Geologic Map of the Cloverdale Quadrangle, Ada County, Idaho

Kurt L. Othberg
Loudon R. Stanford
Willis L. Burnham

Technical Report 90-6
May 1990

Idaho Geological Survey
University of Idaho
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Kurt L. Othberg[1], Loudon R. Stanford[1], and Willis L. Burnham[2]

INTRODUCTION

This map is one of several geologic maps for the region covered by the Boise 1° x 2° quadrangle. Until now, no geologic maps at this scale had been produced for the area. County Report 3, *Geology and Mineral Resources of Ada and Canyon Counties* (Savage, 1958), contains a countywide geologic map that includes the area of the Cloverdale 7 1/2-minute quadrangle. Although the 1958 report still provides useful information, this new, larger scale map gives a further interpretation of the geology and furnishes the detail needed for understanding the region's land, water, and mineral resources.

Key quadrangles near Boise were chosen for this major geologic mapping program undertaken to unravel the stratigraphy, chronology, and geologic history of the fastest growing region in the state. With financial assistance of the U.S. Geological Survey's COGEOMAP Program, the Idaho Geological Survey has conducted since 1986 detailed mapping of nine 7 1/2-minute quadrangles. The *Geologic Map of the Cloverdale Quadrangle, Ada County, Idaho* is among the first published maps from that project. The long-term goal of the program is to compile and publish two regional geologic maps at 1:100,000 scale. These smaller scale maps will represent both detailed and reconnaisance mapping of sixty-four 7 1/2-minute quadrangles. The more-detailed geologic maps, such as this one, will be released in the Technical Report series.

This report consists of two parts, a geologic map and an expanded description of map units in accompanying text. The geologic map can be read alone. The map's legend briefly describes the rock units in addition to providing a correlation diagram and an explanation of symbols. The accompanying text contains further information about physical properties, age-

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dating, associated features, and other details about the units.

DESCRIPTION OF MAP UNITS

Qa Alluvium

LITHOLOGY AND TEXTURE. Surface deposits typically are silty, clayey sands, and organic deposits. Sandy gravel is common at depths below 1-1.5 meters.

SOURCE. Mostly alluvium deposited in the floodplain of Tenmile Creek. Includes deposits of small, ephemeral streams draining the low relief of terraces.

SURFACE SOIL. Soil development ranges from no horizons to weakly developed clayey B and calcic C horizons. Typical soils include the Abo and Oliaga series and unnamed, recent wet stream deposits (Collett, 1980).

AGE. Holocene and Pleistocene. Tenmile Creek appears underfit. Most of the alluvium in its floodplain, therefore, may have been deposited during Pleistocene climatic conditions different from today (Pierce and Scott, 1982).

Qfg Alluvial fan gravel

LITHOLOGY AND TEXTURE. Sandy pebble and cobble gravel (mostly reworked Tenmile Gravel). Thin loess discontinuously covers the surface.

SOURCE. Local stream and debris-flow deposits forming alluvial fans at the base of slopes along Tenmile ridge. These processes were probably most active during periods of greater runoff in the Pleistocene (Pierce and Scott, 1982).

SURFACE SOIL. Soils in alluvial fans have well-developed horizons formed in both the thin loess and the upper part of the fan gravel. Soil types vary due to the range in ages of the deposits. Typical soils include the Brent, Elizah, and Tenmile series (Collett, 1980). Small circular mounds (2-4 meters in diameter) consisting of thicker horizons of surface soil form a patterned ground that may have developed during Pleistocene periglacial conditions (Malde, 1964). The patterned ground normally is visible on aerial photographs only.

AGE. Unit includes Holocene deposits, but most of the alluvial fans probably formed during the Pleistocene (Pierce and Scott, 1982).

Qwg Gravel of Whitney terrace

LITHOLOGY AND TEXTURE. Sandy pebble and cobble gravel. Granitic rocks and porphyritic felsites dominate the lithologies of the gravel clasts. The surface of the gravel is mostly buried by 1-2 meters of loess.

