GEOLOGIC MAP OF THE SOUTH HALF OF THE SOUTHEAST MISSOULA AND THE NORTH HALF OF THE DAVIS POINT 7.5' QUADRANGLES, WESTERN MONTANA

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Introduction

The Montana Bureau of Mines and Geology (MBMG) selected the south half of the Southeast Missoula and the north half of the Davis Point 7.5' quadrangles in western Montana (fig. 1) for detailed (1:24,000-scale) mapping because: (1) existing maps of the area, along the western border of the Butte 1^o x 2^o quadrangle (Lewis, 1998a; Wallace, 1987), do not match the adjacent Missoula West 30' x 60' quadrangle (Lewis, 1998b); (2) the area lies within the Lewis and Clark shear zone that has been a focus of recent MBMG study (Lewis, 1998b; Lonn and McFaddan, 1999; Lonn and Smith, 2005, 2006; Lonn and others, 2007); and (3) MBMG expects this work to contribute to completion of the Missoula East 1:100,000-scale quadrangle in a future year.

The Southeast Missoula and Davis Point quadrangles lie along the enigmatic Lewis and Clark Line (Billingsley and Locke, 1941)--a wide, poorly understood, west-northwest-striking zone of faults and folds that transects the more northerly structural grain of western Montana (fig. 2). Recent MBMG mapping (Lewis, 1998b; Lonn and McFaddan, 1999; Lonn and Smith, 2005, 2006; Lonn and others, 2007) examined the Lewis and Clark Line northwest of the Missoula Valley; the present study addresses the structures of similar trend southeast of the valley. Previous maps of the study area (fig. 3; Lewis, 1998a; Wallace, 1987; Jerome, 1968; Nelson and Dobell, 1961; Langton, 1935) show the structure of this part of the Lewis and Clark Line to be dominated by a series of Cretaceous west-northwest- to east-northeast-striking thrust faults. Although Billingsley and Locke's (1941) original definition of the line was based on a geography controlled by Cenozoic strike-slip and normal faults rather than compressional features, most subsequent workers have concluded that compressive structures are an important component of the Lewis and Clark Line.

The west-northwest-oriented compressional features remain mysterious and have been attributed to 1) sinistral transpression (Smith, 1965; Lorenz, 1984; Hyndman and others, 1988; Reid and others, 1993; Sears and Clements, 2000; Lonn and others, 2007), 2) dextral transpression (Wallace and others, 1990), 3) rotation of originally north-trending folds through left-lateral (Burmester and Lewis, 2003) or right-lateral (Hobbs and others, 1965) shear, or 4) northeast-directed compression that did not involve lateral movement (White, 1993; Yin and others, 1993). Subsequent Cenozoic extension and/or right-lateral shear superimposed high-angle normal and/or dextral faults that roughly parallel and obscure the compressional features (Hobbs and others, 1965; Reynolds 1979; Harrison and others, 1974; Bennett and Venkalakrishnan, 1982; Sheriff and others, 1984; Winston, 1986a; Doughty and Sheriff, 1992; Yin and others, 1993; Lonn and McFaddan, 1999; Lonn and others, 2007).

The larger question of "what localized the Lewis and Clark Line?" also remains unanswered. Although Precambrian structure has been proposed to explain the zone's existence (Hobbs and others, 1965; Harrison and others, 1974; Reynolds, 1979; Leach and others, 1988; Winston, 1986a; Sears, 1988), the recognized structures that define the zone are all Cretaceous or younger.

