UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Preliminary Stratigraphic Correlation of the Cretaceous Blackleaf and Lower Frontier Formations in Beaverhead and Madison Counties, Montana

By

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Open-File Report 85-729

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nonmenclature.

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1985

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PRELIMINARY STRATIGRAPHIC CORRELATION OF THE CRETACEOUS BLACKLEAF AND LOWER FRONTIER FORMATIONS IN BEAVERHEAD AND MADISON COUNTIES, MONTANA

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INTRODUCTION/STRATIGRAPHY

The Cretaceous sedimentary sequence in Madison and Beaverhead Counties, Montana, lies within or east of the southwestern Montana fold-and-thrust belt, near the western depositional edge of the foreland basin complex. These strata record cyclic sedimentation during a succession of marine transgressions and regressions, which were caused by an interaction of source-area tectonism, basin subsidence, and varied sedimentation rates. Lower Cretaceous and lower Upper Cretaceous rocks have been assigned to the Aptian Kootenai Formation, the Albian Blackleaf Formation, and the Cenomanian lower part of the Frontier Formation in the western part of the study area, and the Kootenai, Thermopolis, Muddy, Aspen, and Frontier Formations in the eastern part of the study area. Stratigraphic relationships and regional correlations are illustrated in figure 1.

The Blackleaf-Kootenai contact is in part conformable and is defined in this study at the top of the last gastropod-rich limestone of the upper carbonate member of the Kootenai Formation (fig. 2). Although diachronous, the contact is well defined in the field. Both micritic limestone and mudstone, rich in limestone nodules, occur above this contact, but these units contain no gastropods.

The Blackleaf-Frontier contact is conformable in the Pioneer Range (Frying Pan Gulch and Apex sections) and McCartney Mountain area (McCartney Mountain section) and may be unconformable in the Snowcrest (Antone Peak section) and Gravelly (Warm Springs Creek and Ruby River sections) Ranges, and the Lima Peaks area (Lima Peaks section). The basal Frontier Formation is arbitrarily defined in this study at the base of the first sandstone or conglomerate bed or dark-gray nonvolcanic shale above the upper volcaniclastic lithofacies unit of the Blackleaf Formation. The contact is best defined in the Lima Peaks area, where it is recognized by a sharp color change and lithologic break, and the presence of an erosional surface and lag conglomerate. This contact is probably diachronous, and correlation was best made where palynomorph data were available.

The Blackleaf Formation varies in thickness from a maximum of 600 m at the Apex section north of Dillon to a minimum of 420 m at the Lima Peaks section south of Lima. Comparable subsurface thickness data near the Lima Peaks section are found in Perry and others (1983). The Blackleaf Formation is subdivided into 4 mappable lithofacies units (fig. 2): lower transitional clastic (unit 1), lower mudstone-shale (unit 2), upper clastic (unit 3), and upper volcaniclastic (unit 4).

Unit 1 overlies the upper carbonate member (gastropod limestone) of the Kootenai Formation. This basal unit consists of mudstone, quartz- and chert-rich sandstone, and micritic and nodular limestone, deposited in fluvial, lacustrine, and shallow-marine environments. Paleocurrent directions indicate an eastern and northern provenance for unit 1 detritus. Unit 2 consists predominantly of mudstone, shale, and siltstone deposited in lagoonal to shallow-marine environments. Unit 3 consists of quartz- and chert-rich sandstone bodies and interbedded mudstone deposited in fluvial, deltaic, and shallow-marine environments. Paleocurrent directions indicate an east and west provenance for unit 3 detritus. Unit 4 consists of porcellanitic mudstone, shale, and subordinate lithic sandstone deposited in fluvial, lacustrine, and shallow-marine environments. Paleocurrent directions for unit 4 are sparse. Unit 4 is overlain by the Frontier Formation. The lower Frontier is composed of lithic sandstone, conglomerate, and subordinate mudstone and shale deposited in fluvial and shallow-marine(?) environments, and contains palynomorphs of Cenomanian age. Paleocurrent directions indicate a south or southwest provenance for lower Frontier detritus.

