

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MEASURED STRATIGRAPHIC SECTIONS OF ELKO FORMATION
(MIDDLE AND UPPER CAMBRIAN), AND FAIRHOLME GROUP, ALEXO
FORMATION, AND PALLISER FORMATION (UPPER DEVONIAN),
NORTHWESTERN MONTANA AND SOUTHEASTERN BRITISH COLUMBIA

By

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature. Any use of trade names is for descriptive purposes only and does not imply endorsement by the U.S. Geological Survey.

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INTRODUCTION

Remote, thrust-faulted blocks of undifferentiated Cambrian and Devonian carbonate rocks are exposed in the northern Whitefish Range, Lincoln and Flathead counties of northwestern Montana, and the contiguous MacDonald Range in southeastern British Columbia (Fig. 1). Although these rocks have been mapped and generally described (Deiss, 1939; Barnes, 1963; Smith, 1963; Price, 1961; Hilty, 1989) few published, detailed sedimentologic investigations have been conducted. The purpose of this study is to describe, date and subdivide these remote exposures to help fill a large void on paleogeographic maps of this region.

In British Columbia, equivalent rocks include the Cambrian Elko Formation, the Devonian Fairholme Group, Alexo Formation, and Palliser Formation (Fig. 2) (Fritz and Norris, 1966). In northwestern Montana equivalent rocks include the Cambrian Damnation Limestone and an undifferentiated Devonian interval. In central Montana equivalent rocks include the lower portion of the Cambrian Hasmark Formation, the Devonian Jefferson Formation and Three Forks Formation (Balster, 1980). In southwest Montana rocks of this study are equivalent to the Cambrian Meagher Formation and the lower portion of the Cambrian Hasmark Formation, as well as the Devonian Jefferson Formation and the Three Forks Formation (Balster, 1980).

Preliminary conodont age dates of the Devonian lithologies give ages of Frasnian and Famennian, Lower gigas Zone to Upper rhomboidea Zone (Ziegler, 1962; Ziegler and Sandberg, 1984), with both pelagic and nearshore species represented. Conodonts were not found in the Cambrian rocks of this study.

Six stratigraphic sections were measured for this study (Figs. 3 through 7). Three of the sections contain both Cambrian and Devonian rocks: the Inverted Ridge and Mount Hefty sections in British Columbia, and the Tuchuck I section in Montana. The remaining three sections contain only Devonian rocks: Wedge Canyon, Eureka, and the Tuchuck II sections, all in Montana.

Stratigraphic sections were measured using a Jacob's staff, Brunton compass, and steel tape. Information gathered in the field included lithologic descriptions, bedding thicknesses, megafossil type, primary sedimentary structures, topographic expression, and bed attitude. Four hundred thirteen (413) oriented samples were collected at 3m (9.8 ft.), 6 m (19.7 ft.), 10 m (32.8 ft.), or 12 m (39 ft.) intervals, and at major lithologic changes. Two hundred ninety, 500 g (1.1 lbs.) to 2 kg (4.4 lbs.) samples were collected at 3 m (9.8 ft.) or 6 m (19.7 ft.) intervals and processed for conodonts. Lithologic samples were studied utilizing acetate peels, polished slabs, and petrographic thin sections.

