Open-File Report O-97-2
Geologic Map of the Malheur Butte Quadrangle, Malheur County, Oregon
By Ian. P. Madin and Mark L. Ferns

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
DONALD A. HULL, STATE GEOLOGIST

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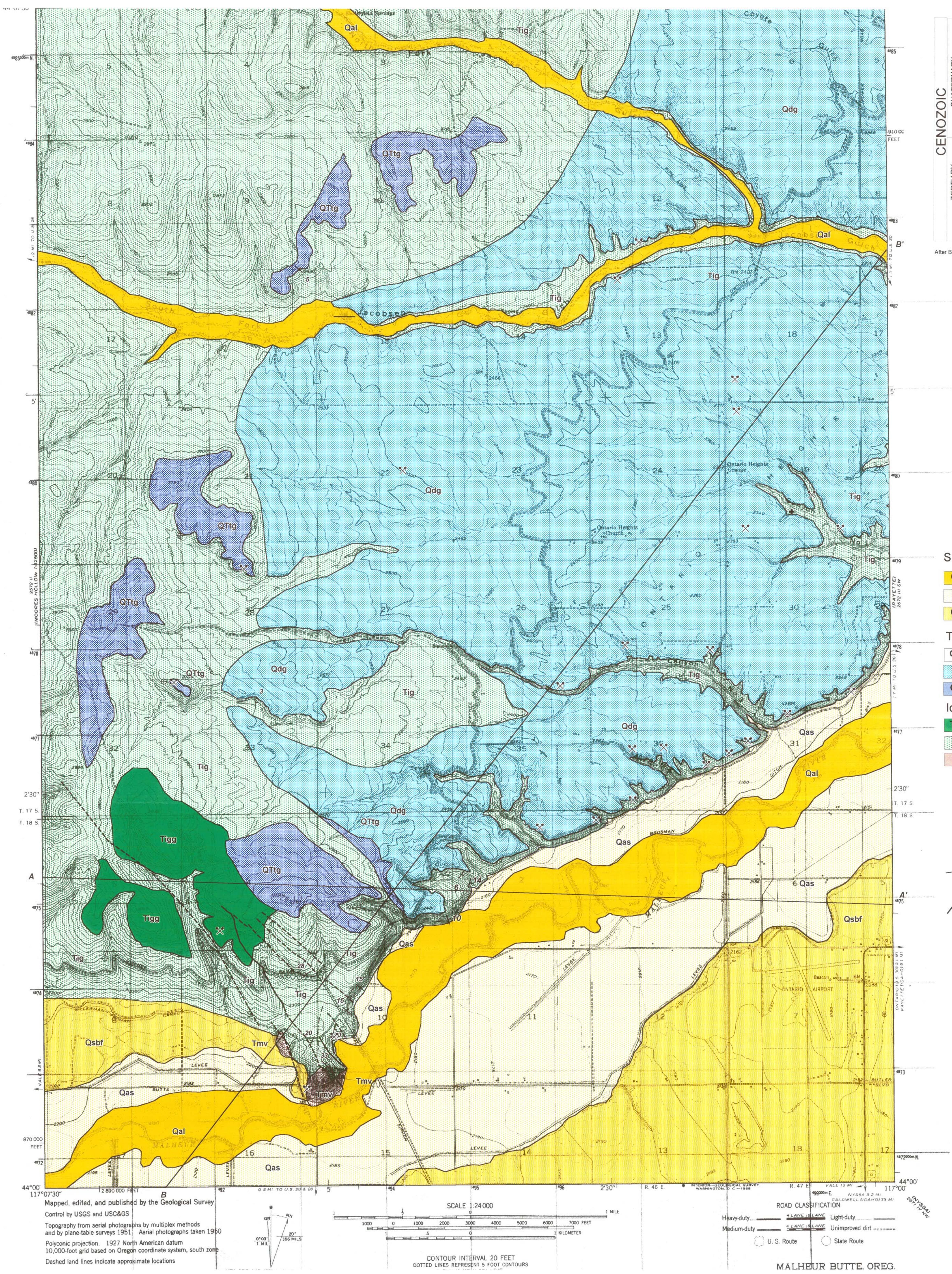
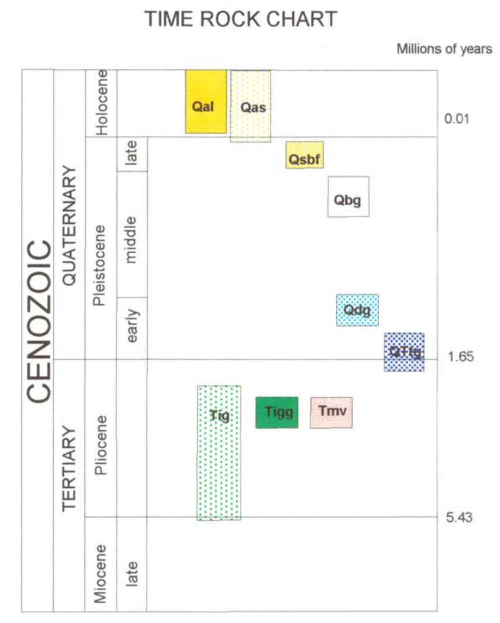
1997



