DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-1508-D

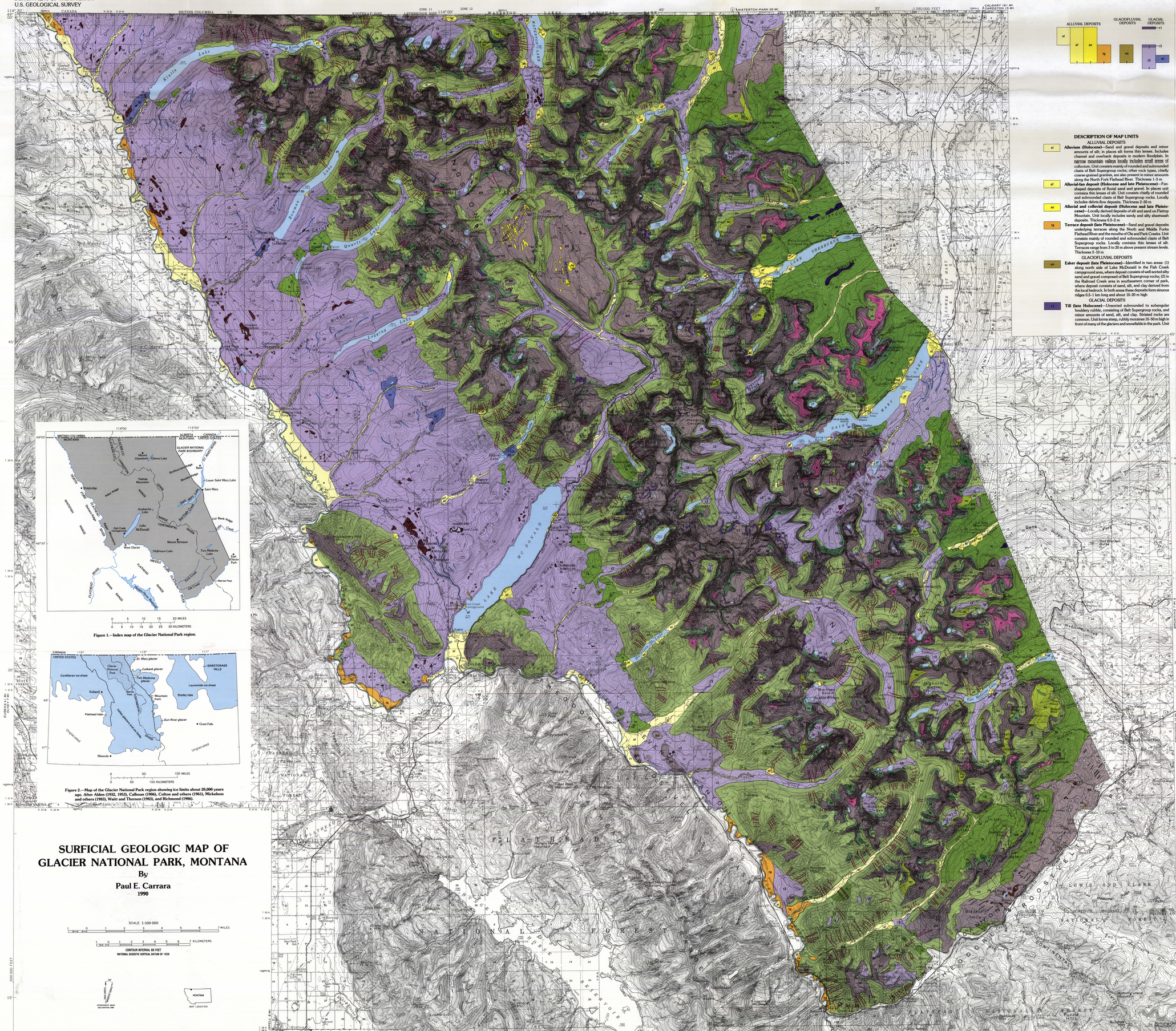


Figure 1.—Index map of the Glacier National Park region.