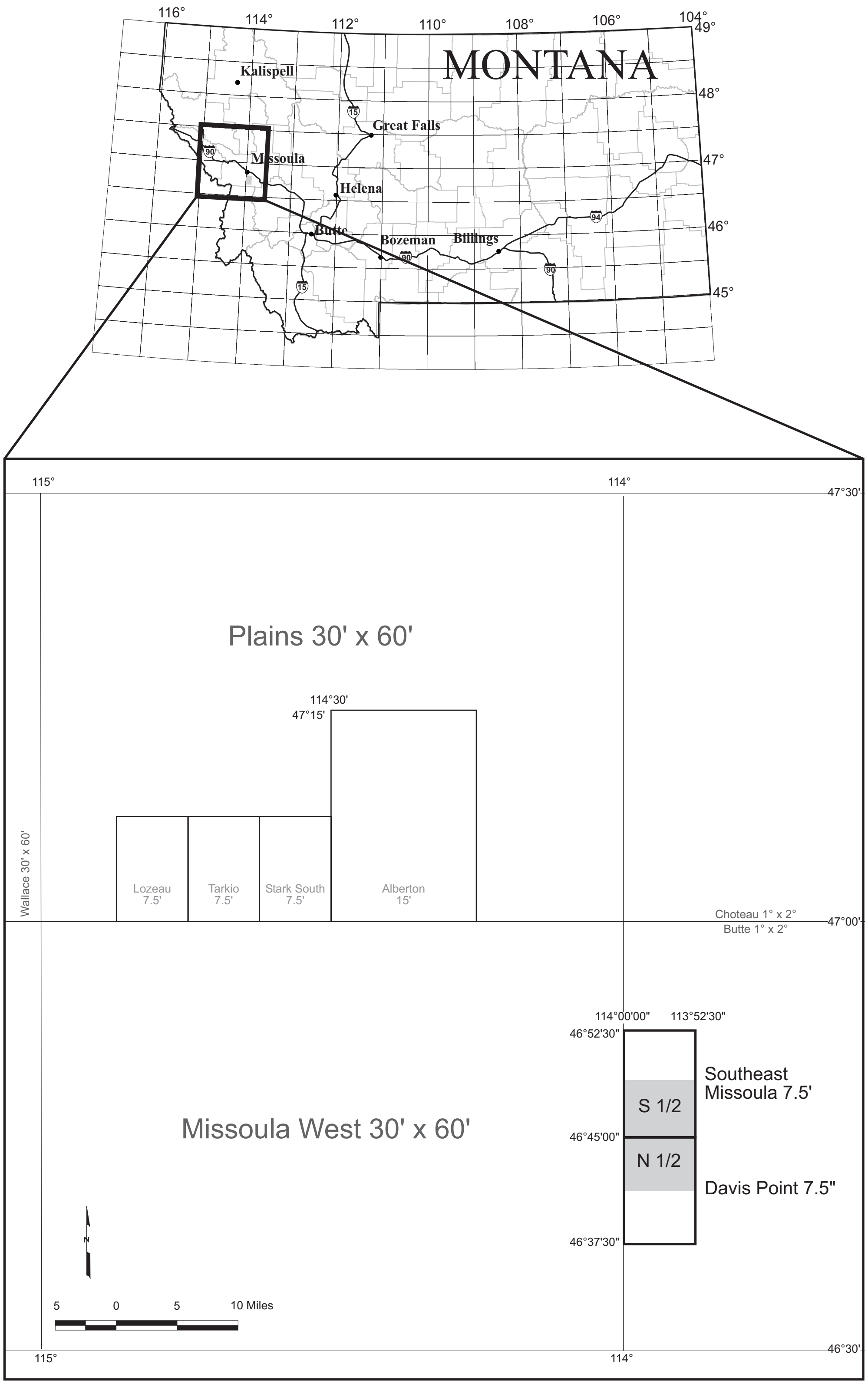


Figure 1. Location of the map area in relation to previous work.

