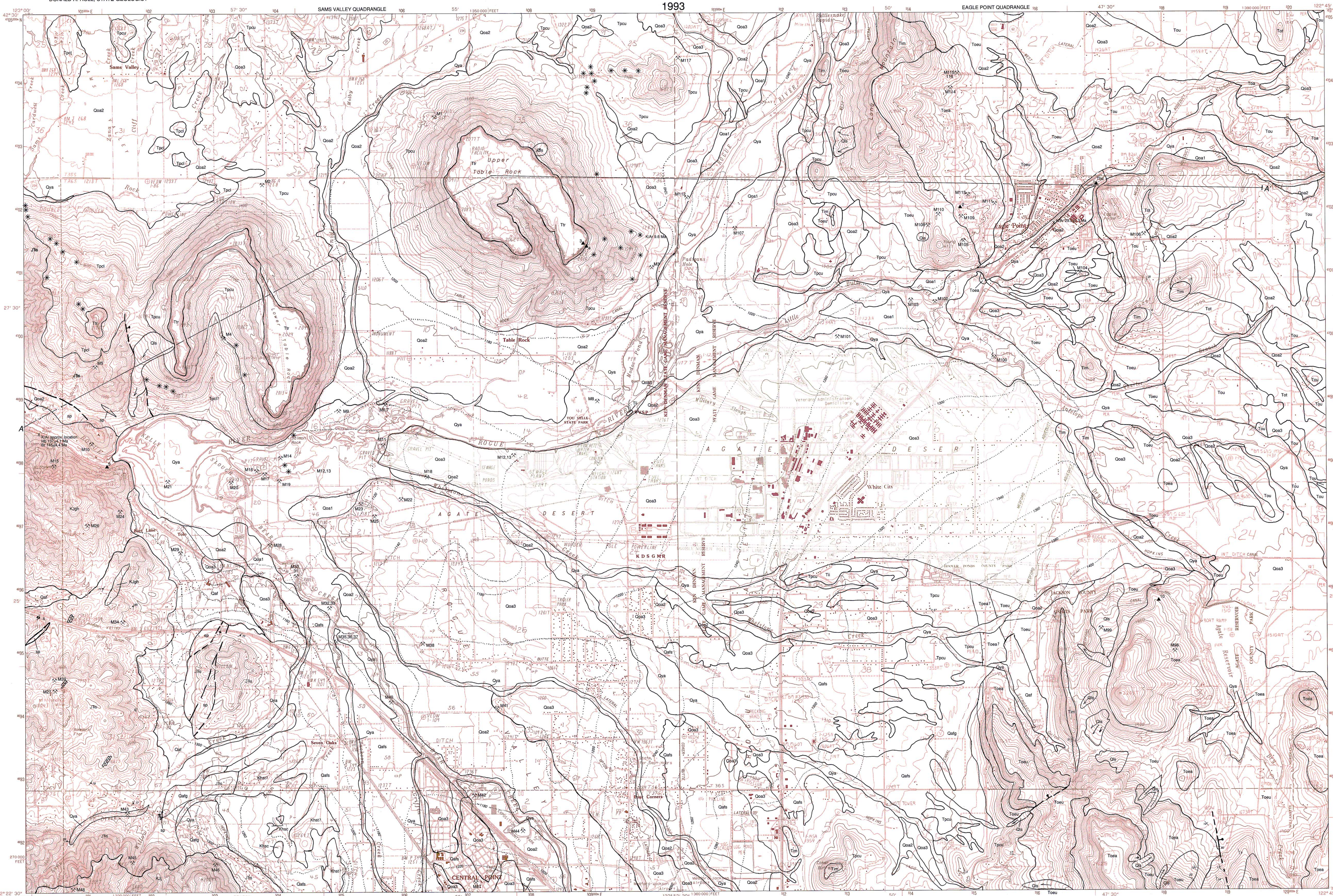
STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
DONALD A. HULL, STATE GEOLOGIST

Preliminary Geologic Map of the Eagle Point and Sams Valley Quadrangles, Jackson County, Oregon

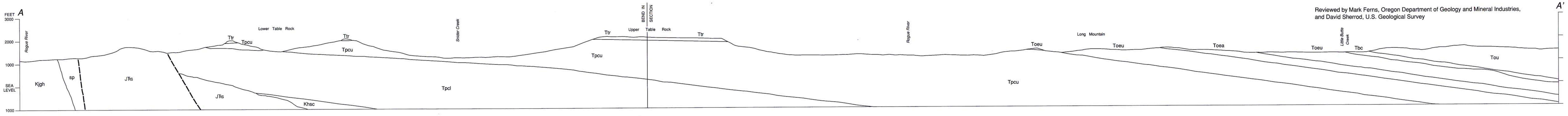
1993



Base maps by U.S. Geological Survey
Lambert conformal conic projection
1927 North American Datum

GEOLOGIC CROSS SECTION

Quaternary units not shown



Geology by Thomas J. Wiley, Oregon Department of Geology and Mineral Industries, and James G. Smith, U.S. Geological Survey

Field checked 1991-1993

Reviewed by Mark Ferns, Oregon Department of Geology and Mineral Industries, and David Sherrod, U.S. Geological Survey

Open-File Report 0-93-13

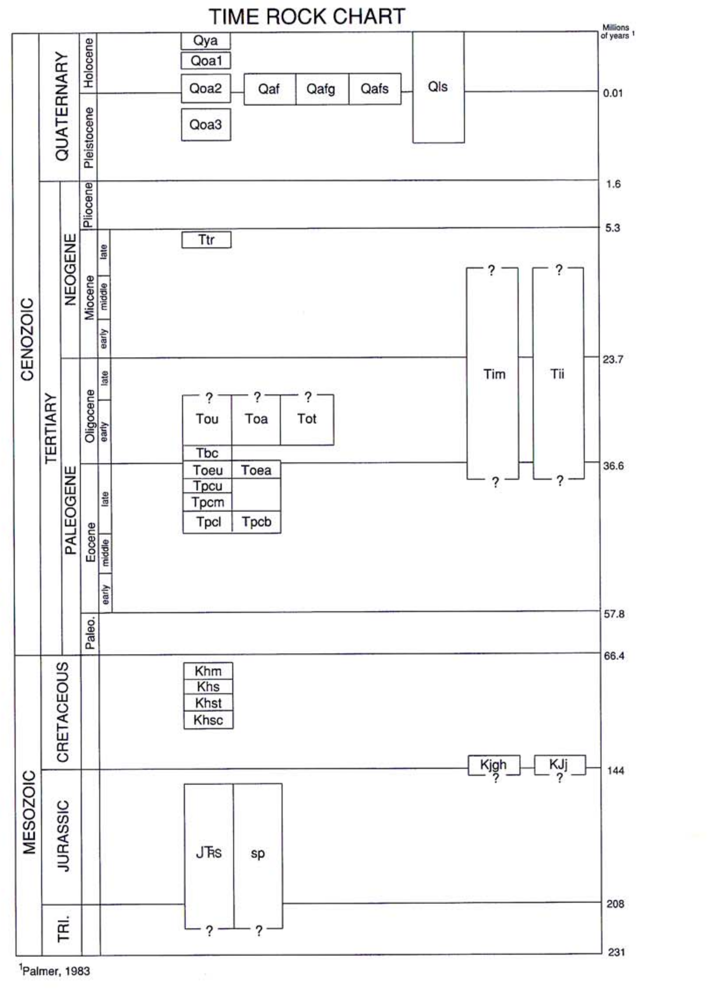
Preliminary Geologic Map of the Medford East, Medford West, Eagle Point, and Sams Valley Quadrangles, Jackson County, Oregon

Compiled by T.J. Wiley and J.G. Smith

Funded in part by the National Geologic Mapping Program (STATEMAP).