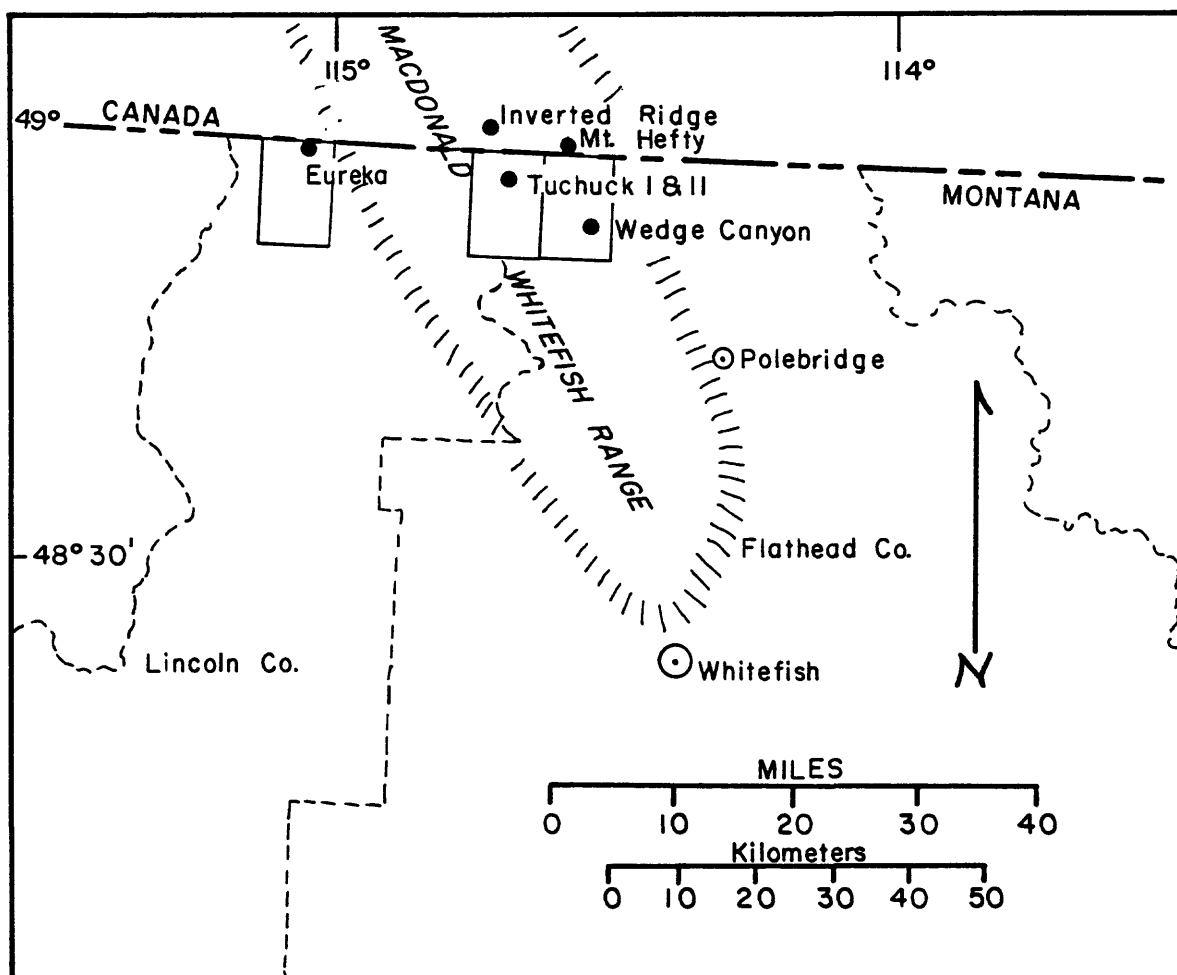


Figure 1. Location map of study area. Section locations are shown as darkened circles. For Canadian sections, refer to map 82 G/2, entitled "Inverted Ridge", Kootenay Land District, British Columbia. For measured sections in Montana, refer to the 7 1/2 Minute Series U.S. Geological Survey topographic maps (shown as rectangles on figure 1); for the Eureka measured section see the Eureka North, Montana quadrangle; for the Tuchuck I and Tuchuck II measured sections see the Tuchuck Mountain, Montana quadrangle; and for the Wedge Canyon measured section see the Mount Hefty, Montana quadrangle. Exact locations of all measured sections are given in the text.

Erathean	System	Series	Stage	BRITISH COLUMBIA (1)	WHITEFISH-MACDONALD RANGE	NORTHWEST MONTANA (2)	CENTRAL MONTANA (3)	SOUTHWEST MONTANA (4)
PALEOZOIC	Miss.			Banff Formation	Banff Formation		Madison Group	Madison Group
				Exshaw Formation	Exshaw Formation			
	DEVONIAN	Upper	Famennian	Palliser Fm	Palliser Formation		Three Forks Fm	Three Forks Fm
				Alexo Formation	Alexo Formation	Devonian Undifferentiated	Jefferson Fm	Jefferson Fm
			Frasnian	Fairholme Grp.	Fairholme Group			
		Middle					Maywood Fm	Maywood Fm
	Lower							
	Ord.Sil.							
	CAMBRIAN	Upper					Red Lion Fm	Red Lion Fm
		Middle		Windsor Mountain Fm		Devils Glen Dolomite		Pilgrim Fm
				Elko Formation		Switchback Shale		Hosmark Fm
PRECAMB	Lower			Gordon Shale	Elko Formation	Pagoda Limestone		Park Fm
				Flathead Sandstone	Gordon Shale	Dearborn Limestone		Meagher Fm
					Flathead Sandstone	Damnation Limestone	Silver Hill Formation	Silver Hill Fm
						Flathead Sandstone	Flathead Sandstone	Flathead Sandstone
				Windermere Group				
				Belt Supergroup	Belt Supergroup	Belt Supergroup	Belt Supergroup	Belt Supergroup
				(1) Fritz and Norris (1966)		(2) Balster (1980)	(3) Balster (1980)	(4) Balster (1980)

Figure 2. Regional stratigraphic terminology for late Precambrian and early to middle Paleozoic rocks in Montana and adjacent British Columbia showing approximate lithologic equivalents to the rocks examined in this study.

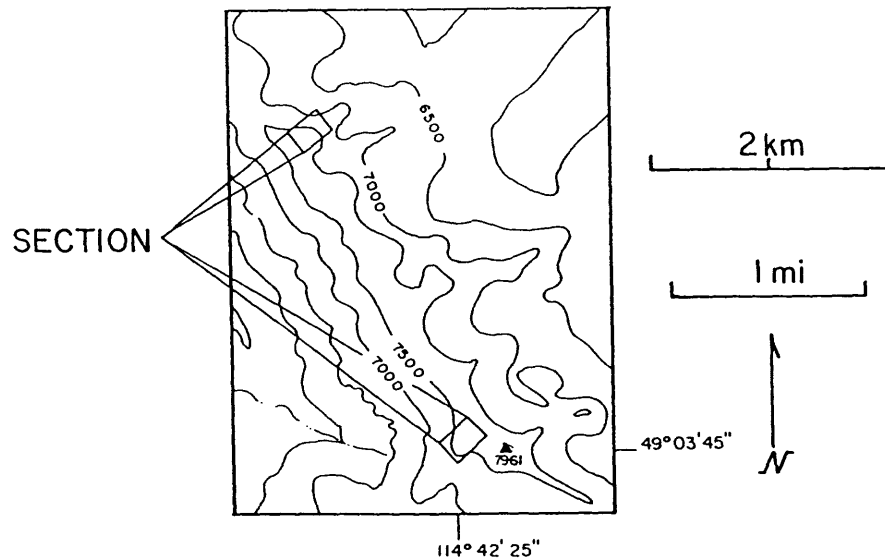


Figure 3. Location map for the Inverted Ridge section, southeastern British Columbia. Section is located by reference to map 82 G/2, entitled "Inverted Ridge", Kootenay Land District, British Columbia.