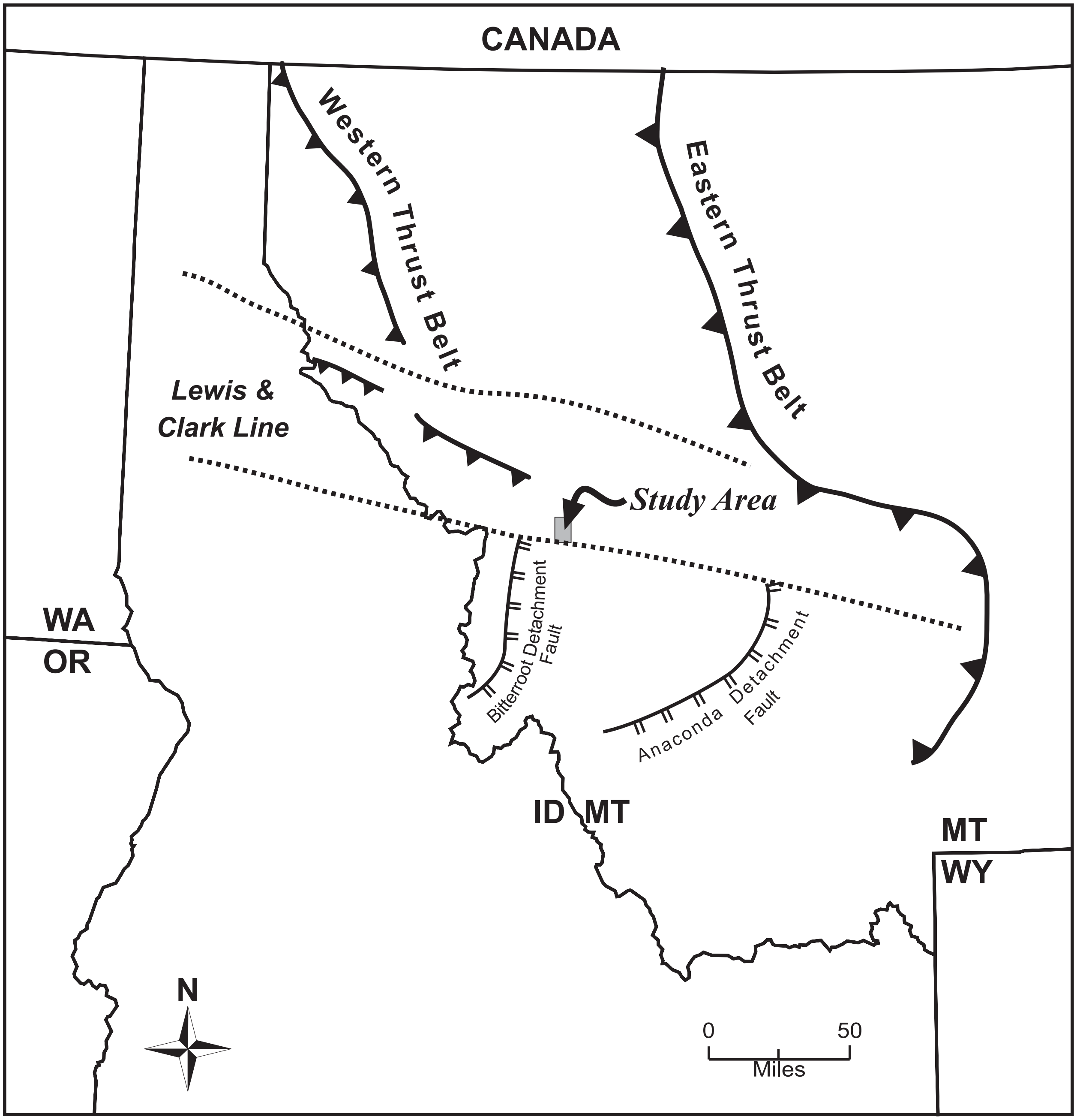
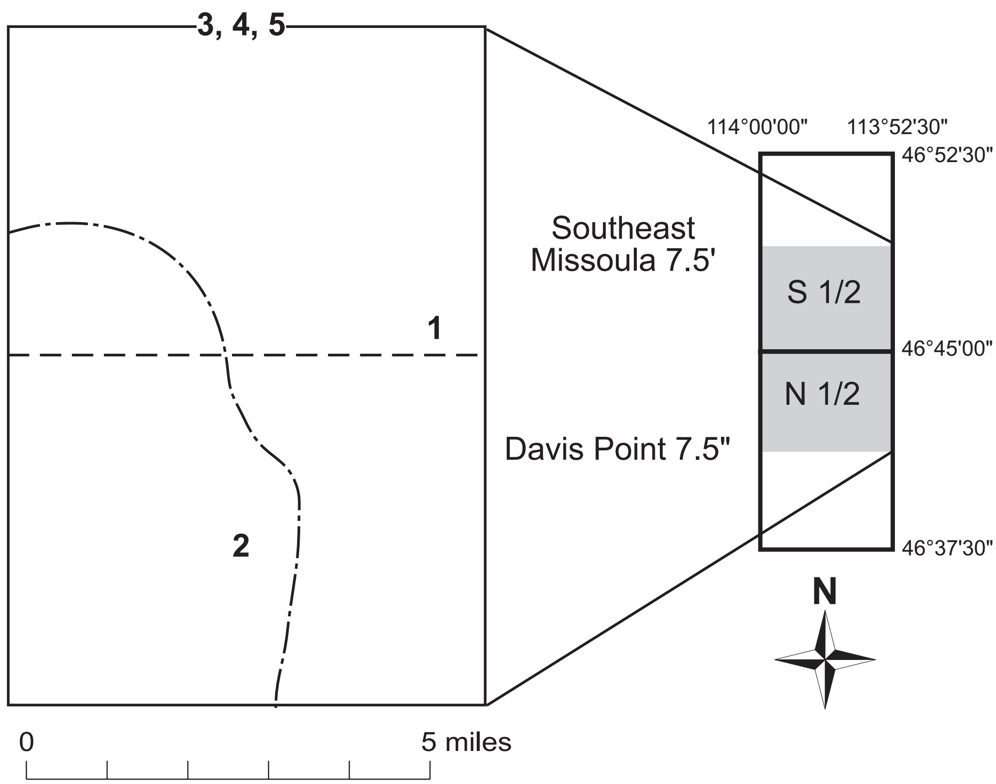


Figure 2. Location of study area with respect to major structural features of western Montana.