Plate 1

TIME ROCK CHART



[1]Palmer, 1983

EXPLANATION

(Full description of geologic units, resources, and geochemistry in accompanying text)

SURFICIAL DEPOSITS

Qya Younger alluvium (Holocene)

Qls Landslide deposits (Holocene and Pleistocene)

Qoa1 Older alluvium (Holocene)

Qoa2 Older alluvium (Holocene and Pleistocene)

Qaf Alluvial fan deposits, undivided (Holocene and Pleistocene)

Qafg Alluvial fan gravel (Holocene and Pleistocene)

Qafs Alluvial fan sand (Holocene and Pleistocene)

Qoa3 Older alluvium (Pleistocene)

DISCONFORMITY

TERTIARY (NEOGENE) VOLCANIC ROCKS

Ttr Andesite of Table Rock (upper Miocene)

ANGULAR UNCONFORMITY

TERTIARY (PALEOGENE) SEDIMENTARY AND VOLCANIC ROCKS

Tou Volcanic and volcaniclastic rocks undivided (upper(?) and lower Oligocene)

Toa Andesite

Tot Tuff and lapilli tuff

Tbc Tuff of Bond Creek (lower Oligocene)

Toeu Volcanic and volcaniclastic rocks undivided (lower Oligocene and upper Eocene)

Toea Andesite

Payne Cliffs Formation of McKnight (1971) (upper Eocene)

Tpcu Upper part (upper Eocene)

Tpcm Middle part (upper Eocene)

Tpcl Lower part (upper and middle(?) Eocene)

Tpcb Conglomerate

DISCONFORMITY

Hornbrook Formation (Upper and Lower Cretaceous)

Khm Mudstone (Upper Cretaceous)

Khs Sandstone (Upper Cretaceous)

Khst Siltstone (Upper Cretaceous)

Khsc Sandstone and conglomerate (Upper and Lower Cretaceous)

ANGULAR UNCONFORMITY

JURASSIC OR OLDER METAMORPHIC ROCKS

JTRs Sandstone and argillite (Jurassic and Upper Triassic?)

sp Metaserpentinite and talc

INTRUSIVE ROCKS

Tii Intermediate intrusive rocks (late Miocene? to late Eocene?)

Tim Mafic intrusive rocks (late Miocene? to late Eocene?)

KJgh Gold Hill pluton (Early Cretaceous and Late Jurassic?)

KJj Jacksonville pluton (Early Cretaceous and Late Jurassic?)

MAP SYMBOLS

Contact--Approximately located

Fault--Dashed where inferred; dotted where concealed; ball and bar on down-thrown side.

25 Strike and dip of beds

Strike and dip of beds (approximate)

Horizontal bed

77 Strike and dip of foliation

Strike of vertical foliation

Strike and dip of joint

Strike of vertical joint

Strike and dip of igneous dike

Strike of vertical dike

Direction of landslide movement (unit Qls)

Marble (unit JTrs) or calcareous sandstone (unit Khsc)

Erosional remnants and rubble of andesite of Table Rock (unit Ttr)

10 Geochemical analysis, location and map number (Table 1, Plate 2)

K/Ar 9.6 Ma X Radiometric age sample site

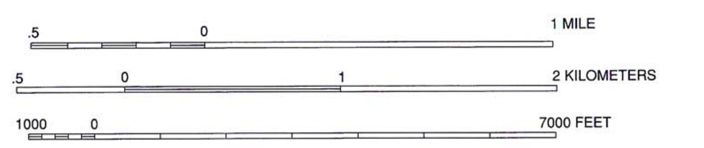
M117 Mine or prospect site--showing map number (Table 2, Plate 2)

q Vein quartz

s Sulfide mineralization--consists chiefly of pyrite but may include chalcopyrite, bornite, sphalerite, galena, or arsenopyrite

1280 Elevation of bedrock beneath alluvium--for selected areas, contour interval 20 feet

SCALE 1:24 000



CONTOUR INTERVAL 20 FEET

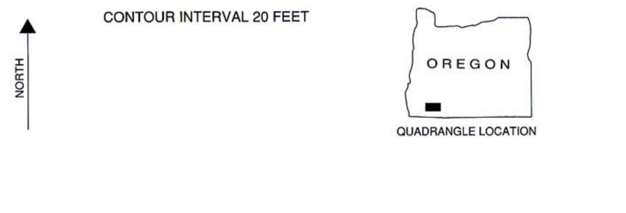


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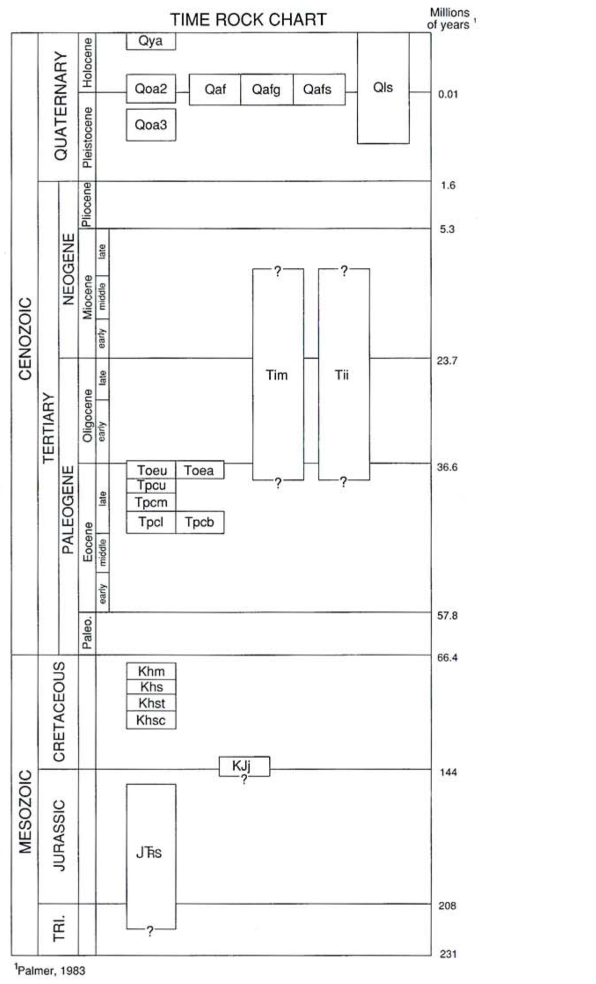
Plate 2

Base maps by U.S. Geological Survey
Lambert conformal conic projection
1927 North American Datum

TIME ROCK CHART



[1]Palmer, 1983

EXPLANATION

(Full description of geologic units, resources, and geochemistry in accompanying text)

SURFICIAL DEPOSITS

- Qya — Younger alluvium (Holocene)
- Qls — Landslide deposits (Holocene and Pleistocene)
- Qoa2 — Older alluvium (Holocene and Pleistocene)
- Qaf — Alluvial fan deposits, undivided (Holocene and Pleistocene)
  - Qafg — Alluvial fan gravel (Holocene and Pleistocene)
  - Qafs — Alluvial fan sand (Holocene and Pleistocene)
- Qoa3 — Older alluvium (Pleistocene)

DISCONFORMITY

TERTIARY (PALEOGENE) SEDIMENTARY AND VOLCANIC ROCKS

- Toeu — Volcanic and volcaniclastic rocks undivided (lower Oligocene and upper Eocene)
- Toea — Andesite

Payne Cliffs Formation of McKnight (1971) (upper Eocene)

- Tpcu — Upper part (upper Eocene)
- Tpcm — Middle part (upper Eocene)
- Tpcl — Lower part (upper and middle(?) Eocene)
- Tpcb — Conglomerate

DISCONFORMITY

Hornbrook Formation (Upper and Lower Cretaceous)

- Khm — Mudstone (Upper Cretaceous)
- Khs — Sandstone (Upper Cretaceous)
- Khst — Siltstone (Upper Cretaceous)
- Khsc — Sandstone and conglomerate (Upper and Lower Cretaceous)

ANGULAR UNCONFORMITY

JURASSIC OR OLDER METAMORPHIC ROCKS

- JTrs — Sandstone and argillite (Jurassic and Upper Triassic?)