Figure 2.—Map of the Glacier National Park region showing ice limits about 20,000 years ago. After Alden (1932, 1953), Calhoun (1906), Colton and others (1961), Mickelson and others (1983), Waitt and Thorson (1983), and Richmond (1986).

SURFICIAL GEOLOGIC MAP OF GLACIER NATIONAL PARK, MONTANA

By
Paul E. Carrara
1990

SCALE 1:100 000

CONTOUR INTERVAL 80 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

APPROXIMATE MEAN DECLINATION, 1988

MONTANA
MAP LOCATION

DESCRIPTION OF MAP UNITS

ALLUVIAL DEPOSITS

al — **Alluvium (Holocene)**—Sand and gravel deposits and minor amounts of silt; in places silt forms thin lenses. Includes channel and overbank deposits in modern floodplain. In narrow mountain valleys locally includes small areas of colluvium. Unit consists mainly of rounded and subrounded clasts of Belt Supergroup rocks; other rock types, chiefly fine-grained granites, are also present in minor amounts along the North Fork Flathead River. Thickness 1-5 m

af — **Alluvial-fan deposit (Holocene and late Pleistocene)**—Fan-shaped deposits of fluvial sand and gravel. In places unit contains thin lenses of silt. Unit consists chiefly of rounded and subrounded clasts of Belt Supergroup rocks. Locally includes debris-flow deposits. Thickness 2-50 m

ac — **Alluvial and colluvial deposit (Holocene and late Pleistocene)**—Locally derived deposits of silt and sand on Flattop Mountain. Unit locally includes sandy and silty sheetwash deposits. Thickness 0.5-2 m

tg — **Terrace deposit (late Pleistocene)**—Sand and gravel deposits underlying terraces along the North and Middle Forks Flathead River and the mouths of Cile and Park Creeks. Unit consists mainly of rounded and subrounded clasts of Belt Supergroup rocks. Locally contains thin lenses of silt. Terraces range from 3 to 20 m above present stream levels. Thickness 2-10 m

GLACIOFLUVIAL DEPOSITS

es — **Esker deposit (late Pleistocene)**—Identified in two areas: (1) along north side of Lake McDonald in the Fish Creek campground area, where deposit consists of well-sorted silty sand and gravel composed of Belt Supergroup rocks; (2) in the Railroad Creek area in southeastern corner of park, where deposit consists of sand, silt, and clay derived from the local bedrock. In both areas these deposits form sinuous ridges 0.5-1 km long and about 10-20 m high

GLACIAL DEPOSITS

t1 — **Till (late Holocene)**—Unsorted subrounded to subangular bouldery rubble, consisting of Belt Supergroup rocks, and minor amounts of sand, silt, and clay. Striated rocks are common. Unit forms steep, rubbly moraines 10-50 m high in front of many of the glaciers and snowfields in the park. Unit is unweathered and supports little vegetation. Many of these moraines were deposited by glacial advances during the mid-19th century (Carrara and McGimsey, 1981, 1988; Carrara, 1987)

t2 — **Till (late Pleistocene)**—Unsorted subrounded to subangular bouldery rubble, consisting of Belt Supergroup rocks, and minor amounts of sand, silt, and clay. Unit commonly forms subdued, vegetated moraines 3-10 m high immediately downvalley from t1 deposits. Unit supports thin soil, which in places contains Mazama ash (Osborn, 1985; Carrara, 1987; Carrara and McGimsey, 1988) dated at about 6,845 B.P. (Bacon, 1983). Unit is thought to date from about 10,000 B.P. or slightly earlier (Carrara, 1987)

a1 — **Ablation till (late Pleistocene)**—Unsorted subrounded to subangular bouldery rubble, consisting mainly of Belt Supergroup rocks, and minor amounts of sand, silt, and clay. Striated rocks are common. This unit, deposited by stagnating mountain glaciers, forms hummocky, poorly drained deposits in valleys tributary to the valley of the North Fork Flathead River. In places this unit overlies t3 deposits, yet it is also older than some t3 deposits that lie upvalley. Thickness exceeds 40 m at some localities. This unit is in places overlain by the Glacier Peak G ash, which has been dated at about 11,200 B.P. (Mehringer and others, 1984)