1. Nelson and Dobel, 1961
2. Jerome, 1968
3. Langton, 1935 (entire area at 1:400,000 scale)
4. Wallace, 1987 (entire area at 1:250,000 scale)
5. Lewis, 1998 (entire area at 1:250,000 scale)

Figure 3. Index of previous geologic mapping in the study area.

Clearly, the Lewis and Clark Line is a complex and controversial feature, and even its boundaries cannot be agreed upon. As Winston (2000) suggests, much of the confusion may stem from workers combining diverse structures of different origins into one feature. In addition, geologic mapping along much of the Lewis and Clark Line is available only at the 1:250,000 scale; more detailed mapping now is resolving some of the conflict (Lewis, 1998b; Lonn and McFaddan, 1999; Lonn and Smith, 2005, 2006; Lonn and others, 2007).

Stratigraphy

The Correlation Chart and the Description of Map Units provide a detailed description of stratigraphy in the map area. Most of the area is underlain by low-grade metasedimentary rocks of the Middle Proterozoic Belt Supergroup. The study area includes the Belt section from the Wallace Formation through the McNamara Formation that has a total estimated thickness of 15,000 feet. Bouldery, late Tertiary deposits cap the bedrock in the northernmost and southwestern portions of the map area, and thin Quaternary deposits are present in the stream valleys.

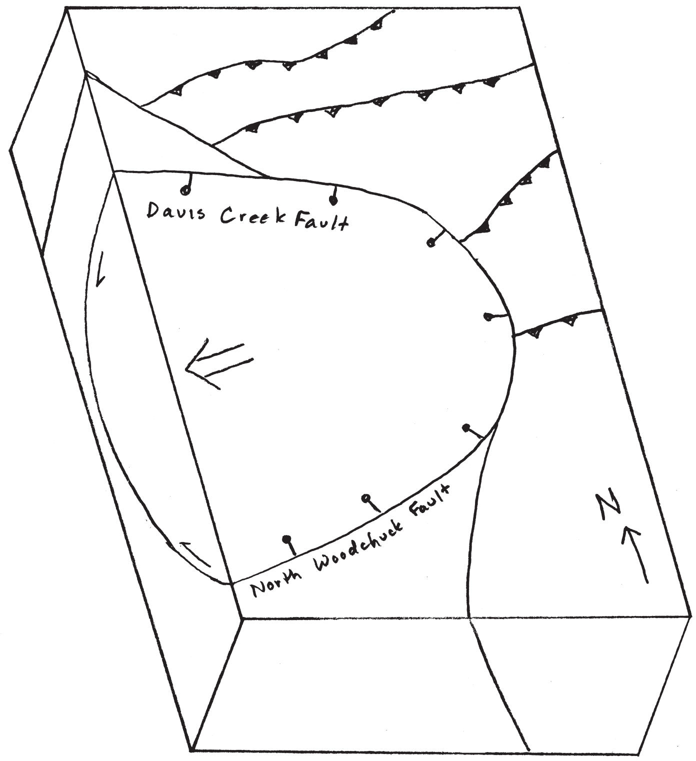
Structure

Structure within the Southeast Missoula and Davis Point quadrangles is characterized by a series of northeast- to east-northeast-striking reverse faults. They are subparallel to bedding and dip southeast at an average angle of 50^{o}, although a range of 45^{o} to 70^{o} can be seen on cross section A-A'. Most of the faults carry Wallace Formation at the base of their hanging wall, suggesting that they merge and sole within the Wallace downdip. Langton (1935), Jerome (1968), and Nelson and Dobell (1961) postulated that these reverse faults postdate an earlier north-south-trending fold set, with offset of the north-south fold axes suggesting sinistral transpression. Although the present study area is too small to see this relationship clearly, Lonn and Smith (2006) and Lonn and others (2007) reached a similar conclusion northwest of Missoula--the westerly striking compressive features of the Lewis and Clark Line cut earlier north-striking folds and reverse faults. Most compressional features on other portions of the Lewis and Clark Line have a west-northwest rather than an east-northeast trend, so possibly this portion of the line has been folded or rotated. The study area lies a few miles northeast of the Bitterroot Detachment (low-angle normal) fault, and within its hanging wall (fig. 2). Counterclockwise rotation of the Bitterroot hanging wall would explain the unusual east-northeast orientation of the reverse faults. However, Doughty and Sheriff (1992) provided evidence for clockwise, not counterclockwise, rotation of the hanging wall.