INTRUSIVE ROCKS

- Tii — Intermediate intrusive rocks (late Miocene? to late Eocene?)
- Tim — Mafic intrusive rocks (late Miocene? to late Eocene?)
- KJj — Jacksonville pluton (Early Cretaceous and Late Jurassic?)

MAP SYMBOLS

- Contact--Approximately located
- Fault--Dashed where inferred; dotted where concealed; ball and bar on down-thrown side.
- Strike and dip of beds
- Horizontal bed
- Strike and dip of foliation
- Strike of vertical foliation
- Strike and dip of joint
- Strike of vertical joint
- Strike of vertical dike
- Syncline--Dotted where concealed, arrow indicates plunge
- Direction of landslide movement (unit Qls)
- Marble (unit JTrs) or calcareous sandstone (unit Khsc)
- Geochemical analysis, location and map number (Table 1, Plate 2)
- Radiometric age sample site
- M73 Mine or prospect site showing map number (Table 2, Plate 2)
- 1200 Elevation of bedrock beneath alluvium for selected areas, contour interval 20 feet.

NORTH

QUADRANGLE LOCATION

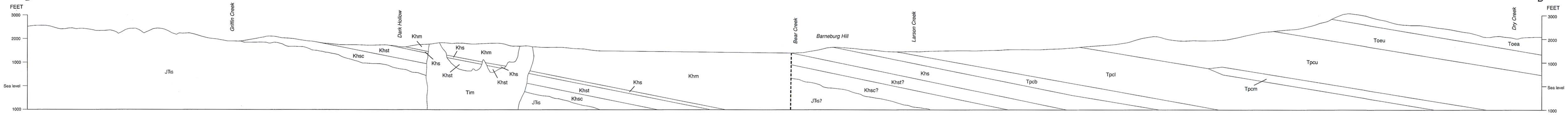
SCALE 1:24 000

.5 0 1 MILE
.5 0 1 2 KILOMETERS
1000 0 7000 FEET

CONTOUR INTERVAL 20 FEET

GEOLOGIC CROSS SECTION

Quaternary units not shown



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INTRODUCTION

Rocks in the Medford area were originally deposited as sediments in ancient oceans and rivers, and as various kinds of volcanic deposits. For more than 200 million years, interaction between what is now the western edge of North America and what was once the sea floor beneath the Pacific Ocean caused repeated transitions from ocean to dry land and from volcano to river valley. Deposits of gold and silver, sand and gravel, and coal all result from some combination of geologic processes related to this history. The western part of the map area is underlain by rocks as old as 200 million years (Ma), representing sea-floor sediments derived from volcanoes and a nearby ancient continental margin. Between 150 and 135 Ma, these rocks were metamorphosed and then intruded by the Jacksonville and Gold Hill plutons. The absence of rocks with ages between 135 Ma and 100 Ma suggests that for at least some of that time the area rose above sea level and underwent erosion. Between 100 and 75 Ma, deepening seas deposited fossiliferous sandstone and mudstone of the Hornbrook Formation. More than 25 million years later, a river system deposited sandstone and conglomerate that form the Payne Cliffs Formation. Volcanoes in the Cascade Range began erupting about 40 Ma and continue active to the present day, with one apparent quiescence from 14 to 10 Ma. A general eastward tilting occurred throughout the region. The oldest untilted lava flow is the andesite of Table Rock; this flow originated east of Prospect and traveled down the ancestral Rogue River valley. Continued erosion has reversed the topography so that the old, lava-filled valley is preserved today as the tops of Upper and Lower Table Rocks. Subsequent cutting and filling produced the complex pattern of bedrock and alluvium along the Rogue River and Bear, Little Butte, and Sams Creeks.

This compilation of geologic mapping is from the following sources: Wells (1956), Beaulieu and Hughes (1977), McKnight (1971, 1984), Nilsen (1984, 1993), Smith and others (1982), James G. Smith (USGS, unpublished mapping), U.S. Soils Conservation Service (unpublished mapping), and U.S. Geological Survey National Ground-Water Site Inventory. Mine and prospect information is from Gray (1991). In many places where the original maps disagree, the geology has been field checked by Wiley. However, most contacts were not field checked.

EXPLANATION

SURFICIAL DEPOSITS

Qya **Younger alluvium (Holocene)** — Gravel, sand, silt, and clay deposited along modern stream channels, maximum surface relief less than 2 m (6 ft); unit may flood intermittently. Age less than 2,350 yr BP (Parsons and Herriman, 1976)

Qls **Landslide deposits (Holocene and Pleistocene)** — Fragments of bedrock mixed with gravel, sand, silt, or clay and displaced downslope by gravity sliding. Includes slumps, earth flows, block glides, debris flows, and rock falls. Landslides are most common where competent lava flows overlie weaker sediment or tuff. Arrows indicate direction of movement

Qoa1 **Older alluvium (Holocene)** — Gravel, sand, silt, and clay in floodplains and terraces 1-5 m (3-16 ft) above modern stream channels. Locally subject to flooding. Age based on ^{14}C dates of 2,350 and 6,930 yr BP (Parsons and Herriman, 1976) and presence of Mazama ash (possibly reworked) in soil

Qoa2 **Older alluvium (Holocene and Pleistocene)** — Gravel, sand, silt, and clay in dissected floodplains and terraces up to 10 m (30 ft) above modern stream channels. Includes dissected alluvial fans in the area east of Bear Creek

Qaf **Alluvial fan deposits, undivided (Holocene and Pleistocene)** — Gravel, sand, and silt in individual or coalescing fan-shaped deposits along valley margins. Typically occur where stream gradients decrease abruptly. In many areas divided on the basis of predominant grain size into:

Qafg **Alluvial fan gravel (Holocene and Pleistocene)** — Cobble and pebble gravel with subordinate sand and silt, typically deposited near fan apex

Qafs **Alluvial fan sand (Holocene and Pleistocene)** — Sand, pebbly sand, and silt with subordinate pebble gravel. Typically found on distal parts of fans, between lobes of unit **Qafg** on upper parts of fans, or on fans derived from areas underlain by granitic rock

Qoa3 **Older alluvium (Pleistocene)** — Gravel, sand, silt, and clay locally cemented to conglomerate, sandstone, and mudstone. Surface of this extensive deposit, the Roxy Anne surface of Parsons and Herriman (1976), is characterized by patterned ground, elevation more than 10 m (30 ft) above major modern stream channels, and local pavement of cobbles and pebbles formed by aeolian removal of fines. Thought to be late Pleistocene in age (Parsons and Herriman, 1976). May include older parts of alluvial fans