MEASURED SECTIONS

Six measured sections and their stratigraphic correlations are presented here using the Stratigraphic Report Graphic (SRG). The SRG is a stratigraphic applications computer program developed by the U.S. Geological Survey and Petroleum Information Corporation of Denver, Colorado. The SRG accepts sedimentologic, paleontologic, lithologic, paleoecologic, and identification data from outcrop sections and cores, and displays these data in a scale-variant format (Petroleum Information Corporation, 1984; Dyman, Materna, and Wilcox, 1985). The SRG is proprietary to Petroleum Information Corporation but is available to the U.S. Geological Survey by contract for a variety of research applications.

The measured sections displayed here were selected from 12 original sections (Dyman, Niblack, and Platt, 1984; Dyman, 1985a) as the most complete and stratigraphically diverse in the region (fig. 3). Outcrop quality varies from good to poor. The best exposed sections are located in the Pioneer Range (Frying Pan Gulch and Apex sections) and McCartney Mountain areas (McCartney Mountain section); but outcrop sections south of Lima (Lima Peaks section) and in the Snowcrest Range (Antone Peak section) are poorly exposed, and composite sections were measured. The Warm Springs Creek (Blackleaf) and Ruby River (Blackleaf and Frontier) sections lie within 5 km of each other and are also presented here as a composite section. The total Blackleaf thickness at these localities is uncertain. Detailed locations for each measured section are presented in Appendix 1.

EXPLANATION OF GRAPHIC SECTIONS

Each graphic section contains the following data:

1. Lithofacies unit number and sample identification (labeled "sample identification"). Each entry includes (a) the year each sample was collected (e.g. 84); (b) measured section abbreviation (e.g. RR); (c) lithologic unit numbers (e.g. UN 49) as they appear in measured section descriptions (Dyman, Platt, and Niblack, 1984; Dyman, 1985a); and (d) a sample number for samples collected at each locality (e.g. RR-70).

2. Lithofacies unit number and depth (labelled "feet/meters"). Each section is displayed as a borehole with increasing depth down section in feet and meters.

3. Visual porosity estimate (labelled "porosity"). Porosity was determined by visual estimate where E = excellent, G = good, F = fair, P = poor, and N = none. These observations are meant only to be qualitative porosity estimates and do not correspond to specific percentages.

4. Lithology. Figure 4 is an idealized graphic section describing the lithology symbols and an explanation of lithologies presented in each section. Arrows to the left of graphic symbols represent the exact position of sample numbers. Data are presented at a scale of 1 inch = 50 feet. Graphic resolution for individual beds at this scale is 2.5 feet (beds less than 2.5 feet thick are not displayed).

5. Grain size in phi units as determined visually.

6. Paleocurrent direction. Arrows indicate vector means from trough cross-bed and imbricate pebble axes. Data from bipolar structures (e.g. parting lineation) are not illustrated in this report.

7. Palynomorph and bivalve sample locations are annotated along the right margin of each section (P = palynomorph and B = bivalve) at the stratigraphic position from which they were collected. Palynomorph and bivalve genera and species are described in Dyman, Niblack, and Platt (1984), and Dyman (1985a).

Dyman (1985b) contains framework grain percents and diagenetic presence-absence data for samples from the seven measured sections presented in this report.

