraphy in the Williston basin: Montana Geological Society, Williston basin symposium, p. 231-237.
_____ 1982, New members of the Madison Limestone (Devonian and Mississippian), north-central Wyoming and southern Montana: U.S. Geologcial Survey Bulletin 1529-H, p. H125-H130.
_____ 1990, HUM lithosome: an example of regional stratigraphic synthesis in the Mississippian of the Western Interior of the United States: U.S. Geological Survey Bulletin 1881-E, 17 p.
Sando, W. J., and Bamber, E. W., 1985, Coral zonation of the Mississippian System in the Western Interior Province of North America: U.S. Geological Survey Professional Paper 1334, 61 p.
Sando, W. J., and Dutro, J. T., Jr., 1974, Type sections of the Madison Group (Mississippian) and its subdivisions in Montana: U.S. Geological Survey Professional Paper 842, 22 p.
Sando, W. J., and Dutro, J. T. Jr., 1980, Paleontology and correlation of the Madison Group on Baldy Mountain, in Hadley, J. B., Geology of the Varney and Cameron quadrangles, Madison County, Montana: U.S. Geological Survey Bulletin 1459, p. 33-46.
Sando, W. J., Gordon, M. Jr., and Dutro, J. T. Jr., 1975, Stratigraphy and geologic history of the Amsden Formation (Mississippian and Pennsylvanian) of Wyoming: U.S. Geological Survey Professional Paper 848-A, 83 p.
Sando, W. J., and Mamet, B. L., 1981, Distribution and stratigraphic significance of Foraminifera and algae in well cores from Madison Group (Mississippian), Williston basin, Montana: U.S. Geological Survey Bulletin 1529-A, 12 p.
Sando, W. J., Sandberg, C. A., and Perry, W. J., Jr., 1985, Revision of Mississippian stratigraphy, northern Tendoy Mountains, southwest Montana: U.S. Geological Survey Bulletin 1656-A, 10 p.
Saperstone, H. I., and Etheridge, F. G., 1984, Origin and paleotectonic setting of the Pennsylvanian Quadrant Sandstone, southwestern Montana: Wyoming Geological Association, 35th Field Conference Guidebook, p. 309-331.

Skipp, B. A. L., 1961a, Stratigraphic distribution of endothyrid Foraminifera in Carboniferous rocks of the Mackay quadrangle, Idaho: U.S. Geological Survey Professional Paper 424-C, p C239-C244.
_____ 1961b, Interpretation of sedimentary features in Brazer Limestone (Mississippian) near Mackay, Custer County, Idaho: American Association of Petroleum Geologists Bulletin, v. 45, no. 3, p. 376-389.
Skipp, Betty, and Hall, W. E., 1975, Structure and Paleozoic stratigraphy of a complex of thrust plates in the Fish Creek Reservoir area, south-central Idaho: U.S. Geological Survey Journal of Research, v. 3, no. 6, p. 671-689.
Skipp, Betty, Hoggan, R. D., Schleicher, D. L., and Douglass, R. C., 1979b, Upper Paleozoic carbonate bank in east-central Idaho - Snaky Canyon, Bluebird Mountain, and Arco Hills Formations, and their paleotectonic significance: U.S. Geological Survey Bulletin 1486, 78 p.
Skipp, Betty, and Mamet, B. L., 1970, Stratigraphic micropaleontology of the type locality of the White Knob Limestone (Mississippian), Custer County, Idaho: U.S. Geological Survey Professional Paper 700-B, p. B118-B123.
Skipp, Betty, Sando, W. J., and Hall, W. E., 1979a, The Mississippian and Pennsylvanian (Carboniferous) Systems in the United States - Idaho: U.S. Geological Survey Professional Paper 1110-AA, 42 p.
Sloss, L. L., and Moritz, C. A., 1951, Paleozoic stratigraphy of southwestern Montana: American Association of Petroleum Geologists Bulletin, v. 35, no. 10, p. 2135-2169.
Wardlaw, B. R., 1985, Late Mississippian-Early Pennsylvanian (Namurian) conodont biostratigraphy of the northern Rocky Mountains: 10th International Congress of Carboniferous Stratigraphy and Geology, Compte Rendu, v. 4, p. 391-401.
Wardlaw, B. R., and Pecora, W. C., 1985, New Mississippian-Pennsylvanian stratigraphic units in southwest Montana and adjacent Idaho: U.S. Geological Survey Bulletin 1656-B, 9 p.

TABLE 1. Geographic locations and references for control points on chronometric lithofacies profile D-C (Fig. 5).