A major fault displaying normal movement, the Davis Creek fault, is also present in the map area. This fault strikes east and dips south, and a northwest-striking reverse(?) fault that appears to cut the east-northeast reverse fault system splays from it near the western edge of the study area. Eastward, the trace of the Davis Creek fault system curves south, cutting two east-northeast reverse faults. The Davis Creek fault's relationship with the

North Woodchuck fault is unclear. They are either the same fault, suggesting it is a low-angle normal fault with a spoon-shaped geometry (fig. 4a), or the Davis Creek fault continues its southward trace as a strike-slip fault (fig. 4b). The second interpretation is suggestive of a down-to-the-south listric normal fault that curves into a strike-slip fault. In either case, the Davis Creek and associated faults apparently post-date the reverse fault system and likely resulted from later extensional tectonism in Late Cretaceous to Eocene time.

a)



b)

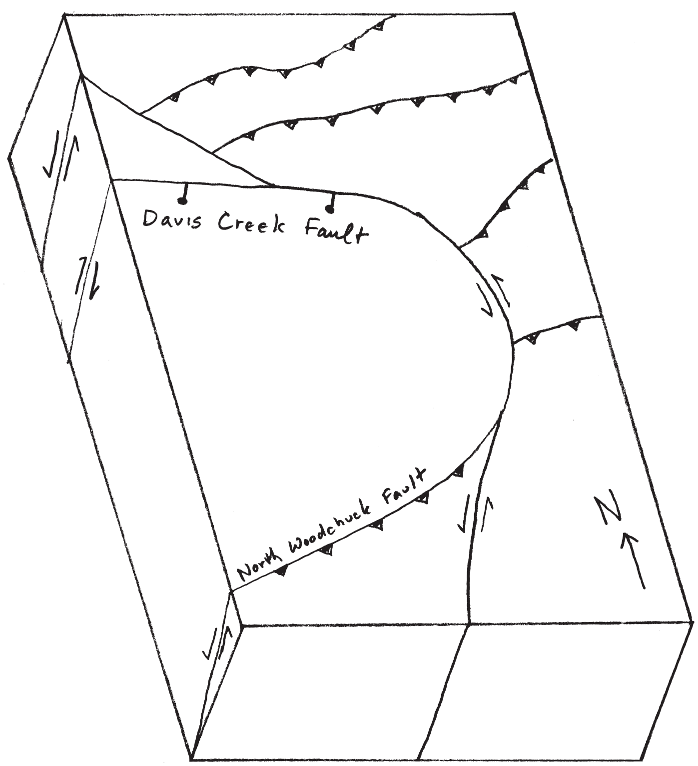
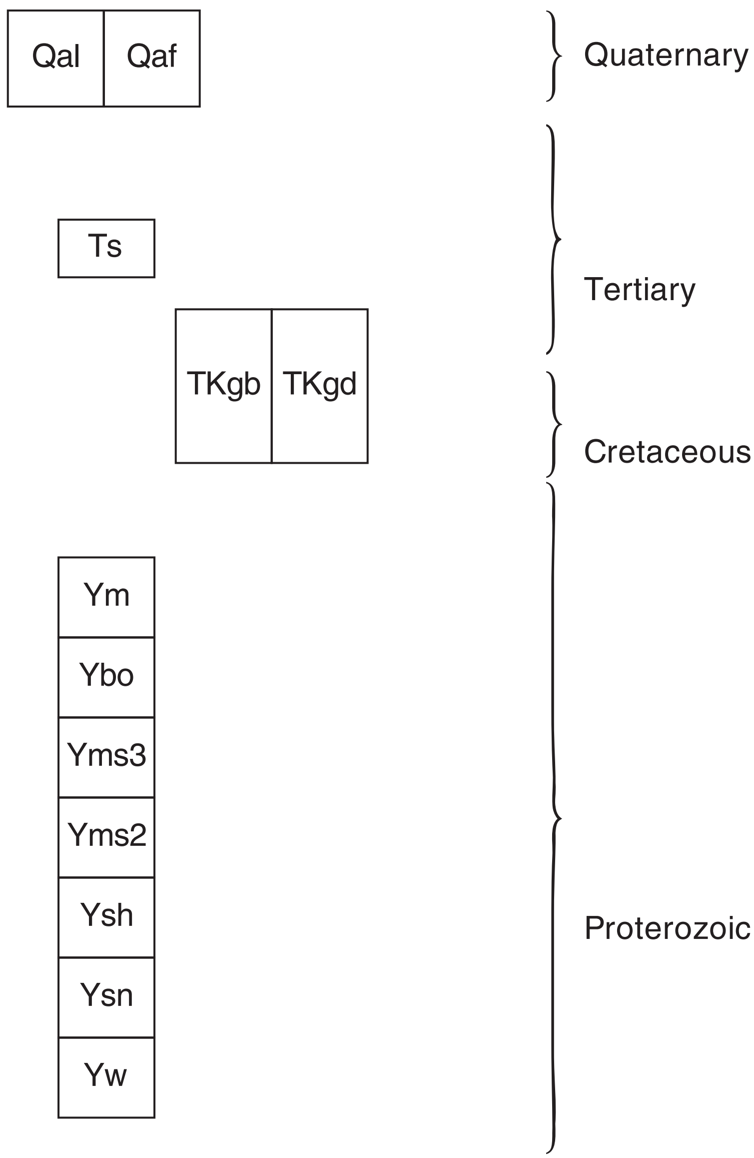


Figure 4. Block diagrams showing two interpretations for the Davis Creek–North Woodchuck fault system. See text for explanation.