t3 — **Till (late Pleistocene)**—Unsorted subrounded to subangular bouldery rubble, consisting mainly of Belt Supergroup rocks, and minor amounts of sand, silt, and clay. Striated rocks are common. Found on valley floors within mountainous areas where it was deposited as ground moraine by local mountain glaciers; here, its thickness is usually 1-3 m. Also found in the valleys of the North and Middle Forks Flathead River where it was deposited as a thick blanket of ground moraine by the large trunk glaciers that filled these valleys; here, its thickness exceeds 30 m in places. Locally includes small areas of bedrock and colluvium. This unit is in places also overlain by the Glacier Peak G ash

MASS-WASTING DEPOSITS

rg — **Rock-glacier deposit (Holocene and late Pleistocene)**—Lobate masses of unsorted angular blocky rubble; interstices filled with unsorted sand, silt, clay, and ice. Unit occurs at the head of some cirques. Thickness 10-30 m

ta — **Talus deposit (Holocene and late Pleistocene)**—Unsorted and mainly unvegetated, angular, bouldery rubble in a matrix of sand, silt, and clay at bases of steep valley walls or cliffs. Some of the larger deposits exceed 30 m in thickness

ls — **Landslide deposit (Holocene and late Pleistocene)**—Unit includes large rock slumps, slump-earth flows, and rock block slides (Varnes, 1978). The size and the kind of clasts and the grain size of the matrix vary according to the bedrock units involved in the landslide. Rock slumps are common in the eastern side of the park in those areas underlain by Cretaceous sedimentary rocks. Rock block slides, although not common, are present in areas underlain by Belt Supergroup rocks. Rock slumps and slump-earth flows are common in areas in the western side of the park underlain by the soft sedimentary rocks of the late Paleogene Kishenehn Formation. Some of the larger landslides exceed 50 m in thickness and cover several square kilometers. Locally includes small areas of till and colluvium

co — **Colluvial deposit (Holocene and late Pleistocene)**—Mainly locally derived slope deposits consisting of unsorted angular gravel-size clasts in a matrix of unsorted sand, silt, and clay. Unit locally includes some small areas of bedrock and till as well as talus, rock avalanche, and debris-flow deposits. Commonly 1-5 m thick

so — **Solifluction and related deposit (Holocene and Pleistocene)**—Includes solifluction lobes, sorted polygons, and sorted stone stripes. Unit found mainly in unglaciated upland areas. Locally includes other mass-wasting deposits. Thickness 0.5-2 m

FROST-HEAVED DEPOSITS

fr — **Frost rubble (Holocene and Pleistocene)**—Unsorted veneer of angular pebbles, cobbles, and boulders derived from the underlying bedrock by frost action. Unit found in unglaciated upland areas. Thickness commonly less than 1 m

ORGANIC DEPOSITS

Organic deposit (Holocene and late Pleistocene)—Peat and organic muck. Common in the valley of the North Fork Flathead River. Thickness 2-5 m

MISCELLANEOUS DEPOSITS

Diamicton (early Pleistocene or Pliocene?)—Unsorted subrounded to subangular bouldery rubble, consisting of Belt Supergroup rocks, and minor amounts of sand, silt, and clay. Unit occurs beneath Boulder, Cut Bank, and Swiftcurrent Ridges. Striated rocks are common. In places, unit is weakly cemented by calcium carbonate. Locally, unit is as much as 60 m thick. This unit is equivalent to the "pre-Wisconsin glacial drift" of Alden (1932)