DISCONFORMITY

TERTIARY (NEOGENE) VOLCANIC ROCKS

Ttr **Andesite of Table Rock (upper Miocene)** — Black, glassy, olivine-bearing augite andesite with up to 25 percent distinctive tabular plagioclase phenocrysts as large as 1 by 5 by 5 mm. Caps prominent mesas in Sams Valley area; scattered rubble and remnants (asterisks) that occur south and west of Lower Table Rock and north and east of Upper Table Rock may indicate original distribution. Distinctive petrography and whole-rock chemistry (see Table 1, lab. nos. BAG-614, 615) also characterize flow remnants in the Shady Cove, Trail, McLeod, Big Butte Creek, and Prospect areas to the northeast. Distribution indicates that this lava originated near Prospect and spread across the area now occupied by Olson Mountain as it flowed down the ancestral Rogue River valley toward the Sams Valley area where it is preserved as inverted topography on Upper and Lower Table Rocks. Age based on K/Ar dates from two sites: 1) 9.6 Ma whole-rock age from a boulder of columnar andesite near the intersection of Modoc and Antioch Roads southeast of Upper Table Rock (Robert Duncan and Clifton Mitchell, Oregon State University, unpublished data) and 2) 7.10 ± 0.2 and 6.77 ± 0.2 Ma whole-rock ages from Bear Mountain in the southeastern part of the Trail quadrangle (Fiebelkorn and others, 1983). Maximum thickness is 60 m (200 ft)

ANGULAR UNCONFORMITY

TERTIARY (PALEOGENE) SEDIMENTARY AND VOLCANIC ROCKS

Tou **Volcanic and volcaniclastic rocks undivided (upper? and lower Oligocene)** — Interbedded lapilli tuff, tuffaceous conglomerate, tuff, tuff breccia, block-and-ash tuff, small intermediate to mafic flows and intrusions, volcanic sandstone, and volcanic mudstone. Interpreted as pyroclastic, sedimentary, and volcanic rocks deposited on a broad, aggrading volcaniclastic dispersal apron adjacent to active volcanoes. Sediment is typically compositionally and texturally immature; it probably was deposited by processes ranging from fully turbulent dilute stream flow (volcanic sandstone and mudstone) to viscous debris flow (tuff breccia and tuffaceous conglomerate) as a result of erosion and redeposition of gravitationally unstable primary volcanic and pyroclastic deposits. Tuff, lapilli tuff, and tuffaceous conglomerate are predominantly chaotic, poorly sorted, and matrix supported; they are interpreted as ash-flow and sediment-gravity-flow deposits. Lapilli tuff, tuff breccia, and block-and-ash tuff above unit **Tbc** east of Eagle Point occupy the same stratigraphic position as the tuff of Mosser Mountain (Hladky, 1992) in the Shady Cove quadrangle to the north and may represent more proximal facies of that unit. Thickness about 550 m (1,800 ft). Locally divided into:

Toa **Andesite** — Tan-weathering, gray to dark gray, fine-grained to glassy pyroxene andesite, locally glomeroporphyritic. Typically plagioclase and augite phyric. Most flows contain zoned plagioclase phenocrysts

Tot **Tuff and lapilli tuff** — Welded and unwelded dacitic ash-flow tuff and lapilli tuff in northeast corner of Eagle Point quadrangle

Tbc **Tuff of Bond Creek (lower Oligocene)** — Unit of Smith and others (1982) Buff to olive, partially welded, rhyodacitic, biotite-quartz-plagioclase-sanidine ash-flow tuff. Hackly weathering. Potassium/argon ages of 34.9 ± 1, 34.9 ± 1, and 35.0 ± 1 Ma on biotite reported by Fiebelkorn and others (1983) from outcrops in Douglas County. Thickness approximately 30 m (100 ft) in Little Butte Creek

Toeu **Volcanic and volcaniclastic rocks undivided (lower Oligocene and upper Eocene)** — Gray-weathering, tan, olive, brown, and light blue-gray lapilli tuff, tuffaceous conglomerate, mudstone, tuffaceous sandstone, tuff, lava flows, and intrusions. Lapilli tuff and tuffaceous conglomerate are poorly sorted and matrix supported and are interpreted as ash-flow, mudflow, and sediment-gravity-flow (lahar) deposits. Clasts range in size up to 2 m, are angular to rounded, usually subrounded; common lithologies include andesitic and basaltic lava and latitic to rhyolitic welded tuff. Mudstone is thickly laminated and may be intercalated as lenses within conglomerate. Sandstone and tuffaceous sandstone is coarse to pebbly; locally plane laminated or cross bedded. Andesite is aphyric to porphyritic (with andesine and augite phenocrysts) and platy to massive; Fiebelkorn and others (1983) report an age of 29.5 ± 0.3 Ma for andesite from Little Butte Creek east of Eagle Point (Note that this andesite seems to lie beneath tuff of Bond Creek). Near the base of unit **Toeu** volcanic rocks are intercalated with fluvial conglomerate and sandstone of Payne Cliffs Formation. Thickness of unit about 400 m (1,310 ft). Locally divided into:

Toea **Andesite** — Tan-weathering, gray to dark gray, fine-grained to glassy pyroxene andesite flows and breccias, locally glomeroporphyritic. Typically plagioclase and augite phyric, phenocryst size and abundance varies in different flows. Plagioclase phenocrysts may be zoned. May include small intrusions and basaltic flows not mapped separately. Thickness to 120 m (400 ft)

Payne Cliffs Formation of McKnight (1971) (upper Eocene) — Divided into:

Tpcu **Upper part (upper Eocene)** — Sandstone, conglomerate, mudstone, and coal. Interpreted as representing fluvial deposits; provenance suggests local derivation in part. Sandstone and pebbly sandstone are gray, green, or tan lithic to arkosic wacke that is micaceous, cross bedded, laminated, or massive and is locally tuffaceous; beds to 2 m thick. Pebble conglomerate is light olive to gray, weathers grayish brown, green, or yellowish orange, and is generally clast supported, locally imbricated or cross bedded, with beds to 5 m thick (average

0.75 m); typical clasts are subrounded to well-rounded oblate spheroids that average 2 cm in diameter, with maximum diameter <10 cm and wood fragments to 50 cm. Conglomerate clasts are predominantly porphyritic intermediate volcanic rocks with less common clasts of quartzite, mafic volcanic, vein quartz, intrusive, silicic metavolcanic, and other metamorphic rocks. Mudstone is gray to grayish green. Low quality coal was mined from 1-m beds along the eastern side of Bear Creek Valley. Minimum age reported by Brown (1956) is late Eocene based on fossil leaves from middle part of the formation near Ashland and along the contact with overlying volcanic rocks (Peck and others, 1964). Intruded by basaltic dike with late Eocene K/Ar whole-rock minimum age of 36.9 ± 0.8 Ma in adjacent Boswell Mountain quadrangle (Robert Duncan, written communication, 1992). Maximum thickness about 600 m (1,970 ft)

Tpcm **Middle part (upper Eocene)** — Conglomerate lens and associated sandstone and tuff described by McKnight (1984). Not recognized north of Medford. Increased proportion of andesitic and other volcanic clasts and tuff signal onset of nearby volcanic activity, most likely in the Western Cascades. Thickness 130 m (430 ft)

Tpcl **Lower part (upper and middle? Eocene)** — Primarily arkosic sandstone, with subordinate conglomerate (to 10 percent), mudstone, and coal. Numerous 2- to 5-meter thick fining-upward sequences are interpreted by McKnight (1984) as braided-fluvial channel deposits. These sequences typically consist of thin conglomerate that grades upward to trough cross-bedded medium-grained sandstone and then to ripple-laminated fine-grained sandstone. Thickness, including subunit **Tpcb** basal conglomerate, is about 1,000 m (3,280 ft)