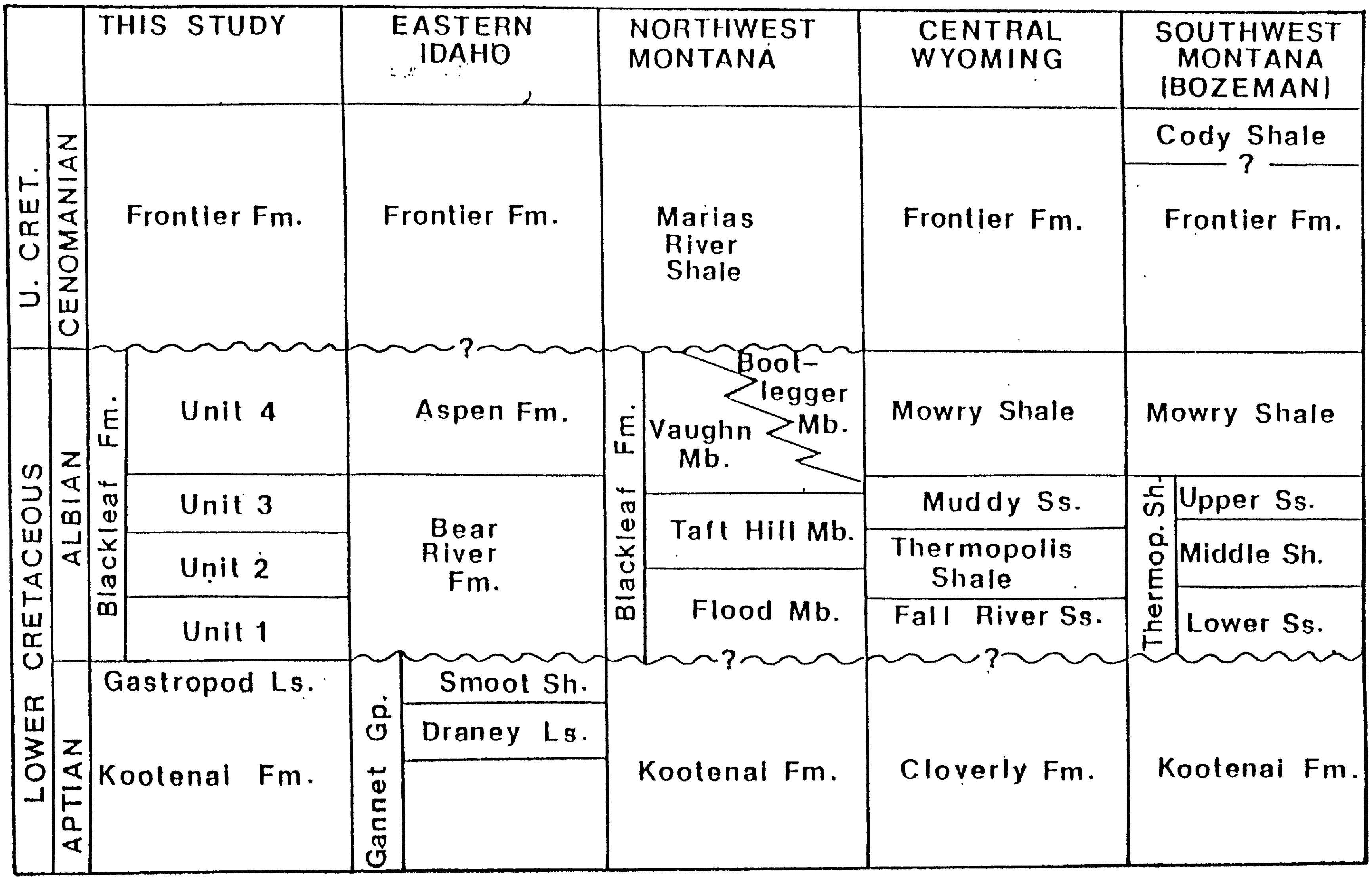


Figure 1. Blackleaf and Frontier Formation correlation chart for the region. Data from Gwinn (1960), Roberts (1972), McGookey and others (1972), Schwartz (1972), Vuke (1972), and Cobban and others (1976).