BEDROCK

BR — **Bedrock (late Paleogene, Cretaceous, and Proterozoic)**—Includes: (1) late Paleogene sedimentary rocks of the Kishenehn Formation, consisting of lacustrine and fluvial sediments in west side of park (Constenius, 1981); (2) Cretaceous sedimentary rocks, consisting predominantly of the Upper Cretaceous Marias River Shale, a dark-gray marine mudstone, in east side of park (Mudge and Earhart, 1983); and (3) Proterozoic rocks of the Belt Supergroup, consisting mainly of siltites and argillites and subordinate amounts of igneous rocks that occur as sills, dikes, and flows in central mountainous region of park (McGimsey, 1985; Ross, 1959; Raup and others, 1983; Whipple and others, 1984). In places, unit is mantled by small, thin patches of surficial material

Contact

Glacial meltwater channel

Orientation of drumlinoid feature

Prominent snow avalanche track—Many have well-defined forest trimlines. Limits of avalanche tracks are approximate

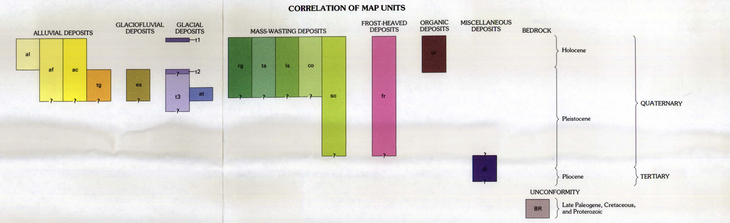
M→ **Bog, exposure, or soil pit location containing Mazama ash**

G→ **Bog or exposure containing Glacier Peak G ash**

H→ **Exposure containing Mount St. Helens Jy ash**

8,720±80 **Locality of ^{14}C age**—In years B.P. (see table 1)

CORRELATION OF MAP UNITS



DISCUSSION

GEOLOGY AND GEOGRAPHY

Glacier National Park, in northwestern Montana adjacent to the Canadian border, encompasses about 4,000 km² of Flathead and Glacier Counties (fig. 1). The park contains three physiographically distinct areas: (1) the valleys of the North and Middle Forks Flathead River on the west, (2) the central mountainous region, and (3) the plains on the east. Bedrock in the park ranges in age from late Paleogene to Proterozoic (Ross, 1959; Raup and others, 1983) and is in many places mantled by surficial deposits of Quaternary age.

On the west, the heavily forested valleys of the North and Middle Forks Flathead River trend northwest to southeast; valley floors range in altitude from about 975 to 1,280 m. These valleys have been downdropped on the east and are underlain by 5,000 m of upper Paleogene sedimentary rocks of the Kishenehn Formation, consisting of lacustrine and fluvial sediments (Constenius, 1981). In some places, these rocks have failed, resulting in large landslides, such as the one in the Hallroom Lake area. In other areas, these rocks are covered by till of late Pleistocene age as much as 30 m thick. Depressions within this till contain numerous bogs filled with peats, organic muck, and volcanic ashes.

The central part of Glacier National Park is dominated by two rugged mountain ranges that trend northwest to southeast and contain numerous small glaciers and snowfields. The Livingston Range, on the west, extends for 40 km from the Canadian border south to the Lake McDonald region. The Lewis Range, on the east, extends for 85 km from the border south through the park to Marias Pass. Large areas of these ranges lie above timberline (about 2,000 m) and many of the peaks in these ranges exceed 2,800 m in altitude. Mount Cleveland (3,191 m), in the Lewis Range, is the highest peak in the park. Relief in these ranges is rugged and many of the valley floors are as much as 1,500 m below their surrounding summits. The Continental Divide follows the crest of the Lewis Range northward to a position about 16 km south of the border, then shifts westward and follows the crest of the Livingston Range north into Canada.