TIME ROCK CHART



After Berggren and others, 1985

EXPLANATION

Surficial Units

- Qal — Alluvial channel and floodbank deposits (Holocene and upper Pleistocene)
- Qas — Alluvial plain deposits (Holocene and upper Pleistocene)
- Qsbf — Bonneville Flood deposits (upper Pleistocene)

Terrace Deposits

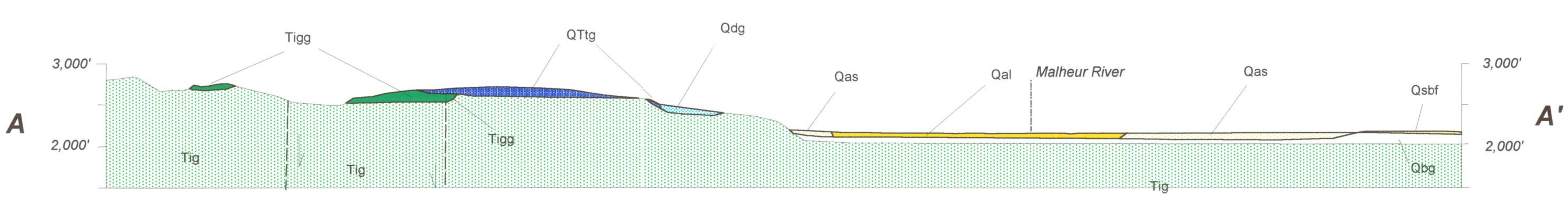
- Qbg — Lower terrace deposits (upper or middle Pleistocene)
- Qdg — Intermediate terrace deposits (lower Pleistocene)
- QTtg — Upper terrace deposits (upper Pliocene or lower Pleistocene)

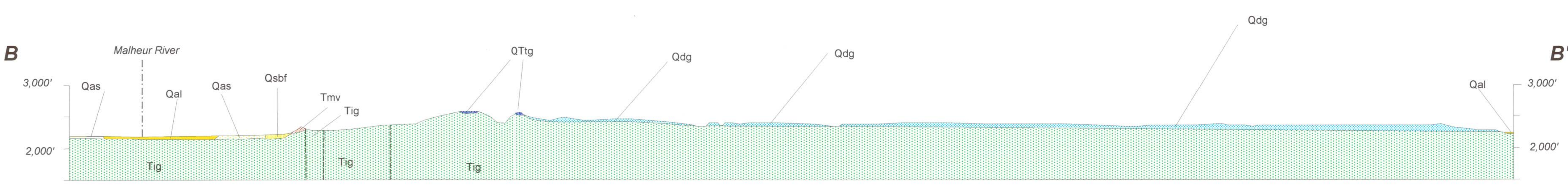
Idaho Group

- Tig — Glenns Ferry Formation (Pliocene and upper Miocene?)
- Tigg — Conglomerate and sandstone (Pliocene)
- Tmv — Volcanic rocks of Malheur Butte (Pliocene)