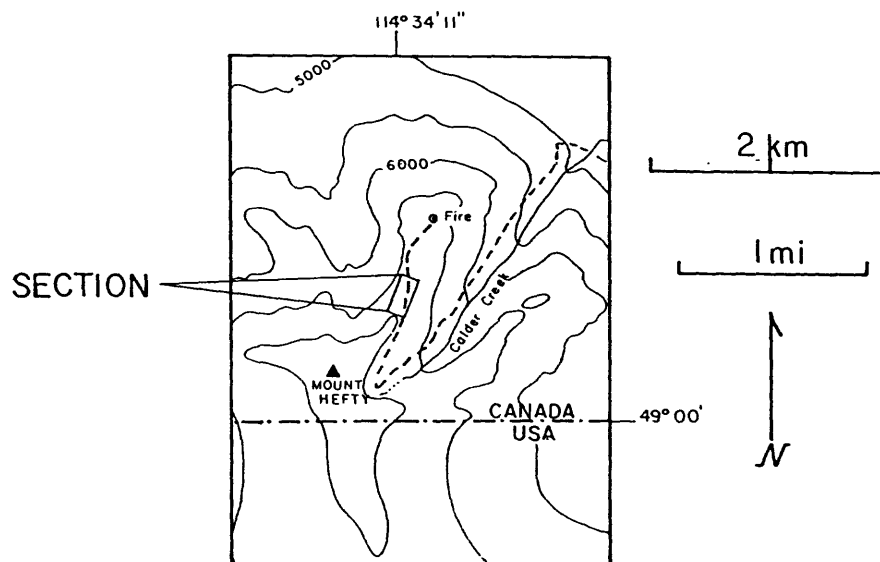


Figure 4. Location map for the Mount Hefty section, southeastern British Columbia. Section is located by reference to map 82 G/2, entitled "Inverted Ridge", Kootenay Land District, British Columbia.

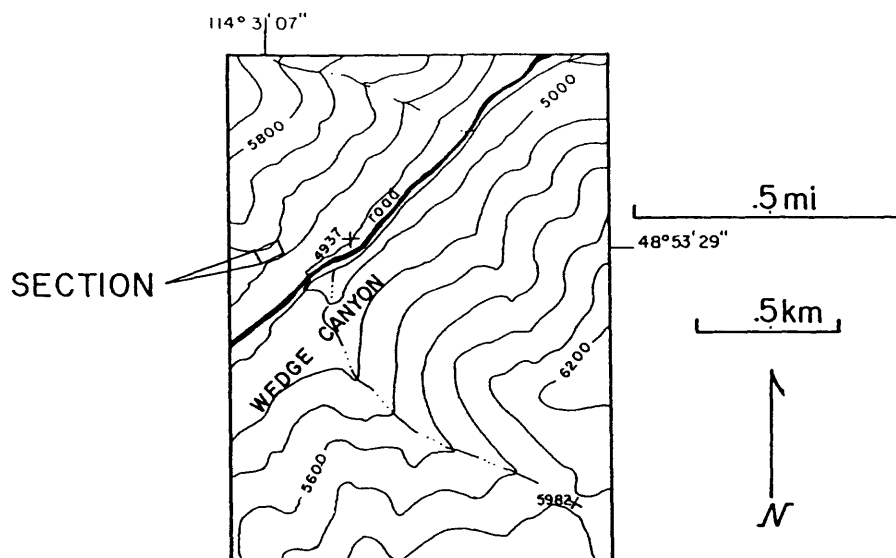


Figure 5. Location map for the Wedge Canyon measured section, northwestern Montana. Section is located by reference to U.S. Geological Survey 7.5 minute quadrangle entitled "Mount Hefty, Montana".

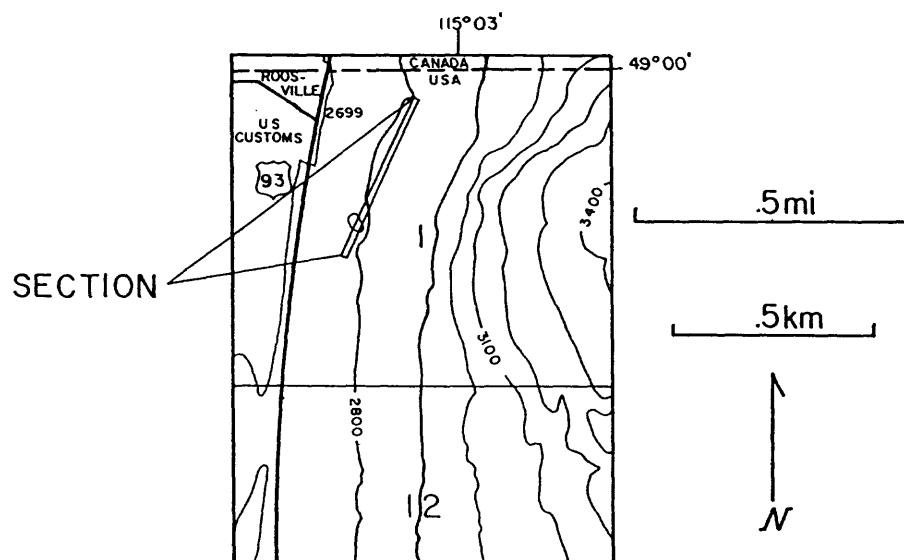


Figure 6. Location map for the Eureka measured section, northwestern Montana. Section is located by reference to the U.S. Geological Survey 7.5 minute quadrangle entitled "Eureka North, Montana".