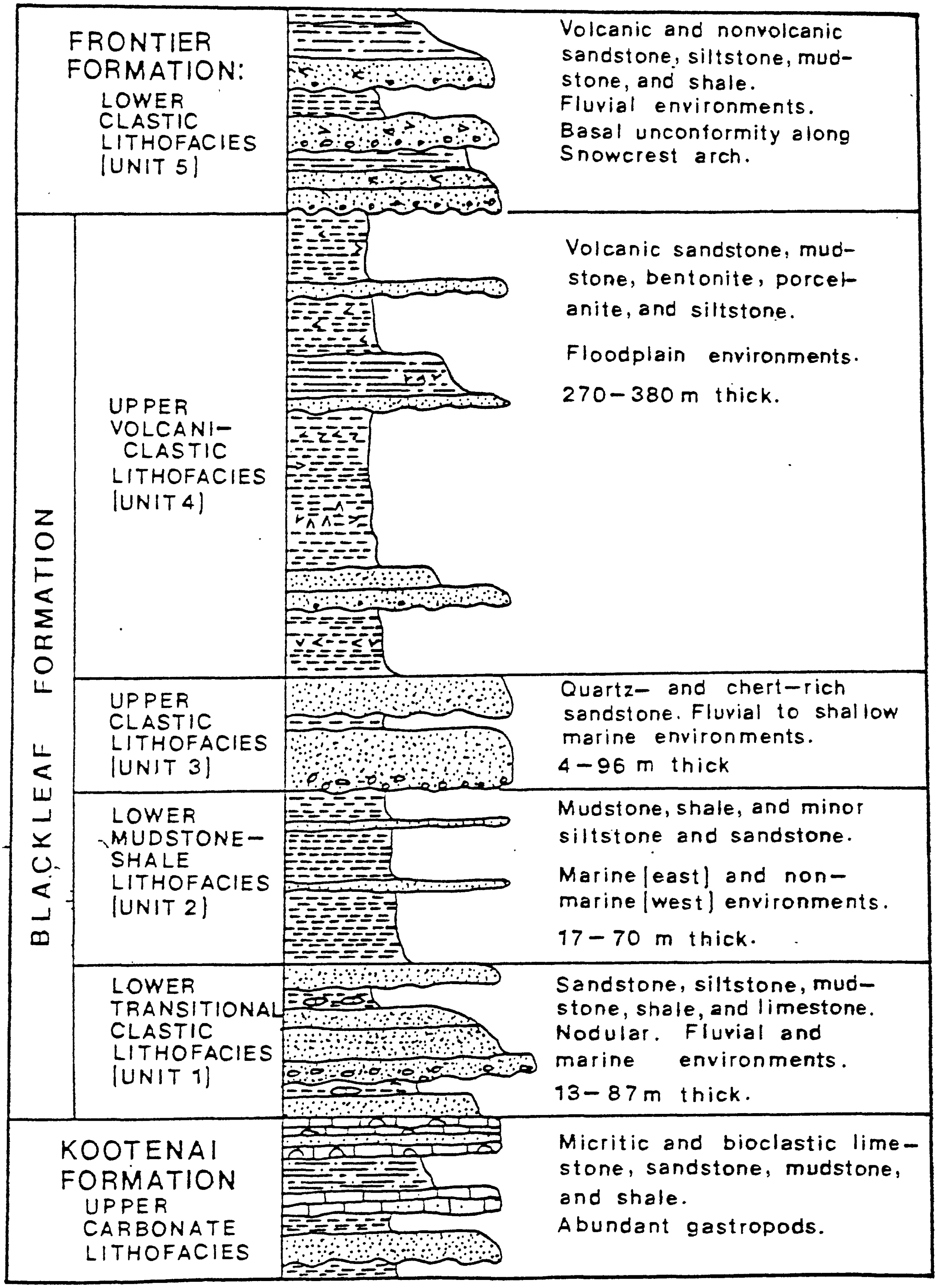


Figure 2. Generalized Blackleaf and Frontier Formation lithofacies descriptions, Madison and Beaverhead Counties, Montana.