CONTROL NUMBER	LOCATION	REFERENCES
34	Big Wood River area, T. 2 N., R. 19 E., Blaine Co., Idaho	Skipp & others (1979a)
35	Pioneer Mountains, T. 1 N., R. 22 E., Blaine Co., Idaho	Skipp & Hall (1975); Skipp & others (1979a)
36	Cabin Creek, T. 6 N., R. 22 E., Custer Co., Idaho	Skipp (1961a, b), Skipp & Mamet (1970), Skipp & others (1979a)
37	Hawley Mountain, T. 9 N., R 26 E., Butte Co., Idaho	Mamet & others (1971), Skipp & others (1979a)
38	Bell Mountain, T. 11 N., R, 27 E., Lemhi Co., Idaho	Huh (1967, 1968)
39	Copper Mountain, T. 10 N., R. 30 E., Clark Co., Idaho	Huh (1967, 1968), Skipp & others (1979a)
40	Railroad Canyon, T. 17 N., R. 27 E., Lemhi Co., Idaho	Wardlaw & Pecora (1985), Skipp & others (1979a)
41	Lake Canyon, T. 12 S., R. 12 W., Beaverhead Co., Montana	Huh (1967, 1968)
42	Bell Canyon & Bell-McKenzie Divide, T. 11 S., R. 10 W., Beaverhead Co., Montana	Sando & others (1985) Wardlaw & Pecora (1985)
43	Blacktail Mountains, T. 9 & 10 S., R. 8 W., Beaverhead Co., Montana	Sloss & Moritz (1951), Wardlaw & Pecora (1985), Huh (1967, 1968), Pecora (1981)
44	Baldy Mountain (Arasta Creek), T. 7 S., R. 3 W., Madison Co., Montana	Sando & Dutro (1980), Wardlaw & Pecora (1985)
45	Squaw Creek, T. 4 S., R. 4 E., Gallatin Co., Montana	Sando (field notes)
4	Sacajawea Peak, T. 2 N., R. 6 E., Gallatin Co., Montana	Sando & others (1975), Gutschick & others (1980)
46	Delpine, T. 9 N., R. 10 E., Meagher Co., Montana	Gardner & others (1946), Easton (1962), Maughan & Roberts (1967), Sando & others (1975)
47	Stonehouse Canyon, T. 11 N., R. 20 & 21 E., Golden Valley Co., Montana	Ditto
48	Ralph Lowe Sandquist #1 well, T. 16 N., R. 36 E., Garfield Co., Montana	Peterson (1984)
49	Pan American NPRR well, T. 17 E, R. 45 E., McCone Co., Montana	Peterson (1984)
50	Shell NPRR #1 Richey well, T. 23 N., R. 50 E., Dawson Co., Montana	Sando (1960, 1978), Sando & Mamet (1981)
51	Texaco #1 L. J. Hyde well, T. 154 N., R. 98 W., Williams Co., North Dakota	Peterson (1984)

TABLE 2. DATA ON PRELIMINARY LITHOSOMES SHOWN IN FIGURES 5 AND 6.

LITHOSOME	FORMAL AND INFORMAL EQUIVALENTS IN STUDY AREA	TENTATIVE REFERENCE SECTION
ALAB	Alaska Bench Limestone	Control Number 47 (Table 1)
BAKKUP	Upper black shale unit of Bakken Formation	Mobil Kennedy well F-32-24-P (NDGS core 607), Dunn Co., ND (Holland & others, 1987, fig. 2)
BIGOO	Big Goose Member of Madison Limestone	Little Tongue River, Sheridan Co., WY (Sando, 1982, p. H128)
BLUM	Bluebird Mountain Formation	Gallagher Peak, Clark Co., ID (Skipp & others, 1979b, p. 42-51)
BULL	Bull Ridge Member of Madison Limestone, Sun River Dolomite, and equivalent beds in Mission Canyon Limestone and Charles Formation	Bull Lake Creek, Fremont Co., WY (Sando, 1968)
COCANUS	Shale and siltstone facies of of upper tongue of Cottonwood Member of Madison Limestone and Lodgepole Limestone	Clarks Fork Canyon, Park Co., WY (Sandberg, 1963; Sandberg & Klapper, 1967, p. B20-B21)
CONRAN	Conover Ranch Formation	Control Number 43 (Table 1)
COPBAS	Copper Basin Formation	Control Number 35 (Table 1)
DAR	Darwin Sandstone Member of Amsden Formation	Darwin Peak, Teton Co., Wy (Blackwelder, 1918; Sando & others, 1975)
DELPH	Delle Phosphatic Member of Woodman Formation, Chainman Shale, Deep Creek Formation, Deseret Limestone, Little Flat Formation, Aspen Range Formation, and Brazer Dolomite	South Lakeside Mountains, Tooele Co., UT (Sandberg & Gutschick, 1984)
EVAPLO	Lower solution zone of Madison Limestone and equivalent beds in Mission Canyon Limestone and Charles Formation	Little Tongue River, Sheridan Co., WY (Sando, 1976b)
EVAPUP	Upper solution zone of Madison Limestone and equivalent beds in Mission Canyon Limestone and Charles Formation	Ditto
HEAT	Heath Formation	Control Number 47 (Table 1)
HORSE	Horseshoe Shale Member of Amsden Formation	Livingston Ranch, Fremont Co., WY (Sando & others, 1975)
KIBB	Kibbey Formation	Control Number 47 (Table 1)
LIBIG	Little Bighorn Member of Madison Limestone	Little Tongue River, Sheridan Co., WY (Sando, 1982)
MCGOW	McGowan Creek Formation	McGowan Creek, Custer Co., ID (Sandberg, 1975)
MCKAN	McKenzie Canyon Limestone	Control Number 43 (Table 1)

