Preliminary Geologic Map of the Southwest Part of the Medford 30 x 60 Minute Quadrangle, Oregon and California

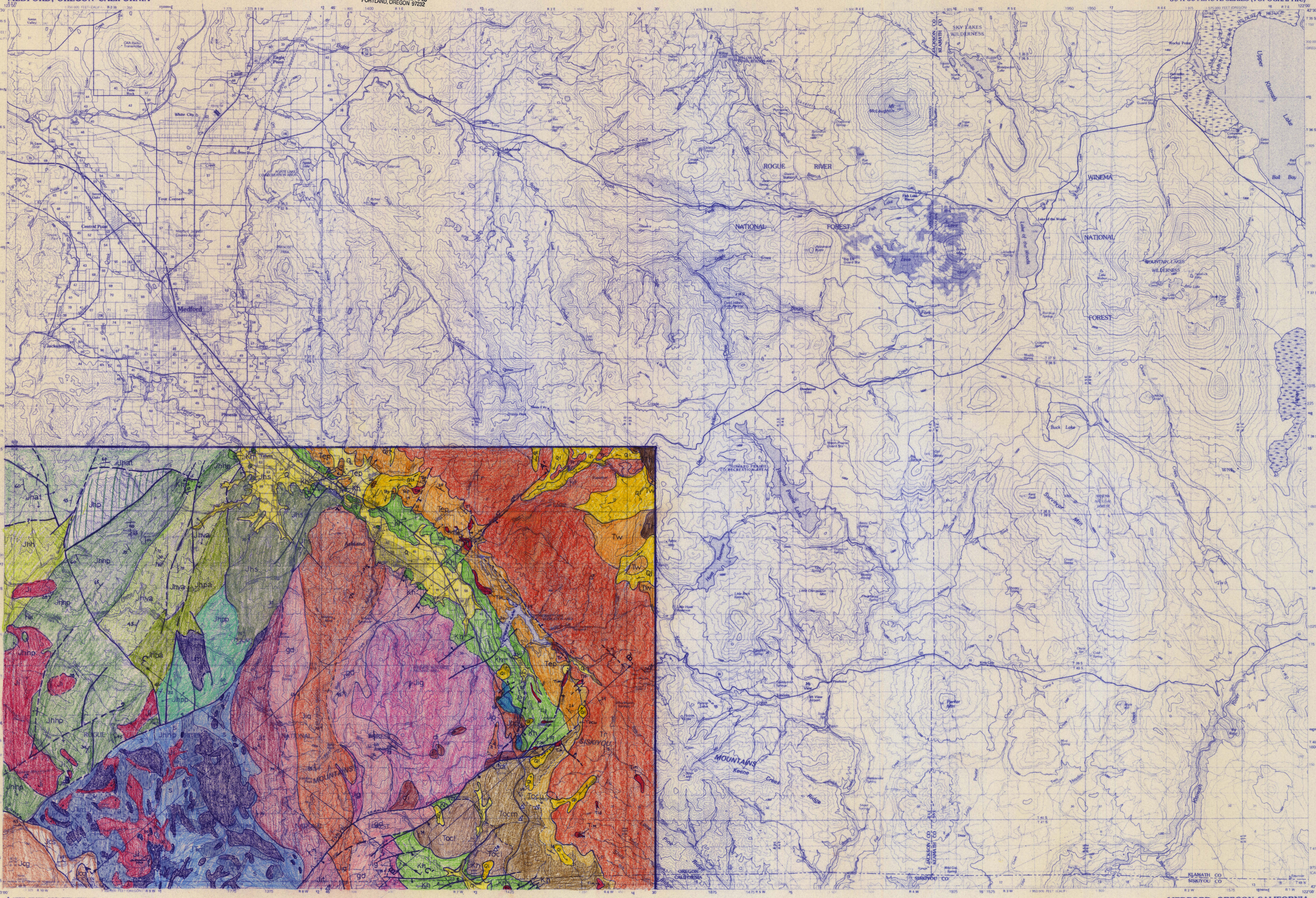
Open-File Report O-97-03

Compiled by Jad D'Allura
Southern Oregon State College

Funded in part by the National Geologic Mapping Program

MEDFORD, OREGON–CALIFORNIA

30 X 60 MINUTE SERIES (TOPOGRAPHIC)



SCALE 1:100 000

CONTOUR INTERVAL 50 METERS

Reviewed by Frank R. Hladky and Thomas J. Wiley,
Oregon Department of Geology and Mineral Industries

MEDFORD, OREGON-CALIFORNIA
42122-A1-TM-100
1978
PHOTOINSPECTED 1991

42122-A1-TM-100

Medford
OREGON–CALIFORNIA

1:100 000-scale *metric* topographic map

30 X 60 MINUTE QUADRANGLE SHOWING

- Contours and elevations in meters
- Highways, roads and other manmade structures
- Water features
- Woodland areas
- Geographic names

GEOLOGICAL SURVEY

1978
PHOTOINSPECTED 1991

Produced by the United States Geological Survey

Compiled from USGS 1:62 500-scale topographic maps dated 1954-55. Planimetry revised from aerial photographs taken 1974-75 and other source data. Revised information not field checked. Map edited 1978

1927 North American Datum (NAD 27). Projection and 10 000-meter grid: Universal Transverse Mercator, zone 10 25 000-foot ticks: Oregon coordinate system, south zone and California coordinate system, zone 1

The difference between NAD 27 and North American Datum of 1983 (NAD 83) is too small to show at this scale. The values of the shift between the datums for 7.5-minute intersections are given in USGS Bulletin 1875

There may be private inholdings within the boundaries of the National or State reservations shown on this map

Map photoinspected using 1990-91 photographs
No major culture or drainage changes found

CONTOUR INTERVAL 50 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929
ELEVATIONS SHOWN TO THE NEAREST METER

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS

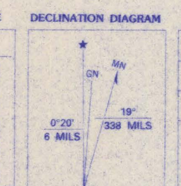
CONVERSION TABLE

Meters	Feet
1	3.2808
2	6.5617
3	9.8425
4	13.1234
5	16.4042
6	19.6850
7	22.9659
8	26.2467
9	29.5276
10	32.8084

To convert meters to feet multiply by 3.2808

To convert feet to meters multiply by 0.3048

DECLINATION DIAGRAM



UTM grid convergence (GN) and 1978 magnetic declination (MN) at center of map
Diagram is approximate