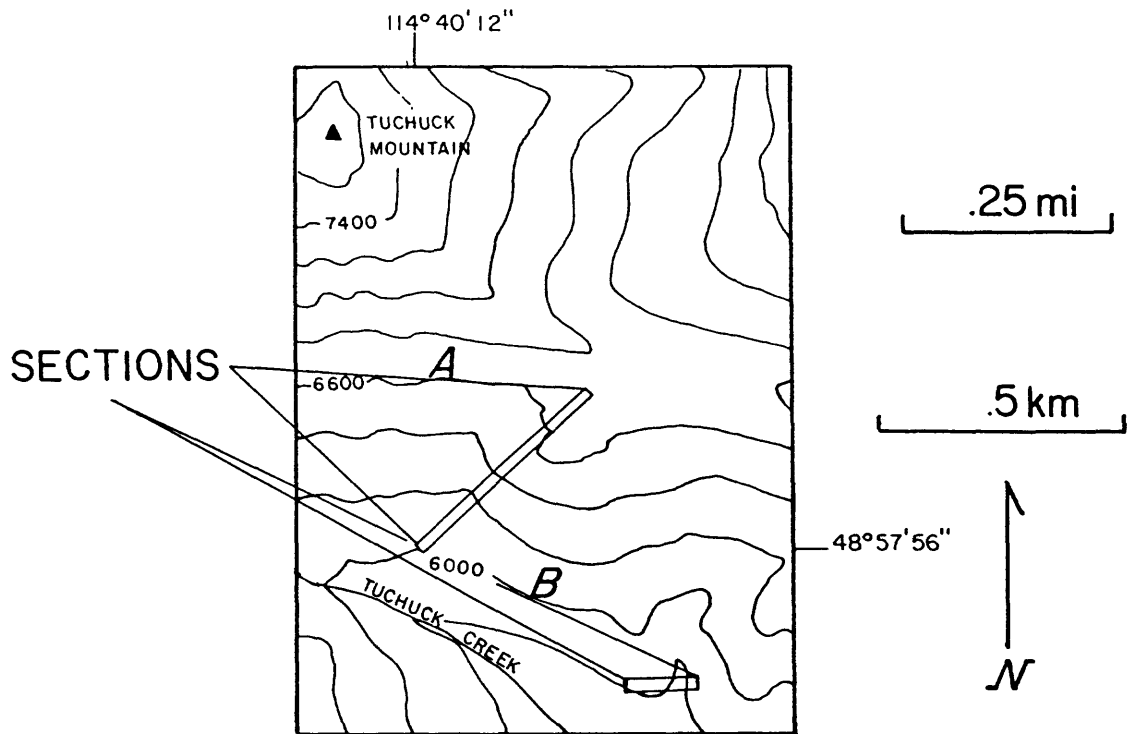


Figure 7. Location map for the Tuchuck I and Tuchuck II sections, northwestern Montana. Sections are located by reference to U.S. Geological Survey 7.5 minute quadrangle entitled "Tuchuck Mountain, Montana".

MEASURED SECTIONS

INVERTED RIDGE. The measured section at Inverted Ridge, in the southeastern MacDonald Range, is located by reference to map 82 G/2, entitled "Inverted Ridge", Kootenay Land District, British Columbia, scale 1:50,000 (Fig. 3).

The base of the Inverted Ridge section is located within the NW 1/4 of the SE 1/4 of a grid square bordered by an easting grid line, number 67, immediately to the left (west) of the grid square, and a northing grid line, 37, immediately below (south) of the grid square. The section was offset northwest along the top of Inverted Ridge approximately 2,750 m (9023 ft.) to a major northwest trending spur in the SE 1/4 of the SW 1/4 of grid square 66-39. At this point, measurement was continued down the spur to the northeast.

The section is accessed by driving north from Flathead Customs, at the international boundary, along a fair-weather dirt road for 4.1 miles (6.6 km). Turn left onto an unimproved, four-wheel-drive dirt road that follows Couldrey Creek for 9.6 miles (15.5 km), always remaining north of Couldrey Creek. At 9.6 miles, the road switches back almost 180 degrees to the north and climbs steeply for 1.2 miles (1.9 km). The road ends at an abandoned logging staging area near the confluence of two small creeks in grid square 67-35. Access to the spur on which the section base lies is up a steep logging skid trail that exits the staging area to the north. The base of the Cambrian carbonate section is 800 m (2,624 ft.) map distance up the spur. The base of the section is marked by a 30 cm (12 in.) long, white steel stake driven into the conformable contact between the Gordon Shale and the overlying carbonate unit, the Cambrian Elko Formation.

The section was measured along the spur, directly up the slope to the highest point on the ridge. The section was then offset northwest along the top of the ridge 2,750 m (9,000 ft.) to a major northeast-trending, steeply descending spur. Section measurement was continued down the spur to a distinct carbonate-shale contact (the Mississippian Exshaw Formation). Attitudes of the beds throughout the section range from N 45° W, dipping 67° S, to N 64° W, dipping 32° N. Seventy five meters (246 ft.) above the base of the section, at the base of the Cambrian Elko Formation, the beds become overturned, dipping to the south for the remainder of the section.

Lithologic and paleontologic samples were collected at 6 m (19.7 ft.) intervals and at major lithology changes, except between 31 m (102 ft.) and 131 m (430 ft.), where samples were collected every 12 m (39 ft.). Each paleontologic sample weighed approximately 500 g (1.1 lbs.). All Devonian samples and the upper 100 m (328 ft.) of the Cambrian carbonates were processed and examined for conodonts. The measured section is 796 m (2612 ft.) thick.

[Measured By W. P. Seward]

MISSISSIPPIAN-DEVONIAN EXSHAW FORMATION
(Unconformable Contact)
TOP OF DEVONIAN PALLISER FORMATION

UNIT #	THICKNESS (m) cum.		LITHOLOGY
15	186	796	INTRACLAST LIME WACKESTONE-PACKSTONE. Olive black 5Y 2/1; massive to medium bedded, cliff former; bioturbated, pellets, vertical burrows to 1 cm (.4 in.) diameter cryptalgal laminations; disarticulated brachiopod valves, abraded crinoid ossicles, gastropods, ostracodes, phylloid algae, oncoids, ramose bryozoans, laminar stromatoporoids, tintaculitids, conodonts; intraclasts to 2 cm (.4 in.) diameter, minor pyrite, hardgrounds, hydrocarbons common throughout along stylolitic boundaries and fractures; burrows commonly infilled with intraclasts, white calcite infilling of fractures, geopetal features beneath brachiopod valve shelter voids; moderately porous; samples IR-92 to IR-122
14	18	610	FENESTRAL LIME MUDSTONE. Pinkish gray 5 YR 8/1; very thinly laminated, ledge former; bioturbated, ovoid fenestrae, cryptalgal laminations(?); possible trough cross laminae; porous; samples IR-88 to IR-91

(Conformable contact)

TOP OF DEVONIAN ALEXO FORMATION

13	50	592	MEDIUM-GRAINED CALCAREOUS SILTSTONE. Pale yellowish orange 10 YR 8/6; thin bedded very gentle slope former; well rounded, well sorted, thinly laminated, 1 cm (.5 in.) planar cross beds; 6 m (19.7 ft.) of lime mudstone from 547 m (1795 ft.) to 553 m (1814 ft.); porous; samples IR-81 to IR-87
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(Conformable contact)

