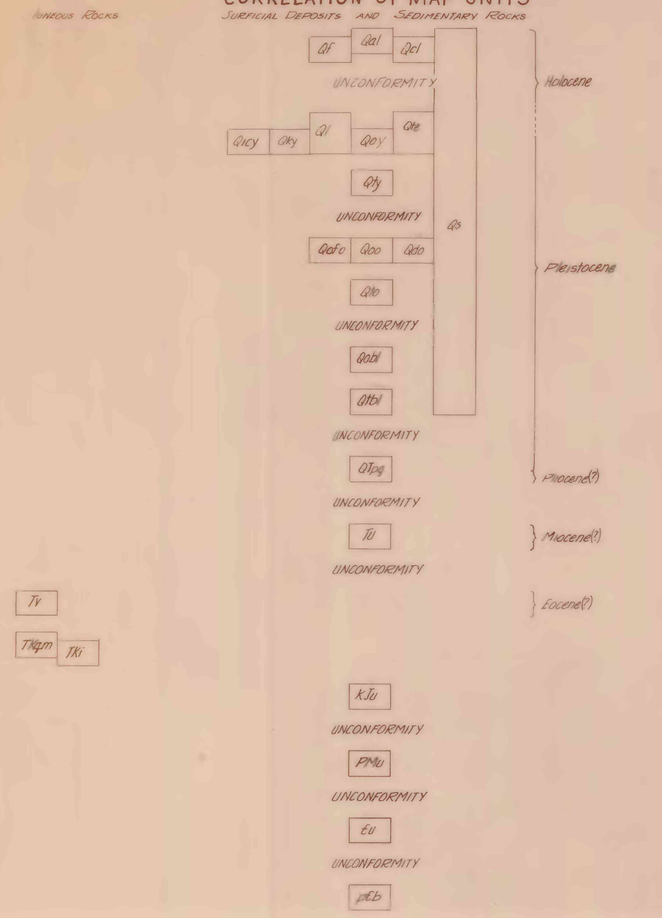
CORRELATION OF MAP UNITS



CONTACT--Approximately located or inferred

FAULT--Dashed where approximately located or inferred; dotted where concealed. Ball on downthrown side

ANTICLINE--Showing trace of axial plane and direction of plunge of axis

SYNCLINE--Showing trace of axial plane and direction of plunge of axis

DESCRIPTION OF MAP UNITS

[This is a combined map description for quadrangles in the southern part of the Big Fork-Avon environmental study area (Open-File Reports 79-437 to 79-447). Not all units will appear on all maps.]

Qal ALLUVIUM (HOLOCENE)--Light to dark gray and brownish gray; stream-deposited, unconsolidated, moderately to well-bedded, interstratified assemblage of silt, sand, and gravel. Typically clay-rich and cohesive where incised into claystones, siltstones, and shales of older basin-fill deposits. Gold-bearing sand and gravel occur locally in the northward-draining valleys of the Garnet Range, and in the westward-draining valleys of the mountains east of Helmville and Avon. Characterized by shallow depths to ground water. Soil drainage is poor and shrink-swell potentials are inferred to be relatively low

Qf ALLUVIAL FAN DEPOSITS (HOLOCENE)--Small, moderately sloping, poorly sorted, crudely stratified silt, sand, gravel, cobbles, and boulders at the mouths of small gullies and high-gradient streams. Ground-water conditions are quite variable, and flash-flood hazard potential is high, especially near the upper apex of the fan. Shrink-swell potential is inferred to be generally low

Qcl COLLUVIUM (HOLOCENE)--Unsorted debris that has slid or been washed downslope to form small, thin, and hummocky deposits. Best developed in terrane underlain by Tertiary volcanic rocks. Shrink-swell potentials are variable, and are inferred to range from moderate to high

Qs LANDSLIDE DEPOSITS (QUATERNARY)--Small, fan- and lobate-shaped hummocky masses of semiconsolidated soil, till, Tertiary basin fill, and volcanic debris. Clay and soil-moisture content are generally high. Small springs or seeps are common. Many of these landslides are active and all should be considered unstable. Shrink-swell potentials are variable, and are inferred to range from moderate to high