MAP SYMBOLS

- Contact
- Fault, bar on downthrown side
  Dashed where approximately located
  Dotted where concealed
- Anticline fold axis
- 5 Strike and dip of bed
- Horizontal bed
- Mine or prospect





2 x Vertical Exaggeration

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by Ian P. Madin and Mark L. Ferns, Oregon Department of Geology and Mineral Industries,

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GEOLOGY OF THE MALHEUR BUTTE QUADRANGLE, MALHEUR COUNTY, OREGON

INTRODUCTION

The Malheur Butte quadrangle is located in northern Malheur County, near the west margin of the western Snake River plain. Oldest rocks exposed in the quadrangle are fine-grained silt- and sandstone deposited between 5 and 2 Ma along the shores of a large lake, known as Lake Idaho (Cope, 1883; Jenks and Bonnichsen, 1989) that extended from eastern Oregon to central Idaho during the Pliocene. Fluvial gravels and tephra record deformation and volcanism in a small, strike-slip basin near the end of the Pliocene. Younger units include three distinct terraces formed during subsequent downcutting by the Snake and Malheur rivers. The upper two terraces constitute an important local sand and gravel resource. Youngest units include slackwater deposits of the catastrophic Bonneville Flood (circa 14,000 B.P.), which underlie the fertile agricultural lands of northern Malheur county.

ACKNOWLEDGEMENTS

The geology of the Malheur Butte quadrangle was mapped in 1995 in cooperation with the Oregon Department of Corrections, in order to determine whether seismogenic faults were exposed in the quadrangle. We would like to thank Kurt Othberg, Idaho Geological Survey, for his constructive review of the map and text.

EXPLANATION

Qal Alluvial deposits (Holocene) Overbank flood and channel deposits of sand and silt along the Malheur River. Mainly silt and fine sand derived from reworked loess and Bonneville Flood deposits (Qsbf). Locally includes fine- to medium-grained, volcanic-clast gravels. Unit is overlain by poorly drained soils of the Quincy and Powder series (Lovell, 1980).

Qas Alluvial deposits (Holocene and upper Pleistocene) Pale gray to tan, thin-bedded silt and fine- to medium-grained sand deposited on the alluvial plain adjacent to the Malheur River channel. Depositional surface has been largely modified by modern agricultural operations. Unit is 3 to 7 m thick and overlies the lowermost Snake River terrace (Qbg). Unit is overlain by poorly drained soils of the Umapine and Stanfield series (Lovell, 1980).

Qsbf Bonneville Flood Deposits (upper Pleistocene) Massive to thinly bedded tan silt and fine sand deposited during the Bonneville Flood (Malde, 1968). Unit consists of 3 - 12 m of overbank silt and fine sand deposited on a broad bench adjacent to the Snake and Malheur rivers. Unit overlies a buried terrace unit (Qbg) that appears only in water well logs. Outcrop corresponds to unit Qtal1 of Gannett (1990). Areal distribution is defined by the low bench at 2180 ft elevation south of the Malheur River. The low bench is marked by the well-drained soils of the Owyhee and Greenleaf series (Lovell, 1980). Age of the Bonneville Flood is about 14,000 years B.P. (Scott and others, 1983; Malde, 1991).

PLEISTOCENE TERRACE DEPOSITS Three distinct terrace surfaces form a stepped series of gently inclined surfaces in the quadrangle. The terraces record successive stages of lateral planation of Idaho Group lacustrine rocks by the ancestral Snake River. Plane surfaces are covered with 3 - 17 m gravel, silt and sand. Coarse cobble gravels at the base of each terrace were deposited in broad flood-plains cut into the older Idaho Group lacustrine rocks. Higher terrace gravels are comprised largely of light colored granitic and porphyritic rhyolite clasts derived from the Idaho Batholith and Challis Volcanics respectively, both units exposed in Idaho to the east.