LITHOSOME	FORMAL AND INFORMAL EQUIVALENTS IN STUDY AREA	TENTATIVE REFERENCE SECTION
MIDCAN	Middle Canyon Formation and equivalent beds in Allan Mountain Limestone	Control Number 37 (Table 1)
MISCAN	Mission Canyon Limestone , Castle Reef Dolomite, and Little Tongue Member of Madison Limestone	Monarch-U.S. 89, Cascade Co., MT (Sando & Dutro, 1974, p. 8)
OTT	Otter Formation	Control Number 47 (Table 1)
PAINLO	Basal crinoidal limestone of Paine Member of Lodgepole Limestone and equivalent beds in Allan Mountain Limestone	Dry Fork, Cascade Co., MT (Sando & Dutro, 1974, p. 12-16)
PAINUP	Limestone above basal crinoidal beds of Paine Member of Lodgepole Limestone and equivalent beds in Allan Mountain Limestone	Dry Fork, Cascade Co., MT (Sando & Dutro, 1974, p. 12-16)
QUAD	Quadrant Sandstone, Wells Formation, and Tensleep Sandstone	Big Sheep Canyon, Beaverhead Co., MT (Saperstone & Eldridge, 1984)
RAILCAN	Railroad Canyon Formation, Arco Hills Formation, South Creek Formation	Railroad Canyon, Lemhi Co., ID (Wardlaw & Pecora, 1985, p. B7)
RANCH	Ranchester Limestone Member of Amsden Formation	Amsden Creek, Sheridan Co., WY (Sando & others, 1975)
SALT	Upper salt unit of Charles Formation	Control Number 50 (Table 1)
SCOTT	Scott Peak Formation, lower part of Lombard Limestone, and equivalent beds in Monroe Canyon Limestone and Aspen Range Formation	Control Number 37 (Table 1)
SNAKAN	Snaky Canyon Formation	Gallagher Peak, Clark Co., ID (Skipp & others, 1979b)
SURCAN	Surrett Canyon Formation, upper part of Lombard Limestone, and equivalent beds in Monroe Canyon Limestone and Aspen Range Formation	Control Number 37 (Table 1)
TYLE	Tyler Formation	Control Number 47 (Table 1)
WOOD	Woodhurst Member of Lodgepole Limestone and Madison Limestone and equivalent beds in Allan Mountain Limestone	Dry Fork, Cascade Co., MT (Sando & Dutro, 1974, p. 12-16)