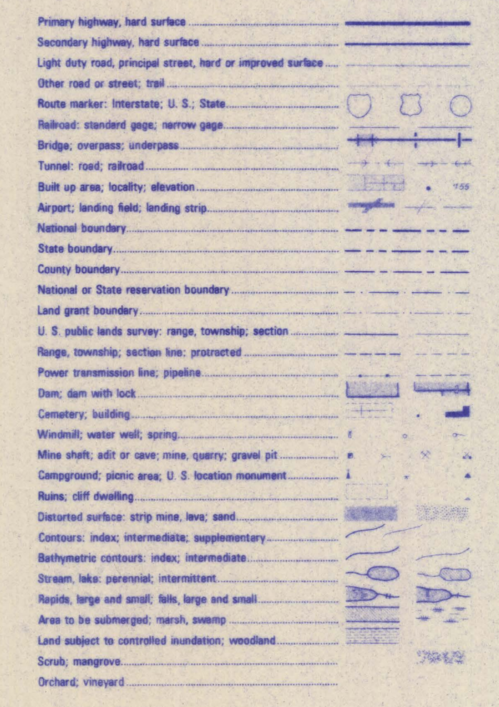
ADJOINING MAPS

1	2	3
4		5
6	7	8

1 Canyonville
2 Crater Lake
3 Williamson River
4 Grants Pass
5 Klamath Falls
6 Happy Camp
7 Yreka
8 Tule Lake

FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225
OR RESTON, VIRGINIA 22092

Topographic Map Symbols



State of Oregon
Department of Geology and Mineral Industries
Donald A. Hull, State Geologist

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EXPLANATION OF MAP UNITS

Q — **Alluvium, colluvium, alluvial fans** (Holocene and Pleistocene)--Includes recent alluvium of active streams and poorly-sorted deposits with angular to subangular clasts forming fans, terrace deposits (rounded clasts, less matrix, better sorting), and thick slope mantling material.

Ql — **Landslide deposits** (Holocene and Pleistocene)--Unconsolidated, poorly-sorted deposits commonly containing angular fragments embedded in soil, hummocky topography. Arrows indicate direction of movement. Headwalls present only in Holocene slides.

Ti — **Dikes and sills** (lower Eocene to lower Miocene and younger)--Dominantly fine-grained, commonly porphyritic intrusive rocks, many too small to locate at the scale of the map, intrude all formations but are most common in weaker units such as the mudstone of the Hornbrook Formation. Compositions range from basalt through andesite to dacite. **Tim** = basalt and andesite, including hornblende andesite to dacite; **Tid** = dacite and minor rhyolite. Ages are variable.

Th — **Heppsie Formation** (lower Miocene)--Heppsie Andesite of Wells (1956) redefined by Hladky (1994) containing medium- to dark-gray fine grained to aphanitic basaltic andesite, basalt, and andesite flows with minor pyroclastic rocks.

Ages include a K-Ar date of 22.8 +/- 0.8 Ma from plagioclase (Fiebelkorn and others, 1983) and an Ar-Ar date of 22.6 +/- 1 Ma (Hladky, 1995).

Tw — **Wasson Formation** (lower Miocene)--Silicic volcanic rocks erupted from numerous vents including the Eagle Butte silicic eruptive complex (Hladky, 1995). Rocks consist of dacite with minor rhyolite flows and associated welded and non-welded tuff.

Ar-Ar ages of 23.35 +/- 0.39, 22.87 +/- 0.21, and 21.4 +/- 0.76 Ma indicate that the Wasson Formation is only slightly older than the Heppsie Formation.

Tr **Roxy Formation** (lower Miocene and Oligocene)--Originally defined by Wells (1956) for volcaniclastic, pyroclastic and flow rocks ranging from basalt through dacite or rhyolite, the term is being revised to reflect local volcanic centers and mappable lithologies (Hladky, 1996) and stratigraphic pinch outs (Bestland, 1987); fragmental rocks to include epiclastic volcanic sandstone, conglomerate and breccia, and lapilli tuff comprise the bulk of the section with local accumulation of basaltic, andesitic, and dacitic rock in eruptive centers or as intracanyon flows.

K-Ar ages (Fiebelkorn and others, 1983) are 30.2 +/- 0.9 Ma and 27.8 +/- 0.9 Ma (both basalt, whole rock) in the lower part of the section northeast of Ashland; slightly higher in the section, ages are 27.4 +/- 1 Ma and 25.2 +/- 0.8 Ma (both plagioclase ages). A K-Ar age of 30.8 +/- 2 Ma (Wiley and Smith, 1993) on an intrusion which forms Roxy Ann Peak northeast of Medford gives a minimum age for the base of the formation. Note that the ages overlap those of the Colestin Formation which is, in part, coeval with the Roxy Formation. Recent investigation (Hladky, 1996) has identified lower Miocene ages for some of the rocks mapped by Wells (1956) as part of the Roxy Formation.

Toc **Colestin Formation** (upper and lower Oligocene)--Non-marine andesitic to dacitic or rhyolitic volcaniclastic, pyroclastic, and flow rocks with minor basaltic material deposited primarily in a graben (Carlton, 1972; Bestland, 1987); pyroclastic and volcaniclastic rocks comprise more than 80% of the exposed area; environment of deposition presumed to be on flanks of volcanoes; local unconformities, syndepositional faulting, and episodic lobate debris flows generate a complex stratigraphy; provisional lower (**Tocl**) and middle (**Tocm**) units roughly correspond to Carlton's lower and middle members; the rocks below the contact at the base of Bestland's Tc (poorly consolidated volcaniclastic beds) generally correspond to the Tocl while those below the Tcts (light-colored tuffaceous rocks and lithic sandstones); provisional contact between middle and upper (**Tocu**) units roughly corresponds to the upper part of Carlton's upper member and the rocks above the base of Bestland's Tcts; the formation thins to the north as well as to the south where it lies unconformably on the Payne Cliffs Formation.

K-Ar ages in the upper part of the middle unit (Fiebelkorn and others, 1983) are 29.9 +/- 1.5 Ma (plagioclase), 26 +/- 0.8 Ma (basalt, whole rock), and 29.9 +/- 0.3 Ma (andesite, whole rock); a young Ar/Ar age of 27.3 +/- 0.6 Ma (Duncan, pers. comm., 1992) is reported near the base of the formation; tropical to subtropical upper Eocene leaf fossils, whose ages are suspect, are found in the middle and upper parts of the formation; rocks of the upper unit are tentatively correlated to the Soda Springs Member of the Roxy Formation (Vance, 1984) south of the Oregon-California border which has a fission track age of 27 Ma. The underlying Iron Gate member of Vance's Roxy Formation are, by Bestland's definition, part of the Colestin Formation. The Ager (upper) member of Vance's Colestin Formation has fission track ages of 31.3 and 33.1 Ma while his (lower) Klamathon member is undated.

LOCAL UNCONFORMITY

Tep **Payne Cliffs Formation** (upper Eocene)--Fluviatile braided stream deposits of sandstone, conglomerate, mudstone, and minor coal deposits (McKnight, 1984; Wiley and Smith, 1993). The upper part is comprised of green, easily-weathered, very poorly sorted, subangular andesitic to dacitic pebbly mudstones, pebbly sandstones, and minor tuffaceous rocks characterized by their absence of muscovite. Overlies cross bedded, laminated or massive sandstone with muscovite as well as clast-supported pebble conglomerate containing volcanic rock fragments and lesser metamorphic rock fragments; tuffaceous rocks are present; lower part is primarily an arkosic sandstone with subordinate conglomerate, mudstone, and coal; conglomerate contains metamorphic and rare plutonic clasts.