SOURCE. Primarily channel alluvium of the former Boise River deposited on the river-cut surface of the second terrace above the modern Boise River. In the Cloverdale quadrangle the Whitney terrace is about 23 meters (75 feet) above the present floodplain. Most transported clasts came from the Idaho batholith and associated felsic rocks of the central Idaho mountains.

THICKNESS. The gravel fill underlying the terrace is about 12 meters (40 feet) thick. It overlies weakly consolidated Tertiary-age sands, silts, and claystones incised by the former Boise River during valley deepening.

SURFACE SOILS. Soils in the Whitney terrace primarily formed in loess. The soils have clayey and calcic B horizons and locally have weak duripan (caliche) characteristics, at about 1 meter in depth, that may extend into the gravel. Typical soils include the Power and Purdam series (Collett, 1980).

AGE. Late to middle Pleistocene. By tracing the Whitney terrace upstream into the Boise River canyon, its geomorphic position can be shown to be higher than that of the basalt of Mores Creek mapped in the Lucky Peak quadrangle (Othberg and Burnham, 1990). Whitney terrace is, therefore, older than the basalt of Mores Creek, i.e., greater than 0.107 Ma.

Qsg Gravel of Sunrise terrace

LITHOLOGY AND TEXTURE. Sandy pebble and cobble gravel. Granitic rocks and porphyritic felsites dominate the lithologies of the gravel clasts; 5-10 percent of the clasts consist of gray unweathered basalt. The surface of the gravel is mostly buried by 1-2 meters of loess.

SOURCE. Primarily channel alluvium of the former Boise River deposited on the river-cut surface of the third terrace above the Boise River. In the Cloverdale quadrangle the Sunrise terrace is about 35 meters (115 feet) above the present floodplain. Most transported clasts came from the Idaho batholith and associated felsic rocks of the central Idaho mountains. Basalt clasts came from Pleistocene basalt flows in the Boise River drainage basin.

THICKNESS. The gravel fill underlying the terrace is about 13 meters (44 feet) thick. It overlies weakly consolidated Tertiary-age sands, silts, and claystones incised by the former Boise River during valley deepening.

SURFACE SOILS. Soils in the Sunrise terrace formed in both loess and the upper part of the gravel deposit. The soils have weak to strongly developed duripan (caliche) characteristics with a maximum thickness of about 0.5 meter (1.5 feet). The duripan is found at about 1 meter in depth and extends into the gravel. Typical soils include the Purdam and Elizah series (Collett, 1980).

AGE. Middle(?) Pleistocene. Terrace position and relative soil development indicate the age of the gravel of Sunrise terrace is older than the gravel of Whitney terrace and younger than the gravel of Gowen terrace.

STRUCTURE. No surface expression of faulting in the Sunrise terrace was observed. One ephemeral exposure in the Boise Paving Company's gravel pit shows, however, that the lower 3-3.7 meters (10-12 feet) of the gravel of Sunrise terrace is faulted where it overlies a fault in Tertiary sands (sec. 19, T. 3 N., R. 2 E.).

Qgg Gravel of Gowen terrace

LITHOLOGY AND TEXTURE. Sandy pebble and cobble gravel. Granitic rocks and porphyritic felsites dominate the lithologies of the gravel clasts; 5-10 percent of the clasts consist of gray unweathered basalt. The surface of the gravel is mostly buried by 1-2 meters of loess and thin alluvium in minor drainageways.

SOURCE. Mostly channel alluvium of the former Boise River deposited on the river-cut surface of the fourth terrace above the Boise River. In the Cloverdale quadrangle the Gowen terrace is about 55 meters (180 feet) above the present floodplain. Most transported clasts came from the Idaho batholith and associated felsic rocks of the central Idaho mountains. Basalt clasts came from Pleistocene basalt flows in the Boise River drainage basin.

THICKNESS. The gravel fill underlying the terrace is 9-14 meters (30-45 feet) thick. It overlies weakly consolidated Tertiary-age sands, silts, and claystones incised by the former Boise River during valley deepening.

SURFACE SOILS. Soils in the Gowen terrace primarily formed in loess. The soils have clayey B horizons and platy duripans (caliche) 0.5-1 meter thick. Duripans are found at about 1 meter in depth, and some of their white calcic properties extend into the gravel. The typical soil is the Elizah series (Collett, 1980).