These mountain ranges are underlain by Proterozoic sedimentary rocks of the Belt Supergroup, ranging in age from about 800 Ma to 1,600 Ma (Raup and others, 1983). The rocks consist of a sequence of argillites, siltites, and carbonates that have a maximum stratigraphic thickness of 5,200 m (Whipple and others, 1984). Because these rocks have been affected only by low-grade metamorphism, many of their original sedimentary features (ripple marks, mud cracks, salt casts, and fossil algal stromatolites) are well preserved. In places these rocks have been intruded by diabasic and gabbroic sills and dikes. The upper part of the section contains mafic lava flows 10-60 m thick (McGimsey, 1985). This entire sequence of rocks was thrust eastward over Cretaceous sedimentary rocks along the Lewis thrust fault during the Paleocene (Raup and others, 1983), and today forms a broad syncline whose axis closely parallels the Continental Divide (Ross, 1959).

Numerous surficial deposits mantle these mountain ranges. A large rock block slide is present immediately west of Avalanche Lake and several are present in the area north of Glenns Lake. Steep valley sides, whose forest is scarred in places by snow avalanche tracks, are mantled by colluvium. Talus cones and sheets are common at the base of steep slopes and cliffs. Till mantles the floors of many of the mountain valleys. In the higher regions of these two ranges, two sets of moraines can be found in front of the present-day glaciers and snowfields (Osborn, 1985; Carrara, 1987; Carrara and McGimsey, 1988). High, unglaciated upland surfaces locally have a thin cover of stone stripes, sorted polygons, and solifluction deposits.

East of the mountain front is the western margin of the Montana plains. This area consists of low, rounded hills mantled in places by a veneer of glacial till. Altitudes range from about 1,370 to 2,000 m. This area is underlain by sedimentary rocks of mainly the Upper Cretaceous Marias River Shale, which is a dark-gray marine mudstone (Mudge and Earhart, 1983). In places immediately east of the mountain front, Pleistocene valley glaciers emerging from the Lewis Range gouged deep, steep-sided valley walls in these soft rocks. After deglaciation, many of these rocks failed and formed massive landslides.

GLACIER NATIONAL PARK DURING THE LATE WISCONSIN GLACIATION

During the height of the last major glaciation, about 20,000 years ago, much of northwestern Montana, including the Glacier National Park region, was covered by glacial ice (fig. 2). To the west, the southern margin of the Cordilleran ice sheet stretched from the Puget Sound area of Washington to western Montana. This large ice sheet was formed by the coalescence of valley glaciers in the mountains of British Columbia and flowed south overriding low mountain ranges in Washington, Idaho, and Montana. Lobes from this ice sheet flowed into various river valleys south of the main ice mass. The easternmost lobe of this ice sheet, the Flathead lobe, flowed south into the Flathead Lake region (Alden, 1953; Waitt and Thorson, 1983; Richmond, 1986).

On the plains of Montana east of Glacier National Park lay the southwestern lobe of the Laurentide ice sheet. This ice sheet covered most of Canada, and its southern margin stretched from Montana east to the Atlantic Ocean. The southwestern lobe of this ice sheet, the Shelby lobe, advanced south from Canada across the Montana plains into this region (Alden, 1932; Mickelson and others, 1983).

Between these two large ice sheets, in the mountains along the Continental Divide, valley glaciers and icefields developed (Alden, 1953; Richmond, 1986). The present-day Glacier National Park region was covered by hundreds of meters of glacial ice so that only the higher peaks protruded as nunataks above this ice cover. On the western side of the Continental Divide, glaciers flowed from valleys along the western flank of the Livingston Range and the eastern flank of the Whitefish Range. Many of these glaciers were 10-20 km long and several hundreds of meters thick. These glaciers merged with a large trunk glacier flowing southeast down the valley of the North Fork Flathead River. This trunk glacier, which headed in the mountains of British Columbia, filled the valley of the North Fork with at least 1,000 m of ice. Evidence for such an ice thickness is given by striations and erratics along the crest of the Apgar Mountains and Demers Ridge (Alden, 1953), and by sinuous meltwater channels, which trend northwest-southeast, on the interflows on the west flank of the Livingston Range, such as Adair Ridge. This ice drained to the southwest, overrode the Apgar Mountains, and merged with the Flathead lobe of the Cordilleran ice sheet.

