YNCLINE -- Showing trace of axial plane and direction of plunge

## Introduction

of akis

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 Councies. 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 Mig Mork-Avon area. Mitkind mapped the northern half of the area and his maps are available as Open-Pile Reports (listed below). Weber is now a geologist with the U.S. Forest Service in Great Palls, Montana; Nitkind is a geologist with the U.S. Geological Survey in Denver, Chlorado.

The area studied extends from the fig 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, Aranch 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, Vederal Building, 1961 Stout Street, Denver, Colorado 80202

Sait Lake City Public Inquiries Office, U.S. Geological Survey, 8015, Federal Office Residing, 125 South State Street

Salt Lake City, Utab 84111

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

79-437 1. Avon (N. 2/3) 16. Lake Ingz Bata Mountain (W. 1/3) 79-438 17. Marcum Mountain (W. ha)f) 18. Nevada Lake (S. half) 79-446 Browns Lake 79-439 19. Ovando Chamberlain Mountain 79-440 20. Ovanda (S. 1/3) 79-447 6. Chimney Lakes (NE 1/4) 79-441 21. Ovando Mountein (S. half) Cilly Creek 22. Peck Lake (E. half) 77-539 Condon (W. half) 77-540 23. Salmon Luke ). Coopers Lake (S. half) 77-465 24. Salmon Prairie 77-861 O. Crater Lake (W. half) 78-173 25. Seeley Lake East (1. Cygnet Lake 2. Fino (SW 1/4) 79-442 27. Swam Lake (SW 1/4) 13. Grounough 28. Moodworth 79-443 14. Helmville (N. half) 79-444 29. Yew Greek (NE 1/A) 15. Holland Lake (W. half)

## 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.)

ALLUVIUM (ROLOCENE) -- Light to dark gray and brownish gray:
stream-deposited, unconsolidated, moderately to wellbedded, interstratified assemblage of stit, sand, and
gravel. Typically clay-rich and cohesive where incised
into claystones, siltatones, and shales of older basinfill deposits. Gold-bearing sand and gravel occur locally
in the northward-draining valleys of the Garnet Mange, and
in the westward-draining valleys of the mountains east of
Nelmville and Avon. Characterized by shallow depths to
ground water. Soil drainage is pour and shrink-swell
potentials are inferred to be relatively low

ALLOVIAL FAN DEPOSITS (ROLDCENE) -- Small, moderately sloping, poorly sorted, crudely stratified ailt, 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

COLLOYIOM (BOLOGENE) -- Unsorted debris that has alid or been washed downslops to form enall, thin, and homocky deposits. Best developed in terrans underlain by Tertiary volcanic rocks. Shrink-swell potentials are variable, and are inferred to range from moderate to high

LANDSLIDE DEPOSITS (QUATERNARY) -- Small, fan- and lobate-shaped hummocky masses of semiconsolidated spil, till, Tertiary basin fill, and vulcanic debrts. 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

SEDDIENTS DEPOSITED BY MELTWATERS OF PINEDALE GLACIATION

Lacustrine Deposits -- Pink; rhytheically hedded silt, sandy silt, and clay with included lenses of sand and gravel. Forms gently simpleg, smooth surfaces at altitudes generally below 1,158 m (3,800 ft). Soil drainage ranges from tair to poor, but lateral permability may be high within the interbedded sandy beis and lenses. High Frostbeave susceptibility. Disy-rich beds have a moderate shrink-swell potential

Ice-Contact Deposit-Dark brown and brown; composed of moderately well sorted silt, sand, and gravel. Forms an elongate, gently sloping beach. Clasts range in shape from angular to rounded; most are rounded. Sizes range from 1 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

Kame Deposits -- Dark brown and brown; consists of understaly to poorly sorted silt, sand, and gravel. Fores amali, conical to ellipsoidal, steep-sided billocks. Few wellrounded cobbles scattered irregularly through the unit. Formed by a glacial stream that Flower down late a stagment ice mass

Outeman--Light brown, and grayish brown; moderately well sorted; composed of silt, send, and subrounded to rounded pebbly and cobbly gravel. Commonly the upper I m (2 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 sater commonly occurs at shallow depths

In addition to these maps, another map, by Witkind which discusers

the seissicity of the Big York-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,

Surficial deposits

Most of the surficial deposits to the southern part of the Big.