AGE. Middle Pleistocene. About the same age as the basalt of Gowen terrace (Qgb), mapped in the Lucky Peak quadrangle (Othberg and Burnham, 1990), which has a K/Ar date of 0.572 ±0.210 Ma (see Table 1).

STRUCTURE. Northwest-trending linear topographic features in the surface of Gowen terrace suggest faulting. One ephemeral exposure in a gravel pit (sec. 30, T. 3 N., R. 2 E.) demonstrates fault offset in the gravel of Gowen terrace.

Qfb Basalt of Fivemile Creek.

LITHOLOGY AND TEXTURE. Medium gray olivine basalt. Thin sections show a cumulophyric texture of a few percent small interlocking olivine grains. Loess 0.5-2 meters thick discontinuously covers the basalt.

SOURCE. Lava flow or flows that erupted from a small vent near the headwaters of Fivemile Creek in the Lucky Peak quadrangle (Othberg and Burnham, in press). The base of the lava flow is unexposed in the Cloverdale quadrangle, but well logs show the lava lying on sand and gravel. The sand and gravel probably compose a terrace that is completely buried by basalt within the Cloverdale quadrangle.

THICKNESS. Due to erosion, flow thinning (and possibly faulting), the basalt ranges in thickness from 3 to 11 meters (10-35 feet).

TABLE 1. Potassium-argon ages based on whole rock analyses of Quaternary basalts within or near the Cloverdale quadrangle (Berkeley Geochronology Center, Institute of Human Origins, Berkeley, California).

Unit	K/Ar Number	Sample Number	K^+ (%)	Weight (grams)	$^{40}Ar^1$ (mol/gm)	$^{40}Ar^1$ (%)	Age $\pm\sigma$ (Ma)
Basalt of Mores Creek (Qmb)	5838B-2	MC-1	1.397	6.56930	2.588×10^{-13}	09.0	0.107 ± 0.012 [2]
Basalt of Gowen terrace (Qgb)	5937-1	GT-4	0.945	7.01441	9.369×10^{-13}	08.3	0.572 ± 0.210
Basalt of Fivemile Creek (Qfb)	5934-1	30-3	0.532	4.22543	8.987×10^{-13}	11.2	0.974 ± 0.130
Basalt of Hubbard Reservior (Qhb)	5837B-1	TCC-1	0.864	5.12164	1.500×10^{-12}	05.8	1.001 ± 0.098

[1]Radiogenic component.

[2]Previous K/Ar date of 0.44± 0.20 Ma reported by Howard and others (1982).

Decay constants: $\lambda\varepsilon + \lambda\varepsilon' = 0.581\times10^{-10}yr^{-1}$; $\lambda_\beta = 4.962\times10^{-10}yr^{-1}$; $\lambda = 5.543\times10^{-1}yr^{-1}$; and $^{40}K/K_{total} = 1.167\times10^{-4}$

SURFACE SOILS. Soils in this lava surface formed in both loess and basalt. A well-defined stream drainage eroded into the surface of the basalt forms a relief of about 15 meters (50 feet). Soils formed in thick loess are found on the least eroded areas. The most widespread soil has a very clayey B horizon and a duripan (caliche) up to 1 meter thick. Duripans are found at about 0.5-1 meter in depth, and their white calcic properties extend into the upper part of the basalt. Typical soils include the Kunaton, Ridenbaugh, and Sebree series (Collett, 1980). Small circular mounds (2-4 meters in diameter) consisting of thicker horizons of surface soil form a patterned ground that may have developed during Pleistocene periglacial conditions (Malde, 1964). The patterned ground normally is visible on aerial photographs only.

STRATIGRAPHY. Based on the position of the terrace buried by this lava flow, the basalt of Fivemile Creek is older than the gravel of Gowen terrace but younger than Tenmile Gravel (the buried terrace is a river-cut surface cut into the Tenmile Gravel). Based on the similar K/Ar dates for both the basalt of Hubbard Reservoir and the basalt of Fivemile Creek, the buried terrace may correlate with the Amity terrace. Differences in elevation between the two terraces may have been caused by fault offset along one or more NW-SE fault trends expressed within the Cloverdale quadrangle. Laboratory analyses indicate a normal paleomagnetic polarity for the basalt of Fivemile Creek.