TOP OF DEVONIAN FAIRHOLME GROUP

12	183	542	BIOTURBATED LIME MUDSTONE-WACKESTONE. Brownish black 5 YR 2/1; thin bedded, cliff and steep ledge former; bioturbated; brachiopod valves concentrated in thin bedded, limonite-rich
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horizons 2-3 cm (1 in.) thick, crinoid ossicles, tintaculitids conodonts; microlaminae, 1 mm (.025 in.) thick argillaceous flasers, intraclasts, framboidal pyrite, 1 cm shale innerbeds; solid, tarry hydrocarbons concentrated along argillaceous partings; not porous; samples IR-51 to IR-80

- | | | | |
|----|----|-----|---|
| 11 | 12 | 359 | DOMAL STROMATOLITIC DOLOMITE FLOATSTONE. Dark gray N3 to brownish black 5 YR 2/1; medium bedded cliff former; domal algal heads to 21 cm (8.25 in.) diameter (out of growth position, completely replaced by white calcite) conodonts; tarry hydrocarbons along stylolitic boundaries surrounding algal heads; porous; samples IR-49 to IR-50 |
| 10 | 34 | 347 | CRYPTALGAL DOLOMITE BOUNDSTONE-MUDSTONE. Dark gray N3 to brownish black 5YR 2/1; medium bedded, cliff former; cryptalgal laminations, laminoid and ovoid fenestrae, bioturbation; vertical burrows to 1 cm (.4 in.) diameter; fragmented brachiopod valves, conodonts, bryozoans; matrix recrystallized, crystals to 1 mm (.05 in.), especially within burrow infilling; basal 6 m (19.7 ft.) is a ramose bryozoan floatstone, geopetal features within fenestrae; porous; samples IR-43 to IR-48 |

Section offset along ridge 2,750 m (9022 ft.) to a major northeast-trending spur.

- | | | | |
|---|----|-----|--|
| 9 | 18 | 313 | CRINOID BRACHIOPOD LIME WACKESTONE. Brownish black 5 YR 2/1 to dark gray N3; thin bedded, steep ledge former; vertical burrows, 5 mm (.2 in.) diameter commonly bioturbated; abraded crinoid ossicles, broken brachiopod valves concentrated in burrow infilling of valve shelter voids; samples IR-40 to IR-42 |
| 8 | 20 | 295 | INTRACLAST LIME MUDSTONE. Brownish black 5 YR 2/1, light brownish gray 5 YR 6/1 in upper 6 m (19.7 ft.); thin bedded, cliff former; bioturbated except for very thinly laminated non-bioturbated mudstone between 6 m (19.7 ft.) and 12 m (39.4 ft.); conodonts; stylolites, compacted intraclasts; not porous; samples IR-36 to IR-39 |
| 7 | 48 | 275 | CLOTTED CRYPTALGAL LIME BOUNDSTONE. Brownish black 5 YR 2/1 to dark gray N3 to medium gray N5; thin bedded, ledge former; cryptalgal laminations, horizontal and inclined burrows to 1 cm (.5 in) in diameter; stylolites; unit includes sedimentary breccia; pale yellowish |

brown 10 YR 6/2; ledge former; angular dolomite clasts to 15 mm (.6 in.) diameter; porous; samples IR-28 to IR-35

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|---|---|-----|---|
| 6 | 6 | 227 | MEDIUM GRAINED CALCAREOUS QUARTZ ARENITE. Pale yellow orange, 10 YR 8/6; well rounded, poorly sorted, thinly laminated and thin bedded, steep slope former; isolated clasts of light gray dolomite to 1 cm; interbedded with thin beds of light green shale; porous; sample number IR-27. |
|---|---|-----|---|

(Unconformable Contact)

TOP OF CAMBRIAN ELKO FORMATION

- | | | | |
|---|-----|-----|---|
| 5 | 24 | 221 | BIOTURBATED INTRACLAST DOLOMITE WACKESTONE. Light brownish gray 5 YR 6/1; thin bedded, forms ledges; strongly bioturbated; deformed intraclasts to 2 mm (.08 in.) diameter; not porous; samples IR-23 to IR-26. |
| 4 | 37 | 197 | BIOTURBATED INTRACLAST CRYPTALGAL DOLOMITE MUDSTONE-BOUNDSTONE. Light brownish gray 5 YR 6/1; thin bedded, forms steep resistant ledges; bioturbated; cryptalgal laminations, intraclasts; not porous; samples IR-17 to IR-22. |
| 3 | 12 | 160 | FENESTRAL DOLOMITE MUDSTONE. Pinkish gray 5 YR 8/1 to light brownish gray 5 YR 6/1; thin bedded, forms ledges; ovoid and laminoid fenestrae infilled with white calcite, questionable cryptalgal laminations; vuggy porosity; samples IR-15 and IR-16. |
| 2 | 43 | 148 | ONCOID DOLOMITE FLOATSTONE-MUDSTONE. Light brownish gray 5 YR 6/1 to medium gray N 5, lightening to pink gray 5 YR 8/1 at 40 m; forms massive cliffs, oncoids to 2 cm in diameter floating in a micritic matrix; intraclasts; porous; samples IR-10 to IR-14. |
| 1 | 105 | 105 | BIOTURBATED DOLOMITE LIME MUDSTONE. Brownish gray, 5 YR 4/1 to brownish or olive black 5 YR 2/1 or 5Y 2/1, commonly with dark yellowish orange 10 YR 6/6 or medium gray N 5 mottling; thin bedded, forms steep slopes and ledges; horizontal burrows to 1 cm (.4 in.) diameter, trilobite fragments, geopetal silt infilling of burrows; not porous; sample numbers IR-1 to IR-9. |

(Conformable Contact)

TOP OF CAMBRIAN GORDON SHALE

MOUNT HEFTY. The measured section at Mount Hefty, in the southeastern MacDonald Range, is located by reference to map 82 G/2, entitled "Inverted Ridge" Kootenay Land District, British Columbia, scale 1:50,000 (Fig. 4).