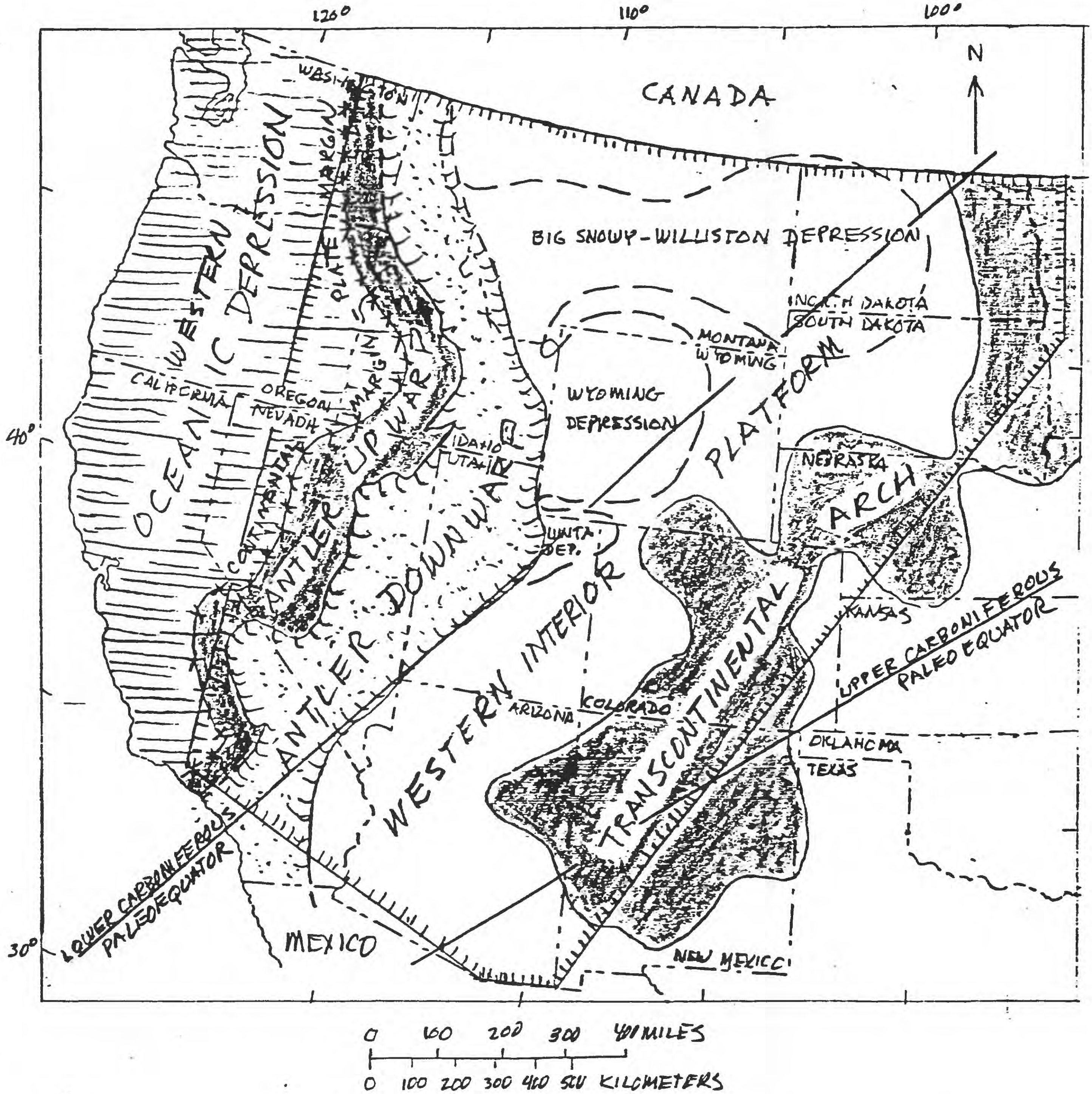


Figure 1. Map of western United States showing Mississippian paleotectonic units and location of study area (hachured polygon). Modified from Sando and Bamber (1985, fig. 2).