AGE. Early Pleistocene. Sample from the adjacent Boise South quadrangle (NE1/4 sec. 1, T. 2 N.,R. 2 E.) has a K/Ar date of 0.974 ±0.130 Ma (see Table 1) Because of this lava's normal magnetic polarity, its age may correspond with the Jaramillo Normal Subchron of 0.91-0.98 Ma (Mankinen and Dalrymple, 1979; Berggren and others, 1985).

STRUCTURE. Northwest-trending linear topographic features in the surface of the basalt of Fivemile Creek suggest faulting. Exposures of fault offset in the basalt were not observed.

Qhb Basalt of Hubbard Reservoir

LITHOLOGY AND TEXTURE. Medium gray olivine basalt. Hand-specimens and thin sections show distinct dyktytaxitic texture and abundant tabular plagioclase crystals that vary from evenly dispersed to cumulophyric. Olivine occurs as abundant grains less than 1 millimeter in size. Loess 0.5-2 meters thick discontinuously covers the basalt.

SOURCE. This basalt probably erupted from one of several shield volcanoes south and southeast of Hubbard Reservoir and flowed northwest down the Indian Creek valley.

THICKNESS. Although thicknesses reported in well logs range from 10 to 95 feet, the average thickness for this basalt in the Cloverdale quadrangle is about 40 feet. Typically, the basalt overlies gravel.

SURFACE SOILS. Soils in this lava surface formed in both loess and basalt. The soils have very clayey B horizons and platy duripans (caliche) up to 1 meter thick. Duripans are found at about 0.5-1 meter in depth, and their white calcic properties extend into the upper part of the basalt. The typical soil is the Colthorp series (Collett, 1980).

STRATIGRAPHY. Basalt of Hubbard Reservoir appears to be younger than the gravel of Amity terrace. The relationship is unclear because of deformation along strongly expressed NW-SE fault trends, which in part have placed the Amity terrace at a higher elevation than the basalt. The data collected suggest that the Hubbard Reservoir lava flowed onto the Amity surface burying all but the northeast portion of the terrace. Probably as a result of faulting and erosion along Tenmile Creek, the geomorphic position of the basalt of Hubbard Reservoir has no clear correlation with units northeast of Tenmile Creek. Field fluxgate magnetometer measurements indicate a normal magnetic polarity for the basalt of Hubbard Reservoir.

AGE. Early Pleistocene. A basalt sample from near Tenmile Community Church has a K/Ar date of 1.001 ±0.098 Ma (see Table 1). Because of this lava's normal polarity, its age may correspond with the Jaramillo Normal Subchron of 0.91-0.98 Ma (Mankinen and Dalrymple, 1979; Berggren and others, 1985).

STRUCTURE. Northwest-trending linear topographic features in the surface of the basalt of Hubbard Reservoir suggest faulting. Exposures of fault offset in the basalt were not observed.

Qag Gravel of Amity terrace

LITHOLOGY AND TEXTURE. Sandy pebble and cobble gravel. Granitic rocks and porphyritic felsites dominate the lithologies of the gravel clasts. The surface of the gravel is mostly buried by 0.5-2 meters of loess.

SOURCE. Mostly channel alluvium deposited on a river-cut surface. It was to this level that the former Boise River had incised Tenmile Gravel and the weakly consolidated Tertiary-age sands, silts, and claystones. At this stage of valley development, the Boise River still flowed westward as in Tenmile Gravel time. Most transported clasts came from the Idaho batholith and associated felsic rocks of the central Idaho mountains.

THICKNESS. The gravel fill underlying the terrace is about 10 meters (33 feet) thick. It overlies weakly consolidated Tertiary-age sands, silts, and claystones incised by the former Boise River during early basin incision.