From the Lake McDonald area south, the Lake McDonald glacier, which drained the Flattop Mountain area, and glaciers flowing from valleys along the western flank of the Lewis Range in the park and from valleys along the eastern flank of the Flathead Range merged with a large trunk glacier that occupied the valley of the Middle Fork Flathead River. This large trunk glacier, which headed in the Lewis and Clark Range about 100 km to the southeast in the present-day Great Bear Wilderness, formed a local ice field in the area west of Marias Pass. Some of this ice flowed to the northwest and joined the large trunk glacier flowing south in the valley of the North Fork Flathead River and eventually merged with the Flathead lobe of the Cordilleran ice sheet. Other ice from this glacier flowed east across the Continental Divide and was a major source of ice for the former Two Medicine glacier.

East of the Continental Divide in the Glacier National Park region, some glaciers advanced beyond the mountain front and formed large piedmont glaciers on the adjoining plains. The largest of these piedmont glaciers was the Two Medicine glacier. Mountain glaciers along a 60-km length of the mountain front merged to form this glacier, including glaciers from the Two Medicine Valley and ice from the icefield west of the Continental Divide in the Marias Pass area. This piedmont lobe had a maximum width of about 50 km, extended about 55 km east of the mountain front, and deposited a veneer of hummocky till over a 2,000-km² area (Calhoun, 1906; Alden, 1932).

To the north in Glacier National Park, glaciers occupied the valleys of Lake and Cut Bank Creeks. These glaciers flowed east and merged on the plains to form a small piedmont lobe that extended beyond the mountain front about 15 km (Calhoun, 1906; Alden, 1932).

Farther north, a large glacier flowed down Saint Mary Valley, beyond the mountain front and into Canada where its terminal deposits lie beneath till of a subsequent advance of the Laurentide ice sheet (Calhoun, 1906; Alden, 1932; Horberg, 1954). In the vicinity of Lower Saint Mary Lake this glacier was about 370 m thick (Alden, 1932). This large glacier was fed by other glaciers flowing from the valleys of Divide, Red Eagle, Boulder, Swiftcurrent, Kennedy, and Otatso Creeks in Glacier National Park. In the interior of the park, the valleys of the Belly and Waterton Rivers were filled with large glaciers, about 400 m thick, that flowed north into Canada.

CHRONOLOGY OF LATE PLEISTOCENE AND HOLOCENE EVENTS IN THE GLACIER NATIONAL PARK REGION

Volcanic ashes erupted from volcanoes in the Cascade Range of the Pacific Northwest have been identified in postglacial deposits in the Glacier National Park region. Glacier Peak G ash, erupted from Glacier Peak in Washington State, has been identified in postglacial deposits at nine sites in the map area. This ash was erupted about 11,200 B.P. (Mehringer and others, 1984). At two of these sites, this ash is underlain by an ash erupted from Mount St. Helens Jy (Jy) in Washington State. The Mount St. Helens Jy ash is thought to date from about 11,400 B.P. (Carrara and others, 1986).

Because the Glacier Peak G and Mount St. Helens Jy ashes were both erupted in the late Pleistocene, when the Glacier National Park region was undergoing extensive deglaciation, the presence of these ashes at a site provides information concerning the extent and timing of deglaciation. Also, at sites where these ashes were found with associated pollen and plant and insect macrofossils, information concerning revegetation and environmental conditions has also been obtained (Carrara and others, 1986).

The location of sites containing the Glacier Peak G and Mount St. Helens Jy ashes in the Glacier National Park region indicate that between 11,200 and 11,400 B.P. deglaciation was at least 90 percent complete. By this time remaining glaciers, if any, were confined to local mountain valleys (Carrara, 1986). In addition, data from Banff and Jasper National Parks, Alberta, indicate that by 10,000 B.P. late Wisconsin glaciers had receded to positions close to those of present-day glaciers (Luckman and Osborn, 1979). A similar amount of deglaciation at that time is inferred for the Glacier National Park region. Hence, by 10,000 B.P. any remaining glaciers were probably confined to those same cirques and well-shaded niches that contain present-day glaciers and snowfields.