SEDIMENTS DEPOSITED BY MELTWATERS OF PINEDALE GLACIATION (QUATERNARY)--YOUNGER ICE

Ql Lacustrine Deposits--Pink; rhythmically bedded silt, sandy silt, and clay with included lenses of sand and gravel. Forms gently sloping, smooth surfaces at altitudes generally below 1,158 m (3,800 ft). Soil drainage ranges from fair to poor, but lateral permeability may be high within the interbedded sandy beds and lenses. High frost-heave susceptibility. Clay-rich beds have a moderate shrink-swell potential

Qicy Ice-Contact Deposit--Dark brown and brown; composed of moderately well sorted silt, sand, and gravel. Forms an elongate, gently sloping bench. Clasts range in shape from angular to rounded; most are rounded. Sizes range from 3 mm to 20 cm (1/8-8 in.); dominant sizes range from 13 mm to 5 cm (1/2-2 in.). Cobbles and small angular to rounded boulders 0.6-1 m (2-3 ft) are scattered across the surface. Formed in contact with wasting ice

Qky Kame Deposits--Dark brown and brown; consists of moderately to poorly sorted silt, sand, and gravel. Forms small, conical to ellipsoidal, steep-sided hillocks. Few well-rounded cobbles scattered irregularly through the unit. Formed by a glacial stream that flowed down into a stagnant ice mass

Qoy Outwash--Light brown, and grayish brown; moderately well sorted; composed of silt, sand, and subrounded to rounded pebbly and cobbly gravel. Commonly the upper 1 m (3 ft) is composed of light-brown, fine- to medium-grained sand. Generally forms broad, smooth-surfaced plains which grade to the main valley of the Blackfoot River, and lie 1.5-6 m (5-20 ft) above the modern stream channel. Ground water commonly occurs at shallow depths

Qte Terrace Deposits--Gray, tan, brown, and pink; unconsolidated, moderately well sorted, well-bedded silt, sand, gravel, and cobbles in smooth-surfaced, dissected deposits flanking modern stream channels, and in abandoned channels 5-6 m (15-20 ft) above modern stream channels. These deposits are typically moderately to well-drained, and are inferred to have relatively low shrink-swell potential

SEDIMENTS DEPOSITED BY MELTWATERS OF PINEDALE GLACIATION (UPPER PLEISTOCENE)--OLDER ICE

Qoo Outwash--Dark brown, reddish brown, and brown; consists of moderately well sorted silt, sand, and subangular to rounded gravel and cobbly gravel. Forms smooth, locally dissected plains and terraces which lie 6-30 m (20-100 ft) above the younger outwash deposits. Ground water occurs at moderate depths

Qofo Outwash Fan Deposit--Even-surfaced, gently sloping, cone-shaped deposit of unconsolidated, moderately sorted silt, sand, gravel, and cobbles. Probably formed at some time after the Blackfoot River was diverted by lobes of ice which lay in the Montana, North Fork of the Blackfoot, and Nevada Creek valleys

Qdo Deltaic Gravels--Tan to brown; locally crossbedded, unconsolidated, well-sorted, medium- to coarse-grained sand, and gravel. Clasts range in shape from angular to round. Deposited in a small glacial lake formed where southward advancing ice impinged upon the northern flank of the Garnet Range blocking the northward flowing ancestral Pearson Creek (see Chamberlain Mountain quadrangle)

TILL OF PINEDALE GLACIATION (UPPER PLEISTOCENE)

Qty Till Deposited by Younger Ice--Characterized by a striking knob-and-kettle topography with many lakes and swamps. Consists of a heterogeneous assemblage of unsorted gravel, cobbles, and boulders in a light reddish-brown to tan silty to clayey matrix. Many large boulders are scattered across both the lateral and ground moraines, and the terminal moraine near Kleinschmidt Lake; locally parts of the moraine surface slope as much as 65 percent. Clasts range in shape from angular to well rounded, and are predominantly quartzites, argillites, and limestones of the Belt Supergroup. Soil drainage and permeability is variable, but generally is poor