Tpcb **Conglomerate** — Massive to crudely bedded conglomerate with subordinate sandstone. Quartzite clasts predominate; less common clasts include siliceous metavolcanic, vein quartz, metamorphic, and granitic compositions. Interpreted as bed-load deposit of a braided stream system (McKnight, 1984). Thickness up to 160 m (530 ft)

DISCONFORMITY

Hornbrook Formation (Upper and Lower Cretaceous) — Divided into:

Khm **Mudstone (Upper Cretaceous)** — Buff-weathering dark-gray to brown to olive mudstone with light-brown interbedded sandstone. Sliter and others (1984) report a late Turonian age (approximately 90 Ma) for these rocks in the Dark Hollow area and a late Campanian age (approximately 75 Ma) for rocks in the Ashland area. They suggest deposition occurred at depths of 500 to 1,000 m and interpret these rocks as thin-bedded to medium-bedded turbidites. Nilsen and others (1983) and Nilsen (1993) regard this unit as equivalent to the Blue Gulch Mudstone Member in the Hornbrook area. Thickness of 585 m (1,920 ft) measured by McKnight (1971), thickness along cross section B-B′ about 780 m (2,560 ft)

Khs **Sandstone (Upper Cretaceous)** — Brown-weathering thin-bedded fine- to medium-grained sandstone including conglomeratic intervals, mudstone, and concretions. Sliter and others (1984) report middle and late Turonian megafossils and foraminifers from Dark Hollow, from the Barneburg Hill area, and from the 49 Mine just south of the map area. Interpreted as representing thick-bedded to amalgamated turbidite sands deposited in water 200-500 m deep. Nilsen and others (1983) and Nilsen (1993) consider these rocks are equivalent to the Rocky Gulch Sandstone Member in the formation's type area near Hornbrook, California. Sandstone tentatively assigned to this unit either overlies unit **Khm** in the Barneburg Hill area or is juxtaposed against unit **Khm** along a buried north-northwest-striking down-to-the-west fault located beneath the alluvium west of Bear Creek (See cross section B-B′). Thickness of 220 m (720 ft) measured by McKnight (1971); thickness along cross section B-B′ of 40 m (130 ft) near Dark Hollow and 280 m (920 ft) near Barneburg Hill

Khst **Siltstone (Upper Cretaceous)** — Dark-gray siltstone with minor fine-grained sandstone and mudstone. Sliter and others (1984) report early Turonian megafossils and middle Turonian planktic foraminifers from the south end of the Dark Hollow area. They suggest a depositional environment equivalent to an outer shelf to upper slope setting. Nilsen and others (1983) and Nilsen (1993) regard these rocks as equivalent to the Ditch Creek Siltstone Member in the type area. Thickness of 23 m (75 ft) measured by McKnight (1971), thickness along cross section B-B′ of 130 m (430 m) near Dark Hollow

Khsc **Sandstone and conglomerate (Upper and Lower Cretaceous)** — Medium-grained, cross-bedded sandstone and lenses of coarse-cobble to pebble conglomerate. Sandstone is locally limy near the base and commonly contains 10-cm to 1-m concretions. Sliter and others (1984) report late Albian to middle Cenomanian ages (approximately 100 to 92 Ma) for these rocks and consider them to have originated in a shoreline to inner-neritic environment. Nilsen and others (1983) and Nilsen (1993) regard the sandstone as equivalent to the Osburger Gulch Sandstone Member and conglomerate as equivalent to the Klamath River Conglomerate Member in the type area. Thickness of 110 m (360 ft) measured by McKnight (1971), thickness along cross section B-B′ of 120 m (390 m)

ANGULAR UNCONFORMITY

JURASSIC OR OLDER METAMORPHIC ROCKS

JTrs **Sandstone and argillite (Jurassic and Upper Triassic?)** — Metamorphic sandstone and argillite with lesser amounts of quartz-biotite schist, marble, and meta-igneous rocks not mapped separately. Metamorphic sandstone includes both volcanic sandstone and minor quartzite; volcanic sandstone is composed of angular to subrounded grains of pyroxene, hornblende, and plagioclase in a tuffaceous matrix, locally giving it the appearance of a lava flow. Metamorphism varies from greenschist to amphibolite facies. Metamorphic grade seems to be higher near the Rogue River and Willow Hill, where metavolcanic rocks, quartz-biotite schist, metaserpentinite, talc, argillite, and marble form an assemblage similar to the greenstone, argillite, and metaserpentinite unit mapped by Donato (1992) in the Carberry Creek quadrangle to the south. However, the outcrop belt is interrupted by the Gold Hill and Jacksonville plutons and associated contact metamorphism, making it difficult to map a contact between the northern and southern parts of this unit. Steeply dipping cleavage suggests isoclinal folding accompanied metamorphism prior to, or contemporaneous with, intrusion of the plutons. Age based on conodont platform fragments (Devonian-Triassic; Irwin and others, 1983) and *pentacrinus*? (Mesozoic?; Irwin and Galanis, 1976) in limestone from the Gold Hill area and better dated Late Triassic limestone localities to the south and west (Irwin and others, 1983). Limestone is interpreted as older blocks redeposited in younger sediments (Irwin and others, 1983); enclosing sediments must be younger than the limestone, yet no younger than the plutons, and may therefore range in age from Late Triassic to Jurassic. Locally divided into:

sp **Metaserpentinite and talc** — Crops out in western part of Sams Valley quadrangle, internally sheared and fault bounded. Donato (1992) interprets similar rocks in nearby quadrangles as regionally metamorphosed along with surrounding sedimentary and volcanic rocks

INTRUSIVE ROCKS

Tii **Intermediate intrusive rocks (late Miocene? to late Eocene?)** — Diorite and aphyric to porphyritic andesite in dikes and larger intrusive bodies. Dark gray to gray to olive where fresh.

Tim **Mafic intrusive rocks (late Miocene? to late Eocene?)** — Gabbro and basalt in dikes and larger intrusive bodies. Dark gray to black where fresh. Crystal assemblage typically includes plagioclase and augite with or without hypersthene and olivine. Potassium/argon age from Roxy Ann Peak of 30.8 ± 2 Ma (Fiebelkorn and others, 1983).

KJgh **Gold Hill pluton (Early Cretaceous and Late Jurassic?)** — Hornblende biotite granodiorite. Concentrically zoned plagioclase. Small dikes and sills extend into adjacent units. Fiebelkorn and others (1983) report K/Ar ages of 145 ± 4.4 Ma for biotite and 137 ± 4.1 Ma for hornblende from a locality near the Rogue River (Site is north of mapped extent of unit **KJgh**, location shown on map is approximate)

KJj **Jacksonville pluton (Early Cretaceous and Late Jurassic?)** — Hornblende biotite tonalite. Fiebelkorn and others (1983) report K/Ar ages of 141 ± 4.2 Ma on biotite and 137 ± 4.1 Ma on hornblende from a sample collected near Walker Creek northwest of Jacksonville

GEOLOGIC SUMMARY

The oldest rocks in the map area are Triassic and Jurassic in age and include metamorphosed and deformed quartzose and volcanic sandstone, argillite, volcanic rocks, tuff, and serpentinite (unit JTrs). These rocks form an association common to many of the tectonostratigraphic terranes in the Klamath Mountains including the May Creek terrane to the north and the Marble Mountains, North Fork, and Hayfork terranes to the south. The presence of serpentinite and interlayered, compositionally mature quartzite, immature volcanic sandstone, pyroclastic rocks, and lava flows and breccia suggests a Mesozoic basin floored by oceanic or transitional crust that received sediment from both continental and arc sources. Subsequent metamorphism, folding, and development of platy cleavage records basin collapse and possibly accretion to North America. Intrusion of the Jacksonville and Gold Hill plutons about 140 Ma may have accompanied or slightly postdated this deformation.