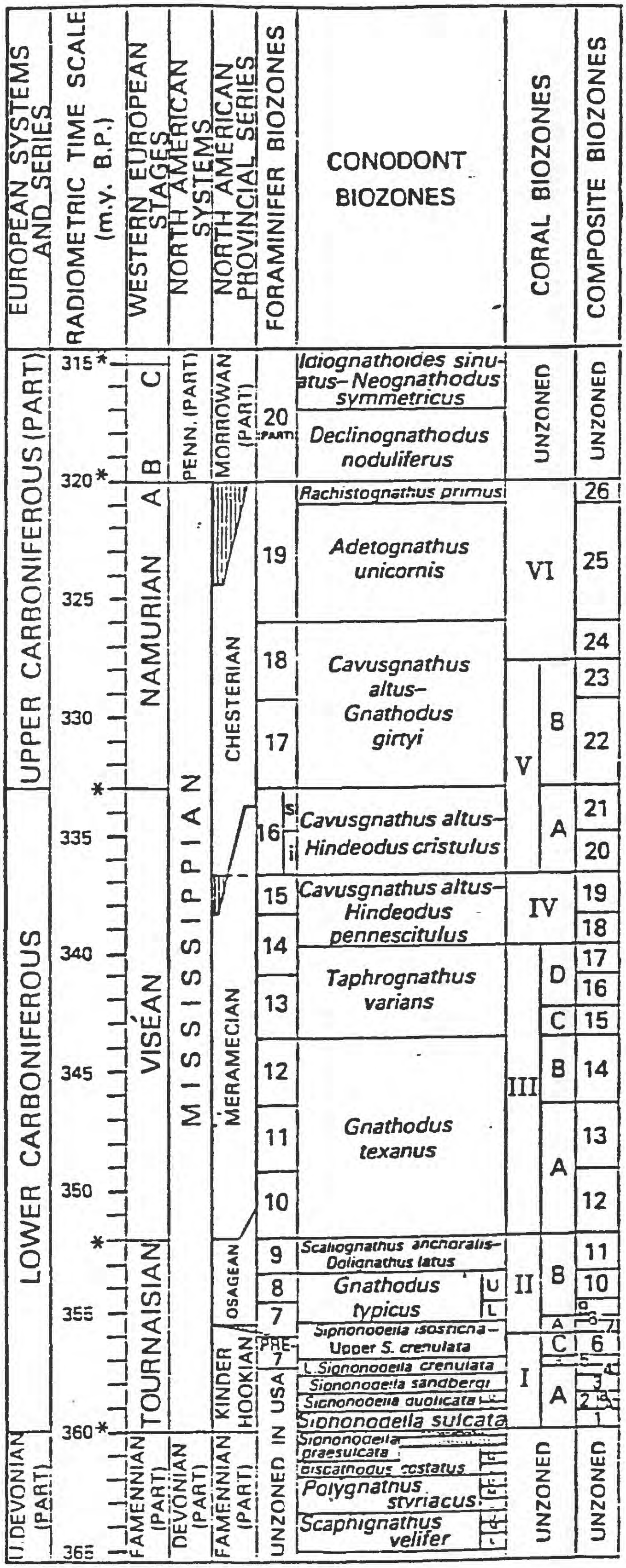


Figure 2. Western Interior Mississippian time scale, showing biozonations based on foraminifers, conodonts, and corals and composite biozonation used in chronometric correlation of lithosomes (modified from Sando, 1985, fig. 3).

Faunal control
- o forams
- × conodonts
- • corals
- + brachiopods
- Δ other

DATE: 6/86

DATA SHEET-STRATIGRAPHIC SECTION

NAME: Baldy Mountain (Arasta Creek) NUMBER: MT-15

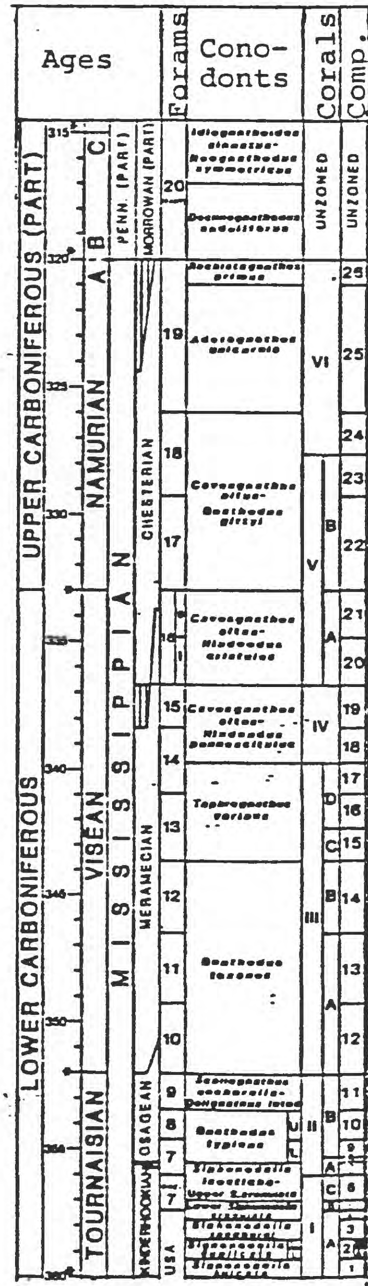
LOCATION: Sec. 26, 27, 34, 35 - T. 7 S., R. 3 W., Madison County, Montana

SOURCE: Sando & Dutro (1980), Wardlaw & Pecora (1985), Pecora & Wardlaw (unpub. MS.), Sando (file)

KIND OF DATA:

Lith log ✓ Descrip. ✓ Thickness ✓ Fossils ✓ Detailed ✓
Generalized Composite

REMARKS:



