GEOLOGIC MAP OF THE DAVIS POINT AND ELK MOUNTAIN 7.5′ QUADRANGLES, WESTERN MONTANA

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2008

Montana Bureau of Mines and Geology
Open-File Report 568

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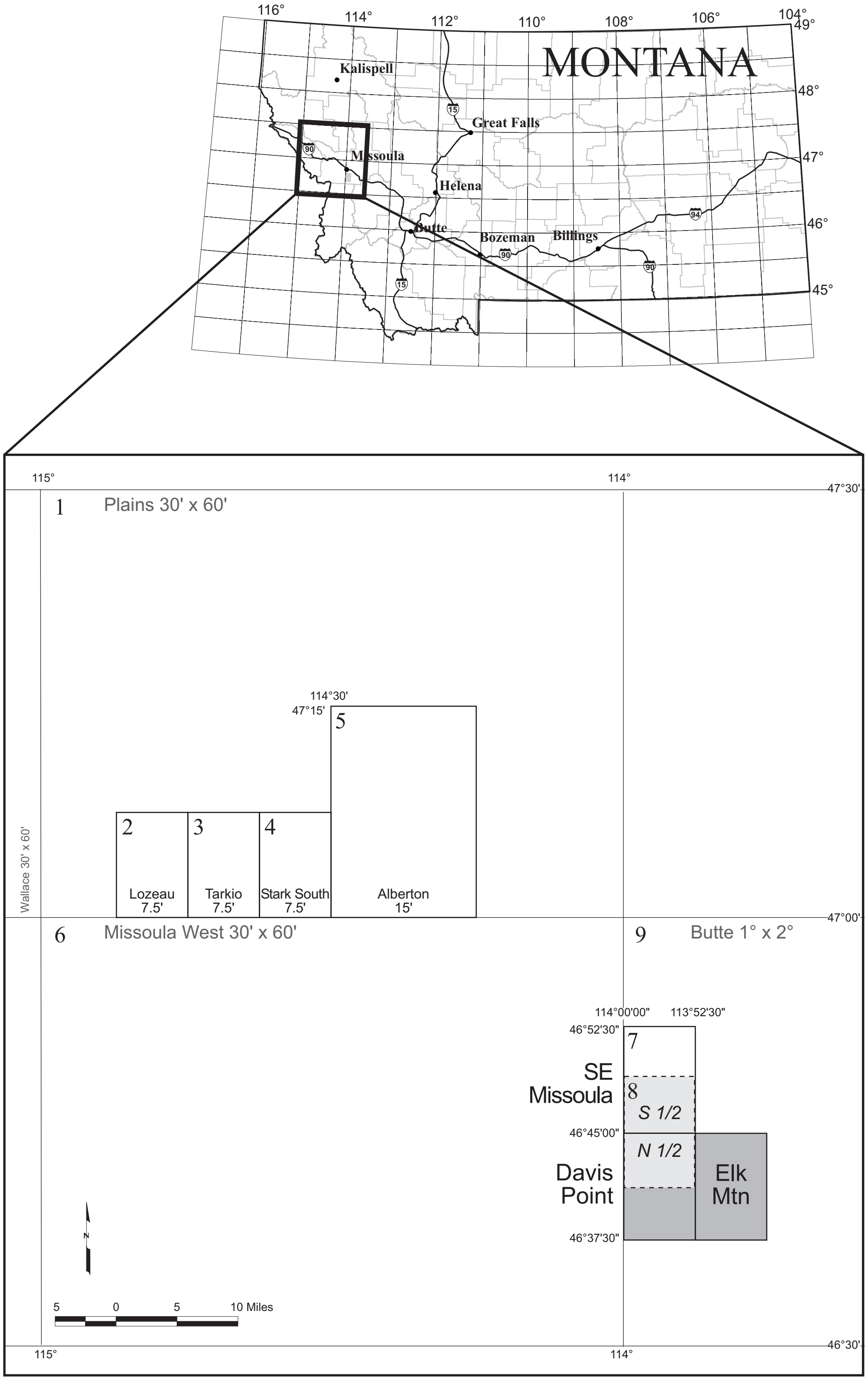
Introduction