Sliter and others (1984) describe a marine transgression beginning about 130 Ma (Hauterivian) that reached this area about 100 Ma (late Albian) when basal marine beds of the Hornbrook Formation were deposited. The presence of bathyal fauna of benthic foraminifers suggests water depths of 500 to 1,000 m were eventually reached (Sliter and others, 1984). Although the Hornbrook Formation is not preserved overlying the Jacksonville or Gold Hill plutons, its presence only a few hundred meters away from an intrusive contact suggests the Jacksonville pluton was exposed by 100 Ma. The thick section of Hornbrook Formation siltstone (unit Khst) and thin section of sandstone (unit Khs) shown in the Dark Hollow area on cross-section B-B' may be the result of unmapped faults buried beneath alluvium or the occurrence of a silty facies in unit Khs.

Paleocene to middle Eocene ages have not been reported from this area. The oldest Tertiary ages are for late Eocene fossils collected from the middle part of the Payne Cliffs Formation; the lower part of that formation may be somewhat older, perhaps as old as middle Eocene. Nonmarine rocks of the Payne Cliffs Formation overlie the Hornbrook Formation and are interpreted as the deposits of braided and high-sinuosity bedload streams. Typically, the lower part of the Payne Cliffs Formation consists of a basal conglomerate scoured into the underlying Hornbrook Formation and overlain by a thick sequence of arkosic sandstone. However, in Sams Valley, wells thought to be drilled in the lower part of the Payne Cliffs Formation have encountered more than 150 m (500 ft) of siltstone, mudstone, and coal. In the Sams Valley quadrangle the base of the Payne Cliffs Formation rests directly on Jurassic and Triassic metamorphic rocks (unit JTrs). A second thick conglomeratic section locally forms the middle part of the Payne Cliffs Formation and records the onset of nearby volcanism in an increased abundance of volcanic clasts and sand grains and the presence of several tuff beds. Volcaniclastic sandstone and conglomerate with subordinate tuffaceous mudstone and coal characterize the upper part of the Payne Cliffs Formation.

The contact with younger volcanic and volcaniclastic rocks (units Toeu and Toea) is mapped at the transition from predominantly fluvial cross-bedded sandstone and clast-supported pebble conglomerate to lava and ash flows, tuff, and matrix-supported pebble, cobble, and, boulder conglomerate that herald the onset of volcanism in this area. These volcanic and related sedimentary rocks exhibit lateral variations in lithologic and textural character common to volcanic facies, for example: interbedded lava flows, hot and cold debris flows, autoclastic breccia, and block and ash tuff or tuffaceous conglomerate with extreme lateral variations in clast diameter and clast type. These relationships are similar to those shown for the Fisher Formation (Vokes and others, 1951; Hoover, 1963) and related upper Eocene and lower Oligocene flows (Lux, 1982) 130 km (80 mi) to the north near Cottage Grove in Lane County. Early in Oligocene time an exceptionally thick, regionally extensive ash-flow tuff, the tuff of Bond Creek (34.9 Ma; Smith and others, 1980, 1982), was deposited over a large part of the Western Cascade Range. This tuff can be tracked about 1 mile south of Little Butte Creek. The tuff of Bond Creek is overlain by interbedded lapilli tuff, tuff, flows, and polymodal matrix-supported conglomerate (units Tou, Tot, and Toa) that suggest the local tectono-volcanic setting remained much the same as it had been prior to deposition of the tuff of Bond Creek.

Small dikes and intrusions (units Tii and Tim) are present throughout the map area. Potassium/argon data suggest a minimum age of 30.82 Ma (Fiebelkorn and others, 1983) for the basaltic intrusion that forms the top of Roxy Ann Peak.

Rocks older than late Miocene have been broadly folded and generally tilted eastward. A broad northeast-plunging syncline in the Jacksonville area is defined by attitudes in the Hornbrook Formation. Folds with wavelengths of one or more kilometers also occur in the Boswell Mountain (Wiley and Hladky, 1991) and Trail quadrangles to the north and form the Condrey Mountain dome to the south (Mortimer and Coleman, 1984).

Upper and Lower Table Rocks and a small hill to the west are capped by a late Miocene andesite lava flow (unit Ttr) that originated east of Prospect and poured down the Rogue River canyon. This lava is the oldest feature in the area that unconformably overlies the folded and tilted Mesozoic through Paleogene section described above. It suggests that modern drainage patterns were largely established by late Miocene time.

Mapped faults offset most pre-Quaternary units, including the upper Miocene andesite of Table Rock. Northwest-, north-, and northeast-striking faults with moderate to steep dips were most commonly recognized. Since the mid-1800's several small earthquakes have been recorded in this area.

Four stages of Quaternary alluvial fans and valley fill are shown. The age, grain size, and provenance of these units often produces distinctive soil types. For this preliminary map, the correlation between Quaternary surficial deposits and soils was spot-checked and both the boundaries between different Quaternary units and the boundaries between Quaternary units and bedrock were interpreted from unpublished soil mapping prepared by the United States Soil Conservation Service.

GROUND-WATER RESOURCES

Areas underlain by pre-Tertiary metasedimentary and metavolcanic rocks, sedimentary units of the Cretaceous Hornbrook Formation and Eocene Payne Cliffs Formation, and Cretaceous igneous intrusions are characterized by low primary permeability and low storage. Ground water contained in these rocks is controlled by flow along joints and fractures (secondary permeability). Water well yields vary according to the degree and nature of fractures encountered during drilling. Highly fractured, rigid rocks tend to produce larger quantities of ground water than do highly fractured softer units, such as mudstone of the Hornbrook Formation. Seasonal fluctuations in water level tend to be more pronounced at higher elevations, away from ground-water discharge areas; however, significant seasonal fluctuations can occur wherever there is a combination of low yield, low storage, and (relatively) high demand.

Areas underlain by Eocene and Oligocene volcanic rocks and volcanogenic sedimentary rocks are characterized by low to high primary porosity and permeability. Where permeability is low, usable quantities of ground water are restricted to volcanic inter-flow zones and zones of secondary permeability.

Unconsolidated and semiconsolidated alluvium in the Rogue River and Bear Creek valleys is thick enough to form a significant aquifer and is capable of producing large quantities of water. Where saturated, alluvial fan deposits are capable of supplying minor quantities of water to wells. Ground water high in dissolved solids (saline water) can be encountered at shallow depths in bedrock adjacent to creeks and other ground-water discharge points.

Dissolved ions found in concentration include sodium, chloride, fluoride, boron, and sulfur. High levels of arsenic have been measured from wells developed in volcaniclastic water-laid sedimentary strata east of the Bear Creek valley. Nitrate and coliform bacteria have been identified in some wells developed in alluvial deposits containing shallow ground water.

Bedrock-alluvium contacts reported from 85 water wells in the area (U.S. Geological Survey National Ground-Water Site Inventory) have been contoured (dotted 20-ft contours) to produce a preliminary bedrock elevation map for selected areas covered by alluvium. An approximation of the depth to bedrock can be calculated by subtracting bedrock elevation from surface elevation.

MINERAL RESOURCES

Geochemical analyses for samples collected during this investigation are shown on Table 1 (whole-rock analyses). Mines and prospects are listed on Table 2. Gold, silver, and copper mines and prospects occur in older metasedimentary and metavolcanic rocks and in placer and paleo-placer deposits near the upper contacts with these rocks (Jacksonville area). Gold has also been reported from the Payne Cliffs Formation or associated Tertiary intrusive rocks northeast of Fern Valley (Mark Ferns, oral communication, 1992). The Payne Cliffs Formation hosts minor amounts of low grade coal that has not been mined for many years (Winchell, 1914). Most mining activity in the area is for construction-grade sand, gravel, and stone. Stone mined from borrow pits and quarries for construction includes tuff, andesite, basalt, and granite.