The Mazama ash, which erupted from Mt. Mazama, the present site of Crater Lake, Oregon, about 6,845 B.P. (Bacon, 1983), was also deposited in the Glacier National Park region. This ash commonly occurs in bogs as well as in the soil overlying glacial and periglacial deposits in the higher regions of the park. The Mazama ash is a useful time-stratigraphic marker and provides a minimum date for many of the deposits in the higher regions of the park that could not be radiocarbon dated because of a lack of associated organic material (Osborn, 1985; Carrara, 1987; Carrara and McGimsey, 1988).

In addition, a number of radiocarbon ages have been obtained from organic material recovered from bogs and exposures along stream banks in the Glacier National Park region (table 1). Radiocarbon ages on the lowestmost organic material at these sites provide minimum dates for the beginning of organic sedimentation as well as minimum dates of deglaciation. Radiocarbon ages on wood fragments from some of these sites provide minimum dates of reforestation.

Because Glacier National Park was extensively covered by glacial ice about 20,000 years ago, most of the surficial deposits shown on this map were deposited during or after the late Pleistocene regional deglaciation. Only those deposits in areas not covered by glacial ice during the last glaciation may date from earlier periods.

Table 1.—*Radiocarbon ages in the Glacier National Park region*

^{14}C age	Laboratory No.	Material dated
780±70	W-5169	Wood[1]
8,730±80	W-5041	Pine fragments[2]
9,510±350	W-5571	Pine fragments[2]
9,600±250	W-5575	Gyttja containing conifer fragments[3]
9,680±110	W-5182	Peat[1]
9,850±260	W-5577	Gyttja containing willow fragments[3]
9,910±100	W-5191	Pine fragments[2]
9,930±120	W-5187	Peat and pine fragments[2]
10,090±130	W-5185	Gyttja[3]
10,630±250	W-5348	Spruce or larch fragments[2]
11,150±90	W-5043	Organic material[3] (<0.125 mm).

[1]Material found at base of landslide.
[2]Minimum date of reforestation following deglaciation.
[3]Minimum date of organic sedimentation following deglaciation.