The Montana Bureau of Mines and Geology (MBMG), in conjunction with STATEMAP Advisory Committee, selected the Elk Mountain and the south half of the Davis Point 7.5′ quadrangles in western Montana (fig. 1) for detailed (1:24,000-scale) mapping because: (1) it extends recent large-scale mapping eastward from the adjacent south half Southeast Missoula and north half Davis Point 7.5′ quadrangles (Lonn, 2007); (2) the area lies within the Lewis and Clark shear zone, a focus of recent MBMG studies (Lewis, 1998b; Lonn and McFaddan, 1999; Lonn and Smith, 2005, 2006; Lonn, 2007; Lonn and others 2007); and (3) MBMG's strategy is to map some structurally complex 7.5' quadrangles that will lead to completion of the Missoula East 1:100,000-scale quadrangle in 2010. During the course of fieldwork, some modifications were made to the previously mapped north half of the Davis Point quadrangle (Lonn, 2007) and so geologic maps of the entire Davis Point and Elk Mountain quadrangles are included in this report.

The Davis Point and Elk Mountain quadrangles lie along the 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). 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 Cretaceous compressive structures are an important component of the Lewis and Clark Line. The west-northwest-oriented compressional features 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; Yin and Oertel, 1995). Subsequent Cenozoic extension and/or right-lateral shear (Hobbs and others, 1965; Reynolds 1979; Harrison and others, 1974; Bennett and Venkatakrishnan, 1982; Sheriff and others, 1984; Winston, 1986a; Doughty and Sheriff, 1992; Yin and others, 1993; Yin and Oertel, 1995; Lonn and McFaddan, 1999; Lonn and others, 2007) superimposed high angle normal and/or dextral faults that roughly parallel and obscure the compressional features. This series of tectonic events has created an extremely complex structural geometry along the Lewis and Clark Line.

The Lewis and Clark Line forms the southern boundary of the Late Cretaceous Libby thrust belt, the northern boundary of the Late Cretaceous Sapphire allochthon and Georgetown thrust, and the northern borders of the Eocene Bitterroot and Anaconda metamorphic core complexes (fig. 2). Although the Lewis and Clark Line appears to postdate the compressional features of the Libby thrust belt and Purcell anticlinorium (Lonn and others, 2007), its relationships to the Sapphire allochthon and the core complexes are still unknown.



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1. Lonn & others, 2007
2. Lonn & Smith, 2005
3. Lonn & Smith, 2005
4. Lonn & Smith, 2006
5 Wells, 1974
6. Lewis, 1999
7. Lonn, 2007
8. Lonn, 2007
9. Lewis, 1998a; Wallace, 1987