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GEOCHEMISTRY

(see Table 1)

Sampling methods

Rock samples collected for combined major- and minor-oxide and trace-element analysis provide an indication of their normal chemical composition. However, the number of samples was not enough to determine the complete range of 'normal' chemical compositions for these rock types in the quadrangle.

Sample preparation

The rock samples were crushed to minus ¼in. in a Braun chipmunk crusher and then crushed to about minus 10 mesh in a Marcy cone crusher. Both crushers employed manganese-steel crushing media. Each crushed sample was split in a Jones-type splitter to obtain a nominal 100-g subsample. Each subsample was then milled to about minus 200 mesh in an Angstrom disk mill. Each whole-rock analytical subsample was milled in corundum media.

All sample preparation was done in the Department of Geology and Mineral Industries (DOGAMI) laboratory.

Chemical analysis

Whole-rock analysis

X-ray fluorescence analyses were performed by X-Ray Assay Laboratories (XRAL) of Don Mills, Ontario, Canada. XRAL used a fused button for its analyses (1.3 g of sample roasted at 950°C for one hour, fused with 5 g of lithium tetraborate, and melt-cast into a button). Loss on ignition (LOI) was determined by roasting.

Table 1. Whole-rock analyses, Medford East, Medford West, Eagle Point, and Sams Valley quadrangles, Jackson County, Oregon[1]

Map no.	Laboratory no.	1/4	1/4	Sec.	T. (S.)	R. (W.)	UTM coordinates	Elev. (ft)	Lithology and location	Map unit
1	BAG-613	NW	NW	2	36	1	4702405N 516927E	1,295	Tuff of Bond Creek, Little Butte Creek	Tbc
2	BAG-612	SE	NE	4	36	1	4702018N 514787E	1,420	Andesite, pit west of Eagle Point	Toea
3	BAG-614	NW	SW	1	36	2	4701445N 508860E	2,030	Top of andesite flow, Upper Table Rock	Ttr
4	BAG-615	NW	SW	1	36	2	4701412N 508872E	1,920	Base of andesite flow, Upper Table Rock	Ttr
5	BAG-617	SE	SW	18	36	2	4697915N 501335E	1,170	Gold Hill pluton near Gold Ray Dam	KJgh
6	BAG-618	SE	SW	19	37	2	4686689N 501201E	2,080	Jacksonville pluton at quarry	KJj
7	BAG-619	SW	NW	12	38	2	4680811N 509037E	1,640	Olivine basalt dike, Dark Hollow Road	Tim
8	BAG-620	SW	NE	14	37	1	4688927N 517854E	3,460	Olivine basalt neck, Roxy Ann Peak	Tim
9	BAG-621	SE	SE	14	37	1	4688085N 518232E	3,000	Andesite, pit southeast of Roxy Ann Peak	Toea
10	BAG-622	NW	NE	26	36	1	4695805N 517909E	1,690	Andesite, pit west of Agate Reservoir	Toea

[1] Analyses by XRAL, Inc.

Table 1. (continued)

Map no.	Oxides (wt. percent)												Selected Trace Elements (ppm)						
	SiO_2	Al_2O_3	TiO_2	Fe_2O_3T	MnO	CaO	MgO	K_2O	Na_2O	P_2O_5	LOI	SUM	Cr	Rb	Sr	Y	Zr	Nb	Ba
1	69.9	13.1	0.257	1.96	0.04	2.66	0.58	2.11	2.06	0.04	7.05	99.9	72	74	359	<10	102	<10	832
2	56.7	17.7	1.16	8.76	0.12	7.20	2.18	1.19	3.22	0.20	1.45	100.0	172	28	293	18	125	19	319
3	56.7	17.0	1.32	7.67	0.15	5.81	2.71	2.36	4.51	0.62	1.25	100.3	74	35	712	27	172	25	776
4	56.5	17.1	1.31	7.75	0.14	5.93	2.86	2.17	4.52	0.59	1.50	100.6	76	37	731	33	172	15	782
5	67.3	16.2	0.408	2.75	0.07	3.22	1.44	2.44	5.51	0.12	0.45	100.1	101	59	801	<10	138	18	586
6	63.8	17.0	0.582	4.01	0.10	4.67	2.33	1.54	5.39	0.18	0.75	100.6	114	35	1110	22	129	22	526
7	50.1	13.2	0.627	9.67	0.18	9.30	11.0	0.58	1.60	0.12	3.80	100.4	925	19	392	16	52	18	91
8	50.1	14.1	0.679	10.2	0.17	9.91	12.2	0.36	1.54	0.11	0.90	100.5	945	18	337	14	35	10	93
9	53.1	15.8	1.15	12.8	0.23	8.48	4.33	0.84	2.68	0.14	0.70	100.3	102	33	187	15	86	12	248
10	51.7	16.6	1.13	13.1	0.21	8.74	3.81	0.38	2.79	0.14	2.25	100.9	76	41	213	13	75	14	164

Table 2. Mines and prospects

Mine no.	Name	Sec.	T.	R.	UTM coordinates	Commodity
M1	No name	7	35S	2W	4703570N 506163E	Gold
M2	Modoc pit	5	36S	2W	4702365N 503767E	Sand and gravel
M3	Military gravel pit	1	36S	2W	4701063N 509934E	Sand and gravel, gold
M4	Lull quarry	8	36S	2W	4699928N 503152E	Stone
M5	Buckskin	7	36S	2W	4699500N 501125E	Gold,, silver
M6	Table Rock site	15	36S	2W	4698991N 505699E	Sand and gravel
M7	Whittle Bar	15	36S	2W	4698976N 505696E	Sand and gravel
M8	Van Wey pit	13	36S	2W	4698962N 509077E	Sand and gravel
M9	Whittle	16	36S	2W	4698794N 504975E	Sand and gravel
M10	Gold Ray granite	18	36S	2W	4698275N 501100E	Stone (granite), clay
M11	Face bar	15	36S	2W	4698250N 505677E	Sand and gravel
M12	Gebhard pit	16	36S	2W	4698082N 504744E	Sand and gravel
M13	No name	16	36S	2W	4698078N 504744E	Sand and gravel
M14	Kendall bar	16	36S	2W	4698075N 504033E	Sand and gravel
M15	Conger Quartz	18	36S	2W	4697950N 500749E	Gold
M16	No name	16	36S	2W	4697832N 503662E	Sand and gravel
M17	No name	17	36S	2W	4697800N 503815E	Sand and gravel
M18	No name	15	36S	2W	4697733N 506382E	Sand and gravel
M19	Wilton White gravel pit	16	36S	2W	4697681N 504005E	Sand and gravel
M20	Soda Creek	17	36S	2W	4697677N 503267E	Sand and gravel
M21	Parker bar	17	36S	2W	4697676N 502284E	Sand and gravel
M22	Owens pit	22	36S	2W	4697411N 505956E	Sand and gravel
M23	Kirtland Road pit	21	36S	2W	4697322N 505313E	Sand and gravel
M24	Old Fort Lane	19	36S	2W	4697207N 501523E	Gold
M25	Parker pit	20	36S	2W	4697120N 503390E	Sand and gravel
M26	Bowden	19	36S	2W	4697000N 501000E	Gold, silver
M27	Millionaire	36	36S	2W	4696950N 500950E	Silver, copper, lead, manganese
M28	Dugan pit	21	36S	2W	4696664N 503880E	Sand and gravel
M29	No name	20	36S	2W	4694569N 502456E	Sand and gravel
M30	No name	21	36S	2W	4696190N 504295E	Sand and gravel
M31	Venable pit	21	36S	2W	4696190N 504299E	Sand and gravel
M32	No name	28	36S	2W	4695690N 504815E	Sand and gravel
M33	Colpitts-Tuer-Pemincer	28	36S	2W	4695679N 504815E	Sand and gravel
M34	Mansfield	30	36S	2W	4695450N 501550E	Gold
M35	No name	28	36S	2W	4695170N 504929E	Sand and gravel
M36	No name	28	36S	2W	4695155N 504929E	Sand and gravel
M37	Tuer pit	28	36S	2W	4695155N 504936E	Sand and gravel
M38	No name	27	36S	2W	4695119N 506308E	Sand and gravel
M39	Eagle	25	36S	3W	4694550N 500450E	Gold, silver
M40	RP-334	34	36S	2W	4694207N 505807E	Sand and gravel
M41	Linn Road shale pit	35	36S	2W	4694102N 507452E	Stone
M42	Blackwell Rd. pit and placer	2	37S	2W	4692744N 507116E	Sand and gravel
M43	Winchester-Hoosten	6	37S	2W	4692436N 501616E	Gold
M44	No name	2	37S	2W	4692163N 507855E	Sand and gravel
M45	Willow Creek pit	6	37S	2W	4691673N 501701E	Stone (granite)
M46	The Star	5	37S	2W	4691631N 502995E	Gold
M47	High Banks pit	10	37S	2W	4691357N 507112E	Sand and gravel
M48	Bailey Gold Pocket	6	37S	2W	4691250N 500750E	Gold
M49	No name	12	37S	2W	4690927N 509331E	Sand and gravel
M50	Lull granite	8	37S	2W	4690836N 503319E	Stone (granite)