Qto Till Deposited by Older Ice--Characterized by somewhat subdued knob-and-kettle topography. Consists of a heterogeneous assemblage of gravel, cobbles, and boulders in a reddish-brown, dense, granular, calcareous, clayey to silty, locally sandy matrix. Generally less than 15 percent of the till is gravel size or larger. Sparce boulders are scattered across both the lateral and ground moraines; surface slopes are commonly less than 23 percent. Clasts range in shape from angular to well rounded, and are predominantly quartzites, argillites, and limestones of the Belt Supergroup. Soil drainage and permeability generally is poor

Qobl OUTWASH OF BULL LAKE(?) ICE (PLEISTOCENE)--Brown and reddish brown; unconsolidated, mildly calcareous, well-bedded and moderately well sorted silt, sand, gravel, and cobbles. Forms even-surfaced, gently sloping, highly dissected remnants which are about 12 m (40 ft) above the outwash of the older ice. Soil drainage is moderate to good

Qtbl TILL DEPOSITED BY BULL LAKE(?) ICE (PLEISTOCENE)--A generally foraless, gently undulating deposit of low relief characterized by sparse kettle depressions, and a few boulders scattered across the surface. Consists of an unconsolidated, unsorted assemblage of sand, gravel, cobbles, and boulders in a brown to reddish-brown, compact, clayey matrix. Locally large glacial boulders, 3-4 m (10-13 ft) across, are scattered through the till; they are especially common near Nimemile Prairie (see Greenough quadrangle). Clay content is higher and this till consequently is more susceptible to mass movement than the younger tills. Where deeply dissected yields a discontinuous rubble veneer of cobbles and boulders

QTog PIEDMONT ALLUVIUM (QUATERNARY AND TERTIARY)--Reddish brown and tan; unconsolidated, moderately well sorted, stratified silty sand and silt, sand, and gravel which mantle broad, smooth-surfaced benches that flank the mountains in the Helmville-Avon area. Deposits thin basinward, and typically are coarser-grained near the mountains. Overlies truncated pre-Tertiary and Tertiary sedimentary and volcanic rocks, and is augmented by modern stream valleys and gullies. Locally the upper part of the deposit is weakly cemented by calcium carbonate. Soundness and durability of the gravel is quite variable but typically is poor if the gravels contain high percentages of volcanic rock types. Those deposits rich in volcanic rock types are most common in basins which are adjacent to extensive outcrops of volcanic rocks

Tu BASIN DEPOSITS, UNDIVIDED (TERTIARY)--Brown, grayish brown, and yellowish brown; semiconsolidated to consolidated clays, shales, siltstones, and sandstones with minor amounts of conglomerate. Also included are white, gray, brown, yellowish brown, and red beds of altered volcanic ash, and ash-rich shale and siltstone. Competence is fair to good in the brown siltstones and sandstones but poor in the light-colored shales, clays, and ash beds. "Popcorn" surface on the shales, clays, and ash beds indicate a high-swell potential. Soil drainage is fair to poor. In many localities this unit underlies till, outwash, or alluvium and restricts and controls the downward and lateral migration of the local ground water

Tv VOLCANIC ROCKS, UNDIVIDED (TERTIARY)--Small outcrops of trachyte, andesite, lamprophyre, and extrusive volcanic breccia are in the western part of the area near Greenough (see Greenough quadrangle). Extensive basalt and andesite flows, volcanic breccias, and minor amounts of rhyolite, dacite, diorite, gabbro, latite, and welded tuff are in the eastern part of the area near Helmville and Avon (see Helmville and Avon quadrangles). The volcanic breccias are clay rich and very susceptible to mass movement