AGE CORRELATION OF MAP UNITS



MAP SYMBOLS

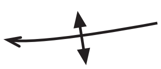
Contact: dashed where approximately located

Reverse or thrust fault: teeth on upthrown block; dotted where concealed. Regionally, it can be demonstrated that long segments of these faults have been reactivated as normal faults by subsequent extension (see figures 2 and 4)

Normal fault: dotted where concealed; bar and ball on downthrown side

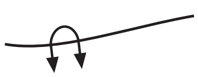
Fault: stratigraphic effect denoted by U & D; dashed where approximately located; dotted where concealed

Fault: unknown sense of movement; dashed where approximately located; dotted where concealed

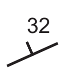


Anticline: showing trace of axial plane and plunge direction where known

Syncline: showing trace of axial plane and plunge direction where known



Overturned anticline: showing trace of axial plane and dip direction of bedding



Strike and dip of bedding

Strike and dip of overturned bedding

Strike and dip of bedding where sedimentary structures were used to confirm stratigraphic tops

Horizontal bedding

Vertical bedding

Strike and dip of cleavage

Area of tectonic breccia

Description of Map Units

Descriptions use the terminology of Winston (1986b) for describing bed thickness and sedimentary structures.

Qal — ALLUVIUM OF MODERN CHANNELS AND FLOODPLAINS (HOLOCENE)
Well- to moderately sorted gravel, sand, and minor silt along active stream channels and on modern floodplains. Unit includes minor colluvium at the bases of hill slopes. Thickness is probably less than 50 feet.

Qaf — ALLUVIAL FAN DEPOSITS (HOLOCENE)
Poorly sorted gravel, sand, and silt in distinctly fan-shaped landforms at the mouths of small drainages.

Ts — SEDIMENTARY ROCKS (TERTIARY)
Unconsolidated, poorly sorted conglomerate containing locally derived subangular to subrounded boulders in a silty matrix. Lonn and Sears (2001) assigned these deposits to the Miocene and Pliocene Sixmile Creek Formation and proposed a debris-flow origin.

TKgd — GRANODIORITE (CRETACEOUS OR TERTIARY)
Dark-weathering, fine-grained, equigranular biotite or hornblende granodiorite containing 32-37% plagioclase, 20-27% quartz, 18-20% biotite and hornblende, and 12-15% potassium feldspar (Jerome, 1968). Occurs mostly along fault zones of Late Cretaceous to early Tertiary age. In outcrop and hand sample, difficult to distinguish from pyroxene gabbro (TKgb).

TYgb — PYROXENE GABBRO (CRETACEOUS OR TERTIARY)
Dark-weathering, fine-grained, pyroxene gabbro with diabasic texture consisting of 40% altered plagioclase, 30% altered pyroxene, 14% myrmekitic and micrographic intergrowths, 5% quartz, 5% chlorite, and 4% ilmenite. In outcrop and hand sample, difficult to distinguish from granodiorite (TKgd).

Ym — MCNAMARA FORMATION (MIDDLE PROTEROZOIC)
Dense, interbedded green and red siltite and argillite in microlaminae and couplets. Mudcracks and chips are common. Contains diagnostic, thin chert beds and chert rip-up clasts. Dominated by mudcracked even couplet and mudcracked lenticular couplet sediment-types. About 2,300 feet thick in the study area, where the top is not exposed. Immediately to the northeast, Nelson and Dobell (1961) estimated the complete section to be 4,000 feet thick.

Ybo — BONNER FORMATION (MIDDLE PROTEROZOIC)
Pink, medium- to coarse-grained feldspathic, cross-bedded quartzite. Contains some granule-sized grains, and locally includes micaceous, maroon-colored argillite interbeds. Mostly comprised of the cross-bedded sand sediment-type.

Thickness 1,600 feet.

Yms3 MOUNT SHIELDS FORMATION, MEMBER 3, INFORMAL (MIDDLE PROTEROZOIC)

Red quartzite to argillite couples and couplets with abundant mudcracks, mudchips, and salt casts. Includes green interbeds, and also some red microlaminae. About 2,500 feet thick.

