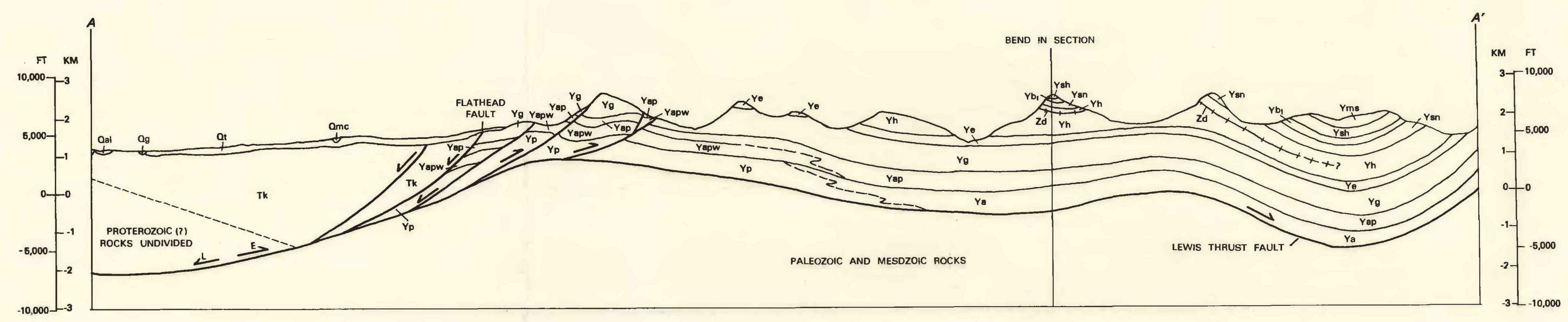
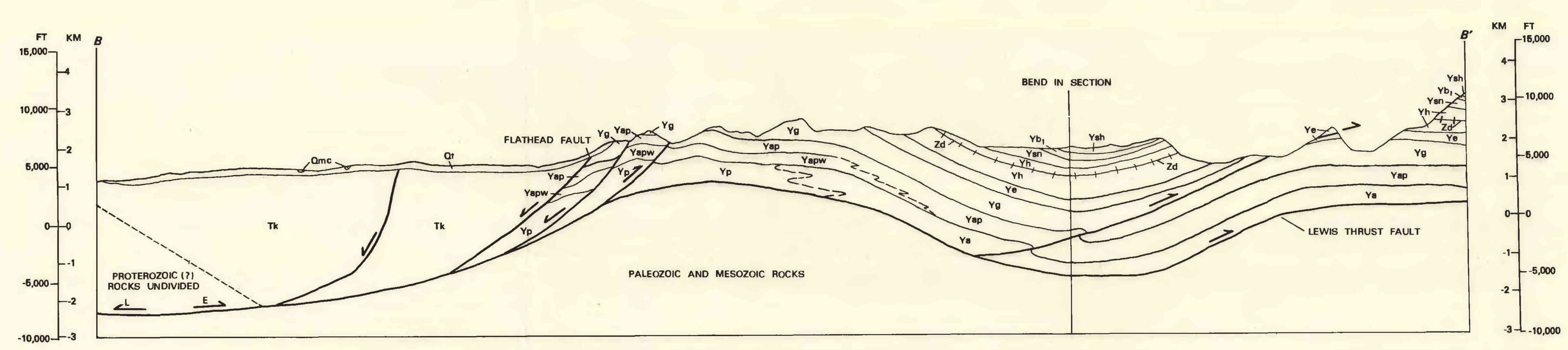
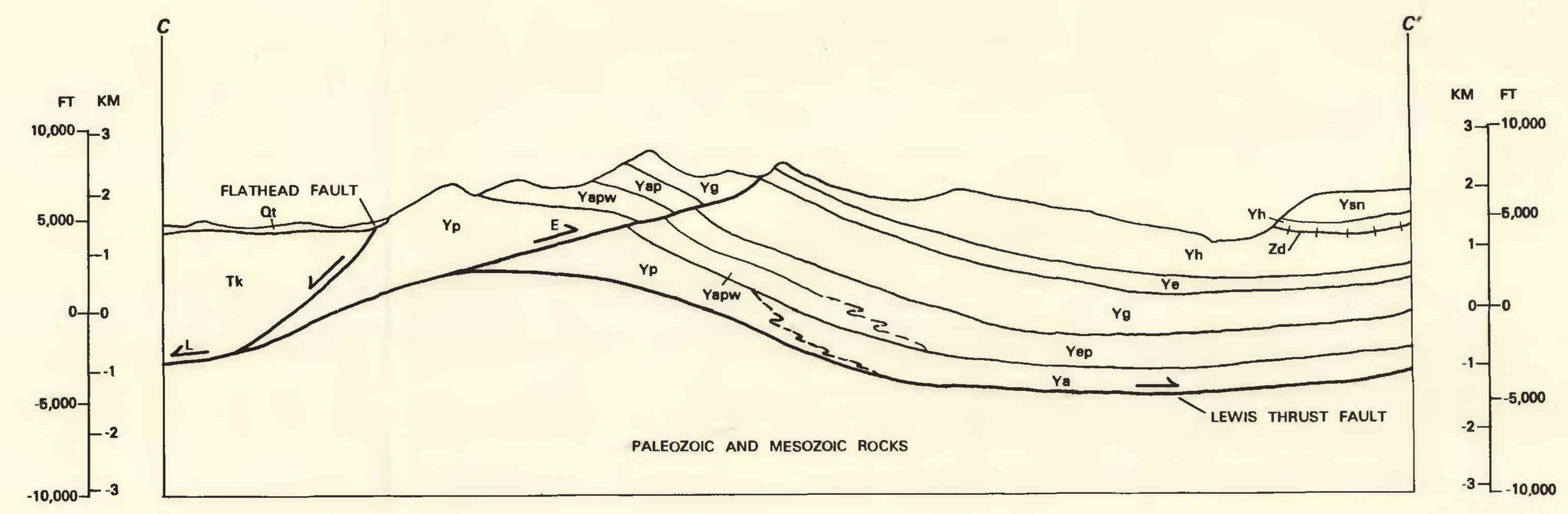
Base from U.S. Geological Survey 1:100,000 Glacier National Park (Part of Waterton-Glacier International Peace Park), 1968