Qbg Lower terrace deposits (middle or upper Pleistocene) Fluvial gravel and sand deposits 3 to 17 m that are encountered only in water wells drilled through units Qas and Qsbf. Unit is not exposed at the surface and is shown only in cross section. Base of the unit, based on water wells, is at about 2130 ft elevation, about 20 ft lower than the present day Malheur river channel.. Unit is tentatively correlated with the Whitney terrace of Burnham and Wood (1992) on basis of elevation and degree of incisement by the Snake River to the east. Othberg and others (1995) suggest a minimum age of 107 ka for the Whitney terrace, based on a radiometric date on a basalt flow erupted during terrace incisement. Unit is correlative with unit Qtal1 of Gannett (1990).

Qdg Intermediate terrace deposits (lower Pleistocene) Terrace deposit of silt, sand, and gravel 8 to 17 m thick. Unit consists of a lower 3 - 8 m thick bed of gravel overlain by 5 to 10 m of water and wind lain silt and sand. Upper fine-grained section typically consists of a pale gray, thinly laminated tuffaceous siltstone overlain by a massive tuffaceous sandstone. Lower section typically consists of a matrix-supported, well-sorted gravel with clasts as large as 25 cm. Clasts include coarsely crystalline granitic and pegmatitic cobbles typical of the Idaho Batholith and potassium feldspar-phyric rhyolite porphyry cobbles typical of the Challis Volcanics. Gravel matrix consists largely of coarse quartz, feldspar, and mica grains.

Terrace surface is an eastward sloping tableland which drops from 2600 ft elevation on the west to 2300 ft elevation on the east. Small streams have cut channels as deep as 80 ft through the terrace into underlying Tig sediments. Terrace surface in places is heavily mantled by loess and Bonneville Flood deposits (Qbsf). Tentatively correlated on basis of degree of dissection and elevation, with the 1.58 Ma Deer Flat-Amity terrace of Othberg and others (1995).

QTtg Upper terrace deposits (lower Pleistocene or upper Pliocene) Extensively eroded terrace 5 to 10 m thick of sand and cobble gravel. Cobble clasts are similar to Qdg clasts and include coarsely crystalline granitic and pegmatite cobbles and potassium feldspar-phyric porphyry rhyolite cobbles. Terrace forms isolated plateaus between 2700 and 2800 ft elevation on the west side of the quadrangle. Tentatively correlated on the basis of elevation and degree of dissection with the Tenmile Gravel terrace of Othberg and others (1995), who place the age of the Tenmile Gravel between 1.58 and 1.7 Ma.

IDAHO GROUP The sequence of lacustrine and fluviatile sediments and mafic lava flows deposited in the western Snake River plain between the late Miocene and early Pleistocene comprise the Idaho Group (Malde and Powers, 1962). In the quadrangle, units include:

Tig Glenns Ferry Formation (Pliocene) Fine- to medium-grained sandstone and siltstone. In map area, unit consists of floodplain and fluvial facies. Floodplain facies consists of light tan, thin-bedded tuffaceous silt- and claystone with lenses of fine-medium-grained arkosic sandstone. Overlying fluvial units near Malheur Butte include massive and cross-bedded channel sands and fine-grained pebble conglomerate. Upper age limit of the Glenns Ferry Formation is cited as between 1.76 Ma (Othberg and others, 1995) and 2 Ma (Malde, 1991). Oldest reported date in the Glenns Ferry Formation is a 3.23 ± 0.4 Ma fission track date reported by Kimmel (1982) on ash near the base of the formation. The sequence of coarse conglomerate and hydrovolcanic deposits comprising the upper part of the Glenns Ferry Formation north of Malheur Butte is mapped separately as:

Tigg Conglomerate (Pliocene) Interbedded deposits of weakly lithified coarse conglomerate, sandstone, and vitric lapilli tuff. Unit fills a narrow channel incised into the upper part of the Glenns Ferry Formation north of Malheur Butte. Clasts include well-rounded coarse grained granite and pegmatite, and rounded black andesite and basalt, obsidian, and silicified tuff cobbles. Dark gray lapilli tuff crops out as 2 - 3 ft thick ledges in the upper part of the unit. Large (> 2 ft diameter) blocks of aphyric lava locally occur with the gravel cobbles. Pliocene age based on tentative correlation of the lapilli tuff and aphyric lava blocks with the Malheur Butte volcano, which has been radiometrically dated at 2.78 $\pm$ 0.84 Ma (Lees, 1994).