The age is poorly constrained by Upper Eocene subtropical to tropical leaf fossils (Brown, 1956; Peck and others, 1964) discovered in the middle of the formation. A late Eocene K-Ar date on a basalt dike intrusive into the upper part of the unit is 36.9 +/- 0.8 Ma (Wiley and Smith, 1993).

UNCONFORMITY

Kh **Hornbrook Formation** (Upper Cretaceous)--Predominantly submarine sequence of gray green sandstone, dark gray mudstone, and quartzite-cobble rich conglomerate which has been subdivided into four (Elliott, 1971) or five (Nilsen, 1993) members; the members, named by Nilsen are in ascending order: largely non-marine **Klamath River Conglomerate member** (locally absent); fossiliferous shallow marine **Osburger Gulch Sandstone member**; shallow to deep marine **Ditch Creek Siltstone member** with locally abundant sandstone interbeds and some coal; deep marine thin- to thick-bedded sandstone and siltstone with locally abundant conglomerate **Rocky Gulch Sandstone member**; shallow to deep marine mudstone and thinly interbedded turbidite sandstone of the **Blue Gulch Mudstone member** with a shallow marine sandstone lens (Rancheria Gulch Sandstone Beds).

The Hornbrook Formation records a major transgression which is older in the north (near Grave Creek, north of the Medford 30' x 60' quadrangle; Sliter and others, 1984). To the southwest of Medford, the basal beds are Late Albian to Middle Cenomanian (Sliter and others, 1984) while in the Ashland area, they are Middle Turonian in age. The upper age limit is late Campanian to early Maestrichtian.

The upper contact is an erosional unconformity with local low angle discordance.

NONCONFORMITY

Ji **Granitoid intrusive rocks** (Upper Jurassic)--Dominated by the Mount Ashland Pluton; several intrusive phases are recognized within the Mt. Ashland Pluton (Gribble and others, 1990); early hornblende gabbro and two-pyroxene gabbro occur south of the Medford 30' x 60' quadrangle. From youngest to oldest the phases are:

Jig **biotite granodiorite and granite suite**--Hornblende is subordinate to absent; included in this phase are hornblende-rich diorites (**di**) with minor pyroxene; dikes of Jig intrude Jiq;

Accessory minerals in all above phases include apatite, zircon, epidote, allanite, and sphene; numerous late aplitic to pegmatitic dikes intrude earlier phase rocks.

Jiq **quartz monzodiorite suite**--Biotite-hornblende monzodioritic to granodioritic (**gd**) rocks which are moderately to strongly foliated; contains abundant mafic microgranitoid enclaves and common large alkali feldspar megacrysts. Pod-shaped enclaves are interpreted to be mafic magma intruded into still-mobile host rocks (Gribble and others, 1990).

Jit **biotite-hornblende tonalite suite**--Biotite-hornblende tonalite with strong foliation in an earlier western phase and weaker foliation in later eastern phase; the eastern tonalitic phase is gradational eastward to a biotite-hornblende granodiorite (**gd**).

Granitoid intrusions other than the Mt. Ashland Pluton--Mostly tonalitic (Blair, and others, 1981); the quartz diorite Squaw Mountain Pluton is characterized by swarms of amphibolite, dunite, peridotite, and gabbro xenoliths small bodies within the Marble Mountain terrane are tonalitic or gabbroic, many of which exhibit deformation fabrics. Intrusive rocks within the Marble Mountain terrane contain labradorite rimmed by oligoclase altered in part to epidote, hornblende surrounding pyroxene, with quartz, biotite, chlorite, and almandine garnet.

Ages of the Mount Ashland Pluton range from 167 +/- 3.5 Ma on hornblende to 148 +/- 4.4 Ma on biotite (Fiebelkorn and others, 1983) within the quartz monzodiorite phase; Lanphere and others, 1968, record an anomalously young hornblende age of 146 Ma on what has been mapped as an earlier phase of the pluton (Barnes and others, 1986). Hacker and others (1995) report 151-153 Ma U/Pb ages from part of the pluton. An Ar/Ar age of the Squaw Mountain Pluton is 164 +/- 1 Ma (Donato, 1993). Within the Marble Mountain terrane, a garnet-bearing metadiorite has a hornblende Ar/Ar age of 149 +/- 2 Ma and discordant zircon U/Pb ages of 150 and 151 Ma and Pb/Pb age of 169 +/ 17 Ma; folded meta-tonalites have U/Pb zircon ages of 152 and 153 and a Pb/Pb age of 165 and 167 Ma (Donato and others, 1996).

Mt. Ashland pluton is overlain nonconformably by the late Cretaceous Hornbrook Formation.

Jh **Western Hayfork terrane** (Middle Jurassic)--Part of the Applegate Group of Wells, 1956; predominantly marine calc-alkaline greenish-gray volcanigenic sandstone, gray argillite, minor conglomerate, volcanic breccia and flows; turbidite structures are evident in some of the sandstones; **all rocks are metamorphosed** to the greenschist facies and contain a variable amount of chlorite, green hornblende or actinolite, albite, epidote, and quartz; rocks close to contacts with intrusive bodies exhibit hornfelsic and granofelsic fabrics; an increase in metamorphic grade toward the contact with the Marble Mountain terrane has been noted; the unit presumably is younger to the east;

Jha Contact metamorphosed siliceous schist and amphibole gneiss as roof pendants; minor marble; hornblende hornfels facies with quartz, biotite, hornblende; minor garnet and plagioclase;

The map units of Blair and others, 1981, are:

Jhs **sedimentary unit**--Fine grained gray to green argillite, slate, and sandstone with volcanic detritus; contact metamorphosed near Mount Ashland Pluton; possibly correlative to the "volcaniclastic, epiclastic, and hemipelagic unit" of Harper and Wright (1984); in fault contact (?) with Jhpp;

Jhpp **porphyritic augite-plagioclase andesite**--Andesite with relict pilotaxitic fabric; locally vesicular; agglomerate with aphanitic black clasts in highly sheared matrix; gradational to Jhpa;

Jhpa **porphyritic plagioclase andesite**--Andesite with numerous plagioclase phenocrysts in a pilotaxitic fabric; agglomerates and local plagioclase-rich crystal tuffs; depositional contact (?) with Jhva;

Jhva **vesicular augite-plagioclase andesitic to basaltic flows**--Andesite and basalt associated with andesitic sandstone, conglomerate, and tuff; local pillow and pillow breccia structures; contains rare fine-grained marble lenses; original composition variable but most rocks contain plagioclase and pyroxene phenocrysts; gradational to Jhhp;

um Partially serpentinized peridotite and dunite; fault-bounded body;

Jhhp **porphyritic hornblende-plagioclase andesite**--Andesite with minor dacite; sandstone, dark gray argillite, conglomerate, and flows; composition is variable but hornblende and plagioclase or locally abundant pyroxene phenocrysts in hyalopilitic to pilotaxitc groundmass are common in andesites; gradational to Jhh;

Jhh **porphyritic hornblende andesite**--Andesite with hornblende up to 1 cm; rare dacite contains quartz and plagioclase phenocrysts; abundant clastic units to include sandstone and black argillite; in addition to metamorphic minerals mentioned above are biotite and carbonates; in fault contact with Jhat; the Ar/Ar age of 173 Ma reported below is from the upper part of this unit;

Jhat **andesitic and dacitic tuff, tuff breccia, and minor flows and volcaniclastic sediments**--Upper part of unit consists of augite-plagioclase andesite and andesitic basalt flows with breccia and agglomerate; local ophitic basalt intrusions and porphyritic dacite to rhyodacite flows; lower in the section the unit primarily is clastic with porphyritic andesite plagioclase +/- augite or hornblende phenocrysts in sandstone, tuff, and tuff breccia; thick lenses or beds of argilite, chert, and sandstone; partially metamorphosed to same minerals as other Jh units with local prehnite.