The base of the Mount Hefty section is located within the NE 1/4 of the SE 1/4 of the grid square bordered by grid line number 77, immediately to the left (west) of the square, and a northing grid line, 31, immediately below (south) of the grid square.

The section is reached by driving north from Flathead Customs at the international boundary, along the main road that heads directly north into British Columbia. Follow the fair-weather dirt road for .5 miles (.8 km). Turn left onto an unimproved, four-wheel-drive dirt road that winds west several kilometers. The road turns to the southwest and climbs steeply out of a low, wet, forested area as it parallels Calder Creek on the northwest side of the creek. The road turns back to the northeast to an abandoned fire lookout station 1.1 miles (1.8 km) northeast of the summit of Mount Hefty. The measured section lies on and parallels the ridge that is northwest of the road.

The base of the section is conformable with the Cambrian Gordon Shale and is easily seen from the road. The stratigraphic top of the section is located at the first major cliff on the north side of the road as one drives southwest back along the road from the abandoned fire lookout station. The cliff is a prominent, resistant fault breccia that is visible in the road cut. The Devonian lithologies are overturned, with attitudes that range from N 85° W, dipping 35° S, to N 72° W, dipping greater than 85° S. The upright Cambrian strata have attitudes that range from N 42° W, dipping 42° N, to N 50° W, dipping greater than 85° N.

Lithologic and paleontologic samples were collected at 6 m (19.7 ft.) intervals from 0 to 42 m (137.8 ft.), thereafter at 3 m (9.8 ft.) intervals. Each paleontologic sample weighed approximately 1500 g (3.3 lbs.). All Devonian samples and the upper 100 m (328 ft.) of the Cambrian carbonates were processed and examined for conodonts. The measured section is 303 m (994 ft.) thick.

[Measured by W.P. Seward]

MISSISSIPPIAN BANFF FORMATION
(Faulted Contact)

DEVONIAN PALLISER FORMATION

UNIT #	THICKNESS (m)		LITHOLOGY
		cum.	
13	20	303	FAULT BRECCIA. Dolomite clasts; pale yellowish brown 10 YR 6/2; massive, cliff former; conodonts; porous; samples H-88 to H-93.

12	33	283	LAMINATED DOLOMITE MUDSTONE. Dusky yellowish brown 10 YR 2/2; thin to medium bedded, ledge former; bioturbation; conodonts; 2 mm (.08 in.) laminations; not porous; samples H-77 to H-87.
11	25	250	INTRACLAST CRINOID LIME WACKESTONE. Dusky yellowish brown 10 YR 2/2; thin to medium bedded, ledge former; bioturbated; pellets, crinoid ossicles, brachiopod valves, ostracodes, gastropods, ramose bryozoans, conodonts; intraclasts; hydrocarbons; porous; samples H-69 to H-76.
10	27	225	FAULT BRECCIA. Dolomite cemented limestone clasts; dark yellowish brown 10 YR 4/2; massive ledge former; rare brachiopod valves and crinoid ossicles in several clasts, conodonts; rare pellets and intraclasts; hydrocarbons; porous; samples H-60 to H-68
9	27	198	INTRACLAST CRINOID LIME MUDSTONE-WACKESTONE. Olive gray 5 Y 4/1 to olive black 5 Y 2/1; thin bedded, slope former; bioturbated, vertical burrows; crinoid ossicles, brachiopod valves, ostracodes, gastropods, conodonts; intraclasts, cortoids, laminoid and ovoid fenestrae, hydrocarbons; not porous; samples H-51 to H-59.

(Faulted Contact)

TOP OF CAMBRIAN ELKO FORMATION

8	22	171	BIOTURBATED DOLOMITE MUDSTONE. Grayish orange 10 YR 7/4; thin bedded, slope former; bioturbated, intraclasts, laminoid fenestrae in top 9 m (30 ft.); not porous; samples H-44 to H-50.
7	6	149	DOLOMITE OOID PACKSTONE. Grayish orange 10 YR 7/4; thin bedded, slope former; ooids; 1 cm (.4 in.) planar cross beds; porous; samples H-42 and H-43.
6	20	143	BIOTURBATED DOLOMITE MUDSTONE. Olive black 5 YR 2/1; thin bedded, slope former; bioturbated, horizontal burrows; geopetal infilling of burrows indicates section is upright; not porous; sample H-35 to H-41.
5	12	123	FENESTRAL DOLOMITE MUDSTONE. Dark yellow brown 10 YR 2/2 to gray orange 10 YR 7/4; thin bedded, slope former; bioturbated; laminoid and ovoid fenestrae throughout, hardgrounds; porous; samples H-31 to H-34.

- | | | | |
|---|----|-----|---|
| 4 | 9 | 111 | ONCOID DOLOMITE FLOATSTONE. Light olive gray 5 YR 5/2; thin bedded, slope former; oncoids to 2 cm (.8 in.) in diameter floating in a micrite matrix; not porous; samples H-28 to H-30. |
| 3 | 30 | 102 | BIOTURBATED DOLOMITE MUDSTONE. Light brownish gray 5 YR 6/1 to moderate yellow brown 10 YR 5/4, a distinct light colored unit; thin bedded, slope former; bioturbated; minor ovoid and laminoid fenestrae, intraclasts; not porous; samples H-18 to H-27. |
| 2 | 19 | 72 | ONCOID DOLOMITE FLOATSTONE. Grayish orange 10 YR 7/4 to light olive gray 5 YR 5/2; thin bedded, slope former; oncoids to 2 cm (.8 in.) in diameter floating in a micrite matrix; not porous; samples H-12 to H-17. |
| 1 | 53 | 53 | BIOTURBATED DOLOMITE LIME MUDSTONE. Olive black 5 YR 2/1; thin bedded, steep ledge former; bioturbated, minor horizontal and vertical burrows in the lower 25 m; trilobite fragments, minor ovoid fenestrae; basal 18 m are calcareous; not porous; sample numbers H-1 to H-11. |

(Conformable Contact)

TOP OF CAMBRIAN GORDON SHALE

WEDGE CANYON. The measured section at Wedge Canyon, northeastern Whitefish Range, Montana, is located by reference to USGS 7 1/2 Minute Quadrangle maps entitled Mount Hefty, Montana (Fig. 5).