Time slices	Lithosomes /fauna	Unit thickness Ft	Unit thickness M	Composite thickness Ft	Composite thickness M	Notes
20	QUAD		110		110	Peritid. ss & dolomic.
19	RANCH		20		130	Peritid.&shal.subtid. mic., dolomic., sh., siltst., ss.
18	CONRAN		22		152	Peritid.&shal.subtid. sh.,mic.,dolomic., ss. siltst.
17, 16, 15	SURCAN		62		214	Shal.-dp. subtid. mic. & sh.
14, 13	KIBB		19		233	Peritid. siltst., sh., ss.
12, 11	?					Hiatus
10	BULL	309.5	94.3		327.3	Shal.subtid.-peritid. mic.
	EVAPUP	37.0	11.3		338.6	Dolomic. sol. brec.
9, 8, 7, 6	MISCAN	583.5	177.9		516.5	Shal.subtid-peritid. mic.,dolomic., spar.
5	WOOD	511.0	155.8		627.3	Shal. subtid. mic.&spar
4	PAINUP	235.5	71.8		699.1	Dp.subtid. mic.
3, 2, 1	PAINLO	2.8	0.9		700.0	Shal.subtid.glauc. mic.
	Three Forks Fm.					

Figure 3. Sample data sheet used to compile data for control points on chronometric lithofacies profiles (Section 44 on Fig. 5).