Geology mapped during 1979-1982







Only Quaternary deposits that cover large areas are shown on cross sections

Double arrows along faults indicate earlier movement (E) and later movement (L)

CORRELATION OF MAP UNITS

Qa, Qal, Qf, Qg — Holocene
UNCONFORMITY
Qls, Qat, Qt, Qmc — Pleistocene
UNCONFORMITY
} QUATERNARY

Tk — Oligocene-Eocene } TERTIARY
Zd — LATE PROTEROZOIC

Yms, Yb_2, Yms, Ysh, Ysn, Yb_1, Ysn — Missoula Group
Yh
Ye, Yg, Yap, Yapw — Ravalli Group
Ya, Yp
} Belt Supergroup } MIDDLE PROTEROZOIC

DESCRIPTION OF MAP UNITS

Qa ALLUVIUM (HOLOCENE)--Silt, sand, and gravel in streams tributary to the North Fork of the Flathead River. Includes channel, overbank, terrace, and some colluvial deposits. Clasts composed entirely of Belt Supergroup rocks

Qal ALLUVIUM (HOLOCENE)--Silt, sand, and gravel along the North Fork of the Flathead River. Includes channel and overbank deposits in floodplain. Clasts predominantly of Belt Supergroup rocks, but clasts of other lithologies are present

Qf ALLUVIAL-FAN DEPOSITS (HOLOCENE)--Fan-shaped deposits of fluvial silt, sand, and gravel; clasts commonly rounded and predominantly of Belt Supergroup rocks. Unit may include some debris-flow deposits

Qg TERRACE GRAVELS (HOLOCENE AND PLEISTOCENE)--Silt, sand, and gravel in stream terraces 5-30 m above the North Fork of the Flathead River. Clasts predominantly of Belt Supergroup rocks. Thickness ranges from 2-10 m

Qls LANDSLIDE DEPOSITS (HOLOCENE AND PLEISTOCENE)--Predominantly large slump deposits within older glacial deposits. Movement primarily by rotational shear along a basal-slip surface. Many of the landslides have well-defined scarps in headward region. Ponds or bogs are locally present in the toe region. Largest landslides are thicker than 50 m and cover several square kilometers