TKgm QUARTZ MONZONITE INTRUSIVE ROCKS (TERTIARY AND CRETACEOUS)--Consists of the intrusive Garnet stock and other smaller igneous bodies. Generally shows well-developed blocky jointing; weathers to spheroidal boulders. Gold minerals are in quartz veins that fill fractures in the quartz monzonite in a zone within about half a mile of the surrounding marble and limestone country rock

TKi ACIDIC AND INTERMEDIATE INTRUSIVE ROCKS (TERTIARY AND CRETACEOUS)--Includes small intrusive igneous bodies ranging in composition from quartz monzonite to dacite

KJu CRETACEOUS AND JURASSIC BEDROCK, UNDIVIDED--Folded and faulted outcrops of (in descending order) the Cretaceous Blackleaf and Kootenai Formations and the Jurassic Swift, Rierdon, and Sawtooth Formations

PMu PERMIAN TO MISSISSIPPIAN BEDROCK, UNDIVIDED--Folded and faulted outcrops of the Phosphoria and Quadrant Formations, and the Madison Group. Locally some limestone and dolomite beds of the Jefferson Formation (Devonian) may be included with the Madison Group

Єu CAMBRIAN STRATA, UNDIVIDED--Folded, faulted and locally intruded and metamorphosed outcrops of the (in descending order) Wolsack and Silver Hill Formations and Flathead Quartzite. Near the Garnet stock the limestones of the Wolsack(?) and Silver Hills Formations have been metamorphosed to marble

pЄb BELT SUPERGROUP ROCKS, UNDIVIDED (PRECAMBRIAN)--Consists of various units of the Belt Supergroup, chiefly the Mount Shields (argillite and sandstone), Shepard (argillite and dolomite), and Snowslip (argillite and sandstone) Formations in the northern part of the area; and the quartzite and claystone of Black Mountain, Bonner Quartzite and the Mount Shields, Shepard, and Snowslip (calcareous mudstone and quartzite) Formations in the southern part of the area

Introduction

The eleven maps in the set (79-437 through 79-447) are part of a series prepared as a result of a cooperative venture between Missoula and Powell Counties, Montana and the U.S. Geological Survey. Weber, the senior author, at one time served as geologic consultant to the counties, and he is primarily responsible for the geologic mapping of the southern half of the Big Fork-Avon area. Witkind mapped the northern half of the area and his maps are available as Open-File Reports (listed below). Weber is now a geologist with the U.S. Forest Service in Great Falls, Montana; Witkind is a geologist with the U.S. Geological Survey in Denver, Colorado.

The area studied extends from the Big Fork Quadrangle on the north to the Avon Quadrangle on the south (see Index map). All the maps are products of that study and are intended for use by environmental and land-use planners.

Copies of the available maps can be purchased from:

Open File Services Section,
Branch of Distribution,
Box 25425, Federal Center,
Denver, Colorado 80225

The maps can also be examined at the following offices:

Denver Public Inquiries Office,
U.S. Geological Survey,
1012, Federal Building,
1961 Stout Street,
Denver, Colorado 80202

Salt Lake City Public Inquiries Office,
U.S. Geological Survey,
8015, Federal Office Building,
125 South State Street
Salt Lake City, Utah 84111

Spokane Public Inquiries Office,
U.S. Geological Survey,
678, U.S. Courthouse Building,
West 920 Riverside Avenue,
Spokane, Washington 99201

In addition to these maps, another map, by Witkind which discusses the seismicity of the Big Fork-Avon area, has been published as U.S. Geological Survey Miscellaneous Field Studies Map MF-923 and is titled Major active faults and seismicity in and near the Big Fork-Avon area, northwestern Montana.