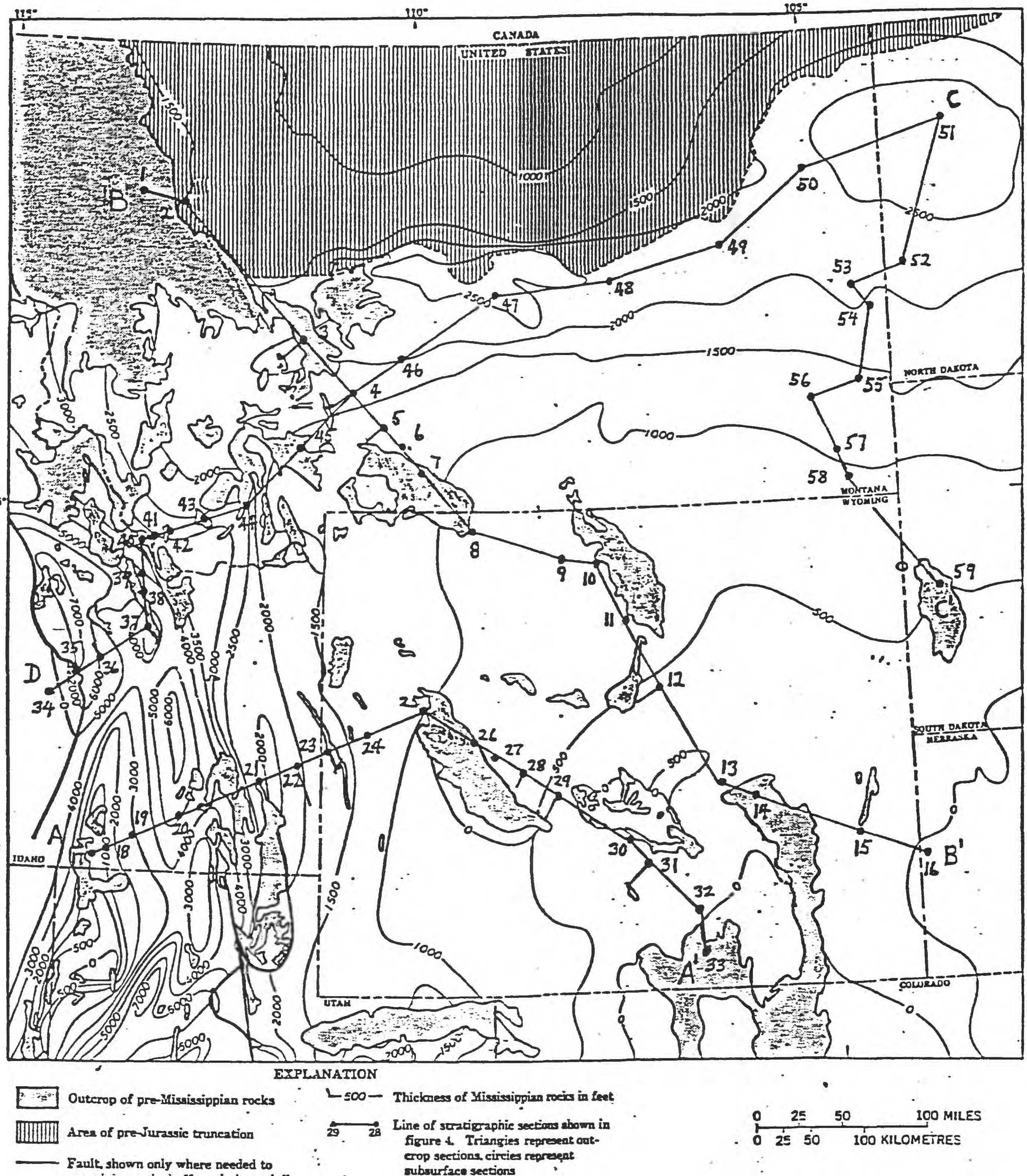


Figure 4. Geologic map of northern part of Western Interior basin showing Mississippian isopachs and locations of some preliminary chronometric profiles (modified from Sando (1976, fig.2).

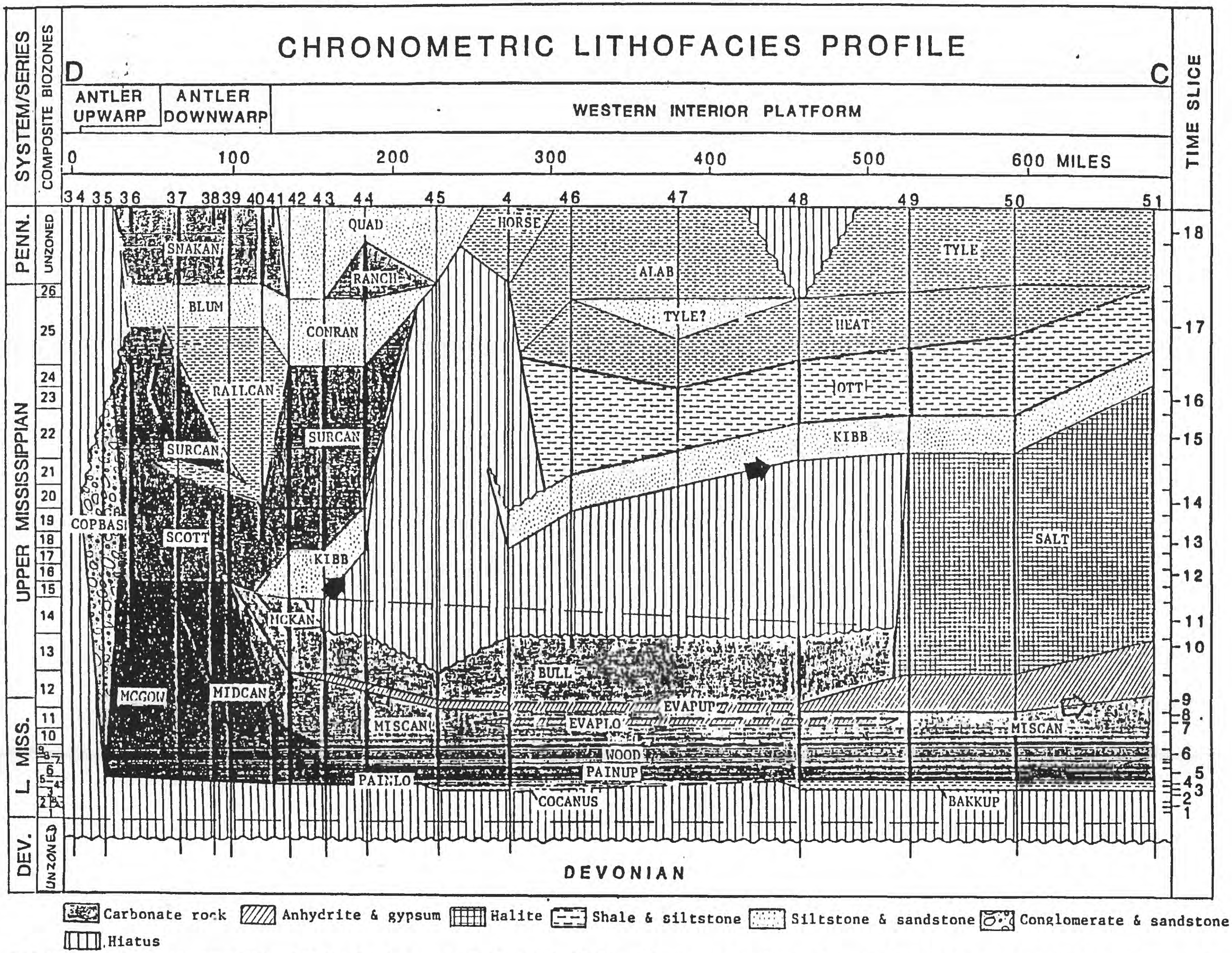


Figure 5. Chronometric lithofacies profile D-C (Fig. 4) across depositional strike of northern part of Western Interior basin, showing preliminary Mississippian lithosomes. See Table 1 for geographic locations of control points. Closed arrows indicate transgression; open arrows indicate regression.