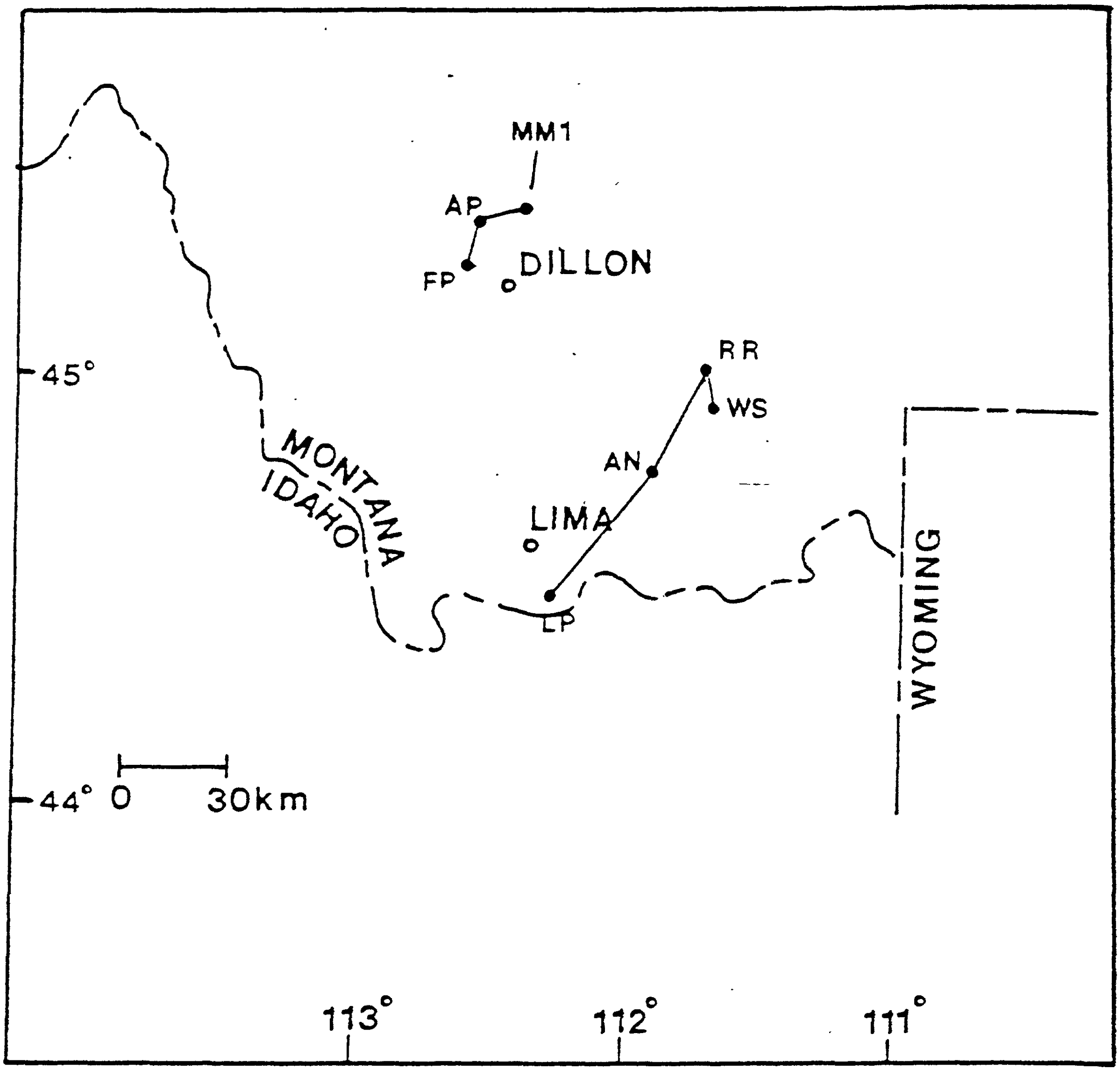
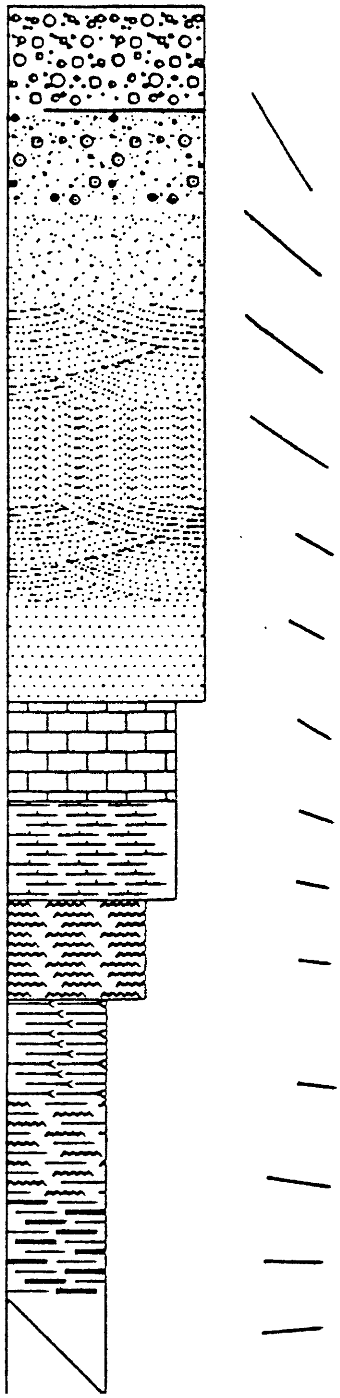