Jhp **porphyritic plagioclase andesitic flows, tuffs, and agglomerates**--Andesitic flows, tuffs, and agglomerates characterized by plagioclase phenocrysts in a pilotaxitic groundmass; minor quartz-plagioclase dacite and hornblende-augite flows; fault-bounded on all sides; relative age unknown.

The Applegate Group (Wells, 1956) is correlated to the Western Hayfork terrane by Barnes and others, 1993. An $^{40}Ar/^{39}Ar$ age of 173 +/- 1 Ma from a detrital hornblende of a metagraywacke near Applegate Dam (Donato, 1993) west of the map is consistent with hornblende ages (177-168 Ma) in the Western Hayfork terrane of California (Fahan and Wright, 1983). Hornblende-phyric dikes thought to be related to the volcanic rocks are dated at 175 +/- 2 Ma and 167 +/- 3 Ma (Donato, 1995). A cross-cutting, weakly-metamorphosed dike near the Applegate Dam is dated at 156 +/- 1 Ma (Donato, 1993).

In fault contact with the structurally lower Marble Mountain terrane; intruded by late Jurassic plutons; unconformably overlain by late Cretaceous sedimentary rocks.

Jc **Condrey Mountain terrane** (Middle Jurassic)--

Jcg The structurally lowest unit consists of medium to fine grained gray graphite-muscovite-albite-quartz schist with minor chlorite and pyrite; quartz veins are common.

Jcs The upper unit is a greenish gray, fine grained, well foliated greenschist consisting of chlorite, epidote, actinolite, albite, and quartz with varying amounts of white mica and calcite. Local blueschist minerals occur to the southeast of the map area near the structurally lowest part of the section (Helper, 1986). The rocks have undergone four ductile deformation events, the first three producing tight to isoclinal folds while fourth generation folds are symmetric, open and upright kinks and chevron folds with axes trending perpendicular to earlier structures (Helper, 1986).

A zircon found in a metavolcanic rock near the center of the Condrey Mountain terrane yeilded a U-Pb age of formation of 170 +/- 1 Ma. Rb/Sr metamorphic ages are 139-134 Ma from the structurally highest part of the terrane and are 134-125 Ma from the structurally lowest part (Helper and others, 1989). Lanphere and others, 1968, report a 141 Ma muscovite K-Ar date from the upper part of the terrane near the California-Oregon border.

In fault contact with the older but structurally higher Marble Mountain terrane.

JTrm **Marble Mountain terrane** (Upper Paleozoic to Lower Jurassic) --
A melange metamorphosed to upper greenschist-middle amphibolite facies and consisting of: **serpentinitized ultramafic rocks** (**u**; stippled pattern on the map) and related rocks such as dunite, pyroxenite, serpentinite, talc and tremolite schist; fine to medium grained **amphibole schist, gneiss, and fels** (**a**; vertical dashed pattern on map) with hornblende and plagioclase (An_{25-57}; Hotz, 1967) with minor epidote, quartz, sphene, and magnetite; fine grained, commonly foliated and folded **siliceous metasedimentary rocks** (**s**; no pattern on map) with minor layers of marble or calc-silicates; most are schistose with quartz and mica; biotite, muscovite, and plagioclase are

common with minor hornblende, almandine garnet, tourmaline, chlorite, potassium feldspar, and pyroxene; quartzite is common. Amphibole schist and siliceous metasedimentary rocks are undivided on the map. The terrane exhibits characteristics of a folded dismembered ophiolite with isoclinal folds most of whose fold axes trend to the north. Most rocks are foliated and recrystallized, many showing signs of retrograde metamorphism. Correlation to its weakly metamorphosed equivalent, the Rattlesnake Creek terrane defined by Wright and Wyld (1994), suggests that it is no younger than Upper Triassic to Lower Jurassic in age; the lower part of it may be Paleozoic. An $^{40}Ar/^{39}Ar$ cooling age of metamorphic hornblende as measured near the Applegate Dam to the west of the map area is 151 +/- 2 Ma (Donato, 1993).

In fault contact with both the structurally lower Condrey Mountain terrane and the structurally higher Western Hayfork terrane.

GEOLOGIC SUMMARY

The Medford 30' x 60' quadrangle contains rocks ranging from early Mesozoic through Quaternary in age. Rocks of the Klamath Mountains geologic province, located in the southwest portion of the quadrangle, consist of metamorphosed early to middle Jurassic oceanic plate, arc, and melange rocks intruded by granitic rocks of late Jurassic age. These older rocks are unconformably overlain by upper Cretaceous marine sandstone, mudstone, and conglomerate which in turn are overlain unconformably by non-marine lower Eocene to lower Miocene volcanic and epiclastic rocks of the Western Cascade Series.

The Klamath Mountains geologic province is comprised of an amalgamation of numerous metamorphosed lithotectonic units (tectonostratigraphic terranes) of oceanic, within plate, or island arc affinities separated by faults. Generally, and with major exceptions, the ages of the terranes decrease toward the east. Faulting between geologic terranes is generally accepted to have been orignially low-angle and related to consuming plate margin tectonism. However, intra-terrane high angle and possibly lateral faults affected most units prior to their low-angle juxtaposition.

The oldest rocks in the map area belong to the Marble Mountains terrane (MMT). They have been correlated by Donato (1987) and others to the Rattlesnake Creek terrane (RCT) of the western Klamath Mountains in southwestern California as described by Wright and Wyld (1994). The lower RCT in southwestern California is a serpentine-matrix melange chemically constrained to be of oceanic affinity and containing rocks such as peridotite, greenstone, amphibolite blocks, pillow basalt, and mafic plutonic rocks. Ages of blocks within the melange range from Paleozoic (with widely diverse ages) to lower Jurassic. The melange unit is overlain by a relatively coherent cover of upper Triassic and lower Jurassic arc-type (tholeiitic to shoshonitic) volcanic, hemipelagic, and clastic sedimentary rocks. Gabbroic to dioritic intrusions with U/Pb zircon crystallization ages of 205-196 Ma (early Jurassic) intrude both sequences and are considered to be related to the upper unit (Wright and Wyld, 1994).