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

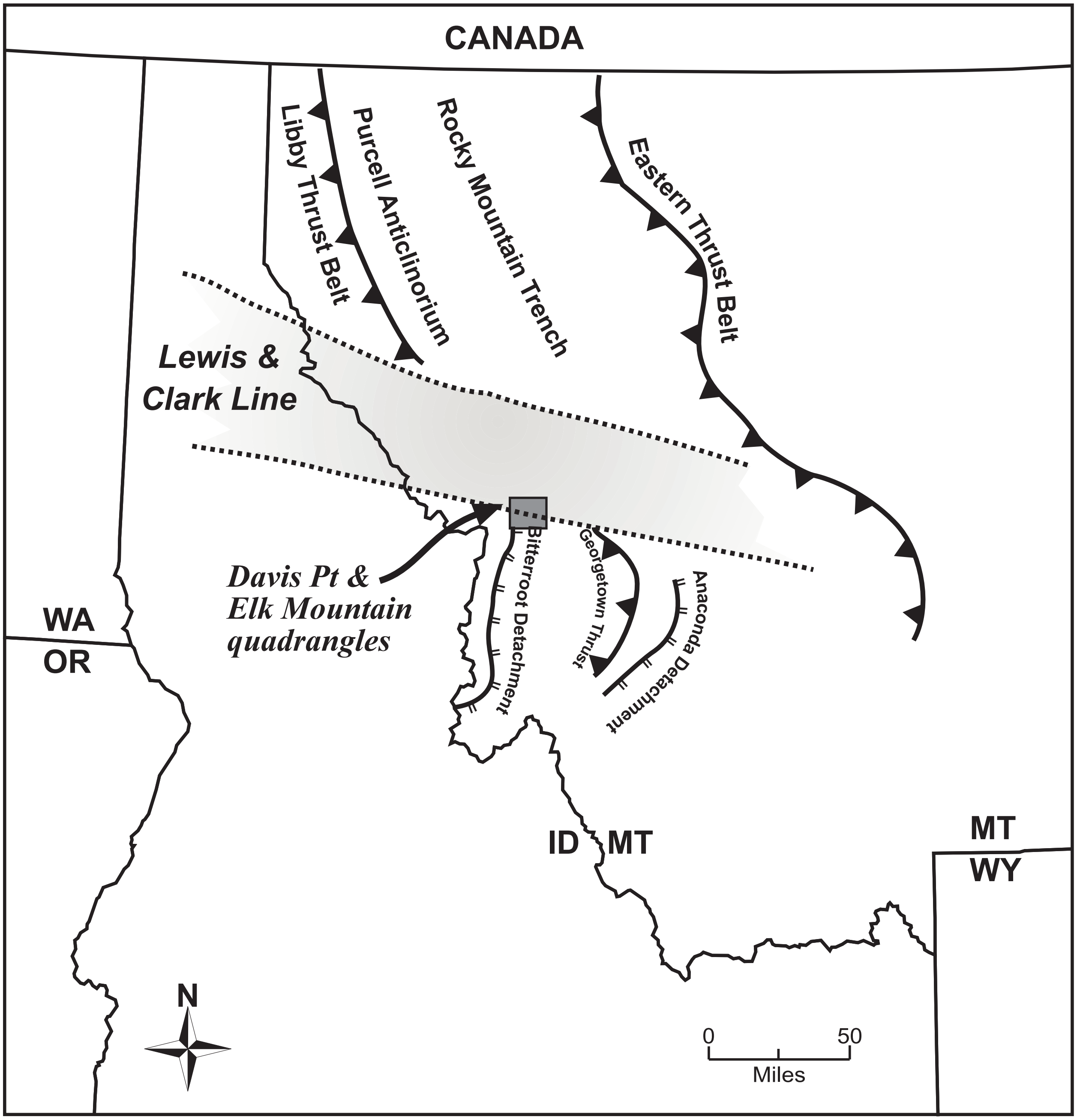


Figure 2. Location of Davis Point and Elk Mountain 7.5' quadrangles with respect to major structural features of western Montana.

Stratigraphy

The correlation chart (p. 6) and the Description of Map Units (p.7) 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 map area includes the Belt section from the middle Wallace Formation through the McNamara Formation with a total estimated thickness of 15,000 feet. Unconsolidated Tertiary deposits cap the bedrock in the western part of the map area, and thin Quaternary deposits are present in the stream valleys.

Structure

Three generations of faults and at least two fold generations dominate the structural geology of the Davis Point and Elk Mountain quadrangles. The oldest faults are the east- to northeast-striking reverse faults represented by the North Woodchuck fault that crosses both maps. This fault and the splays in its footwall form the southern, trailing edge of a major east-trending imbricate thrust system that is well-developed north of the map area (Nelson and Dobell, 1960; Lonn, 2007). These Cretaceous reverse and thrust faults strike east to northeast, dip south at moderate angles, and place older strata over younger strata. Lonn (2007) proposed that they flatten and sole in the Wallace Formation. Some folding occurred prior to the formation of this fault system.