SURFACE SOILS. Soils in the Amity terrace primarily formed in thin loess. The soils have clayey B horizons and platy duripans (caliche) 0.5-1 meter thick. Duripans are found at about 0.5-1 meter in depth, and their properties commonly extend into the upper part of the gravel. Typical soils include the Pipeline and Elizah series (Collett, 1980).

STRATIGRAPHY. As with all other terraces, the gravel of Amity terrace overlies weakly consolidated interbedded sands, silts, and claystones of Tertiary-age that are equal to and older than Tenmile Gravel. In turn, the gravel of Amity terrace is overlain (in part) by the basalt of Hubbard Reservoir. The gravel's stratigraphic relationship with the other Boise River terraces is not precisely known, but soil duripan development in the Amity terrace suggests an age at least as old as the Gowen terrace. Similar K/Ar dates for both the basalt of Hubbard Reservoir and the basalt of Fivemile Creek suggest the respective terraces are of similar age. If this is so, the difference in elevation between the Amity terrace and that underlying the basalt of Fivemile Creek is probably due to fault offset along one or more NW-SE fault trends expressed within the Cloverdale quadrangle. Geomorphic position suggests a correlation of the gravel of Amity terrace with the sediments of Deer Flat surface mapped in the Caldwell-Nampa area (Wood and Anderson, 1981).

AGE. Early Pleistocene. The basalt of Hubbard Reservoir onlaps the Amity terrace. The gravel of Amity terrace is, therefore, somewhat older than 1.001 Ma.

STRUCTURE. Northwest-trending linear topographic features in the surface of the Amity terrace suggest faulting. Exposures of fault offset in the gravel were not observed within the Cloverdale quadrangle.

Ttg Tenmile Gravel

LITHOLOGY AND TEXTURE. Sandy pebble and cobble gravel. Contains numerous lenses and discontinuous beds of sand. Lithologies of gravel clasts are dominated by granitic rocks and porphyritic felsites that came from the central Idaho mountains. Exposures in gravel pits show an "upper," coarser, and less weathered portion of the Tenmile Gravel. The underlying "lower" Tenmile Gravel is distinctly more weathered, with more decomposed stones, and contains a higher percentage of sand beds and lenses. The surface of the Tenmile Gravel is discontinuously covered with 0.5-2 meters of loess.

SOURCE. Mostly braided channel alluvium deposited in a thick fill where the former Boise River exited the mountain front and flowed westward into the basin.

LOCATION. Remnants of Tenmile Gravel now form the long, high east-west ridge, informally known as Tenmile ridge, that is located south of the Boise River and the city of Boise. Although formed in a braided river channel, initially in the lowest position of the basin landscape, Tenmile ridge now sets high on the landscape owing to numerous fault movements and the gravel deposit's relatively high resistance to erosion.

THICKNESS. Logs of deep water wells indicate a maximum thickness of about 150 meters (500 feet) for the Tenmile Gravel in this quadrangle. In the least eroded areas of Tenmile ridge, the "upper" less weathered portion of the Gravel constitutes 10-30 meters (33-100 feet) of the total deposit. Toward the north and west at depth, the "lower" Tenmile Gravel probably thins and interfingers with other, finer grained Tertiary deposits.

SURFACE SOILS. Soils on Tenmile ridge formed in thin loess and gravel. The original landform and deposit have been eroded into valleys and broad interfluves. The more eroded lower slopes have soils younger than those on the higher interfluves. In the Cloverdale quadrangle lower slopes have calcic soils with clayey B horizons (for example, the Tenmile series). Soils on the interfluve ridges typically are in the Chilcott series, which has very clayey B horizons and platy duripans (caliches) more than 1-meter thick (Collett, 1980). In some areas circular mounds 4-6 meters in diameter, consisting of thicker horizons of surface soil, form a patterned ground that may have formed during Pleistocene periglacial conditions (Malde, 1964). The stream valleys are mostly dry today. The valleys cut into Tenmile ridge are the source of gravel redeposited onto the adjacent alluvial fans (Qfg). Both formed mostly during periods of greater runoff in the Pleistocene (Pierce and Scott, 1982).

FORMAL NAME. Tenmile Gravel was named by Savage (1958). Wood and Anderson (1981) restricted the definition of Tenmile Gravel to include clast lithologies originating in the Boise River drainage basin only. They identified Tenmile Gravel in remnant high surfaces as far west as the Snake River.