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

"Otbl -- Till deposited by Sull Lake(?) ice." Subsequently, some 20,000

to 30,000 years ago during the Pinedale Glaciation of the Pleistocene, another elacier again moved southward into the area. It apparently

reached almost as far south as Relaville, before it withdrew and then readvanced again. This readvance, however, did not extend as far to the south, probably reaching only to Eleinschmidt 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, "Oty--Till deposited by younger

material, chiefly sand and gravel, was carried far to the south by the

been inadvertently grouped and thus mapped as the deposits of a single

similarly identified on the map by the letters "bl" or "o" or "y"

depending upon which glacier furnished them.

advance.

aeltwaters of the wasting glaciers. These deposits, termed outwash, are

In some localities deposits of more than one ice advance may have

In addition to the debris, mainly till, deposited by the ice, other

are shown on the maps by the letters "bl" added to the symbol, thus

Fork-Avon area were formed primarily during several advances and

subsequent melts of large glaciers. The first advance recognised

horthwestern Montana.

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

SEDIMENTS REPOSITED BY MELTWATERS OF PIREDALE CLACIATION (UPPER PLEISTOCENE) -- OLDER ICK

Ourwash-Dark brown, reddish brown, and brown; consists of understely well corted allt, send, and subangular to nounded gravet and cobbdy gravet. Forms smooth, locally dissected plains and terraces which lie 6-10 a [20-100 ft] above the younger outwash deposits. Sround water occurs at moderate depths

Outwash Fan Deposit -- Even-surfaced, gently aloping, coneshaped deposit of unconsolidated, nonscrately sorted slit, sand, gravel, and cobbles. Probably formed at some time after the Blackfoot River was diverted by lobes of ice which lay in the Honture, North Fork of the Blackfoot, and Nevada Creek valleys

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

## TILL OF PINEDALE CLACIATION (UPPER PLEISTOCENE)

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 readish-brown to tan silty to clayey matrix. Many large boulders are scattered across both the lateral and ground moralnes, and the terminal moralne near Kleinschmidt Lake; locally parts of the moralne surface slope as much as 65 percent. Clasts range in shape from angular to well rounded, and are predominantly quartrites, argillites, and limestones of the Relt Supergroup. Soil drainage and permeability is variable, but generally is poor

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

Qob! OUTWASH OF BULL LAKE(?) ICE (FLEISTOCENE) -- Brown and readish brown; unconsolidated, mildly calcareous, well-bedded and moderately well sorted slit, sand, gravel, and cobbles.

Forms even-surfaced, gently sloping, highly dissected remains which are about 12 m (40 ft) above the outwash of the older ice. Soil drainage is moderate to good

formless, 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, clayer matrix. Locally large glacial boulders, 3-4 m (10-13 ft) across, are scattered through the till; they are especially common near dimentle Prairie (see Greenough quadrangle). Clay content is higher and this till consequently is more associated to mass movement than the younger fills. Where deeply dissected yields a discoutinuous rubble vensor of cobbles and boulders

FIRMOUT ALLUVIEW (QUATERBARY AND TERVIARY) -- Residah brown and tem; enconsolidated, enderately well sorted, stratified silty sand and silt, sand, and gravel which mantle broad, smooth-surfaced benches that flank the mountains in the Neinvillo-Avon area. Deposits thin basinward, and typically are coateer-grained near the mountains. Overlies truncated pre-Tertiary and Tertiary sedimentary and volcanic rocks, and is segmented by modern stream valleys and gallies. Locally the upper part of the deposit is weakly cemented by calcium carbonate. Soundness and durability of the gravel is quite veriable 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