Drive north along the all-weather, gravel, North Fork Road from the town of Polebridge Montana for 10 miles (16.1 km) to the Whale Creek Road turnoff (NE 1/4, S 24, T 36 N, R 22 W, Whale Buttes Quadrangle). Turn west (left) onto the all-weather, gravel, Whale Creek Road, drive 2.2 miles (3.5 km), turn north (right) onto the unmaintained, dirt, Teepee Canyon Road. The road winds gradually west and enters Wedge Canyon along Teepee Creek. Drive 6.4 miles (10.3 km) along the Teepee Canyon Road (located on the Mount Hefty Quadrangle) to the fourth avalanche shoot on the north (left) side of the road.

The base of the measured section is located at the bottom of a prominent cliff, 60 m (197 ft.) vertically and 153 m (502 ft.) horizontally from the road. The section is clearly visible from the road. The coordinates of the base of the section are 114° 31' 8" East - 48° 53' 27" North. The section is a vertical to overhanging cliff 40 m (131 ft.) high. Only the bottom five meters (16.4 ft.) and the top three meters (9.8 ft.) of the section are accessible without rapelling or ascension equipment.

The base of the section is covered and marked by a 30 cm (11.8 in.) long white steel stake driven into the outcrop approximately 20 m (65.6 ft.) east, along the base of the cliff, from the avalanche shoot. The top of the section is marked by a rapid change from the vertical cliff and steep ledges to a very gradual, vegetated slope. The lithologies at the top of the section are horizontal and thin to medium bedded. The majority of the section, however, is massive.

Lithologic and paleontologic samples were collected at various intervals, from 3 m (9.8 ft.) to 10 m (32.8 ft.), depending upon accessibility. Each paleontologic sample weighed approximately 500 g (1.1 lbs.). All samples were processed and examined for conodonts. The measured section is 52 m (170.6 ft.) thick.

[Measured by W.P. Seward]

(Covered Contact)

TOP OF DEVONIAN PALLISER FORMATION

UNIT #	THICKNESS (m)		LITHOLOGY
		cum.	

1	50	50	INTRACLAST LIME PACKSTONE-MUDSTONE. Brown black 5 YR 2/1; massive, cliff former; bioturbated, cryptalgal laminations, vertical burrows, horizontal burrows top 6 m (19.7 ft.), cryptalgal bindstone at basal 3 m (9.8 ft.); abraded crinoid ossicles, ostracode valves, disarticulated brachiopod valves, conodonts; abundant intraclasts to 3 mm (.12 in.) diameter, white calcite infills
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fractures, stylolites; tarry hydrocarbons
along stylolites and fractures, geopetal
fabric beneath fossil shelter voids;
porous; samples WC-1 to WC-18.

(Covered Contact)

DEVONIAN PALLISER FORMATION (?)

EUREKA. The measured section, on the northwest edge of the Whitefish Range, Montana, is located by reference to the USGS 7 1/2 minute quadrangle map entitled Eureka North, Montana (Fig. 6). The location of the base of the section is: NE 1/4, SW 1/4, S 1, T 37 N, R 24 W.

Drive north from the town of Eureka, Montana seven miles (11.3 km) along US Highway 93 to the US Customs station at the International Boundary. One hundred twenty meters south of the international boundary, cross through a barbed wire gate east off Highway 93. Drive three tenths of a kilometer (.2 mi.) along the well graded, all-weather gravel road to the base of the first cliff 20 meters west of the road.

The base of the section is covered. The top of the section is marked by the end of outcrop on the south side of a large northwest-southeast trending ravine, near a cul-de-sac of a gravel road that closely parallels the section to the north. The attitude of the massively bedded section ranges from N 64° W, dipping 34° N to N 124° W, dipping 34° N.

Lithologic and paleontologic samples were collected at 3 m intervals. Each paleontologic sample weighed approximately 1500 g. All samples were processed and examined for conodonts. The measured section is 206 m (676 ft.) thick.

[Measured by W.P. Seward]

(Top of Cliff Forming Unit)

TOP OF DEVONIAN PALLISER FORMATION

UNIT #	THICKNESS (m)		LITHOLOGY
		cum.	
4	155	206	INTRACLAST BIOCLAST LIME MUDSTONE-WACKESTONE. Brownish gray 5 YR 4/1 for lower 70 m (230 ft.), dark yellowish brown 10 YR 4/2 for upper 85 m (279 ft.); massive ledge and cliff former; bioturbated, uncommon vertical burrows, pellets; crinoid ossicles, brachiopods, gastropods, ostracodes, stromatoporoids, all fossils disarticulated and out of growth position; intraclasts, cortoids; not porous; samples E-13 to E-63.
3	6	51	CRYPTALGAL DOLOMITE BOUNDSTONE. Medium light gray N 6 to pinkish gray 5 YR 8/1; massive, cliff former; crypalgal laminations, pellets; intraclasts, stylolites; not porous; samples E-10 and E-12.
2	36	45	CRINOID INTRACLAST LIME WACKESTONE. Olive black 5 YR 2/1; massive, ledge former; bioturbated; crinoid ossicles, brachiopods, minor gastropods; intraclasts; covered interval from 30 m to 42 m; not porous; sample

numbers E-2 to E-9.

1	9	9	CRYPTALGAL LIME BOUNDSTONE. Light brown gray 5 YR 6/1; massive, thick ledge former; cryptalgal laminations, intraclasts; not porous; sample E-1.
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(Covered Contact)

DEVONIAN ALEXO FORMATION

TUCHUCK I. The measured section at Tuchuck Mountain, in the northern Whitefish Range, is located by reference to USGS 7 1/2 minute quadrangle map entitled: Tuchuck Mountain (Fig. 7). The Tuchuck I section is composed entirely of Cambrian Elko Formation. The top of the section is an exposed erosional surface.