Rocks of the MMT within the Marble Mountains 50 km south-southwest of the Medford 30' x 60' quadrangle have been described by Donato (1987) and Miller and Hacker (1993). While Donato interprets the terrane as a metamorphosed ophiolitic tectonic melange, Miller and Hacker consider the amphibolite facies rocks to be, instead, multiply-folded isoclinal nappe-like structures imbricated with massive metamorphosed ultramafic rocks along east-dipping shear zones. This interpretation is similar to that of Kays and Ferns (1980) in the Medford 30' x 60' quadrangle. Within the Observation Peak area of this quadrangle, rocks are multiply-folded and, as in the Marble Mountains area, lack a recognizable matrix, appearing as a block-on-block melange. Rock types include meta-ultramafic rocks, meta-gabbros and -diorites, meta-siliceous sedimentary rocks, and amphibolite gneiss of at least two different origins. Dark coarse-grained, multiply-folded hornblende-rich blocks are considered relict to the unit and likely are rocks incorporated into the melange from an earlier metamorphic source area. Rodingites along some contacts between ultramafic and non-ultramafic bodies (amphibole gneisses, metasedimentary units) indicate that the ultramafic bodies had undergone post-emplacement metasomatism prior to regional metamorphism. The volcanic cover sequence of the Rattlesnake Creek-Marble Mountain terrane represents an early Jurassic plutonovolcanic arc and is the presumed basement (the 200 Ma Rattlesnake Creek arc of Hacker and others, 1995) upon which later arcs, such as the Western Hayfork arc, were constructed. The older, melange part of the terrane is polygenetic and has a multistage origin, developing initially in an oceanic fracture zone then in a forearc or subduction zone setting (Wright and Wyld, 1994). The volcanic unit of Miller and Hacker (1993) is not present in the Medford 30' x 60' quadrangle, its position occupied by the Mt. Ashland pluton. Lineations and fold axes which generally plunge north to north-northeast are associated with folding of earlier foliations.

The Condrey Mountain terrane (CMT) as interpreted by Donato and others (1980) is a metamorphosed marine marginal basin and volcaniclastic sequence containing of greenschist facies minerals. These minerals include chlorite, epidote, actinolite, muscovite, quartz, feldspar, and/or graphite and, at lower structural levels, blueschist minerals. The terrane is at least as old as 170-172 Ma, early Jurassic (Helper and others, 1989). In the map area, an outer zone whose grade of metamorphism increases from greenschist to lower amphibolite facies (**Jcs** on the map) exists adjacent to the Orleans fault (the Condrey Mountain fault of Hacker and others, 1995). An inner graphitic zone (**Jcg**) occurs to the south and west. All rocks are schistose to gneissose, commonly show a lineation, and are folded more than once.

The Western Hayfork terrane,(WHFT) is comprised of calc-alkaline volcaniclastic arc rocks with lesser flow and hemipelagic rocks of between 177-168 Ma in age. Recent correlation of part of the Applegate Group of Wells (1956) with rocks of the Western Hayfork terrane by Donato (1993) and Donato and others (1996) is based on similarity of lithology and structure as well as trace elements signatures and age (173 +/- 1 Ma). Clastic rocks, some showing Bouma sequences suggesting deposition from turbidity flows, comprise more than 80% of the section with lesser flow and hemipelagic rocks. The unit is metamorphosed to the low- to mid- greenschist facies. The grade of metamorphism increases in a crude manner toward the contact with the Marble Mountain terrane (MMT). Near intrusive rocks, contact metamorphic mineral assemblages up to hornblende hornfels facies are present. Although a weak metamorphic foliation and some lineations are developed in the rocks, primary fabrics commonly are preserved. Isoclinal folds, while present, are rare; tight folding around north-northeast-trending axes and variable dips of bedding suggest that folding within the formation is common.

During the 170-165 Ma interval, telescoping of rocks occurred coincident with compressional tectonics and crystallization of 170-167 Ma plutons (Hacker and others, 1995). Within the WHFT, the presence of plutons and dikes suggest that the Klamath Mountain region was dominated by extensional tectonics. Deformation produced post-WHFT north-trending folds, flattening, and low angle faults as rocks were thrust toward the west. Folds with similar styles are seen in the CMT and WHFT as well as the MMT and are concommittant with a metamorphic event. This deformation is constrained between the 168 Ma age of the WHFT and ages of plutons, such as the Vesa Bluffs pluton (165 Ma; Hacker and others, 1995) to the south of the Medford 30' x 60' quadrangle, which cut middle Jurassic faults. In addition, the Mount Ashland pluton north of the Little Applegate River cross cust the WHFT-MMT fault contact.

Extensional plutonism without identified volcanic rock of the same age in the Medford 30' x 60' quadrangle occurred between 167 to 155 Ma (Hacker and others, 1995). A wide variation in ages of the Mt. Ashland pluton (167 +/- 3.5 Ma hornblende, K/Ar and 148 +/- 4.4 Ma biotite, K/Ar; Lanphere and others, 1968; similar hornblende and a 144 Ma biotite K/Ar dates from another sample; Hotz, 1979) have been reported. U/Pb ages are considered to approximate the age of magmatic crystallization. Because the closure temperature defined by the retention of argon within crystalline structures is 450-525°C in hornblende and <350°C in biotite (far below the solidus temperature of plutonic rocks), ages determined from K/Ar or Ar/Ar measurements in plutonic rocks are considered cooling dates. In extrusive rocks where crystallization is rapid, Ar ages are more likey to reflect crystallization ages. The Ashland pluton (Ar/Ar hornblende cooling age of 153.6 +/- 1.2 Ma, late Jurassic, and U/Pb zircon crystallization age of 151-153 Ma; Hacker and others, 1995) intruded somewhat later than the Squaw Mountain pluton (164 Ma) and plutons to the south of the Medford 30' x 60' quadrangle.

Intrusive into the Marble Mountains terrane are several generations of plutonic rocks (Donato and others, 1996), most of which have been metamorphosed. That which is considered to be the oldest, a garnet-bearing quartz diorite, has an Ar/Ar age of 149 +/- 2 Ma but shows discordant zircon ages of 158 to 169 +/- 17 Ma. Younger folded metadiorites have discordant zircon ages of U/ Pb 150 and 153 Ma and Pb/Pb 165 and 167 Ma.