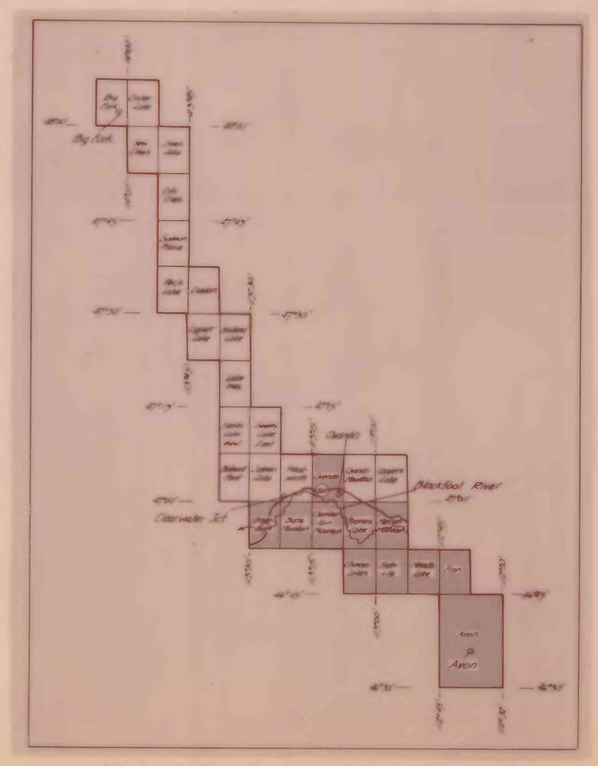
Surficial deposits

Most of the surficial deposits in the southern part of the Big Fork-Avon area were formed primarily during several advances and subsequent melts of large glaciers. The first advance recognized locally probably occurred about 150,000 years ago, during the Bull Lake Glaciation of the Pleistocene, when ice from the mountains to the north spread southward across the Blackfoot River. Deposits of this glacier are shown on the maps by the letters "bl" added to the symbol, thus "Qtbl--Till deposited by Bull Lake(?) ice." Subsequently, some 20,000 to 30,000 years ago during the Pinedale Glaciation of the Pleistocene, another glacier again moved southward into the area. It apparently reached almost as far south as Helmville, before it withdrew and then readvanced again. This readvance, however, did not extend as far to the south, probably reaching only to Kleinschmidt Lake. Deposits of these two advances have also been differentiated on the map. The deposits of the first, or older, advance are shown on the map by the letter "o" added to the symbol, thus "Qto--Till deposited by older ice." The deposits of the second, or younger advance, are shown on the map by the letter "y" added to the symbol, thus, "Qty--Till deposited by younger ice."

In addition to the debris, mainly till, deposited by the ice, other material, chiefly sand and gravel, was carried far to the south by the meltwaters of the wasting glaciers. These deposits, termed outwash, are similarly identified on the map by the letters "bl" or "o" or "y" depending upon which glacier furnished them.

In some localities deposits of more than one ice advance may have been inadvertently grouped and thus mapped as the deposits of a single advance.

1.	Avon (N. 2/3)	79-437	16.	Lake Inez	77-200
2.	Nats Mountain (W. 1/3)	79-438	17.	Marcum Mountain (W. half)	79-445
3.	Big Fork	78-174	18.	Nevada Lake (S. half)	79-446
4.	Browns Lake	79-439	19.	Ovando	77-196
5.	Chamberlain Mountain	79-440	20.	Ovando (S. 1/3)	79-447
6.	Chimney Lakes (NE 1/4)	79-441	21.	Ovando Mountain (S. half)	77-465
7.	Cilly Creek	77-860	22.	Peck Lake (E. half)	77-539
8.	Condon (W. half)	77-540	23.	Salmon Lake	77-197
9.	Coopers Lake (S. half)	77-466	24.	Salmon Prairie	77-861
10.	Crater Lake (W. half)	78-173	25.	Seeley Lake East	77-202
11.	Cygnet Lake	77-198	26.	Seeley Lake West	77-201
12.	Finn (SW 1/4)	79-442	27.	Swan Lake (SW 1/4)	78-135
13.	Greenough	79-443	28.	Woodworth	77-203
14.	Helmville (N. half)	79-444	29.	Tew Creek (NE 1/4)	78-136
15.	Holland Lake (W. half)	77-199			



Index map showing quadrangles in the Big Fork-Avon area. Those quadrangles in Open-File Reports 79-437 to 79-447 are shaded.