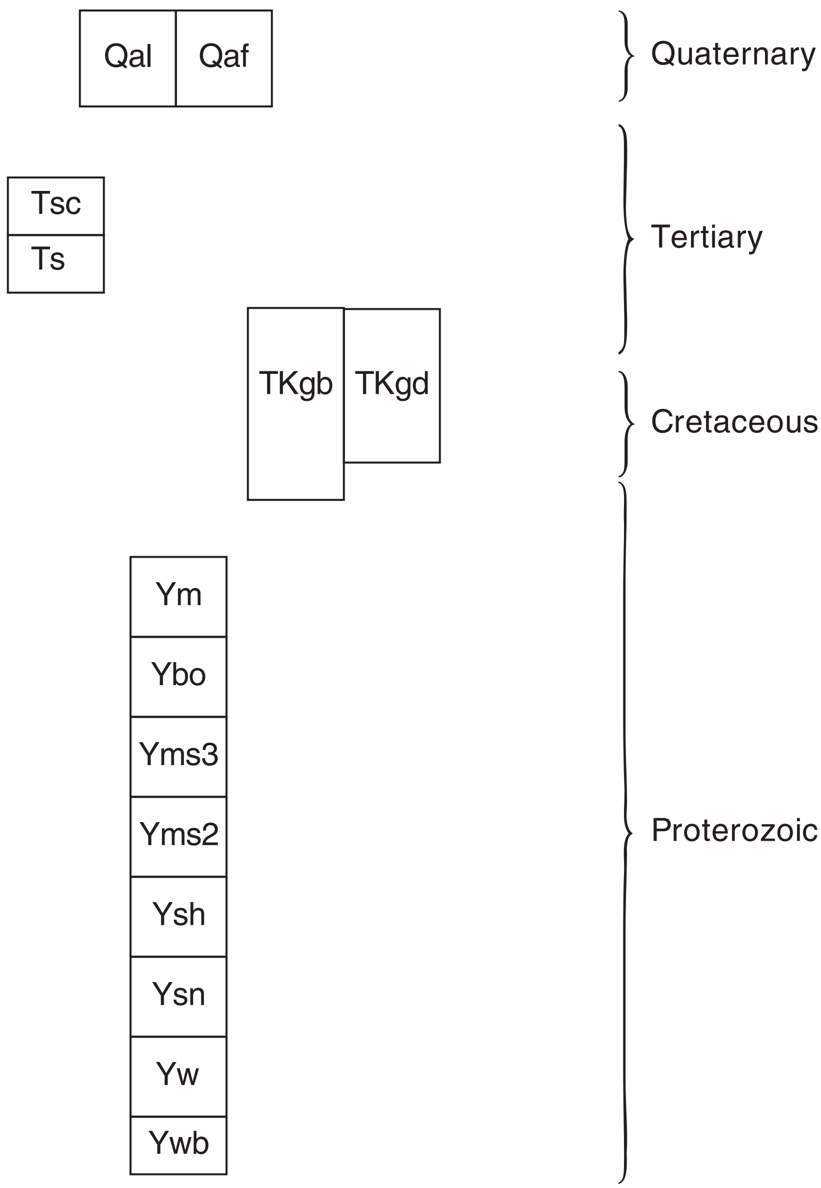
A few miles south of and parallel to the North Woodchuck fault is the south-dipping Eightmile Creek fault with younger strata in its hanging wall. The two sub-parallel faults bound a sliver of older Wallace and Snowslip Formations between two blocks of younger Missoula Group strata. This structural geometry is common in western Montana (Lewis, 1998c; Lonn and others, 2007), and is thought to form either: 1) by extensional reactivation of a pre-existing thrust (Lewis, 1998c; Lonn and others, 2007), or 2) contemporaneously with the thrust through extrusion or extraction of a wedge of older rocks between two coeval faults with opposing senses of motion (Lonn and others, 2007). A third alternative proposed by Lidke and others (1988) is that the Eightmile Creek fault is an out-of-sequence, younger-over-older thrust.

Langton (1935), Jerome (1968), and Nelson and Dobell (1961) postulated that the 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 others (2007) reached a similar conclusion northwest of Missoula; the approximately 80 Ma westerly striking compressive features of the Lewis and Clark Line cut earlier north-striking folds and reverse faults. Some folding also occurred coevally with the faults as demonstrated by east-trending fold axes. Both the North Woodchuck fault system and the Eightmile Creek fault are intruded by Tertiary or Cretaceous gabbroic to granodioritic igneous rocks.

The Davis Creek fault, a west- to northwest-striking, down-to-the-south/southwest normal fault, offsets both the North Woodchuck and Eightmile Creek faults and represents the second fault generation. It also crosses the entire map area and appears to become the Ranch Creek fault of Lidke and others (1988) to the southeast. The Davis Creek fault is also intruded by Tertiary or Cretaceous gabbro and granodiorite.

The youngest faults are the high-angle, north- to northeast-striking faults that displace the east-trending structures. The sense of motion on these faults is unknown. They appear to postdate and offset the igneous intrusions.