SASIN DEPOSITS, UNDIVIDED (TERTIARY) -- Brown, grayish brown, and yellowish brown; semiconsolidated to consolidated clays, shales, sittstones, and sandstones with minor amounts of conglomerate. Also included are white, gray, brown, yellowish brown, and red beds of altered volcanic ash, and ash-righ shale and siltstone. Competence is fair to good in the brown siltstones and sundstones 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, notwash, or alluvium and restricts and controls the downward and lateral migration of the local ground water

VALCANIC ROCKS, UNDIVIDED (TRATIARY) -- Small outcrope of trachyte, andesite, lamprophyte, and extrusive volcanic breccia are in the western part of the area near Greenough (see Greenough quadrangle). Extensive baselt and andesite flows, volcanic breccias, and minor amounts of rhyolite, dacite, diorite, gabbro, latite, and welded toff 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

Consists of the intrusive Carnet stock and other smaller igneous bodies. Generally shows well-developed blocky jointing; weathers to spheroidal boulders. Gold minerals are in quarts veins that fill fractures in the quarts monzonite in a zone within about half a mile of the surrounding marble and limestone country rock

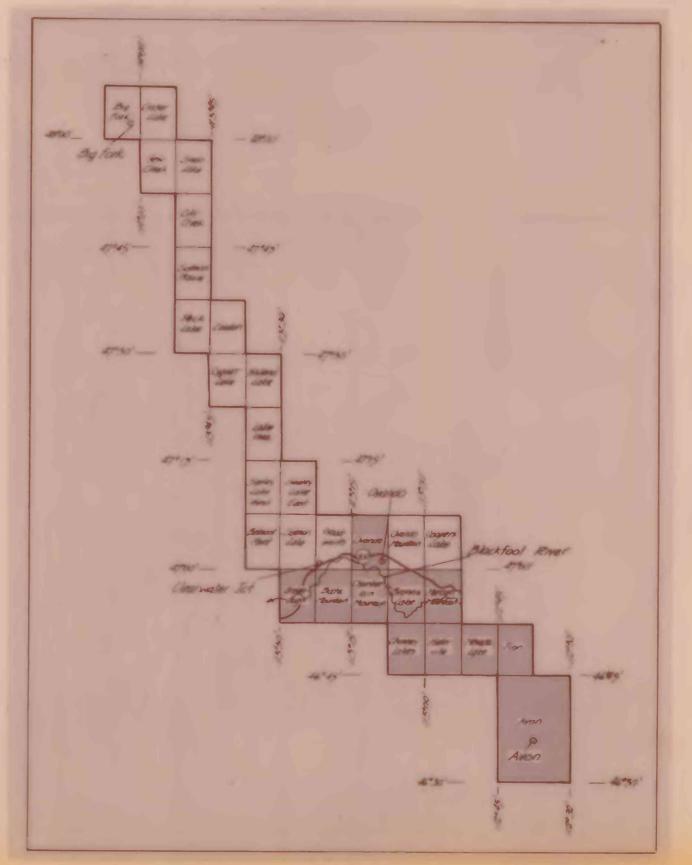
GRETACEOUS) -- Includes small intrusive igneous bodies ranging in composition from quartz monzonite to danke

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

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 Jafferson Formation (Devomian) may be included with the Madison Group

CAMBRIAN STRATA, UNDIVIDED—Folded, faulted and locally introded and metamorphosed outcrops of the (in descending order) Masmark and Silver Hill Formations and Flathead Quartrite. Near the Garnet stock the linestones of the Nasmark(?) and Silver Hills Formations have been metamorphosed to marble

SELT SUPERGROUP ROCKS, UNDIVIDED (PRECAMBRIAN) -- Consists of various units of the Beit Supergroup, chiefly the Mount Shields (argillite and sandstone), Shepard (argillite and dolosite), and Snowslip (argillite and sandstone)
Formations in the northern part of the area; and the quertzite and claystone of Black Mountain, Bonner Quartzite and the Mount Shields, Shepard, and Snowslip (calcareous modatone and quartzite) Formations in the southern part of the area



Index map showing quadrengled to the Siz Sork-Avon area. Those quadrangles in Open-Tile Reports 79-437 to 79-447 are shaded.