STRATIGRAPHY. The gravel deposit thins, interfingers with, and is replaced by finer sediments to the west and northwest. Whether these finer grained sediments are equivalent to sandy, silty sediments of the Terteling Springs Formation or the Glenns Ferry Formation is unclear. No radiometric dates or fossils are available for establishing a precise age for the Tenmile Gravel. Within the Tenmile Gravel, the contrast in weathering and decomposition of clasts between the "lower" gravel and the "upper" gravel suggests a two-aged deposit. At depth the "lower" gravel appears to thin, interfinger with, and be replaced by finer sediments to the north and northwest.

AGE. Stratigraphy, degree of weathering, surface morphology, and soil characteristics suggest both a Pleistocene and Pliocene age for the Tenmile Gravel. Othberg (1986) suggests that the Tenmile Gravel is time-transgressive and represents gravelly river facies deposited over considerable time near the mountain front. Furthermore, the Tenmile Gravel's most extensive westward progradation probably happened in response to late Pliocene to early Pleistocene climatic change and occurred at about the same time that the drainage of the western Snake River Plain was captured through Hells Canyon (Othberg, 1987). The "upper," less weathered Tenmile Gravel probably was deposited at this time.

STRUCTURE. Northwest-trending linear topographic features in the surface of the Tenmile Gravel suggest faulting. One fault exposed in a gravel pit trends approximately N. 40° W. and dips 80°-90° N. Several normal faults in the Tenmile Gravel are exposed in gravel pits and roadcuts east of the Cloverdale quadrangle.