Qat ABLATION TILL (UPPER PLEISTOCENE)--Unsorted, subrounded clasts of Belt Supergroup rocks that range from clay size to boulders. Unit forms poorly drained, hummocky deposits that contain ponds and bogs at the mouths of several valleys along the western flank of the Livingston Range. Maximum thickness is probably greater than 30 m

Qt TILL (UPPER PLEISTOCENE)--Unsorted material that ranges from clay size to boulders. Clasts are commonly subrounded rocks from the Belt Supergroup. Unit deposited by ice lobe that flowed southeast along North Fork of Flathead River valley. Thickness commonly ranges from 10 m to 30 m

Qmc MELTWATER CHANNEL DEPOSITS (UPPER PLEISTOCENE)--Fluvial silt, sand, and gravel deposited in channels by meltwater of retreating glaciers that filled North Fork of Flathead River valley. Unit is mostly on broad divides between major drainages on the western side of the Livingston Range. In many places, deposits are overlain by 1 m to 3 m of peat

Tk KISHENEHN FORMATION OF DALY, 1912 (TERTIARY)--Consists of two informal members that are undifferentiated on the map. Upper member, also called the Kintla Creek Member in Canada, is as much as 3,000 m thick and consists of red-, brown-, and gray-variegated calcareous claystone, mudstone, and siltstone interstratified with silver-gray to gray, calcareous sandy pebble-cobble conglomerate and conglomeratic sandstone. Contains minor amounts of lignite and light-gray marlstone. Lower member consists of a heterogeneous assemblage of fine-grained, gray rocks, and is as much as 3,000-4,000 m thick. Contains sandstone, siltstone, montmorillonitic mudstone-claystone, sandy pebble conglomerate, oil shale, and marlstone. Lignite seams, some as much as 0.7 m thick, are common. Crops out in the western part of mapped area along and near North Fork of Flathead River. 200-7,000 m thick

Zd DIORITIC INTRUSIVE ROCKS (LATE PROTEROZOIC)--Mostly diorite and quartz diorite in sills as thick as 80 m. Intrudes metasedimentary rocks of middle and upper parts of Belt Supergroup in mapped area. Sills in mapped area have not been dated; however, sills of similar character in Bob Marshall Wilderness south of Glacier Park have been dated by potassium-argon methods by J. D. Obradovich (oral commun., 1966) as 750±25 m.y. old

BELT SUPERGROUP

Metasedimentary and metavolcanic rocks of lower to upper parts of Belt Supergroup are widely distributed throughout mapped area. Belt Supergroup in the northwestern part of Glacier Park is as much as 3,800 m thick

Missoula Group

Lower three formations of Missoula Group crop out in northern, eastern, and southeastern parts of mapped area and are as much as 1,450 m thick. Upper part of Missoula Group is absent due to erosion

Yms MOUNT SHIELDS FORMATION (MIDDLE PROTEROZOIC)--Upper part mostly very thin bedded red argillite and siltite. Middle part consists mostly of greenish-gray to buff, thin-bedded dolomitic argillite and siltite. Lower part consists of red argillite, siltite, and quartzite. Also includes beds about 1 m thick of creamy-buff limestone, stromatolitic in part. Dark-gray, amygdaloidal, subaerial basalt member about 10 m thick (shown as Yb_2 on map) occurs in lower 26 m of formation in northwestern part of mapped area. Nearly complete section of formation is exposed near Campbell Mountain in northeastern part of mapped area. About 600 m thick near Campbell Mountain

Ysh SHEPARD FORMATION (MIDDLE PROTEROZOIC)--Consists of yellowish-gray to greenish-gray dolomitic argillite and siltite and contains lesser amounts of pale-green argillite, light-gray quartzite, calcarenite, limestone, and dolomite. Contains numerous thin beds of stromatolites, particularly in southern outcrops. Crops out in northern and eastern parts of mapped area. Thins northwesterly from about 350 m near Flattop Mountain to about 150 m in northwest