AGE CORRELATION OF MAP UNITS



Description of Map Units

Descriptions use the sediment type 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.
Tsc	SIXMILE CREEK FORMATION (PLIOCENE AND MIOCENE) 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.
Ts	SEDIMENTARY ROCKS, UNDIVIDED (MIOCENE?) Mostly sand and silt. Brown, weakly indurated, poorly sorted, poorly stratified, biotite-rich, subangular sand and silt containing abundant volcanic ash. Occurs beneath the Sixmile Creek Formation, and is probably Miocene in age (Lonn and Sears, 2001).
TKgd	GRANODIORITE AND GABBRO, UNDIVIDED (TERTIARY OR CRETACEOUS) 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, 1961). Contains some gabbroic phases that were not mapped separately. The gabbro consists of 40% altered plagioclase, 30% altered pyroxene, 14% myrmekitic and micrographic intergrowths, 5% quartz, 5% chlorite, and 4% ilmenite (Jerome, 1961). The two rock types are difficult to distinguish in the field, and commonly occur together in the same intrusive body. Occurs mostly along fault zones of Late Cretaceous to early Tertiary age.
TKgb	PYROXENE GABBRO (TERTIARY OR CRETACEOUS) 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-size grains, and locally includes micaceous, maroon argillite interbeds. Mostly composed 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 diagnostic, well-formed, cubic 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. Thickness appears to vary from 2,000 to 3,300 feet.

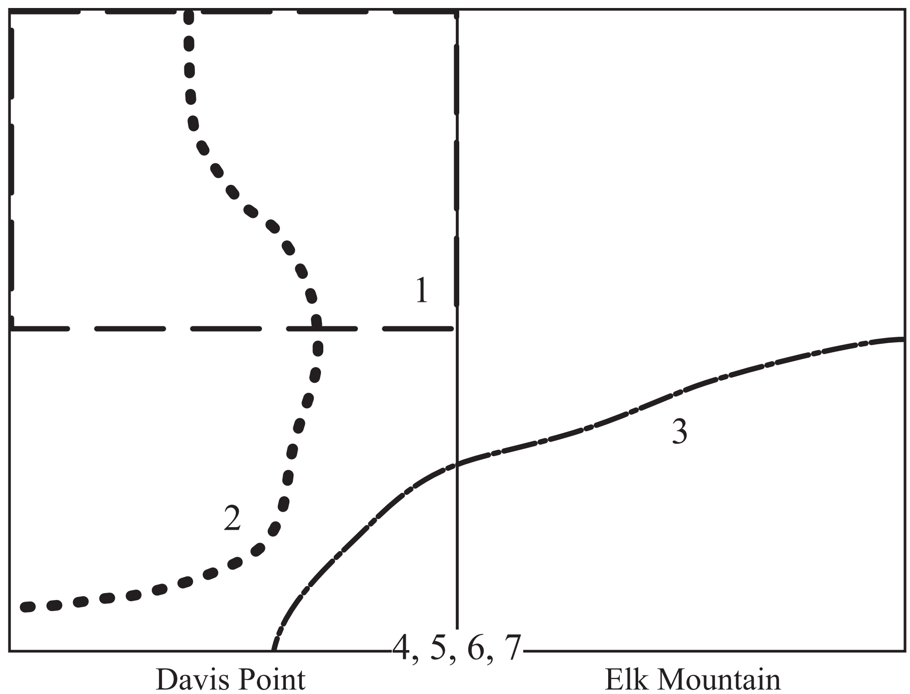
Ysh — SHEPARD FORMATION (MIDDLE PROTEROZOIC)
Dolomitic and non-dolomitic, dark green siltite and light green argillite in microlaminae and couplets, and lenticular couplets of white quartzite and green siltite. Poorly exposed, but weathers into thin plates. Dolomitic beds have a characteristic orange-brown weathering rind. Ripples and load casts are common, and mudcracks are rare. Thickness approximately 600 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. Desiccation 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. Wallace Formation is characterized by the distinctive “black and tan” lithology of pinch-and-swell couples and couplets composed of tan weathering, dolomitic, hummocky cross-stratified quartzite and siltite capped by black argillite. 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.

Ywb WALLACE FORMATION, BRECCIA UNIT (MIDDLE PROTEROZOIC)

Angular clasts of white, fine-grained quartzite and bedded "black and tan" lithology in an orange-weathering, dolomitic and calcitic matrix. Clasts range from less than 1 inch to several feet in diameter. Possibly formed by slumping of partially lithified sediments, although in the study area this unit is found only along the Eightmile Creek fault so a tectonic origin cannot be ruled out. Thickness unknown.