Late Jurassic deformation, generally referred to as the Nevadan Orogeny, resulted from the collapse of an interarc basin represented by the Josephine Ophiolite of Harper and Wright (1984) which is located to the west of the Medford 30' x 60' quadrangle. The major fault, the Orleans Thrust (Jachens and others, 1986), has a minimum displacement of 110 km and cuts not only middle Jurassic rocks but beheads the late Jurassic Mt. Ashland pluton. Open, kink, and chevron folds were developed in all terranes at this time. The Nevadan Orogeny, whose age appears to have varied somewhat from place to place, is constrained by hornblende cooling dates of 151-146 Ma (Harper, 1992) developed during thrusting and 150-146 Ma calc-alkaline dikes which cut the thrust east of the Medford 30' x 60' quadrangle. A 150 +/- 1 Ma U/Pb zircon crystallization date in a syntectonic plutonic complex in the southwestern Klamath Mountains intrudes the Orleans thrust but post-dates substantial movement on that thrust (Griesau and Harper, 1992). Cooling ages of 148 +/- 2 Ma at the structually highest part of the MMT and 152 Ma in the lowest part (Donato and Lanphere, 1992) as well as a 141 K/Ar age in the CMS (Lanphere and others) and 156-150 Ma K/Ar in the upper plate of the Orleans thrust (Helper, 1992) indicate the longevity of the "Nevadan Orogeny" and concomittant metamorphism. A 135-124 Ma event in the CMS has been related by Helper (1992) to later subduction but is considered by Hacker and others (1995) to be the later stages of a continuous event.

Latest Jurassic and early Cretaceous plutonism during which the Jacksonville, and Gold Hill hornblende biotite tonalite and hornblende biotite granodiorite (Wiley and Smith, 1993) plutons were intruded, marked the end of major plutonism in the Klamath Mountains.

Uplift and erosion exposed WHFT and plutonic rocks of the Mt. Ashland pluton prior to the deposition of the basal non-marine rocks of the late Cretaceous Hornbrook Formation. In the Medford 30' x 60' quadrangle, the oldest rocks are late Albian (about 100 Ma) in age. The Hornbrook Formation consists of a 1,200 m thick primarily marine transgressive sequence of, in decreasing abundance, mudstone, sandstone, and conglomerate. The conglomerate contains an abundance of well-rounded metamorphic, dominantly white quartzite clasts with lesser plutonic rock. Elliott (1971) and Nilsen (1993) record northwest, north, and northeast paleocurrent directions, the latter dominating in all units but the Klamath River Conglomerate member. North and northwest directions indicate longshore drift patterns while northeast indicators represent an offshore direction of transport. The composition of the sediments are consistent with a Klamath Mountain source area. The presence of bathyal fauna of benthic formainifera indicates water depths of 500 to 1000 m in some parts of the formation (Sliter and others, 1984) while other parts represent shallow water deposits (Osburger Gulch and Rocky Gulch Sandstone members). Most members (Nilsen, 1993), save the basal Klamath River Conglomerate member, are present throughout the map area but local deep erosion has removed a significant portion of the formation southwest of Medford to the nothwest of Ashland. The Hornbrook Formation contains rocks as young as late Campanian to early Maestrichtian (about 70 Ma) in age.

Paleocene to lower Eocene rocks are not recognized in the map area, however, Upper Eocene non-marine rocks of the Payne Cliffs Formation (McKnight, 1984) unconformably overlie those of the Hornbrook Formation. In many places, the attitudes within the two units are nearly identical but local scouring and absence of significant thickness of the Hornbrook Formation southwest of Medford and near Ashland argue for substantial erosion, some of which may have been fault-controlled. The Payne Cliffs Formation is characterized by siltstone, arkosic arenite, rare coal, and conglomerate containing well-rounded metamorphic and rare plutonic cobbles. The upper part of the unit contains, in addition to the same lithologies, a significant admixture of volcanic rock fragments and water-lain tuffaceous deposits which herald the onset of Western Cascade volcanism. The Payne Cliffs Formation has an aggregate thickness of about 2300 m (McKnight, 1984). Paleocurrent fabrics and the petrography of the conglomerate clasts indicate a Klamath Mountains source area. Sedimentary fabrics to include crudely bedded gravels and subordinate sand led McKnight (1984) to conclude that the basal Payne Cliffs Formation was deposited by braided streams flowing in a north to northeasterly direction. The overlying deposits of fining-upward sequences of conglomerate and sandstone with few mudstones indicates a similar but distal braidplain environment. A coarse conglomerate lens near the middle of the formation suggests renewed uplift of the source area. The upper part of the formation was thought to be gradational to the Roxy Formation yet southeast of Emigrant Reservoir near the Siskiyou Summit fault (SSF), ash flow tuff (27 Ma?) and related rocks of the upper part of the Colestin Formation overlie both the SSF and the Payne Cliffs Formation with marked angular unconformity. The upper part of the Payne Cliffs Formation is absent in this area. In addition, north of Ashland, the upper part of the Payne Cliffs Formation, which is wholly volcaniclastic, is overlain with notable unconformity by the lavas of the Roxy Formation. Late Eocene fossil leaves (Peck and others, 1964) in the middle of the formation and a latest Eocene K-Ar age (36.9 +/- 0.8 Ma) on a basalt dike intrusion into the upper part of the unit (Wiley and Smith, 1993) date the upper part of the formation. The age of the lower part of the formation is uncertain.

The Colestin Formation (Wells, 1956, Carlton, 1972, Bestland, 1987) consists of basaltic, basaltic andesitic, andesitic, and dacitic to rhyolitic volcaniclastic, pyroclastic, and lesser flow rocks primarily deposited in a graben (the "Colestin Basin") south of the Siskiyou Summit fault (SSF) and to the northeast of Medford. Wiley and Smith (1993) have abandoned the name Colestin northeast of Medford, instead, identifying "Volcanic and volcaniclastic undivided" rocks overlain in part by the lower Oligocene (34-35 Ma) tuff of Bond Creek. Most of the rocks south of the SSF were deposited on the flanks of volcanic structures, were affected by syndepositional faulting, and represent somewhat distinctive volcanic centers (Bestland, 1987). Paleocurrent directions are rare. Although the Colestin Formation has a maximum thickness of 1,600 m (Bestland, 1987) in the Colestin Basin, it thins to both the north and the south. The upper part of the Colestin Formation overlaps both the SSF and the eroded remnants of the southern extension of the Payne Cliffs Formation. Near the basal part of the formation, an Ar/Ar age 27.3 +/- 0.6 Ma (Duncan, per. com., 1992) is younger than the K/Ar ages (Fiebelkorn and others, 1983) of overlying rocks within the middle part of the formation (29 +/- 0.3 and 29.9 +/- 1.5 Ma). The youngest K/Ar age near the top of the formation is 26 +/- 0.8 Ma. Fission track ages of 27 Ma (Vance) of the upper Colestin ash flow rocks is compatible with this age.

The relationship between the middle and lower Colestin Formation and the Payne Cliffs Formation is complex. As the lower part of the Payne Cliffs Formation is non-volcanic, it seems that there is little reason to correlate the two. Late Eocene fossil leaf localities reported from within the Colestin Formation (Peck and others, 1964) clearly conflict with upper Oligocene K/Ar dates (Fiebelkorn and others, 1983) in the middle and upper parts of the Colestin Formation. As a thin part of the upper Colestin Formation (D'Allura, 1996) unconformably overlies both the lower Payne Cliffs Formation and SSF and extends toward the Emigrant Reservoir area, further work there may indicate that the upper part of the Payne Cliffs Formation bearing volcanic detritus is time-equivalent to the lower and middle parts of the Colestin Formation. In addition, the base of the conglomerate lens in the middle part of the formation may coincide with a low angle unconformity.