Drive north along the all-weather, gravel, North Fork Road from the town of Polebridge Montana for 15 miles (24.2 km) to the Tuchuck Campground turnoff (SW 1/4, S 35, T 37 N, R 22 W, Trailcreek, Montana Quadrangle). Turn west (left) onto the fair-weather Tuchuck Campground Road, drive 8 miles (12.8 km) to Tuchuck Campground (located on the Mount Hefty Quadrangle).

From Tuchuck Campground, hike northwest 4.5 miles (7.2 km) along an established hiking trail (located on the Tuchuck Mountain Quadrangle). Leave the trail and follow the main drainage of Tuchuck Creek approximately 1 mile (1.6 km) cross-country to the base of the section on the north side of the canyon.

The base of the measured section is located below a large "amphitheater" eroded into the Cambrian Elko Formation. The coordinates are 114° 40' 13" East and 48° 58' 11" North. The base of the section, measured from the top of the Gordon Shale, is conformable. The section is composed solely of Cambrian Elko Formation carbonates.

The section is measured along the left (north) edge of the "amphitheater" directly up the steep ledges and white cliffs to the flat area at the top of the slope. The attitude of the beds is N 15° W, dipping 35° N.

Lithologic and paleontologic samples were collected at 3 m (9.84 ft.) intervals. Each paleontologic sample weighed approximately 1200 g (2.65 lbs.). The upper 33 m (108 ft.) of the section were processed and examined for conodonts. The measured section is 152 m (499 ft.) thick.

[Measured by W.P. Seward]

(Top of Cliff Forming Unit within Elko Formation)

EROSIONAL SURFACE

UNIT #	THICKNESS (m)		LITHOLOGY
		cum.	
5	38	152	BURROWED DOLOMITE MUDSTONE. Light brownish gray 5 YR 6/1 to olive black 5 YR 2/1; thin bedded, steep ledge former; mottled, vertical and horizontal burrows; geopetal features; 1 m (3.3 ft.) thick flat pebble conglomerate at 28 m (92 ft.) above base of unit; not porous; samples T-39 to T-51.
4	16	114	BURROWED FENESTRAL DOLOMITE MUDSTONE. Light brownish gray 5 YR 6/1; thin bedded, steep ledge former; ovoid and laminoid fenestrae, vertical burrows, questionable cryptalgal laminations at 10 m (32.8 ft.) above base of

unit; minor intraclasts, geopetal features;
not porous; samples T-34 to T-38.

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|---|----|----|---|
| 3 | 17 | 98 | ONCOID DOLOMITE FLOATSTONE. Light brownish gray 5 YR 6/1; massive cliff former; oncoids to 2 cm (.8 in in diameter floating in a micritic matrix; not porous; samples T-29 to T-33. |
| 2 | 3 | 81 | CROSS-BEDDED OOID DOLOMITE GRAINSTONE. Light brownish gray 5 YR 6/1; medium bedded ledge former; 1 cm thick planar cross-beds; dolomitization obscures oolitic fabric; porous; sample T-28. |
| 1 | 78 | 78 | BIOTURBATED LIME-TO-DOLOMITE MUDSTONE. Olive black 5 YR 2/1 to brownish gray 5 YR 4/1, with dark yellow orange 10 YR 6/6 mottling from base to 10 m (32.8 ft.), other mottling dark gray N 3 to light brownish gray 5 YR 6/1 in upper 15 m (49 ft.); thin bedded to massive ledge to cliff former, commonly bioturbated, ovoid and laminoid fenestrae, vertical and horizontal burrows; disarticulated and broken trilobite fragments in lower 25 m, (82 ft.); questionable disarticulated and broken brachiopod fragments at 9 (29.5 ft.) and 12 m (39.4 ft.) above base of the unit; minor intraclasts, geopetal features, 1 m (3.3 ft.) thick sedimentary breccia sequences at 18 (59 ft.) and 39 m (128 ft.) above base of unit; not porous; samples T-1 to T-27. |

(Conformable Contact)
TOP OF CAMBRIAN GORDON SHALE

TUCHUCK II. The measured section at Tuchuck Mountain, in the northern Whitefish Range, is located by reference to USGS 7 1/2 minute quadrangle map entitled: Tuchuck Mountain, Montana (Fig. 7).

From Tuchuck Campground, hike northwest 4.5 miles (7.2 km) along an established hiking trail (located on the Tuchuck Mountain Quadrangle). Leave the trail and follow the main drainage of Tuchuck Creek approximately .66 miles (1.1 km) cross-country to the base of the section on the north side of the canyon.

The base of the measured section is located at the bottom of a light gray 9 m (29.5 ft.) high cliff which strikes directly up the prominent spur. The section was measured across the next drainage, directly east, and up the massive, gray limestone cliff. The top of the section is covered. The attitudes of the beds range from N 15° E to N 25° E, dipping 35° S.

Lithologic and paleontologic samples were collected at 3 m (9.8 ft.) intervals. The paleontologic samples weighed approximately 1500 g (3.3 lbs.). All samples were processed and examined for conodonts. The measured section is 37 m (121.4 ft.) thick.

[Measured by W.P. Seward]

(Covered Contact)

DEVONIAN PALLISER FORMATION

UNIT #	THICKNESS (m)		LITHOLOGY
		cum.	
1	37	37	INTRACLAST LIME WACKESTONE-BOUNDSTONE. Dusky brown 5 YR 2/2 to dark yellowish brown 10 YR 4/2; massive to medium bedded cliff former through the first 22 m (72 ft.), thin bedded to massive ledge and cliff former through remaining 15 m (49.2 ft.); cryptalgal laminations, laminoid fenestrae, bioturbation; oncoids, crinoid ossicles, minor, gastropods, conodonts; intraclasts, not porous; samples T-II-1 to T-II-13.

Covered Contact

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