Tmv Malheur Butte volcanics (Pliocene) Vent complex of bluish-gray, platy aphyric lava flows, pyroclastic deposits, and subvolcanic intrusion. Unit includes the eroded core of a small volcano erupted through and into the Glenns Ferry Formation. The vent plug is comprised of complexly intermixed andesite - with sparse plagioclase phenocrysts- and glassy aphyric black dacite (Lees, 1994). Pliocene age based on Ar^{40}/Ar^{39} age of 2.78 $\pm$ 0.84 Ma (Lees, 1994).

GEOLOGIC HISTORY

The Glenns Ferry Formation, the oldest unit exposed in the quadrangle, records Pliocene sedimentation along the fluvial floodplain/deltaic margin of Lake Idaho, a large lake that occupied most of the western Snake River plain during the late Miocene and Pliocene (Cope, 1883; Jenks and Bonnichsen, 1989). Thin-bedded, fine-grained tuffaceous Glenns Ferry Formation silt- and claystones exposed at Malheur Butte are lithologies suggestive of a floodplain setting. Overlying cross-bedded sandstone and pebble conglomerates are indicative of a fluvial or deltaic environment. Regionally extensive upward-coarsening of the Glenns Ferry Formation has been noted elsewhere by Othberg (1994) who suggests that the lake margin shrank during a period of climate change in the Northern Hemisphere.

Upward coarsening in the Glenns Ferry Formation near Malheur Butte can also be attributed to faulting along the margin of the western Snake River plain. The Malheur Butte fault zone is a N15°W trending zone of faults and folds approximately 7000 ft in width that extends northward from Malheur Butte. The fault zone is a north- northwest- trending rift or rhombo-chasm partially filled with syntectonic channel gravels and tephra. Strike-slip component of faulting is suggested by folding in lower Glenns Ferry Formation silt- and claystones. Within the N15°W trending-zone, a fold axis and parallel small displacement faults trend N0°E - N10°W. Channel gravels (mapped separately as unit Tigg) exposed in the top of the Glenns Ferry Formation have been cut by small intragraben faults. Gray lapilli tuffs presumably erupted from Malheur Butte to the south are interbedded with the gravels and provide evidence for syndepositional volcanism. Northward transport is suggested by the presence of large aphyric lava blocks almost certainly derived from Malheur Butte to the south. Age of faulting is somewhat constrained by the Malheur Butte volcano, situated on the south end of the fault zone. Silt-, clay-, and sandstone in the lower Glenns Ferry Formation were folded and hydrothermally altered prior to the at 2.78 $\pm$ 0.84 Ma eruption of Malheur Butte. Offset of beds in the upper Glenns Ferry Formation gravels indicate some post-volcanic faulting

During the late Pliocene, the ancestral Snake River carved a terrace across the Glenns Ferry Formation, leaving a 15 - 30 ft thick layer of cobble gravel (unit Ttg). The change from predominantly lacustrine and fluvial-deltaic shoreline deposits of the Glenns Ferry Formation to the high energy fluviatile terrace gravel deposits record the capture of the ancestral Snake River by the Columbia River system and the emptying of Lake Idaho through Hells Canyon (Wheeler and Cook, 1954). Initial stage of downcutting formed the Tenmile Gravel and Tuana Gravel (Malde, 1991) and, tentatively, the Ttg terrace. These gravels are the oldest remnants of the high-energy drainage system developed following the Snake River capture. The older terrace had been extensively dissected by about 1.58 Ma, when a younger terrace gravel was deposited across the Ontario Heights. A temporary return to a lacustrine setting is indicated by the widespread deposition of tuffaceous silt- and fine-grained sand on top of basal Qdg gravels. Incisement by the Snake River resumed with formation of a third terrace -tentatively correlated with the Whitney Terrace- in the late Pleistocene.