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GEOLOGIC MAP OF THE CLOVERDALE QUADRANGLE, ADA COUNTY, IDAHO

BY

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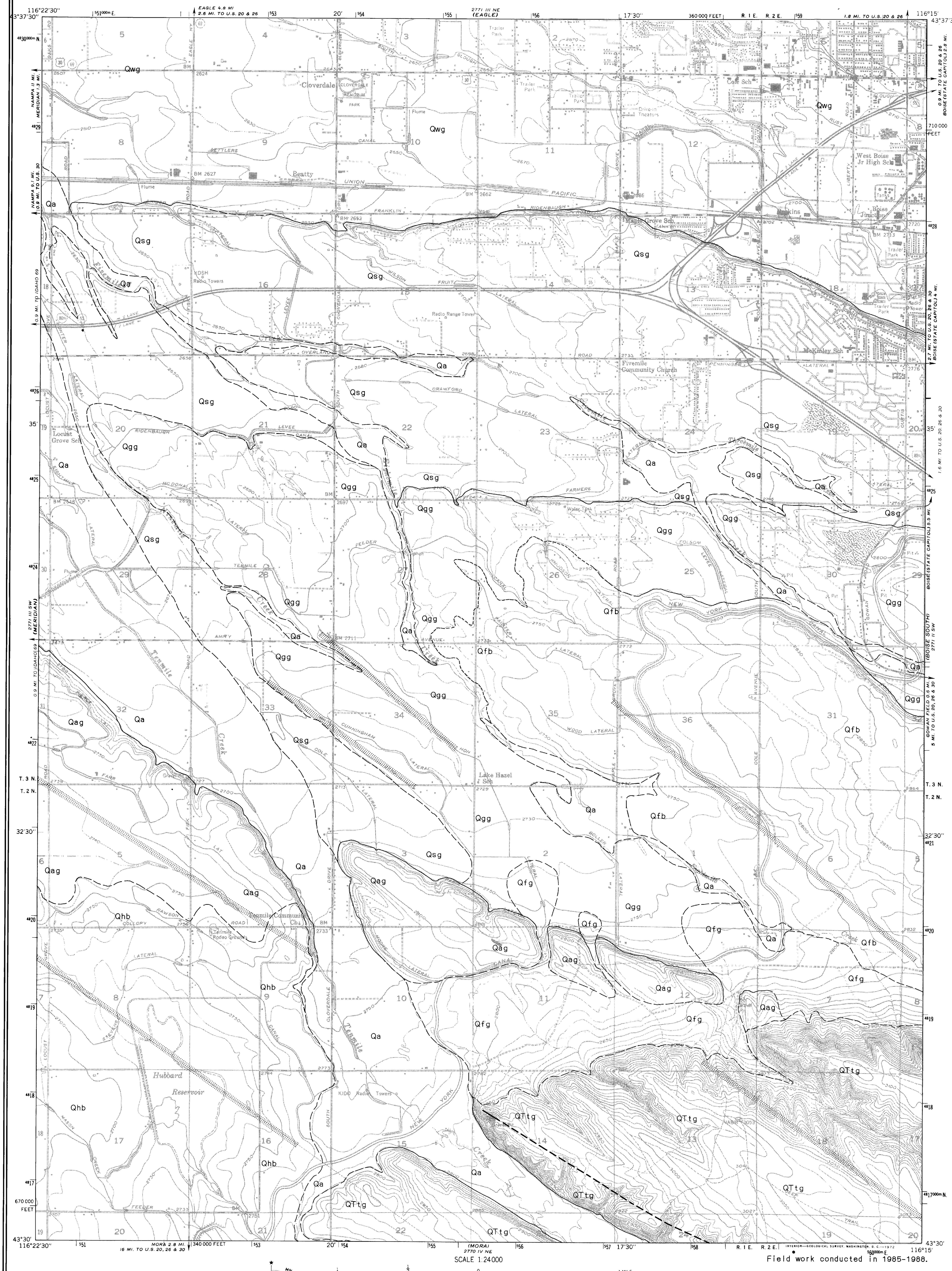
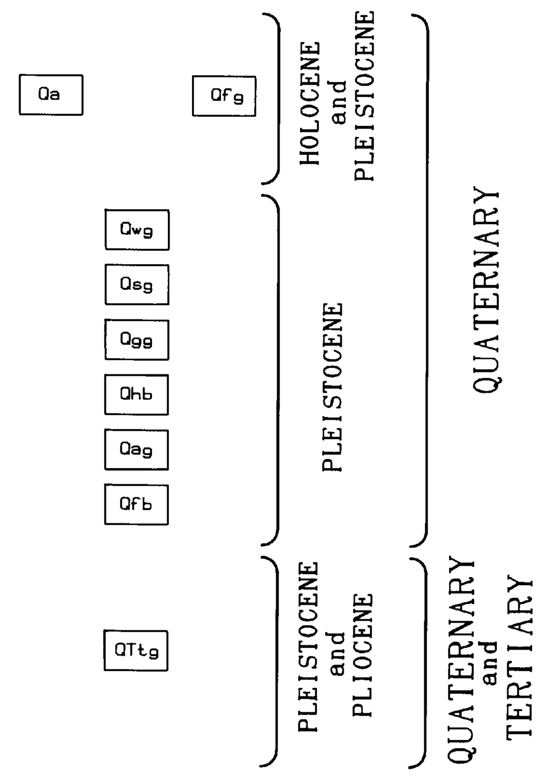
1990



CORRELATION OF MAP UNITS



EXPLANATION

Refer to accompanying text

- Qa — Alluvium
- QFg — Alluvial fan gravel
- Qwg — Gravel of Whitney terrace
- Qsg — Gravel of Sunrise terrace
- Qgg — Gravel of Gowen terrace
- Qhb — Basalt of Hubbard Reservoir
- Qag — Gravel of Amity terrace
- QFb — Basalt of Fivemile Creek
- QTtg — Tenmile Gravel

CONTACT

- Definite
- Approximate
- Inferred

FAULT

- Definite
- Approximate
- Trend: linear topographic feature that suggests fault control

Culture and drainage by multiplex methods from aerial photographs taken 1951
Topography by plane-table surveys 1953
Polyconic projection. 1927 North American datum
10,000-foot grid based on Idaho coordinate system, west zone

UTM GRID AND 1971 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24000

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

QUADRANGLE LOCATION

Field work conducted in 1985-1988.

Funded in part by the U.S. Geological Survey's COGEOMAP program.

Computer-aided cartography by Loudon R. Stanford.

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