The Roxy Formation (Wells, 1956) is comprised of numerous volcanic centers separated by distal vent facies and coarse alluvial facies rocks (after Smedes and Proska, 1972). In many areas, volcaniclastic and pyroclastic rocks comprise 70% or more of the section. Of the volcaniclastic rocks, tuffaceous sandstone, water-worked tuff, tuff breccia, and poorly sorted lahar deposits dominate with less abundant matrix-supported volcanic conglomerate, agglomerate, and mudstone. Pyroclastic rocks are primarily air fall deposits although ash-flow tuff is common. Lateral stratigraphic variations are common but stratigraphic markers may be followed for distances up to 6 kilometers or more. Compositions are variable and depend on proximity to different volcanic centers. Basaltic andesite and andesite are most common but basalt, dacite, and rhyolite form significant deposits and flows. Latite forms a small part of the formation.

Usefulness of the original definition of the Roxy Formation (Wells, 1956), whose base is defined as "the top of the uppermost layer of waterlain pyroclastics that is succeeded by at least 100 feet of flows...", recently has been called into question. Bestland (1987) moved the gradational boundary of the Colestin Formation higher into the Roxy owing to pinch out of basal Roxy flows near the Siskiyou Summit fault. Wiley and Smith (1993) note that Roxy Ann Peak, the namesake of the formation, is an intrusion. Moreover, separate volcanic centers can be mapped within the unit, providing a better understanding of volcanic stratigraphy of this region (Hladky, 1995; 1996).

The Roxy Formation ranges in age from at least 30.2 +/- 0.9 Ma to lower Miocene (Hladky, 1994). As reported ages within the Colestin Formation overlap those of the basal part of the Roxy Formation, the two formations are partially coeval.

Silicic volcanic rocks of the Wasson Formation erupted from various centers during the early Miocene, partially coinciding wtih eruption of late Roxy rocks. While the centers were restricted, pyroclastic deposits were widespread. Shortly thereafter, lower Miocene basaltic andesite flows with lesser basalt and andesite of the Heppsie Formation covered the rocks of the Wasson Formation.

Tertiary intrusive rocks form small sills or dikes within all Cretaceous and younger units. Particularly weak units, such as the Blue Gulch Sandstone member of the Hornbrook Formation as well as those of the Colestin Formation and volcaniclastic members within the Roxy Formation, host many of the intrusive rocks. Compositions range from gabbro and basalt to dacite. Most intrusive rocks are fine grained to aphanitic and contain few phenocrysts. Distinctive light colored intrusions near and southwest of Emigrant Reservoir are hydrothermally altered and appear to be related to fault zones. Ages are variable but none are older than the latest Eocene (36.9 +/- 0.8 Ma) intrusive into the Payne Cliffs Formation north of the Medford 30' x 60' quadrangle (Wiley and Hladky, 1991). Other ages include 30.82 Ma for the intrusion at Roxy Ann Peak northeast of Medford, and 24.6 +/- 1 Ma (Fiebelkorn and others, 1983) for an andesite intrusion into the upper Roxy Formation near Soda Mountain eight kilometers northeast of Pilot Rock.

Bedding attitudes of Cretaceous and younger units strike northwest and dip easterly. Steeper dips are notable in older units becoming less steep in younger units. Dips in some of the late Oligocene to early Miocene rocks may represent attitudes little disturbed from their original orientations near Grizzly Peak (Hladky, 1996) but near the Siskiyou Summit fault, attitudes within the late Oligocene rocks are notably steeper and invariably inclined moderately to the east.

The easterly dips are, in part, attributed to the formation of a structural dome in the Condrey Mountain area (Mortimer and Coleman, 1985), a portion of which is exposed in the southwest part of the Medford 30' x 60' quadrangle. This feature, which exposes the Condrey Mountain terrane in a fenster bounded by the late Jurassic Orleans fault, is thought to have been uplifted as much as 7 km between 14 and 5 Ma, middle Miocene and earliest Pliocene time (Mortimer and Coleman, 1985). One of the major faults associated with the dome is the Siskiyou Summit fault yet this fault is overlain by a 27 Ma (?), late Oligocene, tuff of the upper Colestin Formation. Moreover, Mortimer and Coleman did not recognize the significance of unconformities between and within formations (at the base of the Hornbrook Formation, within the Payne Cliffs Formation, above that formation, and possibly at the base of the Rocky Gulch Sandstone member of the Hornbrook Formation) as well as within the Colestin Formation (Bestland, 1987). While Neogene formation of the major domal feature is probable, periodic tectonism affected local depositional patterns within rock units as young and younger than the late Cretaceous Hornbrook Formation.

Post-Cretaceous high angle faulting displaces older units more so than younger units (D'Allura, 1996). Most of the faulting presumably formed after deposition of the Hornbrook Formation (which shows remarkable stratigraphic continuity) but prior to the deposition of the Payne Cliffs Formation in the Ashland area and of the Colestin Formation south of the SSF. That some of the same faults cut younger units, commonly the Payne Cliffs and Colestin Formations but less so in the Roxy Formation, is attributed to reactivation of older faults. Most of the faults trend northeast but a few trend to the northwest. Some Tertiary intrusive rocks are localized along fault planes while others are cut by later faults. Clearly, faulting is not restricted to a single time period.

Contrary to clockwise rotations within the Tertiary rocks of the Oregon coast ranges and elsewhere, Cretaceous and younger rocks of the Medford 30' x 60' quadrangle have undergone no serious rotation or latitudinal translation, although east-west extension in the Basin and Range province has undoubtedly occurred (Nilsen, 1993).

ACKNOWLEDGEMENTS

I am grateful for suggestions, advice, and helpful hints from Monty Elliott, field discussions and mapping with Harry Smedes, students of Southern Oregon State College who spent time with me in the field, and all for field work of those students who suffered mightily through Southern Oregon State's field camp in the Observation Peak-Wrangle Gap area of the Klamath Mountains. Sincere thanks to Frank Hladky and Tom Wiley for their effort in securing means by which the map could be compilated and for their guidance. The map was funded, in part, by the National Geologic Mapping Program (STATEMAP) administered by the U. S. Geological Survey through the Oregon Department of Geology and Mineral Industries. Thematic Mapper imagery, used for general lithologic analysis, was provided by Warren Cohen, Forestry Sciences Lab, Oregon State University. Finally, thanks to all the kind landowners who permitted tresspass for the sake of science or just neighborliness. Special thanks to Joe Dauenhauer.