Yms2 MOUNT SHIELDS FORMATION, MEMBER 2, INFORMAL (MIDDLE PROTEROZOIC)

Pink to gray, flat-laminated to cross-bedded, fine- to medium-grained quartzite. Contains some tan-weathering dolomitic blebs. Cross-bedded intervals are difficult to distinguish from the Bonner Formation. About 2,000 feet thick.

Ysh SHEPARD FORMATION (MIDDLE PROTEROZOIC)

Dolomitic and non-dolomitic, dark-green siltite and light-green argillite in microlaminae and couplets, and lenticular couplets of white quartzite and green siltite. Poorly exposed, but weathers into thin plates. Dolomitic beds have a characteristic orange-brown weathering rind. Ripples and load casts are common, and mudcracks are rare. Thickness approximately 800 feet.

Ysn SNOWSLIP FORMATION (MIDDLE PROTEROZOIC)

Interbedded intervals of quartzite to red argillite couples and couplets, and dark-green siltite to light-green argillite couplets. Dessication cracks and mud rip-up clasts are common throughout. Some intervals of quartzite to red argillite couplets are interbedded. Thickness about 2,600 feet.

Yw WALLACE FORMATION (MIDDLE PROTEROZOIC)

The upper 3,300 feet are exposed in the map area. The Wallace Formation is characterized by the dinstinctive “black and tan” lithology comprised of tan-weathering, dolomitic, hummocky cross-stratified quartzite and siltite capped by black argillite in pinch-and-swell couples and couplets. The quartzite/siltite beds commonly have scoured bases or bases with load casts. Molar tooth structure and non-polygonal crinkle cracks are common throughout the section.