Ysn SNOWSLIP FORMATION (MIDDLE PROTEROZOIC)--In southern part of area, upper part of formation is mostly green argillite and siltite, in part dolomitic. Also contains greenish-gray quartzite and thin beds of gray limestone; some are stromatolitic. Pillow basalt member in upper part, called Purcell Lava by Daly (1912) and Purcell Basalt by Wilmarth (1938) and shown on map as Yb_1, is as much as 120 m thick. Middle part contains green to red beds of argillite, siltite, and quartzite which are underlain in turn by green dolomitic beds of argillite and siltite. Lower part of formation consists of interbedded green and pinkish-red argillite, siltite, and quartzite. Green beds are locally dolomitic. Formation is exposed throughout eastern half of mapped area. Thins toward northwest from about 460 m near Mount Cannon to about 360 m near Hole-in-the-Wall. Latter thickness includes pillow basalt member

Middle Belt carbonate

Yh HELENA FORMATION (MIDDLE PROTEROZOIC)--Consists of thin to thick beds of gray to dark-gray argillaceous dolomite, gray limestone and, in lower part, calcarenite and quartzite. Most beds weather tan to buff. Beds of stromatolites occur throughout and are most numerous in upper part. Most stromatolites are in form of cabbage-heads or mounds and are as large as 2-3 m in diameter. A stromatolite form called conophyton, unique to Helena Formation, forms beds as much as 15 m thick in upper part. Thick stromatolitic units in upper part commonly form conspicuous, massive ribs in otherwise thinly bedded sequence of rocks. Middle part is more thickly bedded, less argillaceous, and forms cliffs. Lower part is thin bedded, and unit becomes increasingly argillaceous near lower contact. Crinkled texture called molar-tooth structure is common on weathered outcrops. Helena Formation is widely distributed throughout eastern part of mapped area and is about 720 m thick

Ravalli Group

The Ravalli Group includes the Empire, Grinnell, and Appekunny Formations in mapped area and is as much as 1,485 m thick

Ye EMPIRE FORMATION (MIDDLE PROTEROZOIC)--Mostly consists of green beds of argillite and siltite. Many beds, particularly in upper part, are dolomitic, and some are calcareous and stromatolitic. Carbonate beds weather buff and are commonly interstratified with green argillite and siltite, which imparts a banded appearance. At most places near middle part, formation contains two sequences of red argillite and siltite, each about 3 m thick, which are separated by green argillite and siltite. Locally contains thin beds of quartzite and calcarenite. Formation is transitional between overlying middle Belt carbonate and underlying rocks of Ravalli Group. Widely distributed throughout Proterozoic rock terrane; as much as 200 m thick

Yg GRINNELL FORMATION (MIDDLE PROTEROZOIC)--Consists of two contrasting lithofacies--a highly quartzose facies near southeastern part of mapped area and an argillitic facies in northern part. Quartzose facies is interlayered sequence of red argillite and siltite, characterized by mudcracks and interstratified with abundant, white, crossbedded quartzite and sandstone. Quartzite is typically coarse grained and contains abundant red mud clasts. Argillite facies contains small amount of quartzite, mostly in upper half of formation, but is dominantly red, purple, and green argillite and siltite. Widely distributed in western part of Proterozoic terrane; thickness about 720 m

Yap APPEKUNNY FORMATION (MIDDLE PROTEROZOIC)--Upper part consists of couplets of green argillite beds and siltite beds--argillite is more abundant than siltite. Bedding thickness ranges from about 1 mm to 5 cm; contains minor amounts of light-gray quartzite in lenticular beds a few centimeters thick. Formation in vicinity of Waterton River valley is mostly thin-bedded, green to gray argillite and siltite and is not subdivided

Yapw Wolfgun Member--Upper part at type locality, near Anaconda Creek in south-central part of mapped area, consists of thin-bedded, green, dark-greenish-gray, and tannish-gray argillite and siltite. Middle part contains limestone and calcareous siltite beds and stromatolitic zones as thick as 0.7 m. Stromatolitic beds are discontinuous and occur locally 120-170 m above base of member. Siltite beds in middle part locally contain calcareous pods elongate parallel to bedding, possibly of algal origin. Lower part contains sequences of dark-gray, rusty, laminated argillite and siltite, similar to beds in underlying Prichard(?) Formation. North of type locality, Wolfgun Member contains decreasing amounts of carbonate minerals; near Long Bow Lake, it contains very minor amounts of carbonate. Thickness 365 m at type locality; thins to about 150 m near Long Bow Lake in northern part of mapped area