1. Lonn, 2007
2. Jerome, 1968
3. Lidke & others, 1988
4. Langton, 1935 (entire area at 1:400,000 scale)
5. Wallace & Klepper, 1976 (entire area at 1:48,000 scale)
6. Wallace, 1987 (entire area at 1:250,000 scale)
7. Lewis, 1998a (entire area at 1:250,000 scale)

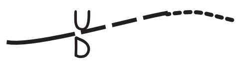
Figure 3. Index of previous geologic mapping in the Davis Point and Elk Mountain 7.5' quadrangles.

MAP SYMBOLS


Contact: dashed where approximately located


Reverse or thrust fault: teeth on upthrown block; dotted where concealed.

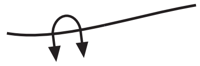

Normal fault: dotted where concealed; bar and ball on downthrown side



Fault: sense of relative displacement denoted by U & D; dashed where approximately located; dotted where concealed

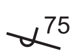

Fault: unknown sense of movement; dashed where approximately located; dotted where concealed


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

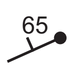

Overturned anticline: showing trace of axial plane and dip direction of bedding


Overturned syncline: 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

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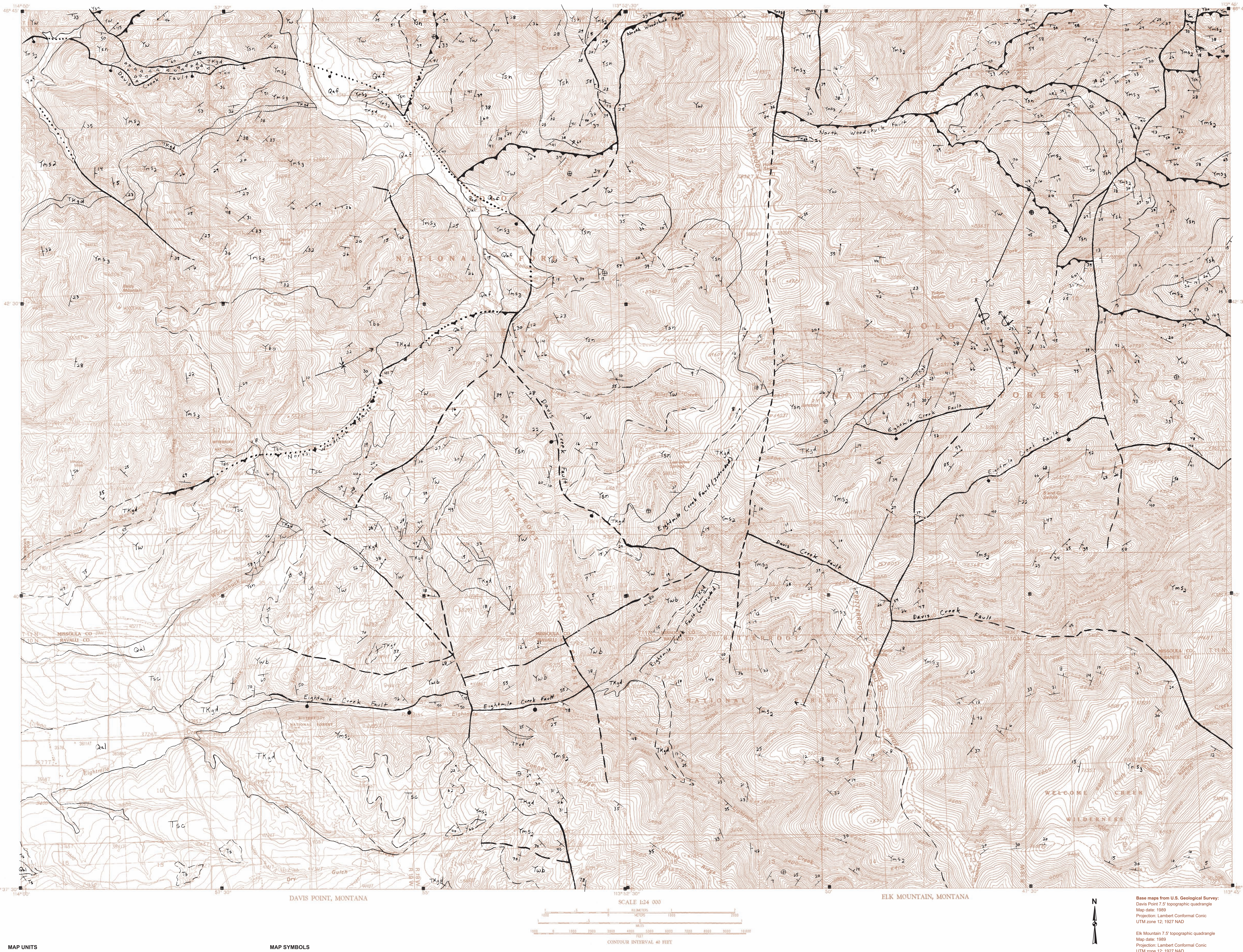