continued next page

Table 2. (continued)

Mine no.	Name	Sec.	T.	R.	UTM coordinates	Commodity
M51	Wellman pit	8	37S	2W	4690494N 503406E	Stone (granite)
M52	Lucky King	7	37S	2W	4690490N 501395E	Gold
M53	granite pit	7	37S	2W	4689831N 501523E	Stone (granite)
M54	Kirkland Road pit and placer	11	37S	2W	4689692N 508166E	Sand and gravel
M55	John Peak Site	17	37S	2W	4688897N 502287E	Stone (granite)
M56	*Demoss pit*	17	37S	2W	*4688430N 503494E*	*Stone (granite)*
M57	Nash pit	19	37S	2W	4687330N 502112E	Stone (granite)
M58	No name	19	37S	2W	4687254N 501104E	Stone (granite)
M59	R C Gilbert	19	37S	2W	4687113N 501826E	Stone (granite)
M60	Sayler Site	19	37S	2W	4687111N 500576E	Stone (granite)
M61	*Morton granite pit*	19	37S	2W	*4687002N 501194E*	*Stone (granite)*
M62	Oregon granite	19	37S	2W	4686987N 501187E	Stone (granite)
M63	Walker Creek	19	37S	2W	4686980N 501202E	Stone (granite)
M64	Bob Swindler	20	37S	2W	4686974N 502631E	Stone
M65	Jonathan Way	19	37S	2W	4686793N 501965E	Stone (granite)
M66	Jacksonville pit	19	37S	2W	4686723N 501281E	Stone (granite)
M67	Lininger Site	19	37S	2W	4686695N 500872E	Stone (granite)
M68	Walker Creek	19	37S	2W	4686675N 500852E	Stone (granite)
M69	Brownsboro pit and placer	25	37S	2W	4685345N 509407E	Stone
M70	Rogue Aggregates pit	25	37S	2W	4685345N 509407E	Sand and gravel
M71	Jacksonville Placer 5	32	37S	2W	4684797N 502504E	Gold
M72	Opp	36	37S	3W	4684200N 500250E	Gold, silver, copper, lead, *tellurium*
M73	Jacksonville Brick and Tile	31	37S	2W	4683950N 500850E	Clay
M74	Boitano Rock pit	32	37S	2W	4683211N 502518E	Stone
M75	No name	3	38S	2W	4682947N 506031E	Stone
M76	Ensele quarry	6	38S	2W	4682550N 500950E	Limestone
M77	*Wells pit*	1	38S	3W	4682417N 500092E	Stone
M78	No name	3	38S	2W	4682041N 506160E	Sand and gravel
M79	Blue Bucket	10	38S	2W	4680850N 506500E	Gold
M80	N Slope Shale pit	12	38S	3W	4680543N 500309E	Stone
M81	Sugar Pine	7	38S	2W	4680015N 501956E	Gold
M82	*Sunrise*	23	38S	2W	4678000N 507400E	Gold
M83	Mankins Prospect	19	38S	2W	4677550N 501750E	Gold
M84	Shale pit	19	38S	1W	4677380N 510517E	Stone
M85	No name	24	38S	1W	4677408N 519546E	Sand and gravel
M86	No name	23	38S	1W	4677682N 518125E	Sand and gravel
M87	No name	18	38S	1W	4678500N 511150E	Stone
M88	Jay's pit	18	38S	1W	4678563N 511890E	Stone
M89	RP-52-53 Nash	15	38S	1W	4679127N 516265E	Sand and gravel
M90	Phoenix gravel pit	15	38S	1W	4679281N 516127E	Sand and gravel
M91	Nash RP-51	32	37S	1W	4683531N 513027E	Sand and gravel
M92	Crater Coal Co.	36	37S	1W	4684006N 518703E	Coal
M93	Medford Ready Mix pit	25	37S	1W	4685900N 519650E	Sand and gravel, *clay*
M94	Roxy Ann	14	37S	1W	4688123N 518265E	Stone (basalt)
M95	Roxy Ann	14	37S	1W	4689123N 516138E	Coal
M96	Meridian Sub	7	37S	1E	4689839N 520507E	Sand (basalt)
M97	Hansen Coal Mine	3	37S	1W	4691194N 515181E	Coal
M98	140 *rock quarry*	26	36S	1W	4695001N 518177E	Stone
M99	Meridian pit	26	36S	1W	4695368N 517029E	Stone
M100	East Jenson Sand and Gravel	10	36S	1W	4699656N 515327E	Sand and gravel
M101	No name	8	36S	1W	4699970N 512836E	Stone
M102	No name	9	36S	1W	4700540N 514388E	Stone
M103	West Sensen Sand and Gravel	36	36S	1W	4700558N 514000E	Sand and gravel
M104	Grers Shale pit	3	36S	1W	4701027N 516671E	Stone
M105	Jenco/Little Butte	4	36S	1W	4701519N 514836E	Stone
M106	George A. McLean	2	36S	1W	4701585N 517675E	Chromium
M107	No name	6	36S	1W	4701695N 511235E	Sand and gravel
M108	No name	6	36S	1W	4701731N 514295E	Sand and gravel
M109	Tucker/Gilbert	4	36S	1W	4701865N 514806E	Stone
M110	Hale quarry	4	36S	1W	4701880N 514445E	Stone
M111	Hansen site	3	36S	1W	4702068N 515333E	Stone
M112	Owen/Given gravel bar	6	36S	1W	4702177N 510504E	Sand and gravel
M113	Greb pit	4	36S	1W	4702235N 514900E	Stone
M114	No name	33	35S	1W	4703911N 514638E	Stone
M115	No name	28	35S	1W	4704150N 514758E	Stone
M116	No name	28	35S	1W	4704150N 514762E	Stone
M117	No name	30	35S	1W	4704390N 510330E	Sand and gravel