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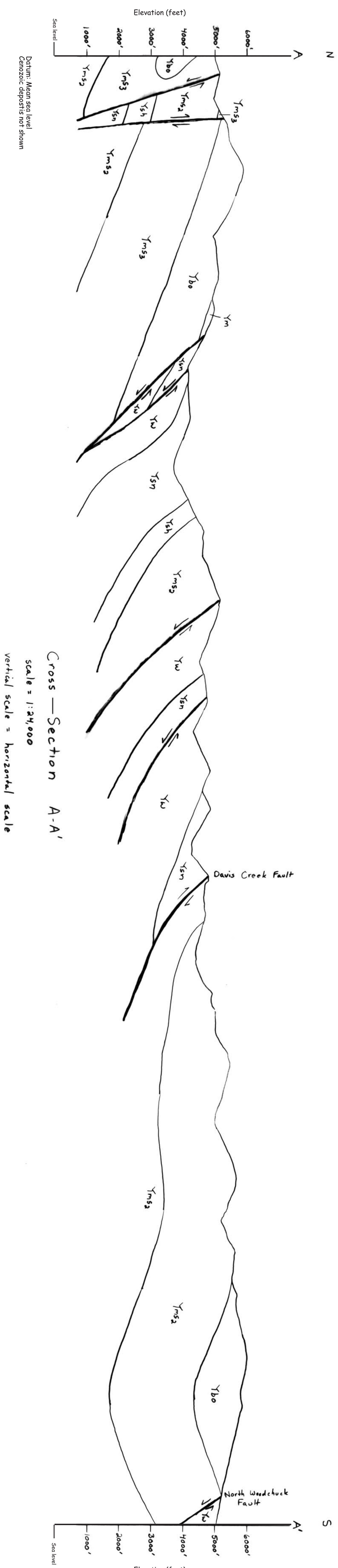
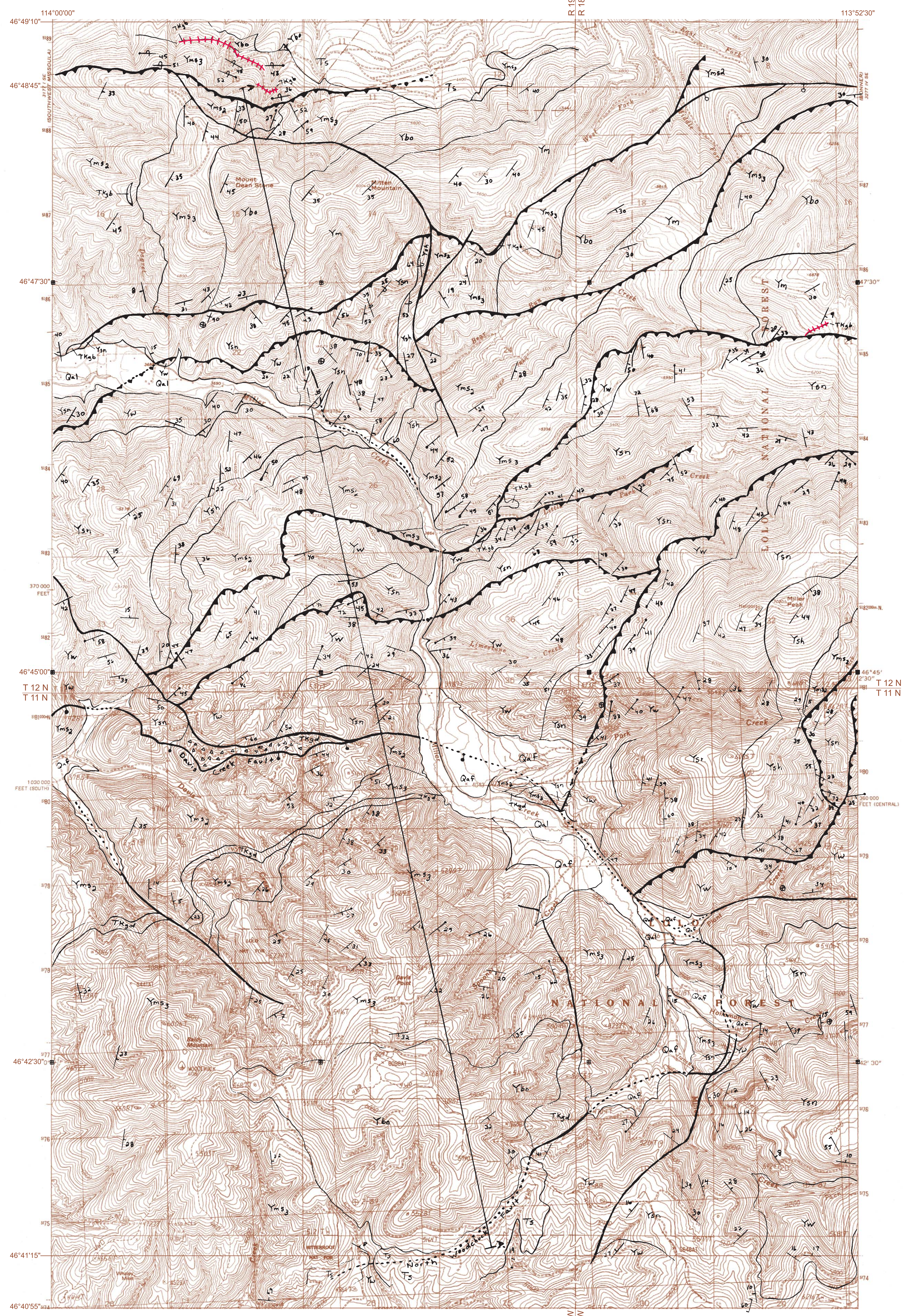
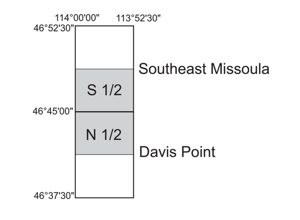
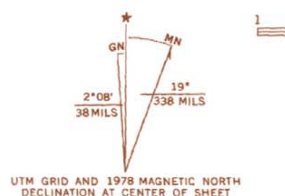


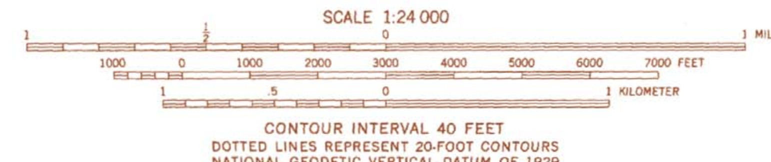


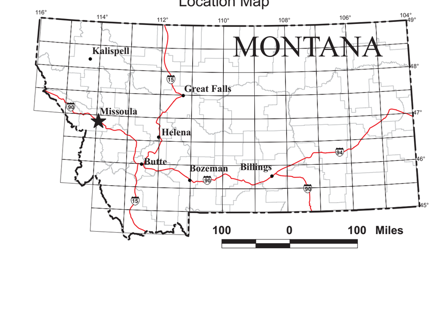
Base maps from U.S. Geological Survey

Parts of:
Southeast Missoula 7.5' topographic quadrangle
Map date: 1964; Photorevised 1978
Projection: Polyconic
UTM zone 12; 1927 NAD
and
Davis Point 7.5' topographic quadrangle
Map date: 1989
Projection: Lambert Conformal Conic
UTM zone 12; 1927 NAD









For a more detailed description of the map units and symbols, please refer to the text accompanying this map.

MBMG Open File 555

Geologic Map of S1/2 Southeast Missoula and N 1/2 Davis Point 7.5' Quadrangles Western Montana

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2007

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