Figure 3. Measured section cross-section locations MM = McCartney Mountain, AP = Apex, FP = Frying Pan, LP = Lima Peaks, AN = Antone Peak, RR = Ruby River, and WS = Warm Springs Creek sections.



EXPLANATION

Conglomerate, clast supported. May be imbricated and cross-bedded

Conglomeratic sandstone. Conglomerate as basal lag or disseminated throughout unit.

Massive sandstone. No observable textures or structures.

Sandstone with moderately or steeply dipping trough sets (Greater than 10 degree dip).

Sandstone with ripple marks of all type.

Sandstone with gently dipping trough sets (less than 10 degrees dip).

Sandstone with horizontal lamination and/or parting lineation.

Limestone, nondescript to bioclastic.

Limestone, micritic.

Siltstone, may include ripples, horizontal lamination, or may be structureless with bioturbation.

Mudstone may be bentonitic or porcelanitic, volcanic rich.

Mudstone or claystone, nonvolcanic.

Shale, weakly to strongly fissile.

Covered interval.

Figure 4. Idealized graphic section showing lithologic symbols and explanation, and symbol width.

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APPENDIX 1
MEASURED SECTION LOCATIONS ON CHART

Lima Peaks section.
Sections 13, 14, and 18, T. 15 S., R. 8 W., Lima Peaks Quadrangle, Beaverhead County, Montana (Dyman, Niblack, and Platt, 1984).

Antone Peak section.
NW 1/4 section 22, SW 1/4 section 11, T. 12 S., R. 5 W., Antone Peak Quadrangle, Beaverhead County, Montana (Dyman, 1985a).

Apex section.
SE 1/2 section 7, S 1/2 section 6, T. 5 S., R. 8 W., Twin Adams Mountain Quadrangle, Beaverhead County, Montana (Dyman, 1985a).

McCartney Mountain I section.
E 1/2 sections 21 and 28, S 1/2 section 16, T. 4 S., R. 8 W., Block Mountain Quadrangle, Madison county, Montana (Dyman, 1985a).

Frying Pan Gulch section.
Section 30, T. 6 S., R. 9 W., Bond Quadrangle, Beaverhead County, Montana (Dyman, 1985a).

Ruby River section.
SE 1/4 section 18, T. 9 S., R. 3 W., Home Park Ranch Quadrangle, Madison County, Montana (Dyman, 1985a).

Warm Springs Creek section.
E 1/2 section 15, and NE 1/4 section 22, T. 9 S., R. 3 W., Varney Quadrangle, Madison County, Montana (Dyman, 1985a).