Pre-Ravalli rocks

Ya ALTYN FORMATION (MIDDLE PROTEROZOIC)--Consists of buff, light-gray, dark-gray, and orange dolomite, argillaceous dolomite, and stromatolitic limestone; contains a few thin beds of reddish argillite. Upper part is thin bedded, argillaceous, and forms recessive slopes. Middle part contains thick, resistant beds that form prominent cliffs. Carbonate rocks contain abundant, coarse, subangular to subrounded clastic debris of quartz and feldspar. Crops out near east shore of Waterton Lake in northeastern part of mapped area. Base is not exposed, and only uppermost 200 m of Altyn is in mapped area. Formation inferred to grade westward into rocks of upper part of Prichard(?) Formation

Yp PRICHARD(?) FORMATION (MIDDLE PROTEROZOIC)--Consists mostly of laminated to thin-bedded, black and light-gray argillite, argillitic siltite, and siltite. Outcrops are characteristically rusty from oxidation of iron sulfide minerals in the rocks. Thin beds of calcareous and dolomitic silty argillite and siltite are interlaminated with noncalcareous argillite and siltite over a 600-meter interval near top of formation. In lower part of this interval, silty argillite contains coarse detrital quartz, feldspar, and calcite. Crops out along stream valleys on west side of Livingston Range and along McDonald Creek. Also occurs in klippen on high parts of Dutch Ridge in south-central part of mapped area. Base of formation is not exposed. Thickest section in mapped area, about 850 m, extends from McDonald Creek to near top of Stanton Mountain

GEOLOGIC SETTING

Rocks in the northwestern part of Glacier National Park range in age from Middle Proterozoic to Tertiary. Large areas, particularly in the western part of the mapped area, are covered by unconsolidated Quaternary-age deposits, mostly of glacial origin. The Proterozoic rocks, which are exposed in the eastern half of the mapped area, are folded and are displaced by northwest-striking thrust and normal faults. The metasedimentary and mafic extrusive rocks (Middle Proterozoic age) are locally intruded by sills of dioritic composition which are inferred to be of Late Proterozoic age. Sedimentary rocks of Tertiary age crop out near the western boundary of the park.

The Proterozoic rocks strike northwest and dip gently to moderately southwest and northeast. They are part of the allochthon formed by the Lewis thrust fault, which underlies the mapped area at depth and surfaces about 20 km east of the mapped area. Thrust faults, synclines, and anticlines that deform the Proterozoic rocks are closely related to movement on the Lewis thrust fault. Southwest-dipping normal faults that trend northwesterly in the central and western parts of the area postdate the Lewis thrust. Rocks along these faults are downdropped to the west; the largest of these, the Flathead fault, shows more than 4,000 m displacement. The Flathead fault controlled the eastern margin of the Tertiary basin, which is now filled with lacustrine and fluvial sedimentary rocks. Recurrent rotational movement on the Flathead fault tilted the Tertiary rocks eastward.

During the Pleistocene this region was extensively glaciated. The last major glacial episode culminated about 20,000 years ago. At that time the valley of the North Fork of the Flathead River lay under more than a thousand meters of ice flowing to the south. Valleys draining west from the Livingston Range were filled by valley glaciers tributary to the larger glacier occupying the Flathead River valley.

CONTACT--Long-dashed where inferred; dotted where concealed

NORMAL FAULT--Ball and bar on downthrown side; dashed where inferred, dotted where concealed

THRUST FAULT--Sawteeth on upper plate; dashed where inferred, dotted where concealed

SILL OR DIKE

VOLCANIC FLOW

ANTICLINE--Dashed where inferred

OVERTURNED ANTICLINE

SYNCLINE--Dashed where inferred

MONOCLINE

STRIKE AND DIP OF BEDS

20 Inclined

30 Overturned

PARK BOUNDARY

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PRELIMINARY GEOLOGIC MAP AND CROSS SECTIONS OF THE NORTHWEST PART OF GLACIER NATIONAL PARK, MONTANA

By

Robert L. Earhart, Omer B. Raup, Jon J. Connor, Paul E. Carrara, Debra H. McGimsey, Kurt N. Constenius, and Richard E. Van Loenen

1983

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