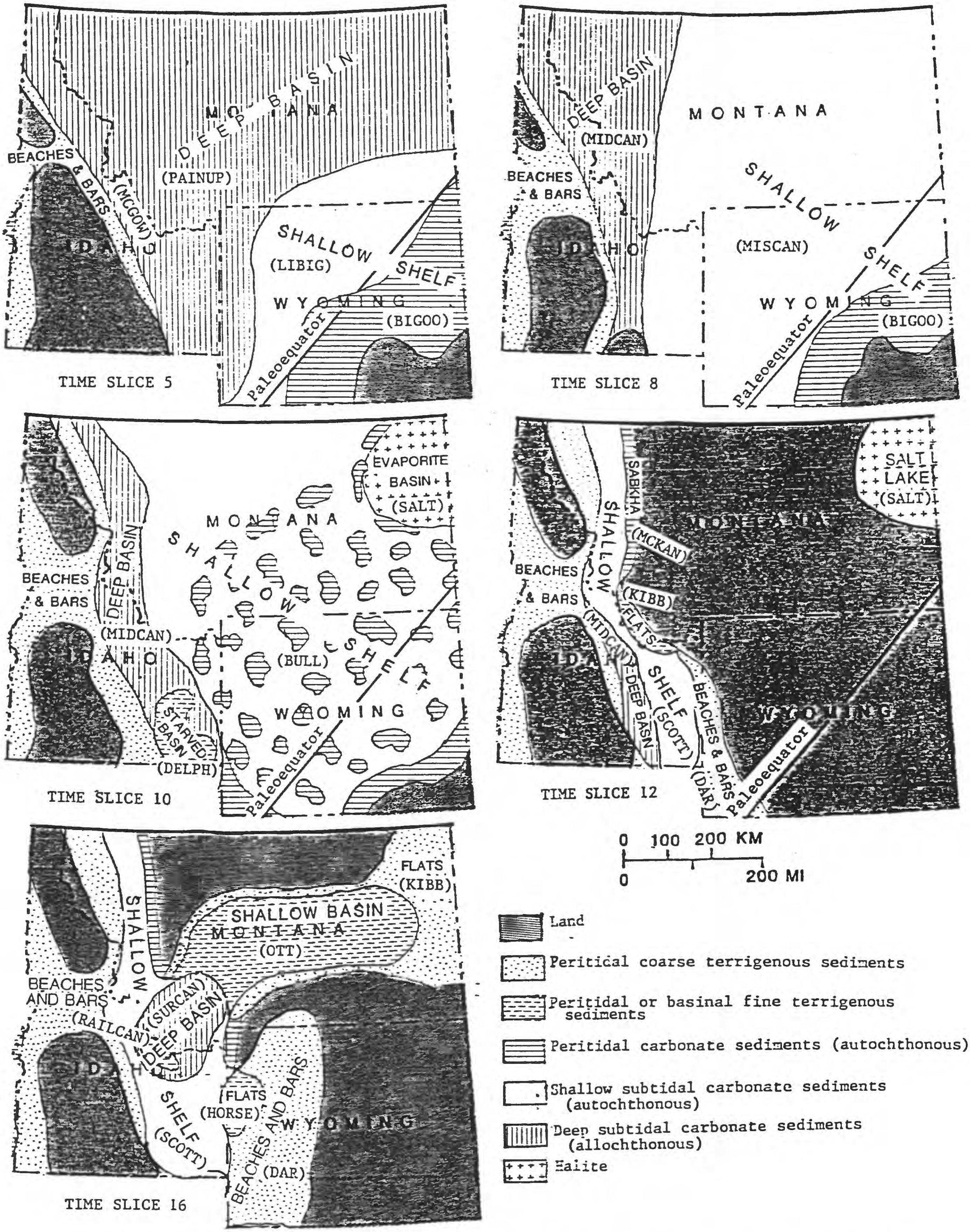


Figure 6. Preliminary paleogeographic maps of northern part of Western Interior basin showing distribution of preliminary lithosomes (in parentheses) in five selected time slices (Fig. 5).