RADIOMETRIC AGES

no.	Formation	material dated	location	age, Ma
1.	Roxy	basalt, whole rock; K/Ar	42°12'54"N 122°37'12"W	30.2+/-0.9[1]
2.	Roxy	basalt, whole rock; K/Ar	42°13'18"N 122°36'30"W	27.8+/-0.9[1]
3.	Roxy	andesite, plagioclase; K/Ar	42°10'42"N 122°33' W	27.4+/-1.0[1]
4.	Roxy	andesite, plagioclase; K/Ar	42°07'30" 122°30'18"W	25.2+/-0.8[1]
5.	Colestin	andesite, whole rock; K/Ar	42°02'24"N 122°36'12"W	29.9+/-0.3[1]
6.	Colestin	ash flow tuff; K/Ar	42°02'48"N 122°35'12"W	29.9+/-1.5[1]
7.	Colestin	basalt, whole rock; K/Ar	42°02'48"N 122°36'06"W	26.0+/-0.8[1]
8.	Colestin	ash flow tuff; Ar/Ar	42°01'17"N 122°37'17"W	27.3+/-0.6[2]
9.	Ashland pluton, tonalitic suite;	hornblende biotite ; K/Ar	42° N 122°45' W	147[3] 146[3]
10.	Ashland pluton, quartz monzodiorite suite;	hornblende biotite; K/Ar	42°10' N 122°44' W	167+/-3.5[1] 148+/-4.4[1]
*11.	Ashland pluton	hornblende; Ar/Ar zircon; U/Pb	loc. unk. loc. unk.	152+/-1.2[4] 151-153[4]
12.	Squaw Mtn. pluton	hornblende; Ar/Ar	42°03'50"N 122°59'03"W	164+/-1[5]
13.	Condrey	muscovite	42°0' N	141[3]

Mountain	K/Ar cooling	122°55'	W

RADIOMETRIC AGES (cont.)

no.	Formation	material dated	location	age, Ma
14.	Meta-diorite (gt-bearing)	hornblende Ar/Ar	42°03'05"N 122°49'52"W	149+/-2[6]
		zircon; U/Pb		158[6]
		zircon; Pb/Pb		169+/-17[6]
15.	meta-tonalite (folded)	zircon; U/Pb	42°01'16"N	153-150[6]
		zircon; Pb/Pb	122°53'09"W	165-167[6]

[1] Fielbelkorn and others, 1983.
[2] Duncan, unpublished, 1992.
[3] Lanphere and others, 1968.
[4] Hacker and others, 1995.
[5] Donato, 1993.
[6] Donato and others, 1996.

MAP SYMBOLS

 contact, dashed where located approximately.

 fault, dashed where located approximately, dotted where covered; ball and bar on downthrown side.

 reverse or thrust fault, barbs on upper plate.

 strike and dip of beds.

 strike and dip of foliation.

 lineation, showing azimuth and amount of plunge.

 site of radiometric age date.

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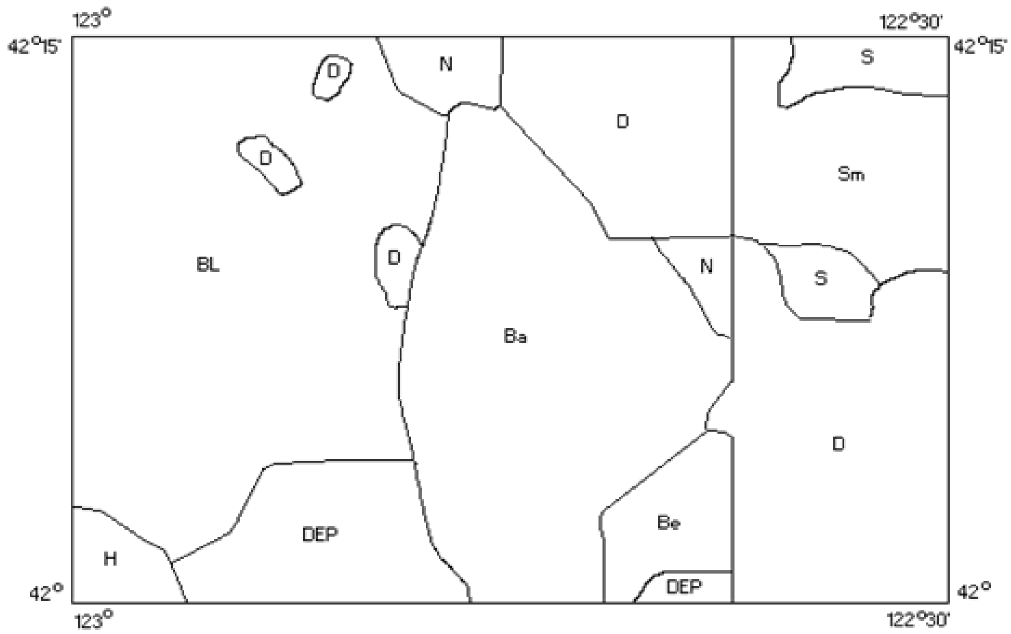
INDEX MAP OF SOURCES OF GEOLOGIC INFORMATION



KEY TO REFERENCES FOR INDEX MAP
(see List of References)

Ba = Barnes, C. and others, 1986.

Be = Bestland, E., 1987.

Bl = Blair, W., and others, 1981.

D = D'Allura, J., unpublished, 1990-1996.

DEP = D'Allura J., M. Elliott, and W. Purdom, Southern Oregon State College Field Camp work, 1980-1988.

H = Helper, M., 1986.

N = Nilsen, T., 1993.

S = Smedes, H., unpublished, 1996.

Sm = Smith, J. and others, 1982.

Short Explanation List

Surficial Deposits

Q Alluvium, colluvium, alluvial fans (Holocene and Pleistocene)

Ql Landslide deposits (Holocene and Pleistocene)

Tertiary Rocks

Th Heppsie Formation (Lower Miocene) basalt, andesite flows and pyroclastic rocks

Tw Wasson Formation (Lower Miocene) silicic volcanic rocks

Tr Roxy Formation (Oligocene and Lower Miocene) basalt, andesite, and dacite flows and pyroclastic rocks

Toc Colestin Formation (Upper Oligocene) intermediate to silicic volcaniclastic rocks with basaltic andesite flows

Tep Payne Cliffs Formation (Upper Eocene) non-marine sandstone and conglomerate; upper part is volcaniclastic

Unconformity

Mesozoic Rocks

Kh Hornbrook Formation (Upper Cretaceous) marine mudstone, sandstone, and minor conglomerate

Angular Unconformity

Jh Western Hayfork Terrane (Middle Jurassic) meta-sandstone, argillite, and meta-volcanic rocks, predominantly deposited in a marine environment

Fault Contact

Jc Condrey Mountain Terrane (Middle Jurassic) foliated greenschist and graphite-albite-quartz schist

Fault Contact

JTrm Marble Mountain terrane (Upper Paleozoic to Lower Jurassic) melange with amphibole schist, quartz-mica schist, and meta-ultramafic rocks metamorphosed to the amphibolite facies

Intrusive Rocks

Ti Basalt, andesite, and dacite dikes and sills (Upper Eocene to Miocene); **Tim** = basalt, andesite; **Tid** = dacite

Ji Granitic rocks (Upper Jurassic)