Base maps from U.S. Geological Survey:
Davis Point 7.5' topographic quadrangle
Map date: 1989
Projection: Lambert Conformal Conic
UTM zone 12; 1927 NAD

Elk Mountain 7.5' topographic quadrangle
Map date: 1989
Projection: Lambert Conformal Conic
UTM zone 12; 1927 NAD

MAP UNITS

Qal	Alluvium of modern channels and floodplains (Holocene)
Qaf	Alluvial fan deposit (Holocene)
Tsc	Sixmile Creek Formation (Pliocene and Miocene)
Ts	Sedimentary rocks, undivided (Miocene?)
TKgd	Granodiorite and gabbro, undivided (Tertiary or Cretaceous)
TKgb	Pyroxene gabbro (Tertiary or Cretaceous)
Ym	McNamara Formation (Middle Proterozoic)
Ybo	Bonner Formation (Middle Proterozoic)
Yms3	Mount Shields Formation, member 3, informal (Middle Proterozoic)
Yms2	Mount Shields Formation, member 2, informal (Middle Proterozoic)
Ysh	Shepard Formation (Middle Proterozoic)
Ysn	Snowslip Formation (Middle Proterozoic)
Yw	Wallace Formation (Middle Proterozoic)
Ywb	Wallace Formation, brecccia unit (Middle Proterozoic)

For a more detailed description of the map units, symbols and additional information please refer to the text that accompanies this map.

MAP SYMBOLS

Contact: dashed where approximately located

Reverse or thrust fault: teeth on upthrown block; dotted where concealed.

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

Fault: sense of relative displacement denoted by U & D; dashed where approximately located; dotted where concealed

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

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

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

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

32 Strike and dip of bedding

75 Strike and dip of overturned bedding

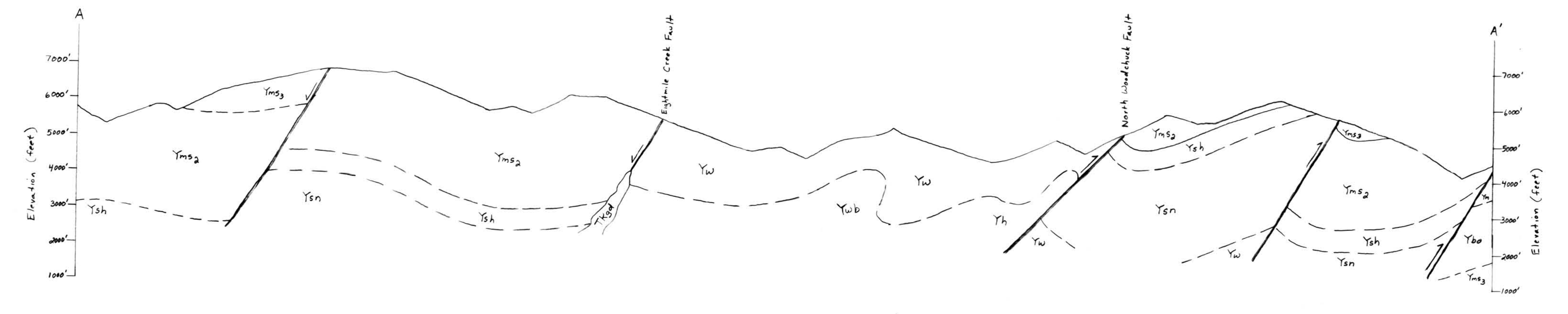
60 Strike and dip of bedding where sedimentary structures were used to confirm stratigraphic tops

Horizontal bedding

Vertical bedding

70 Strike and dip of cleavage

Area of tectonic breccia



Cross Section A-A'
scale = 1:24,000
vertical scale = horizontal scale

MBMG Open File 568

Geologic Map of the Davis Point and Elk Mountain 7.5' Quadrangles Western Montana

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2008

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Map layout: Susan Smith, MBMG.

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