The Malheur River had partially cut through the lower terrace when, at about 14,000 years B.P. most of the quadrangle was buried by 20 - 30 ft of silt and fine sand deposited by the Snake River during the late Pleistocene Bonneville flood (Malde, 1968; Gannett, 1990). Downstream hydraulic damming at Farewell Bend formed a flooded backwater whose high stand reached an elevation of at least 2447 ft (Othberg and others, 1995). Wind-blown silt (loess) and sand picked up from the flooded lowlands subsequently mantled much of the adjoining highlands. Bonneville Flood deposits along the Malheur River floodplain have been reworked by periodic flooding by the Malheur River into modern alluvium.

STRUCTURE AND SEISMIC HAZARDS

A major fault zone cuts Pliocene units in the southwest corner of the quadrangle. The Malheur Butte fault zone, shown by Brown and others (1980) extends northwest of Malheur Butte for several tens of miles. The Malheur Butte fault zone is a N15°W trending zone of faults and folds approximately 7000 ft in width. The fault zone is clearly visible on air photographs as a parallel series of major lineaments that cross Glenns Ferry Formation units. Local tilting of lower Glenns Ferry Formation strata is readily apparent along small displacement faults (<3 ft) exposed in the banks of the Owyhee canal. Strike-slip component of faulting is suggested by folding of lower Glenns Ferry Formation silt- and claystones. Within the N15°W trending-zone, fold axis and parallel small displacement faults trend N0°E - N10°E. The Malheur Butte fault zone is tentatively interpreted as a north- northwest- trending rift or rhombo-chasm that was partially filled with syntectonic channel gravels and tephra during a period of strike-slip faulting and volcanism.

A similarly oriented series of small, normal displacement faults are exposed to the west at Vale (Brown, 1982). These make up part of the Vale fault zone, considered by Lawrence (1976) to be the northernmost of a series of left-lateral strike-slip faults that terminate the northern margin of the Great Basin. Undeformed terrace gravels atop the fault trace indicate that Malheur Butte fault zone has probably not seen active movement since the middle Pliocene and is not currently active.

GEOLOGIC RESOURCES

Sand and gravel, used for aggregate in the local construction industry, are the main mineral resources mined in the quadrangle. Active mines situated in the upper (QTtg) and intermediate (Qdg) terraces. Past mines have generally started where the lower gravel unit in the intermediate Qdg terrace has been exposed by channels cut through the terrace. Economic feasibility of past operations on the intermediate terrace appear to have been dependent upon working shallow gravels Mining of the intermediate Qdg terrace usually ceased when the gravel is mined back to where the complete 5 - 10 m section of overlying sand and silt is preserved. Although there is less cover on the upper terrace gravels, the quantity of gravel is limited. Thick gravels in the Tigg unit have thick overburden and are of limited areal extent.

A hydrothermal alteration zone of about 80 acres areal extent is exposed on the east flank of Malheur Butte. Most of the zone consists of bedded silt- and claystone that have been altered in situ to a greenish-brown clay. Although the site is listed as a possible bentonite clay resource (Gray, 1993) the clay does not appear to have significant swelling characteristics.

Narrow ribs of silicified sandstone that crop out northeast of Malheur Butte presumably mark weakly altered fault zones. The most intensely altered zone is exposed on the east side of Malheur Butte, where weakly silicified breccias crop out adjacent to the unaltered volcanic neck of Malheur Butte. Although the potential for precious metal resources at this site appear slight, significant hot spring-type mineralization occurs along similarly oriented fault zones at Vale Buttes, to the east, and Tub Mountain, to the northwest.

Potential energy resources include natural gas and geothermal. Although natural gas has been identified in water wells drilled into the Idaho group, exploration to date has failed to define a natural gas resource in the western Snake River plain (Newton and Corcoran, 1963). Similarities between the Malheur Butte fault zone and the faults in the Known Geothermal Resource Area at Vale (Brown and others, 1980) may afford some slight potential for geothermal resources in the quadrangle.

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