REFERENCES CITED

Alden, W.C., 1912, Pre-Wisconsin glacial drift in the region of Glacier National Park: Geological Society of America Bulletin, v. 23, p. 687-708.
_____1932, Physiography and glacial geology of eastern Montana and adjacent areas: U.S. Geological Survey Professional Paper 174, 133 p.
_____1953, Physiography and glacial geology of western Montana and adjacent areas: U.S. Geological Survey Professional Paper 231, 200 p.
Bacon, C.R., 1983, Eruptive history of Mount Mazama and Crater Lake caldera, Cascade Range, U.S.A.: Journal of Volcanology and Geothermal Research, v. 18, p. 57-115.
Calhoun, F.H.H., 1906, The Montana lobe of the Keewatin ice sheet: U.S. Geological Survey Professional Paper 50, 62 p.
Carrara, P.E., 1986, Late Pleistocene deglaciation and reforestation of the Glacier National Park region, Montana: American Quaternary Association, 9th Biennial Meeting, Abstracts with Programs, p. 122.
_____1987, Holocene and latest Pleistocene glacial chronology, Glacier National Park, Montana: Canadian Journal of Earth Sciences, v. 24, p. 387-395.
Carrara, P.E., and McGimsey, R.G., 1981, The late-neoglacial histories of the Agassiz and Jackson Glaciers, Glacier National Park, Montana: Arctic and Alpine Research, v. 13, p. 183-196.
_____1988, Map showing distribution of moraines and extent of glaciers from the mid-19th century to 1979 in the Mount Jackson area, Glacier National Park, Montana: U.S. Geological Survey Miscellaneous Investigations Series Map I-1508-C, scale 1:24,000.
Carrara, P.E., Short, S.K., and Wilcox, R.E., 1986, Deglaciation of the mountainous region of northwestern Montana, U.S.A., as indicated by late Pleistocene ashes: Arctic and Alpine Research, v. 18, p. 317-325.
Colton, R.B., Lemke, R.W., and Lindvall, R.M., 1961, Glacial map of Montana east of the Rocky Mountains: U.S. Geological Survey Miscellaneous Investigations Series Map I-327, scale 1:500,000.
Constenius, K.N., 1981, Stratigraphy, sedimentation, and tectonic history of the Kishenehn Basin, northwestern Montana: Laramie, Wyo., University of Wyoming, M.S. thesis, 115 p.
Horberg, Leland, 1954, Rocky Mountain and continental Pleistocene deposits in the Waterton region, Alberta, Canada: Geological Society of America Bulletin, v. 65, p. 1093-1150.
Luckman, B.H., and Osborn, G.D., 1979, Holocene glacier fluctuations in the middle Canadian Rocky Mountains: Quaternary Research, v. 11, p. 52-77.
McGimsey, R.G., 1985, The Purcell Lava, Glacier National Park, Montana: Boulder, Colo., University of Colorado, M.S. thesis, 283 p.
Mehringer, P.J., Jr., Sheppard, J.C., and Foit, F.F., Jr., 1984, The age of the Glacier Peak tephra in west-central Montana: Quaternary Research, v. 21, p. 36-41.
Mickelson, D.M., Clayton, Lee, Fullerton, D.S., and Borns, H.W., Jr., 1983, The late Wisconsin glacial record of the Laurentide ice sheet in the United States, *in* Porter, S.C., ed., Late Quaternary environments of the United States—Volume 1, The late Pleistocene: Minneapolis, Minn., University of Minnesota Press, p. 3-37.
Mudge, M.R., and Earhart, R.L., 1983, Bedrock geologic map of part of the northern disturbed belt, Lewis and Clark, Teton, Pondera, Glacier, Flathead, Cascade, and Powell Counties, Montana: U.S. Geological Survey Miscellaneous Investigations Series Map I-1375, scale 1:125,000.
Osborn, G.D., 1985, Holocene tephrostratigraphy and glacial fluctuations in Waterton and Glacier National Parks, Alberta and Montana: Canadian Journal of Earth Sciences, v. 22, p. 1093-1101.
Raup, O.B., Earhart, R.L., Whipple, J.W., and Carrara, P.E., 1983, Geology along Going-to-the-Sun Road, Glacier National Park, Montana: West Glacier, Mont., Glacier Natural History Association, 62 p.
Richmond, G.M., 1986, Tentative correlation of deposits of the Cordilleran ice sheet in the Northern Rocky Mountains: Quaternary Science Reviews, v. 5, p. 129-144.
Ross, C.P., 1959, Geology of Glacier National Park and the Flathead region, northwestern Montana: U.S. Geological Survey Professional Paper 296, 125 p.
Varnes, D.J., 1978, Slope movement types and processes, *in* Schuster, R.L., and Krizek, R.J., eds., Landslides, analysis and control: National Academy of Sciences, Transportation Research Board Special Report 176, p. 11-33.
Waitt, R.B., Jr., and Thorson, R.M., 1983, The Cordilleran ice sheet in Washington, Idaho, and Montana, *in* Porter, S.C., ed., Late Quaternary environments of the United States—Volume 1, The late Pleistocene: Minneapolis, Minn., University of Minnesota Press, p. 53-70.
Whipple, J.W., Connor, J.J., Raup, O.B., and McGimsey, R.G., 1984, Preliminary report on the stratigraphy of the Belt Supergroup, Glacier National Park and the adjacent Whitefish Range, Montana, *in* McBane, J.D., and Garrison, P.B., eds., Northwestern Montana and adjacent Canada: Montana Geological Society, 1984 Field Conference Guidebook, p. 33-50.

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